

FLORA OF BHUTAN

INCLUDING A RECORD OF PLANTS FROM
SIKKIM AND DARJEELING

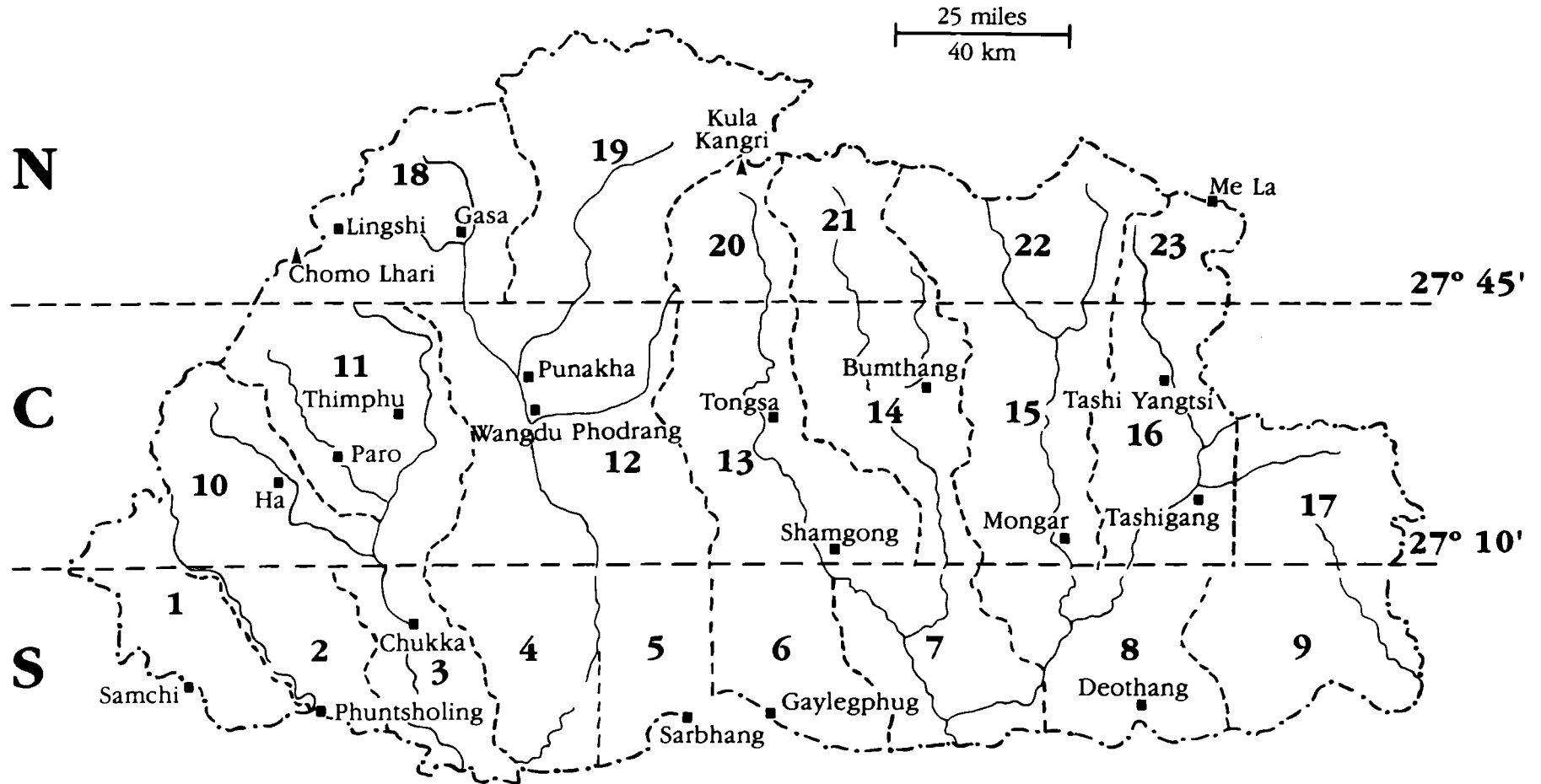
VOLUME 3 PART 2

THE GRASSES OF BHUTAN

H.J. NOLTIE

། འབྲུག་གི་རྩྭ་ཤིང་སྐྱོན་གྱི་རྒྱུ།

ROYAL BOTANIC GARDEN EDINBURGH
ROYAL GOVERNMENT OF BHUTAN
2000



Map of Bhutan showing botanical districts:

South (S): 1, Samchi; 2, Phuntsholing; 3, Chukka; 4, Sankosh; 5, Sarbhang; 6, Gaylegphug; 7, Manas; 8, Deothang; 9, Dhansiri.

Central (C): 10, Ha; 11, Thimphu; 12, Punakha; 13, Tongsa; 14, Bumthang; 15, Mongar; 16, Tashigang; 17, Sakden.

North (N): 18, Upper Mo Chu; 19, Upper Pho Chu; 20, Upper Mangde Chu; 21, Upper Bumthang Chu; 22, Upper Kuru Chu; 23, Upper Kulong Chu.

Drawn by Abi Lezmore/S.J. Rae.

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*Dedicated to my grandmother, Doris Woolliscroft (née Padman), 1894–1996,
in whose garden I saw my first Setaria, as a bird-seed alien.*

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INTRODUCTION

This part of the *Flora* is devoted to the single family Gramineae (also known as Poaceae). The grasses form the second largest family in the *Flora* being smaller than Orchidaceae (132 genera, 577 species) and slightly larger than Compositae (127 genera, 372 species). 126 genera and 389 native and introduced species are treated here, of which 112 genera and 324 species have so far been recorded in Bhutan itself. In addition to the interest arising from its size and diversity, Gramineae is also the most important family occurring in Bhutan in terms of its usefulness to man. The delimitation and arrangement of tribes and genera used here largely follow those of Clayton & Renvoize (1986).

It must be admitted at the outset that members of the family have a not totally undeserved reputation for being difficult to identify. There are several reasons for this, including the sheer size of the family and the resulting complexity of keys and books devoted to their identification. An additional problem arises from the small size of the floral parts on which their classification is largely based. Accurate identification can really only be achieved in the laboratory or herbarium using a high-powered binocular microscope, since it is necessary to be able to measure floral parts to fractions of a millimetre. With practice many taxa can be identified to species level in the field, but some only to genus. To aid identification this part of the *Flora* is more fully illustrated than previous ones, and illustrations of the spikelets of nearly every species are included.

Since detailed accounts of the highly characteristic vegetative and floral structures of the Gramineae are easily available elsewhere, they will not be repeated here. Such information can be found in the introductory chapters of Bor (1973) and Hubbard (1984) or in the excellent introduction to the family based on the work of Agnes Chase (Clark & Pohl, 1996). Many of the specialist terms are explained in a glossary (see p. 847).

One of the great fascinations that becomes apparent when studying the family is the huge range of variation developed upon the basic spikelet structure. When examining a specimen, the first thing to do is to identify and remove a single spikelet, the basic unit of the inflorescence. The spikelet should be placed in a drop of water on a microscope slide or tile, and gently teased apart using a pair of needles or two sets of fine forceps. If water is not used the spikelet merely jumps around and if one forces it to sit still in the dry state, its brittle parts will be destroyed by pressure from the instruments. Having done this, one must determine the number of florets and identify the

individual parts. This is usually only difficult in the relatively few cases where some of the parts are not developed.

The bamboos, or woody grasses, form a very distinct group, but as they are the subject of a book in their own right (Stapleton, 1994a), their uses and ecology are not treated in detail in this Introduction.

GRASS COMMUNITIES AND HABITATS

Given the value of grasses as fodder plants, the communities and habitats in which they occur are of some importance and interest. Very little information has been published on grass communities in Bhutan, and it is hoped that this book will act as a stimulus for such work. Nevertheless, it is worthwhile to summarise what is known so far.

Grass-dominated communities in Bhutan, as elsewhere in the Indian sub-continent, are largely the result of man's activities. To quote Tsuchida (1987) 'grasslands are mostly established by human influences such as felling, grazing, mowing and burning'.

The first attempt at a classification of Bhutanese grassland types was apparently by R.P. Singh in an unpublished report of 1978 (quoted by Roder *et al.*, 1998). Singh described five types as follows: *Saccharum* reed dominant cover, 800–2000m; *Chrysopogon–Themeda* cover, 2500–2800m; thin and short bamboo dominant cover, 2500–3000m; high-altitude scrub cover, above 2800m; alpine and subalpine cover, 3500–5000m. Needless to say these are extremely rough and ready groupings.

Tsuchida (1987) published the first paper devoted exclusively to the grass communities of Bhutan, but his classification is of rather limited use and can best be described as a brave attempt. It was based on a small-scale survey undertaken late in the season, and species identification was evidently a problem. Some identifications are obviously wrong, and many extremely important species (such as *Cymbopogon* spp., *Apluda mutica*, *Themeda* spp. and *Schizachyrium delavayi*) were overlooked. Tsuchida recorded 84 quadrats over a wide range of altitudes, but identified a total of only 54 grass species. He came up with a classification based on four altitude zones and within each of these three communities were identified, with different dominants, based on habitat moisture. Tsuchida correctly noted that species composition was greatly affected by grazing pressure.

Table 1. Grass communities of Bhutan after Tsuchida (1987)

	Dry	Mesic	Humid
Zone A: 150–2500m	<i>Chrysopogon aciculatus</i>	<i>Cynodon dactylon</i>	<i>Paspalum scrobiculatum</i>
Zone B: 2500–3500m	<i>Agrostis nervosa</i>	<i>Arundinella hookeri</i>	<i>Carex nubigena</i>
Zone C: 3500–4000m	<i>Festuca</i> spp.	<i>Agrostis pilosula</i> , <i>A. inaequiglumis</i>	<i>Carex nubigena</i>
Zone D: 4000–5000m	<i>Festuca</i> spp.	<i>Poa</i> spp., <i>Deyeuxia pulchella</i> , <i>Kobresia</i> spp.	<i>Juncus</i> spp.

In the same year as Tsuchida, Miller (1987c) published a paper on the grassland resources of Bhutan, which included accurate species lists for a wide range of localities. In a later unpublished report Miller (1988) came up with a simple, but useful, preliminary classification of grasslands. Miller's work was based on extensive field experience, and although the four types he recognised were identified in eastern Bhutan, the last three have been found to occur throughout the country:

Table 2. Grass communities of Bhutan after Miller (1988)

Grassland type	Altitude
[I] <i>Cymbopogon</i> grassland	700–2100m
[II] <i>Schizachyrium</i> grassland	2000–3100m
[III] <i>Danthonia</i> grassland	3000–4000m
[IV] <i>Kobresia/Carex</i> alpine meadow	3900–4800m

Tsuchida visited Bhutan again in 1989 and published a second paper on its grasslands (Tsuchida, 1991). This really amounts to a series of species lists for a large number of quadrats, but taken from a wider range of habitats and arranged under a greater number of altitudinal zones than in his previous paper. It suffers from the same faults as its predecessor, with some doubtful identifications and easily identified species recognised at the expense of more critical ones.

At the moment it is not possible to provide a detailed ecological account of Bhutanese grass communities. As Roder *et al.* (1998) wrote 'the plant communities of major grassland ecosystems remain poorly documented and virtually no description of individual species is available'. This work must be undertaken as a matter of urgency, but in the meanwhile it is possible to

provide lists of the commonest species found in various altitudinal zones and habitats. In the following lists no attempt has been made to quantify or assess 'dominance', though the most frequently encountered species are given first; they are not to be taken as precisely defined communities and not all of the species listed will be present at a particular locality. The lists are based largely on fieldwork undertaken in August 1998, and I have tried to relate the categories to the communities/zones of Miller and Tsuchida.

VEGETATION TYPES RICH IN GRASSES

TERAI

Although only extremely small fragments of Terai occur along the Indian border in Bhutan, in areas such as the Royal Manas National Park, virtually no information is available on the occurrence of Terai grassland, such as is found in adjacent parts of Assam. What appears to be this type of grassland is mentioned in the vegetation surveys of the Royal Manas National Park (Rawat, 1994) and the Phipsoo Wildlife Sanctuary (Rawat & Wangchuk, 1996) as 'frequently burnt grasslands on plateaus and flat areas'. The species identifications in these reports are in some cases dubious, but the genera of tall grasses recorded (*Saccharum*, *Themeda*, *Imperata*, *Phragmites* and *Arundo*) are very probably correct. It is almost certain, however, that many important species have been overlooked. Species likely to occur, on the basis of old collections from the 'Sikkim Terai' and Assam, include *Coelorachis striata*, *Phacelurus zea*, *Polytoca digitata*, *P. wallichiana*, *Saccharum arundinaceum*, *S. narenga*, *Themeda arundinacea* and *T. longispatha*.

LOW-ALTITUDE RIVER BANKS/FLATS (150–750m)

Grasses are conspicuous colonisers of low-altitude alluvial fans and the flood zones of the larger rivers (e.g. the Torsa at Phuntsholing and the Sankosh below Wangdi). This habitat is also mentioned in the vegetation surveys of the Royal Manas National Park (Rawat, 1994) and the Phipsoo Wildlife Sanctuary (Rawat & Wangchuk, 1996). Plate 2.

Saccharum spontaneum
Cymbopogon jwarancusa
Perotis indica
Digitaria longiflora

Eragrostis tenella
E. atrovirens
Panicum curviflorum

DISTURBED COMMUNITIES RICH IN GRASSES (e.g. ROADSIDES)

These highly artificial communities seem to be the main type of vegetation recorded by Tsuchida, but can hardly be described as 'grasslands'. They are undoubtedly very important for grazing and as a source of fodder that is cut by hand and fed to tethered/stabled animals.

Subtropical/Warm Temperate Zone (150–1800m):

Dry habitats

Digitaria ciliaris

Sporobolus diander

S. fertilis

Setaria pumila

Axonopus compressus

Cynodon dactylon

Chrysopogon aciculatus

Digitaria setigera

Eleusine indica

Eragrostis uniolooides

E. atrovirens

Imperata cylindrica

Paspalum scrobiculatum

Pennisetum clandestinum

Wet habitats (e.g. damp verges; ditches)

Paspalum distichum

P. conjugatum

Echinochloa colona

E. crus-galli

Sacciolepis indica

Arundinella bengalensis

Cliffs/roadside banks

Arundinella nepalensis

Neyraudia arundinacea var.
zollingeri

Pogonatherum paniceum

Capillipedium assimile

Saccharum spontaneum

Thysanolaena latifolia

Setaria palmifolia

Cool Temperate Zone (above 2000m):

Dry habitats

Digitaria ciliaris

D. cruciata

Eleusine indica

Axonopus compressus

Cynodon dactylon

Eragrostis nigra

Pennisetum clandestinum

Poa annua

Setaria pumila

Sporobolus fertilis

Wet habitats

Paspalum distichum

Polypogon fugax

Echinochloa crus-galli

Arthraxon quartinianus

Cliffs/roadside banks

Calamagrostis emodensis

Eulalia quadrinervis

Miscanthus nepalensis

Saccharum rufipilum

Cymbopogon khasianus (west only)

CHIR PINE FOREST (900–1800m)

One of most important grass habitats of Bhutan, dominated by members of the tribe Andropogoneae. This community is found in the deep, dry valleys especially in the east of the country, but also in the Sankosh valley in central Bhutan. It is 'much influenced by human activities ... including frequent fires that are deliberately set to produce fresh grazing for livestock and to produce new lemon grass growth' (B.A.P., 1998). This grassland type was recognised by Miller, but not treated separately by Tsuchida (1987), who included it under his Zone A. Plate 3.

<i>Chrysopogon gryllus</i>	<i>Apluda mutica</i>
<i>Cymbopogon bhutanicus</i>	<i>Arundinella nepalensis</i>
<i>C. munroi</i>	<i>A. setosa</i>
<i>Heteropogon contortus</i>	<i>Chrysopogon serrulatus</i>
<i>Rottboellia cochinchinensis</i>	<i>Saccharum spontaneum</i>
<i>Capillipedium parviflorum</i>	<i>Digitaria abludens</i>

COOL TEMPERATE GRASSLAND (c.2300–3000m)

Such grassland is one of the most important types for the grazing of livestock, and occurs from west to east in the blue-pine zone. I have seen it in the Thimphu and Bumthang valleys and at Chendebi, and it is reported from Sakden in the extreme east of the country by Miller. Recognised by Miller, this type corresponds to Tsuchida's Zone B, though the latter failed to recognise *Schizachyrium delavayi*, one of the most important constituents. Plates 2 & 3.

<i>Schizachyrium delavayi</i>	<i>Bromus staintonii</i>
<i>Themeda triandra</i> var. <i>laxa</i>	<i>Cymbopogon khasianus</i> (west only)
<i>Helictotrichon virescens</i>	<i>Elymus sikkimensis</i>
<i>Agrostis micrantha</i>	<i>Eragrostis ferruginea</i>
<i>A. petelotii</i>	<i>E. nigra</i>
<i>Arundinella hookeri</i>	<i>Festuca rubra</i> subsp. <i>clarkei</i>
<i>Bothriochloa bladhii</i>	<i>Pennisetum flaccidum</i>
<i>Brachypodium sylvaticum</i>	<i>Saccharum sikkimense</i>

SUBALPINE PASTURE (3600–4000m)

Subalpine pasture is very important as summer grazing for cattle, yak and sheep. It no doubt occurs throughout the country, and has been extensively studied by rangeland specialists especially in the north-west and far east of

the country (see below). It corresponds to Miller's third type, and to Tsuchida's Zone C. Plate 3.

<i>Danthonia cumminsii</i>	<i>Agrostis nervosa</i>
<i>Elymus nutans</i>	<i>Bromus himalaicus</i>
<i>Calamagrostis lahulensis</i>	<i>Festuca polycolea</i>
<i>C. scabrescens</i>	<i>F. wallichiana</i>
<i>Agrostis pilosula</i>	<i>F. cumminsii</i>
<i>A. inaequiglumis</i>	<i>Helictotrichon parviflorum</i>
<i>Stipa bhutanica</i>	<i>Phleum alpinum</i>
<i>Trisetum spicatum</i>	

ALPINE PASTURE (over 4000m)

As with the previous category, a very important habitat for the summer grazing of yak and sheep. In terms of volume/cover, however, grasses are of less importance than members of the Cyperaceae (*Carex* and *Kobresia* spp.). For example Dunbar (1979) recorded a transect at Lingshi, at 4050m: the total plant cover was only 41%, and of this grasses represented under 25%. This is Tsuchida's Zone D and Miller's fourth type.

<i>Festuca cumminsii</i>	<i>Poa</i> cf. <i>attenuata</i>
<i>F. polycolea</i>	<i>P. pagophila</i>
<i>F. tibetica</i>	<i>P. ludens</i>
<i>Deschampsia cespitosa</i>	<i>Stipa mongholica</i>
<i>Agrostis inaequiglumis</i>	<i>S. milleri</i>
<i>A. pilosula</i>	<i>S. koelzii</i>

USEFUL GRASSES

FODDER

Animal husbandry is one of most important sectors of Bhutanese agriculture, and grasses are therefore of major economic importance as fodder plants. The domesticated animals of Bhutan are as follows: at high altitude yak (*Bos grunniens*) and their hybrids with cattle, sheep and a few cattle (*Bos taurus*); at middle altitudes cattle (mostly *Bos indicus* including siri cattle), horses and sheep; in low, subtropical regions a few buffalo and goats are kept. Herders at middle and low altitudes use mithun bulls (*Bos frontalis*) for cross-breeding with cattle. These animals are of vital importance as the source of milk products, meat and wool, for draft-power and transport, and as a source of manure. Transhumance is practised, with yak and sheep being grazed at very

high altitudes in summer and moved to lower elevations in winter (November to May). Similarly, cattle are taken from middle altitudes in summer to lower ones in winter.

Much work has been done on native rangeland resources and ways to improve their productivity, chiefly by management and the introduction of exotic species. This work was largely initiated by the Department of Animal Husbandry and projects associated with it, but since 1995 all research has been undertaken in the interdisciplinary Renewable Natural Resource Research Centres (RNR-RCs) – this change has been of great benefit as potential conflicts of interest between forestry, conservation and grazing can now be better addressed. Little of the work has been formally published and much is hidden in the reports of various foreign consultants. It is difficult to find copies of these reports, though apparently a full set is kept at RNR-RC Jakar and a useful summary of this work has recently been made by Roder *et al.* (1998). It must be emphasised that, until now, work has been hampered by difficulties of identification which it is hoped this volume will do something to remedy. In the past the only means of identification within the country has been the keys in Bor's book *The Grasses of Burma, Ceylon, India and Pakistan*. Great though that book is, the keys are difficult to use, partly because it covers such a large number of species from a wide geographical area. In addition, there have been many changes, both in nomenclature and species delimitation, since its initial publication in 1960.

Much of the initial work on native grasslands was undertaken in the alpine zone and in the east of the country under the auspices of projects such as the Highland Livestock Development Project (1987–93) and other similar ones funded by FAO/UNDP and the Asian Development Bank. This work was undertaken primarily by foreign consultants. One of the earliest of these was G.A. Dunbar who worked in NW Bhutan in 1979 and was apparently the first to send grasses to Kew for identification. Dunbar recognised some 25 grass species as being important for fodder in the alpine zone (Dunbar, 1979). This work increased in volume from the mid-1980s. During this period an important contribution was that of D.J. Miller who first visited the country in 1985 and made very substantial grass collections, also identified at Kew. The results were a series of largely unpublished reports (Miller, 1987a, 1987b, 1987c, 1988 and undated). This research continues, but much of it is now undertaken by Bhutanese nationals. Of particular importance in this latter category is the doctoral dissertation on high-altitude rangelands by Pema Gyamtsho (Gyamtsho, 1996).

Development work on temperate pasture has largely been based at research centres in Bumthang (from 1974) and Serbitang (from 1976). Much less has been undertaken in the subtropical zone, though there was an important early

base at Samchi in the 1960s. Much of this work has centred around the introduction of exotic fodder grasses and legumes, and it remains true that little research has been carried out on the productivity, or potential for improvement, of native species. Several of the early consultants pointed out the need for such research, as it is the native species that are already adapted to local conditions. Miller, for example, suggested investigating the high-altitude species *Elymus nutans* and the temperate *Pennisetum flaccidum*. So far, *Schizachyrium delavayi* appears to be the only native species to have been assessed in terms of its productivity (Roder *et al.*, 1998).

Pasture, *tsamdro* (*tsamdrog*) (Dz), is an extremely important natural resource in Bhutan, but is often of rather poor quality and is reported to be under great pressure from over-stocking in some areas. The latest estimate is that 3.9% of the total area of country (over 400,000ha) is under *tsamdro*. This is not evenly distributed over the country, and the *dzongkhags* with the greatest areas of pasture are Thimphu (17.3%), Bumthang (8.2%), Ha (7%), Paro (6.4%) and Gasa (5.3%) (L.U.P.S., 1997). This land is owned by the Government, with herders having the grazing rights only. This practice has led to problems, as there has been little incentive for grazers to manage the natural resource by controlling animal numbers, or to improve it. Grazing areas are mainly within the forests, pastures cleared from forests, or in the zone above the treeline. Grazing of animals in forests has, hardly surprisingly, led to a conflict of interest between agriculture and forestry. In some environments, especially in broad-leaf forest systems, over-grazing can hamper tree regeneration and increase the occurrence of unpalatable/poisonous species such as *Cirsium*, *Ligularia*, *Senecio* and *Aconitum*. This was observed in several areas in 1998, e.g. above Gedu and on the east side of the Kori La near Mongar.

One of greatest problems in Bhutan is shortage of winter fodder due to the long dry period starting in October. The problem is worsened where there is an overlap of summer and winter grazing, the same land often being grazed by cattle and horses in summer and yak in winter. Increasing winter fodder has thus been a priority. In Bhutan the use of hay as a winter feed was traditionally rather restricted: in the alpine zone meadows of *Elymus nutans*, *Danthonia* and *Helictotrichon* were maintained for hay-making at Laya (M.P.W., 1986); around Bumthang hay was made from small fenced areas (*tsa dham*) dominated by *Schizachyrium delavayi* (Roder *et al.*, 1998). Hay-making has now spread throughout the country as a result of development work.

Alpine and subalpine pasture

As stated above, these areas are very important for summer grazing. It should be noted that pasture in the upper forest and scrub zone has, at least

formerly, been artificially maintained by fire, with the burning of fir and shrubs (M.P.W., 1986). According to many of the reports on rangelands/grazing, (e.g. Gibson, 1991), much of the alpine and subalpine pasture is over-grazed and for Merak-Sakden Miller (1988) stated that 'climax' grassland (with *Danthonia*, *Phleum alpinum* and *Trisetum spicatum*) only occurred in inaccessible areas. Grazing pressure was studied in some detail by Peter Harris, one of the main observations being that over-grazing leads to an increase of less palatable species such as *Agrostis* spp.

Although experiments with introducing exotic species have been made in the alpine zone (e.g. at Kitiphu and Soi Yaksa) it has frequently been pointed out that improvement of these pastures will best be effected by 'better grazing management rather than replanting pasture with improved species' (M.P.W., 1986).

These pastures are also extremely important habitats for native ungulates such as takin (*Budorcas taxicolor*), blue sheep (*Pseudois nayaur*), sambar (*Cervus unicolor*) and musk deer (*Moschus chrysogaster*) as pointed out by Roder *et al.* (1998).

Temperate areas

The native grasslands of middle altitudes can be fairly productive, if well managed. Miller (1988), for example, recorded a productivity of 1500kg dry matter/hectare for grassland in good condition in Merak-Sakden. Over-grazing of this type of pasture leads to a loss of productivity, and an increasing proportion of less palatable, tougher species such as *Arundinella hookeri* and *Agrostis* spp., and weeds such as *Potentilla* and *Anaphalis* (Tsuchida, 1987; Miller 1988).

Much work on the improvement of productivity of these grasslands has been undertaken, mainly through the use of imported species. Of these the most important in the temperate zone have been *Dactylis glomerata*, *Festuca arundinacea* and *Lolium multiflorum*, which are all now widespread. At lower altitudes *Pennisetum clandestinum* has become important. In addition to the cultivation of exotic grasses, the introduction of white clover (*Trifolium repens*) has also had a major impact. Clover is now widespread throughout the temperate and subalpine region, and has substantially improved the nutritive value of the grasslands occurring there (W. Roder, pers. comm.).

GRAIN

In Bhutan, as elsewhere, cereals represent another major category of useful grass. These are, in order of area under cultivation: maize (*Zea mays*), rice

(*Oryza sativa*), wheat (*Triticum aestivum*), barley (*Hordeum vulgare*) and the millets – finger millet (*Eleusine corocana*), common millet (*Panicum miliaceum*), fox-tail millet (*Setaria italica*) and giant millet (*Sorghum bicolor*); in addition rye (*Secale cereale*) has been introduced recently. Most of these cereals have been cultivated for centuries and are represented by local land-races. Currently great emphasis is being placed on the conservation of such local races in Bhutan (B.A.P., 1998).

The area of irrigated rice, *chhuzhing* (Dz), is presently 1% of the total land area. 2.4% of the land area is currently under dry land cultivation, *kamzhing* (Dz), and of this a very large proportion is used for growing maize (L.U.P.S., 1997).

Cereals are used as a staple food, either in the form of grain, as flour, or roasted to make *tsampa*. Another major use, however, is for alcohol production. Most of the grains are used for brewing *chang* and some are used for distilling *ara*.

OTHER USES

Bamboos

The bamboos are used by man for almost countless purposes, and details of some of these can be found in Stapleton (1994a). Some of the major uses are as follows. The massive culms of *Dendrocalamus* and *Bambusa* are used for construction purposes and sections of culm, with hollow internodes, are made into containers for various liquids. The culms of many of the more slender genera are split and woven into a range of artefacts including mats used for the sides and roofs of houses, various sorts of basket, hats and the characteristic Bhutanese 'lunch boxes' (*bangchung*). Traditional Bhutanese archery bows are also made of bamboo. The young shoots of *Dendrocalmus hamiltonii* are eaten by man, and the leaves of many species are of importance as animal fodder. Bamboos with extensively creeping rhizome systems also have an important role in soil conservation.

Essential oils

Cymbopogon oil production is extremely important in the Kuru Chu and Manas valleys and has been identified as a non-timber forest product whose production could be expanded (B.A.P., 1998). Further information can be found in the generic account (p. 802), but it is interesting to point out that the species being exploited had previously been misidentified and it was only recognised to be an endemic species (*Cymbopogon bhutanicus*) during the research for this volume.

Brooms

The inflorescences of *Thysanolaena latifolia* are used extensively in Bhutan, as elsewhere in the Himalaya, as soft, flexible brooms. The leaves/stems of *Cymbopogon* sp. and *Yushania microphylla* are also used for this purpose and I have seen brooms made of the inflorescences of *Eragrostis nigra* at Taba.

Ornament

The utricles of *Coix* are occasionally used as ornamental beads.

Medicine

Rather few grasses are used medicinally. I have no information on the subject from Bhutan, though *Thysanolaena latifolia* is reported to be used in Sikkim (Rai & Sharma, 1994). According to Hole (1911) *Saccharum arundinaceum*, which occurs in Bhutan, has medicinal uses. In Nepal, the following species are listed as being used medicinally: *Coix lachryma-jobi*, *Cynodon dactylon*, *Phragmites karka* and *Vetiveria zizanioides* (Anon., 1970). The following grasses that seem to be unambiguously identified are included in a Materia Medica of Indo-Tibetan medicine: *Cynodon dactylon*, *Hordeum vulgare*, *Saccharum officinarum*, *S. spontaneum*, *Thysanolaena latifolia* and *Vetiveria zizanioides* (Dash, 1987). It is likely that most of these are species used in traditional Bhutanese medicine.

PROBLEM GRASSES

Grasses, when growing in the 'wrong' place, can sometimes become weeds and cause a reduction of yield in crops. Parker (1992) made an extensive study of Bhutanese weeds, but concluded that the weed problem in Bhutan was not severe. He also pointed out that weeds can often be an important source of forage; this applies especially in the case of grasses, for example in fallow land after harvest. Parker recorded 20 species of herbaceous grass as weeds, the main ones are given below.

Table 3. Major grass weeds of Bhutan, after Parker (1992). Note: Parker did not recognise *Digitaria cruciata* which is included under his *D. ciliaris*

Crop	Grass weeds
Maize	<i>Digitaria ciliaris</i>
Rice	<i>Echinochloa crus-galli</i>
Potato	<i>Digitaria ciliaris</i>
Vegetables	<i>Digitaria ciliaris</i> , <i>Cynodon dactylon</i>
Orchards (temperate)	<i>Digitaria ciliaris</i> , <i>Cynodon dactylon</i> , <i>Pennisetum flaccidum</i>
Orchards (subtropical)	<i>Paspalum conjugatum</i> , <i>Axonopus compressus</i>

A small number of grass species are known to be harmful to livestock. Of species occurring in Bhutan *Stipa brandisii* is known to be poisonous, due to the production of cyanogenic glucosides (Freitag, 1985). A Gamble specimen of *Neyraudia arundinacea* var. *zollingeri* from Darjeeling bears a note that the species is poisonous to buffalo.

GRASSES AND RELIGION

In Bhutan cultural life, the natural environment and religion are inextricably linked. It is not surprising, therefore, that certain grasses have ritual uses. The following are taken from the account of Bhutanese rituals by Mynak Tulku (1997). One of the important rituals of Buddhist ceremonies in Bhutan is the making of dough offerings called *tormas*. These are commonly made of barley flour, maize flour or cooked rice and some require the mixing of the symbolic grouping of the 'Five Grains' (rice, wheat, barley, white peas/buckwheat, sesame/unhusked rice or thick-shelled barley). In the Feast Offering (*tshog*), a special red *torma* is made of edible objects which can include barley and brown sugar. Roder & Gurung (1990) suggest that the small scale cultivation of sugar cane throughout Bhutan is to make sugar for such ceremonies. In the Fire Ceremony (*jinsek*), various grasses may be given as offerings, including *kusa* (*kusha*) grass (see below) for protection from impurities, barley to gain rapid accomplishment and wheat to overcome illness.

One of the eight auspicious substances, *durva*, is the grass *Cynodon dactylon* (Beer, 1998). This and another grass, *kusha* (variously interpreted, but often taken to be *Saccharum spontaneum*), figure in the Vedic legend of the churning of the ocean. Drops of the nectar of immortality (*amrita*) are believed to have fallen on these grasses, thereby conferring special significance upon them. They therefore figure in Buddhist iconography and, as seen above, *kusha* is used in the Fire Ceremony.

INTRODUCED GRASSES

The introduction of grasses into Bhutan is a recent phenomenon. 'Early introductions of exotic fodder species such as kikuyu [*Pennisetum clandestinum*] and Napier grass [*Pennisetum purpureum*] were probably made by enterprising farmers or government officials in the early part of this century. Selected subtropical species were introduced to Samchi in the early 1960s' (Roder *et al.*, 1998). However, with a rapid increase in agricultural development work from the mid-1970s introduction of exotic grass species has rapidly escalated. A list of introduced species recently tried for fodder is given as Appendix 1

(p. 853). No doubt most of these species will not persist, but several have already become established either deliberately or accidentally. In Darjeeling there have been many introductions from the mid-nineteenth century onwards, and several species were introduced to Sikkim from an experimental grass farm started at Gangtok in the 1940s (Gould, 1957).

Some 64 introduced species are included in the following account, representing some 20% of the total grass flora. Ten genera out of 126 are represented only by introduced species.

HISTORY OF GRASS COLLECTING

This book is based almost entirely on specimens studied in British herbaria; literature records have only been included in the case of extremely distinctive species, as there have been so many mistaken identifications in the past. Until recently grasses have been very under-collected in Bhutan, and much work is still required. Given the small number of collections it seems worthwhile to enumerate them, giving an opportunity to acknowledge those who have made special efforts with the family.

The following are the specimens seen from Bhutan (excl. bamboos):

COLLECTOR (DATE)	NO. OF SPECIMENS
W. Griffith (1838)	20
R.E. Cooper (1914, 1915)	50
Ludlow, Sherriff <i>et al.</i> (1933–49)	28
B.J. Gould (1938)	6
Botanical Survey of India (1963–5)	39 (+ 21 not seen, cited in M.F.B.)
S. Bowes Lyon (1966–94)	21
Grierson, Long, Sinclair (1975–84)	212
G.A. Dunbar (1979)	42
C. Sargent (1983)	10
D. Keith (1983)	22
I. Broad (1985)	7
D.J. Miller (1986–7)	70 (+ 145 not seen, cited in Miller, 1988)
J.R.I. Wood (1987–92)	388
C. Parker (1991–2)	72
R. Pradhan, T. Wangdi (1995–8)	170
H.J. Noltie <i>et al.</i> (1998)	346
T. Gyaltzen (1998)	36
K. Wangdi (1998)	54

Records of two other collections have been published, but the specimens have not been seen by the author: 39 specimens collected by Hara *et al.* in

1967, cited in F.E.H. 2.; 159 specimens collected by K. Tsuchida in 1985, cited in Tsuchida (1987).

A larger number of specimens has been studied from Sikkim, Darjeeling and Chumbi, but as can be seen these are almost entirely old collections. Of particular importance are the following:

COLLECTOR (DATE)	NO. OF SPECIMENS
J.D. Hooker (1848–9)	284
W.S. Kurz (1868)	27
C.B. Clarke (1869–84)	258
W.J. Treutler (1874)	40
J.S. Gamble (1874–82)	112
H.A. Cummins (1888–93)	31
G.A. Gammie (1892)	21
Ribu (\pm Rohmoo) (1911–13)	56
N.L. Bor & Kirat Ram (1943–5)	75
Bor's Collector (1945)	111

Other small collections seen: H. & R. Schlagintweit (1855), T. Anderson (1862), J.L. Lister (1877), Dungboo (1878–9), G. King (1880s), H.H. Haines (1893–1903), H.E. Hobson (1897), Hedley Wood (1898–9), F. Younghusband (1903), P. Bruhl (1903), W.W. Smith (1910), R.E. Cooper (1913–14), H.N. Ridley (1913), A. Meebold, R.H. Beddome, I.H. Burkill (1909–11), G.H. Cave (1916), J.M. Cowan (1923), J. Pradhan (1945).

The only post-World War II collections studied from Sikkim and Darjeeling are as follows:

D. Chatterjee (1956)	4
Hara <i>et al.</i> (1960)	17
M.L. Sharma (1968–75)	23
P.N. Mehra (1969)	8
Pradhan, Norbu & Naku (1972)	16
Alpine Garden Soc. Exped. to Sikkim (AGSES) (1983)	4
Edinburgh Exped. to Sikkim & Darjeeling (ESIK) (1992)	157
Edinburgh Exped. to Northern Sikkim (EENS) (1996)	52

PHYTOGEOGRAPHY

Although external distributions have not been given in previous parts of the *Flora*, an attempt has been made to do so for the grasses in Appendix 2 (see p. 856). The external distributions are, however, in many cases only approximations, due to taxonomic or distributional uncertainties. Examples are given below of some of the native species representative of the major

phytogeographic elements, using a modified version of the categories used in Noltie (1994).

1. Widespread temperate N Hemisphere (Eurasia; \pm N America)
20 spp., including: *Alopecurus aequalis*, *Brachypodium sylvaticum*, *Dactylis glomerata*, *Deschampsia cespitosa*, *Festuca gigantea*, *Poa annua*.
- 1a. Widespread (Eurasian) arctic-alpines
2 spp.: *Phleum alpinum*, *Trisetum spicatum*.
2. C Asian
9 spp.: *Elymus dahuricus*, *E. himalayanus*, *E. schrenkianus*, *E. nutans*, *Poa* cf. *attenuata*, *P. calliopsis*, *Stipa mongholica*, *S. purpurea*, *S. roborowskyi*.
3. Tibetan
7 spp.: *Calamagrostis tibetica*, *Colpodium tibeticum*, *Elymus thoroldianus*, *Poa asperifolia*, *P. poophagorum*, *P. pseudotibetica*, *Trikeriaia oreophila*.
4. Sino-Himalayan (NW Himalaya to SW China)
17 spp., including: *Calamagrostis emodensis*, *Danthonia cumminsii*, *Glyceria tonglensis*, *Himalayacalamus falconeri*, *Oryzopsis munroi*, *Stipa koelzii*.
- 4a. E Sino-Himalayan (E Nepal to SW China)
19 spp., including: *Agrostis petelotii*, *Calamagrostis nivicola*, *Elymus tanguorum*, *Eragrostis ferruginea*, *Melica onoei*, *Schizachyrium delavayi*.
5. Himalayan (NW Himalaya to Bhutan)
29 spp., including: *Eulalia mollis*, *Garnotia polypogonoides*, *Poa ludens*, *P. pagophila*, *Stipa roylei*, *Thamnocalamus spathiflorus*.
- 6a. E Himalayan endemic (E Nepal to Bhutan; \pm Khasia)
62 spp., including: *Arundinaria racemosa*, *Colpodium wallichii*, *Cymbopogon khasianus*, *Dendrocalamus sikkimensis*, *Poa dzongicola*, *Yushania microphylla*.
- 5b. Bhutanese endemics
4 spp.: *Arundinella dagana*, *Bambusa clavata*, *Cymbopogon bhutanicus*, *Stipa bhutanica*.
- 5c. Sikkim/Darjeeling endemics
10 spp.: *Agrostis ushae*, *Anthoxanthum sikkimense*, *Calamagrostis debilis*, *Catabrosa sikkimensis*, *Drepanostachyum polystachyum*, *Poa cooperi*, *P. lachenensis*, *P. longii*, *P. nitide-spiculata*, *P. rohmooiana*.
- 5d. E Himalayan Terai endemics
5 spp.: *Arundinella decempedalis*, *Chrysopogon lancearius*, *Coelorachis khasiana*, *Isachne dimyloides*, *Themeda longispatha*.
6. Tropical SE Asian (Peninsular India, Malesia, China; \pm Japan, Australia)
72 spp., including: *Phragmites karka*, *Pseudosorghum fasciculare*, *Rottboellia cochinchinensis*, *Sacciolepis indica*, *Setaria palmifolia*, *Thysanolaena latifolia*.

- 6a. NE Indian, Burmese, Indo-Chinese (\pm S China)
 14 spp., including: *Eulalia fastigiata*, *Neomicrocalamus andropogonifolius*,
Panicum incomtum, *Phacelurus zea*, *Polytoca digitata*, *Spodiopogon lacei*
- 6b. Peninsular Indian
 ?1 sp.: *Themeda quadrivalvis*.
7. Widespread tropical (Old World; \pm New World) – confused due to introductions
 53 spp., including: *Aristida adscensionis*, *Eleusine indica*, *Elytrophorus spicatus*, *Heteropogon contortus*, *Oplismenus compositus*, *Setaria pumila*.

These can be summarised as follows:

7% widespread temperate Eurasian and arctic-alpines (1); 5% C Asian/Tibetan (2, 3); 11% Sino-Himalayan (4); 34% Himalayan (5) incl. 25% restricted to E Himalaya (5A, B, C, D); 43% widespread tropical (6, 7).

In general grasses have rather wide distributions as can be seen from the 43% of species with a widespread tropical or SE Asian distribution. Nonetheless, as expected from comparison with other families, there is a sizeable Sino-Himalayan or Himalayan element, and within this some 25% of species are endemic to the E Himalayan region. The number of narrow 'political' endemics, i.e. restricted to Bhutan or Sikkim, is rather small, and at least some of these are no doubt artefacts and will prove to be more widespread in the light of further exploration.

At infraspecific level there is also some apparent endemism: *Deschampsia cespitosa* subsp. *sikkimensis* (N Sikkim/S Tibet); *Stipa jacquemontii* subsp. *chuzomica* (W Bhutan); *Cymbopogon flexuosus* var. *sikkimensis* (Darjeeling/Sikkim/W Bhutan).

DISJUNCTIONS

The distributions of certain species show interesting disjunctions. For example *Elymus duthiei*, *Tripogon purpurascens*, *Microstegium falconeri*, *Stipa jacquemontii* are known from the W Himalaya (\pm W Nepal) and Bhutan, but are apparently absent from C and E Nepal. *Neyraudia curvipes* is known only from Bhutan and Mount Kinabalu in Borneo.

Within the country, due to its small size, many grass species appear to be widely distributed, occurring in similar habitats throughout the country. However some are undoubtedly restricted, e.g. *Cymbopogon khasianus* seems only to be found in the west of the country, and not in similar habitats in the east. Many others are restricted to particular habitats.

NUMBER OF SPECIES

As stated above, some 126 genera and 389 species are so far known from the area covered by the *Flora* (Sikkim, Darjeeling, Chumbi and Bhutan) and no doubt most of these will be found in Bhutan sooner or later. So far 112 genera and 324 species have been recorded in Bhutan itself. The totals for the *Flora* area suggest that there is probably not a large number of species still to be found, if one compares the numbers with those recorded from adjacent areas. Using the same generic and specific concepts as in the present volume 111 genera and c.337 species are recorded for Nepal (E.F.N.), and using the same generic concepts 136 genera and c.475 species are recorded for the seven NE states of India, the old 'Assam', (Shukla, 1996). The areas covered by these adjacent Floras, however, are much larger. The area covered by the *Flora of Bhutan* is approximately 60,000km²: Nepal has an area more than twice this size (147,181km²) and the NE states of India collectively cover more than four times our area (255,083km²).

SPECIES DIVERSITY WITHIN GENERA

Most grass genera in Bhutan are represented by rather few species, and only eight have more than 10. Of these most are temperate and alpine: *Poa* (29), *Agrostis* and *Digitaria* (13), *Calamagrostis* and *Festuca* (12), *Stipa* (11). There are only two large warm-temperate/subtropical genera: *Eragrostis* (13) and *Panicum* (11).

NEED FOR FURTHER WORK

This volume should be seen as a first attempt to describe the grasses of Bhutan. Much work remains to be done on the ecology and detailed distribution of species within the country. Such work will require the systematic collection of specimens, which should be deposited in the new National Herbarium to be built at Serbithang, where they will form a national reference collection available to conservationists, ecologists and agriculturists. A large amount of taxonomic work is also still required. The following extremely variable species would, in particular, merit further study: *Tripogon filiformis*, *Danthonia cumminsii*, *Arundinella nepalensis* and *Brachypodium sylvaticum*. Particular problems occur in the genera *Agrostis*, *Calamagrostis*, *Cymbopogon* and *Poa*, and the treatments of these should be taken as provisional.

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Finally the great debt to N.L. Bor (1893–1972) that is owed by all who work on grasses of the Indian subcontinent must be acknowledged. Bor's immense knowledge is available not only through his numerous publications, culminating in the monumental *The Grasses of Burma, Ceylon, India and Pakistan*, but also in the truly vast number of herbarium specimens that he identified at K, BM and E. These publications and authenticated specimens form the cornerstone on which the present work has been based.

ABBREVIATIONS

For reasons of conciseness the following standard works used for synonymy and localities are abbreviated as follows (*Flora of Bhutan* Bibliography numbers given in brackets):

F.B.I.: Hooker, J.D. (ed.) (1897). *The Flora of British India. Vol. 7. Cyperaceae, Gramineae and General Index*. London: L. Reeve & Co. (80).

M.F.B.: Subramanyam, K. (ed.) (1973). *Materials for the Flora of Bhutan. Rec. Bot. Surv. India* 20: 1–278. (117).

E.F.N.: Hara, H., Stearn, W.T. & Williams, L.H.J. (1978). *An Enumeration of the Flowering Plants of Nepal. Vol. 1*. London: British Museum (Natural History). (72).

F.E.H.1: Hara, H. (ed.) (1967). *The Flora of Eastern Himalaya*. Tokyo: University of Tokyo Press. (69).

F.E.H.2: Hara, H. (ed.) (1971). *Flora of Eastern Himalaya. Second Report. Forming Bulletin no. 2 of the University Museum, the University of Tokyo*. Tokyo: University of Tokyo Press. (71).

In the lists of localities, literature records are separated from those based on seen specimens by a semicolon. For other literature references see Bibliography (p. 841).

Abbreviations for languages and dialects of common names of plants used in the volume are:

Dz: Dzongkha
Keng: Kengkha
Sha: Shachop

Lep: Lepcha
Eng: English
Nep: Nepali (Lhotsampa)

Other abbreviations:

incl.: including
excl.: excluding
infl(s).: inflorescence(s)

fl.: flowering period
fr.: fruiting period

For remaining abbreviations, e.g. botanical authorities, see Volume 1 Part 1, p. 34.

Family 233. GRAMINEAE (POACEAE)

Annual or perennial; tufted, rhizomatous or stoloniferous. Leaves in basal, vegetative shoots and inserted distichously along stems (culms); blade usually \pm linear; sheath open or closed, with a commonly membranous ligule at junction with base of blade. Culms herbaceous or woody, jointed, internodes usually hollow. Infls. composed of spikelets. Spikelets arranged in a panicle or raceme, racemes sometimes spike-like, partial infls. sometimes subtended by bladeless sheaths (spathes). Spikelets of distichously arranged bracts, the lower pair (occasionally one absent) sterile, called glumes, and one or more florets, if more than one then inserted along a slender axis (rachilla) that may break up (disarticulate), or persist. Florets composed of a lemma and a usually 2-keeled palea subtending a single flower. Flower usually bisexual, ovary with a single ovule, stigmas commonly 2, feathery; stamens usually 3 (sometimes 1, 2 or 6), subtended by 2(-3, or occasionally more) minute scales (lodicules). Fruit an indehiscent grain (caryopsis), pericarp sometimes free, occasionally fleshy.

The name *tsa* (Dz) refers generally to grasses.

Although categories below family level have not generally been used in the *Flora of Bhutan*, the genera of Gramineae, being very numerous, are easier to deal with if grouped into tribes. However, the tribes recognised in this family are based on suites of characters, any one of which may or may not be present in a given genus, some are also microscopic or embryological. As a result, some of the tribes do not have a characteristic appearance and it is very difficult to get a 'feel' for many of them. For this reason, only the Bambuseae, with its specialised morphology and terminology, is formally described.

Constructing a key to the tribes is still a formidable task, and it has not been possible to use only 'easy' characters such as infl. form, or presence/absence of awns, as these are never consistent within a tribe or even a genus! A rigorous key, which coped with all this variation, would require the construction of couplets of labyrinthine complexity. To avoid this complexity, atypical members of some 'awkward' genera are not formally keyed out, but merely mentioned by name, and an illustration reference given. When such a name is found in the following key, the reader should go directly to the illustration, to see whether or not it is the plant he is trying to identify.

The key to tribes, though complex, will be easier to use than the daunting one given in Bor (1973) as it deals with far fewer genera than occur in the whole subcontinent. Inevitably it will be imperfect, and users may need to try the keys of several tribes in order to reach the correct genus. The keys to genera should be easier to use than the key to tribes.

ARTIFICIAL KEY TO TRIBES

1. Culms woody, bearing bladeless sheaths **I. BAMBUSEAE**
+ Culms not woody or if slightly woody and reed-like, then lacking bladeless sheaths 2
2. Spikelets with 1, 2 or more florets, if florets 2, then both bisexual or the upper sterile 3
+ Spikelets always with 2 florets, the lower usually male or sterile, the upper fertile 26
3. Spikelets with 1 floret (if with more than one, *Chloris*, the fertile one different in shape from the rest, Fig. 36) 4
+ Spikelets with 2 or more florets 13
4. Lemma with three equal awns arising from the apex **XII. ARISTIDEAE**
+ Lemma awnless, with a single awn, or if with three awns, then the outer shorter and clearly separated from the central 5
5. Infl. spike-like or with several, digitately arranged spikes 6
+ Infl. a panicle 8
6. Spikelets arranged in threes, the central, fertile one flanked by two filiform, sterile spikelets **VIII. TRITICEAE** p.p. (*Hordeum*)
+ Spikelets inserted singly 7
7. Infl. a single, oblong, spike-like raceme
 VI. AVENEAE p.p. (*Duthiea*, *Phleum*, *Alopecurus*, *Phalaris*)
+ Infl. of linear, digitately arranged, spike-like racemes (for exceptions see Fig. 36: *Microchloa* has a single, linear spike-like raceme; *Perotis* has a single, oblong spike-like raceme, and glumes with filiform awns)
 XIV. CYNODONTEAE
8. Glumes reduced to minute swellings (spikelet sometimes subtended by glume-like sterile florets); palea 1-keeled **II. ORYZEAE**
+ Glumes well developed; palea 2-keeled 9
9. Spikelets paired; whole spikelet deciduous, surrounded by short, stiff hairs **XVII. ARUNDINELLEAE** p.p. (*Garnotia*)
+ Spikelets borne singly; spikelets breaking up above glumes; glumes often persistent 10

233. GRAMINEAE (POACEAE)

- 10. Glumes exceeding floret 11
- + Glumes (at least the lower) shorter than spikelet (except *Colpodium*, Fig. 21) 12

- 11. Lemmas usually hardened, margins clasping palea; awn usually present, terminal (absent in *Milium*) **III. STIPEAE**
- + Lemmas not hardened, margins not clasping palea; awn when present inserted on back of lemma **VI. AVENEAE** p.p.

- 12. Lemmas 5-veined, unawned; pericarp never free
 IV. POEAE p.p. (*Catabrosa, Colpodium*)
- + Lemmas 3-veined, sometimes obscurely so, awned or unawned; pericarp sometimes free
 XIII. ERAGROSTIDEAE p.p. (*Sporobolus, Muhlenbergia*)

- 13. Infl. spike-like or of digitately arranged spikes 14
- + Infl. paniculate (if spike-like, *Lolium*, then lower glume absent on lateral spikelets, Fig. 14) 17

- 14. Lemma dorsally awned **VI. AVENEAE** p.p. (*Trisetum spicatum*)
- + Lemma unawned or awn, if present, terminal 15

- 15. Glumes awned **X. ARUNDINEAE** p.p. (*Elytrophorus*)
- + Glumes not awned 16

- 16. Lemmas 5-veined, usually with a single, terminal awn (sometimes absent in *Triticum*); infl. always spike-like; ovary with a hairy, terminal appendage **VIII. TRITICEAE**
- + Lemmas 3-veined, unawned or if a terminal awn present, then with 2 or 4 subsidiary, shorter awns/points; infl. spike-like or of digitately arranged spikes; ovary lacking a terminal appendage
 XIII. ERAGROSTIDEAE p.p. (*Tripogon, Eragrostiella, Eleusine, Dactyloctenium*)

- 17. Leaf blades broad with cross-veinlets linking longitudinal veins; subtropical **IX. CENTOTHECEAE**
- + Leaf blades without cross-veinlets; subtropical to alpine 18

- 18. Leaf sheaths tubular **V. MELICEAE**
- + Leaf sheaths with free margins 19

19. Tall, reed-like grasses, culms becoming semi-woody 20
+ Plants not reed-like, culms remaining soft 22
20. Spikelets small (under 2mm), falling entire with pedicels; panicles
not plumose **XI. THYSANOLAENEAE**
+ Spikelets large (over 6mm), disarticulating above glumes; panicles
plumose 21
21. Lemmas prominently mucronate, long-hairy near margins, glumes
less than half length of spikelet
XIII. ERAGROSTIDEAE p.p. (*Neyraudia*)
+ Lemmas not mucronate, glabrous, or if long-hairy then glumes almost
equalling spikelet **X. ARUNDINEAE** p.p. (*Phragmites, Arundo*)
22. Ligule a line of hairs or a minute, ciliate rim (membranous in
Leptochloa, Fig. 32) 23
+ Ligule membranous 24
23. Lemmas unawned
XIII. ERAGROSTIDEAE p.p. (*Eragrostis, Leptochloa*)
+ Lemmas with a stout, geniculate awn
X. ARUNDINEAE p.p. (*Danthonia*)
24. Ovary with hairy, terminal appendage, so stigmas apparently lateral;
awns usually present (absent in *Bromus catharticus*) ... **VII. BROMEAE**
+ Ovary lacking appendage, stigmas terminal; awns present or absent...25
25. Glumes shorter than lowest lemma, upper florets obviously exerted;
lemmas awnless or with \pm straight awn from entire or bilobed tip
IV. POEAE
+ Glumes usually about equalling or exceeding lowest lemma; lemmas
usually awned (not in *Phalaris*); awn usually geniculate, dorsal
VI. AVENEAE
26. Spikelets breaking up at maturity 27
+ Spikelets falling entire at maturity 28
27. Glumes deciduous; upper lemma usually crustaceous; spikelets borne
singly, not awned **XVI. ISACHNEAE**
+ Glumes persistent, upper lemma never crustaceous; spikelets paired,
usually awned **XVII. ARUNDINELLEAE** p.p. (*Arundinella*)

28. Upper lemma crustaceous; spikelets usually borne singly, not awned, glabrous (*Melinis* is exceptional, with a hyaline upper lemma and awned lower lemma, Fig. 41) **XV. PANICEAE**
 + Upper lemma not crustaceous; spikelets usually paired or in 3s, with one sessile and the other 1/2 pedicelled; commonly awned, commonly hairy **XVIII. ANDROPOGONEAE**

Tribe I. BAMBUSEAE Kunth ex Nees (Woody bamboos)

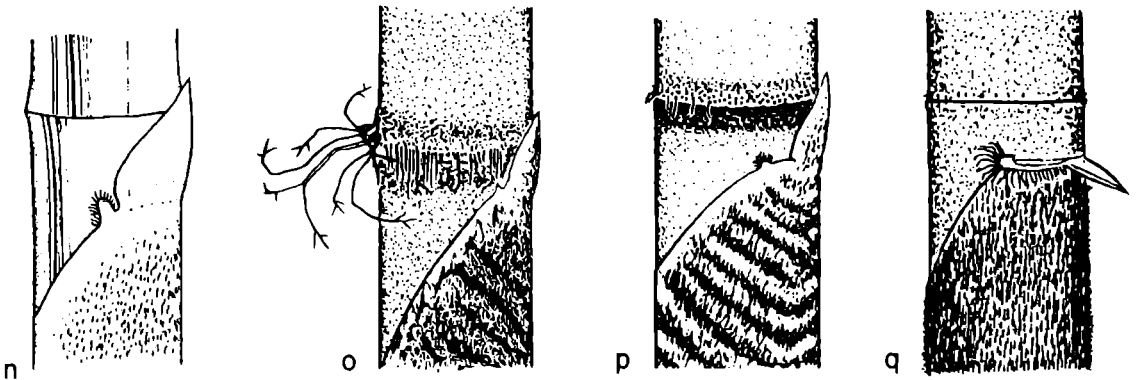
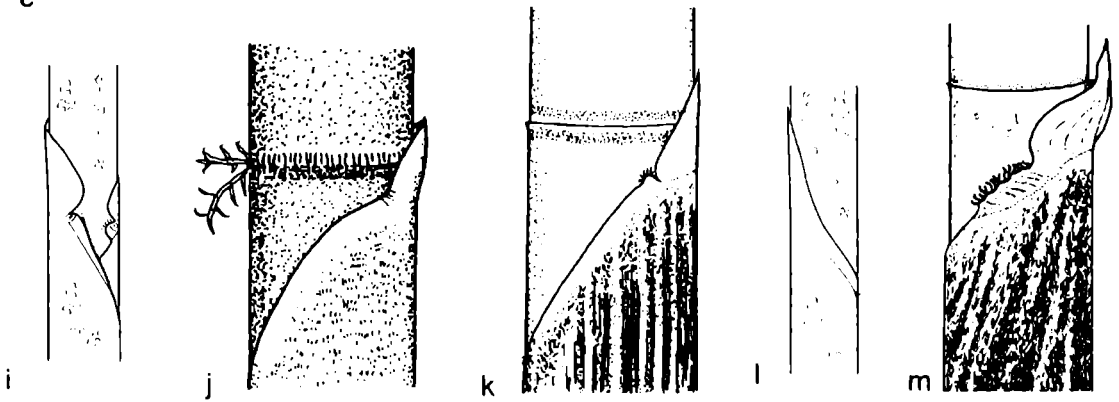
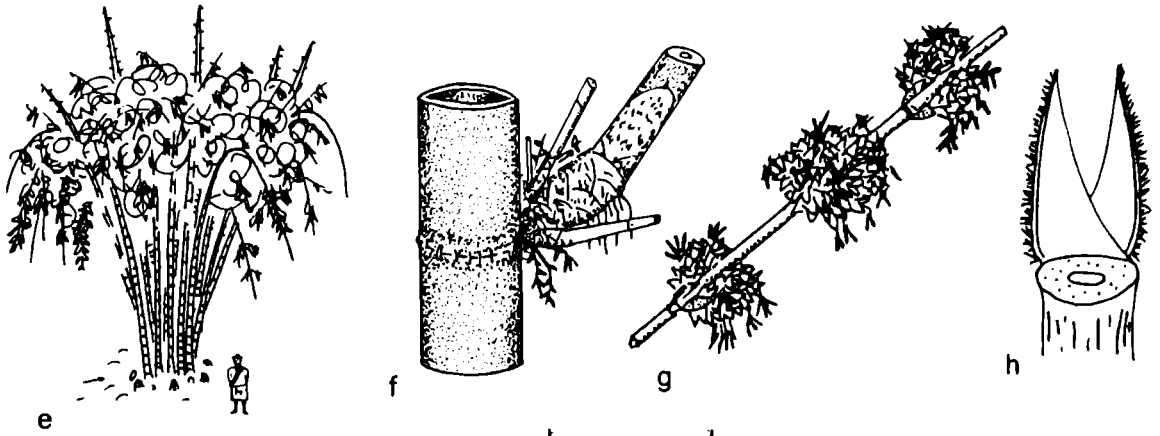
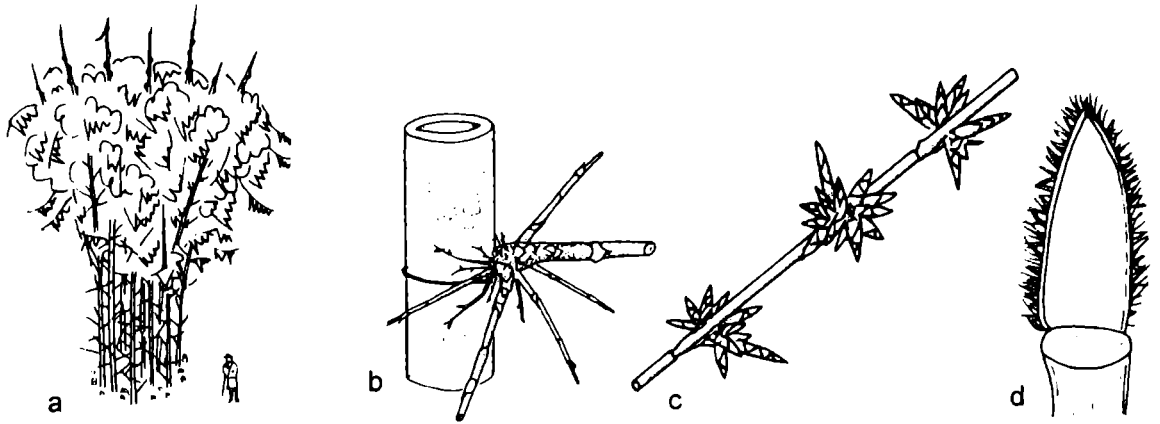
C.M.A. Stapleton

As many technical terms are used to describe the rather complex vegetative and infl. structures of bamboos, and apply only to them, a description of the Tribe, with an explanation of some of the specialist terminology is included.

Perennial grasses. Rhizomes well developed, leptomorph (long, thin, with monopodial branching, Fig. 4a) or pachymorph (thick with sympodial branching, rootless neck section sometimes elongated, Fig. 4d). Culms woody, erect (Fig. 3a) to pendulous (Fig. 3k), arising singly and well separated (habit diffuse, Fig. 8c), in a single, dense clump (habit unicaespitose, Fig. 1a), or in a series of clumps of tillering culms connected by long rhizomes (habit pluricaespitose). Internodes often with a single, wide groove above branches. Buds at culm nodes enclosed by a single, broad prophyll with margins free (Fig. 3l) or fused (Fig. 3b), by a narrow prophyll and matching sheath (Fig. 8d), or by a narrow prophyll and sheath fused together at back and/or front (Fig. 7c). Branches at culm nodes 1 to many, similar in size (Fig. 5b) or with smaller branches around larger central ones (Fig. 1b,f). Sheaths subtending minor branches either all present, or some absent so that multiple initials or distinct ranks of initials are visible (Fig. 5d). Leaf sheaths with inner and outer ligules, ± auricles and oral setae (Fig. 6g–s). Leaf blades broad, eventually deciduous, articulated from sheath on a pseudo-petiole, venation parallel, cross-veins sometimes prominent (tessellated). Culm leaves (culm sheaths) distinct from

FIG. 1.

a–d, **Bambusa** sp.: a, clump habit; b, mid-culm branching; c, three infls. on flowering branch; d, bract subtending infl.; e–h, **Dendrocalamus** sp.: e, clump habit; f, mid-culm branching; g, three infls. on flowering branch; h, bracts subtending infl.; i–q, lower culm sheaths: i, **Bambusa alamii**; j, **B. balcooa**; k, **B. clavata**; l, **B. multiplex**; m, **B. nutans** subsp. **cupulata**; n, **B. tulda**; o, **Dendrocalamus hamiltonii**; p, **D. hookeri**; q, **D. sikkimensis**. Drawn by C. Stapleton (after Stapleton, 1994a).



I. BAMBUSEAE

foliage leaves, thickened, with progressively reduced blades (Fig. 1i–q). Infl. a simple or complex branching system, with spikes of sessile flowers (florets), a short peduncle and basal glumes together forming spikelets (pseudo-spikelets if glumes subtend buds). Infl. branches (paraclades) subtended by sheaths (bracteate), or with sheaths much reduced or absent (ebracteate). Young infl. bud enclosed by a single broad prophyll (Fig. 1d), or a narrow prophyll and matching sheath (Fig. 1h). Branching of infls. simple (racemose) or compound (paniculate). Branches (paraclades) separate or clustered (fascicled), often divergent with small axillary swellings (pulvini). Spikelets sessile or borne on a stalk or promontory, the first sheath a prophyll inserted at or distant from the point of branching, often constituting the lower glume. Prophyll and glumes basal to spikelet with or without subtended buds. Spikelets (pseudo-spikelets) either with basal buds capable of repeated ramification (flowering iterant) and often developing into dense capitate clusters (Fig. 1g), or with basal buds absent or vestigial and incapable of further development (flowering semelant, Fig. 5c,g). Stamens 3 or 6(–c.120). Lodicules (0–)3(–12 or more). Flowering cyclical, usually at intervals of 15 to 150 years. Flowering of a species synchronised over districts (gregarious), or sporadic.

The bamboos are extensively used in the area for a wide variety of purposes. The larger species occur naturally or as cultivated plants up to 1600m, and are widely used for poles, edible shoots and animal fodder. Smaller species occurring naturally as forest understorey up to 3400m, or cultivated around settlements, or forming extensive areas of pure bamboo pastureland, are used for basketry, house roofs, walls and floors, edible shoots and fodder.

Taxonomic key

1. Infl. fully bracteate; all axes within the infl. subtended by a sheath and bearing a prophyll close to the point of branching 2
- + Infl. partially or wholly ebracteate; infl. axes with some to all of the subtending sheaths and prophylls reduced, modified or absent 9
2. Rhizomes leptomorph (all internodes longer than wide, culms well differentiated from rhizomes); culm nodes prominently swollen, often bearing thorns; stamens 3 **15. Chimonobambusa**
- + Rhizomes pachymorph (root-bearing internodes wider than long, rhizomes normally developing directly into culms); culm nodes not prominently swollen; stamens 6 3
3. Culm sheath blade needle-like; florets separated on long, sinuous rhachilla **14. Neomicrocalamus**

- + Culm sheath blade triangular or lanceolate; florets usually overlapping on straight rhachilla 4
- 4. Style short, solid; central branch large or dormant; mainly giant bamboos 12–30m tall 5
- + Style elongate, hollow; branches subequal; mainly bamboos of medium height, 8–16(–20)m tall 6
- 5. Infl. bud enclosed within a single, broad, 2-keeled prophyll; new culms usually covered with light, waxy deposits **1. Bambusa**
- + Infl. bud enclosed between two, narrow, single-keeled bracts; new culms covered with thick, dark, waxy deposits **2. Dendrocalamus**
- 6. Rhizome neck over 50cm long; culms diffuse or pluricaespitose 7
- + Rhizome neck under 50cm long; culms unicaespitose 8
- 7. Culm thick-walled, diameter under 7cm; culm sheath blade lanceolate, reflexed, persistent; fruit more than 5cm **3. Melocanna**
- + Culm thin-walled, diameter under 4cm, culm sheath blade triangular, erect, deciduous; fruit less than 1cm **6. Pseudostachyum**
- 8. Infl. globular **4. Cephalostachyum**
- + Infl. spicate **5. Teinostachyum**
- 9. Rhizomes leptomorph (all internodes longer than wide, culms well differentiated from rhizomes) **7. Arundinaria**
- + Rhizomes pachymorph (root-bearing internodes wider than long, rhizomes normally developing into culms) 10
- 10. Mid-culm branch prophylls broad, 2-keeled; lateral branches initially 4, subtended by sheaths **8. Thamnocalamus**
- + Mid-culm branch prophylls narrow, single-keeled; lateral branches initially 6 or more, without subtending sheaths 11
- 11. Culms pendulous to semi-scandent; nodes with wide, corky ring; front of mid-culm budscale initially closed; glumes 1–2 **13. Ampelocalamus**
- + Culms erect to pendulous; nodes without corky ring; front of mid-culm budscale always open, with free margins; glumes 2 12
- 12. Mid-culm buds tall; fewer than 10 branches in the first year 13
- + Mid-culm buds short; more than 10 branches in the first year 14

I. BAMBUSEAE

13. Rhizomes to 30cm long; culms unicaespitose **9. Borinda**
+ Rhizomes to 300cm long; culms diffuse or pluricaespitose... **10. Yushania**
14. Spikelets with more than 1 floret; interior of culm sheath distally rough **11. Drepanostachyum**
+ Spikelets usually with 1 floret; interior of culm sheath smooth
12. Himalayacalamus

Field key to genera (from Stapleton, 1994a)

1. Clump-forming bamboos; culms growing in clumps of more than 10... 2
+ Spreading bamboos; culms growing separately, or in groups of up to 10 10
2. Maximum culm diameter more than 7cm 3
+ Maximum culm diameter less than 7cm 4
3. Culm with light covering of pale wax; central branches fairly uniform, usually quite small **1. Bambusa**
+ Culm covered with dark or thick, furry wax; central branches varied, often very large **2. Dendrocalamus**
4. Maximum internode length more than 40cm 5
+ Maximum internode length less than 40cm 7
5. Leaves with cross-veins linking long veins **9. Borinda**
+ Leaves with no cross-veins between long veins 6
6. Culm nodes with no collar, or with thick, flat, even collar
4. Cephalostachyum
+ Culm nodes with thin, projecting, wavy collar **13. Ampelocalamus**
7. Buds tall, chilli-shaped **8. Thamnocalamus**
+ Buds short, onion-shaped 8
8. Culm sheath blade more than 2cm wide **1. Bambusa**
+ Culm sheath blade less than 1cm wide 9
9. Culm sheath rough inside at top **11. Drepanostachyum**
+ Culm sheath smooth inside at top **12. Himalayacalamus**

10. Culms with rings of thorns around the nodes **15. Chimonobambusa**
 + Culms with no thorns 11
11. Leaves with no cross-veins between long veins 12
 + Leaves with distinct cross-veins between long veins 13
12. Culm diameter over 4cm **3. Melocanna**
 + Culm diameter 2–4cm **6. Pseudostachyum**
 + Culm diameter under 2cm **14. Neomicrocalamus**
13. Rhizome rooting at all nodes **7. Arundinaria**
 + Long lengths of rhizome without roots **10. Yushania**

1. BAMBUSIA Schreber

C.M.A. Stapleton

Tropical and subtropical bamboos. Rhizomes pachymorph, without extended necks. Culms 2–25m, usually glabrous, or lightly waxy. Culm sheaths usually with large auricles and long, dense oral setae. Branches small and uniform, or large and variable. Leaf blades under 25cm. Infl. fully bracteate, spicate to globular, enclosed within a 2-keeled prophyll. Spikelets with basal buds (flowering iterant), terminating in an incomplete, or rudimentary, floret. Florets usually separated by clearly distinguishable, disarticulating rachilla internodes. Palea keeled, acute, never deeply bifid. Stamens 6, filaments free. Lodicules 3.

1. Culm diameter over 5cm 2
 + Culm diameter under 4cm 5
2. Culm sheaths without auricles **2. B. balcooa**
 + Culm sheath with auricles 3
3. Culm sheath auricles over 10mm wide 4
 + Culm sheath auricles 2–10mm wide **3. B. clavata**
4. Leaf sheath auricles small, oral setae erect **5. B. nutans**
 + Leaf sheath auricles large, oral setae spreading **6. B. tulda**
5. Culm sheath auricles large, dissimilar **1. B. alamii**
 + Culm sheath auricles absent or small, similar **4. B. multiplex**

I. BAMBUSEAE

1. *B. alamii* Stapleton. Nep: *mugi bans*. Fig. 1i, Fig. 2a,l.

Culms to 10m, to 4cm in diameter, erect to drooping, internodes waxy, branches many. Culm sheaths persistent, completely glabrous; blades broad, erect; auricles strongly dissimilar, one rounded, one very large and elongated down sheath margin; oral setae to 1cm, dense, wavy; ligule 1–2mm wide, entire. Leaf sheaths glabrous; auricles large, spreading; oral setae long, erect or spreading; blades to 25 × 2.5cm, glabrous; ligule short. Infl. spicate; spikelets 2–3cm; lemmas glabrous; paleas truncate, keels distally ciliate; anthers slightly apiculate.

Bhutan: S — Gaylegphug district. Cultivated, 200–300m.

The culms are used for weaving, and the foliage as animal fodder.

B. alamii has been considered to be a synonym of *B. jaintiana* R.B. Majumdar (Alam & Hassan, 1994). *B. jaintiana* was minimally diagnosed on the basis of a type collection from the Khasia Hills of Meghalaya. It was stated, in the diagnosis, to have smaller auricles than *B. tulda*, whereas *B. alamii* has larger auricles. The isoparatype of *B. jaintiana* at K seems to be identical to *B. tulda*, and the holotypes need to be compared.

2. *B. balcooa* Roxb. Nep: *dhanu bans*. Fig. 1j, Fig. 2b.

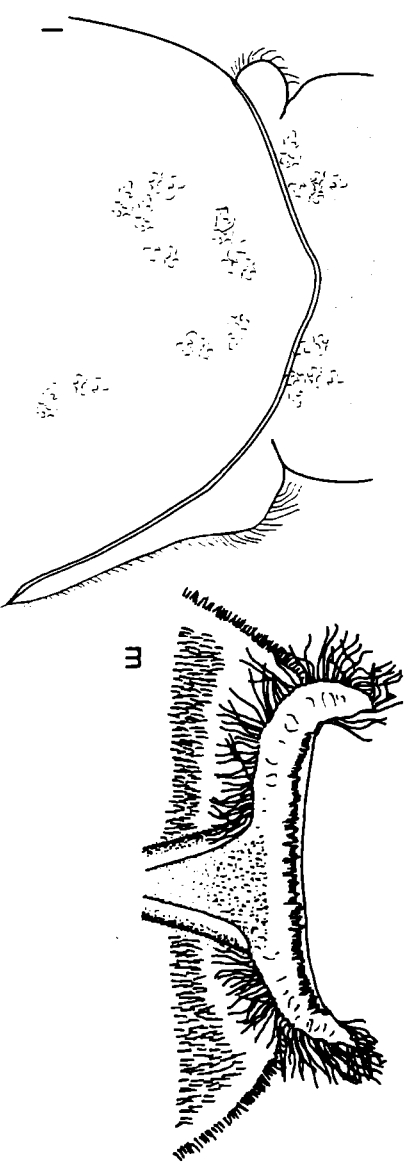
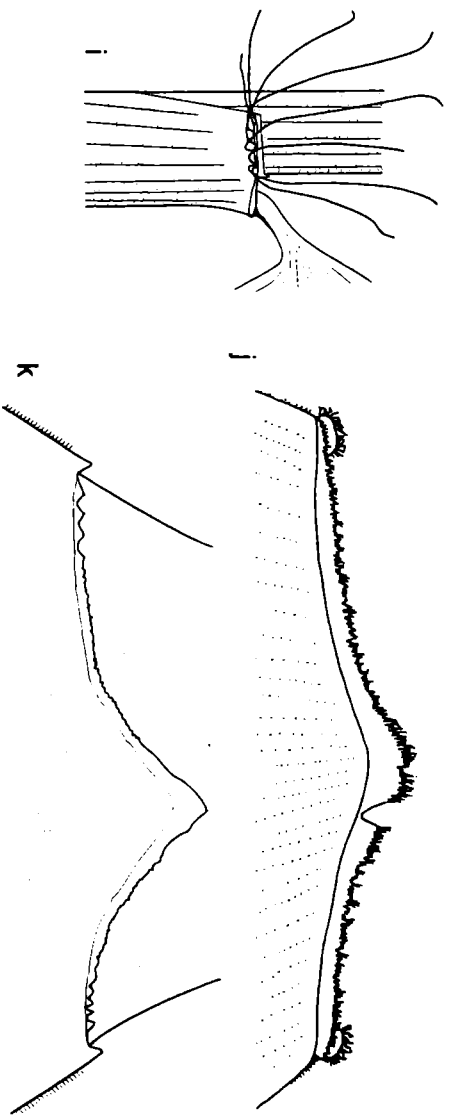
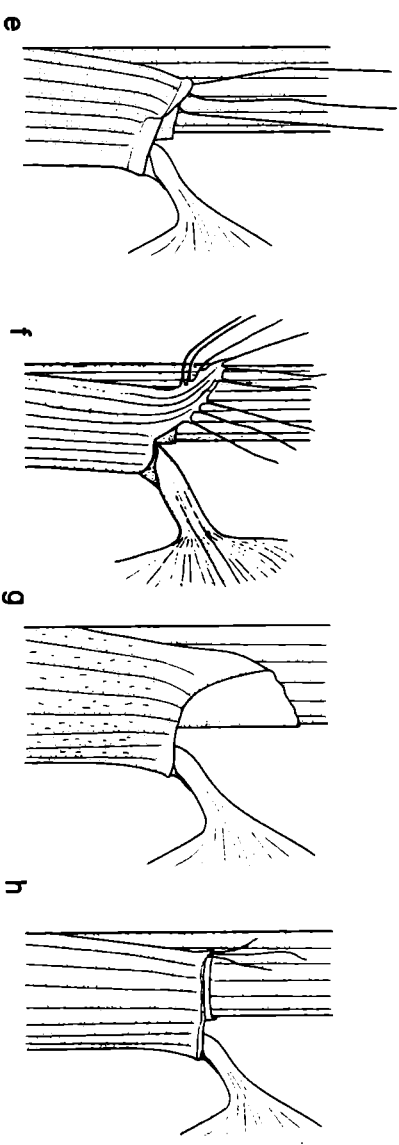
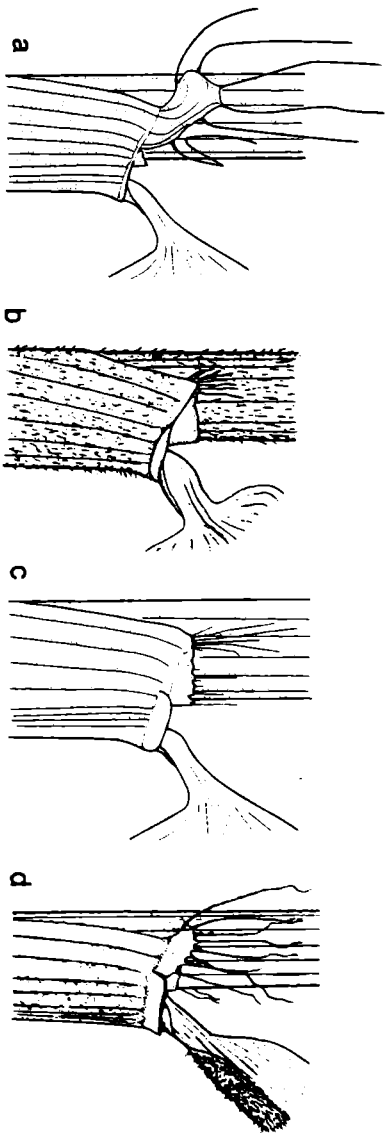
Culms to 25m, to 16cm in diameter, erect to drooping; internodes with dense, brown, furry wax at first, becoming glossy; nodes with aerial roots, bearing branches to base; central branches very large, ultimate branchlets thorn-like. Culm sheaths with dense, dark brown hairs; auricles and oral setae absent; blade edges corrugated at base; ligule 3–5mm wide, wavy, finely serrate. Leaf sheaths with dense, deciduous, brown hairs; ligule short; auricles absent; oral setae few, short, erect. Infl. spicate to globular. Mature spikelets disarticulating tardily, c.10 × 8mm, strongly flattened, with prominent, long, white cilia on lemma margins and palea keels; lemmas green with purple edges, apex sharp; anthers yellow, the tips apiculate, glabrous, ± purple.

Bhutan: S — Sarbhang district (Sarbhang). Cultivated, 200–300m.

The culms are used for heavy-duty construction purposes such as beams, pillars and ox-carts; the foliage is used as animal fodder.

FIG. 2.

a–i, leaf sheaths: a, *Bambusa alamii*; b, *B. balcooa*; c, *B. clavata*; d, *B. multiplex*; e, *B. nutans* subsp. *cupulata*; f, *B. tulda*; g, *Dendrocalamus hamiltonii*; h, *D. hookeri*; i, *D. sikkimensis*. j–m, culm sheath ligule and auricles: j, *Bambusa clavata*; k, *Dendrocalamus hamiltonii*; l, *Bambusa alamii*; m, *Dendrocalamus sikkimensis*. Drawn by C. Stapleton (after Stapleton, 1994a).



I. BAMBUSEAE

3. *B. clavata* Stapleton. Dz: *pagshing*; Nep: *chile bans*. Fig. 1k, Fig. 2c,j.

Culms to 18m, to 9cm in diameter, erect to drooping; internodes largely without wax; nodes with dense rings of white wax above and below, aerial roots lacking; branches medium-sized, absent from lower nodes. Culm sheaths with dark brown hairs; auricles small; oral setae short; blades broad, appressed, deciduous; ligules broad, fimbriate, often with a single, deep erosion or cleavage. Leaf sheaths glabrous; ligule short, ciliate; auricles absent; oral setae few, erect, short. Infl. initially club-shaped with a single spikelet, or spicate, becoming globular. Spikelets large, to 3cm, basally constricted, disarticulating tardily; lemmas green with purple, apiculate tips, margins glabrous; anthers yellow, the tips purple, initially penicillate.

Bhutan: C — Punakha (Tinlegang) and Tongsa (Shemgang) districts; S — Sarbhang and Gaylegphug districts. Cultivated, 300–1600m.

The culms are used for construction and roofing, and the leaves as animal fodder.

4. *B. multiplex* (Loureiro) Raeuschel ex Schultes & Schultes f.; *B. glaucescens* (Willdenow) Merrill; *B. nana* Roxb. Eng: *Chinese bamboo*. Fig. 1l, Fig. 2d.

Culms short, erect, 6–10m (under 2m in some cultivated varieties); internodes waxy or sparsely brown-setose, often variously striped; branches small, the central one dominant. Culm sheaths persistent, glabrous, with erect, narrowly triangular blades; auricles small or absent; oral setae short; ligule 1–2mm wide, entire. Leaf sheaths distally pubescent; auricles large, spreading; oral setae long, erect or spreading; ligule short; blades to 10cm, or only c.3cm, ± striped in some cultivated varieties, abaxial surface glaucous or pubescent. Infl. spicate; spikelets cylindric; rhachilla internodes elongate, disarticulating readily; florets completely glabrous, except for the distally, minutely ciliate palea keels.

Bhutan: S — Samchi (Samchi town) and Phuntsholing (Phuntsholing town) districts. Cultivated as low, ornamental hedging.

5. *B. nutans* Wall. ex Munro subsp. *cupulata* Stapleton; *B. teres* Munro. Dz: *jhushing*; Lep: *wahlo*; Nep: *mal bans*. Fig. 1m, Fig. 2e.

Culms to 23m, to 10cm in diameter, erect or drooping; nodes scarcely raised; branching uniform, branch diameter to 2cm. Culm sheath with appressed, jet-black hairs; auricles large, broad; oral setae many, wavy, copper-coloured; blade prominently cupped, readily deciduous, the interior pubescent in centre. Leaf sheath glabrous; auricles small; oral setae few, erect, deciduous; ligule short, truncate, blade to 30cm. Infl. spicate; spikelets to 5cm, cylindric, often curving, rarely flattened; rhachilla internodes elongate, disarticulating very readily, usually before the spikelets become flattened; lemma margins

glabrous, interior distally tomentose; palea keels shortly ciliate. Flowering gregarious.

Bhutan: S — Phuntsholing to Deothang districts; C— Punakha district (Wangdi Phodrang); **Darjeeling** (Lebong to Badamtan, Great Rangit valley); **Sikkim** (Tista, Rungbee). Cultivated, 300–1500m.

Widely cultivated; the culms are used for general-purpose construction and archery bows, and the leaves as animal fodder.

6. B. tulda Roxb. Dz: *jhushing*; Nep: *singhane bans*. Fig. 1n, Fig. 2f.

Culms to 15m, to 7cm in diameter, usually erect, slightly crooked; walls thick; nodes raised; branching strong, uniform to base, with central branch to 3cm in diameter. Culm sheath with dense, dark brown hairs; auricles large, one taller than broad; blade not cupped, persistent, interior with few hairs. Leaf sheath pubescent or glabrous; auricles large; oral setae persistent, upright or spreading; ligule short, truncate; blade to 25cm. Infl. spicate; spikelets to 35mm, cylindric, becoming flattened; rhachilla internodes elongate, disarticulating readily but usually after the spikelets become flattened; lemma margins distally short-ciliate, interior distally tomentose; palea keels with long, white cilia.

Bhutan: S — Sarbhang district (Chirang). Cultivated.

The culms are used for construction and the leaves as animal fodder.

2. DENDROCALAMUS Nees

C.M.A. Stapleton

Tropical and subtropical bamboos. Rhizomes pachymorph, without extended necks. Culms 6–30m, with dense, furry wax. Culm sheaths usually with small auricles; oral setae absent to many. Branches dissimilar, often large. Leaf blades to 50cm. Infl. fully bracteate, globular, enclosed between two separate, 1-keeled bracts. Spikelets with basal buds (flowering iterant), terminating in an incomplete or rudimentary floret. Florets dense, on short, non-disarticulating, rhachilla internodes. Paleas keeled and acute, never deeply bifid. Stamens 6, filaments free. Lodicules scarce to 3.

1. Culm sheath auricles always absent see *Bambusa balcooa*
+ Culm sheaths with auricles 2

2. Culm sheath auricles very small, triangular, lacking oral setae

1. **D. hamiltonii**

1. BAMBUSEAE

- + Culm sheath auricles small, rounded, oral setae present 3
- 3. Culm sheath auricle 2–10mm wide see *Bambusa clavata*
- + Culm sheath auricle 7–40mm wide 4
- 4. Culm sheath auricle to 2cm wide; leaf sheaths with few, deciduous oral setae to 3mm long **2. D. hookeri**
- + Culm sheath auricle over 2cm wide; leaf sheaths with many, persistent oral setae over 5mm long **3. D. sikkimensis**

1. D. hamiltonii Munro var. **hamiltonii**; *Bambusa monogynia* Griff. Dz: *pagshi*; Sha: *lee shing*; Nep: *tama bans*. Fig. 1o, Fig. 2g,k.

Culms to 25m, to 9cm in diameter, strongly pendulous above, densely covered in persistent, brown and white, furry wax; walls thin; branches fewer towards base, central branch to 5cm in diameter, smallest branches recurving from culm; nodes with dense, long aerial roots. Culm sheaths persistent, often decaying on culm, triangular, with patches of dark brown, appressed hairs; auricles small, triangular, lacking setae; ligule broad and serrate, acute at centre, sides erose. Leaf sheaths with white hairs; shoulders rising, slightly hooked; auricles and oral setae absent; ligule very long; blade to 40cm. Infl. very dense, globular, protogynous; spikelets soft, bell-shaped, 6mm long, initially purple; stigmas and anthers reddish-purple; grain spherical. Flowering both gregarious and sporadic, sporadic flowering very common.

Bhutan: S — Phuntsholing to Deothang districts; **Sikkim** (Tista, Yoksam, Pemiongchi, Rungbee). Both naturally occurring and cultivated, 300–1500m.

Common in deciduous forest and widely cultivated for weaving, light construction, edible shoots and animal fodder.

var. **edulis** Munro. Nep: *guliyo tama bans*; Keng: *su*; Lep: *rugvi*.

Differs from var. *hamiltonii* as follows: spikelets soft, yellowish-brown, to 15mm; anthers yellow; leaf sheath ligules shorter; with fewer, recurving branchlets.

This variety becomes more common, and replaces var. *hamiltonii*, towards E Bhutan and has particularly palatable new shoots. Flowering both gregarious and sporadic, sporadic flowering very common.

2. D. hookeri Munro. Dz: *pagshi*; Lep: *patu*. Fig. 1p, Fig. 2h.

Culms to 18m, to 9cm in diameter, nodding to drooping, initially densely covered in brown, furry wax, becoming glossy, dark green; walls thin; nodes with dense, short aerial roots; branches absent near base, central branch to

5cm wide. Culm sheaths deciduous, broad, with V-shaped lines of dense, dark brown, erect hairs; auricles 1–2cm, rounded; oral setae curving; ligule broad, serrate. Leaf sheaths glabrous; ligule very short, truncate; auricles absent; oral setae few, erect; blade to 40cm. Infl. dense, globular; spikelets to 8mm, hard, ovate, initially olive-green; palea keels ciliate; anthers yellow, penicillate. Flowering gregarious.

Bhutan: C — Tongsa, Bumthang, Mongar and Tashigang districts; **Sikkim** (Pemiongchi, Rinchinpong, Mamring). Cultivated, 900–1500m.

Occasionally cultivated for light construction and animal fodder.

3. D. sikkimensis Oliver. Dz: *zhang*; Sha: *demtshar*; Lep: *pugriang*. Fig. 1q, Fig. 2i,m.

Culms to 25m, to 15cm in diameter, erect to nodding, initially densely covered in brown, furry wax, becoming glossy orange; walls thin, internodal cavities very large; nodes with few aerial roots; branches absent near base, central branch to 5cm in diameter. Culm sheaths deciduous, broad, with thick, velvety, dark brown, erect hairs; auricles 2–5cm, wavy; oral setae long, curving; ligule broad, rolled, fimbriate. Leaf sheaths glabrous; ligule very short, truncate; auricles absent; oral setae many, erect and spreading; blade to 40cm. Infl. dense, globular, large; spikelets to 12mm, hard, ovate, initially olive-green with purple tips; palea keels densely shaggy; anthers yellow, long-apiculate.

Bhutan: C — Tongsa (Shemgang), Bumthang, Mongar and Tashigang districts; **S** — Deothang district; **Sikkim** (Rangit Valley, 'Sikkim superior'). On ridges in dry deciduous forest; also cultivated, 500–1200m.

The culms are used to make containers and the foliage as animal fodder.

3. MELOCANNA Trinius

C.M.A. Stapleton

Tropical and subtropical bamboos. Rhizomes pachymorph, necks to 2m; clumps very open. Culms 3–20m, erect or nodding. Culm sheaths corrugated at apex, external ligule present; blades long and narrow. Branches many, subequal. Leaf blades without obvious cross-veins. Infls. fully bracteate, initially terminal to a leafy branch, tall and narrowly triangular; branches (paraclades) unilateral, subtending bracts long, narrow, projecting, with a short awn from midrib or keel. Spikelets with basal buds (flowering iterant), terminating in rhachilla extension or rudimentary floret. Fertile lemma 1. Palea unkeeled. Stamens 6, filaments free or irregularly connate. Style long, hollow. Fruit to 12cm, with thick, fleshy pericarp.

I. BAMBUSEAE

1. **M. baccifera** (Roxb.) Kurz; *M. bambusoides* Trinius. Nep: *phelim bans*. Fig. 3a–d.

Culms to 12m, to 5cm in diameter; internodes to 30cm, smooth, dull; nodes level, white-pruinose below. Culm sheath deciduous, with scarce, white, deciduous hairs; distally with deep, transverse corrugation; blade to 50cm, narrow, recurved; exterior ligule pronounced. Leaf sheaths glabrous; ligule short; auricles small or narrow and laterally spreading; oral setae long, erect, white; blades to 30 × 5cm, glabrous. Fruit to 13cm, acuminate, the size and shape of a pear. Flowering gregarious.

Sikkim (Singtam (Biswas *et al.*, 1991)). Cultivated.

4. CEPHALOSTACHYUM Munro

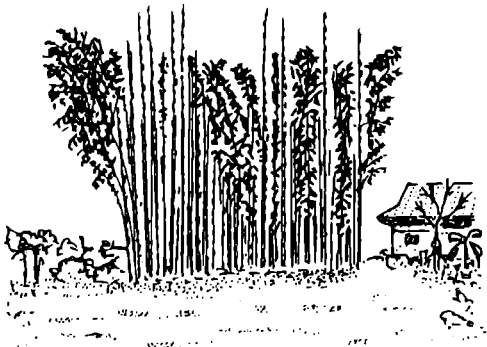
C.M.A. Stapleton

Subtropical bamboos. Rhizomes pachymorph, without extended necks; clumps dense. Culms 6–12m, pendulous; internodes long. Branches subequal; buds short, 2-keeled, closed. Leaf blades without obvious cross-veins, abruptly acuminate. Infl. fully bracteate, initially terminal to a leafy branch, subglobular or globular at maturity; branches (paraclades) unilateral, subtending bracts long, narrow, projecting, with a long awn from midrib or keel; prophylls 2-keeled, one weak, the other strong and awned. Spikelets with basal buds (flowering iterant), terminating in a rachilla extension or rudimentary floret. Fertile lemma 1. Palea delicate, with cross-venation, keels close. Stamens 6, filaments free. Lodicules large, papery, papillate. Style long, hollow. Flowering gregarious.

- 1. Apex of culm sheaths horizontal, lacking auricles; culm nodes glabrous 1. **C. capitatum**
- + Apex of culm sheaths produced into auricles, auricles with visible cross-veins; culm nodes hairy 2. **C. latifolium**

FIG. 3.

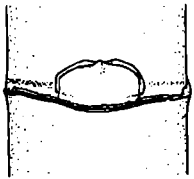
a–d, **Melocanna baccifera**: a, clump habit; b, mid-culm bud; c, culm with sheaths; d, leaf sheath. e–f, **Cephalostachyum** sp.: e, mid-culm bud; f, clump habit. g & i, **C. latifolium**: g, culm with sheaths; i, leaf sheath. h & j, **C. capitatum**: h, culm and sheath; j, leaf sheath. k–o, **Pseudostachyum polymorphum**: k, clump habit; l, mid-culm bud; m, culm sheath; n, culm; o, leaf sheath. Drawn by C. Stapleton (after Stapleton, 1994a).



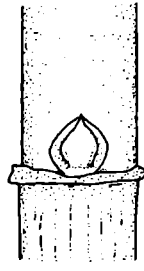
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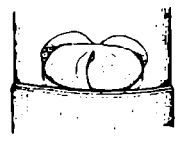
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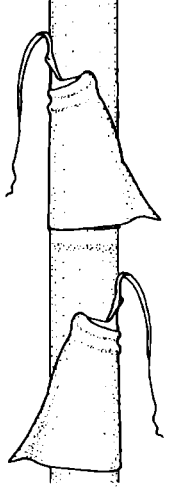
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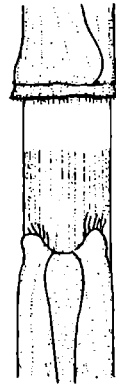
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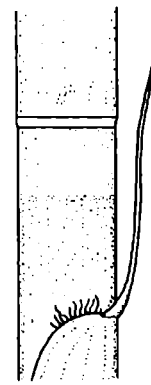
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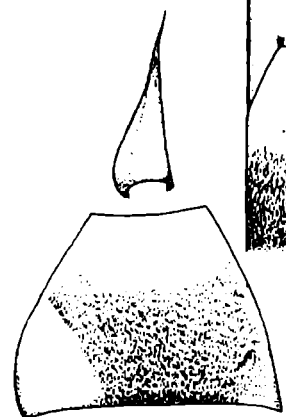
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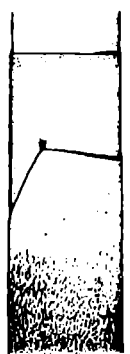
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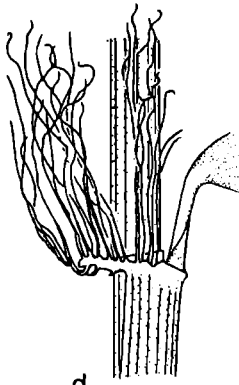
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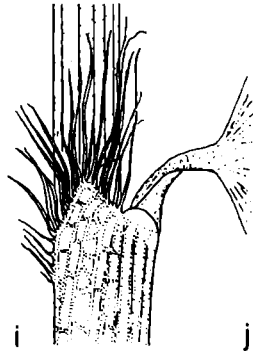
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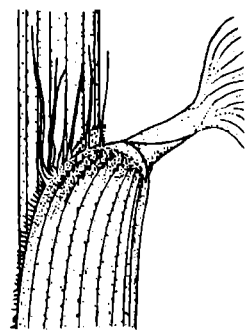
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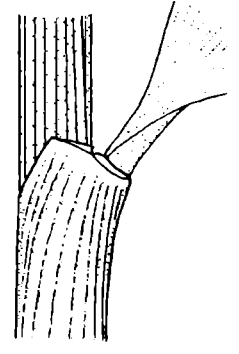
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o

I. BAMBUSEAE

1. *C. capitatum* Munro; *Schizostachyum capitatum* (Munro) R.B. Majumdar *illeg. hom.*; *S. munroi* S. Kumar & P. Singh, incl. var. *decompositum* Gamble. Dz: *jhi*; Keng: *pishima*; Nep: *dulloo bans*; Lep: *payong*. Fig. 3h,j.

Culms to 10m, to 4cm in diameter; internodes to 70cm, smooth, white-pruinose above; nodes level, glabrous. Culm sheaths to 30cm, smooth; margins tough; shoulders level; oral setae long, erect, red, cylindric; blades rolled, often longer than the sheath. Leaf sheath shoulders level; oral setae erect or spreading, cylindric; ligule very short, densely tomentose; blades to 25 × 4cm. Infl. compound, unilateral, becoming subglobular. Spikelets orange-yellow, cylindric; empty glume c.1cm with strong, c.3mm awn; fertile lemma c.1cm, with scabrid, c.2mm awn, exterior glabrous, interior distally tomentose; palea shortly bifid, scabrous between minutely scabrous keels; anthers bifid.

Bhutan: C — Punakha district (Tashitang); S — Deothang district; **Darjeeling** (Songchunglu); **Sikkim.** Habitat not recorded, 1200–1830m.

Culms widely collected from forest areas for weaving into mats; infls. used as paint brushes.

Developmental changes lead to alteration in appearance of the infls. as flowering progresses. Older infls. may be less globular, lateral rather than terminal, and lacking leaves. Such material was described as var. *decompositum* Gamble, but it does not seem to differ substantially from the type variety.

Because of its local name, this species was previously enumerated as *Teinostachyum dullooa* (Stapleton 1994a, 1994b). Although Gamble (1896) included Assamese collections of *dulloo bans* in *T. dullooa*, and adopted that vernacular name as an epithet, the type of *T. dullooa* is from a different species.

2. *C. latifolium* Munro; *C. fuchsianum* Gamble; *Schizostachyum latifolium* (Munro) R.B. Majumdar. Dz: *jhi*; Keng: *pishima*; Lep: *palom*; Nep: *ghopi bans*. Fig. 3g,i.

Culms to 15m, to 5cm in diameter; internodes to 1m, striate, rough, white-pruinose above; nodes thickened, with a corky collar and fringe of hairs. Culm sheaths to 50cm, ridged; edges membranous; shoulders raised, tessellate, delicate; oral setae long and erect, white, flattened, quickly deciduous; blade to 30cm, flat, shorter than the sheath. Leaf sheath shoulders raised; oral setae long, erect, white, flattened, quickly deciduous; ligule long, glabrous; blades broad, to 35 × 7cm. Infl. compound, unilateral, becoming subglobular. Spikelets orange-yellow, cylindric; empty glume c.1cm, with c.6mm awn; fertile lemma c.2cm, with c.2mm, scabrid awn, exterior papillose, interior distally tomentose in centre; palea shortly bifid, scabrous between the minutely scabrous keels; anthers blunt or apiculate.

Bhutan: S — Phuntsholing (S of Gedu), Chukka (Jumudag to Chasilakha), Sarbhang (Sarbhang to Damphu) and Gaylegphug districts; C — Tongsa district (SE of Shemgang); **Darjeeling** (Songchunglu, Labha). Subtropical forest, 1500–2000m.

Culms widely collected from forest areas for weaving into roofing mats; infls. used as paint brushes. The prominent, but quickly deciduous, oral setae of the leaf sheaths, not noticed when *C. latifolium* was described, led to the unnecessary, later, description of *C. fuchsianum*.

5. TEINOSTACHYUM Munro

C.M.A. Stapleton

Subtropical bamboos. Rhizomes pachymorph, without extended necks; clumps dense. Culms 6–12m, pendulous; internodes long. Branches subequal; buds short, 2-keeled, open. Leaf blades without obvious cross-veins. Infl. fully bracteate, spicate, divaricating, initially terminal, later lateral, never globular or unilateral; bracts subtending branches (paraclades) short, not projecting, with awn absent or short; prophylls with 2 equal keels. Spikelets with basal buds (flowering iterant), terminating in a rhachilla extension or rudimentary floret. Fertile lemmas several. Stamens 6, filaments free or connate. Style long, hollow.

1. **T. dulloa** Gamble; *Neohouzeaua dulloa* (Gamble) Camus; *Schizostachyum dulloa* (Gamble) R.B. Majumdar. Nep: *tokhre bans*; Lep: *paksalu*.

Culms to 15m, to 5cm in diameter; internodes to 1m, smooth, white-pruinose above; nodes level, glabrous. Culm sheaths to 30cm, ridged; edges thick; shoulders level; oral setae dense, long, erect, white, cylindrical; blades slightly rolled, sometimes longer than the sheath, interior with dense, thick, opaque, short, scabrous bristles; ligule margin long-ciliate or fimbriate. Leaf sheath shoulders level; oral setae erect or spreading, cylindrical; ligule long, densely tomentose, margin long-ciliate or fimbriate; blade to 25 × 6cm. Infl. compound, unilateral, becoming subglobular. Spikelets very narrow, cylindrical; empty glume and fertile lemmas c.4mm, exterior lightly pubescent; filaments connate, anthers blunt, minutely penicillate.

Darjeeling (Rani Tal, Ramti). Habitat not recorded, 700m.

Collections from Bhutan known as *dulloo bans* (Stapleton 1994a, 1994b) are now identified as *Cephalostachyum capitatum* (see opposite).

6. PSEUDOSTACHYUM Munro

C.M.A. Stapleton

Tropical and subtropical bamboos. Rhizomes pachymorph, extended necks to 3m. Culms 6–16m, pendulous or semi-scandent, in many separate clumps from the same plant (pluricaespitose); walls very thin; internodes short; buds open. Leaf blades with cross-veins visible. Infl. bracteate, all bracts short, not projecting, with awn absent or short, prophylls with 2 equal keels; panicles with curving, wiry branches and pedicels; spikelets with basal buds (flowering iterant), initially narrow, often becoming swollen, curved and hispid. Stamens 6, filaments free. Style hollow. Grain spherical, c.5mm. Flowering gregarious.

1. **P. polymorphum** Munro; *Schizostachyum polymorphum* (Gamble) R.B. Majumdar. Keng: *dai*; Nep: *philim*. Fig. 3k–o.

Culms to 16m, to 4cm in diameter; internodes to 20cm, lightly waxy above, smooth; wall less than 3mm thick; nodes level and glabrous. Culm sheaths very broad, brown-pubescent below, distally waxy; blade triangular, erect, quickly deciduous. Leaf sheaths pruinose; ligule short; auricles and oral setae absent; blade to 35 × 5cm, with weak cross-veins.

Bhutan: S — Sarbhang district (Burborte Khola near Phipsoo); C — Tongsa district (Tingtibi); **Darjeeling** (Latpanchor, Manzing); **Sikkim** (Rungbi Jhora). Subtropical forest, 280–1200m.

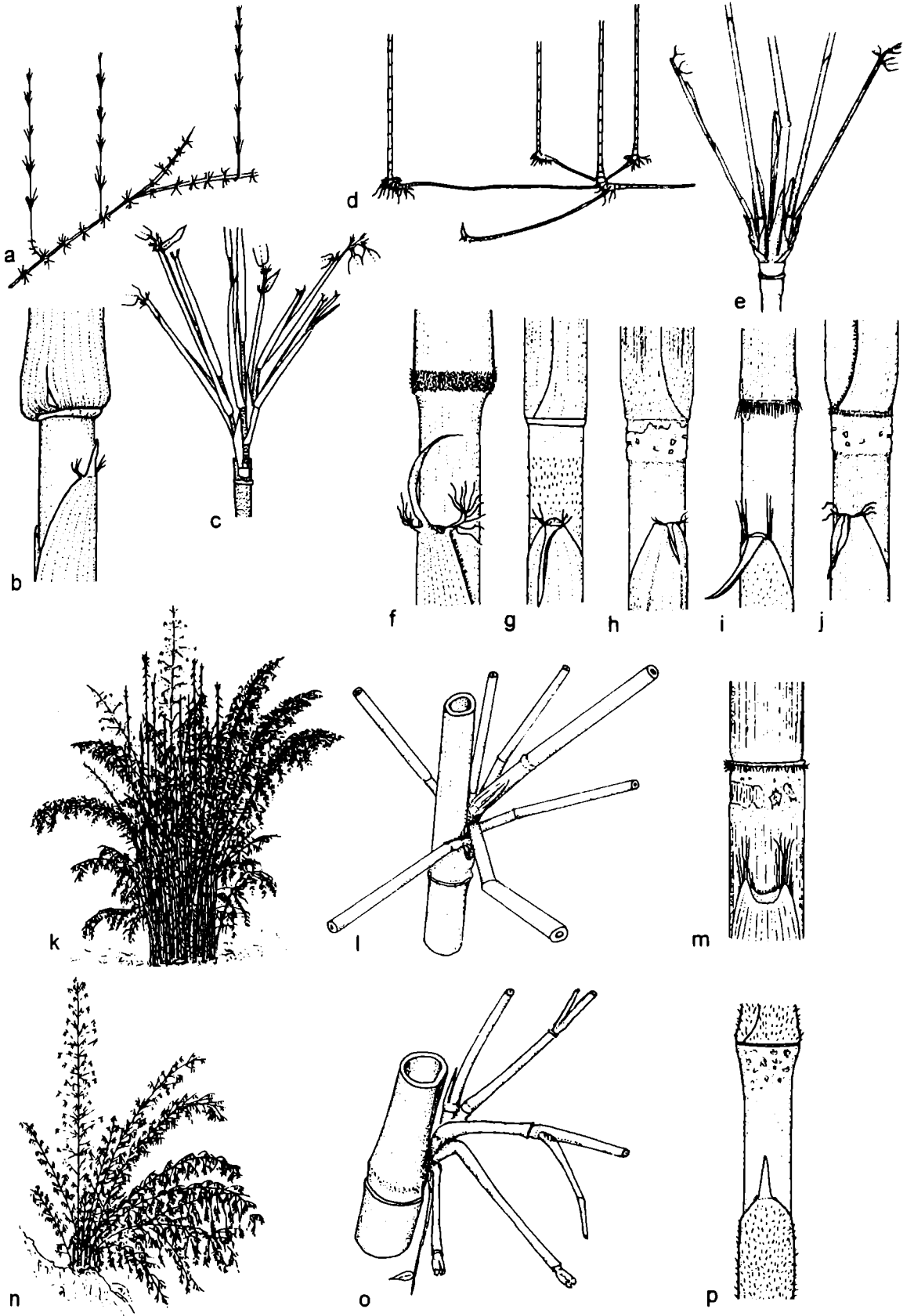
7. ARUNDINARIA Michaux

C.M.A. Stapleton

Temperate bamboos. Rhizomes leptomorph. Culms tillering, in many separate clumps from the same plant (pluricaespitose), erect to drooping;

FIG. 4.

a–c, **Arundinaria racemosa**: a, clump habit; b, culm with sheaths; c, mid-culm branching. d–e, **Yushania** sp.: d, clump habit; e, mid-culm branching. f, **Y. hirsuta**: culm with sheaths. g, **Y. maling**: culm with sheaths. h, **Y. microphylla**: culm with sheaths. i, **Y. pantlingii**: culm with sheaths. j, **Y. yadongensis**: culm with sheaths. k–m, **Borinda grossa**: k, clump habit; l, mid-culm branching; m, culm with sheath. n–p, **Thamnocalamus spathiflorus**: n, clump habit; o, mid-culm branching; p, culm with sheath. Drawn by C. Stapleton (after Stapleton, 1994a).



I. BAMBUSEAE

internodes smooth. Branch buds tall, enclosed within single, 2-keeled prophylls, always open at the front. Branches erect, central branch without compressed basal nodes, branching away from culm, complement becoming fan-shaped. Lateral branch axes always subtended by sheaths. Leaf blades with prominent cross-veins. Infl. branching erect, racemose or paniculate, subtended by very small remnants of sheaths, or rings of hairs, branching often with small pulvini and rarely fascicled; glumes not subtending buds (flowering semelauctant); rhachilla sinuous, strongly flattened; palea curved. Stamens 3. Flowering gregarious.

1. A. racemosa Munro; *Fargesia racemosa* (Munro) T.P. Yi; *Yushania racemosa* (Munro) R.B. Majumdar. Keng: *maxilla*; Lep: *miknu*. Fig. 4a–c, Fig. 6g.

Culms to 2m, nodding; internodes always smooth. Culm sheaths glabrous; auricles small; oral setae spreading; blade erect. Leaf sheath nearly glabrous, without cross-veins; ligule short; auricles small, narrow, erect; oral setae erect, nearly glabrous, stout, persistent; blade to 10cm, margins equally thickened, abaxial surface sparsely long-pilose, adaxial glabrous, cross-veins very prominent. Spikelets with up to 10 florets; rhachilla internodes scabrous with pubescent edges, distally pubescent; fertile lemma scabrous, margins pubescent; palea scabrous, keels ciliate; anthers shortly bifid.

Bhutan: C — Thimphu, Punakha, Tongsa, Bumthang and Mongar districts; N — Upper Mo Chu and Upper Kuru Chu districts; **Sikkim** (Singalila range, Phalut). Coniferous forest and pasture, 2900–3500m.

8. THAMNOCALAMUS Munro

C.M.A. Stapleton

Temperate bamboos. Rhizomes pachymorph, necks to 30cm; culms loose to dense, in a single clump (unicaespitose). Culms drooping to pendulous; internodes to 25cm, smooth, waxy. Mid-culm buds tall, enclosed within single, 2-keeled prophylls, the front of all culm buds open, with lateral branch axes always subtended by sheaths. First year branches usually 5 at mid-culm, from compressed basal nodes on central branch, strongly flattened on one side. Culm sheaths usually with upright, persistent blades. Cross-veins of leaf blades prominent. Infl. partially ebracteate, dense, with racemose or paniculate branching, never unilateral, shortly exerted from broad, persistent subtending sheath; branches occasionally fascicled, pulvini absent, usually subtended by substantial sheaths, or occasionally by rings of hairs; lower glumes often with vestigial basal buds (flowering semelauctant). Stamens 3. Flowering gregarious.

1. **T. spathiflorus** (Trinius) Munro subsp. **spathiflorus**; *T. aristatus* (Gamble) E.G. Camus; *T. spathiflorus* subsp. *aristatus* (Gamble) D.C. McClintock; *Arundinaria spathiflora* Trinius; *A. aristata* Gamble. Dz: *hum*; Lep: *pumoon*; Nep: *rato nigalo*. Fig. 4n–p, Fig. 6n.

Clumps loose. Culms to 5m, slightly crooked; internodes to 20cm, initially lightly grey-waxy, becoming red or yellow; nodes slightly raised. Branches dissimilar, angular, flattened on one side; branchlets becoming multi-noded, pendulous. Culm sheaths tough, symmetrical, densely pubescent with stiff, erect, deciduous hairs; blade distinct; auricles similar; ligule flat. Leaf sheaths glabrous; auricle small; oral setae spreading, red, scabrous; exterior ligule prominently ciliate; petiole waxy, red; blade linear-lanceolate, to 12cm. Pedicels 1–7mm. Spikelets 2–4cm; fertile lemmas 5–15mm, with 5mm, scabrous awn; palea distinctly bifid.

Bhutan: C — Thimphu and Punakha districts; N — Upper Mo Chu and Upper Pho Chu districts; **Sikkim** (Phalut). Common in mixed temperate forest, 2800–3660m.

var. **bhutanensis** Stapleton. Dz: *hum*.

Differs from subsp. *spathiflorus* as follows: clumps tighter; culms with denser wax; culm sheath apex strongly asymmetric, one shoulder horizontal, often with a triangular auricle, ligule oblique; leaf blades broader, more ovate.

Bhutan: N — Upper Kuru Chu district; C — Mongar/Tashigang district (Donga La). Mixed temperate forest, 2800–3500m.

9. BORINDA Stapleton

C.M.A. Stapleton

Subtropical to temperate bamboos. Rhizomes pachymorph, necks to 30cm. Culms in a single dense to loose clump (unicaespitose), erect or curving below, nodding to drooping above; internodes to 50cm, usually striate, lightly waxy; nodes scarcely raised. Mid-culm branch buds very tall, enclosed between 2, single-keeled bracts, open at front, lateral branch axes lacking subtending sheaths. Basal culm buds closed at front by fusion of margins. First year branches usually 7 at mid-culm, from compressed basal nodes on central branch. Culm sheaths usually delicate, blades long, reflexed, deciduous. Leaf blades persistent or deciduous in winter, cross-veins strong. Infl. ebracteate, contracted, with erect branches (paraclades); branching paniculate, never unilateral, mostly exerted from narrow subtending sheath, not fascicled, pulvini absent, subtended by greatly reduced sheath remnants or hairs; glumes

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loose at base, with space for buds, frequently subtending buds of limited viability (flowering semelauctant). Stamens 3.

1. **B. grossa** (T.P. Yi) Stapleton; *Fargesia grossa* T.P. Yi. Dz: *rhui*, *baa*. Fig. 4k–m, Fig. 6m.

Clumps dense; culms to 10m, to 4.5cm in diameter, erect below, drooping above; internodes to 50cm, prominently striate, lightly waxy; nodes densely waxy below, level, shortly pubescent. Culm sheaths triangular, to 25cm, distally with dense, deciduous, erect, brown bristles, pilose near base; blade slender, to 7cm, decurrent; auricles absent or small; oral setae 8mm, thick, erect, straight, brown, glabrous, striate; ligule shortly fimbriate, pubescent. Leaf sheaths glabrous; auricles absent; oral setae 5mm, erect, wavy; ligule pubescent, truncate; blade to 25cm, persistent in winter. Pedicels to 25mm. Spikelets 2–5cm; fertile lemmas 10–15mm, with 3–5mm awn, edges pubescent; palea blunt or very shortly bifid.

Bhutan: C — Punakha, Tongsa, and Bumthang districts. Wet, temperate, mixed forest, often in association with *Tsuga dumosa*; also cultivated, 2600–3200m.

An economically important, naturally occurring, forest product, and widely cultivated around houses near the Pele La. Culms extensively and systematically harvested for weaving into fencing lattices and roofing mats.

10. YUSHANIA Keng f.; *Butania* Keng f.; *Burmabambus* Keng f.

C.M.A. Stapleton

Temperate bamboos. Rhizomes pachymorph, necks to 3m. Culms in many separate clumps from the same plant (pluricaespitose), forming extensive thickets, erect below, nodding to drooping above; internodes to 50cm, lightly waxy, usually rough. Mid-culm branch buds very tall, enclosed between 2, single-keeled bracts, open at front, lateral branch axes lacking subtending sheaths. Basal culm buds closed at front and back by fusion of margins. First year mid-culm branches usually 7, from compressed basal nodes on central branch. Central branch often dominant, especially at lower nodes. Culm sheaths basally thickened, usually with reflexed blades. Cross-veins of leaf blades strong. Infl. ebracteate, open, branches (paraclades) spreading widely; branching paniculate, never unilateral, completely exerted from narrow subtending sheath, not fascicled, pulvini frequent, subtended by hairs; glumes basally tight, without any subtended buds or space for buds (flowering semelauctant). Stamens 3. Flowering gregarious.

Yushania species have invasive rhizomes. Larger species form dense thickets that restrict tree regeneration and are difficult to control; they provide, however, winter grazing for livestock and wildlife, and the culms are harvested for fencing and *eccra* walling.

- 1. Rhizome neck hollow 2
- + Rhizome neck solid 3
- 2. Leaf sheath auricles small; oral setae spreading 3. **Y. microphylla**
- + Leaf sheath auricles absent; oral setae erect 5. **Y. yadongensis**
- 3. Leaf sheath auricles large, persistent; oral setae spreading widely
- 1. **Y. hirsuta**
- + Leaf sheath auricles small or absent, oral setae few, erect 4
- 4. Base of new culm sheath glabrous, or with small, deciduous hair ring
- 2. **Y. maling**
- + Base of new culm sheath with prominent, persistent frill of hairs
- 4. **Y. pantlingii**

1. Y. hirsuta (Munro) R.B. Majumdar; *Sinarundinaria hirsuta* (Munro) Chao & Renvoize. Dz: *hima*. Fig. 4f, Fig. 6h.

Rhizome necks solid. Culms to 8m; internodes to 40cm, densely scabrous. Culm sheaths very tough, dark brown, glabrous with broad, dense, basal ring of dark brown hairs; auricles large, spreading, antler-like; oral setae long, spreading, persistent. Leaf sheaths long-pilose, hairs deciduous; auricles large, sickle-shaped, spreading; oral setae long, spreading, persistent; ligule long, pubescent; exterior ligule shortly ciliate. Flowers unknown.

Bhutan: S — Chukka district; C — Thimphu and Tongsa districts; N — Upper Mo Chu district; **Sikkim** (Penlong La, Gangtok). Coniferous and broad-leaved forest, 1800–2800m.

Type material from Meghalaya has denser, more persistent leaf sheath hairs, broader, less sickle-shaped auricles, and mainly pubescent culm sheaths that are glabrous at the base. Bhutanese material differs in having the culm sheath pubescence closer to that of *Y. pantlingii* from Sikkim. Flowers are not known from either Meghalaya or Bhutan.

2. Y. maling (Gamble) R.B. Majumdar; *Sinarundinaria maling* (Gamble) Chao & Renvoize. Nep: *maling*; Lep: *pheung*. Fig. 4g, Fig. 6i.

Rhizome necks solid. Culms to 5m; internodes to 30cm, initially densely scabrous below nodes. Culm sheaths papery, with scattered, appressed or erect, brown hairs, and variable ring of upward-pointing hairs around base; auricles absent or small; oral setae few, erect or spreading. Leaf sheath

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glabrous; ligule long, rounded; auricles absent; oral setae few, tall, erect, glabrous. Spikelets long, narrow; rhachilla densely pubescent with white tuft below lemmas; fertile lemmas scabrous, mucronate, with pronounced midrib; palea pubescent between scabrous or ciliate keels.

Bhutan: S — Chukka district; N — Upper Mo Chu district; **Darjeeling** (Ghoom to Sukia Pokhri, Labha, Panksari); **Sikkim** (Dzongri). Mixed temperate forest, 1800–3100m.

3. *Y. microphylla* (Munro) R.B. Majumdar; *Sinarundinaria microphylla* (Munro) Chao & Renvoize. Dz; *mingma*; Keng: *meg*. Fig. 4h, Fig. 6j.

Rhizome necks hollow. Culms to 3m; internodes smooth, persistent, blackening, waxy ring present below nodes. Culm sheaths tough, \pm striped, with light, matted, white hairs towards base; auricles absent; oral setae scarce. Leaf sheaths pubescent at margins; ligule short, truncate; auricles pronounced; oral setae spreading, tough, scabrous; blade with one margin strongly thickened and long-scabrous, abaxial surface persistently pilose. Flowers unknown.

Bhutan: C — Punakha, Tongsa, Bumthang and Tashigang districts. Cool-temperate areas, forming extensive stands in subalpine pasture, 2300–3500m.

4. *Y. pantlingii* (Gamble) R.B. Majumdar; *Semiarundinaria pantlingii* (Gamble) Nakai; *Butania pantlingii* (Gamble) Keng f.; *Sinarundinaria pantlingii* (Gamble) Chao & Renvoize. Keng: *zing*. Fig. 4i, Fig. 6k.

Rhizome necks solid. Culms to 8m; internodes finely striate, lightly scabrous. Culm sheaths quite tough, distally appressed brown-setose or pilose towards base in the centre, one margin long-ciliate, with prominent basal fringe of reflexed, light brown hairs; auricles absent or small; oral setae few, erect; ligule quite tall, rounded, shortly pubescent, shortly fimbriate. Leaf sheath glabrous, tough, one margin initially long-ciliate; ligule very short; auricles absent; oral setae tall, erect, scabrous at base; exterior ligule long-ciliate on one side or short-ciliate on both sides. Spikelets long, narrow; rhachilla densely pubescent, with white tuft below the glabrous fertile lemmas; palea tomentose between scabrous keels.

Bhutan: C — Tongsa (Changkha to Chendebi) and Tashigang districts. Common in coniferous and broad-leaved forest, 1700–2600m.

The culms are very tough and used for flooring.

Central and eastern collections are similar in having a prominent frill of hairs below the nodes; they are tentatively included in *Y. pantlingii* on the basis of their leaf sheath characteristics and the hairs on the culm sheath bases. Eastern collections, however, are also quite similar to *Y. elegans* (Kurz) R.B. Majumdar from Nagaland and further collections and study are required.

5. *Y. yadongensis* T.P. Yi. Fig. 4j, Fig. 6l.

Rhizome necks hollow. Culms to 3m; internodes lightly scabrous, striate; persistent, blackening, waxy ring present below nodes; nodes with a light ring of hairs. Culm sheaths tough, with scarce white hairs; auricles small; oral setae few, densely scabrous. Leaf sheaths glabrous or margins pubescent; ligule rounded; auricles absent; oral setae erect, tough, scabrous; blade abaxially lightly pilose. Flowers unknown.

Bhutan:C — Thimphu district; **N** — Upper Mo Chu district; **Sikkim** (Dzongri). Mixed temperate forest; along streams in blue pine forest, 2300–3700m.

This species was included under *Y. microphylla* in Stapleton (1994a).

11. DREPANOSTACHYUM Keng f.

C.M.A. Stapleton

Subtropical bamboos. Rhizomes pachymorph, necks to 25cm. Culms in a single dense clump (unicaespitose), to 5m, usually smooth, erect below, pendulous above; internodes to 25cm; nodes raised. Mid-culm branch buds ovate, enclosed between 2, single-keeled bracts, open at front; lateral branches many, visibly 2-ranked, lacking subtending sheaths. Mid-culm branches c.25 in first year, later to 80, subequal, from compressed basal nodes on central branch. Culm sheaths scabrous at apex or pubescent on interior, distally acuminate. Cross-veins of leaf blades not visible. Infl. ebracteate, open, with erect or spreading, strongly fascicled, sickle-shaped branches (paraclades); branching paniculate, never unilateral, completely exerted from short subtending sheaths, pulvini absent, subtended by hairs or reduced sheaths; glumes delicate, always 2, without basal buds (flowering semelauctant); spikelets mainly with more than 1 floret. Stamens 3. Flowering gregarious.

Drepanostachyum species are widely browsed by livestock and sometimes planted to provide fodder, and culms for weaving.

1. Culm sheaths with basal ring of dense, brown hairs **1. D. annulatum**
+ Culm sheaths without basal ring of dense, brown hairs 2
2. Leaf sheath ligules more than 2mm long **4. D. polystachyum**
+ Leaf sheath ligules less than 2mm long 3
3. Leaf sheath auricles over 2mm wide **2. D. intermedium**
+ Leaf sheath auricles 0–2mm wide **3. D. khasianum**

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1. *D. annulatum* Stapleton. Dz: *him*; Nep: *ban nigalo*. Fig. 5i,n,o, Fig. 6o.

Culms to 3m; internodes to 20cm, dark green, initially with uniform, dense, deciduous wax; nodes raised, with ring of deciduous, brown hairs. Culm sheaths blotched above, glabrous or sparsely pilose, with basal ring of dense, brown hairs; interior densely pubescent below ligule; ligule long; auricles and oral setae absent. Leaf sheath glabrous; auricles and oral setae absent or scarce; ligule rounded, long; blade mainly glabrous. Fertile florets 2–3; lemma distally scabrous, margins distally shortly ciliate initially; palea and keels scabrous, apex shortly bifid or truncate.

Bhutan: S — Chukka district (Chukka). Deciduous forest, 1000–2000m.

2. *D. intermedium* (Munro) Keng f.; *Chimonobambusa intermedia* (Munro) Nakai; *Sinarundinaria intermedia* (Munro) Chao & Renvoize. Nep: *tite nigalo*; Lep: *parmiok*. Fig. 5j, Fig. 6a,b,p.

Culms to 4m; internodes to 20cm, dark green, wax scarce; nodes raised. Culm sheaths glabrous; interior densely scabrous below ligule; ligule very long; auricles and oral setae absent. Leaf sheath variably pilose; auricles large; oral setae long, spreading; ligule long, rounded or truncate; blade abaxially pubescent. Spikelets with 2–3 fertile florets; lemma mainly glabrous, distally shortly ciliate initially; palea keels distally scabrous, apex shortly bifid.

Bhutan: S — Sarbhang district; C — Tongsa district (S of Shemgang, near Khosela); **Darjeeling** (above Sivoke, Goke); **Sikkim** (Yampung). Evergreen oak and chestnut forest; also cultivated, 1000–2100m.

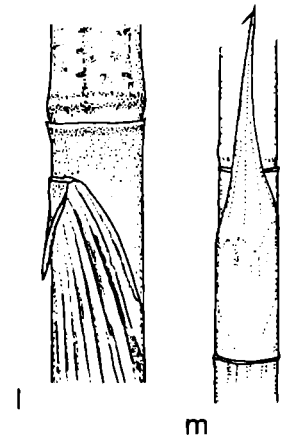
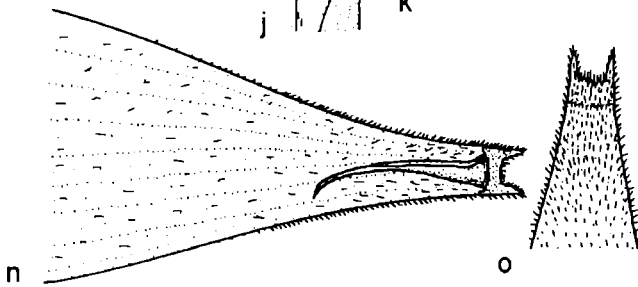
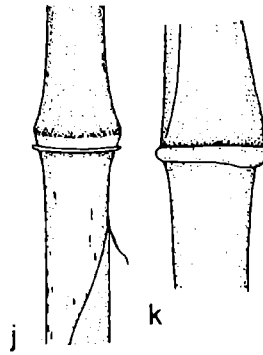
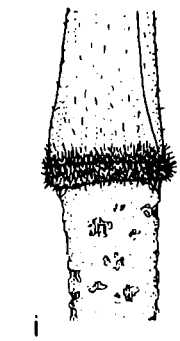
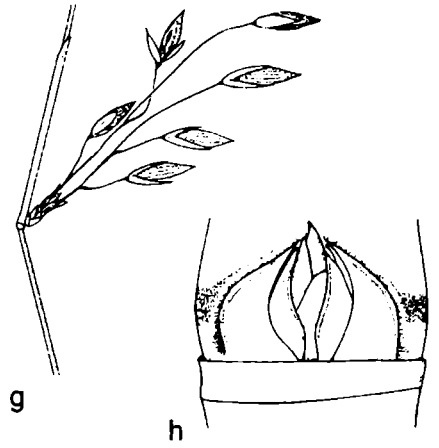
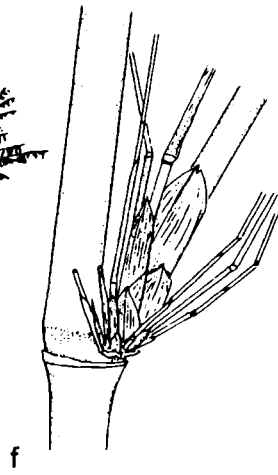
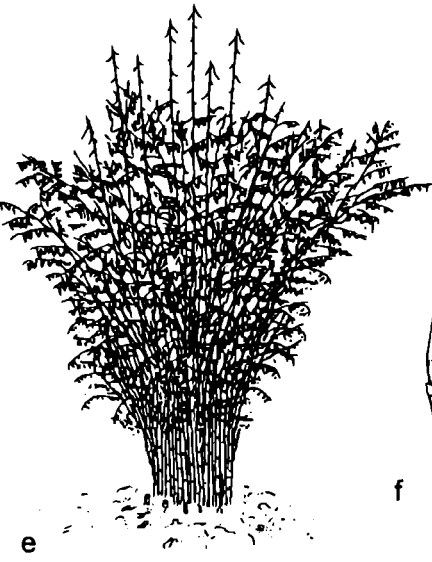
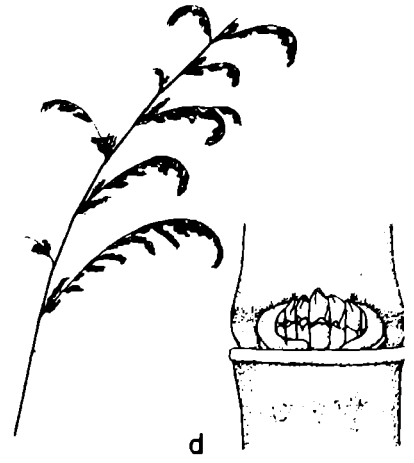
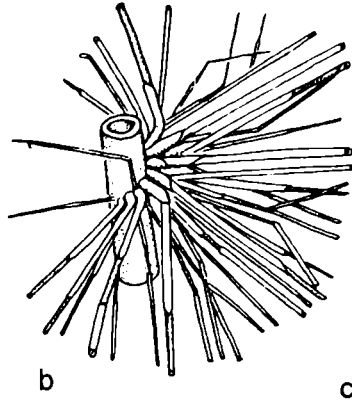
The Sikkim material (collected by Kennedy) was initially misidentified as *D. suberectum*, which is treated here as a synonym of *D. khasianum*.

3. *D. khasianum* (Munro) Keng f.; *Chimonobambusa khasiana* (Munro) Nakai; *Drepanostachyum suberectum* (Munro) R.B. Majumdar. Dz: *daphe*; Nep: *ban nigalo*. Fig. 5k, Fig. 6c,d,q.

Culms to 3m; internodes to 20cm, dark green, wax scarce; nodes raised. Culm sheaths glabrous; interior lightly scabrous below ligule; ligule short;

FIG. 5.

a–d, *Drepanostachyum* sp.: a, clump habit; b, mid-culm branching; c, infls.; d, mid-culm bud. e–h, *Himalayacalmus* sp.: e, clump habit; f, mid-culm branching; g, infls.; h, mid-culm bud. i–m, culm nodes with sheaths: i, *Drepanostachyum annulatum*: culm node; j, *D. intermedium*: culm node and sheath apex; k, *D. khasianum*: culm node; l, *Himalayacalamus falconeri*; m, *H. hookerianus*; n & o, *Drepanostachyum annulatum*: n, culm sheath apex exterior; o, culm sheath apex interior. Drawn by C. Stapleton (after Stapleton, 1994a).



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auricles and oral setae absent. Leaf sheath glabrous; auricles absent; oral setae absent or scarce; ligule rounded, long, densely pubescent; blade mainly glabrous. Spikelets with 1–2 fertile florets; lemma mainly glabrous, distally shortly ciliate initially; palea keels distally scabrous, apex shortly bifid.

Bhutan: C — Punakha (Tinlegang, Wangdi Phodrang) and Tongsa districts; N — Upper Mo Chu district. Deciduous, subtropical forest and roadsides, 1000–1600m.

4. *D. polystachyum* (Gamble) R.B. Majumdar.

Rhizome, culms and culm sheaths not known. Leaf sheaths glabrous; auricles and oral setae absent; shoulders rising steeply, very shortly ciliate; ligule very long, striate, basally shortly pubescent, lacerate; blade abaxially lightly pubescent with glandular hairs; cross-veins faint. Spikelets with 3–5 fertile florets; palea longer than lemma; lemma margins lightly pubescent; palea keels scabrous.

?**Darjeeling** (Hoom). Habitat not recorded, 1200–1500m.

Further work is required – the Mann syntype from Meghalaya is rather different and previous lectotypification (Chao & Renvoize, 1989) was inadequate.

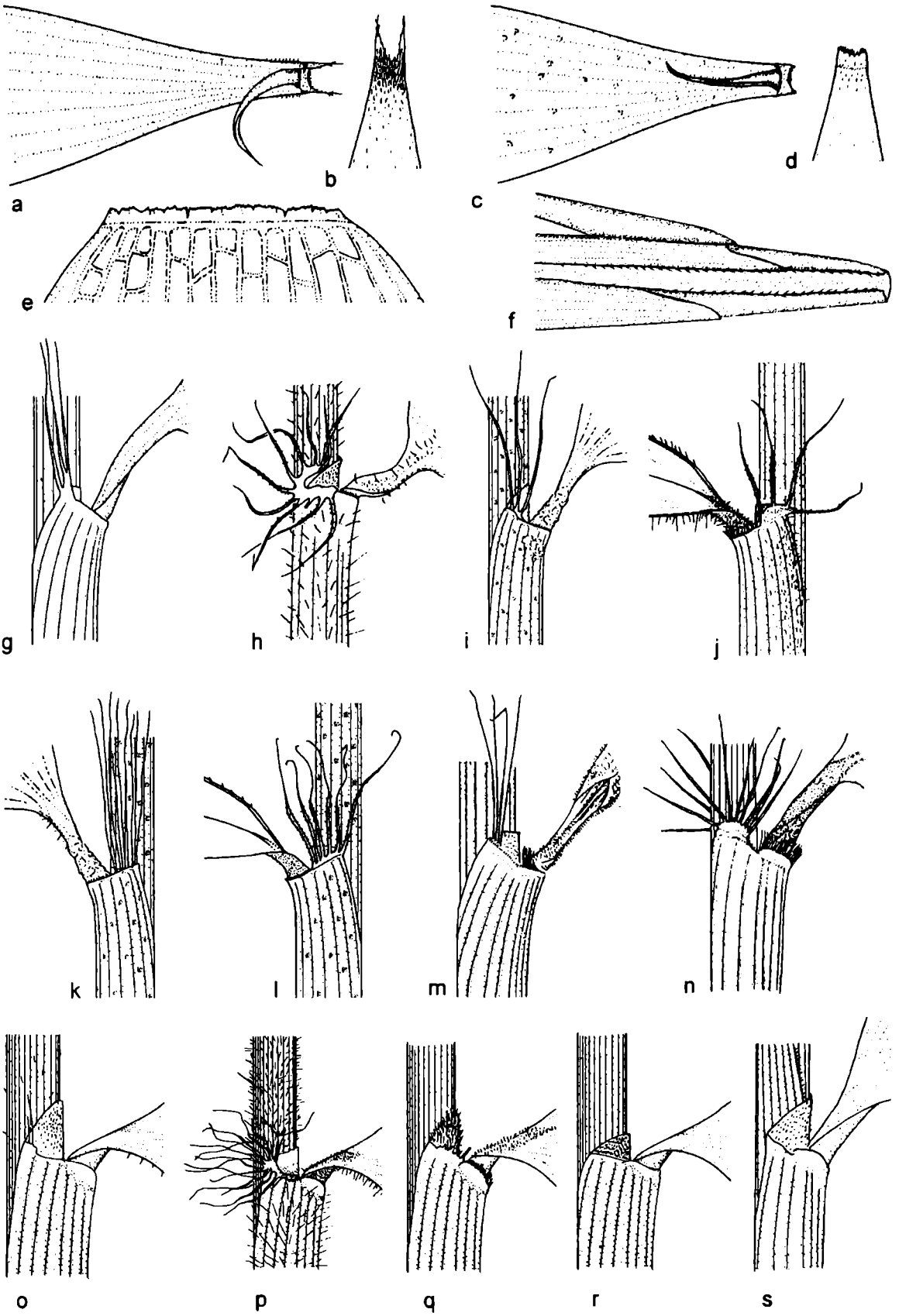
12. HIMALAYACALAMUS Keng f.

C.M.A. Stapleton

Subtropical to temperate bamboos. Rhizomes pachymorph, necks to 25cm. Culms in a single dense clump (unicaespitose), to 12m, erect below; internodes to 50cm; nodes slightly raised. Mid-culm branch buds ovate, enclosed between 2, single-keeled bracts, open at front, few lateral branch axes visible, lacking subtending sheaths. Mid-culm branches c.15 in first year, later to 40, from compressed basal nodes on central branch; central branch large or dormant, sometimes with aerial roots. Culm sheaths glabrous below ligule on interior, distally usually acute or obtuse rather than acuminate. Leaf blades usually lacking cross-veins. Infl. ebracteate, open, with short or erect, fascicled

FIG. 6.

a–f, culm sheath apices: a & b, *Drepanostachyum intermedium*; c & d, *D. khasianum*; e, *Himalayacalamus falconeri* (interior); f, *H. hookerianus*. g–s, leaf sheaths: g, *Arundinaria racemosa*; h, *Yushania hirsuta*; i, *Y. maling*; j, *Y. microphylla*; k, *Y. pantlingii*; l, *Y. yadongensis*; m, *Borinda grossa*; n, *Thamnocalamus spathiflorus*; o, *Drepanostachyum annulatum*; p, *D. intermedium*; q, *D. khasianum*; r, *Himalayacalamus falconeri*; s, *H. hookerianus*. Drawn by C. Stapleton (after Stapleton, 1994a).



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branches (paraclades); branching paniculate with basal branches absent, never unilateral, completely exerted from short subtending sheaths, pulvini absent, subtended by hairs or reduced sheaths; glumes delicate, always 2, without basal buds (flowering semelauctant); spikelets mainly with 1 fertile floret. Stamens 3. Flowering gregarious.

1. Culm sheaths short, broad at apex, asymmetrical; new culms with thin white wax **1. H. falconeri**
- + Culm sheaths tall, narrow at apex; new culms with thick blue wax
2. H. hookerianus

1. H. falconeri (Munro) Keng f.; *Thamnocalamus falconeri* Munro. Nep: *singhane*. Fig. 5l, Fig. 6e,r.

Culms to 6m; new shoots with thick, glutinous exudate, drying to a thin, white wax; internodes to 30cm, smooth, red above and below nodes; nodes white, slightly raised. Culm sheath glabrous, apex broad, asymmetric, distally obtuse; auricles and oral setae absent; ligule broad, short. Leaf sheath glabrous; auricles and oral setae absent; ligule rounded, short; blade glabrous. Spikelets 1, rarely 2; pedicels to 3mm; lemma glabrous, prominently mucronate, margins distally short-ciliate; palea glabrous, keels glabrous or slightly scabrous, with distal tuft of hairs.

Bhutan: S — Chukka (Gedu, Chasilakha) and Deothang (S of Riserboo) districts; **Sikkim** (Laghep, Tendong, Karponang). Cool, broad-leaved forest, 2000–3100m.

Culms harvested from the forest and used for weaving; the leaves are used as animal fodder and the shoots are edible.

2. H. hookerianus (Munro) Stapleton; *Sinarundinaria hookeriana* (Munro) Chao & Renvoize; *Chimonobambusa hookeriana* (Munro) Nakai; *Drepanostachyum hookerianum* (Munro) Keng f. Nep & Lep: *padang, parang*. Fig. 5m, Fig. 6f,s.

Culms to 8m; internodes to 40cm, smooth, uniformly bluish-green to purple or yellow; nodes level. Culm sheaths glabrous, very long, distally long-acuminate; auricles and oral setae absent; ligule narrow, long. Leaf sheath glabrous; auricles and oral setae absent; ligule rounded, long; blade glabrous. Spikelets 1(–2); pedicels to 20mm; lemma pubescent, prominently mucronate, margins distally long-ciliate; palea pubescent, keels scabrous.

Bhutan: S — Sarbhang district (Chirang, Lamidanda); **Darjeeling** (Pasheting, Lodagaon to Rissisum, Darjeeling to Lebong); **Sikkim** (Yoksam, Chungthang). Native in forest in Sikkim; cultivated in Bhutan, 1000–2110m.

The culms are used for weaving and the leaves as animal fodder.

13. AMPELOCALAMUS S.L. Chen, T.H. Wen & G.Y. Sheng

C.M.A. Stapleton

Subtropical bamboos. Rhizomes pachymorph with necks to 25cm. Culms in a single, dense clump (unicaespitose), to 12m, erect below, pendulous to semi-scandent above; internodes to 50cm; nodes often with a prominent, corky ring. Mid-culm branch buds ovate, enclosed within a 2-keeled, fused budscale, initially closed at front; lateral branches without subtending sheaths. Mid-culm branches c.25 in first year, from compressed basal nodes on central branch, subequal, strongly geniculate, aerial roots present or absent. Culm sheaths distally acuminate with broad apex, margins often prominently ciliate or fimbriate. Leaf blades lacking cross-veins. Infl. partially bracteate, open, with pendulous, fascicled branches (paraclades), completely exerted from short subtending sheaths; branching racemose to paniculate, never unilateral, pulvini absent, subtended by hairs, or reduced, but often substantial, sheaths. Spikelets large; pedicels thin, wiry, scabrous or pubescent; glumes 1–2, delicate, the lower lacking in terminal spikelet, the upper often subtending a rudimentary axis (flowering semelauctant). Stamens 3. Flowering gregarious.

1. **A. patellaris** (Gamble) Stapleton; *Dendrocalamus patellaris* Gamble; *Patellocalamus patellaris* (Gamble) W.T. Lin; *Sinocalamus patellaris* (Gamble) T.Q. Nguyen; *Chimonobambusa jainiana* C.R. Das & D.C. Pal; *Drepanostachyum jainianum* (C.R. Das & D.C. Pal) R.B. Majumdar; *Sinarundinaria jainiana* (C.R. Das & D.C. Pal) H.B. Naithani. Nep: *nibha*, *ghopi bans*; Lep: *pajiok*. Fig. 7a–c,g,i.

Culms to 12m, to 5cm in diameter, strongly pendulous or semi-scandent above; internodes to 50cm, strongly striate, sparsely black-setose; nodes with prominent, wavy, corky collar. Culm sheath with long-feathered margins; blade broad, reflexed. Leaf sheath glabrous; shoulders rising, with long, erect oral setae; auricles absent; ligule short, fimbriate. Spikelets 2–3cm; florets 4–7; pedicels to 35mm; glumes pale; lemmas darker, deeply furrowed, lightly scabrous, margins long-pubescent; palea nearly glabrous, keels scabrous; apex blunt, shortly ciliate.

Darjeeling (Kalimpong); **Sikkim** (Jungat). Cultivated, 1220m.

The culms are used for weaving and the leaves as animal fodder.

14. NEOMICROCALAMUS Keng f.

C.M.A. Stapleton

Rhizomes pachymorph, necks long. Culms in many, separate, dense clumps from the same plant (pluricaespitose), to 12m, solid or hollow, narrow, semi-

I. BAMBUSEAE

scandent; internodes to 50cm, smooth or scabrous; nodes level. Mid-culm buds tall, enclosed within a 2-keeled prophyll, open at front; lateral branches subtended by sheaths. First year branches c.15 at mid-culm, from compressed basal nodes on large, dominant, scandent central branch, strongly geniculate. Culm sheaths tough, smooth or scabrous, apex narrow; blade needle-shaped. Leaf sheaths glabrous; auricles and oral setae absent; blade thin, acuminate, lacking cross-veins; foliage forming dense curtains over tree branches. Infl. bracteate, open, with paniculate branching; branches (paraclades) subtended by sheaths, with prophylls at the point of branching; spikelets sessile; florets broad, not overlapping; glumes 1–2; both prophylls and glumes lacking subtending buds (flowering semelauctant); rhachilla long, sinuate. Stamens 6.

1. **N. andropogonifolius** (Griff.) Stapleton; *Bambusa andropogonifolia* Griff. Sha: *ringshu*; Keng: *ula*; Nep: *langma*. Fig. 7d–f,h,j, Fig. 8a–b.

Rhizome necks to ?1m, clumps pluricaespitose, dense. Culms to 12m, very smooth, narrow, hollow, semi-scandent; internodes to 50cm, glossy green; nodes level. Culm sheaths tough, smooth, glabrous, blotched, apex narrow, blade needle-shaped. Leaf sheaths glabrous; auricles and oral setae absent; blade thin, broad, long-acuminate, glabrous; ligule triangular, glabrous. Infl. not known.

Bhutan: S — Manas and Deothang districts. Subtropical forest, 300–1800m.

Harvested from natural forest. Culm strips are dyed and woven into hats, arrow quivers and food containers (Dz: *bangchung*).

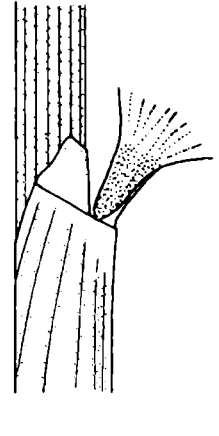
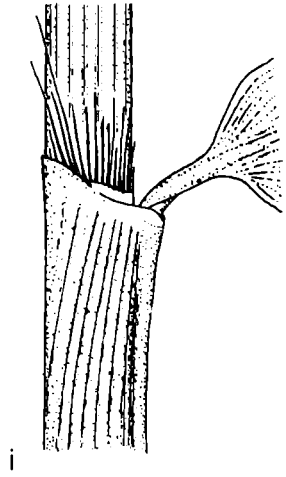
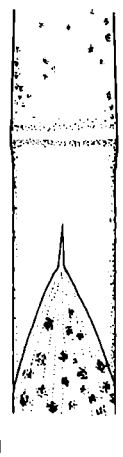
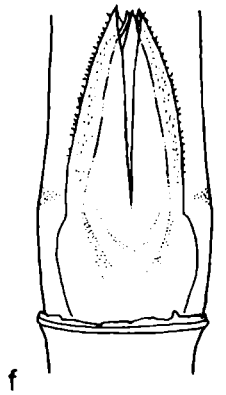
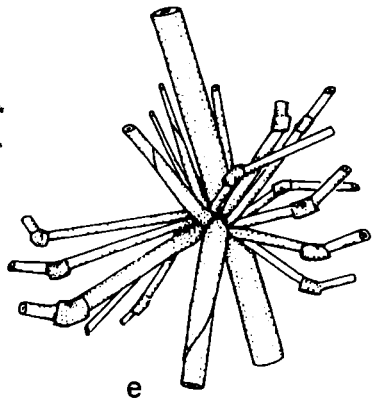
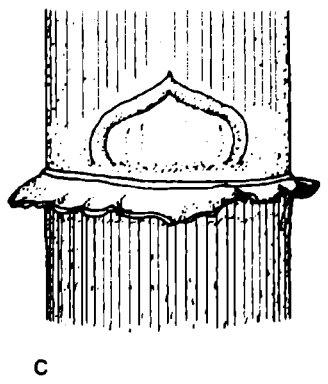
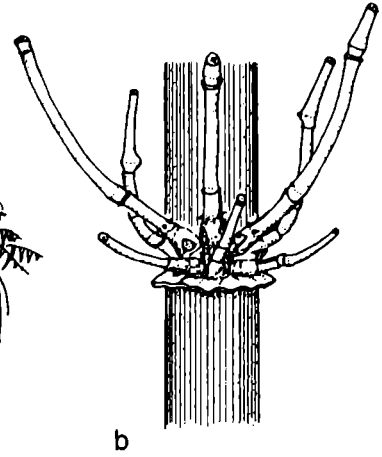
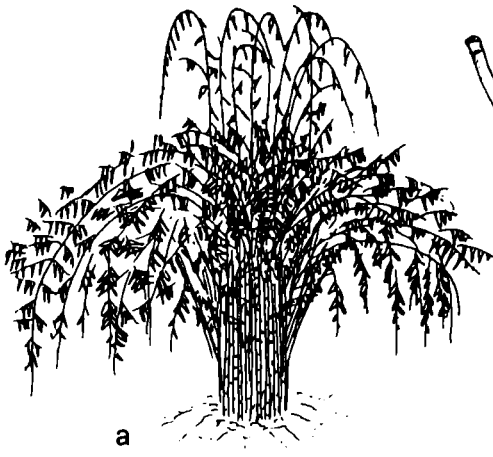
15. CHIMONOBAMBUSA Makino

C.M.A. Stapleton

Rhizomes leptomorph; culms arising singly. Culms to 8m, erect; nodes swollen, often with ring of thorns; internodes smooth or scabrous, ridged above branches, often slightly quadrangular. Mid-culm branch buds ovate, enclosed between 2, single-keeled bracts, open at front; lateral branches 2, from compressed basal nodes on dominant central branch, with subtending

FIG. 7.

a–c, g, i, **Ampelocalamus patellaris**: a, clump habit; b, mid-culm branching; c, mid-culm bud; g, culm node and sheath apex; i, leaf sheath. d–f, h, j, **Neomicrocalamus andropogonifolius**: d, clump habit; e, mid-culm branching; f, mid-culm bud; h, culm node and sheath apex; j, leaf sheath. Drawn by C. Stapleton (after Stapleton, 1994a).



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sheaths. Branches usually 3. Leaf blades with strong cross-veins. Infl. bracteate, mainly exerted from broad, persistent, often bladed sheaths; branches (paraclasses) erect, dense, clustered, subtended by sheaths; branching racemose to paniculate, never unilateral, pulvini absent; branching always prophyllate, prophyll of lateral spikelets a lower glume; terminal spikelet with 1–2 glumes; prophyll and glumes lacking subtending buds or with buds that may (flowering itercauctant) or may not (flowering semelauctant) develop. Spikelets narrow, cylindrical. Florets just overlapping; rhachilla long. Stamens 3. Flowering gregarious.

1. **C. callosa** (Munro) Nakai. Dz: *u*; Keng: *rawa*; Nep: *khare bans*. Fig. 8c–i.

Culms to 6m; nodes pubescent, with ring of thorns; internodes smooth, mottled brown, terete. Culm sheaths lightly pubescent; blades small, erect; auricles absent; oral setae few, erect. Leaf sheaths glabrous with ciliate edges; auricles small, spreading laterally; oral setae long and erect. Infl. axis pubescent. Terminal spikelet rudimentary. Lateral spikelets long; glumes with small vestigial buds; florets fewer than 10; rhachilla glabrous; lemma glabrous; palea keels ciliate.

Bhutan: S — Phuntsholing, Chukka (N of Jumudag) and Deothang (S of Riserboo) districts; C — Tongsa (Shemgang) and Tashigang districts. 1400–2200m.

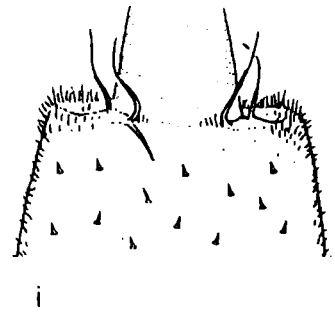
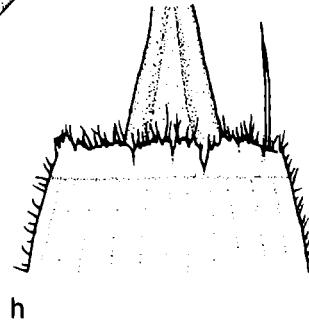
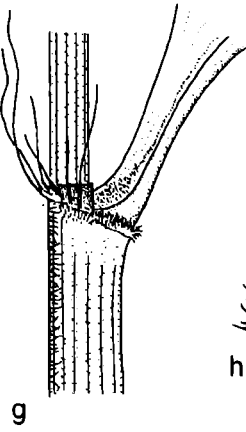
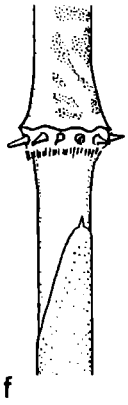
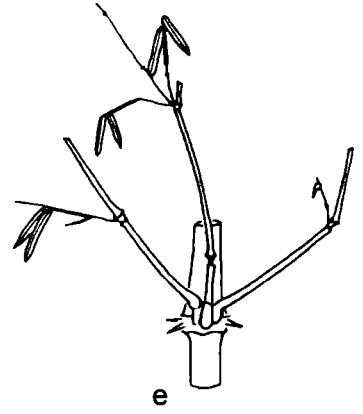
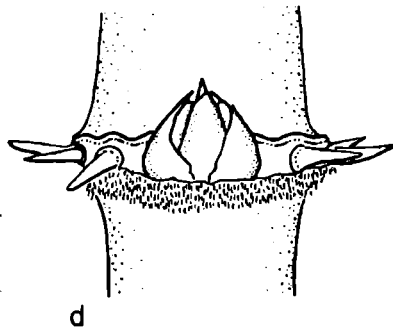
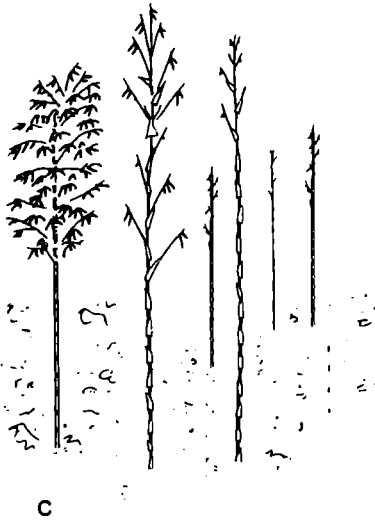
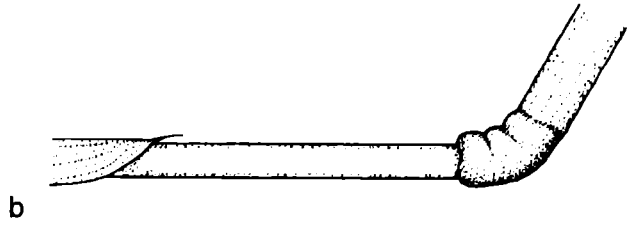
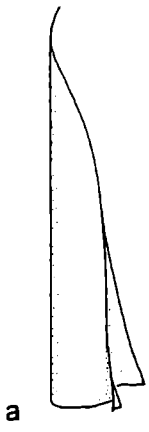
Gamble (1896) reported that Pantling had found a thorny bamboo in Sikkim (Paong gong) in 1895. This collection was cited by Chao & Revoize (1989) under *Sinarundinaria griffithiana* (Munro) Chao & Renvoize (*Chimonocalamus griffithianus* (Munro) Hsueh & Yi); however it shows no thorns whatsoever, and seems to represent an as yet unidentified species of *Yushania*, rather than either *Chimonobambusa callosa* or *Chimonocalamus griffithianus*. There is no evidence that the thorny, clump-forming genus *Chimonocalamus* is found in the Himalaya.

Tribe II. ORYZEAE Dumortier

1. Spikelets with 2, glume-like, sterile lemmas below fertile floret **16. Oryza**
+ Spikelets consisting of a single fertile floret **17. Leersia**

FIG. 8.

a–b, *Neomicrocalamus andropogonifolius*: a, culm sheath; b, swollen node on branchlet. c–i, *Chimonobambusa callosa*: c, clump habit; d, mid-culm bud; e, mid-culm branching; f, culm node and sheath apex; g; leaf sheath; h & i, culm sheath apex: h, interior; i, exterior. Drawn by C. Stapleton (after Stapleton, 1994a).



16. ORYZA L.

Perennial or annual, tufted or shortly rhizomatous. Culms unbranched or branched, erect, or decumbent below and rooting from lower nodes. Leaves mainly on culm, blades narrowly oblong, flat, glabrous; ligule membranous. Infl. a panicle, branched to 2 orders, branches whorled. Spikelets pedicelled, borne singly, fertile floret single, bisexual, subtended by two reduced, sterile florets each consisting of a small, glume-like lemma, whole spikelet deciduous above glumes or persistent (in cultivated species), pedicels short, cup-shaped at apex. Glumes represented by microscopic swellings at pedicel apex. Sterile lemmas linear to triangular, herbaceous, 1-veined. Fertile floret: lemma conduplicate, acuminate, awned or not, margins clasping palea, keeled, each side \pm oblong, 5-veined, crustaceous; palea similar in texture and shape to lemma (but narrower), conduplicate, keeled, 3-veined, margins very narrowly hyaline. Stamens 6.

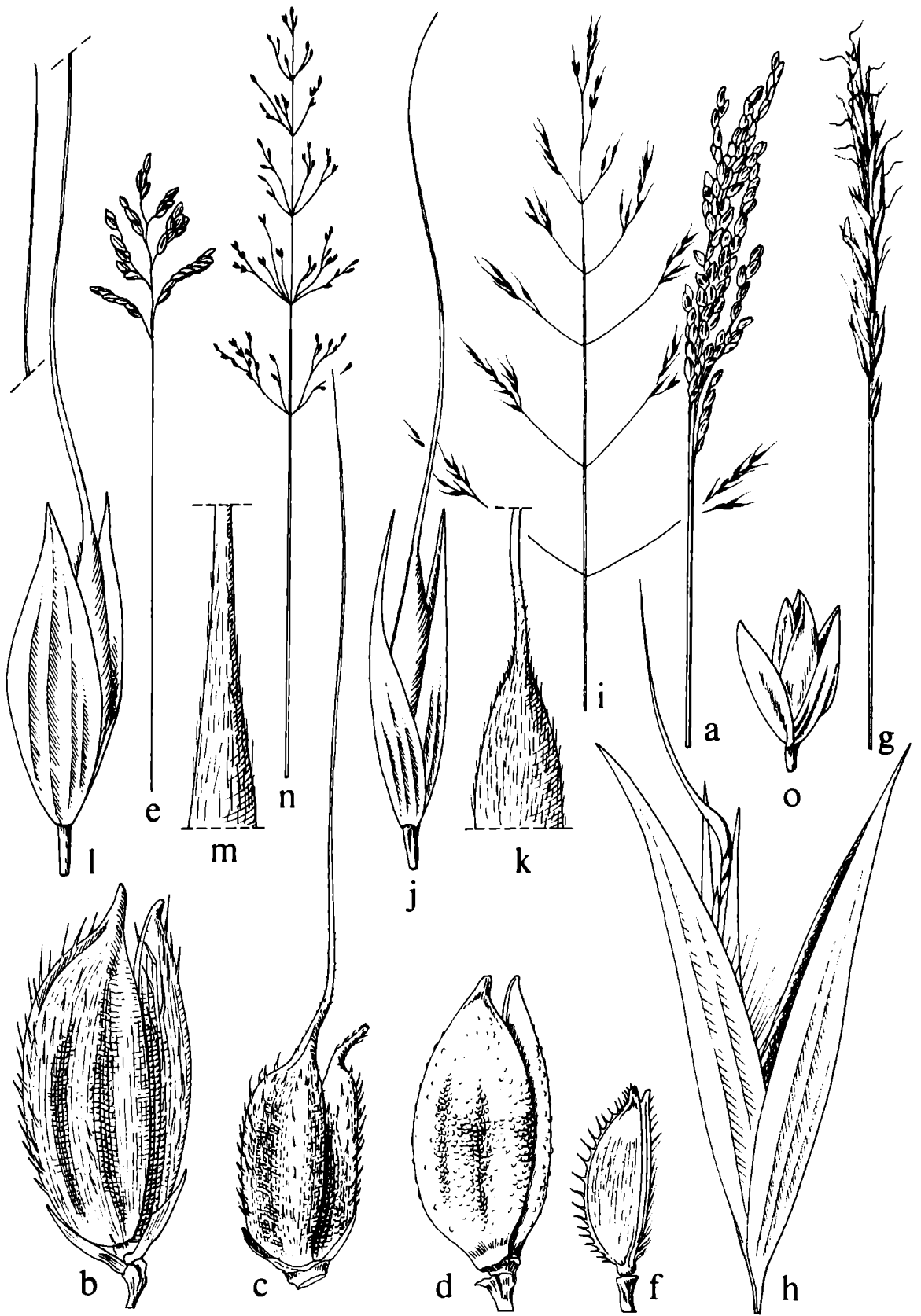
- 1. Cultivated plant; spikelets large (over 8mm) **1. O. sativa**
 + Wild plants; spikelets small (under 6mm – excl. awn) 2
- 2. Fertile lemma ciliate on keel, awned **2. O. minuta**
 + Fertile lemma not ciliate on keel, unawned
- 3. O. meyeriana** var. **granulata**

1. O. sativa L. Dz: *chhum*; Sha: *bara*; Eng: *rice*. Fig. 9a–b. Plate 1.

Tufted annual. Culms to 75(–190)cm, erect, unbranched. Leaf blades 15–36.5(–60) \times 1–1.3(–2.2)cm, glabrous; sheaths glabrous; ligule 8–12mm, acute, glabrous. Infl. 13–17.5cm, lowest branches single or paired, the longest 6–10cm, secondary branches short, appressed, pedicels 1.5–4mm, hairy. Spikelets 7.5–8.5 (to tip of palea) \times 3–3.2mm, persistent. Sterile lemmas equal, 2–2.4 \times 0.8mm, triangular, acute, weakly keeled, glabrous, margins whitish-green. Fertile lemma 7–8.2mm, each side 2–2.2mm wide, \pm oblong, abruptly acuminate, surface finely reticulately pitted, sparsely hispid on sides

FIG. 9.

a–b, **Oryza sativa**: a, infl. ($\times \frac{1}{3}$); b, spikelet ($\times 6$). c, **O. minuta**: spikelet ($\times 6$). d, **O. meyeriana** var. **granulata**: spikelet ($\times 6$). e–f, **Leersia hexandra**: e, infl. ($\times \frac{2}{3}$); f, spikelet ($\times 6$). g–h, **Trikeria oreophila**: g, infl. ($\times \frac{2}{3}$); h, spikelet ($\times 6$). i–k, **Oryzopsis munroi**: i, infl. (rigid form from below Thimphu) ($\times \frac{1}{3}$); j, spikelet ($\times 6$); k, lemma apex ($\times 12$). l–m, **O. aequiglumis**: l, spikelet ($\times 6$); m, lemma apex ($\times 12$). n–o, **Milium effusum**: n, infl. ($\times \frac{1}{3}$); o, spikelet ($\times 6$). Drawn by Louise Olley.



II. ORYZEAE

above, keel shortly ciliate near apex. Palea 6.7–8mm, abruptly acuminate, each side 1.2–1.4mm wide, narrowly oblong, keel and sides shortly hispid above. Anthers c.1.8mm.

Bhutan: cultivated up to 2625m; **Terai; Darjeeling:** cultivated up to 1370m; **Sikkim:** cultivated up to 1500m.

The most valued grain crop in Bhutan, though, due to growth requirements, not the largest in terms of area under cultivation. In most areas it is intercropped with other crops, such as wheat or maize, but in the Punakha valley it is possible to grow two crops per year. Bhutan is not self-sufficient in rice and much has to be imported from India. Cultivation occurs up to a surprisingly high altitude. The forms at higher altitudes (over 2000m) would mostly be classified, on the basis of enzymes and cross-compatibility, as 'subspecies' (sensu Grist, 1975) 'Japonica' including forms with red pericarps (*maap*) as well as white ones (*kaap*); at lower altitudes the varieties belong to 'Indica' and intermediate types (Chettri, 1992). Red rice (Plate 4) is highly valued in Bhutan, but elsewhere this colour form is regarded as highly undesirable. The red colouration is in the pericarp, and is inherited as though controlled by a single, dominant gene (Grist, 1975). Rice straw is important as a winter feed for livestock.

The forms grown are mainly local, polymorphic, land-races of which there are over 300 named varieties in Bhutan. They are, in general, low-yielding and susceptible to disease (fungal blast, bacterial blight) and insect predation. Now improved varieties are being tried, introduced via Bondey Farm (Paro), but problems arise from a lack of cold-tolerance required at high altitudes.

Dry land rice (Sha: *pangbara*) is grown un-irrigated in Shemgang and E Bhutan.

Weedy forms (Dz: *khem, sem*), with deciduous, sometimes awned spikelets occur in crops or adjacent marshes in Paro and Wangdi districts – these are presumably reversions from cultivated forms, or primitive varieties. The wild *O. rufipogon* Griff., a marsh or aquatic plant, with deciduous spikelets and long awns, is likely to occur in S Bhutan, but no specimens have been seen.

2. *O. minuta* J. Presl; *O. latifolia* sensu F.B.I., non Desvaux. Lep: *tuk gro zo*. Fig. 9c.

Perennial; rhizomes shortly creeping. Culms to 110cm (or more), sometimes decumbent at base and rooting from lower nodes. Leaf blades 18.5–34.5 × 1.2–1.4cm, glabrous, margins scabrid; sheaths glabrous, auriculate at apex; ligule c.2mm, truncate-fimbriate, hairy on back. Infl. 40–41cm, lowest branches in whorls of 3–5, the longest 17.5–24cm, secondary branches short, appressed, pedicels to 1mm. Spikelets pale green, deciduous, 4.8–5.2 (to tip of palea) × 2.1–2.5mm. Sterile lemmas equal, 1.5–1.9 × 0.6–0.7mm, triangular, acute, weakly keeled, keels minutely scabrid, margins whitish-green. Fertile lemma 4.4–5mm, abruptly acuminate and long awned, each side 1.7–1.9mm wide, ± oblong, surface reticulate with oblong papillae, sparsely hispid, keel ciliate, awn to 16.7mm. Palea 4.7–4.9mm, abruptly mucronate, each side c.0.9mm

wide, narrowly oblong, keel ciliate, mucro 0.6–0.7mm.

Bhutan: S — Chukka district (Khurul Pokhari, c.3km W of Kalikhola); **Terai** (Dulkajhar); **Darjeeling** (Great Rangit). Swampy, slightly shaded grassland, 150–610m. August–October.

This, the widespread SE Asian form, has been distinguished as var. *silvatica* (Camus) Veldkamp.

3. *O. meyeriana* (Zollinger & Moritzi) Baillon var. ***granulata*** (Nees & Arnott ex Watt) Duistermaat. Fig. 9d.

Differs from *O. minuta* as follows: sheaths with a ring of cilia at apex; infl. shorter (6–12cm), branches simple, borne singly, the lowest 2.2–4cm; spikelets larger (5.9 × 2.2–2.8mm); sterile lemmas smaller and unequal, the lower c.0.3mm, the upper 0.8–1 × 0.6–0.7mm; fertile lemma subacute, glabrous, unawned, 5.4–5.5mm; palea subacute, 5.3–5.5mm.

Terai (unlocalised Hooker specimen); '**Sikkim**' (unlocalised Treutler specimen, possibly from the Terai or Darjeeling). [150–]305m. July–September.

17. LEERSIA Swartz

Differs from *Oryza* in having spikelets consisting of a single fertile floret (basal, glume-like, sterile lemmas absent).

1. *L. hexandra* Swartz. Fig. 9e–f.

Perennial. Culms decumbent and rooting from lower nodes, branched, the erect part 12–26cm, nodes hairy. Leaf blades 3.4–11.7 × 0.3–0.5cm, glabrous, linear, acute, becoming inrolled; sheaths glabrous, auriculate at apex, auricles fused to ligule; ligule 1.5–2.7mm, rounded, glabrous. Infl. 2.5–11.5cm, triangular in outline, branches single, the lowest 1.5–6.3cm, lower part naked, spikelets overlapping and appressed in upper part, pedicels 0.3–0.6mm. Spikelets deciduous, 3.5–4 × 1.3–1.4mm. Lemma 3.5–3.9mm, each side 1–1.3mm wide, ± oblong, abruptly acuminate, minutely hispid on veins (especially the lateral), keel ciliate on upper $\frac{2}{3}$, hairy at base. Palea 3.3–3.6mm, abruptly acuminate, each side 0.6–0.8mm wide, narrowly oblong, keel ciliate above, hairy at base. Anthers 2–2.3mm.

Bhutan: S — Samchi (Daina Khola 10km W of Samchi), Phuntsholing (Toribar) and Chukka (W of Kalikola) districts; **Terai** (Jalpaiguri Duars). Ditches around rice paddies; damp grassy ground by river, 300–500m. October–March.

III. STIPEAE

Tribe III. STIPEAE Dumortier

1. Lemmas unawned; spikelets small (under 3.5mm) **21. *Milium***
+ Lemmas awned; spikelets larger (over 4.5mm) 2
2. Apex of lemma divided into two deep, acute lobes, awned in sinus
19. *Trikeria*
+ Apex of lemma not or very minutely lobed 3
3. Awn usually geniculate, with a twisted column, never deciduous (if awn not twisted below and geniculate, then lemma with deflexed bristles at apex); callus of floret hairy; leaf blades usually inrolled
18. *Stipa*
+ Awn not geniculate, not twisted below, sometimes deciduous; callus glabrous; leaf blades flat **20. *Oryzopsis***

18. STIPA L.

Densely tufted perennials, occasionally with short rhizomes. Leaves mainly basal, blades usually very narrow, inrolled, occasionally flat. Culms erect, unbranched; leaf blades shorter than basal ones; ligule membranous. Infl. a raceme or panicle (branched to 2 orders), branches inserted singly, or in pairs or whorls. Spikelets pedicelled, floret 1, bisexual, disarticulating above glumes; callus rounded or acute, hairy. Glumes equal or unequal, \pm similar, equalling spikelet (except exserted awn), obscurely 3–5-veined, papery. Lemma oblong-to linear-lanceolate, convex, gradually tapered into awn, obscurely 5-veined, thinly to thickly coriaceous, margins incurved and sometimes extended upwards into minute lateral lobes, awn with twisted column, uni- or bi-geniculate, variously hairy. Palea linear-lanceolate, obscurely keeled, thinly coriaceous, margins inflexed. Lodicules 3, large, hyaline.

A broad generic concept is used here following Freitag (1985), though excluding *Trikeria* which he included in *Stipa*.

Spikelet measurements are to the tip of the longer glume; those for the floret are from the callus base to the point of awn-insertion; those for the lemma are from the junction with the callus to the awn base.

1. Glumes drawn into long, twisted, filiform apices; lemma awns spirally twisted into a tail **8. *S. koelzii***
+ Glumes \pm acute, not drawn into filiform apices; lemma awns not twisted into a tail 2

- 2. Lemma with deflexed, apical bristles **11. S. roylei**
+ Lemma lacking deflexed, apical bristles 3
- 3. Awn scabrid throughout; lemmas brown and coriaceous; lowland plants (below 2500m) 4
+ Awn hairy at least on column; lemmas not brown and coriaceous; alpine plants (above 3000m) 5
- 4. Leaves flat; culms over 60cm; infl. over 30cm, branches broadly spreading **9. S. brandisii**
+ Leaves filiform, inrolled; culms to 40cm; infl. to 15cm, branches very short, appressed, so panicle \pm linear
10. S. jacquemontii subsp. **chuzomica**
- 5. Spikelets (glumes) green **7. S. roborowskyi**
+ Spikelets (glumes) purple 6
- 6. Awn scabrid above upper (or only) articulation 7
+ Awn hairy above upper articulation (hairs near apex over 0.5mm) 9
- 7. Spikelets (to tip of glumes) over 13mm **6. S. rohmooiana**
+ Spikelets under 8.5mm 8
- 8. Panicle effuse, branches flexuous, spreading **3. S. duthiei**
+ Panicle linear, branches short, erect **4. S. bhutanica**
- 9. Panicle linear, branches short, erect; glumes very unequal ... **2. S. milleri**
+ Panicle effuse, branches flexuous, spreading; glumes subequal 10
- 10. Spikelets (to tip of glumes) under 6.5mm **1. S. mongholica**
+ Spikelets over 13mm **5. S. purpurea**

1. S. mongholica Turczaninow ex Trinius; *S. concinna* Hook. f. Fig. 10a–c.

Branching intravaginal. Blades of basal leaves to 17cm, filiform (0.3–0.5mm wide), inrolled, glabrous or minutely hispid on veins beneath. Culms 8.5–47cm; leaves 2–3, distant; blades short (1.1–5cm); sheaths long (6.5–19.5cm), glabrous; ligule 1.5–3mm, acute. Infl. 3.5–16cm, triangular in outline, branches filiform, flexuous, the longest 0.6–6cm, spreading or suberect, nodes glandular. Spikelets dark purple, 4.5–6.2mm; pedicels 0.7–1.4cm. Glumes subequal; the lower purple below, yellowish-hyaline near apex, 4.1–5.7 × 1.6–2mm, lanceolate-elliptic, acute to apiculate, sometimes slightly irregularly toothed; the upper 4.1–6.1 × 1.2–1.8mm, similar to lower or slightly

III. STIPEAE

longer. Floret 3.8–5.6mm; callus 0.4–0.6mm, rounded, scar circular, hairs 0.3–0.6mm. Lemma brownish-purple, 3.7–5.1 × 0.6–0.8mm, oblong-lanceolate, apical lobes 0.2–0.9mm, hairy, margins concealing palea, back appressed-hairy, hairs 0.3–0.7mm; awn uni- or weakly bi-geniculate, 12.5–15.7mm, 4.5–7.2 + 6.5–9.2mm, plumose-hairy throughout, hairs 1–2mm. Palea 3.3–5.3 × 0.5–0.8mm, linear-lanceolate, long-hairy in lower half, sparsely short-hairy above. Anthers 1.1–1.6mm, cells with tuft of minute hairs at apex.

Bhutan: C — Thimphu district (beyond Phajoding, above Talukah Gompa); N — Upper Mo Chu district (E bank of Tharizam Chu, Lingshi Dzong); **Sikkim** (Lhonak, Jelep La, Yume Samdong, Tsomgo, Namnam); ?**Chumbi** (Chomolhari). Damp cliff-ledges; shady ground by stream under *Juniperus* and *Salix*; rock-ledges on dry ridge, 3660–5030m. August–October.

S. concinna was separated on having a more contracted panicle and smaller spikelets, but I can see no way of justifying this: the variation is continuous, and many specimens with loose panicles have small spikelets.

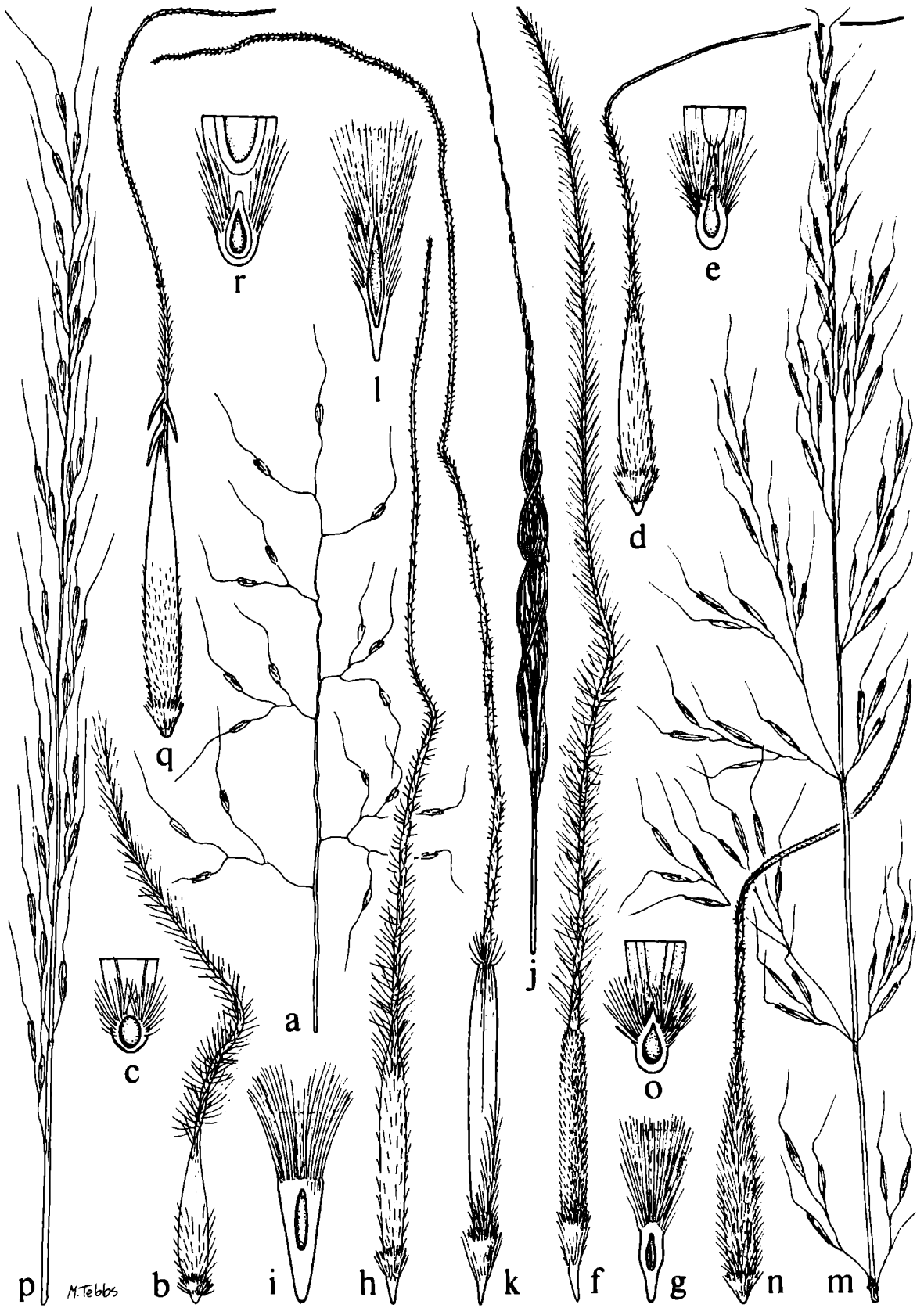
2. *S. milleri* Noltie. Fig. 11g–k.

Vegetatively similar to *S. mongholica*, but culms shorter (to 4.5cm). Infl. 3.7–6cm, linear, ± simple, spikelets borne singly or in pairs on infl. axis, pedicels 0.7–1.2cm, erect. Spikelets purplish, 9.4–10.2mm. Glumes unequal; the lower green with purple margins, 9.5–10.2 × 1.5–1.6mm, narrowly lanceolate, acuminate; the upper 7.5–7.6 × 1–1.2mm, oblong-lanceolate, apex minutely toothed. Floret 4.7–5mm; callus 0.5–0.7mm, acute, scar lanceolate, hairs c.0.5mm. Lemma 4.4–4.6 × 0.8mm, oblong, apical lobes 0.2mm, back appressed-hairy in lower third, hairs to 0.3mm; awn weakly uni-geniculate, c.13mm, 5 + 9mm, plumose-hairy throughout, hairs 1–1.1mm at base, 0.7–0.8mm at apex. Palea c.4 × 0.5mm, linear-lanceolate, glabrous.

Bhutan: N — Upper Mo Chu district (above Jangothang); **Sikkim** (Lasha Chhu). Grazed alpine turf, 4270–4555m. July–October.

FIG. 10.

a–c, *Stipa mongholica*: a, infl. (× 2/3); b, floret (× 4); c, callus scar (× 24). d–e, *S. duthiei*: d, floret (× 4); e, callus scar (× 24). f–g, *S. purpurea*: f, floret (× 4); g, callus scar (× 14). h–i, *S. roborowskyi*: h, floret (× 4); i, callus scar (× 14). j–l, *S. koelzii*: j, infl. (× 2/3); k, floret (× 4); l, callus scar (× 20). m–o, *S. brandisii*: m, infl. (× 2/3); n, floret (× 4); o, callus scar (× 14). p–r, *S. roylei*: p, infl. (× 2/3); q, floret (× 4); r, callus scar (× 24). Drawn by Margaret Tebbs.



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3. *S. duthiei* Hook. f. Fig. 10d–e.

Similar to *S. mongholica*, but differs as follows: culms taller (to 48cm); spikelets larger (c.7.4mm); glumes larger (c.7.4mm); floret longer (c.6.1mm), callus more pointed (c.0.6mm, scar elliptic, hairs longer, c.0.9mm); lemma glabrous in upper half, awn with shorter (c.0.5mm) hairs on twisted column, minutely scabrid (not plumose) above joint; anthers longer (c.2.3mm).

Sikkim (unlocalised Hooker specimen). Habitat not recorded, 4270–4880m.

Freitag (1985) cited *Griffith* 2694 (BM) as belonging to this species. I have not seen this specimen, but duplicates with the same number at K are *S. bhutanica*.

4. *S. bhutanica* Noltie. Fig. 111–p.

Blades of basal leaves 5–15cm, filiform (0.3–0.5mm wide), inrolled, glabrous or minutely hispid on veins beneath. Culms 8–32.5cm; leaves 2–3, distant; blades 3–8.3cm; sheaths 6.8–11cm, glabrous; ligule 2.8–3.3mm, triangular, acute or blunt. Infl. 5–10.5cm, linear, spikelets borne singly or in pairs on infl. axis (lowest node occasionally branched). Spikelets purplish, 7.1–8.1mm; pedicels 0.4–0.9cm, filiform, erect. Glumes subequal; the lower purple, 7.1–8 × 1.6–1.9mm, lanceolate, apex very acute, hyaline; the upper 6.9–8 × 1.3–1.4mm, more oblong, less acute than lower. Floret 6.5–7.5mm; callus c.0.5mm, rounded, scar circular, hairs 0.7–1mm. Lemma green streaked purple, 6–7 × 0.7–0.8mm, linear, back shortly hairy at extreme base, hairs 0.4–0.6mm, with longer (c.0.6mm) hairs near to and overtopping apex; awn uni-geniculate, 13–16.3mm, 6–7 + 7–9.3mm, column hairy, hairs 0.7–0.9mm, minutely scabrid above joint. Palea 4.2–5 × 0.5–0.6mm, linear, subacute, sparsely hairy. Anthers 1.6–1.7mm, cells not bearded.

Bhutan: C — Ha (W side of Chelai La), Thimphu (mountain E of Thimphu) and Bumthang (Kitiphu) districts; unlocalised *Griffith* specimen. Open, dry mountain-top, 3500–3960m. July–September.

5. *S. purpurea* Grisebach. Fig. 10f–g.

Branching intravaginal. Blades of basal leaves to 4.4(–15)cm, filiform, inrolled (0.4mm wide), stiffly erect, glabrous beneath, upper surface minutely hispid on veins. Culms 6(–40)cm; leaves 3; blades to 3(–8)cm; sheaths glabrous; ligule 2.4(–6)mm, apex acute, minutely ciliate. Infl. to 7(–12)cm, lax, spikelets few (c.3), borne singly on infl. axis. Spikelets dark purple, 13.5(–16)mm; pedicels to 2.5cm, filiform, spreading. Glumes subequal; the lower purple, 13.5(–16) × c.1.6mm, oblong-lanceolate, finely acuminate to filiform, hyaline apex; the upper 13(–14) × c.1.6mm, slightly more oblong and narrower than lower. Floret 8.5(–9)mm; callus 1.7(–2)mm, acute, scar

lanceolate, hairs 0.7mm. Lemma c.7.1 × 0.6mm, linear, back densely hairy in lower half, hairs 0.2mm, margins concealing palea; awn bi-geniculate, 50(–70)mm, 6 + 4 + 40mm, plumose throughout, hairs longest (c.2mm) just above upper joint, decreasing in length above and below (c.1.5mm at base). Palea c.6.2 × 0.4mm, linear, subacute, sparsely hairy in lower half.

Sikkim (Chholhamoo). [Probably dry, sandy plain], 5240m.

A single, immature specimen seen; the measurements in brackets are taken from Freitag (1985).

6. *S. rohmooiana* Noltie. Fig. 11a–f.

Similar to *S. purpurea*, but differs as follows: floret shorter (c.7.5mm); callus shorter (c.1.2mm); lemma shorter (c.6.3mm, hairs on back longer (c.0.5mm), awn shorter (22.2–24mm), hairy only below lower articulation (hairs shorter, 0.8–1.2mm) minutely scabrid above.

Sikkim (Chugya, Chaerlung). Habitat not recorded, 4570–4880m. September.

7. *S. roborowskyi* Roshevitz. Fig. 10h–i.

Branching intravaginal. Culms 8–16.5cm; leaf 1; blade to 10.5cm; sheath glabrous; ligule to 3.5mm, acute; blades of basal leaves to 7cm, filiform, inrolled (c.0.4mm wide), stiffly erect, minutely scabrid beneath, upper surface minutely hispid on veins. Infl. to 12–21cm, linear, very elongate, branches very distant, short (to 2cm), erect, each with 1–3 spikelets. Spikelets green, 13.5–14mm. Glumes subequal; the lower whitish-green, 14–14.4 × c.1.9mm, narrowly lanceolate, finely acuminate; the upper 12.2–13.1 × 1.3–1.6mm, slightly shorter and narrower than lower. Floret 7–7.4mm; callus c.1mm, acute, scar lanceolate, hairs 0.7–1mm. Lemma c.6.2 × 0.7mm, linear, apex overtopped by hairs, back densely appressed-hairy, hairs c.0.6mm, margins concealing palea; awn bi-geniculate, c.30mm, 5.3–7 + 4–4.5 + 20mm, lower part of column plumose (hairs 1.4–1.7mm), upper part of column with hairs 1–1.2mm, shortly hairy above upper joint (hairs 0.6–0.8mm). Palea 6–6.2 × 0.5mm, linear, acute, sparsely hairy. Anthers c.2mm.

Sikkim (Gurudongmar). Habitat not recorded, 5310m. August.

8. *S. koelzii* R.R. Stewart; *S. consanguinea* sensu Bor, non Trinius & Ruprecht. Fig. 10j–l.

Branching intravaginal. Culms 6–35cm; leaves 2–3; blades 6–14cm, 0.8–1.7mm wide, glabrous beneath, scabrid on veins above; sheaths glabrous; ligule c.0.6mm, truncate-ciliate; blades of basal leaves 6–16cm, scabrid on veins above and sometimes with hairs near margins. Infl. (excl. tail) 6.5–17cm, linear, with awns twisted into a terminal tail, branches stiffly erect, unbranched,

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longest branch of lowest whorl 1–2.5cm, bearing 1–3 spikelets. Spikelets green tinged purple, 14–29mm; pedicels 0.1–1.2cm. Glumes hyaline tinged purple, subequal, linear, gradually tapered into long, twisted, filiform tail; the lower 8–16 + 8–12 × 0.9–1.3mm; the upper 12–18 + 9–15 × 1–1.7mm. Floret 8.7–11mm; callus 1.9–2.3mm, acute, scar narrowly elliptic, hairs 1–1.7mm. Lemma 6.6–9 × 0.6–1.2mm, linear-lanceolate, apex overtopped by tuft of hairs (0.6–1mm), truncate or with two lateral terminal lobes to 1.3mm, margins hairy, concealing palea, with line of hairs at extreme base along centre; awn bi-geniculate, 6–11.5cm, 10–15 + 5–10 + 45–90mm, hairy on lower part of column, hairs to 0.8mm, minutely scabrid above lower joint. Palea 6.9–8.6 × 0.5–0.9mm, linear, acute, usually glabrous. Anthers c.3.5mm.

Bhutan: C — Ha (W side of Chelai La), Thimphu (hill E of Thimphu, hill above Thimphu hospital) and Bumthang (Kitiphu) districts; N — Upper Mo Chu district (Soi Yaksa, Jangothang, Laya, E bank of Tharizam Chu); 'quite common in N and NW Bhutan' according to Dunbar; **Sikkim** (Chugya, Lhonak). Dry grassland on hilltops and ridges, 3300–5270m. July–October.

Some specimens have terminal lemma lobes, others do not; the length of the hairs on the awn column is also variable.

9. *S. brandisii* Mez; *S. sibirica* sensu Bor, non (L.) Lamarck. Fig. 10m–o.

Branching extravaginal. Blades of basal leaves to 36cm, glabrous. Culms 65–81cm; leaves c.3; blades yellowish-green, 21–33cm, flat, to 7mm wide, glabrous; sheaths glabrous; ligule 0.6–0.7mm, truncate. Infl. 30–41cm, narrow when dry, branches spreading widely in life, slender, erect, whorled, again branched, longest branch of lowest whorl 9.5–15cm, bearing up to 16 spikelets. Spikelets green, 8.4–9mm; pedicels 0.2–0.7cm. Glumes green, subequal; the lower 8.4–8.6 × c.2mm, oblong-lanceolate, apex acuminate or irregularly minutely toothed; the upper 8.3–8.6 × 1.7–2mm. Floret 7.1–7.4mm; callus 0.6–0.8mm, rounded, scar ± circular, hairs c.0.7mm. Lemma brown, coriaceous, 6.6–6.8 × 0.8–0.9mm, linear-lanceolate, gradually tapered into awn, back covered in white, bristly hairs, hairs c.0.7mm, overtopping apex, margins

FIG. 11.

a–f, *Stipa rohmooiana*: a, sheath apex of culm leaf (× 5); b, infl. (× 2/5); c, lower glume (× 5); d, upper glume (× 5); e, floret (× 5); f, callus scar (× 13). g–k, *S. milleri*: g, habit (× 1/4); h, lower glume (× 5); i, upper glume (× 5); j, floret (× 5); k, callus scar (× 13). l–p, *S. bhutanica*: l, infl. (× 1/2); m, lower glume (× 5); n, upper glume (× 5); o, floret (× 5); p, callus scar (× 13). q–u, *S. jacquemontii* subsp. *chuzomica*: q, habit (× 1/5); r, lower glume (× 5); s, upper glume (× 5); t, floret (× 5); u, callus scar (× 13). Drawn by Louise Olley.



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almost concealing palea; awn uni-geniculate, 14–16.2mm, 6–7 + 8–9.2mm, minutely scabrid throughout. Palea 5.6–6 × 0.6–0.9mm, linear, truncate, back bristly. Anthers c.4.5mm, bearded at apex.

Bhutan: C — Thimphu district (Paro, Shaba to Chuzom). Gullies in dry, open country, 2200m. August–September.

Plants contain cyanogenic glycosides and are poisonous to livestock (Freitag, 1985). In Bhutan apparently restricted to the area around the Confluence, where it is subdominant among scrub.

10. *S. jacquemontii* Jaubert & Spach subsp. *chuzomica* Noltie. Fig. 11q–u.

Branching extravaginal. Blades of basal leaves to 14cm. Culms to 40cm; leaves c.3; blades 7.5–13cm, filiform, inrolled, c.0.7mm wide, minutely hispid above; sheaths glabrous; ligule c.0.2mm, truncate. Infl. 8–13cm, narrow, branches slender, very short, erect, whorled, again branched, longest branch of lowest whorl 1.3–1.5cm, bearing 3–7 spikelets. Spikelets c.6mm; pedicels 0.4–1cm. Glumes whitish-hyaline, subequal; the lower c.5.8 × 1.7mm, oblong-lanceolate, apex apiculate; the upper c.5.6 × 1.2mm. Floret c.4.6mm; callus 0.3mm, rounded, scar ± pear-shaped, hairs c.0.7mm. Lemma brown, coriaceous, c.4.1 × 0.7mm, linear-lanceolate, gradually tapered into awn, back covered in white, bristly hairs, hairs to 0.5mm, overtopping apex, margins not concealing palea; awn weakly bi-geniculate, to 27.7mm, 4.2 + 3.5 + 20mm, minutely scabrid throughout. Palea c.2.6mm, much shorter than lemma, oblong, truncate, back bristly.

Bhutan: C — Thimphu district (Paro valley just above Confluence). Dry slopes among *Cotoneaster-Ceratostigma* scrub, growing with *S. brandisii*, 2160m. September.

11. *S. roylei* (Nees) Mez; *Orthoraphium roylei* Nees. Fig. 10p–r. Plate 4.

Shortly rhizomatous; branching extravaginal. Blades of basal leaves to 23cm, filiform, c.0.5mm wide, inrolled, glabrous beneath, minutely hispid on veins and with some longer, scattered hairs above. Culms 32–53cm; leaves 3–5; blades 18.5–33cm; sheaths usually glabrous; ligule 0.8–1.7mm, blunt. Infl. 12–27cm, linear, branches slender, erect, the lowest paired, 3.5–9cm bearing 3–6 spikelets. Spikelets green, 7.2–10mm; pedicels 0.2–1.1cm. Glumes green, unequal; the lower 5.5–8.2 × 1.4–1.7mm, oblong, subacute, margins and apex widely hyaline; the upper longer, 7–9.8 × 1.6–1.8mm, otherwise similar to lower. Floret 9.1–10.9mm; callus 0.5–0.7mm, rounded, scar lanceolate, hairs 0.7–1mm. Lemma green streaked purple, 8.6–10.2 × 0.7–1mm, linear-lanceolate, gradually tapered into awn, with 3–5 stout, deflexed bristles near apex, back appressed-hairy, densely so in lower half, margins not concealing palea; awn not geniculate, 12.8–17mm, shortly hairy (hairs to 0.5mm)

at base, scabrid above. Palea 5.1–6.4 × 0.7–0.8mm, linear-lanceolate, very acute, shortly hairy in lower $\frac{2}{3}$. Anthers c.2.1mm.

Bhutan: S — Chukka district (road to Microwave Station above Gedu); C — Ha, Thimphu, Punakha, Tongsa, Bumthang, Mongar and Tashigang districts; **Darjeeling** (Tonglu, Kalapokri, Phullalong); **Sikkim** (Yampung, Lachung, Jelep La, Yumthang; Dzongri, Chakung Chu, Porie Phoolie (Freitag, 1985)). Banks and clearings in oak, blue pine/spruce, juniper/hemlock and fir forest, 2320–4270m. August–October.

19. TRIKERAIA Bor

Differs from *Stipa* as follows: apex of lemma deeply lobed, lobes acute, awned in the sinus.

Freitag (1985) included this genus under *Stipa*.

1. *T. oreophila* Cope. Fig. 9g–h.

Densely tufted. Blades of basal leaves to 12.5cm, c.1.5mm wide, usually inrolled, glabrous. Culms 14–30.5cm; leaves 2; blades 2–5.7cm, glabrous, inrolled, 0.6–1.2mm wide; sheaths glabrous; ligule c.0.5mm, truncate, minutely ciliate. Infl. 3.5–8.5cm, densely cylindrical, branches short, erect, the lowest 8.5–12mm bearing 2 spikelets. Spikelets green tinged purple, 9–12mm; pedicels 1–5mm, pubescent. Glumes green flushed purple, unequal; the lower 8.8–12 × 1.9–2.6mm, oblong, keeled towards apex, acuminate, 5(–7)-veined, minutely scabrid on veins, margins narrowly hyaline; the upper shorter, 8.3–11.5 × 1.5–2.5mm, lanceolate, 5-veined. Floret 7.2–9.5mm; callus 0.2–0.4mm, rounded, scar circular, hairs 0.3–0.7mm. Lemma finally brown, 6.7–9.5 × 0.6–1.3mm, linear-lanceolate, apical lobes 4.2–7mm, very acute, back hairy, hairs to 1.8mm; awn 9.1–11.8mm, uni-geniculate, 3.8–6 + 4.5–6.8mm, glabrous. Palea 5.3–7.3 × 0.6–0.9mm, linear-lanceolate, very acute, back hairy. Anthers 0.7–1mm.

Bhutan: N — Upper Mo Chu district (Jangothang, Soi Yaksa); **Sikkim** (Chholhamoo). Dry, south-facing slope with *Elymus* sp., *Stipa* sp. and *Ephedra* sp., 3810–5240m. August–October.

Doubtfully recorded species:

T. hookeri (Stapf) Bor; *Stipa hookeri* Stapf

This species occurs just outside our area in Tibet (Kambajong, and immediately to the N of Sikkim) and was erroneously recorded for Sikkim by Freitag (1985). It differs from *T. oreophila* in being a larger species (culms to 70cm); leaves broader; ligule c.2mm; glumes 3-veined and anthers longer (c.4.5mm).

20. ORYZOPSIS Michaux

Tufted perennials. Culms erect, unbranched. Leaf blades flat, linear to narrowly oblong, very acute; ligule membranous. Infl. a lax panicle, branched to 2 orders, branches whorled, spreading. Spikelets pedicelled, dorsally compressed, lanceolate, borne singly, disarticulating above glumes; floret single, bisexual; callus short, obtuse, glabrous. Glumes ± equal and similar, equalling spikelet (except exerted awn), oblong-lanceolate, convex, acuminate, 5–7-veined, thinly herbaceous, margins often hyaline. Lemma brown, coriaceous, oblong- to linear-lanceolate, convex, weakly keeled, apex acuminate, gradually or abruptly narrowed into a persistent or deciduous, ± straight awn, appressed-hispid, 5-veined, margins incurved, clasping edges of palea. Palea brown, coriaceous, narrowly lanceolate, acuminate, appressed-hispid, 2-veined, keels rounded, margins inflexed. Lodicules 3, large, hyaline.

The two Bhutanese species are sometimes placed in the genus *Piptatherum* P. Beauvois (e.g. Freitag, 1975), but a broad concept of *Oryzopsis*, following Clayton & Renvoize (1986), is used here.

- 1. Lemma shorter than glumes, up to 5.7mm, abruptly contracted into slender, deciduous awn **1. O. munroi**
- + Lemma about equalling glumes, over 6mm, gradually narrowed into persistent awn **2. O. aequiglumis**

1. O. munroi Stapf ex Hook. f.; *Piptatherum munroi* (Stapf ex Hook. f.) Mez. Fig. 9i–k.

Culms 60–77cm. Leaf blades 16–32 × 0.4–0.7mm, smooth above, minutely hispid on veins beneath, glaucous beneath; sheaths minutely hispid on veins; ligule (2.5–)4–8mm, apex rounded, becoming torn. Infl. 19–32cm, branches mainly paired, slender, flexuous, naked in lower half, longer branch of lowest pair (5.5–)11–17cm. Glumes often flushed purple, surface granular; the lower 6–8.2 × 2.1–2.4mm, 5–7-veined; the upper 6–7.8 × 1.8–2.2mm. Lemma brown to blackish-brown, 4.2–5.7 × (0.9–)1.2–1.5mm, oblong-lanceolate, abruptly apiculate, apiculus abruptly narrowed into awn, back covered in appressed, white hairs, margins ciliate towards apex, sometimes forming an apical tuft, so awn appearing subterminal, awn (6.7–)9.4–13.2mm, slender, deciduous, minutely hispid. Palea 4.2–5.2 × 1–1.4mm, oblong-lanceolate, apiculate, similar in colour, texture and hairiness to lemma. Anthers 2–2.7mm.

Bhutan: C — Thimphu (Thimphu to Hongsu, Dotena to Barshong), Punakha/Tongsa (Pele La) and Bumthang (E side of Yuto La) districts; N — Upper Mo Chu district (Laya); **Darjeeling** (Phalut, Singalila); **Sikkim**

(Tsongo, Kopup). Rock-ledges and gullies in open, *Abies* forest; dry bushland and grassy banks among cultivation, (2100–)3050–3960m. August–October.

Our specimens tend to have larger spikelets and lemmas than those described by Freitag (1975) for W Himalayan specimens. They clearly belong to *O. munroi*, however, which is best characterised by the relative lengths of glumes and lemma, and the awn base. The specimens from the dry valley below Thimphu are rather distinct (measurements in brackets above): they have narrower leaves, more rigid infls. with shorter branches, and shorter lemma awns—they merit further investigation.

2. *O. aequiglumis* Duthie ex Hook. f.; *Piptatherum aequiglumis* (Duthie ex Hook. f.) Rozhevitz. Fig. 9l–m.

Differs from *O. munroi* as follows: lemma linear-lanceolate, longer (c.6.5 × 1.2mm), about equalling glumes, gradually narrowed at apex into persistent awn, awn longer (c.15mm); palea longer and narrower, c.6.5 × 1mm.

Bhutan: C — Punakha district (N side of Nobding-Phobjikha Pass). On rocks by stream in very shady, moist, broad-leaved forest, 2700m. September.

21. MILIUM L.

Shortly rhizomatous, loosely tufted perennial. Culms erect, unbranched. Leaf blades flat, linear-lanceolate, acute; ligule membranous. Infl. a lax panicle, branches slender, whorled, spreading. Spikelets pedicelled, borne singly, disarticulating above persistent glumes; floret 1, bisexual, dorsally compressed; callus short, obtuse, glabrous. Glumes equalling spikelet, ± equal, upper narrower than lower, convex, 3-veined, herbaceous, margins very narrowly hyaline. Lemma coriaceous, shining, narrowly elliptic, convex, subacute, glabrous, obscurely 5-veined, margins incurved, tightly clasping edges of palea. Palea similar in colour and texture to lemma, narrowly elliptic, back raised, slightly convex, veins grooved, margins widely incurved. Lodicules 2.

1. *M. effusum* L. Eng: *wood millet*. Fig. 9n–o.

Culms to 64cm. Culm leaves 3; blades to 13.5 × 0.6cm, glabrous; sheaths glabrous; ligule to 8mm, acute. Infl. 16–20cm, with up to 7 whorls of 1–3 slender, spreading branches, spikelets borne near ends of branches, longest branch of lowest whorl to 6cm bearing up to 6 spikelets; pedicels 1–7mm. Spikelets green, c.3.2mm. Glumes minutely scabrid on veins near apex, margins tinged purplish; the lower c.3.1 × 1.2mm, oblong-lanceolate, blunt; the upper c.3.2 × 0.8mm, narrowly oblong-lanceolate, acuminate. Lemma yellowish-green, c.3.1 × 1.1mm, narrowly elliptic, subacute. Palea c.2.9 × 1mm, narrowly elliptic, acute. Anthers c.1.8mm.

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Bhutan: C — Thimphu district (above Motithang). Damp, densely shaded gully, 2700m. June.

Doubtfully recorded species:

Phaenosperma globosum Munro ex Oliver (Tribe Phaenospermateae)

Recorded for Sikkim and Bhutan in Bor (1973), but no specimens have been seen, and none are cited by Bor. This would, therefore, appear to be an error, though its occurrence remains a possibility as the species is found in W China and Arunachal Pradesh.

Tribe IV. POEAE

1. Infl. a spike; spikelets very strongly compressed, the lateral ones lacking an upper glume **23. Lolium**
- + Infl. a panicle; spikelets less strongly compressed, all with two glumes..... 2

2. Spikelets broadly ovate; lemmas inflated, suborbicular, papery **25. Briza**
- + Spikelets narrower; lemmas not inflated, \pm lanceolate 3

3. Lemmas strongly keeled 4
- + Lemmas rounded on back 5

4. Lemmas subacute to acute; spikelets pedicelled, in \pm open panicles **26. Poa**
- + Lemmas gradually narrowed to awn-like apex; spikelets sessile, aggregated into dense, 1-sided partial infls. **27. Dactylis**

5. Spikelets with 3–6 fertile florets; lemmas usually awned 6
- + Spikelets with 1 floret (occasionally some in infl. with 2); lemmas unawned 7

6. Plants perennial; lemmas \pm lanceolate; stamens 3; infl. not usually linear, not 1-sided **22. Festuca**
- + Plants annual; lemmas linear; stamen 1; infl. \pm linear, 1-sided **24. Vulpia**

7. Glumes exceeding lemma; lemma obscurely veined **28. Colpodium**
- + Glumes much shorter than lemma; lemma strongly 3-veined **29. Catabrosa**

22. FESTUCA L.

Perennials. Vegetative shoots arising within leaf sheaths (intravaginal, when plants densely tufted) or at base and outside of leaf sheaths (extravaginal, when plants loosely tufted). Culm leaves with blades flat or inrolled, sometimes auriculate at base; sheaths sometimes with erect, apical auricles at each side of the membranous ligule. Infl. a panicle, lower branches borne singly or in unequal pairs. Spikelets laterally compressed, with 3–6 fertile florets and often a reduced terminal one, disarticulating above glumes and between florets. Glumes shorter than spikelet, the lower usually 1-veined, the upper 3-veined, herbaceous. Lemmas rounded on back, awned from apex, obscurely 5-veined, usually thickly herbaceous. Paleas narrow, commonly bifid, the keels usually ciliate. Ovary glabrous or hairy at apex, stigmas terminal.

Many species in this difficult genus are based on characters that are not easy to determine, such as the nature of the vegetative shoots (innovations); these may be intravaginal (Fig. 14b) or extravaginal (Fig. 14a). The arrangement of the sclerenchyma bundles in the leaf blade is also important and was first applied to the Asian species by Saint-Yves (1928). To see this take a leaf blade from a vegetative shoot (not from a culm), soak in water, place on a microscope slide, and with a new razor blade make a very thin transverse section. This is quite possible as the leaves tend to be rather rigid. Mount in glycerol and examine with a binocular microscope at $\times 500$ magnification. In fresh material the sclerenchyma is easy to see, just under the epidermis, as cream-coloured areas against a green background. In diagrams (e.g. Fig. 12g) the bundles are represented by black.

Although Bor (1973) attempted to incorporate the work of Saint-Yves, his account has been superseded by that of Alexeev (1980), which, as it is in Russian, has unfortunately been largely ignored. Many of Bor's species contain more than one element, so it has not always been possible to give full synonymy.

Measurements of spikelet length are taken (as elsewhere in the book) from the base of the lower glume to the tip of the topmost lemma (excl. awn). Infl. length and lowest branch length are to the tips of the apical spikelet (excl. awn).

- | | |
|---|-------------------------------|
| 1. Lemmas and infl. branches densely hairy | 4. F. rubra s.l., p.p. |
| + Lemmas and infl. branches scabrid or glabrous (lemmas sparsely pubescent in <i>F. boriana</i>) | 2 |
| 2. Culm leaf blades flat, with clasping basal auricles | 3 |
| + Culm leaf blades inrolled or flat, lacking basal auricles | 4 |
| 3. Awns of lemmas over 10mm | 2. F. gigantea |
| + Awns of lemmas under 2mm | 3. F. arundinacea |

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4. Awns of lemmas long, that of *lowest* lemma of a spikelet over (3.2–)3.7mm, lemmas smooth 5
 + Awns of lemmas shorter, that of *lowest* under 2.6mm (N.B. awns of upper lemmas in spikelet longer), lemmas usually hispid 7
5. Glumes small (the upper 0.9–3.7mm, under half length lowest lemma); lemma awns tapered to weak, flexuous, thread like apex; basal leaves lacking at flowering; culm leaf blades usually flat (commonly over 4mm wide) **1. F. leptopogon**
 + Glumes larger (the upper 3.5–6.5mm, more than half length lowest lemma); awns stiff at apex; inrolled basal leaves present at flowering; culm leaf blades usually inrolled (sometimes flat), under 3mm wide 6
6. Spikelets over 11mm, florets widely gaping; lowest lemma usually over 6.5mm; glumes linear-lanceolate, the lower over 3.2mm, the upper over 5mm; anthers usually over 1.8mm **4. F. rubra** subsp. **clarkei**
 + Spikelets to 10mm, florets suberect; lowest lemma usually under 6.5mm; glumes ovate-lanceolate, the lower to 3.2mm, the upper to 5mm; anthers usually under 1.5mm **5. F. stapfii**
7. Spikelets usually under 5.5mm; infl. densely linear, straight 8
 + Spikelets over 6mm; infl. commonly more lax and curved 9
8. Densely tufted, tufts hard and slightly swollen at base, basal sheaths very short short; leaf blades often hispid on underside, angled and asymmetric in section with usually 5 or more, unequally wide sclerenchyma bundles; leaves of vegetative shoots less than half culm length **11. F. wallichiana**
 + Loosely tufted, tufts not hard or swollen at base, basal sheaths long; leaf blades always glabrous, terete and symmetric in section, with 3 small, equal sclerenchyma bundles; leaves of vegetative shoots usually more than half culm length **12. F. tibetica**
9. Glumes large (the lower over 5mm, the upper over 6.5mm), hairy; lemmas gradually tapered to apex, not differentiated into an awn of differing texture; basal leaf sheaths pubescent **7. F. boriانا**
 + Glumes smaller (the lower to 4.3mm, the upper to 6.7mm), glabrous; lemma awns distinct; basal leaf sheaths glabrous 10
10. Anthers to 1.1(–1.2)mm 11
 + Anthers over 1.5mm 12

11. Awns short (that of lowest lemma under 1.5mm); culm leaf blades flat; shoots extravaginal so plants not densely tufted; lemmas \pm glabrous **6. F. undata**
 + Awns longer (that of lowest lemma over 2mm); culm leaf blades inrolled; shoots intravaginal, so plants densely tufted; lemmas hispid **8. F. cumminsii**
12. Lowest lemma of spikelet usually over 6mm; anthers usually over 3mm; basal leaves very short (less than $\frac{1}{4}$ culm length) **4. F. rubra** s.l., p.p.
 + Lowest lemma under 5.2mm; anthers under 2.5mm; basal leaves half length to equalling culms 13
13. Lower surface of leaves of vegetative shoots smooth, tough to section as sclerenchyma forming a continuous layer; leaf sheaths buff-coloured **9. F. polycolea**
 + Lower surface of leaves of vegetative shoots angled, not tough to section as sclerenchyma in discrete bundles; leaf sheaths reddish-brown **10. F. bhutanica**

1. F. leptopogon Stapf; *F. subulata* Trinius var. *leptopogon* (Stapf) Saint-Yves. Fig. 12a–b.

Loosely tufted, shoots extravaginal. Leaves of vegetative shoots erect, blades c. $\frac{1}{3}$ culm length, c. 3.5mm wide, flat. Culms (20–)44–200cm, commonly robust, ascending from base; sheaths of lower leaves dull, reddish-brown, becoming fibrous. Culm leaf blades to 25cm, usually flat, 4.2–6.8mm wide, oblong, apex finely tapered, base narrowly truncate, glabrous, occasionally narrow (c. 2mm) and inrolled; ligule truncate, 1–2mm. Infl. 15–37.5cm, branches in distant, unequal pairs, spreading at anthesis, flexuously ascending when dry, the longer of lowest pair 7.4–20.5cm. Spikelets 8–10mm, fertile florets (2–)3, the rachilla internodes very short. Glumes small, narrowly lanceolate, subacute; the lower (0.6–)1.2–2.3mm; the upper (0.9–)1.9–3.7mm. Lemmas smooth, linear-lanceolate, gradually narrowed to very acute apex, awns subterminal, long (to 11mm), the tip filiform, flexuous. Paleas linear, keels smooth, apex acutely bidentate. Ovaries hairy at apex. Lowest floret: lemma 6.5–8.3mm, awn 5.5–8.3mm; palea 5.3–8.7mm; anthers 1.2–1.8mm.

Bhutan: C — Thimphu (near Changri Monastery, above Thimphu Hospital), Tongsa (below Chendebi) and Mongar (above Namning) districts; **Darjeeling** (Tonglu, Darjeeling, Birch Hill, Tiger Hill); **Sikkim** (Lachen, Lachung); **Chumbi** (Yatung). Banks, streamsides and roadsides in broad-leaved (incl. oak–rhododendron) forest; [in Sikkim apparently in coniferous forest], 2000–3350m. June–September.

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Himalayan records of the Japanese/Korean *F. parvigluma* Steudel (Bor, 1973) belong here.

A rather damaged specimen from Kaling, Tashigang district (*Grierson & Long* 2298, E) with very small glumes (lower 1.2mm, upper 2.2mm) differs from *F. leptopogon* in having a glabrous ovary and very small anthers (c.0.6mm): it probably represents a distinct taxon, but further collections are required.

Some specimens from Lachen (including some of the syntypes) are atypical in having very narrow, inrolled leaf blades; in this they resemble *F. stapfii*, but they differ from that species in having smaller glumes and lemmas.

2. *F. gigantea* (L.) Villars. Eng: *giant fescue*. Fig. 12c–d.

Resembles *F. leptopogon* in its infl. and flat leaf blades, but differs as follows: often more robust; culm leaf blades wider (4–11mm), with clasping, auriculate bases; spikelets longer (8.5–12.5mm), rachilla internodes well developed; lemmas rough on surface; glumes longer, the lower 3.5–5.1mm, the upper 4.3–6mm; ovaries glabrous at apex. Lowest floret: lemma 7–7.6mm, awn 9.8–17.5mm; palea 6.5–7.1mm; anthers 2.3–3.6mm.

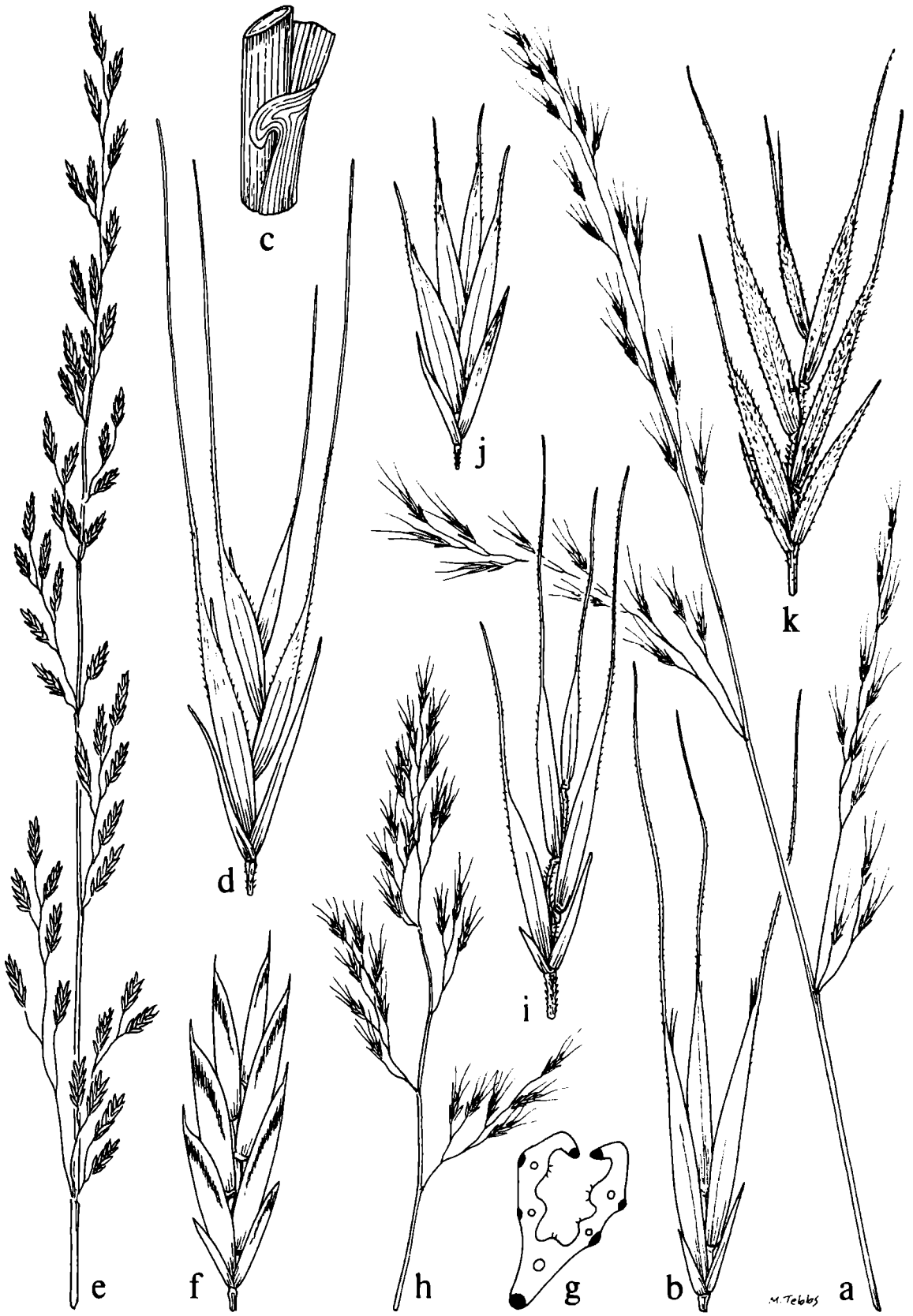
Bhutan: C — Thimphu (above Thimphu Hospital, near Tangu Monastery), Tongsa (3km W of Tongsa) and Tashigang (below Kori La) districts; **Darjeeling** (Jalapahar Road, Darjeeling). Broad-leaved forest (incl. oak); scrub by road; beside stream in cultivated area, 2120–2700m. July–September.

3. *F. arundinacea* Schreber. Eng: *tall fescue*. Fig. 12e–f.

Not tufted, shoots extravaginal. Leaves of vegetative shoots erect, blades c. $\frac{1}{3}$ culm length, 5–7mm wide, flat. Culms 49–82cm, stout, erect. Culm leaf blades 18–30cm, 5–9mm wide, flat, with minutely ciliate, clasping auricles at base; ligule truncate, c.1.5mm. Infl. 14.5–35cm, branches single or paired, rather stiffly erect, the lowest 4.5–11cm. Spikelets 11–12mm, fertile florets 5–6, rachilla internodes well developed. Glumes oblong-lanceolate, subacute; the lower 2.7–4.2mm; the upper 3.5–5.3mm. Lemmas oblong-acuminate, gradually narrowed into very short awn, minutely hispid on veins. Paleas linear-lanceolate, apex acute, keels shortly ciliate. Ovaries glabrous at apex. Lowest floret: lemma 6.1–7.5mm, awn 0.2–1.4mm; palea 5.7–7.3mm; anthers 2.7–5mm.

FIG. 12.

a–b, *Festuca leptopogon*: a, infl. ($\times \frac{2}{3}$); b, spikelet ($\times 4$). c–d, *F. gigantea*: c, leaf auricle ($\times 1$); d, spikelet ($\times 4$). e–f, *F. arundinacea*: e, infl. ($\times \frac{2}{3}$); f, spikelet ($\times 4$). g–i, *F. stapfii*: g, leaf T.S. ($\times 50$); h, infl. ($\times \frac{2}{3}$); i, spikelet ($\times 4$). j, *F. undata*: spikelet ($\times 4$). k, *F. boriانا*: spikelet ($\times 4$). Drawn by Margaret Tebbs.



Bhutan: C — Thimphu (S of Tashichho Dzong, Yosepang), Tongsa (below Chendebi) and Bumthang (near Swiss Project, Karsumphe Guest House) districts. Meadows; roadside ditch; weedy garden, 2300–2700m. May–September.

Under-recorded. With *Dactylis glomerata*, the most widely grown of the introduced fodder grasses in improved pasture in temperate parts of Bhutan.

4. *F. rubra* subsp. *clarkei* (Stapf) Saint-Yves. Fig. 13a–c, Fig. 14a.

Tufted, shoots extravaginal. Leaves of vegetative shoots erect, blades $\frac{1}{3}$ to $\frac{1}{2}$ culm length (20–30cm), filiform, c.1mm wide, inrolled, with c.7 rather large sclerenchyma bundles on lower surface, marginal and submarginal ones sometimes fused, sclerenchyma also present on upper leaf surface adjacent to vascular bundles, lower surface sharply angled; basal sheaths short, dull, buff-coloured. Culms 54–100cm, stiff, slender to stout, ascending from base. Culm leaf blades 5–31cm, inrolled (c.0.9mm wide) or flat (to 4.2mm wide); sheath auricles not developed; ligule 0.3–1.4mm. Infl. sometimes purplish, 6.5–23cm, branches single or paired, nodding in life, obliquely erect when dry, the lowest (or longer of lowest pair) 2.5–12cm, bearing 4–23 spikelets, naked in lower third. Spikelets 9–12mm, fertile florets 4–5, rachilla internodes well developed. Glumes narrowly lanceolate, finely acuminate; the lower 3–5.2mm; the upper (4.5–)5–6.5mm. Lemmas narrowly lanceolate, gradually narrowed into awn, awns to 10mm, glabrous on surface, minutely rough on veins above. Paleas linear-lanceolate, apex shallowly bidentate, keels minutely ciliate. Ovaries glabrous at apex. Lowest floret: lemma 6.5–8.5mm; palea (5.1–)6.5–7.4mm; anthers (1.5–)1.9–2.4mm.

Bhutan: C — Thimphu (near Ginnekha, Thimphu), Tongsa (Chendebi), Bumthang (Kiki La), Mongar (Sengor) and Tashigang (Yonphu La) districts. Grassy meadows in open oak forest; roadside bank; pasture; blue pine forest, 2290–3120m. August–October.

FIG. 13.

a–c, *Festuca rubra* subsp. *clarkei*: a, leaf T.S. ($\times 50$); b, infl. ($\times \frac{2}{3}$); c, spikelet ($\times 4$). d–e, *F. cumminsii*: d, leaf T.S. ($\times 50$); e, spikelet ($\times 4$). f–h, *F. polycolea*: f, leaf T.S. ($\times 50$); g, infl. ($\times \frac{2}{3}$); h, spikelet ($\times 4$). i, *F. bhutanica*: leaf T.S. ($\times 50$). j–l, *F. wallichiana*: j, leaf T.S. ($\times 50$); k, infl. ($\times \frac{2}{3}$); l, spikelet ($\times 4$). m–n, *F. tibetica*: m, leaf T.S. ($\times 50$); n, spikelet ($\times 4$). Drawn by Margaret Tebbs.



M. Tebbs

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F. rubra L. s.l.

Various specimens from our area can be referred to *F. rubra* s.l. They differ from subsp. *clarkei* in having shorter awns (that of lowest lemma 1.1–2.5(–4)mm) and shorter, wider basal leaf blades. A Hooker specimen from Sikkim (Lachen, 3660–3962m, K) determined by Alexeev as subsp. *rubra* agrees with European material in having large anthers (2.9–3.6mm), but similar Bhutanese specimens from Chelai La (3048–3902m, *Keith* 175, E; *Miller* 276, K; *NPSW* 351, E) and Pele La (3270m, *NPSW* 287, E) have much smaller anthers (1.5–1.7mm). Further study and more collections are required.

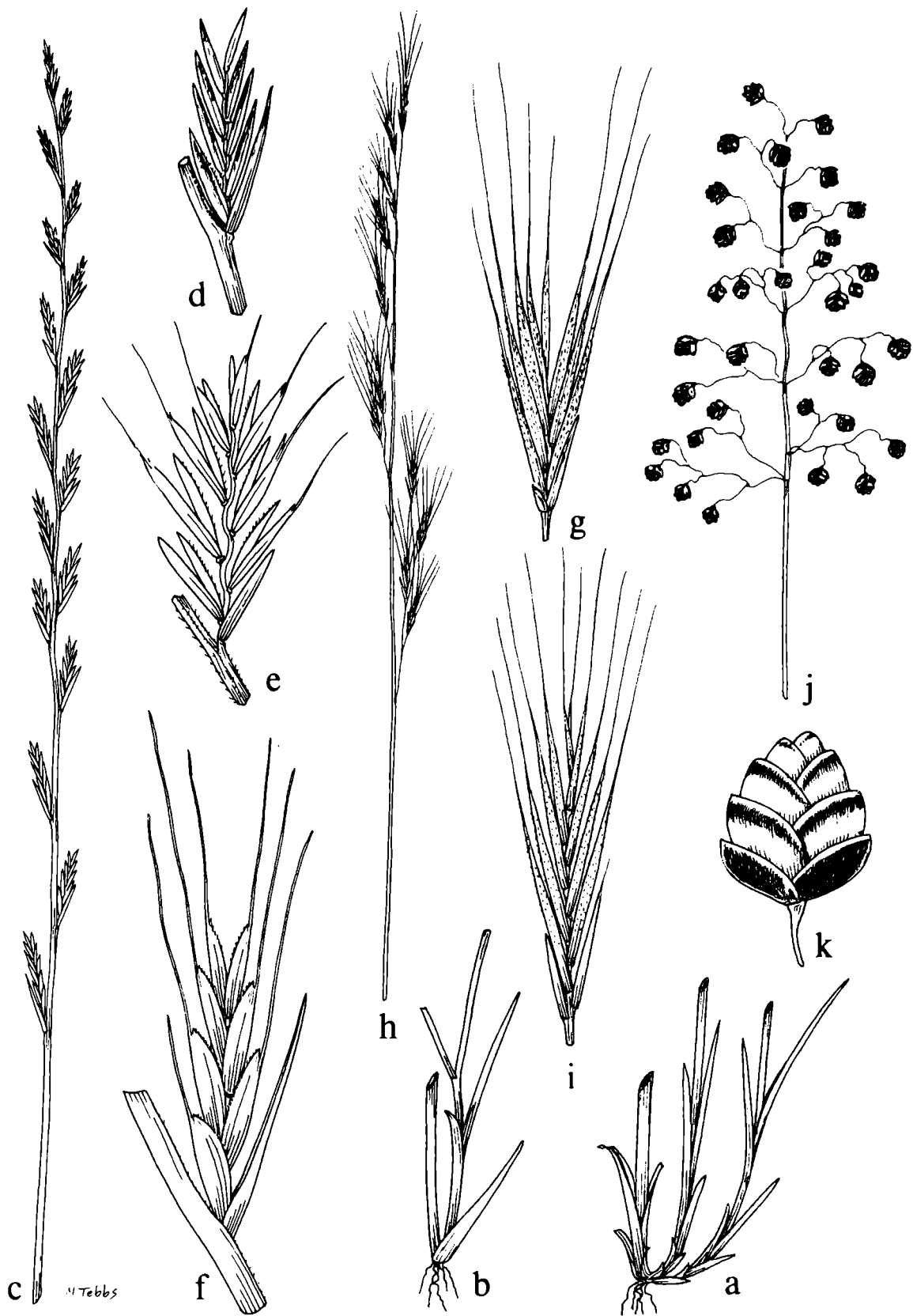
Two specimens of this complex with hairy leaf sheaths, hairy infl. branches (hairs to 0.9mm) and hairy spikelets have been seen from Thimphu district (c.2 hours N of Phajoding, 4150m, *Wood* 7137, E) and Sikkim (Samiti Lake, 4300m, *ESIK* 573, E). In hairiness they resemble *F. rubra* subsp. *arctica* (Hackel) Govoruchin, but they differ from that subsp. as follows: spikelets much larger (12.3–13mm); fertile florets fewer (3–4); glumes larger, sparsely pilose, the lower 7.4–7.6mm, 3-veined, the upper 8.4–9.1mm; lemmas longer (lowest of spikelet 8–12mm), densely pilose, hairs over 0.2mm. It probably represents an undescribed taxon, but further collections are required.

5. F. stapfii E.B. Alexeev; *F. undata* Stapf var. *aristata* Stapf. Fig. 12g–i.

Tufted, shoots intravaginal. Leaves of vegetative shoots erect, blades $\frac{1}{3}$ to $\frac{1}{2}$ culm length, narrow (0.5–1mm wide), inrolled, V-shaped in cross-section, with 7 small, evenly spaced sclerenchyma bundles. Culms 9–64cm, rather slender, erect. Culm leaf blades 3.5–14cm, narrow (0.5–1mm wide) and inrolled, or flat (to 2.7mm wide); ligule truncate, 0.3–0.7mm. Infl. 5–23cm, branches usually borne singly, flexuously ascending when dry, the lowest 3–13cm. Spikelets 7.2–9.3mm, fertile florets 3–4(–5), commonly lanceolate in outline, with florets not widely gaping, rachilla internodes well developed. Glumes acuminate; the lower 1.8–3.2(–4.2)mm, lanceolate; the upper 3.5–5(–5.5)mm, ovate-lanceolate. Lemmas linear-lanceolate, gradually narrowed into slender awn, awns 5–14mm, surface smooth, minutely hispid on veins at apex. Paleas linear, apex very acute, keels shortly ciliate. Ovaries

FIG. 14.

a, *Festuca rubra* subsp. *clarkei*: extravaginal branching ($\times 2$). b, *F. cumminsii*: intravaginal branching ($\times 2$). c–d, *Lolium perenne*: c, infl. ($\times \frac{2}{3}$); d, spikelet ($\times 2$). e, *L. multiflorum*: spikelet ($\times 2$). f, *L. temulentum*: spikelet ($\times 2$). g, *Vulpia myuros*: spikelet ($\times 2$). h–i, *V. bromoides*: h, infl. ($\times \frac{2}{3}$); i, spikelet ($\times 2$). j–k, *Briza media*: j, infl. ($\times \frac{2}{3}$); k, spikelet ($\times 4$). Drawn by Margaret Tebbs.



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glabrous at apex. Lowest floret: lemma 4.4–6.7(–7)mm, awn 3.2–7.5mm; palea 4.5–6.5mm; anthers 1–1.5(–1.8)mm.

Bhutan: C — Ha (near Damthang), Thimphu (pass W of Phajoding, above Thimphu hospital), Punakha (E of Dochu La), Bumthang (near Jakar Dzong) and Sakden (Orka La) districts; **Darjeeling** (Sandakphu, ?Jinephoolie); **Sikkim** (Chamnago, Lachen, Kankola, Phune, Chhoptha). Pastures; banks by tracks; open pine and fir forest; beside stream, 2300–3980m. June–September.

6. *F. undata* Stapf. Fig. 12j.

Differs from *F. stapfii* as follows: shoots extravaginal; awns shorter (that of lowest lemma in spikelet 0.7–1.4mm); ovary hairy; anthers very small (0.5–0.7mm).

Sikkim (Lachen, Samiti Lake); **Chumbi** (Yatung). Rough pasture; abandoned fields, 3050–4250m. June–July.

Until recently known only from the type which has abnormal spikelets. Alexeev referred to them as ‘viviparous’, but they are better described as galled, apparently the result of a fungal infection (S. Helfer, pers. comm.).

7. *F. boriana* E.B. Alexeev. Fig. 12k.

Loosely tufted, some shoots extravaginal. Leaves of vegetative shoots curved, blades short (to 4cm), dead at flowering, c.1mm wide, inrolled, with 7 sclerenchyma bundles, lower surface 5-angled; basal sheaths short, dull, cream or buff-coloured, pubescent. Culms to 31cm, erect. Culm leaf blades to 8.5cm, c.1.2mm wide, inrolled, apex acute; sheath auricles blunt, c.1.5mm; ligule c.0.8mm. Infl. 10–13.5cm, branches inserted singly, flexuously erect when dry, the lowest 6.5–8.5cm, naked in lower half. Spikelets c.10mm, fertile florets 4, rachilla internodes well developed. Glumes pubescent; the lower 5.3–6.5mm, narrowly lanceolate, very acute; the upper 6.5–7.5mm, oblong-lanceolate, acuminate. Lemmas linear-lanceolate, gradually narrowed to very finely acute apex, but not differentiated into an awn, sparsely pubescent, especially near margins, hairs c.0.2mm. Paleas linear, apex acutely bidentate, keels shortly ciliate. Ovaries glabrous at apex. Lowest floret: lemma 10.2–10.4mm; palea 7.1–7.2mm; anthers 1.7–2.1mm.

Bhutan: C — Ha district (To Chu, below Zu La); **Sikkim** (Natu La). Alpine meadows, 3900–3962m. June–July.

8. *F. cumminsii* Stapf; *F. rubra* L. subsp. *schlagintweitii* Saint-Yves (p.p.). Fig. 13d–e, Fig. 14b.

Densely tufted, shoots intravaginal. Leaves of vegetative shoots erect, blades less than $\frac{1}{3}$ (often much less) culm length, narrow (0.3–0.5mm wide), inrolled, usually with 2 wide marginal and one wide median sclerenchyma

bundles, sometimes with a subsidiary, smaller submedian pair, sometimes with 7 subequal bundles; sheaths very short, dull, becoming fibrous. Culms 12–43cm, slender, erect. Culm leaf blades short, 0.8–4cm, narrow (0.4–0.6mm wide), inrolled, apex very acute (needle-like); sheath auricles subacute, c.0.5mm; ligule minute, ciliate, rim-like. Infl. 2–11cm, branches borne singly, rather stiffly ascending, tightly appressed when dry, the lowest 1–6cm. Spikelets 6.5–9.2(–10.6)mm, fertile florets 3–4(–5), rachilla internodes well developed. Glumes narrowly lanceolate, acuminate; the lower 3–3.6(–5)mm; the upper 4.2–5.5(–6.7)mm. Lemmas linear-lanceolate, gradually narrowed into slender, rigid awn, conspicuously hispid on surface and veins above, awns to 7mm. Paleas linear, apex acutely bidentate, keels shortly ciliate. Ovaries glabrous at apex. Lowest floret: lemma 5.2–6.5(–7.2)mm, awn 2–3.2(–4.3)mm; palea 4.3–6(–7)mm; anthers 0.9–1.3mm.

Bhutan: C — Thimphu/Ha (summit of Chelai La) and Thimphu (between Phajoding and the lakes) districts; N — Upper Mo Chu (Soe/Lingshi/Yale La, Jangothang, Soi Yaksa) and Upper Bumthang Chu (Domchen) districts; **Sikkim** (Nathang, Thangu, Chhopta, Jamlinghang to Bikbari, Lachen, Yumthang, Lachung). Steep, open, grassy slopes with scattered boulders beneath cliffs; banks in fir forest, 3350–4300m. July–October.

Further work is required on this species. Alexeev described the leaves as having 3 sclerenchyma bundles. However his lectotype has 5: the marginal ones very broad (2 fused?), a broad median one and a small additional submedian (basal) pair; it also has small anthers 0.7–0.9mm. In the other syntypes the leaves have only 3 sclerenchyma bundles and the anthers are larger (to 1.1mm). Some otherwise indistinguishable specimens, however, have leaves with 7 distinct bundles.

A Sikkim specimen (*ESIK* 696C, E) differs in having minute anthers (c.0.6mm) and very glaucous spikelets, but is probably just a form.

9. *F. polycolea* Stapf; *F. ovina* L. subsp. *polycolea* (Stapf) Saint-Yves. Fig. 13f–h.

Densely tufted, shoots intravaginal. Leaves of vegetative shoots erect, blades $\frac{1}{2}$ or more length of culms, narrow (0.4–0.5mm wide), inrolled, with continuous sclerenchyma layer beneath epidermis, so tough to section, lower surface not angled; sheaths long, shining, cream or buff-coloured, not becoming fibrous. Culms 6–34cm, slender, erect. Culm leaves 1.8–5cm, narrow (0.5–0.7mm wide), inrolled, apex acute; sheath auricles blunt, 0.5–0.9mm; ligule ciliate, 0.3–0.5mm. Infl. 4–9.5cm, spikelets borne singly on main axis in upper half, stiffly spreading at anthesis; branches borne singly below, spreading stiffly at anthesis, the lowest commonly unbranched with 3 spikelets or branched and with up to 7 spikelets. Spikelets 6.1–9mm, fertile florets 2–4,

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rachilla internodes well developed. Glumes acuminate; the lower 2.6–3.5mm, narrowly lanceolate; the upper 3.5–4.3mm, oblong-lanceolate. Lemmas oblong-elliptic, gradually narrowed into slender, rigid awn, conspicuously hispid on surface and veins above, awns to 3.5mm. Paleas linear-lanceolate, keels shortly ciliate, apex acutely bidentate. Ovaries glabrous at apex. Lowest floret: lemma 4.5–5.2mm, awn 1.5–2(–2.8)mm; palea 4.2–5.2mm; anthers 1.6–2.2mm.

Bhutan: C — Ha (Ha La, To Chu), Thimphu (above Phajoding, Dotena, Changkaphug), Bumthang (near Kitiphu) and Sakden (Orka La) districts; N — Upper Pho Chu (on way to Lunana) and Upper Kulong Chu (Shingbe) districts; **Sikkim** (near Jamlinghang, Dzongri, Gamotang, above Chaunrikiang, Yakche, Yakla, Yumthang, Lachen). Alpine meadow; edge of path in *Abies* forest; sandy and gravelly places (moraines, streamsides); among *Rhododendron*/*Potentilla* scrub, 3050–4880m. May–October.

Var. *brevis* Stapf is merely a small form and not worth recognition.

10. *F. bhutanica* E.B. Alexeev. Fig. 13i.

Similar to *F. polycolea* in infl. shape, but differs as follows: culms usually under 10cm; leaf sheaths often reddish-brown, becoming fibrous; lower surface of leaf blades of vegetative shoots 5-angled, sclerenchyma in 3–7 discrete, small bundles; glumes often longer (the lower 3–3.3mm, the upper 4–5mm); lemmas often smaller (lowest of spikelet 3.6–4.5mm, awn 0.8–1.6mm).

Bhutan: N — Upper Mo Chu (Lingshi) and Upper Bumthang Chu (Domchen) districts; **Sikkim** (above Chaunrikiang, Chemathang); **Chumbi** (above Tsethanka). Between rocks in shallow, sandy soil; peaty turf and gravel, 4150–4570m. July–September.

The type (from Chumbi) has large anthers, which Alexeev took as being a diagnostic character. However the other specimens which resemble the type in leaf anatomy are smaller in stature (?grazed) and have smaller anthers. The number of sclerenchyma bundles seems to be variable from 3–7, the lateral ones being very small and weak.

11. *F. wallichiana* E.B. Alexeev; *F. valesiaca* sensu F.B.I.; incl. *F. chumbiensis* E.B. Alexeev. Fig. 13j–l.

Densely tufted, shoots intravaginal, bases of tufts almost woody and slightly swollen. Leaves of vegetative shoots glaucous, blades short (2–9cm), less than half culm length, curved or erect, c.0.4mm wide, inrolled, with (3–)5–7 wide, but unequal sclerenchyma bundles, lower surface 5-angled, asymmetric in section, commonly hispid, sometimes glabrous; sheaths very short, dull, cream-coloured. Culms to 3.5–26cm, slender, erect, leaves restricted to lower half. Culm leaf blades 0.6–2.2cm, c.0.5mm wide, inrolled, apex

acute; sheath auricles scarcely developed, c.0.3mm, only just exceeding ligule, minutely ciliate; ligule 0.1–0.2mm. Infl. 1.2–4.5cm, linear, spikelets mostly inserted singly on main axis on short pedicels, erect, the basal node sometimes bearing a branch with up to 7 spikelets. Spikelets sometimes tinged purple, 4.5–5.7(–6)mm, fertile florets 3–5, rachilla internodes well developed. Glumes minutely hispid at apex; the lower 1.6–2.2(–2.4)mm, narrowly lanceolate, acute; the upper 2.5–3.4mm, oblong-lanceolate, subacute. Lemmas oblong-lanceolate, gradually narrowed into short awns, surface shortly hispid, upper awns longer (to 2mm). Paleas linear, apex shortly bidentate, keels shortly ciliate. Ovaries glabrous at apex. Lowest floret: lemma 3–3.9mm; palea 2.8–3.7mm; anthers 0.8–1.3mm.

Bhutan: C — Ha (5 miles below Ha Dzong, opposite Ha Bazaar, To Chu) and Thimphu (E side of Chelai La, hill E of Thimphu) districts; N — Upper Mo Chu (Laya, Soi Yaksa) and Upper Bumthang Chu (Domchen) districts; **Sikkim** (Chhoptha, Pheedung, Lachen); **Chumbi** (Yatung). Open, dry grassland; moraine ridge; bank in fir forest, 2600–4830m. May–September.

F. chumbiensis seems to be a robust form of *F. wallichiana* from a damp habitat, with stout culms.

12. *F. tibetica* (Stapf) E.B. Alexeev; *F. valesiaca* Schleicher ex Gaudin var. *tibetica* Stapf. Fig. 13m–n.

Differs from *F. wallichiana* as follows: tufts less dense, basal sheaths longer; culms often shorter (4–16cm); leaves of vegetative shoots commonly more than ½ culm length, blades never hispid below, scarcely angled, symmetrical in cross-section, sclerenchyma bundles 3, small, equal in width; infl. shorter (1–2.7cm) and denser; lower glume lanceolate, acuminate; upper glume widely lanceolate, acuminate; awns of lemmas shorter.

Bhutan: N — Upper Mo Chu district (Lingshi, Ngile La, Yale La); **Sikkim** (above Chaunrikiang, Donkia Pass); **Chumbi** (Phari). Open, grassy hillside; peaty trackside and edge of pool, 4270–5800m. July–October.

Alexeev stated the leaves to have 7 vascular bundles, but most of the specimens seen have 4 or 5.

Doubtful species:

F. sikkimensis E.B. Alexeev

This species was described from a Hooker duplicate sheet at LE distributed under the name *F. duriuscula*. The sheet bears rather scrappy specimens of three taxa: *F. rubra*, *F. stapfii* and *F. sikkimensis*. As the latter differs from any Hooker Sikkim specimens at Kew, or any other duplicates distributed

under the name *F. duriuscula* it seems likely to be a misplaced specimen and is unlikely to have come from Sikkim. It differs from all the above species in having very small spikelets and awnless lemmas; the sclerenchyma pattern is described by Alexeev as being like that of *F. cumminsii*.

23. LOLIUM L.

Perennial, biennial or annual. Culm leaf blades flat or inrolled, sometimes clasping at base; ligule membranous, truncate. Infl. a linear, laterally compressed spike, spikelets sunk into concavities on alternate sides of rachis. Spikelets gaping, laterally compressed, disarticulating above glume and between florets, with up to 11 (or more) fertile and 1–2 sterile, terminal florets. Lower glume of lateral spikelets absent; upper glume exceeding lowest lemma, 5–7-veined, coriaceous. Lemmas lanceolate to elliptic, rounded on back, 5-veined, herbaceous, sometimes awned from below apex, margins incurved. Paleas lanceolate to elliptic, keels ciliate, margins inflexed. Ovary glabrous. Anthers 3.

A difficult genus; the species are poorly defined morphologically and hybridisation occurs. It is important to collect basal parts in order to be able to tell if a plant is annual or perennial.

- | | | |
|----|--|--------------------------|
| 1. | Plant perennial, with vegetative shoots present at flowering; culm leaf blades narrow (to 2mm), often inrolled | 2 |
| + | Plant annual or biennial, lacking vegetative shoots at flowering; culm leaf blades flat, commonly over 4mm wide | 3 |
| 2. | Spikelets unawned | 1. L. perenne |
| + | Spikelets awned | 2. L. × hybridum |
| 3. | Glume shorter than spikelet; lowest lemma not or minutely awned; lemmas lanceolate when flattened; floret not turgid at maturity; grain elongate | 3. L. multiflorum |
| + | Glume equalling spikelet; lowest lemma strongly awned; lemmas elliptic when flattened; floret turgid at maturity; grain wide | 4. L. temulentum |

1. **L. perenne** L. Eng: *perennial rye-grass*. Fig. 14c–d.

Perennial. Vegetative shoots present at flowering; leaf blades 7–15cm, narrow, inrolled (c.0.5mm wide) or flat (c.2mm wide). Culms 24–59cm, slender, geniculately ascending, bases sometimes decumbent and rooting from

lower nodes. Culm leaf blades 3–14cm, narrow, inrolled (0.7–1.2mm wide) or flat (2–4mm wide), minutely auriculate at base; ligule 0.3–1.5mm. Infl. 8–25cm, rachis 0.8–2.1mm wide. Spikelets 9–17.8mm, with 4–7(–11) fertile florets. Upper glume shorter than spikelet (commonly about half length), oblong, blunt, 6.3–11.5mm, 7-veined. Lemmas oblong-lanceolate, subacute, apex hyaline, awnless or the upper ones sometimes shortly awned (awns to 4.5mm); paleas oblong-elliptic, acute. Lowest floret: lemma 5.8–7mm; palea 5.5–6.9mm; anthers 2.4–2.7mm. Grains elongate, more than 3 × as long as wide

Bhutan: C — Thimphu (Thimphu) and Bumthang (Byakar) districts; **Darjeeling** (Darjeeling, Jalapahar). Dry roadside bank near cultivation; gardens; wasteground, 2055–2700m. May–October.

Introduced – to Darjeeling from the 19th century onwards, more recently in Bhutan. One of the Darjeeling specimens was determined by Bor as *L. rigidum* Gaudin; the basal parts are virtually lacking, but it seems unlikely to be that species which differs from *L. perenne* mainly in being annual.

2. *L. × hybridum* Haussknecht (*L. perenne* × *multiflorum*)

Intermediate between the two parents, being perennial, but with awned lemmas.

Bhutan: C — Bumthang (Byakar) and Mongar (Sengor) districts. Pasture; roadside banks, 2700–3000m. June–September.

No doubt under-recorded and likely to occur wherever the parents have been introduced.

3. *L. multiflorum* Lamarck. Eng: *Italian rye-grass*. Fig. 14e.

Differs from *L. perenne* as follows: annual or biennial (lacking vegetative shoots at flowering); culms stouter, often taller (37–76cm); culm leaf blades flat, wider (4–6.2mm wide), usually conspicuously auriculate at base; lowest lemma of spikelet commonly longer (6.6–8.6mm), the upper lemmas awned, awns 3.6–6.9mm; paleas longer (6–8.2mm); anthers longer (3.3–3.6mm).

Bhutan: C — Thimphu (Thimphu), Tongsa (Shemgang) and Bumthang (Karsumphe Guest House) districts. Gardens and pastures, 1980–2700m. June–September.

A recent introduction for fodder, and good for producing a short-lived flush. However, as a biennial, it does not persist. Hybridises freely with *L. perenne* and some of the material introduced as *L. multiflorum* is probably of hybrid origin.

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4. *L. temulentum* L. Eng: *darnel*. Fig. 14f.

Similar to *L. multiflorum* vegetatively, but differing from it and from *L. perenne* as follows: upper glume about equalling spikelet (c.15mm); florets turgid at maturity; lemmas more elliptic (c.3mm wide when flattened out), very stoutly awned, the longest awns of a spikelet to 15.4mm; grain c.5 × 1.8mm, less than 3 × as long as wide.

Bhutan: C — Thimphu district (Thimphu). Garden weed, 2300m. June.

No doubt a recent, and probably casual, introduction.

24. VULPIA C.C. Gmelin

Slender, tufted annuals. Culm leaf blades linear, inrolled; ligule membranous, truncate. Infl. a linear, ± one-sided panicle, branches borne singly, erect. Spikelets gaping, laterally compressed, with 4–5 fertile florets and 1–2 reduced, terminal ones, disarticulating above glumes and between florets. Glumes linear-lanceolate, shorter than spikelet, very unequal, herbaceous, the lower shorter, 1-veined, the upper 3-veined. Lemmas linear-lanceolate, rounded on back, awned from apex, 5-veined, thickly herbaceous. Paleas linear, keels ciliate. Ovary glabrous. Anther 1, remaining enclosed within floret.

1. Lower glume very short, to 2mm 1. *V. myuros*
+ Lower glume over 5mm 2. *V. bromoides*

1. *V. myuros* (L.) C.C. Gmelin; *Festuca myuros* L. Eng: *rat's-tail fescue*. Fig. 14g.

Culms 5–11cm, slender, geniculately ascending. Culm leaf blades 3–5.5cm, c.0.5mm wide; ligule 0.3–0.5mm. Infl. 6–13cm, usually longer than culm, often somewhat interrupted, often scarcely exerted from upper leaf sheath. Spikelets 10–12mm; pedicels unequal, 1–4.2mm. Lower glume 0.9–2mm, less than half length of lowest lemma, narrowly triangular, margins narrowly hyaline; upper glume 4–6.2mm, narrowly oblong-lanceolate, margins widely hyaline. Lemmas gradually tapered into slender, rough awn, glabrous or minutely hispid on veins. Lowest floret: lemma 7.2–10mm, awn 6.5–13.5mm; palea 6.1–6.8mm; anther 0.5–0.7mm.

Bhutan: N — Upper Mo Chu district (below Soi Yaksa, above Lhalu). By path; open grassy hillside, 1500–3930m. June–September.

These records are rather surprising, as the species has not previously been recorded from so far east in the Himalaya, nor at such a high altitude; it has perhaps been introduced with crops.

2. V. bromoides (L.) S.F. Gray. Eng: *squirrel-tail fescue*. Fig. 14h-i.

Differs from *V. myuros* as follows: infl. long-exserted from upper leaf sheath; lower glume more than half length of lowest lemma, c.5.4mm.

Bhutan: C — Tashigang district (Yonpu La Airstrip). Disturbed, heathy grassland, 2500m. September.

No doubt an introduction from Europe.

25. BRIZA L.

Tufted, shortly rhizomatous perennial. Culm leaf blades flat; ligule membranous. Infl. a lax panicle, lower branches paired. Spikelets broadly ovate, laterally compressed, with 4–7 fertile florets and often a reduced terminal one, disarticulating above glumes and between florets. Glumes subequal, shorter than spikelet, suborbicular, deeply convex, 3-veined, herbaceous, apex hooded, base cordate, margins widely hyaline. Lemmas spreading horizontally, suborbicular, deeply convex, obscurely 5-veined, papery, apex hooded, margins hyaline. Paleas broadly oblanceolate, shallowly emarginate, hyaline.

1. B. media L. Eng: *quaking grass*. Fig. 14j-k.

Culms 41–62cm, slender, erect. Culm leaf blades linear-lanceolate, the lower to 11cm long, 3.8–5.5mm wide, the upper reduced; ligule c.0.5mm, rounded, blunt. Infl. 7–10 × 4–7cm, broadly ovate in outline, branches obliquely ascending. Spikelets 4–5.1 × 4.5–5.5mm, pedicels filiform. Glumes often purplish, 2.5–3 × 2.4–2.9mm. Lemmas often purplish towards edge, the centre shining, pale. Lowest floret: lemma 3–3.5mm; palea 2.5–2.9mm; anthers 0.6–1mm.

Bhutan: N — Upper Mo Chu district (above Laya); **Sikkim** (Nathang); **Chumbi**. Grassy slope among shrubs, 4170m. July–October.

26. POA L.

Annuals or perennials; tufted or rhizomatous. Leaf blades usually linear; ligule membranous. Infl. paniculate, branches sometimes short, so narrow and condensed. Spikelets laterally compressed, florets 2–6, disarticulating above glumes and between florets, sometimes 'viviparous' with florets proliferating vegetatively, callus sometimes bearing long, woolly hairs. Glumes lanceolate, keeled, keel usually hispid, margins usually hyaline, the lower usually shorter than lower lemma (sometimes longer), 1–3-veined, the upper usually wider, 3-veined. Lemmas keeled, usually 5-veined, sometimes with additional veins.

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surface glabrous or variously scabrid/hairy, apex and margins usually hyaline. Paleas linear, keels scabrid, or ciliate (in whole or part). Anthers 3.

An extremely difficult genus. The following account is provisional and relies heavily on the work of Bor (1951, 1952). The genus is very under-collected in Bhutan (especially in alpine areas) and additional species are likely to occur.

Ligule measurement and shape refer to that of the uppermost culm leaf: the length is taken from the ligule apex to where it joins the midrib of the leaf blade.

1. Leaves coriaceous, apex sharp; glume margins minutely ciliate; hairs on keel and lateral veins of lemmas very long (1–2mm)
1. P. pseudotibetica
- + Leaves not coriaceous, apex not sharp; glume margins not ciliate; hairs on keel and lateral veins of lemmas shorter 2
2. Palea keels bearing at least some cilia or crisped hairs 3
- + Palea keels bearing only rigid spicules 11
3. Spikelets over 5.5mm; lowest lemma over 4.5mm 4
- + Spikelets under 4.5mm (if to 5mm, then lemmas glabrous); lowest lemma to 4mm 5
4. Leaf sheaths rough; ligule over 4.5mm; leaves long, linear, acute
2. P. gammiana
- + Leaf sheaths smooth; ligule to 1.5mm; leaves short, oblong, cuspidate
3. P. polyneuron
5. Lower glume usually overtopping lowest lemma (occasionally not quite reaching it) **4. P. hirtiglumis**
- + Lower glume conspicuously shorter than lowest lemma 6
6. Wool present on callus of florets 7
- + Wool absent 9
7. Ligule over 3mm; lower glume over 2.5mm, 3-veined **8. P. stapfiana**
- + Ligule to 2mm; lower glume to 2.1mm, 1-veined 8
8. Lemmas oblong-lanceolate in profile, blunt, glabrous between the veins **7. P. nepalensis**
- + Lemmas linear-lanceolate in profile, acute, hairy between the veins below **23. P. burmanica**

9. Lemmas narrowly lanceolate in profile, completely glabrous; palea keels with crisped hairs on upper part **22. P. lachenensis**
 + Lemmas oblong-lanceolate in profile, usually hairy on lower part of keel; palea keels with \pm straight cilia on lower part or throughout.... 10
10. Palea keels ciliate throughout; ligule commonly under 2.5mm; infl. branches usually spreading **5. P. annua**
 + Palea keels ciliate below, scabrid towards apex; ligule commonly over 2.5mm; infl. branches usually ascending **6. P. sikkimensis**
11. Rhizomatous perennials 12
 + Non-rhizomatous (tufted perennials or annuals) 17
12. Hairs at base of lateral veins of lemmas long (Fig. 19f); dwarf, slender plants, culms usually under 10cm, not tufted; florets 2–3
9. P. calliopsis
 + Hairs at base of lateral veins of lemmas short; robust plants, culms usually over 10cm (if under 10cm, then plant densely tufted); florets 2–5 13
13. Lower infl. branches whorled; lemmas not scabrid or hairy between veins 14
 + Lower infl. branches paired, deflexed; lemmas scabrid or hairy between veins 15
14. Ligules usually under 2(–3.2)mm; callus woolly **10. P. pratensis**
 + Ligule over 5mm; callus glabrous **11. P. asperifolia**
15. Ligules short (c.0.5mm) **27. P. polycolea**
 + Ligule long (over 1.9mm) 16
16. Spikelets small (usually under 6mm); lemmas small, the lowest of spikelet to 4.9mm **26. P. pagophila**
 + Spikelets larger (over 6.2mm); lemmas larger, the lowest of spikelet usually over 5mm **28. P. nitide-spiculata**
17. Small annual; culms under 5cm **12. P. rohmoiana**
 + Perennial, if possibly annual (*P. rajbhandarii*), then culms over 10cm.... 18

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18. Spikelets large (over 5.5mm), the lower glume usually over-topping the lowest lemma **13. *P. eleanorae***
 + Spikelets not as above, the lower glume not reaching tip of the lowest lemma 19
19. Infl. narrow, branches short, ascending; lower glume 3-veined; plant forming dense, hard tussocks 20
 + Infl. loosely paniculate, branches elongate, spreading, ascending or deflexed; lower glume usually 1-veined; plant not forming dense, hard tussocks 22
20. Spikelets viviparous **16. *P. mustangensis***
 + Spikelets not viviparous 21
21. Lowest lemma over 3mm **14. *P. cf. attenuata***
 + Lowest lemma to 3mm **15. *P. poophagorum***
22. Keel of lemma not hairy in lower part 23
 + Keel of lemma hairy in lower part..... 24
23. Spikelets small, under 3mm; lower glume distinctly shorter than lowest lemma; lowest lemma under 2mm; anthers c.0.5mm .. **17. *P. chumbiensis***
 + Spikelets over 4mm; lower glume almost reaching tip of lowest lemma; lowest lemma over 3mm; anthers over 0.9mm **18. *P. dzongicola***
24. Surface of lemmas smooth or minutely punctate between veins, with no hairs, even near base 25
 + Surface of lemmas scabrid between veins above, usually with some hairs between veins near base 27
25. Leaf sheaths rough; ligule long (over 3.5mm); spikelets narrowly elliptic **19. *P. trivialis***
 + Leaf sheaths smooth; ligule to 2.1mm; spikelets wedge-shaped 26
26. Anthers under 1mm **20. *P. rajbhandarii***
 + Anthers over 1.4mm **21. *P. nemoralis***
27. Anthers under 1mm 28
 + Anthers over 1.5mm 29

28. Wool absent from callus 24. *P. cooperi*
 + Wool present on callus 25. *P. longii*
29. Ligule over 2mm 26. *P. pagophila*
 + Ligule to 1.2mm 29. *P. ludens*

1. *P. pseudotibetica* Noltie; *P. tibetica* Stapf var. *aristulata* Stapf. Fig. 15a–d.

Perennial, with slender, creeping rhizomes. Culms to 45cm, smooth, leafy for lower $\frac{1}{2}$ to $\frac{2}{3}$; leaf blades 4–16cm, apex sharp, strongly ribbed above and beneath, scabrid on ribs above, coriaceous; sheaths smooth; ligule 1.5–5.5mm, subacute, irregularly dentate. Infl. to 9cm, dense, narrowly cylindrical, branches stiffly appressed, smooth, naked only at base, the lowest in whorl of c.4, the longest to 4cm. Spikelets pale brownish-purple (eventually straw-coloured), 6.6–8.2mm, narrowly elliptic, florets 3–4, callus wool absent. Glumes acuminate, margins minutely ciliate below, papery; the lower 4–4.6 × 1.5–1.7mm, 1- or 3-veined; the upper 4.8–6 × 2–2.4mm, 3-veined, surface minutely hairy at base. Lemmas in profile oblong-lanceolate, finely acuminate, chartaceous, lateral veins obscure, the lowest 5.3–5.7mm, half-width 1–1.2mm, flushed purple in upper half, apex narrowly hyaline, keel and outer lateral veins with long (1–2mm), woolly hairs in lower half, surface scabrid above. Palea of lowest floret 4.1–4.9mm, keels scabrid; anthers 2.2–3.1mm.

Sikkim (Chholhamoo). [Presumably on stony/sandy plain], 5420m. August.

2. *P. gammieana* Stapf. Fig. 18a–c.

Stout, tufted perennial. Culms 20–73cm, scabrid beneath infl., leafy for most of length; leaf blades 9.5–15cm, flat, 3.8–6mm wide, gradually tapered to acute apex, glabrous or scabrid above; sheaths usually scabrid, keeled, compressed; ligule 4.3–6mm, acute. Infl. 10–15cm, lax, triangular in outline, branches spreading at anthesis, slender, smooth, naked for more than half length, the lowest paired, the longer to 5.5cm. Spikelets green or purple-flushed, 5.5–6.5mm, widely wedge-shaped, florets (2–)3–5, callus wool plentiful. Glumes acuminate, thickly herbaceous; the lower 2–3.6 × c.1.2mm, 3-veined; the upper 3.9–4.2 × c.1.7mm, 3-veined. Lemmas in profile narrowly lanceolate, acute, thickly herbaceous, lateral veins sharply raised, the lowest 4.5–4.7mm, half-width c.1mm, sometimes flushed purple subapically, apex narrowly hyaline, keel ciliate in lower part, outer and intermediate lateral veins scabrid above, ciliate below, surface hispid between veins, especially near base. Palea of lowest floret 2.8–4.2mm, keels ciliate in lower part (hairs sometimes crisped); anthers 1.1–1.4mm.

Bhutan: C — Thimphu district (above Phajoding); **Sikkim** (Tankra mountain, Jamlinghang). Beside streams in open marshes; shady rhododendron and juniper scrub, 3500–3800m. July–September.

3. *P. polyneuron* Bor. Fig. 18d–f.

Differs from *P. gammieana* as follows: culm leaf blades shorter (3.5–6.5cm), abruptly contracted to hooded, apiculate apex; sheaths usually smooth; ligule shorter (to 1.5mm, truncate-erose); spikelets larger, lemmas wider, with 2 or more supplementary veins, so 7–9-veined; anthers longer (c.2mm).

Sikkim ('NE Sikkim', Nathu La, Bikbari, Thangshing to Lam Pokhri); **Chumbi** (Chubitang). Wet, yak pasture, 3950–4115m. June–July.

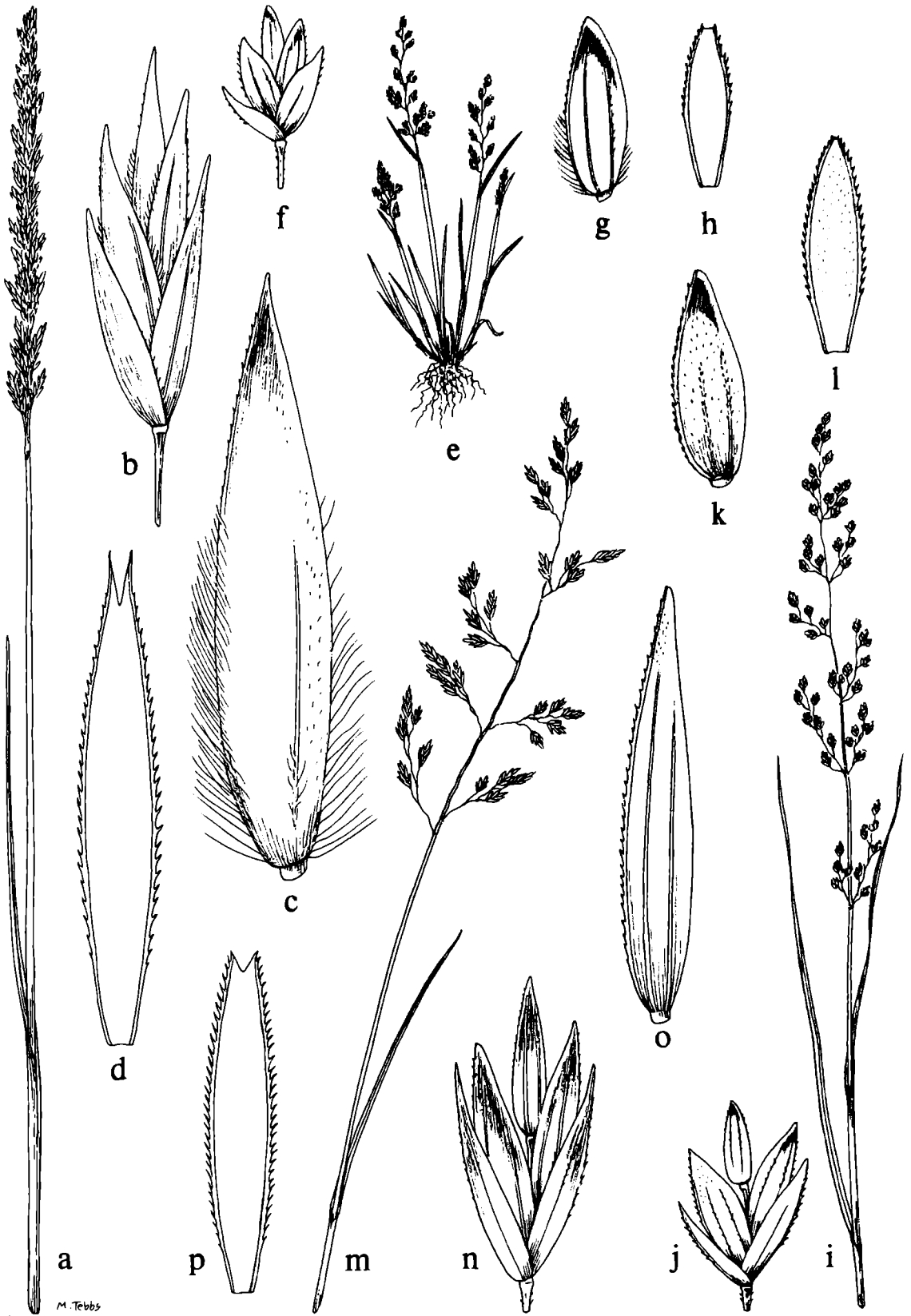
Rajbhandari (1991) excluded this species from *Poa* on account of the number of lemma veins. However, this is not constant and some other species also have more than 5 veins. Recent collections of this handsome species from Sikkim show it to be correctly placed in the genus.

4. *P. hirtiglumis* Stapf. Fig. 18g–i.

Densely tufted perennial, shoots somewhat swollen at base; leaf blades of vegetative shoots to 8cm, narrower than those of culm leaves. Culms 4–26cm, smooth, leafy for most of length; leaf blades 1.3–11cm, flat, rather wide (2–4.7mm), glabrous; sheaths smooth; ligule (1.6–)2.5–5.2mm, truncate or subacute. Infl. 2.5–16cm, lax, triangular in outline, branches spreading or deflexed at anthesis, scabrid, naked for less than or more than half length, the lowest paired, the longer 1–8cm. Spikelets green or purple-flushed, 2.8–4.4mm, wedge-shaped, glumes usually overtopping lower two lemmas, florets (2–)3–4, callus wool usually present. Glumes finely acuminate; the lower 2.4–3.8 × c.1mm, (1–)3-veined; the upper 2.6–4 × c.1.3mm, oblong-lanceolate, 3-veined. Lemmas rather small, lanceolate in profile, acute, lateral veins raised, the lowest 2.1–2.8mm, half-width c.0.8mm, sometimes flushed purple subapically, apex narrowly hyaline, keel ciliate in lower part, outer lateral veins ciliate below, surface densely short-hairy between veins. Palea of

FIG. 15.

a–d, *Poa pseudotibetica*: a, infl. (× 4/7); b, spikelet (× 7); c, lowest lemma and callus (× 14); d, lowest palea (× 14). e–h, *P. rohmooiana*: e, habit (× 4/7); f, spikelet (× 7); g, lowest lemma and callus (× 14); h, lowest palea (× 14). i–l, *P. chumbiensis*: i, infl. (× 4/7); j, spikelet (× 7); k, lowest lemma and callus (× 14); l, lowest palea (× 14). m–p, *P. dzongicola*: m, infl. (× 4/7); n, spikelet (× 7); o, lowest lemma and callus (× 14); p, lowest palea (× 14). Drawn by Margaret Tebbs.



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lowest floret 1.7–2.8mm, keels ciliate below, scabrid above; anthers small, 0.6–0.7mm.

Bhutan: N — Upper Mo Chu district (Zambuthang); **Sikkim** (Chugya, Lambi to Onglakthang, Naku La, Yume Samdong, Donkia Pass). Gravel beside river; wasteground beside habitation, 4020–5490m. July–October.

Rather variable in stature (probably correlated with altitude).

5. *P. annua* L. Dz: *cha*; Sikkim name: *thamcha*; Eng: *annual meadow-grass*. Fig. 18j–l.

Small, tufted annual. Culms 3–17(–27)cm, smooth, leafy for $\frac{1}{2}$ – $\frac{2}{3}$ length; leaf blades 0.4–7cm, flat, 1.4–3.5mm wide, abruptly contracted to apiculate apex, glabrous; sheaths smooth; ligule 1–2.1(–2.4)mm, blunt. Infl. 2–5.3cm, lax, triangular in outline, branches spreading or deflexed at anthesis, smooth, naked for less than half length, the lowest single or paired, the longer 1–2.3cm. Spikelets green, 3.7–5mm, narrowly elliptic, florets 3–5, callus wool absent. Glumes acute; the lower 1.2–1.9 × c.0.7mm, 1- (or 3-) veined; the upper 1.8–2.2 × c.1mm, oblong-elliptic, 3-veined. Lemmas lanceolate in profile, rather blunt, the lowest 2.5–2.9mm, half-width c.0.7mm, apex widely hyaline, keel ciliate in lower part, outer and sometimes intermediate lateral veins ciliate below, surface smooth. Palea of lowest floret 2.2–2.7mm, keels ciliate throughout; anthers 0.6–1.1mm.

Bhutan: S — Chukka and Deothang districts; C — Thimphu, Punakha, Bumthang, Tongsa, Mongar and Tashigang districts; N — Upper Mo Chu and Upper Bumthang Chu districts; **Darjeeling** (Darjeeling, Tiger Hill, Tonglu, Glen Cathcart); **Sikkim** (Yumthang, Phune, N of Dzungri, Domang, Gangtok); **Chumbi**. Disturbed places (roadside banks, footpaths, gardens, shingle by stream); yak pasture; marsh in fir/rhododendron forest; weed of wheat, 1450–4440m. February–September.

Forms with glabrous lemmas and palea keels occur. The two specimens from N Bhutan are intermediate with *P. sikkimensis*, having rather wide leaves, but are small and have no teeth on the palea keels.

Parker (1992) recorded it as a common winter weed, of e.g. wheat and vegetables, occurring mainly over 2000m.

6. *P. sikkimensis* (Stapf) Bor; *P. annua* L. var. *sikkimensis* Stapf. Fig. 17a, Fig. 18m–o.

Very similar to *P. annua*, but differs as follows: sometimes perennial; often more robust (culms to 34cm; culm leaf blades 2.2–10.5cm, 2.5–4.8mm wide); ligules longer ((2–)2.5–4mm); infl. larger, to 19.5cm, lowest branch 3–7cm, branches commonly scabrid; spikelets often tinged purple; lemmas commonly

glabrous on lateral veins and sometimes also on keel; palea keels usually ciliate below and scabrid above.

Bhutan: C — Thimphu (hill E of Thimphu) and Bumthang (above Kurpang) districts; N — Upper Mo Chu (Soe/Lingshi/Yale La, Zambuthang) and Upper Bumthang (Domchen) districts; **Darjeeling** (Sandakphu); **Sikkim** (Lachen, Lachung, Yume Samdong, Phusum, Dzongri, Sebu valley, Chugya); **Chumbi** (Phari, Yatung). Disturbed areas by yak encampments and habitation; scree at base of cliff; sand in river bed; by stream in fir forest, (2620–)3048–4720m. June–October.

7. ***P. nepalensis*** (Grisebach) Duthie; *P. annua* L. var. *nepalensis* Grisebach. Fig. 18p–r.

Tufted annual. Culms 11–51cm, smooth, leafy almost to infl.; leaf blades 4.5–18cm, flat, 2.8–3.4mm wide, scabrid above; sheaths smooth; ligule 0.5–1mm, rounded. Infl. 3.8–21cm, lax, oblong in outline, branches ascending at anthesis, minutely hispid, bearing spikelets to base or naked for more than half length, the lowest in whorls of 3–5, the longest 2–9cm. Spikelets green, 3.4–5.1mm, elliptic, florets 3–6, callus wool plentiful. Glumes acuminate; the lower 1.4–2.1 × c.0.6mm, 1-veined; the upper 2–2.6 × c.1.1mm, 3-veined. Lemmas oblong-lanceolate in profile, blunt, the lowest 2.5–3.2mm, half-width c.0.8mm, apex widely hyaline, keel ciliate in lower part, outer lateral veins ciliate below, surface smooth. Palea of lowest floret 1.8–2.5mm, keels ciliate below, scabrid towards apex; anthers 0.6–0.9mm.

Bhutan: C — Thimphu (Langjophaka), Tongsa (Chendebi) and Sakden (Tashigang to Sakden, above Sakden) districts; N — Upper Kulong Chu district (Lao). Wooded roadside bank; moist grassland in broad-leaved and mixed forest; in garden, 2200–2590m. April–May.

8. ***P. stapfiana*** Bor; *P. tremula* sensu F.B.I., non Lamarck. Fig. 19a–c.

Tufted perennial. Culms over 40cm, smooth, leafy almost to infl.; leaf blades to 8cm, flat, c.2.5mm wide, scabrid above; sheaths smooth; ligule to 4mm, acute. Infl. 12.5–16.5cm, lax, oblong in outline, branches probably spreading or deflexed at anthesis, scabrid, the lowest paired, the longer to 6cm. Spikelets flushed purple, 5–6.6mm, ovate, florets 3–5, callus wool scanty. Glumes oblong-lanceolate, acuminate, 3-veined; the lower 2.8–3.6 × c.1.1mm; the upper 3.4–4 × c.1.3mm. Lemmas lanceolate in profile, subacute, the lowest 3.6–4mm, half-width c.0.8mm, flushed purple in upper part, apex widely hyaline, keel ciliate in lower part, outer lateral veins ciliate below, surface punctate above, with few, short hairs at base between veins. Palea of lowest floret 2.8–3mm, keels with crisped cilia below, scabrid towards apex; anthers 0.9–1mm.

Sikkim (Nathang). Habitat and altitude not recorded.

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I agree with Bor's determination of two old, rather battered, specimens; previously known only from the W Himalaya.

9. *P. calliopsis* Litvinov ex Ovczinnikov; *P. phariana* Bor. Fig. 17b, Fig. 19d-f.

Dwarf perennial, with slender, creeping rhizomes. Culms 1.4–10.5cm, smooth, leafy for less than half length; leaf blades short, 0.6–2cm, folded, glabrous; sheaths smooth; ligule c.1mm, blunt. Infl. 1–3cm, triangular (or narrowly so) in outline, branches smooth, naked for less than half length (spikelets clustered), the lower spreading or deflexed, the lowest paired, the longer 0.6–1.5cm. Spikelets flushed purple and gold, 3.1–4.5mm, narrowly elliptic, florets 2(–3), callus wool plentiful. Glumes sharply acuminate, flushed purple; the lower 2.2–3.1 × c.1.2mm, 1(–3)-veined; the upper 2.4–3.4 × c.1.8mm, oblong-ovate, 3-veined. Lemmas in profile oblong-lanceolate, subacute, the lowest 2.8–3.6mm, half-width c.0.8mm, flushed gold, with subapical purple band, apex hyaline, keel long-ciliate in lower half, outer lateral veins long-ciliate near base, surface shining, smooth, glabrous between veins. Palea of lowest floret 2.3–3mm, keels scabrid throughout or with few, irregular teeth; anthers 0.9–1.3(–1.8)mm.

Bhutan: N — Upper Mo Chu district (Seanchu Passa to Chabecha (Rajhbandari, 1991)); **Chumbi** (Phari). Beside streams; damp places; dry hummocks on plain, 3600–4570m. May.

It is not possible to maintain *P. phariana* which is supposed to differ from *P. calliopsis* in having more compressed and acute lemmas. It is also supposed to have regularly scabrid palea keels, but this character is variable in *P. calliopsis*.

10. *P. pratensis* L.; incl. *P. alpigena* (Blytt) Lindman (*P. pratensis* subsp. *alpigena* (Blytt) Hittonen) and *P. angustifolia* L. (*P. pratensis* subsp. *angustifolia* (L.) Gaudin). Eng: *smooth meadow-grass*. Fig. 17c, Fig. 19g-i.

Perennial with slender, extensively creeping rhizomes. Culms 10–83cm, smooth, usually leafy for less than half length; leaf blades 3.5–17.5cm, flat or folded, 1.5–3.6mm wide, glabrous, or scabrid beneath; sheaths smooth; ligule 0.7–1.8(–3.2)mm, blunt; basal leaves 8–60cm, sometimes narrow and inrolled. Infl. 5.2–14cm, triangular in outline, branches spreading at anthesis, minutely scabrid, naked for less than or more than half length, the lowest in whorls of 2–5, the longest 2.5–9cm. Spikelets green or pale purplish-brown, 3.6–5.5mm, narrowly elliptic, florets (2–)3–5, callus wool plentiful. Glumes acuminate; the lower 1.8–3.1 × c.0.9mm, 1–3-veined; the upper 2.3–3.2 × c.1.3mm, 3-veined. Lemmas in profile narrowly lanceolate, acute, the lowest 2.8–4mm, half-width c.0.8mm, sometimes with subapical purple band, apex narrowly to widely hyaline, keel ciliate in lower half, outer lateral veins usually ciliate near

base, surface punctate, glabrous between veins even at base. Palea of lowest floret 2.2–3.3mm, keels scabrid, back punctate; anthers 1–1.8mm.

Bhutan: C — Ha (5 miles below Ha Dzong, Ha Guesthouse) and Thimphu (Babesa, hill E of Thimphu, Taba) districts; N— Upper Mo Chu district (Laya); **Darjeeling** (Tiger Hill, Phalut); **Sikkim** (Gangtok, Lachung, Lachen, Thanggu); **Chumbi**. Stony, well-drained grassland; disturbed roadside; lawns; edge of paddy field; alpine pasture, 1830–4180m. April–August.

A widespread, temperate Eurasian polyploid, apomictic species complex, here treated in a broad sense. Recent European authors (e.g. Edmondson, 1980) recognise segregate species, as did Bor (1973) who gave three species for India. Rajbhandari (1991) recognised the same taxa at subspecific rank. I can see little point in this: the characters for *P. alpigena*, a small alpine form (recorded for Chumbi), seem very weak. *P. angustifolia* is merely a form with long, very narrow leaves of the vegetative shoots; both broad- and narrow-leaved forms seem to occur at Ha. More conspicuous is variation in infl. density. No doubt some of our material has been introduced recently; recorded by Roder *et al.* (1998) as being tried for fodder on farms in Bhutan from 1975.

Some Hooker specimens from Sikkim were determined by Bor as being possible hybrids between *P. pratensis* and *P. ludens*: they are certainly atypical of the former, but the material is inadequate, mixed and unlocalised.

A specimen from Thanggu (*Younghusband* s.n., K) was determined by Bor as *P. jaunsarensis* Bor, but the specimen seems merely to be a form of *P. pratensis* with a slightly long (3mm) ligule, slender rhizomes and inrolled leaf blades. It is much less robust than the type of *P. jaunsarensis*, a NW Himalayan species doubtfully worthy of specific rank.

11. *P. asperifolia* Bor

A rhizomatous species differing from *P. pratensis* mainly in lacking wool on the callus and in having longer ligules (5–6mm).

Chumbi (Gautsa). Waste places, 3810m. May.

A single, incomplete specimen determined by Bor, but lacking basal parts. The spikelets are certainly similar to those of the type (from near Lhasa), and the ligules are long. More collections, however, are required.

12. *P. rohmooiana* Noltie. Fig. 15e–h.

Diminutive annual. Culms to 3cm, scabrid beneath infl., leafy almost throughout; leaf blades to 1.7cm, flat, to 1.4mm wide, glabrous; sheaths scabrid; ligule c.0.5mm, rounded. Infl. to 3cm, triangular in outline, branches deflexed at anthesis, scabrid, the lowest paired, the longer 0.9–1.3cm. Spikelets tinged purple, to 2.3mm, widely elliptic, florets 3, callus wool absent. Glumes

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acuminate; the lower 1.6×0.7 mm, 1-veined; the upper 1.6×0.9 mm, oblong-ovate, 3-veined. Lemmas in profile narrowly elliptic, blunt, the lowest c.1.5mm, half-width c.0.5mm, apex narrowly hyaline, with subapical purple band, keel ciliate in lower half, lateral veins not conspicuous, the outer minutely scabrid above, glabrous or minutely hairy at base, surface smooth, glabrous between veins even at base. Palea of lowest floret c.1.4mm, keels scabrid above; anthers c.0.5mm.

Sikkim (Chugya). Habitat not recorded, 4570m. September.

This specimen was determined by Bor as *P. tibeticola* Bor and included under that species in Bor, 1951.

13. *P. eleanorae* Bor. Fig. 19j–l.

Tufted perennial; remains of basal leaf sheaths fibrous. Culms 11–45cm, smooth, leafy for most of length; leaf blades to 12cm, narrow, inrolled, glabrous; sheaths smooth; ligule 0.7–1.2mm, truncate-ciliate. Infl. 10.5–24cm, lax (nodes widely separated), triangular in outline, branches deflexed at anthesis, scabrid, naked for less than or more than half length, the lowest paired or in 3s, the longest 4.5–9cm. Spikelets purple-flushed, 5.7–8.2mm, wedge-shaped, glumes usually overtopping lower two lemmas, florets (2–)3, callus wool absent. Glumes acuminate, 3-veined; the lower $5–7 \times c.1.8$ mm; the upper $5.1–7.4 \times c.2$ mm. Lemmas narrowly lanceolate in profile, acute, inner lateral veins scarcely visible so apparently 3-veined, the lowest 4.5–6.1mm, half-width c.1mm, sometimes flushed purple subapically, apex very narrowly hyaline, keel ciliate in lower part, lateral veins glabrous below, surface minutely scabrid, sometimes with longer hairs between veins near base. Palea of lowest floret 3.6–5.1mm, keels scabrid; anthers 0.6–1.1mm.

Sikkim ('NE Sikkim', Nathang). Habitat and altitude not recorded, [3700–4450m in Nepal]. September.

No recent collections from our area. The Bhutan record in Bor (1973) refers to one of the Sikkim specimens. The unlocalised Hooker paratype (Sikkim, *Poa* 4, K) does not belong to this species, having a long, acute ligule, smaller spikelets, and glabrous lemma keels; the specimen, however, is too poor to do anything with.

More work is required on the following three taxa – all high alpiners with dense infls. with appressed branches.

14. *P.* cf. *attenuata* Trinius; *P. nemoralis* L. var. *ligulata* Stapf. Fig. 17d, Fig. 19m–o.

Densely tufted perennial, culm bases forming an almost woody mass. Culms 9–53cm, usually minutely scabrid beneath infl., leafy for most of length

or only in lower half; leaf blades 8–11cm, narrow, 1.3–2.7mm wide, flat, glabrous or scabrid above; sheaths smooth; ligule 1.4–3.5mm, blunt, sometimes scabrid on outside. Infl. 5–10.3cm, narrow, oblong in outline, branches ascending obliquely at anthesis, scabrid, naked for less than half length, the lowest paired, the longer 1.5–4.3cm. Spikelets purple-flushed, (3–)3.5–5.3mm, narrowly elliptic, florets 2–3, callus wool absent or rudimentary. Glumes acuminate, 3-veined; the lower (2–)2.6–3.8 × c.1mm; the upper (2.4–)3.1–4.6 × c.1.4mm. Lemmas oblong-lanceolate in profile, acute, the lowest (2.6–)3.1–4.3mm, half-width c.0.8mm, flushed purple subapically, apex narrowly hyaline, keel shortly ciliate in lower part, lateral veins usually shortly hairy near base, surface minutely punctate. Palea of lowest floret (2–)2.5–3.4mm, keels scabrid; anthers 1–1.9mm.

Bhutan: N — Upper Mo Chu (Laya, Jangothang, E bank of Tharizam Chu) and Upper Pho Chu (Ragajung/Thamkar) districts; **Sikkim** (Yume Samdong, Thanggu, Phaklung, Samiti Lake, below Yulhe Khang glacier, Kongra Lama, Chholhamoo, Tarkarpo); **Chumbi** (Phari, Yatung). Alpine pasture; damp, sandy area by lake; among scrub by river; wasteground by habitation, (3200–)4040–4550m. July–October.

It is not possible to disentangle this complex until studies have been made over the whole of SW and C Asia, the Himalaya and China. At the moment specimens in herbaria matching the above are arbitrarily assigned to *P. sterilis* M. Bieberstein, *P. attenuata* or *P. araratica* Trautvetter (*P. versicolor* Boissier subsp. *araratica* (Trautvetter) Tzvelev). The group is characterised by its densely clumped habit and narrow infls. Despite what Bor (1952) stated (under *P. poophagorum*) about *P. attenuata* being a 'taxonomic dust-bin', our specimens seem closest to that C Asian species. In Bhutan and Sikkim two forms are distinguishable on overall appearance, but cannot be separated using ligule and spikelet characters: a) with slender wiry culms; infl. long exserted from upper leaf sheath; culm bases knobby, woody; b) with shorter, stouter culms; infl. not long-exserted; culm bases not knobby. The latter were identified by Roshevitz as *P. litwinowiana* Ovczinnikov (*P. glauca* Vahl subsp. *litwinowiana* (Ovczinnikov) Tzvelev), but Bor (1952) considered them to be immature *P. araratica* or *P. sterilis*.

15. *P. poophagorum* Bor; *P. poiphagorum* Bor. Fig. 19p–r.

Very similar to *P. cf. attenuata*, but differs as follows: culms shorter (to 14.5cm), smooth below infl.; infl. denser, branches bearing spikelets to base, shorter (longest of lowest whorl to 1.5cm); spikelets smaller (lower glume 1.8–2.5(–3)mm, upper glume 2–2.8(–3.2)mm, lowest lemma 2.2–3(–3.2)mm).

Bhutan: N — Upper Pho Chu district (Liji); **Sikkim** (Chholhamoo, Kongra Lama, Thanggu); **Chumbi** (Chomolhari, Phari, Tang La, Temu La). Dry peaty soil on exposed hill slopes, (3660–)4270–5240m. June–September.

16. *P. mustangensis* Rajbhandari. Fig. 19s.

Similar to *P. poophagorum* in stature and in its dense, narrow racemes, but differs as follows: culms scabrid beneath infl., with upward-pointing scabridities; viviparous (the upper floret developing into a plantlet); lower lemmas larger (c.3.3mm).

Bhutan: N — Upper Mo Chu district (Ngile La); **Sikkim** (Chakalung La). Habitat not recorded [presumably dry, stony places], 4570–4880m. September.

17. *P. chumbiensis* Noltie. Fig. 15i–l.

Tufted perennial. Culms to 30(+?)cm, scabrid below infl., leafy for most of length; leaf blades to 13cm, flat, to 4mm wide, scabrid on veins, especially above; sheaths keeled, very scabrid; ligule to 4.3mm, acute (those of lower leaves to 6mm). Infl. (immature) to 14cm, probably narrowly triangular in outline at anthesis, branches probably spreading at anthesis, very scabrid, the lowest in whorls of 3, the longest to 5.7cm. Spikelets green, c.2.7mm, widely ovate, florets 3, callus wool absent. Glumes acuminate, keels very scabrid; the lower 1.5 × 0.6mm, 1-veined; the upper 2.1 × 0.9mm, 3-veined. Lemmas oblong-elliptic in profile, blunt, the lowest 1.9mm, half-width 0.6mm, flushed purple subapically, apex very narrowly hyaline, keel scabrid above, glabrous below, lateral veins raised, minutely scabrid, surface minutely scabrid. Palea of lowest floret 1.8mm, keels scabrid; anthers 0.5mm.

Chumbi (Yatung). Wet sand, 3050m. June.

18. *P. dzongicola* Noltie. Fig. 15m–p.

Tufted perennial. Culms 13–32cm, smooth, or occasionally scabrid below infl., leafy for just over half length; leaf blades 4.7–22cm, flat, 2–3mm wide, scabrid only on margins; sheaths smooth or occasionally scabrid; ligule 4–6mm, acute. Infl. 6.5–16cm, triangular in outline at anthesis, branches spreading at anthesis, minutely scabrid above, naked in lower half, the lowest single or paired, the longer 3–8cm. Spikelets flushed purple, 4–7.4mm, narrowly oblong, florets (2–)3–6, callus wool absent. Glumes acuminate, surface sometimes punctate; the lower almost reaching tip of lowest lemma, 2.9–3.8 × c.1.3mm, 1–3-veined; the upper 3.3–4.3 × c.1.4mm, 3-veined. Lemmas narrowly lanceolate in profile, subacute, the lowest 3.1–4.1mm, half-width 0.6–0.9mm, flushed purple subapically, apex widely hyaline, keel scabrid throughout, lateral veins raised, sometimes minutely scabrid, surface smooth or punctate. Palea of lowest floret 2.6–3.4mm, keels scabrid, back sometimes scabrid near base; anthers 0.9–1.5mm.

Bhutan: N — Upper Mo Chu district (Zambuthang, Soi Yaksa, Laya, Lingshi); **Sikkim** (S of Thangu). Among rocks in scrub; waste places near houses; wall of dzong; banks among cultivation, 3760–4100m. July–October.

19. *P. trivialis* L. Eng: *rough meadow-grass*. Fig. 19t-v.

Loosely tufted perennial. Culms to 90cm, smooth, leafy for about half length, decumbent at base and rooting from lower nodes; leaf blades 4-9.5cm, flat, 2.8-3.2mm wide, scabrid on veins at least above; sheaths scabrid on veins; ligule 4-5mm, acute. Infl. 8-17cm, oblong in outline at anthesis, branches spreading at anthesis, minutely scabrid above, naked for less than half length, the lowest in whorls of 4-5, the longest 2.5-6cm. Spikelets green, 3-3.7mm, narrowly elliptic, florets 2-3, callus wool usually abundant. Glumes acuminate; the lower 1.9-2.6 × c.0.4mm, 1-veined; the upper 2.2-3 × c.1mm, 3-veined. Lemmas oblong-lanceolate in profile, subacute, the lowest 2.5-3.1mm, half-width c.0.6mm, apex very narrowly hyaline, keel ciliate in lower half, outer lateral veins sometimes ciliate near base, surface smooth or punctate. Palea of lowest floret 2-2.9mm, keels minutely scabrid; anthers 1.1-1.6mm.

Darjeeling (Tiger Hill, Darjeeling Town). Marsh; shady bank in garden, 2110-2600m. July.

Evidently introduced to Darjeeling in the 19th century and still occurring.

20. *P. rajbhandarii* Noltie; *P. himalayana* sensu Bor and sensu F.B.I. p.p. (Wallich and Hooker specimens), non Nees ex Steudel. Fig. 16m-p.

Slender, tufted ?annual or short-lived perennial, occasionally producing short, filiform stolons. Culms 16-45cm, slender, smooth, leafy almost to infl.; leaf blades 4-12cm, flat, 0.9-2.5mm wide, glabrous or scabrid on upper surface; sheaths smooth; ligule 0.4-1.8(-2.3)mm, truncate, sometimes hispid on back. Infl. 8-18cm, lax, paniculate, triangular in outline at anthesis, branches ascending when immature, filiform, minutely hispid, naked for c. $\frac{2}{3}$ length, whorls widely spaced, the lowest of 1-4 branches, the longest 3-7cm. Spikelets pale green, 3.7-5.2mm, narrowly wedge-shaped, florets 2-3(-4), callus wool present but sparse. Glumes very unequal, herbaceous, margins widely hyaline: the lower 1.5-2.2 × c.0.7mm, not reaching halfway along lowest lemma, 1-veined; the upper 2.2-3.3 × 0.9-1.5mm, 3-veined. Lemmas in profile narrowly lanceolate, subacute, the lowest (2.8-)3.3-3.8(-4.2)mm, half-width c.0.8mm, keel appressed-ciliate on lower half, outer lateral veins shortly ciliate near base, surface smooth or sometimes minutely punctate, glabrous between veins. Palea of lowest floret 2.1-2.8mm, keels scabrid; anthers 0.6-0.9mm.

Bhutan: C — Thimphu (Chile La, W of Phajoding, Dechencholing to Punakha, above Talukah Monastery, Dochu La), Punakha (Kotaka) and Bumthang (above Lami Gompa) districts; **Darjeeling** (Sandakphu, Tonglu, Phalut); **Sikkim** (N of Dzongri, Phedang to Tsoka, Jamlinghang, Thangshing,

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Yumthang, Migothang to Nayathang, Nathang, Phusum, Lachung, Dikeeling, Thanggu); **Chumbi** (Yatung). Common in fir forest (damp places and on boulders); marsh by stream; mixed forest, 2700–3960(–4270)m. May–September.

The commonest mid-altitude species of *Poa* in Sikkim and probably under-recorded in Bhutan. Culms sometimes bearing galls on lower internodes.

21. *P. nemoralis* L. Eng: *wood meadow-grass*.

Differs from *P. rajbhandarii* in being a more densely tufted perennial with longer (1.4–2mm) anthers. The lower glume is usually 3-veined.

Chumbi (Gautsa). In shade of a rock, 3810m. May.

The single specimen seen is immature and depauperate. It differs from typical material in having the lower glume 1-veined, glabrous lemmas and lacking wool on the callus. It may not be native being from a locality on the old trade route to Lhasa. Other specimens identified as *P. nemoralis* from our area have been re-determined.

22. *P. lachenensis* Noltie; *P. khasiana* Stapf p.p. (Sikkim plants). Fig. 16i–l.

Differs from *P. rajbhandarii* in having larger spikelets (4.1–6.2mm); callus wool absent; lemmas glabrous; palea keels with crisped hairs on upper part.

Sikkim (Lachen). Habitat not recorded, 3350–3960m. June

Known only from the type specimens collected by Hooker; modern collections required.

23. *P. burmanica* Bor. Fig. 20a–c.

Differs from *P. rajbhandarii* in having the lemmas hairy between the veins; palea keels ciliate.

Bhutan/Arunachal Pradesh (Orka La). Alpine slopes, 3350m. June.

24. *P. cooperi* Noltie. Fig. 16a–d.

Tufted perennial. Culms to 13(+?)cm, smooth, leafy for whole length; leaf blades 4.5–6.9cm, flat, becoming inrolled, c.2.2mm wide, glabrous; sheaths purple, smooth; ligule 1.5–2.2mm, truncate-dentate. Infl. (not fully expanded) to 16cm, branches probably spreading at anthesis, minutely scabrid above,

FIG. 16.

a–d, **Poa cooperi**: a, infl. ($\times \frac{4}{7}$); b, spikelet ($\times 7$); c, lowest lemma and callus ($\times 14$); d, lowest palea ($\times 14$). e–h, **P. longii**: e, infl. ($\times \frac{4}{7}$); f, spikelet ($\times 7$); g, lowest lemma and callus ($\times 14$); h, lowest palea ($\times 14$). i–l, **P. lachenensis**: i, infl. ($\times \frac{4}{7}$); j, spikelet ($\times 7$); k, lowest lemma and callus ($\times 14$); l, lowest palea ($\times 14$). m–p, **P. rajbhandarii**: m, infl. ($\times \frac{4}{7}$); n, spikelet ($\times 7$); o, lowest lemma and callus ($\times 14$); p, lowest palea ($\times 14$). Drawn by Margaret Tebbs.



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the lowest borne singly, to 7.7cm. Spikelets flushed purple, 4.5–5.5mm, narrowly wedge-shaped, florets (3–)4, callus wool absent. Glumes subacute, surface scabrid; the lower 2.4–2.5 × 0.8mm, 1-veined; the upper 3.1–3.4 × 1.3mm, 3-veined. Lemmas oblong-lanceolate in profile, acute, the lowest 3.6–3.8mm, half-width c.0.9mm, flushed purple subapically, apex narrowly hyaline, keel ciliate below, outer lateral veins shortly hairy near base, surface scabrid above and shortly hairy below between the veins. Palea of lowest floret c.3.5mm, keels densely scabrid, back shortly hairy; anthers c.0.9mm.

Sikkim (Laghep). Habitat not recorded, 3050m. July.

25. *P. longii* Noltie. Fig. 16e–h.

Densely tufted perennial. Leaves of vegetative shoots short, blades to 8cm. Culms to 31cm, smooth, leafy for $\frac{2}{3}$ length; leaf blades 3–6.5cm, flat, 1–2mm wide, glabrous; sheaths sometimes flushed purple, smooth or very minutely scabrid; ligule 1–1.8mm, blunt. Infl. very lax, triangular in outline, 6.5–13cm, branches deflexed, filiform, scabrid, naked for more than half length, the lowest borne in pairs, 3s or 4s, the longest to 7.5cm. Spikelets flushed purple, 3.6–5.6mm, narrowly wedge-shaped, florets 2–4, callus wool present, scanty or abundant. Glumes subacute, surface scabrid; the lower 1.1–2.2 × 0.6–0.9mm, 1-veined; the upper 2.5–3.2 × c.1.2mm, 3-veined. Lemmas narrowly lanceolate in profile, subacute, the lowest 2.9–3.8mm, half-width c.0.7mm, flushed purple subapically, apex narrowly hyaline, keel ciliate below, outer and sometimes intermediate lateral veins shortly hairy near base, surface smooth or punctate, with some short hairs between veins near base. Palea of lowest floret 2.3–2.4mm, keels scabrid; anthers 0.7mm.

Sikkim (Bikbari, Phune). Loose stones and scree at base of cliff; edge of yak pasture by river bank, 3430–4000m. July.

26. *P. pagophila* Bor; *P. flexuosa* sensu F.B.I., non Smith. Fig. 17e, Fig. 20d–f. Plate 4.

Tufted perennial, sometimes producing slender rhizomes; whole plant sometimes tinged reddish in life. Basal leaves short, blades to 4.5cm, filiform, c.1mm wide. Culms often short, 5.5–30cm, smooth, leafy in lower half; leaf blades short, 1.6–3.3cm, flat, 1.1–1.3mm wide, glabrous or scabrid beneath; sheaths smooth; ligule 1.9–4mm, blunt. Infl. very lax, triangular in outline, 4.3–8cm, branches deflexed, smooth, naked for about half length or more,

FIG. 17.

a, *Poa sikkimensis*: habit ($\times \frac{2}{3}$). b, *P. calliopsis*: habit ($\times \frac{2}{3}$). c, *P. pratensis*: habit ($\times \frac{2}{3}$). d, *P. cf. attenuata*: habit ($\times \frac{2}{3}$). e, *P. pagophila*: habit ($\times \frac{2}{3}$). Drawn by Margaret Tebbs.



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the lowest borne in pairs, the longer 2–5cm. Spikelets flushed purple or reddish, (3.7–)4.3–5.7(–6.4)mm, wedge-shaped, florets 2(–3), callus wool usually present, but sparse. Glumes scabrid on surface; the lower (2.5–)2.8–3.8 × c.1mm, narrowly lanceolate, acute, 1-veined; the upper (2.9–)3.1–4.2(–4.4) × c.1.6mm, elliptic, blunt, 3-veined. Lemmas oblong-lanceolate in profile, blunt, the lowest (3.6–)4–4.9mm, half-width c.1mm, flushed purple subapically, apex widely hyaline, keel ciliate below, outer lateral veins glabrous or shortly hairy near base, surface scabrid above and shortly hairy below between the veins. Palea of lowest floret 3–4.4(–4.7)mm, keels scabrid; anthers (1.7–)2–3mm.

Bhutan: C — Ha (Ha La), Thimphu (Taka La) and Tongsa (Maruthang) districts; N — Upper Mo Chu (Laya, Lingshi, Ngile La), Upper Pho Chu (Ragajung/Thamkar) and Upper Kulong Chu (Shingbe) districts; **Sikkim** (Dzongri, Chaunrikhiang, Olakthang, Kongra Lama, E side of Sebu La, Yume Samdong, Yumthang, Natu La, Kopup, Lhonak, Lachen, Lachung); **Chumbi** (Chomolhari, Yatung). Scree and rocky slopes; alpine pasture; river beds; glacial moraine and sand, 3500–5180(–5790)m. June–October.

Apparently the commonest species of *Poa* at high altitudes and reaching very extreme elevations (the figure in brackets is on a specimen collected in Sikkim by Spencer Chapman).

27. *P. polycolea* Stapf. Fig. 20j–l.

Differs from rhizomatous forms of *P. pagophila* in having a short ligule (c.0.5mm).

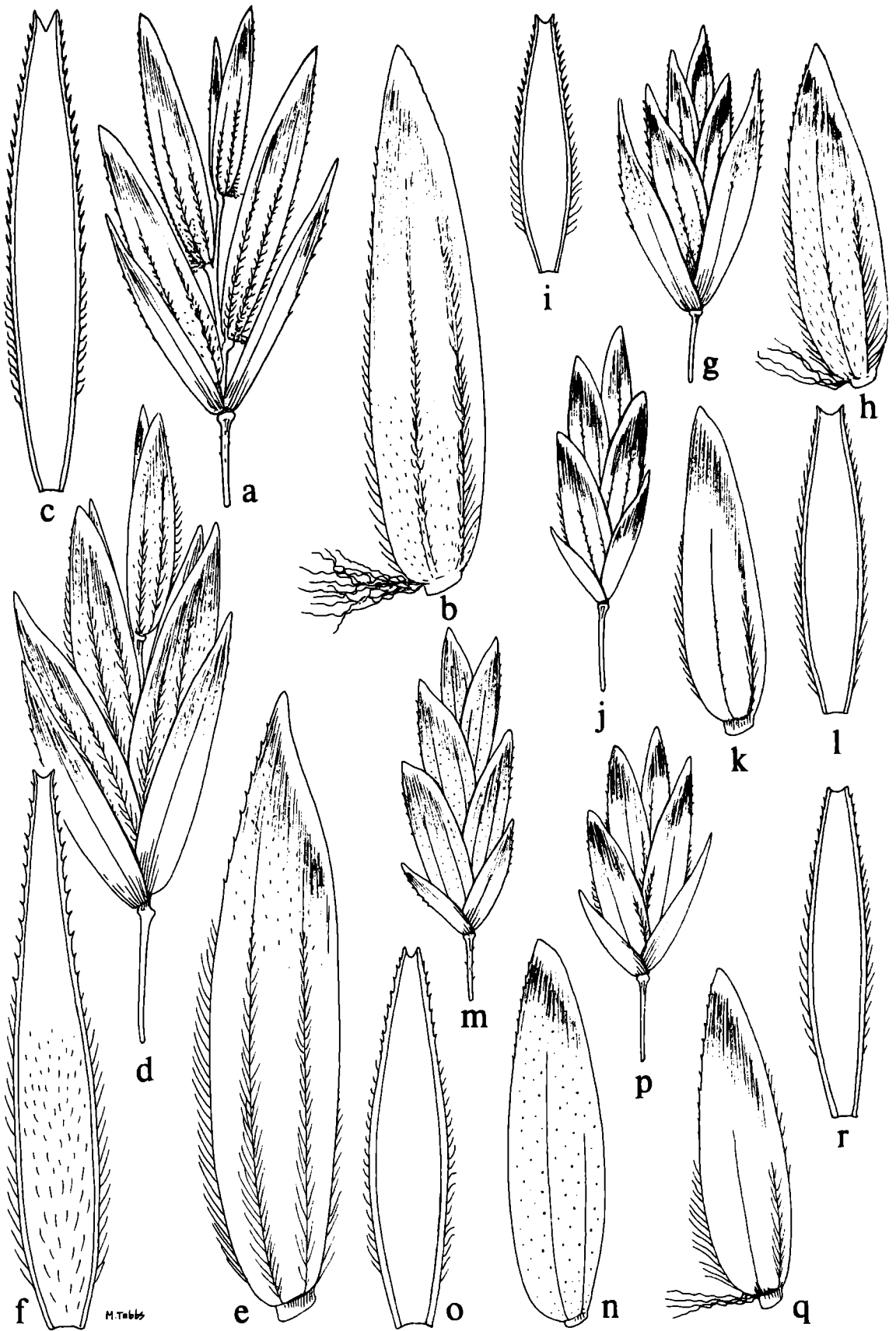
Chumbi (Yatung). In rock clefts, 3050m. June.

28. *P. nitide-spiculata* Bor. Fig. 20g–i.

Like a large *P. pagophila*, but differs as follows: not tufted; rhizomes spreading; ligule longer (3.5–5mm); culm leaf blades longer and wider (to 9.5cm long, to 3.1mm wide), glaucous; spikelets larger (6.2–6.7mm), florets

FIG. 18.

a–c, *Poa gammieana*: a, spikelet (× 8); b, lowest lemma and callus (× 16); c, lowest palea (× 16). d–f, *P. polyneuron*: d, spikelet (× 8); e, lowest lemma and callus (× 16); f, lowest palea (× 16). g–i, *P. hirtiglumis*: g, spikelet (× 8); h, lowest lemma and callus (× 16); i, lowest palea (× 16). j–l, *P. annua*: j, spikelet (× 8); k, lowest lemma and callus (× 16); l, lowest palea (× 16). m–o, *P. sikkimensis*: m, spikelet (× 8); n, lowest lemma and callus (× 16); o, lowest palea (× 16). p–r, *P. nepalensis*: p, spikelet (× 8); q, lowest lemma and callus (× 16); r, lowest palea (× 16). Drawn by Margaret Tebbs.



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3; glumes longer (the lower 3.1–4.2mm, the upper 4.1–5mm); lemmas longer, more acute, apex more narrowly hyaline, the lowest 4.7–5.7mm.

Sikkim (above Thanggu, Jamlinghang, Samiti Lake, Dharali Pass to Bikbari). Marsh beside stream; pebbly sand; damp scrub by lake, 3650–4250m. June–July.

Also very similar to the W Himalayan *P. falconeri* Stapf, from which it differs in being rhizomatous and having wool present on the callus. Rajbhandari (1991) recorded *P. falconeri* for Bhutan, but the specimen cited has been re-determined as *P. dzongicola*.

29. *P. ludens* R.R. Stewart; *P. pseudopratensis* sensu F.B.I. Fig. 20m–o.

Like a tall, slender *P. pagophila*, but differs as follows: culms taller (to 56cm); basal leaves very rigid, blades inrolled; ligule very short (0.5–1(–1.5)mm; infl. often larger (6–14cm, the longer of the lowest branches 3.5–7cm), branches not conspicuously deflexed; lemmas longer (the lowest 4.5–5.5mm), acute, apex less widely hyaline, hairs on keel and outer lateral veins usually longer.

Bhutan: C — Ha/Thimphu (summit of Chelai La), Thimphu (above Phajoding, Pumo La, above Talukah Monstery), Bumthang (Kitiphu) and Sakden (Orka La) districts; N — Upper Mo Chu (Jangothang, Soe/Lingshi/Yale La) and Upper Bumthang Chu (Domchen) districts; **Sikkim** (Lachen, Lasha Chhu, Nathang); **Chumbi** (Yatung). Grassy slopes and clearings in fir forest; scrub-clad slopes, 3600–4080m. June–September.

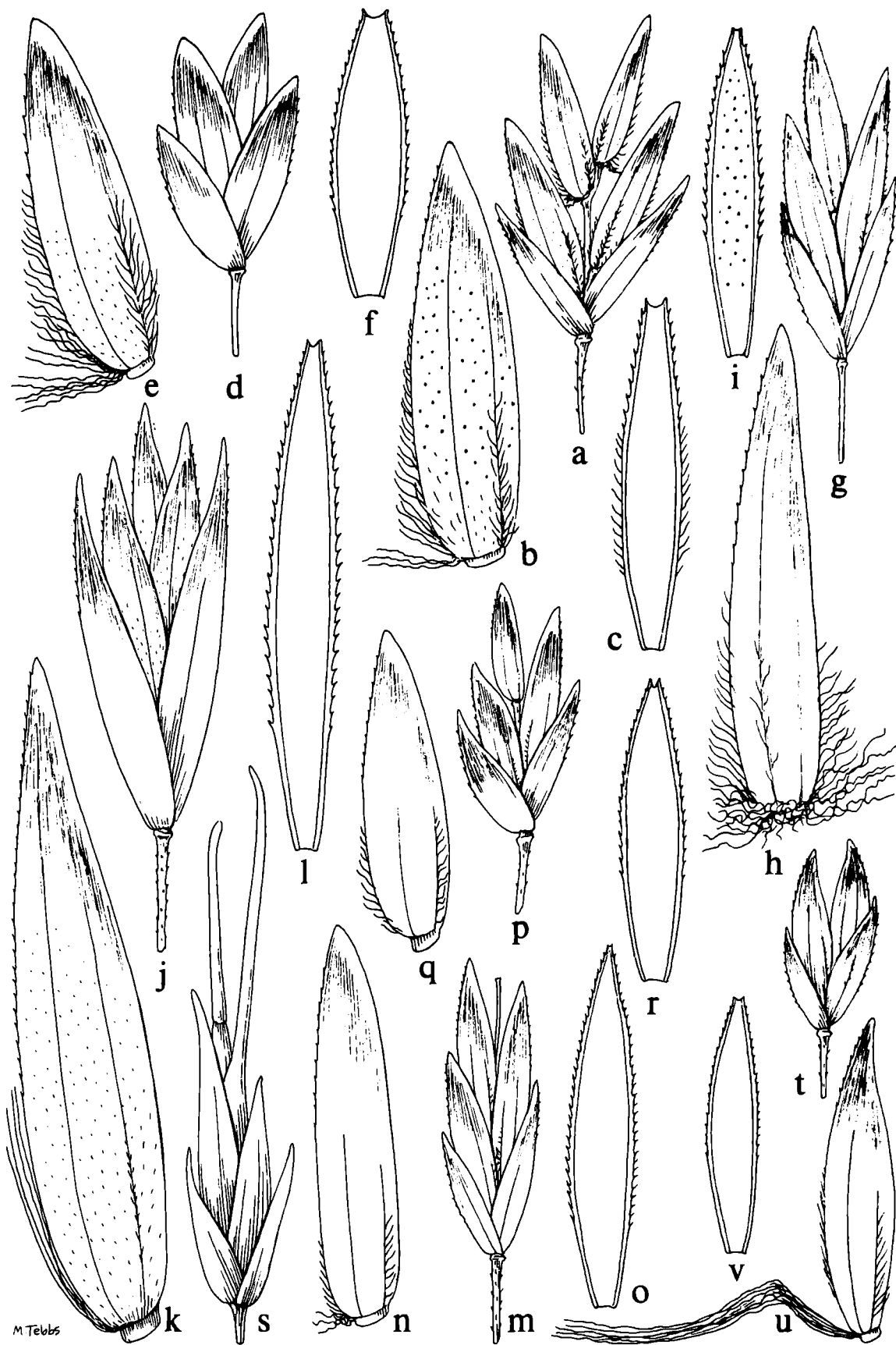
Doubtfully or erroneously recorded species:

P. aitchisonii Boissier

A NW Himalayan species recorded for Sikkim (Dzongri to Olothang) in F.E.H.1; the specimen cited has been re-determined as *P. pagophila*.

FIG. 19.

a–c, **Poa stapfiana**: a, spikelet ($\times 8$); b, lowest lemma and callus ($\times 16$); c, lowest palea ($\times 16$). d–f, **P. calliopsis**: d, spikelet ($\times 8$); e, lowest lemma and callus ($\times 16$); f, lowest palea ($\times 16$). g–i, **P. pratensis**: g, spikelet ($\times 8$); h, lowest lemma and callus ($\times 16$); i, lowest palea ($\times 16$). j–l, **P. eleanorae**: j, spikelet ($\times 8$); k, lowest lemma and callus ($\times 16$); l, lowest palea ($\times 16$). m–o, **P. cf. attenuata**: m, spikelet ($\times 8$); n, lowest lemma and callus ($\times 16$); o, lowest palea ($\times 16$). p–r, **P. poophagorum**: p, spikelet ($\times 8$); q, lowest lemma and callus ($\times 16$); r, lowest palea ($\times 16$). s, **P. mustangensis**: spikelet ($\times 8$). t–v, **P. trivialis**: t, spikelet ($\times 8$); u, lowest lemma and callus ($\times 16$); v, lowest palea ($\times 16$). Drawn by Margaret Tebbs.



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P. lahulensis Bor

A NW Himalayan species recorded for Sikkim (Dzongri to Olothang) in F.E.H.1. I have not seen the cited specimen, but Rajbhandari (1991) determined it as *P. pagophila*.

P. litwinowiana Ovczinnikov; *P. glauca* Vahl subsp. *litwinowiana* (Ovczinnikov) Tzvelev

Recorded for Chumbi (Phari [mis-cited as Jhari]) in Rajbhandari (1991) who seems to have accepted an early (1949) determination of Bor. Bor (1973), however, did not include the record and did not accept the species for India (s.l.). The specimen (*Rohmoo* 238, E) is almost certainly a form of *P. poophagorum* with atypically small spikelets.

P. stewartiana Bor

This name is actually a superfluous one for *P. himalayana*. A NW Himalayan species, it was recorded for Sikkim (Migothang to Nayathang) in F.E.H.1, but the cited specimen was re-determined by Rajbhandari (1991) as '*P. himalayana*' (= *P. rajbhandarii*).

P. supina Schrader

Recorded for Darjeeling (Phalut) in F.E.H.1; the specimen cited has been re-determined as *P. pratensis*.

P. khasiana Stapf

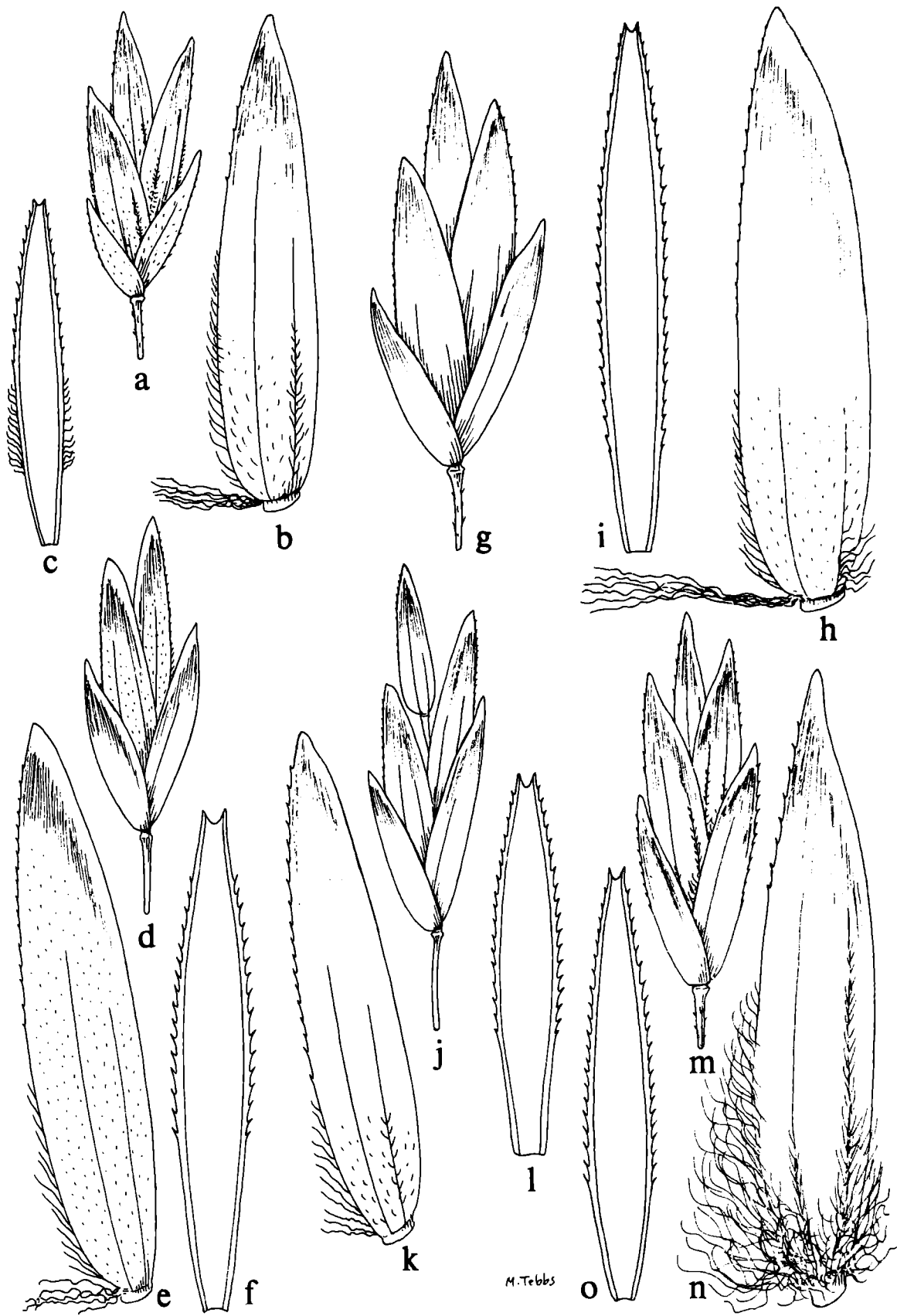
Recorded for Darjeeling in F.E.H.1; a duplicate of one of the cited specimens at BM is a mixture of *P. annua* and *P. rajbhandarii*.

27. DACTYLIS L.

Tufted perennial. Culm leaf blades flat; ligule membranous. Infl. a panicle, partial infls. one-sided, dense, lower branches single. Spikelets sessile, densely clustered, gaping, laterally compressed, with 2–4 fertile florets, disarticulating above glumes and between florets. Glumes shorter than spikelet, unequal, asymmetrically lanceolate, keeled, 1-veined, apex very acute or aristulate,

FIG. 20.

a–c, **Poa burmanica**: a, spikelet ($\times 8$); b, lowest lemma and callus ($\times 16$); c, lowest palea ($\times 16$). d–f, **P. pagophila**: d, spikelet ($\times 8$); e, lowest lemma and callus ($\times 16$); f, lowest palea ($\times 16$). g–i, **P. nitide-spiculata**: g, spikelet ($\times 8$); h, lowest lemma and callus ($\times 16$); i, lowest palea ($\times 16$). j–l, **P. polycolea**: j, spikelet ($\times 8$); k, lowest lemma and callus ($\times 16$); l, lowest palea ($\times 16$). m–o, **P. ludens**: m, spikelet ($\times 8$); n, lowest lemma and callus ($\times 16$); o, lowest palea ($\times 16$). Drawn by Margaret Tebbs.



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margins widely hyaline. Lemmas lanceolate, keeled, 5-veined, herbaceous, apex aristulate, margins narrowly hyaline. Paleas linear, bidentate, hyaline.

1. *D. glomerata* L. subsp. *himalayensis* Domin. Fig. 21f–g.

Culms 80–120cm, stout, erect; leaf blades linear-lanceolate, the longest to 36cm long, to 8.5mm wide, glabrous; ligule c.4.5mm, acute. Infl. 19–23cm, branches flexuously ascending, slender, the lowest 6.5–10cm, naked for at least half length, the partial infls. narrow (c.7mm wide). Spikelets 5.5–6.2mm, florets 2. Glumes minutely ciliate on keel; the lower 2.8–4.1mm; the upper 4–4.6mm. Lemmas minutely ciliate on keel (cilia c.0.1mm), awn short (to 0.7mm). Lower floret: lemma 5.2–5.9mm; palea 4–4.2mm; anthers 1.3–2mm.

Bhutan: C — Thimphu (Wong Chu gorge below Barshong) and Sakden (Meesa Valley near Sakden) districts. Moist riverside grassland in open forest, 3200–3230m. August–October.

subsp. *glomerata*. Eng: *cock's-foot*

Differs from subsp. *himalayensis* in the stiff infl. branches and wider (c.10mm), denser partial infls. Our specimens can also be separated in having much larger spikelets (8.5–9.9mm; florets 2–4; glumes 5.5–6.1mm; lemmas 7.2–8mm) and the lemmas (and sometimes also the glumes) with pectinately ciliate keels, the cilia to 0.5mm.

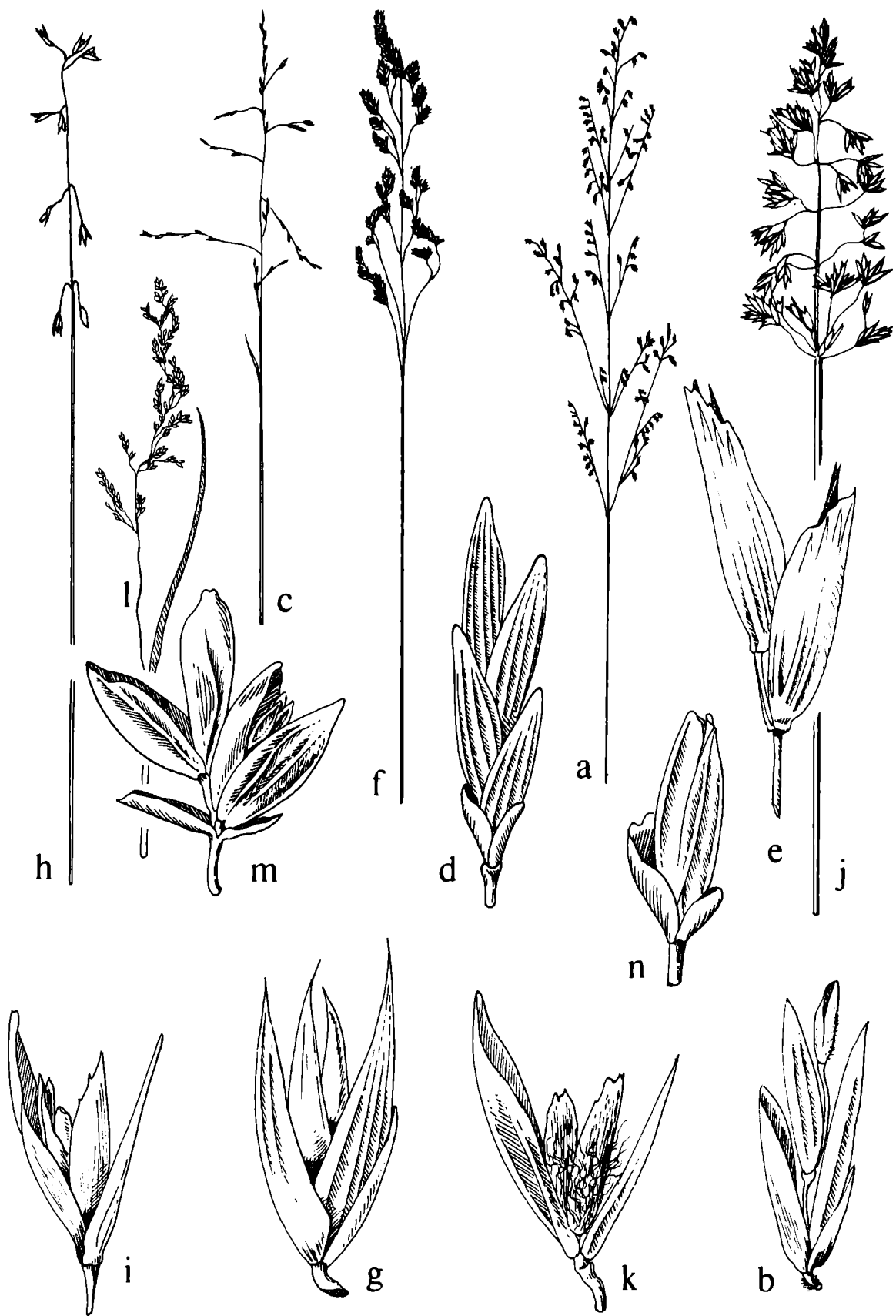
Bhutan: C — Thimphu (Thimphu, Yosepang), Tongsa (Chendebi), Bumthang (Karsumphe Guest House, Lame Gompa) and Mongar (Sengor) districts; **Darjeeling** (Darjeeling). Roadsides; improved pasture, 2130–3000m. July–September.

Introduced to Darjeeling in the 19th century. In recent years one of the most widely introduced fodder grasses in Bhutan. The seed sources include New Zealand and Switzerland – sown in temperate regions and doing well up to 3800m (W. Roder, pers. comm.).

Among our material the two subsp. (native and introduced) are clearly distinct, however this is not always the case for Himalayan material.

FIG. 21.

a–b, *Melica onoei*: a, infl. ($\times \frac{1}{4}$); b, spikelet ($\times 6$). c–d, *Glyceria tonglensis*: c, infl. ($\times \frac{1}{4}$); d, spikelet (6). e, *G. declinata*: lower 2 florets ($\times 6$). f–g, *Dactylis glomerata*: f, infl. ($\times \frac{1}{4}$); g, spikelet ($\times 6$). h–i, *Colpodium wallichii*: h, infl. ($\times \frac{2}{3}$); i, spikelet ($\times 6$). j–k, *C. tibeticum*: j, infl. ($\times \frac{2}{3}$); k, spikelet ($\times 6$). l–n, *Catabrosa sikkimensis*: l, infl. ($\times \frac{2}{3}$); m, spikelet with 2 florets ($\times 10$); n, spikelet with 1 floret ($\times 10$). Drawn by Louise Olley.



28. COLPODIUM Trinius
(incl. *Paracolpodium* (Tzvelev) Tzvelev)

Tufted perennials; shortly rhizomatous. Culms erect. Leaf blades flat; sheaths long, margins fused in lower part; ligule membranous. Infl. a lax raceme or panicle. Spikelets with 1 floret, disarticulating above glumes, callus glabrous, rachilla rudiment present. Glumes equalling spikelet, unequal, thickly herbaceous; the lower narrower, 1-veined; the upper wider, 3-veined. Lemma narrowly ovate, apex hyaline, obscurely 5-veined at base, hairy on veins, thinly herbaceous. Palea weakly 2 keeled, thinly herbaceous, keels hairy.

Our two species are included in *Paracolpodium* by Alexeev (1981).

1. Infl. racemose, pedicels deflexed; lemmas with very short, appressed hairs on veins near base **1. *C. wallichii***
- + Infl. paniculate, spikelets clustered at ends of short branches; lemmas with spreading, woolly hairs on and between veins **2. *C. tibeticum***

1. *C. wallichii* (Hook. f. ex Stapf) Bor; *Catabrosa wallichii* Hook. f. ex Stapf. Fig. 21h-i.

Vegetative shoots with leaf blades 6–10cm, c.1.2mm wide, glabrous. Culms 7–25cm, bearing 2–3 leaves in lower $\frac{1}{2}$ – $\frac{2}{3}$; leaf blades short, 0.9–3cm, 1–2mm wide; sheaths glabrous; ligules 2.2–2.5mm, acute, lacerate. Infl. 2.5–5.5cm, a narrowly cylindrical raceme, spikelets 4–13, pedicels 1–3 per node, deflexed, filiform, about equalling spikelets. Spikelets 3.7–6.5mm. Glumes dark purple, sometimes greenish; the lower 3.7–6mm, narrowly lanceolate, apex subacute; the upper 3.7–6.3mm, oblong-lanceolate, apex asymmetrically toothed. Lemma 3.2–4.9mm, narrowly ovate, apex truncate, 3-toothed, veins very shortly hairy near base. Palea 3.2–4.5mm, keels very shortly hairy near base. Anthers 2–2.5mm. Rachilla rudiment c.1mm.

Bhutan: C — Thimphu (Laname Tso) and Tongsa (Maruthang) districts; **N** — Upper Mo Chu district (Sinchu La); **Sikkim** (Kankola). Moist rocky slopes; among stones in running water, 3800–4570m. June–August.

The Sikkim collection (a syntype) is atypical: the lemmas almost equal the small, subequal, greenish glumes, but similar specimens have been seen from Nepal and grade into the typical form.

2. *C. tibeticum* Bor. Fig. 21j-k.

Differs from *C. wallichii* as follows: plant more robust; blades of culm leaves wider (to 4mm); infl. more robust, branched, spikelets clustered at ends of short branches; lemmas hairy between veins, hairs on veins longer, woolly.

Recorded from the Tibetan (N) side of the Cho La, 4270m, (Upper Kuru Chu district), so almost certainly also in Bhutan.

29. CATABROSA P. Beauvois

Perennial, with creeping stolons. Leaf blades flat; margins of sheaths free; ligule membranous. Infl. a lax panicle, branches whorled. Spikelets with 1 or 2 florets, disarticulating above and beneath glumes, callus glabrous. Glumes much shorter than spikelet, very unequal, thickly herbaceous, the lower narrower, veinless, the upper wider, obscurely 3-veined. Lemma oblong, apex hyaline, strongly 3-veined, glabrous, herbaceous. Palea narrowly oblong, apex hyaline, weakly 2 keeled, glabrous, herbaceous.

1. *C. sikkimensis* Stapf. Fig. 211–n.

Stolons spreading extensively, rooting at nodes. Vegetative shoots with leaf blades 2.5–6cm, glabrous. Culms 4–9cm, leafy throughout; leaf blades 3.5–4.5cm, 1.8–8mm wide; sheaths glabrous; ligules c.2mm, blunt. Infl. 3.5–6cm, narrowly cylindrical. Spikelets 2–2.5mm, floret usually 1, but some with 2 sometimes present in an infl., pedicels slender, minutely rough, about equalling spikelets. Glumes dark purple, papillose, blunt; the lower 0.7–0.8mm, oblong; the upper 1.3–1.5mm, ovate. Lemma dark purple, c.1.8mm, oblong, apex truncate-erose, hyaline. Palea 1.6–1.8mm, apex truncate-erose. Anthers c.1mm, yellow.

Sikkim (Chumegata, Lhonak, Kinchinjhow). Bogs, 4480–5180m. July–September.

Sunk by Cope (1982) under the widespread and variable *C. aquatica* (L.) P. Beauvois. It seems to me that this extreme alpine form (specimens have also been seen from Qinghai) merits some sort of recognition, but further study is required before deciding on its status.

Tribe V. MELICEAE Reichenbach

1. Fertile florets 2, upper floret(s) sterile 30. **Melica**
+ Fertile florets 4–6, upper florets fertile 31. **Glyceria**

30. MELICA L.

Tufted perennial. Culms erect or scrambling. Leaf blades flat, glabrous; sheaths tubular; ligule membranous, truncate. Infl. a panicle, branched to 1

V. MELICEAE

order, branches whorled, spreading at anthesis. Spikelets pedicelled, gaping, borne singly, disarticulating below glumes and tardily between florets; rachilla internodes long, glabrous; lower 2 florets bisexual, upper florets rudimentary, sterile; callus glabrous. Glumes unequal, shorter than spikelet, oblong-lanceolate, convex, subacute, thinly herbaceous, margins widely hyaline; the lower 1-veined; the upper longer and wider, 3-veined. Lemmas oblong-lanceolate, convex, 7-veined, thinly herbaceous, apex hyaline, truncate, minutely 3-toothed, margins narrowly hyaline. Paleas narrowly oblanceolate, 2-keeled, thinly herbaceous, apex bidentate, keels minutely ciliate, margins inflexed.

1. *M. onoei* Franchet & Savatier; *M. scaberrima* (Nees ex Steudel) Hook. f. var. *micrantha* Hook. f. Fig. 21a–b.

Culms to 150cm. Leaf blades to 20 × 0.5cm, narrowly oblong, acute, minutely scabrid on veins above and especially beneath, the scabridities curved; sheaths scabrid on veins; ligule c.2.5mm. Infl. 23–30cm, very lax, whorls distant, longest branch of lowest whorl to 7.5cm; pedicels very slender, apex hairy, often bent. Spikelets purplish, deflexed, 6–6.6mm; fertile florets 2, sterile florets 2 (one very small). Glumes purplish; the lower 2.7–3 × c.1mm; the upper 4–4.3 × 1–1.2mm. Lowest floret: lemma purplish, 5–5.2 × c.1.7mm, veins minutely rough, granular between veins; palea c.4.2 × 0.7mm; anthers 1.1–1.7mm. Rachilla internodes c.1.8mm. Terminal rudimentary florets unequal, the lower consisting of a sterile lemma c.2.2mm, enclosing a second minute floret.

Bhutan: C — Thimphu (near Drukyel Dzong, near Talukah Gompa) and Bumthang (below Jakar Dzong) districts. Banks among scrub, 2580–2800m. September.

Further work is required on this genus in the Sino-Himalaya. Our specimens are identical to one from SE Tibet identified by W. Hempel as *M. schutzeana* Hempel, but this species seems very dubiously distinct from *M. onoei*.

31. GLYCERIA R. Brown

Perennial. Culms decumbent and rooting from lower nodes. Leaf blades flat, glabrous; sheaths tubular; ligule membranous, short, truncate. Infl. a panicle, branched to 1 order, branches ± whorled, spreading at anthesis. Spikelets pedicelled, borne singly, lanceolate, disarticulating above glumes and between florets; florets 4–6, bisexual, all similar; callus glabrous; rachilla internodes zigzag, glabrous. Glumes unequal, shorter than spikelet, convex, 1-veined, hyaline; the upper longer and wider. Lemmas oblong-elliptic, convex,

± blunt, 7-veined, veins parallel, herbaceous, margins hyaline. Paleas narrowly oblanceolate, 2-keeled, thinly herbaceous, apex bidentate, keels narrowly winged, wings minutely hispid, margins inflexed.

1. Spikelets to 9.2mm, with up to 6 fertile florets; apex of lemmas rounded; paleas not exceeding lemmas; ligule to 2.5mm **1. *G. tonglensis***
- + Spikelets over 10mm, with 7 or more fertile florets; apex of lemmas irregularly 3-toothed; apical teeth of paleas of upper florets exceeding lemmas; ligule over 3mm **2. *G. declinata***

1. *G. tonglensis* C.B. Clarke. Fig. 21c-d.

Culms 4–50cm. Leaf blades 7–15 × 0.1–0.4cm, linear or narrowly oblong, rather abruptly contracted to subacute apex; ligule 0.5–1(–2.5)mm. Infl. 6–23cm, longest branch of lowest whorl 2.8–9cm, branches only spreading at anthesis, so panicle usually appearing linear. Spikelets sometimes purplish, 5.8–9.2mm; florets 4–6, sometimes with a terminal vestigial floret. Lower glume 1.5–1.9 × 0.7–1.1mm, oblong-ovate to oblong-lanceolate, acuminate, apex blunt to acute; upper glume similar to lower but larger, 2.1–3 × 1.1–1.5mm. Lowest floret: lemma 2.7–3.5 × 1.2–1.8mm, oblong-elliptic, blunt, midrib (and sometimes also other veins) minutely rough, sometimes granular between veins; palea 2.6–3.5 × 0.7–0.9mm; anthers c.1mm. Rachilla internodes 1–1.2mm.

Bhutan: C — Thimphu (SW of Drukyl Dzong, Chenkaphug, Yosepang, above Thimphu Hospital), Punakha (W side of Pele La), Tongsa (Tongsa to Bubja) and Bumthang (Bumthang) districts; N — Upper Mo Chu district (E bank of Tharizam Chu, Soe/Lingshi/Yale La); **Darjeeling** (Mahalderam, Tonglu, Tiger Hill, Phullalong); **Sikkim** (Karponang, Yume Samdong, Kopup, Kyanglasha, Tukola, Yakche, Lachen, Chakung Chu); **Chumbi.** Marshy places and streamsides: in *Pinus wallichiana* and *Quercus semecarpifolia* forest; under *Juniperus/Salix*, 2130–4080m. May–September.

2. *G. declinata* Brébisson. Eng: *glaucous sweet-grass*. Fig. 21e.

Differs from *G. tonglensis* as follows: leaves wider (0.3–0.6cm); ligules of culm leaves over 3mm; spikelets longer (to 16.5mm) with 7 or more fertile florets; apex of lemma irregularly 3-toothed, strongly granular on back; palea acutely 2-toothed at apex, those of the upper florets distinctly exceeding lemma.

Bhutan: C — Thimphu district (Babesa). Sand beside river, 2300m. September.

No doubt a recent introduction from Europe.

VI. AVENEAE

Tribe VI. AVENEAE Dumortier

1. Spikelets with 2 or more fertile florets 2
- + Spikelets with 1 fertile floret 7

2. Ovary glabrous; awns geniculate with strongly twisted column, (spikelets over 8mm, or if with 2 fertile florets then over 15mm) 3
- + Ovary hairy; awns not geniculate (or if geniculate then either spikelets under to 8mm: *Anthoxanthum hookeri*; or with 2 fertile florets and under 9mm: *Trisetum scitulum*) 4

3. Upper glume 3–5-veined; spikelets to 17.5mm **33. Helictotrichon**
- + Upper glume 11-veined; spikelets over 19mm **34. Avena**

4. Spikelets with 3 florets, the lowest two \pm similar (though awn of lowest lemma sometimes shorter than that of middle floret), the topmost reduced and awnless **38. Anthoxanthum**
- + Spikelets not as above, commonly with 2 similar or dissimilar florets, or if with 3 or more then the uppermost awned 5

5. Florets 2, dissimilar, the lower lemma unawned, the upper with a hooked awn **37. Holcus**
- + Florets 2–4, the lowest lemma awned 6

6. Apex of lemmas \pm acute; awn inserted on upper half of lemma **35. Trisetum**
- + Apex of lemmas truncate-erose; awn inserted near base of lemma **36. Deschampsia**

7. Spikelets large (over 10mm); glumes 7-veined; lemmas with massive, stout awn **32. Duthiea**
- + Spikelets smaller; glumes 1–3-veined; lemmas unawned or with slender awn 8

8. Glumes with slender awns **42. Polypogon**
- + Glumes unawned (occasionally tapered into stout, outward curving mucros)..... 9

9. Fertile floret subtended at base by 1–2 linear, vestigial florets **39. Phalaris**
- + Fertile floret lacking basal, vestigial florets (though sometimes a hairy rachilla rudiment present) 10

10. Infl. dense, spike-like 11
 + Infl. paniculate 12
11. Glumes subacute; lemma awned **44. Alopecurus**
 + Glumes with stout, outward curving mucros; lemma unawned
45. Phleum
15. Spikelet falling entire; glumes thick-textured **43. Cyathopus**
 + Glumes persistent; glumes not thick-textured 13
13. Lemmas unawned 14
 + Lemmas awned 15
14. Glumes exceeding floret (if sometimes shorter, then hairy rachilla rudiment present: *Agrostis petelotii*); lemma weakly veined
40. Agrostis p.p.
 + Glumes shorter than floret; lemma strongly 5-veined
41. Calamagrostis (treutleri)
15. Callus hairs short, rachilla rudiment absent or if present then lemma with apical lateral setae **40. Agrostis p.p.**
 + Callus hairs long (equalling or exceeding floret) or if short then hairy rachilla rudiment present (lemma never with apical, lateral setae)
41. Calamagrostis

32. DUTHIEA Hackel

Tufted perennials. Basal leaves inrolled, erect. Culms erect, sparsely leafy, leaf blades inrolled; ligules membranous, truncate. Panicles narrowly cylindrical, spike-like, one-sided. Spikelets laterally compressed, with 1 bisexual floret and a rachilla rudiment (more than one floret in non-Bhutanese species), disarticulating above glumes; callus ciliate. Glumes subequal, equalling spikelet, weakly convex, papery, margins hyaline, the lower 7-veined, the upper 7–9-veined. Lemma oblong-lanceolate, strongly convex, deeply bifid, awned from base of sinus, coriaceous, margins narrowly hyaline; awn geniculate, column twisted. Palea linear, 2-keeled, apex bifid, keels ciliate above, coriaceous. Ovary strigose; stigma long, hairy.

1. D. brachypodium (P. Candargy) Keng & Keng f.; *D. nepalensis* Bor. Fig. 22a–c.

Basal leaves to 20cm. Culms c.43cm. Culm leaves usually 3, blades to

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15.5cm, to 3.8mm wide, inrolled, linear, acute, glabrous; sheaths glabrous; ligule c.1mm. Infl. greenish, drying brown, 6.5–7.5 × c.1cm. Spikelets 10–13, 14–16mm, rachilla rudiment c.2mm, hairy. Glumes oblong, subacute; the lower c.14.7 × 3.3mm; the upper c.15.5 × 4mm. Lemma 12.8–14.8mm, apical lobes 7.2–8mm, minutely hispid, very shortly setulose, body hairy, hairs to 2mm, awn 8–9 + 11.6–12.8mm. Palea 11–13.5mm. Anthers c.0.7mm.

Bhutan: N — Upper Mo Chu district (Lingshi Dzong). Among rhododendron bushes, 3960m. October.

33. HELICTOTRICHON Besser ex Schultes & Schultes f.

(by A.C. Broome & H.J.N.)

Tufted perennials. Basal leaves flat or inrolled. Culms erect, sparsely leafy, leaf blades flat or inrolled; ligules membranous, truncate. Panicles narrowly cylindrical, branches whorled, drooping, slender. Spikelets oblong-elliptic, laterally compressed, with usually 3 bisexual florets and sometimes a reduced, sterile terminal one, disarticulating above glumes and between florets; callus and rachilla internodes long-ciliate. Glumes shorter than spikelet, unequal, herbaceous, margins hyaline; the lower 1(–2)-veined; the upper 3–5-veined. Lemmas ± oblong-lanceolate, strongly convex, 7-veined, thickly herbaceous, apex bifid, hyaline, margins hyaline; awned from back, awn geniculate, column twisted. Palea linear, hyaline, 2-keeled, keels ciliate. Ovary hairy.

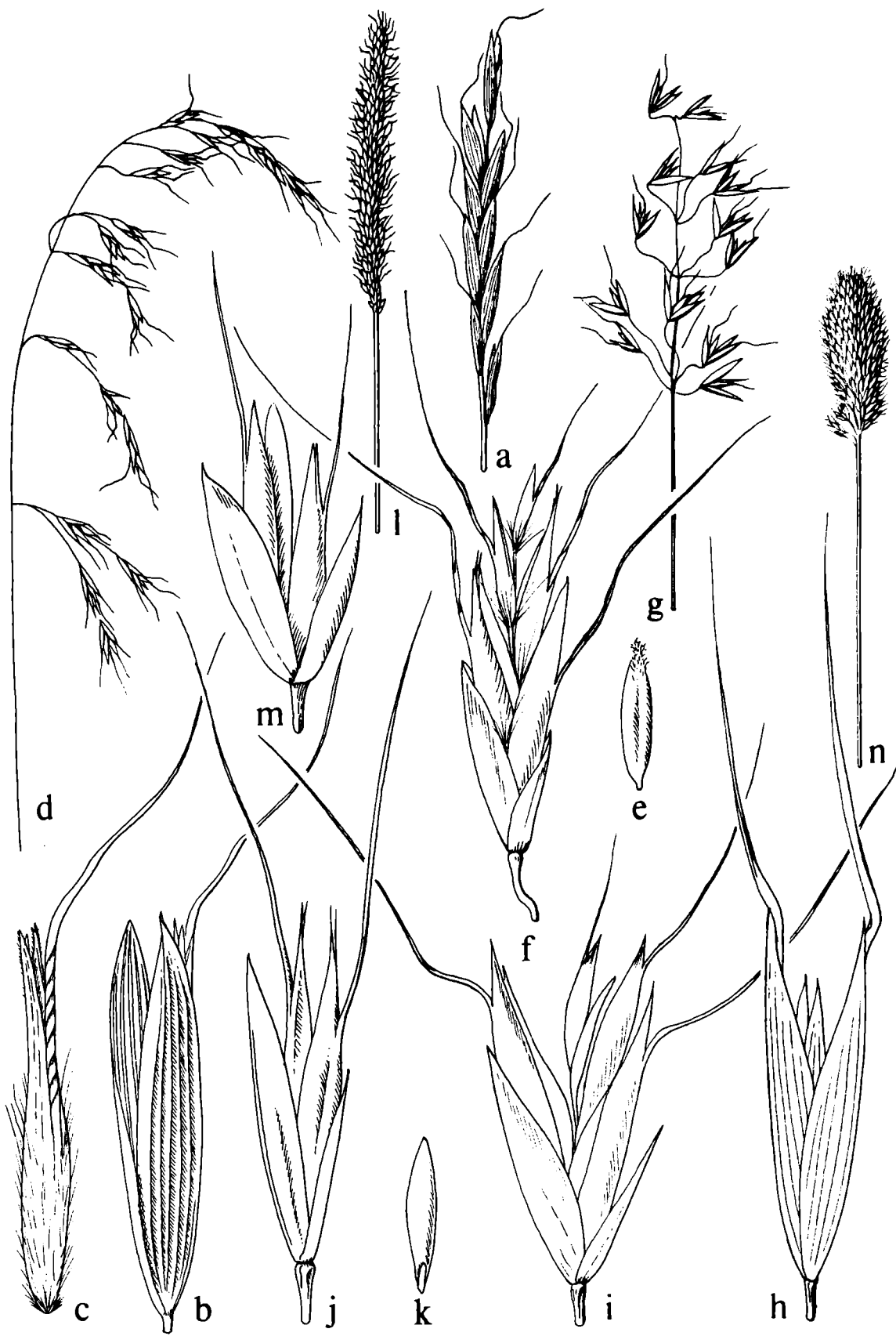
1. Anthers usually over 2.5mm; spikelets over 10mm; basal leaves usually glabrous **1. H. virescens**
+ Anthers to 2mm; spikelets usually under 10mm; basal leaves usually densely hairy **2. H. parviflorum**

1. H. virescens (Nees ex Steudel) Henrard; incl. *H. asperum* (Munro ex Thwaites) Bor; *Avena aspera* Munro ex Thwaites. Fig. 22d–e.

Rhizomes short. Basal leaves 22–34cm, 2.5–4mm wide, usually glabrous. Culms 47–150cm, stout, erect; leaf blades 4–30cm, 1–7mm wide, flat or

FIG. 22.

a–c, *Duthiea brachypodium*: a, infl. (× 2/3); b, spikelet (× 3); c, lemma (× 3). d–e, *Helictotrichon virescens*: d, infl. (× 1/3); e, ovary (showing hairy tip) (× 6). f, *H. parviflorum*: spikelet (× 4). g–h, *Avena fatua*: g, infl. (× 1/4); h, spikelet (× 2). i, *Trisetum sikkimense*: spikelet (× 6). j–k, *T. scitulum*: j, spikelet (× 6); k, ovary (× 6). l–m, *T. spicatum* subsp. *himalaicum*: l, infl. (× 1/2); m, spikelet (× 6). n, *T. spicatum* subsp. *mongolicum*: infl. (× 2/3). Drawn by Louise Olley.



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inrolled, hispid on veins, glabrous or sometimes hairy above; sheaths usually glabrous; ligule 0.5–4.5mm. Infl. green, 14.5–45cm, lowest whorl of 3–6 branches, the longest 3–20cm, bearing 1–12 spikelets. Spikelets 10.7–16.5(–17.5)mm, fertile florets 3. Lower glume 6.1–8.6mm, oblong-lanceolate, acuminate; upper glume 9.2–13mm, oblong, acute. Lemmas scabrid at least above, thickly herbaceous. Lowest floret: lemma 9–13.1mm, awn inserted just above or just below halfway, 4.5–8 + 10–14mm; palea 7–9.5mm. Anthers (2–)2.5–5.8mm.

Bhutan: C — Thimphu (very common in Thimphu and Paro valleys), Punakha (pass between Nobding and Phobjikah), Tongsa (3km W of Tongsa), Bumthang (near Thangbi, Bumthang) and Tashigang (Yonphu La) districts; N — Upper Mo Chu district (near Jambethang, Soe/Lingshi/Yale La, Laya); **Darjeeling** (Tonglu); **Sikkim** (Lachen, Lachung, Karponang, Domang, Chowbhanjan). Very common at mid-altitudes in pastures; open forest (incl. blue pine, hemlock/deciduous and fir); alpine grassland; marsh, 2300–4050m. July–October.

2. *H. parviflorum* (Hook. f.) Bor; *Avena aspera* var. *parviflora* Hook. f. Fig. 22f.

Differs from *H. virescens* as follows: basal leaves densely hairy above and beneath; culms commonly shorter and more slender (to 72cm), leaf blades narrower (to 3mm wide), commonly hairy, inrolled, sheaths hairy; infl. smaller (to 20.5cm), the longest branch of lowest whorl to 9cm, with up to 8 spikelets; spikelets smaller (8–10mm); lowest lemma 6.5–8.5mm; anthers shorter (1.3–2mm)

Bhutan: C — Ha (W side of Chelai La), Thimphu (Motithang to Phajoding, above Phajoding, Chenkaphug, above Thimphu hospital), Punakha (Nobding to Phobjikah), Bumthang (near Thangbi, Bumthang), Mongar (Sengor) and Sakden (Meesa Valley) districts; N— Upper Mo Chu district (Gangyuel to Lingshi, Laya); **Darjeeling** (Singalila); **Sikkim** (Dzongri, Jamlinghang, Islumbo, Natu La). Banks in open forest (incl. blue pine, oak and spruce); above treeline in rough pasture (with rhododendron and bamboo); cliffs and rocks by stream, 2300–4270m. July–October.

The specimens from W Sikkim have wide, flat culm leaf blades.

Much further work is required on the widespread and polymorphic *H. asperum/virescens* complex. Cope (1982) sunk *H. parviflorum* under *H. virescens*, but in our area they seem (despite some intermediates) to be distinguishable. Our specimens of the latter, however, fall outwith the range of spikelet measurements (especially in anther size) given for *H. virescens* by Sevenster & Veldkamp (1983). The two taxa seem to be sympatric in our area, it is possible that we have a polyploid series.

34. AVENA L.

Tufted annuals. Culms erect, leafy. Leaf blades flat; ligules membranous, truncate. Panicles lax, \pm broadly cylindrical, branches whorled, commonly spreading, slender, mainly unbranched. Spikelets large, nodding, widely gaping, laterally compressed, with usually 2 bisexual florets and sometimes a reduced, sterile, terminal one, disarticulating above glumes and between florets, or not disarticulating (in cultivated species); callus and rachilla internodes long ciliate. Glumes subequal, equalling spikelet, 9–11-veined, papery, margins widely hyaline. Lemmas \pm oblong-lanceolate, strongly convex, 7-veined, coriaceous, apex bifid, hyaline, margins hyaline; awned from back, awn geniculate, column twisted. Palea linear, hyaline, 2-keeled, keels ciliate. Ovary hairy.

1. **A. fatua** L. Sha: *bocchar*; Nep: *jangali jar*; Eng: *wild oat*. Fig. 22g–h.

Culms 30–100cm, geniculately ascending to erect, glabrous, or hairy at nodes. Culm leaves usually 3, blades 5.5–18.5cm, 2–9.8mm wide, flat, tapering from base to acute apex, minutely rough on veins and margins, margins sometimes ciliate below; sheaths glabrous; ligule 0.6–4mm, truncate-erose. Panicle green drying straw-coloured, 11–23 \times 3–15cm, cylindrical, pyramidal or one-sided, lax, most branches bearing a single spikelet, lowest whorl of 2–6(–10) branches, the longest 4.7–12cm, bearing 1–4 spikelets. Spikelets nodding, 19.5–25mm, fertile florets 2(–3), sometimes with a reduced terminal one. Lower glume 19.5–23.5 \times 4.2–5.7(–6.7)mm, 9–10(–11)-veined; upper glume 19.8–25 \times 5.2–6.2(–7.3)mm, 11-veined. Lemmas, acute, shortly bifid, back glabrous or with stiff hairs around middle; awn inserted just below halfway. Lowest floret: callus hairs to (1.2–)3–5mm; lemma 15.2–19.7mm, awn 11–14 + 21–27mm; palea 12.5–14.8mm; anthers 2.3–4.2mm.

Bhutan: S — Chukka district (Parker, 1992); C — Ha (Parker, 1992), Thimphu (Thimphu*, Taba, Chebesa), Punakha (c.4km S of Wangdi Phodrang*, Heso Thangkha, Badjo*, Talo), Bumthang (Byakar Valley), Mongar (Kinklekhur) and Tahsigang (Parker, 1992) districts; N — Upper Mo Chu (Laya); **Sikkim** (Lachung, Yumthang*); **Chumbi**. Weed of barley, wheat and rice fields, 1100–3840m. March–October.

Forms with glabrous lemmas (as in the collections marked *) have sometimes been separated as var. *glabrata* Petermann (*A. sativa* var. *sericea* Hook. f.).

Parker (1992) noted that it was 'one of the few species which farmers bother to weed from wheat' and that it was a common and potentially serious weed of cereals over 1000m.

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Cultivated species:

Avena sativa L. Dz: *bachu*; Eng: *cultivated oat*

Japanese varieties of *A. sativa* have been grown as a green fodder crop for the last 20 years in Ha, Paro and Tongsa districts, but are not popular with farmers as they look similar to the weedy *A. fatua* (W. Roder, pers. comm.). It differs from *A. fatua* in having glabrous lemmas and spikelets that do not disarticulate.

35. TRisetum Persoon

(by A.C. Broome)

Tufted perennials. Leaf blades flat or inrolled; ligules membranous, truncate or rounded. Panicles lax and drooping or dense and spike-like, often shiny. Spikelets finally gaping, compressed, fertile florets 2–3(–4), bisexual, the terminal one sometimes vestigial, disarticulating above glumes and between florets. Callus and rachilla internodes usually ciliate. Glumes \pm unequal, shorter than spikelet, herbaceous, sides hyaline; the lower 1-veined; the upper 3-veined. Lemmas compressed, keeled, 5-veined, herbaceous, apex bifid sometimes minutely so, margins hyaline; awned from back, awn usually geniculate, with a twisted column. Paleas not enclosed by lemmas after anthesis, linear, hyaline, apex notched, 2-keeled, keels ciliate. Ovary glabrous.

1. Culm glabrous below panicle; panicles lax, branches obvious 2
+ Culm pubescent below panicle; panicles dense, spike-like, branches not obvious **3. T spicatum**
2. Lower glume to 3.3mm; upper glume to 5.5mm; lowest lemma to 6mm; awn not geniculate, base curved but scarcely twisted
1. T. sikkimense
- + Lower glume over 4.5mm; upper glume over 5.8mm; lowest lemma over 6.4mm; awn geniculate, column twisted **2. T scitulum**

1. T. sikkimense (Hook. f.) Chrtek; *T. flavescens* sensu Bor, non (L.) P. Beauvois; *Avena sikkimensis* Hook. f. Fig. 22i.

Tufted perennial. Culms 84–110cm, geniculately ascending, glabrous. Culm leaves 5–6, blades 11–21.5cm, oblong, 3–5.8mm, acute, with scattered, spreading hairs on veins of upper surface, margins ciliate especially near base; sheaths shortly hairy on veins, margins ciliate at apex; ligule 1–2.4mm, truncate-crose, back hairy. Panicle green or yellowish-brown, 6–25.5cm, lax, whorls distant, branches ascending, flexuous, minutely hairy, lowest whorl of 4–6 branches,

the longest 4.5–7cm, bearing 7–12 spikelets. Spikelets 6–9.4mm, fertile florets 2–4. Glumes green in middle, sides purple, rough on keels; the lower 2.7–3.5mm, linear-lanceolate, acuminate; the upper 4.1–5.5mm, $\frac{2}{3}$ length of spikelet, oblong, acuminate. Lemmas linear-lanceolate, acute, granular, apex bifid, lobes with short setae; awn inserted $\frac{1}{4}$ – $\frac{1}{3}$ below tip, recurved, base scarcely twisted; callus minutely hairy. Lowest floret: lemma 5–6.7mm, setae of apical lobes c.0.5mm, awn 5–10mm; palea 2.6–3.7mm. Anthers c.1mm.

Bhutan: C — Thimphu district (above Motithang); N — Upper Mo Chu district (Anakha Nagu); **Sikkim** (Lachung, Lachen, Yakche; Karponang (Chrték, 1968)). Shaded wooded gully by stream; among scrub, 2590–3350m. July–August.

2. **T. scitulum** Bor; *Avena flavescens* sensu Hook. f., non L. Fig. 22j–k.

Differs from *T. sikkimense* as follows: culms often shorter (12–78cm); margins of leaves and sheaths not ciliate; ligule to 4.3mm; infl. shorter (6.5–16cm), denser, lowest whorl of 1–3 branches; spikelets with (1–)2 fertile florets; glumes longer, the lower 4.5–5mm, the upper 5.8–6.7mm; callus glabrous; lemmas longer, the lowest 6.4–8mm, apical setae longer (usually over 1mm), awn stouter, longer (8.2–12.6mm), geniculate and twisted below; paleas longer (the lowest 4–5mm).

Bhutan: C — Ha district (W side of Chelai La); N — Upper Mo Chu district (above Laya, Zambuthang); C — Thimphu district (between Phajoding and Lakes); **Sikkim** (Prek Chhu Bridge N of Dzongri, Samiti Lake, Lhonak, Yumthang). Alpine turf, among scrub; open areas of scattered scrub and scree; gravel beside river, 3600–4250m. July–October.

3. **T. spicatum** (L.) Richter; *Avena subspicatum* (L.) Clairv.

As pointed out by Veldkamp & van der Have (1983) this polymorphic species has one of the widest distributions of any flowering plant. Hultén (1959) recognised some of the nodes of variation as subspecies. While use of this rank and their distinctness is questionable, and has not been used by other authors for Himalayan material, specimens from our area fall into four \pm discrete categories. It seems useful to point this out and to use Hultén's names.

1. Awns under 0.9mm not exerted from panicle subsp. **hultenii**
+ Awns over 2mm, conspicuously exerted from panicle 2
2. Sheaths densely pubescent; awn twisted; apex of lemma deeply bifid,
lobes with short setae subsp. **alaskanum**
+ Sheaths \pm glabrous; awn not twisted; apex of lemma minutely bifid ... 3

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3. Infl. linear, 3.5–10.5cm, lower whorls often slightly distant; awn of lowest lemma over 3.3mm subsp. **himalaicum**
+ Infl. cylindric, 2–4.5cm, dense; awn of lowest lemma to 3mm
subsp. **mongolicum**

subsp. **himalaicum** Hultén ex Veldkamp. Fig. 221–m.

Loosely tufted perennial. Culms 12–48cm, ascending to erect, pubescent below panicle. Culm leaves 2, blades 3–9cm, 1.8–2.9mm wide, tapering from base, acute, margins ciliate, glabrous or with sparse, spreading hairs on veins above; sheaths glabrous or hairy on margins; ligule 0.5–0.7mm, truncate. Panicles green to gold sometimes tinged purple, slightly shiny, 3–10.5 × 0.8–1.5cm, dense, spike-like, narrowly cylindric; branches erect, appressed, pubescent. Spikelets (3.8–)4.9–5.4mm, fertile florets (1–)2, with a terminal rachilla rudiment. Glumes unequal; the lower 2.9–4mm, linear-lanceolate, acuminate; the upper (3.7–)4.2–4.8mm, slightly shorter than spikelet, oblong-elliptic, acuminate or mucronate. Lemmas greenish-yellow with purplish edges, oblong-lanceolate, acuminate, shiny, tip minutely bifid, minutely hispid on surface; awn inserted slightly above halfway, curved or straight, not twisted below. Lowest floret: lemma (3.7–)4–4.4mm, awn (3.3–)3.6–4.8mm; palea 3.2–4.2mm. Anthers 0.7–1.3mm.

Bhutan: C — Ha (Ha Guest House), Thimphu (E of Thimphu, below Phajoding Monastery, Chelai La) and Bumthang (W side of Thrumsing La, S of Kitiphu) districts; N — Upper Mo Chu district (above Laya); **Sikkim** (Bikbari, Prek Chhu, Yume Samdong, above Thangshing, Dzongri, Phune to Yakche); **Chumbi.** Open grassy areas, sometimes among scrub; fir forest; sand and silt beside river, 2600–4270m. May–November.

Rare forms with a single fertile floret can be told from *Calamagrostis* spp. by the culm being hairy below the infl.

subsp. **alaskanum** (Nash) Hultén

Differs from subsp. *himalaicum* as follows: leaf blades densely hairy above and beneath, sheaths densely pubescent; spikelets larger (5.5–8.6mm), often with 3 fertile florets; lower glume 3.2–5.3mm; upper glume 3.8–5.8mm; lemmas with deeply bifid apex, lobes to 1.7mm, with short setae, the lowest 4.6–7.1mm; awn inserted nearer apex, geniculate, column twisted, 1.5–3.5 + 3.1–4.7mm; anthers 0.9–1.5mm.

Bhutan: N — Upper Mo Chu district (Laya, below Gangyuel, Soe/Lingshi/Yale La); **Sikkim** (Chholhamoo, Lasha Chhu); **Chumbi.** 3810–5420m. June–September.

subsp. **mongolicum** Hultén ex Veldkamp. Fig. 22n.

Differs from subsp. *himalaicum* in its shorter (1.5–4 × 0.8–1.3cm), denser, wider (elliptic in outline) panicle; lower glume wider; awns shorter (that of lowest lemma 2.5–3mm).

Bhutan: N — Upper Mo Chu (Lingshi) and Upper Pho Chu (Lunana) districts; **Sikkim** (Samiti Lake, Chemathang, Chakalung La, Chholhamoo). Sandy moraines, 4570–5240m. July–September.

subsp. **hultenii** Chrtek

Differs from subsp. *himalaicum* in its very short awns c.0.9mm which are not exerted from the panicle.

Sikkim (Tang La). Habitat not recorded, 4570m. September.

36. DESCHAMPSIA P. Beauvois

(by A.C. Broome & H.J.N.)

Tufted perennials. Leaves mostly basal, blades usually inrolled, linear, acute, ribbed on upper surface. Culms erect; leaves few; sheaths glabrous; ligules membranous, narrowly acute, becoming torn. Panicles open to dense, shiny. Spikelets with (1–)2(–3)-florets and a terminal, hairy, rachilla rudiment, compressed, disarticulating above glumes; rachilla internode(s) hairy. Glumes unequal, margins broadly hyaline; the lower ± equalling spikelet, 1-veined; the upper 3-veined. Florets similar in shape, the upper smaller; callus hairy. Lemmas rounded on back, papery, shiny, apex hyaline, truncate-erose; awned from near base, awn almost straight, very weakly geniculate. Paleas linear, 2-keeled, papery, hyaline, apex bifid.

1. Panicle 4.5–23cm, lax to moderately dense, branches 1–5cm, spreading to suberect, flexuous; spikelets 4.25–5mm **1. D. cespitosa** s.l.
- + Panicle 3–5cm, dense, ovoid, lobed, branches 0.3–1.5cm, erect or suberect, rigid; spikelets 3–5mm **D. cespitosa** subsp. **sikkimensis**

1. D. cespitosa (L.) P. Beauvois s.l. Eng: *tufted hair-grass*. Fig. 23a–b.

Culms 10–63cm, erect. Basal leaves 2–15cm, to 3.1(–4.5)mm wide when flat. Culm leaves 2–3, blades 0.5–11.5cm, 1.2–3.4(–4)mm wide, minutely hispid on ridges of upper surface; sheaths glabrous; ligule 3–10mm. Panicle greenish-gold to purplish-brown, 4.5–21cm, pyramidal at anthesis, then cylindrical, lax, branches hispid, filiform, spreading at anthesis, lowest whorl with 2–5 branches, the longest 3–10.5cm. Spikelets 4–5.5(–6.7)mm; lowest rachilla internode 1.1–1.8mm, hairs 0.6–1.3mm; rachilla extension 1.9–2.4mm. Glumes purplish with green to gold margins; the lower 3.3–4.8(–6.7)mm, lanceolate, acute; the upper 4–5.2(–6.6)mm, oblong to oblanceolate, abruptly acuminate

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to acute. Lowest floret: lemma greenish or purplish, 2.7–4mm, ovate to oblong, normally blunt, regularly toothed, lacerate or 2-lobed, obscurely 5-veined, awn 3–4.5mm; palea 2.6–3.3mm; anthers 1.6–2mm; callus hairs 1–1.7mm.

Bhutan: C — Thimphu district (Chimilamsto, Phajoding); N — Upper Mo Chu (S of Lingshi, E bank of Tharizam Chu, Soe Yaksa, Nelli La, Yale La, Jangthang) and Upper Kuru Chu (Narim Thang) districts; **Sikkim** (Lachen, Lachung, Chola, Bikbari, Jamlinghang, Dzongri, Yumthang, Kopup, Nathang, Megu, Chumegata, Chamnago, Thanka La, Tuko La, Jelep La, Natu La.); **Chumbi**. Beside streams and lakes; peaty moorland; woods (presumably *Abies*), 3050–4880m. May–November.

A widespread, very variable and taxonomically complex temperate species. Many subspecies have been recognised in Russia (see Tsvelev, 1984) and Europe. In our area further work is needed, and might reveal interesting patterns. Specimens from moderate altitudes with tall culms and long, narrow infls. probably belong to subsp. *cespitosa*, but other high alpine forms with short culms and triangular, lax infls. almost certainly do not.

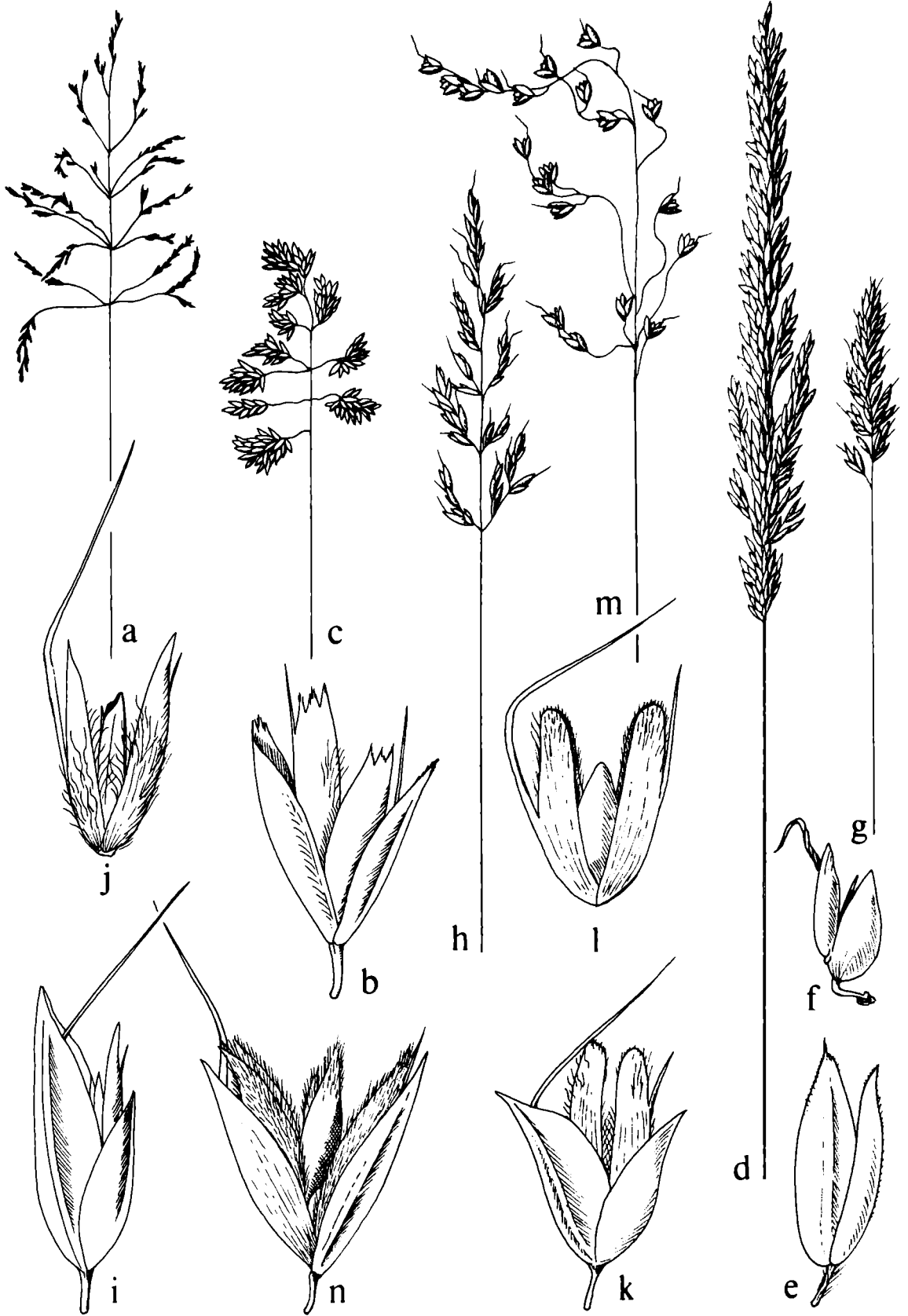
subsp. **sikkimensis** Noltie; var. *colorata* sensu F.B.I. p.p. (Sikkim plants), non Grisebach. Fig. 23c.

Differs from dwarf forms of subsp. *cespitosa* as follows: infl. short (3–7cm), spikelets in dense rounded clusters 1–1.5 × 1–1.3cm (almost as broad as long) at ends of short (0.3–1.2cm) branches, or clusters sessile so infl. ovoid, slightly lobed; branches usually completely smooth; spikelets shorter (4.2–5mm); callus hairs sometimes longer than lemma (1.3–2mm); awns 1–3.1mm, often shorter than lemma; anthers sometimes smaller (1.3–1.9mm); rachilla internode shorter (0.8–1.1mm, sparsely hairy in upper part); rachilla extension shorter (0.6–1.3mm).

Sikkim (Naku La, Chholhamoo, Yume Samdong, Upper Lasha Chhu valley). Shallow runnels at edge of river (probably also moraines), 4545–5430m. July–September.

FIG. 23.

a–b, **Deschampsia cespitosa** s.l.: a, infl. ($\times \frac{1}{3}$); b, spikelet ($\times 6$). c, **D. cespitosa** subsp. **sikkimensis**: infl. ($\times \frac{2}{3}$). d–f, **Holcus lanatus**: d, infl. ($\times \frac{2}{3}$); e, spikelet ($\times 5$); f, florets ($\times 5$). g, **Anthoxanthum odoratum**: infl. ($\times \frac{2}{3}$). h–j, **A. hookeri**: h, infl. ($\times \frac{2}{3}$); i, spikelet ($\times 5$); j, florets ($\times 5$). k–l, **A. sikkimense**: k, spikelet ($\times 6$); l, florets ($\times 6$). m–n, **A. flexuosum**: m, infl. ($\times \frac{2}{5}$); n, spikelet ($\times 5$). Drawn by Louise Olley.



37. **HOLCUS L.**

(by A.C. Broome)

Tufted perennial. Culms leafy; leaf blades flat; ligules truncate, membranous. Panicle moderately dense, branches whorled, erect after flowering, overlapping. Spikelets compressed, disarticulating below glumes, florets 2, the lower bisexual, the upper male. Glumes \pm equal, equalling spikelet, conduplicate, keeled, papery; the lower narrower than the upper, 1-veined; the upper 3-veined. Lemmas conduplicate, subacute, indistinctly veined, shiny; the lower awnless; the upper awned. Paleas linear, hyaline, 2-keeled.

1. **H. lanatus L.** Eng: *Yorkshire fog*. Fig. 23d-f.

Culms 29–96cm, geniculately ascending, tomentose. Culm leaves 4–5, blades 2–20cm, oblong-lanceolate, 4.3–12.5mm wide, acute, densely hairy above and beneath; sheaths hairy; ligule truncate, 1.1–3mm, hairy on back. Panicle whitish to pale green or pinkish, 5.5–14 × 2–4.5cm, elliptic or narrowly cylindrical in outline, branches spreading then erect. Spikelets 3.4–5.1mm, elliptic in outline before anthesis; rachilla internode glabrous. Glumes ciliate on keels and margins, minutely rough or hairy on sides, middle vein extending to form a short mucro; the lower 3.4–4.8mm, narrowly elliptic to oblong, blunt, 1-veined, mucro under 0.5mm; the upper 3.4–5.1mm, ovate, 3-veined, minutely notched, lobes rounded or blunt, mucro 0.2–0.8mm. Lower floret: lemma 1.8–2.5mm, ovate; palea 1.8–2.1mm; anthers 1–1.6mm; callus long- or short-ciliate. Upper floret: lemma 1.8–2.2mm, lanceolate, awn 1.2–4mm, subterminal, hooked; palea 1.3–1.5mm; anthers 0.9–1.3mm.

Bhutan: C — Thimphu (Thimphu valley) and Mongar (Sengor) districts; **Darjeeling** (Dingle, Senchal, Darjeeling, Palmajua to Rimbick). Improved pasture [probably also gardens and waste places], 2130–3000m. July–September.

A widespread temperate species, but not native in our area. In Darjeeling introduced as early as 1862. Introduced more recently to Bhutan as a potential fodder plant, but currently becoming a weed and nuisance in the east of the country (W. Roder, pers. comm.).

38. **ANTHOXANTHUM L.**(incl. *Hierochloë* R. Br.)

(by A.C. Broome & H.J.N.)

Tufted perennials, smelling sweetly of coumarin when dry; rhizomes short or absent. Leaf blades flat; ligule membranous, \pm oblong, lacerate. Panicle

open or contracted. Spikelets compressed, disarticulating below the glumes, florets 3. Glumes unequal or subequal, the upper \pm equalling spikelet, sides hyaline; the lower 1- or 3-veined; the upper 3-veined. Lowest floret male or sterile, lemma shortly bifid, with short, weak awn in sinus, paleate or epaleate. Middle floret male or sterile, lemma like that of lower floret, but more deeply bifid, awn stouter, geniculate, column twisted. Uppermost floret bisexual, lemma awnless, entire, shining.

We agree with Schouten & Veldkamp (1985) that it is impossible to maintain the distinction between *Anthoxanthum* and *Hierochloë* which is based solely on the (variable) sex of the lower two florets.

1. Panicles dense, spike-like, erect, to 3.5cm **1. A. odoratum**
+ Panicles lax, not spike-like, more than 3.5cm 2
2. Panicle branches flexuous; spikelets obovate in outline; uppermost lemma hairy in upper half; lower glume 3-veined **4. A. flexuosum**
+ Panicle branches stiff, suberect; uppermost lemma glabrous; lower glume usually 1-veined 3
3. Culm leaf blades 2.4–6mm wide; spikelets over (4.8–)5.5mm; lobes of lowest 2 lemmas acute; glumes lanceolate; lowest floret male, paleate **2. A. hookeri**
+ Culm leaf blades 1.3–3mm wide; spikelets under 5mm; lobes of lowest 2 lemmas blunt; glumes more ovate; lowest floret sterile, epaleate
3. A. sikkimense

1. A. odoratum L. Eng: *sweet vernal grass*. Fig. 23g.

Culms 9–55cm, ascending. Culm leaves usually 3, blades 1–7cm, widest (to 5.3mm) in lower half, acute, glabrous or sparsely hairy on both surfaces, basal auricles ciliate; sheaths glabrous; ligule to 2.5mm, truncate-lacerate. Infl. straw-coloured, 1.6–4 × 0.6–1.4cm, dense, spike-like, branches very short, erect. Spikelets 6.5–8.5mm (excl. awns), narrowly lanceolate, lowest 2 florets sterile, epaleate, uppermost floret bisexual, paleate. Glumes yellowish-green, very unequal, acuminate, sides papery; the lower 3.2–3.5 × c.2mm, ovate, 1-veined, occasionally sparsely hairy on one side; the upper 6.5–8.5mm, oblong-lanceolate, 3-veined. Lowest floret: lemma 2.7–3mm, shallowly bifid, lobes blunt, sides and margin hairy in lower $\frac{2}{3}$; awn subterminal, 2.5–2.7mm, straight. Middle floret: lemma 2.5–2.6mm, similar to lower, but bifid nearly to base, awn exerted, geniculate, c.3 + 4mm. Uppermost floret: lemma c.2mm, lanceolate, acute, glabrous; palea c.1.7mm.

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Darjeeling (Darjeeling). Habitat not recorded, 2100–2130m. April–October.

Introduced – a widespread, predominantly European species, first recorded in our area in 1876. This early (Clarke) specimen was determined by Melderis as the doubtfully distinguishable *A. alpinum* A. & D. Löve (a diploid form, sometimes recognised at subspecific rank, and having \pm glabrous leaves, glumes and pedicels). The only recent specimen is typical *A. odoratum*, with hairy leaves, glumes and pedicels.

2. *A. hookeri* (Grisebach) Rendle; *Hierochloë hookeri* (Grisebach) Maximovicz. Fig. 23h–j.

Culms 17–84cm, erect or geniculately ascending, bases sometimes decumbent and rooting from nodes, sometimes branched below. Culm leaves 3–6, blades 3–31cm, widest (2.4–6mm) in lower half, acute, hairs on upper surface scattered and spreading, glabrous or sparsely hairy beneath; sheaths hairy on margins; ligules 2–5mm, truncate-lacerate. Infl. straw-coloured to purplish, 5–12cm, narrowly cylindrical, moderately dense, branches erect, lowest single or paired, 1.7–4cm, bearing 3–5(–9) spikelets. Spikelets (4.8–)5.5–8mm (excl. awns), narrowly lanceolate. Glumes purplish, very unequal, oblong-lanceolate, acute, sides papery; the lower (3.1–)3.6–5.3mm, usually 1-veined, occasionally sparsely hairy on one side; the upper (4.8–)5.5–8.4mm, 3-veined. Lowest floret male, usually paleate (occasionally sterile and epaleate): lemma (3.5–)4.2–6.1mm, shallowly bifid, lobes subacute, sides and margins hairy in lower $\frac{2}{3}$, awn 0.7–1.8mm, not exerted; palea 3.7–4.6mm; anthers (2.3–)3.1–3.5mm. Middle floret usually sterile and epaleate (occasionally male and paleate): lemma similar to lower, but bifid to below halfway, awn exerted, geniculate, 1.7–3.1 + 3–8mm. Uppermost floret bisexual: lemma 2.6–3.1mm, lanceolate, acute, glabrous; palea 1.8–2.6mm; anthers 2.4–3.2mm.

Bhutan: S — Chukka (2km S of Chimakothi) and Deothang (Ngangshing to Narfong) districts; C — Ha (Ha to Damthang), Thimphu (above Thimphu hospital, Phajoding, Changkaphug), Tongsa (Tongsa) and Bumthang (Kitiphu) districts; N — Upper Mo Chu (Laya, Anakha Nagu) and Upper Kulong Chu (Shingbe) districts; **Sikkim** (below Tangu, Lachen, Lachung, Chhoptha, Lingmuthang); **Chumbi**. Open grassy hillsides, sometimes in scrub; disturbed blue pine forest; roadside banks and cliffs; alpine pasture, 1900–4080m. June–November.

A specimen from Phajoding (*Wood* 5816, E) is atypical in having a very short (under 4.6mm), weak awn on the upper lemma.

Grisebach, in the original description, pointed out that this taxon was very close to what is now known as *A. horsfieldii* (Kunth ex Bennett) Reeder. In view of the probably justifiable wide concept of this latter species taken by Schouten & Veldkamp

(1985), further study will probably reduce *A. hookeri* and the Khasian *A. clarkei* (Hook.f.) Ohwi to infraspecific rank under *A. horsfieldii*.

3. **A. sikkimense** (Maximowicz) Ohwi; *Hierochloë gracillima* Hook. f. Fig. 23k–l.

Differs from *A. hookeri* as follows: leaves narrower (to 3.3mm wide); spikelets smaller (to 4.3(–5)mm); glumes wider, less unequal, the lower c.2.9 × 1.8mm, ovate, the upper c.4 × 2mm, oblong-ovate; lowest floret sterile, epaleate, lemma c.3.7mm, apical lobes truncate-ciliate; middle floret sterile, epaleate, lemma c.4mm, lobes truncate, awn c.2.6 + 3.6mm; uppermost (bisexual) floret smaller, lemma c.2.3mm.

Sikkim (Lachung). Habitat not recorded, 3050–3350m. August.

No recent collections.

4. **A. flexuosum** (Hook. f.) Veldkamp; *Hierochloë flexuosa* Hook. f. Fig. 23m–n.

Shortly rhizomatous. Culms 17–54cm, ascending from shortly decumbent bases. Culm leaves 3–4, blades 6–17cm, widest (3–8mm) in lower half, acute, glabrous; sheaths glabrous; ligules 3–5mm, truncate-lacerate. Infl. green to straw-coloured, 5.1–12cm, drooping, lax, branches flexuous, spreading at anthesis, lowest paired, the longer 6–8cm, bearing 7–10 spikelets. Spikelets 5.1–6.3mm (excl. awns), widely obovate. Glumes tinged purple, subequal, lanceolate, acute, 3-veined, glabrous, sides papery; the lower 4.4–5.5 × c.2.2mm; the upper 4.8–5.7 × c.2.1mm. Lowest floret male: lemma 4.5–6mm, shallowly bifid, lobes subacute, margins ciliate above, hairy all over, awn subapical, short (1.1–2.9mm); palea 3.5–4mm; anthers c.1.2mm. Middle floret male: lemma similar to lower, but bifid to about halfway, awn exerted, geniculate, c.3 + 4mm; palea c.4mm; anthers 1.1–1.5mm. Uppermost floret bisexual: lemma 3.7–4.5mm, lanceolate, acute, hairy above, lower half glabrous; palea c.3mm.

Bhutan: C — Thimpu district (above Phajoding Monastery); **Sikkim** (Dzongri, Changu, Jamlingang to Bikbari, Bijan, Tosa, Thanka La). Damp, peaty soil, often in *Rhododendron* scrub, 3850–4880m. July–November.

39. PHALARIS L.

(by A.C. Broome)

Annual or perennial. Culms erect, leafy. Leaf blades flat, oblong to lanceolate, glabrous; ligule membranous, oblong, blunt, becoming torn. Panicles compact, ± ellipsoid, or elongate and narrowly cylindrical with obvious

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branches. Spikelets strongly compressed, disarticulating above glumes, with 1 fertile floret and 1 or 2 reduced, sterile florets. Glumes \pm equal, equalling spikelet, conduplicate, keeled, 3-veined, keel winged or not. Fertile floret: lemma conduplicate; palea conduplicate, 1-keeled. Sterile florets epaleate, lemmas linear, hairy.

1. Annual; panicle ellipsoid to cylindric, very dense, branches not obvious; glumes with winged keels; sterile floret 1 **1. P. minor**
- + Perennial; panicle cylindric, lax below, branches obvious, spreading at anthesis; glumes not winged; sterile florets 2 **2. P. arundinacea**

1. P. minor Retzius. Dz: *yup*; Nep: *ghongey banso, ragate jhar*; Eng: *lesser canary grass*. Fig. 24a–b.

Tufted annual. Culms 33–80cm, erect. Culm leaves 5–6, blades 5.5–20cm, 4.6–6.8mm wide, lanceolate, acuminate, glabrous; sheaths glabrous; ligule 4–7.5mm. Panicle green and white, 2.5–4.2 \times 1–1.5cm, very dense, ellipsoid to cylindric, branches short, not obvious, erect. Spikelets 4.7–5.6mm, widely ovate before anthesis. Glumes 5.1–5.5mm, each side semi-lanceolate, c.1.3mm wide, acuminate, keels winged, wing white, erose, wider above. Sterile floret 1, lemma 1.2–1.3mm. Fertile floret: lemma cream-coloured, shining, 2.8–3.1mm, each side ovate, 1.5–1.7mm wide, appressed hairy above, chartaceous; palea c.2.5mm, each side c.0.7mm wide, chartaceous, margins narrowly hyaline, keel ciliate. Grain yellow, shining, c.3 \times 1.8mm, appressed-hairy. Anthers 1.4–1.7mm.

Bhutan: C — Thimphu (Thimphu), Punakha (1km W of Wangdi Phodrang) and Tashigang (Parker, 1992) districts. Weed of gardens and wheat-fields, 1200–2300m. March–June.

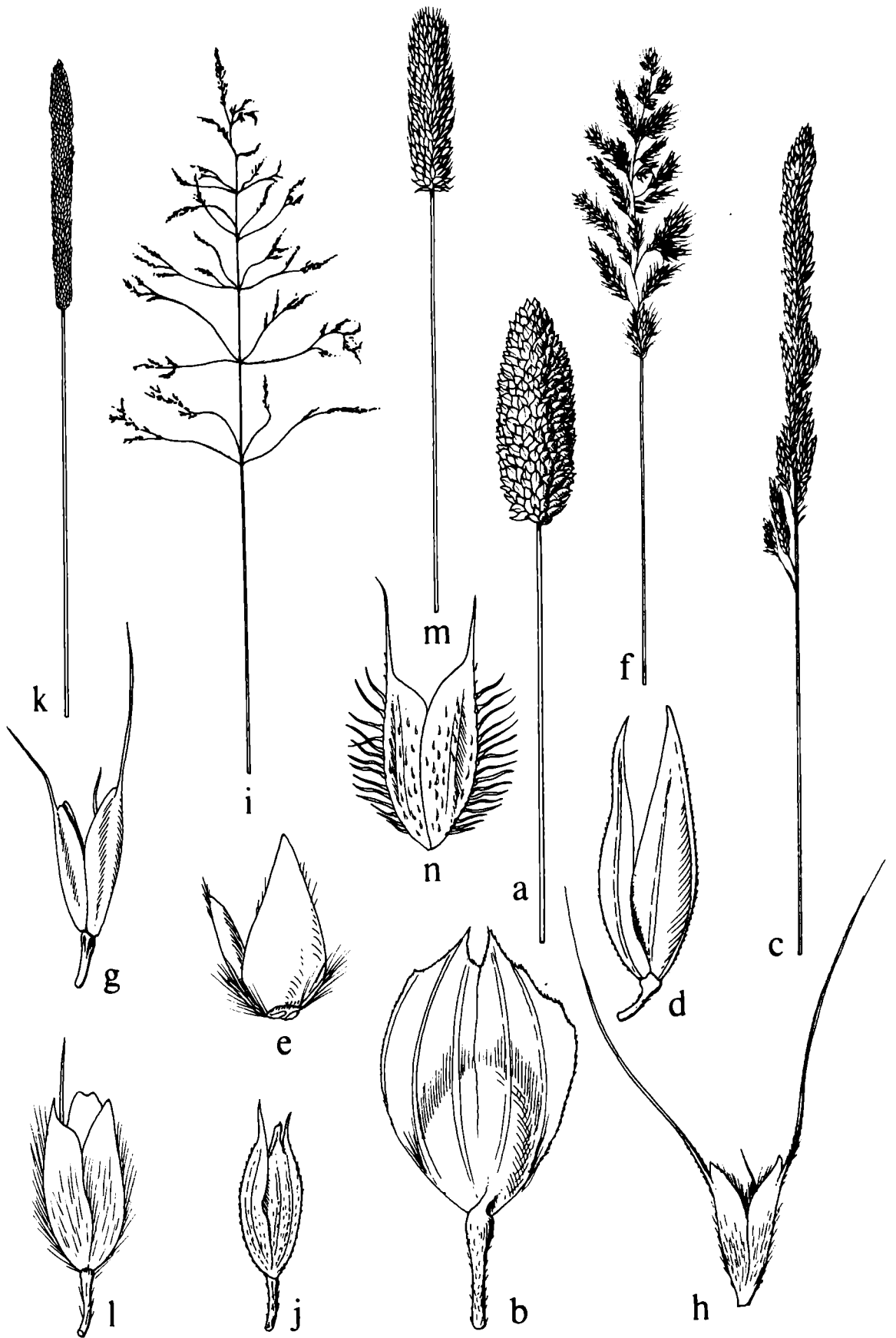
Probably a recent introduction. Parker (1992) noted that although presently localised it has the potential, with increased use of fertilisers, to become a serious problem.

2. P. arundinacea L. var. **arundinacea**. Eng. *reed canary grass*. Fig. 24c–e.

Tufted perennial, rhizomes short. Culms to 150cm, erect. Culm leaves to

FIG. 24.

a–b, **Phalaris minor**: a, infl. ($\times \frac{2}{3}$); b, spikelet ($\times 6$). c–e, **P. arundinacea**: c, infl. in dry condition ($\times \frac{1}{3}$); d, spikelet ($\times 6$); e, fertile floret (palea on left, lemma on right, with two hairy basal rudimentary florets ($\times 8$)). f–g, **Polypogon fugax**: f, infl. ($\times \frac{2}{3}$); g, spikelet ($\times 8$). h, **P. monspeliensis**: spikelet ($\times 8$). i–j, **Cyathopus sikkimensis**: i, infl. ($\times \frac{1}{4}$); j, spikelet ($\times 8$). k–l, **Alopecurus aequalis**: k, infl. ($\times \frac{2}{3}$); l, spikelet ($\times 8$). m–n, **Phleum alpinum**: m, infl. ($\times \frac{2}{3}$); n, spikelet ($\times 6$). Drawn by Louise Olley.



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7 or more, blades 15–45cm, 0.7–1.8cm wide, lanceolate, veins rough; ligule 5.5–8mm. Panicle whitish-green to pale purplish, to 20 × 2cm, narrowly cylindrical, laxer below, branches suberect, spreading at anthesis. Spikelets 4.6–5.6mm, narrowly lanceolate before anthesis. Glumes 4.7–5.4mm, each side oblong-lanceolate, c.1mm wide, acuminate, keels unwinged, minutely hispid. Sterile florets 2, lemmas 1.1–1.4mm. Fertile floret: lemma cream-coloured, shining, 3.2–4.4mm, each side lanceolate, 0.8–1.1mm wide, thinly chartaceous, margins ciliate above, sparsely hairy above; palea 3–3.2mm, each side c.0.5mm wide, thinly chartaceous, margins narrowly hyaline, keel ciliate. Grain pale brown, c.3 × 0.9mm, lanceolate, compressed, appressed-hairy. Anthers c.1.5mm.

Bhutan: C — Thimphu district (Paro to Lango); **Darjeeling** (Darjeeling Town). Damp slopes and roadside ditches, 2150–2200m. May–July.

Doubtfully native.

var. **picta** L. Eng: *gardener's garters*

Differs from the typical variety in having variegated leaves (with longitudinal, cream striations); commonly a smaller plant.

Bhutan: C — Thimphu (Thimphu Post Office) and Mongar (Mongar Town) districts; **Sikkim** (Yoksam Village, Gangtok). Cultivated in gardens for ornament.

40. AGROSTIS L.

Tufted perennials, sometimes rhizomatous or stoloniferous. Culms leafy, erect or geniculately ascending, sometimes scrambling, sometimes branched near base. Basal leaves often narrower than culm leaves. Culm leaf blades flat or inrolled; ligules membranous. Infl. a panicle, branches ± whorled, usually spreading at anthesis and then appressed, sometimes appressed at flowering when panicle linear and spike-like. Spikelets usually under 4mm, single-flowered, gaping, disarticulating above glumes, callus usually glabrous, penicillate rachilla rudiment occasionally developed. Glumes usually equalling spikelet, ± lanceolate, equal to unequal, keeled, 1-veined, papery. Lemma usually shorter than glumes, widely oblong-elliptic, strongly convex, weakly 5-veined, outer veins sometimes developed into apical setae, glabrous or hairy, usually hyaline, unawned or awned, awn (when present) geniculate. Palea hyaline, sometimes minute.

1. Lemma awned	2
+ Lemma unawned	6

2. Lemma hairy **13. A. pilosula**
+ Lemma glabrous 3
3. Lemma with two apical setae; hairy rachilla rudiment developed
9. A. triaristata
+ Lemma lacking apical setae; rachilla rudiment not developed 4
4. Awn arising from upper part of lemma **10. A. hookeriana**
+ Awn arising from middle or lower part of lemma 5
5. Infl. lax, branches obvious; plant stoloniferous **11. A. vinealis**
+ Infl. dense, linear, branches short, appressed; plant tufted .. **12. A. ushae**
6. Penicillate rachilla rudiment present 7
+ Rachilla rudiment absent 8
7. Glumes equal, shorter than lemma, the lower usually under 2mm;
callus hairs to 1mm; sheaths of culm leaves smooth **1. A. petelotii**
+ Glumes unequal, exceeding lemma, the lower usually over 2.5mm;
callus hairs usually over 1.8mm; sheaths of culm leaves scabrid
2. A. zenkeri
8. Panicle linear **7. A. inaequiglumis**
+ Panicle not linear 9
9. Spikelets small, usually under 1.7mm; glumes subacute; palea to
0.5mm, less than half length of lemma; anthers to 0.5mm 10
+ Spikelets usually c.2mm; glumes acute or acuminate; palea usually
over 0.5mm, more than half length of lemma; anthers larger 11
10. Glumes persistent; plant not scrambling **4. A. micrantha**
+ Whole spikelet deciduous; plant large, scrambling **6. A. brachiata**
11. Plant rhizomatous **5. A. capillaris**
+ Plant stoloniferous or tufted 12
12. Plant tufted; panicle open; native **3. A. nervosa**
+ Plant with leafy stolons; panicle contracted; introduced
8. A. stolonifera

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1. **A. petelotii** (Hitchcock) Noltie; *Deyeuxia abnormis* Hook. f. (p.p. – Khasia plants). Fig. 25a–d.

Densely tufted. Culms 11–49cm, slender, erect. Basal leaves erect, short (2–6cm), filiform. Culm leaf blades 3–7.5cm, inrolled and very narrow (c.0.5mm wide) or flat (to 3mm wide), acute, scabrid on upper surface and on veins beneath; sheaths smooth on ribs; ligule blunt, 1.5–2.5mm. Infl. usually tinged purplish, 7–16cm, branches spreading at maturity so infl. laxly pyramidal, branches filiform, lowest in whorls of 2–6, the longest 3–10cm, naked in lower $\frac{1}{3}$ or $\frac{1}{2}$, secondary branches usually short. Spikelets 2–2.5mm. Glumes equal or subequal, usually shorter than spikelet; the lower often purple, 1.8–2.3mm, oblong-lanceolate, subacute, keel hispid; the upper larger (2.8–2.3mm). Callus shortly hairy, hairs to 1mm, minute penicillate rachilla rudiment developed (closely appressed to palea in immature florets), 0.9–2mm to tip of apical hairs. Lemma unawned, 1.9–2.3mm, lanceolate, acute or denticulate, glabrous. Palea 1.3–1.6mm, more than half length of lemma. Anthers 0.5–0.7mm.

Bhutan: S — Deothang district (Wamrong); C — Thimphu (Motithang to Phajoding, hill above Thimphu Hospital, Chenkaphug), Punakha (Nobding to Phubjikah), Tongsa (Tongsa, Chendebi), Bumthang (Thangbi, Kiki La, Batpalathang), Mongar (Sengor) and Tashigang (Yonpu La) districts. Open blue pine forest; pasture; disturbed places by tracks and roadsides, wet or dry, 2300–3350m. July–September.

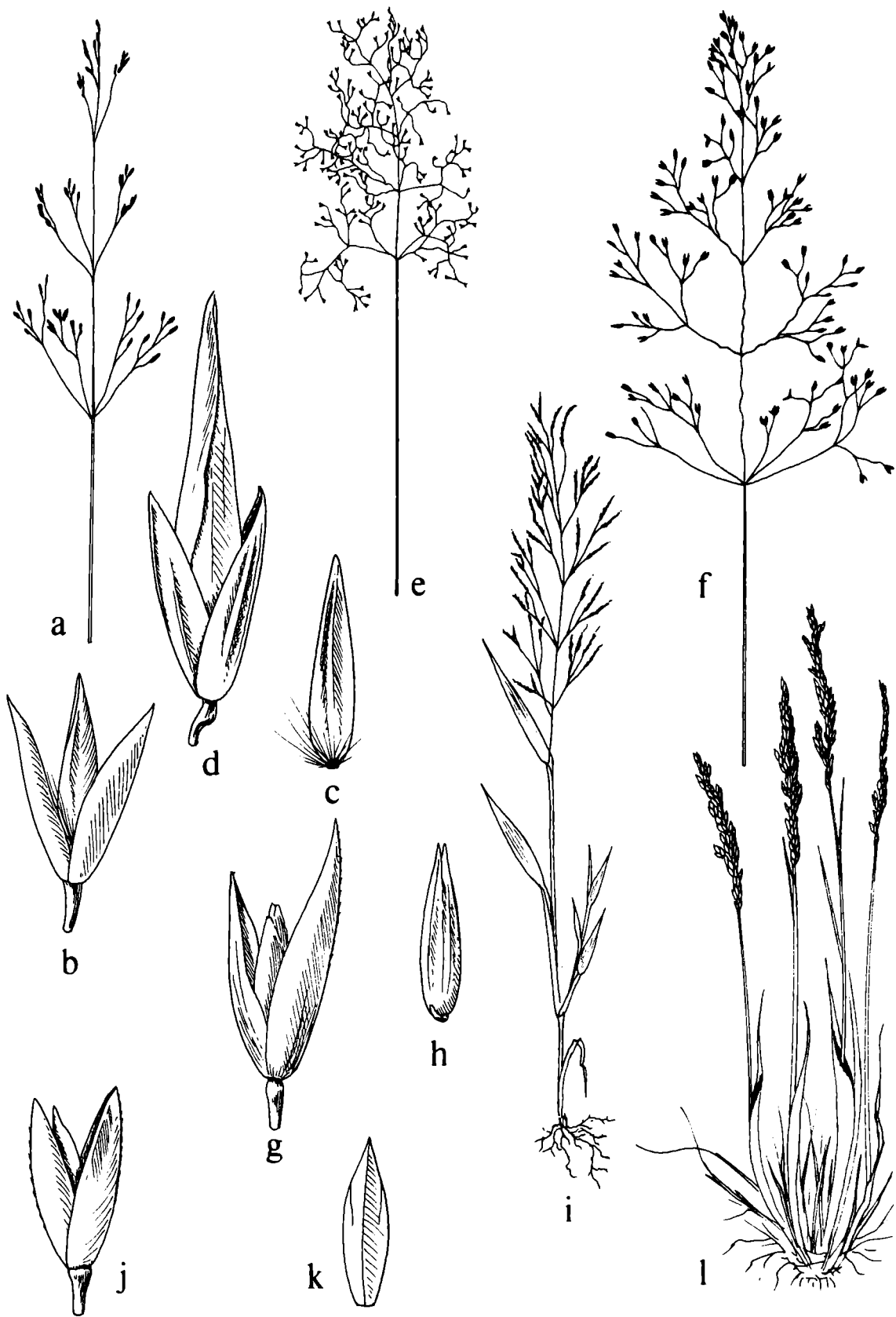
Several specimens have the florets infected with the nematode *Anguina agrostis* which causes the lemma to become abnormally elongated (Fig. 25d).

2. **A. zenkeri** Trinius; *Deyeuxia abnormis* Hook. f. (p.p. – Sikkim plants), *A. nagensis* Bor. Fig. 25e.

Differs from *A. petelotii* as follows: loosely tufted; culms stouter, often scrambling, 33–92cm, sometimes branched; culm leaf blades flat, 9–24 × 2–5mm, sheaths hispid, with downward-pointing scabridities on ribs; infl. larger (7.5–)13–32cm, very effuse, with secondary and tertiary branches well-developed; spikelets larger, 2.6–3.4mm; glumes nearly always exceeding floret, lanceolate-acuminate, unequal, the lower 2.6–3.4mm, the upper 2.5–3.1mm; callus hairs longer ((1.3–)1.8–2.5mm); rachilla more strongly developed, densely hairy, 1.8–2.6mm to tip of longest hairs.

FIG. 25.

a–d, **Agrostis petelotii**: a, infl. ($\times \frac{2}{3}$); b, spikelet ($\times 10$); c, floret ($\times 10$); d, spikelet infected with *Anguina* ($\times 8$); e, **A. zenkeri**: infl. ($\times \frac{1}{4}$). f–h: **A. nervosa**: f, infl. ($\times \frac{2}{3}$); g, spikelet ($\times 12$); h, floret ($\times 12$). i–k, **A. micrantha**: i, habit ($\times \frac{1}{4}$); j, spikelet ($\times 12$); k, floret ($\times 12$). l, **A. inaequiglumis**: habit ($\times \frac{2}{3}$). Drawn by Louise Olley.



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Bhutan: C — Ha (W side of Chelai La), Thimphu (above Motithang, above Serbitang, below Phajoding, hill above Thimphu Hospital), Tongsa (Rukubji to Pele La), Bumthang (Thangbi) and Mongar (Namning) districts; **Sikkim** (unlocalised Kurz specimen). Blue pine and spruce forest; rough grassland; alpine turf among dwarf rhododendron; cliffs in broad-leaved forest, 2600–3600m. September–October.

3. *A. nervosa* Nees ex Trinius; *A. clarkei* Hook. f.; incl. *A. sikkimensis* Bor (*A. divaricata* Grisebach, non Hoffman). Fig. 25f–h.

Tufted perennial. Culms 5–27cm, erect. Basal leaves similar to culm leaves. Culm leaf blades 1.9–9.5cm, 1–2.8mm wide, flat or inrolled, linear or filiform, acute, usually minutely scabrid on veins at least above; sheaths smooth; ligule truncate 1.5–2.7mm. Infl. usually dark purple 1.6–23cm, branches spreading widely at maturity so infl. pyramidal to widely cylindrical, branches filiform, lowest in whorls of up to 5, the longest 0.6–6.5cm, naked in lower half. Spikelets (1.7–)2–3.5mm. Glumes unequal; the lower dark purple, (1.7–)2–3.5mm, lanceolate, acuminate, margins hyaline, keel hispid; the upper shorter ((1.5–)1.75–3mm). Callus glabrous. Lemma unawned, (1.2–)1.35–1.8mm, oblong-lanceolate, truncate, glabrous. Palea (0.2–)0.3–0.5mm, less than half length of lemma. Anthers 0.5–0.7mm.

Bhutan: S — Chukka district (above Gedu); C — Thimphu (mountain E of Thimphu, E side of Chelai La, Dochu La), Punakha (S side of pass between Nobding and Phubjikah), Mongar district (Thruming La) and Sakden (Mera) districts; N — ?Upper Mo Chu district (Langshi [?Lingshi] Hill); **Darjeeling** (Tonglu); **Sikkim** (N of Dzongri, Phune to Yakche, Natu La, Kyanglasha, Tukola, Lachung, Yumthang, Lachen, Nathang, Kangling, Kopup, Tsomgo, Karponang, Chumunko). Open *Abies* forest; marsh in *Abies/Rhododendron* forest; wet sand and gravel; rough yak pasture with scattered dwarf bamboo, 2590–4270m. July–September.

A. sikkimensis cannot be maintained, it is merely a starved form (analogous to high altitude forms of *A. pilosula*) with a very delicate infl., small spikelets and filiform leaf blades and is connected to typical *A. nervosa* by intermediates.

4. *A. micrantha* Steudel; *A. myriantha* Hook. f.; *A. himalayana* Bor. Name at Lachung (?Nep): *charampo*. Fig. 25i–k.

Tufted perennial. Culms 13–84cm, leafy, geniculately ascending, sometimes rooting from lower nodes. Basal leaves \pm lacking at flowering. Culm leaf blades 3.5–14cm, 2.5–7.5mm wide, flat, lanceolate, acute, usually minutely scabrid on veins above and beneath; sheaths smooth, or minutely scabrid on ribs; ligule short and truncate (to 2.2mm) or longer and narrowing upwards (to 4.9mm). Infl. greyish or purplish, 5–19cm, branches spreading at anthesis so infl. widely cylindrical, appressed after flowering, branches filiform, lowest

in whorls of up to 8, the longest 1.6–11cm, naked in lower half. Spikelets 1.2–1.7(–2)mm. Glumes equal or subequal; the lower often purple, 1.1–1.7mm, oblong-elliptic or oblong-lanceolate, subacute or blunt, margins hyaline, keel hispid; the upper similar (1.15–1.5mm). Callus glabrous. Lemma unawned, 1–1.4mm, oblong-elliptic or oblong-lanceolate, truncate, glabrous. Palea 0.3–0.4(–0.7)mm, up to $\frac{1}{3}$ (occasionally to $\frac{1}{2}$) length of lemma, occasionally absent. Anthers 0.4–0.5mm.

Bhutan: S — Chukka and Deothang districts; C — Thimphu, Punakha, Tongsa, Bumthang, Mongar and Tashigang districts; N — Upper Mo Chu district; **Darjeeling** (Senchal Hill, Jalapahar, Tonglu, Darjeeling, Phullalong, Phalut); **Sikkim** (Kopup, Lagyap La, Karponang, Yoksam, Islumbo, Lachen, Lachung, Bakhim). By far the commonest *Agrostis* at mid-altitudes: grassland; marshes; roadside banks; grassy places in blue pine and deciduous woodland; arable fields, 1530–3660(–3960)m. May–November.

5. *A. capillaris* L; *A. tenuis* Sibthorp. Eng: *common bent*

Differs from *A. micrantha* as follows: rhizomatous; culms with few leaves; leaf blades narrower; ligule shorter (1.1–1.5mm); spikelets larger (1.8–2.3mm); palea larger (0.7–0.9mm), almost half length of lemma; anthers larger (0.8–1.2mm).

Bhutan: C — Thimphu (Yosepang) and Tashigang (Yonphu La) districts; **Darjeeling** (Darjeeling). Lawn; disturbed, heathy grassland, 2130–2550m. June–September.

Recently (c.1980) introduced to Bhutan as a fodder plant, but the two Bhutanese specimens are atypical in having rather rigid infls.; the Darjeeling specimens are from the 19th century, and it may not have persisted there.

6. *A. brachiata* Munro ex Hook. f.

Spikelets very similar to those of *A. micrantha*, but differing in falling entire. Differs from *A. micrantha* as follows: culms taller, to 110cm, weak, scrambling; infl. very effuse (similar in shape to that of *A. zenkeri*), cylindric, to 22cm.

Bhutan: C — Thimphu district (road to Tangu Monastery). Damp *Quercus semecarpifolia* woodland, 2700m. August.

7. *A. inaequiglumis* Grisebach. Fig. 251.

Tufted ?perennial. Culms 2–19cm, slender, erect. Basal leaves short, erect, filiform. Culm leaf blades 1.4–8cm, 0.7–2mm wide, acute, minutely hispid on veins above; sheaths smooth; ligule blunt, 0.8–3mm. Infl. tinged purplish, 7–16 × 0.3–0.8cm linear, branches stiffly erect, appressed, the longest 1.1–4.5cm, bearing spikelets to base. Spikelets 1.75–2.5mm. Glumes unequal;

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the lower purple, 1.75–2.5mm, lanceolate, acuminate, margins hyaline, keel hispid; the upper shorter (1.5–2.1mm), more oblong. Callus glabrous. Lemma unawned, 1.1–1.5mm, oblong-elliptic, truncate-denticulate, glabrous. Palea 0.1–0.25mm. Anthers 0.4–0.5mm.

Bhutan: C — Ha (W side of Chelai La), Thimphu (above Phajoding, Dongsho La, Chile La), Bumthang (Kitiphu), Bumthang/Mongar (summit of Thrumsing La) and Sakden (Mera, Nyuksang La) districts; N — Upper Mo Chu district (below Phoudingi); **Sikkim** (Bijan, Yume Samdong, Tsomgo, Yakla, Dzungri, Yumthang, Lachung, Kongra Lama). Bare patches in moist, open moorland; short alpine grassland; damp, mossy streamside, 3350–4880m. July–October.

A specimen from below Barshong, 3200m (*Wood* 7101, E) is possibly a form of this species, but differs in having lemmas with a minute subapical awn.

8. *A. stolonifera* L.; *A. alba* sensu F.B.I., p.p. Eng: *creeping bent*. Fig. 26a.

Mat-forming, leafy, stoloniferous perennial. Culms 22–32cm, geniculately ascending. Culm leaf blades 6–17cm, 2–3mm wide, acute, margins hispid, glabrous; sheaths smooth; ligule narrowed above, blunt, 4–5mm. Infl. tinged purplish, 8–18.5cm, rather dense, branches appressed after anthesis, the longest 2.6–7cm, bearing spikelets almost to base. Spikelets 2.1–2.3mm. Glumes subequal; the lower purple, c.2.2mm, oblong-lanceolate, acuminate, margins hyaline above, keel hispid; the upper more oblong, c.2.1mm. Callus glabrous. Lemma unawned, c.1.8mm, narrowly lanceolate, subacute, glabrous. Palea c.1.2mm, more than half length of lemma. Anthers c.1.2mm.

Bhutan: C — Thimphu district (Thimphu). Gardens, 2300. July.

No doubt a recent introduction.

A very immature specimen from Darjeeling (Senchal, 1800m, *Sharma* 2853, K) probably belongs to this species.

9. *A. triaristata* (Hook. f.) Bor; *Calamagrostis tripilifera* Hook. f.; *C. tripilifera* var. *cumminsii* Hook. f.; *Deyeuxia triaristata* Hook. f. Fig. 26b.

Slender, tufted perennial. Culms (7–)20–40cm. Basal leaves short, filiform.

FIG. 26.

a, *Agrostis stolonifera*: habit ($\times \frac{1}{3}$). b, *A. triaristata*: floret ($\times 8$). c, *A. hookeriana*: floret showing awn inserted above middle ($\times 16$). d, *A. vinealis*: floret showing awn inserted near base ($\times 16$). e, *A. ushae*: infl. ($\times \frac{2}{3}$). f–h, *A. pilosula*: f, infl. of common form ($\times \frac{2}{3}$); g, floret ($\times 16$); h, infl. of form with large infls. ($\times \frac{1}{3}$). Drawn by Louise Olley.



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Culm leaf blades 5.5–11cm, 1.9–4mm wide, linear-lanceolate, very acute, glabrous; sheaths smooth; ligule acute, 4–5mm. Infl. green or purplish, (4.5–)8–14cm, branches spreading at anthesis so infl. laxly pyramidal, branches filiform, lowest in whorls of 2–5, the longest 3.8–8.5cm, naked in lower half. Spikelets 3.4–5.3mm. Glumes equal or subequal; the lower 3.4–5.3mm, narrowly lanceolate, finely acuminate, margins hyaline or purplish, 3-veined, keel green, hispid; the upper similar or slightly shorter (3.4–4.9mm). Callus hairy, hairs 0.6–0.9mm; rachilla rudiment developed, hairy, 1.1–1.7mm (to tip of hairs). Lemma awned, 2.4–3.1mm (excl. setae), broadly lanceolate, thinly herbaceous, apex truncate-lacerate, lateral 2 veins produced into setae 1–1.3mm, inner pair of veins minutely produced; awn arising from lower third, 1.6–2.5 + 3.6–4.7mm. Palea 2–2.4mm, linear-lanceolate, acute. Anthers 0.4–0.7mm.

Bhutan: C — Ha (W side of Chelai La), Thimphu (beyond Phajoding, above Talukah Gompa, above Hongsu, Thimphu), Bumthang (below Kitiphu) and Mongar (E side of Thrumsing La) districts; **Darjeeling** (Sandakphu, Singalila); **Sikkim** (Namnam, Tsomgo, Yumthang, Bijan, Dzongri, Phedang to Tsoka, Kopup, Chumunko, Thanggu). By paths and clearings in *Abies* forest; cliffs and boulder-strewn slopes, (2380–)3050–4270m. July–October.

One specimen (*Bor's Coll.* 782, K) has the floret infected with the nematode *Anguina agrostis* and abnormally elongated.

A specimen from Thrumsing La, 3630m (*Pradhan & Wangdi* EG 97, E) resembles this species in having a penicillate rachilla rudiment but differs as follows: apparently rhizomatous; leaves narrower; lateral veins of lemma not produced into setae, awn of lemma inserted just below halfway; callus hairs shorter (c.0.5mm); rachilla rudiment much longer (to 3.8mm to tip of apical hairs). It probably represents an undescribed species, but further collections are required.

10. *A. hookeriana* C.B. Clarke ex Hook. f. Fig. 26c.

Slender, tufted perennial. Culms 7–50cm. Culm leaf blades 1.5–10cm, 0.5–2.1mm wide, linear-lanceolate, acute, glabrous; sheaths smooth; ligule truncate-lacerate, 1.5–3mm. Infl. usually dark purple, 3–16cm, branches spreading at anthesis so infl. laxly pyramidal, branches filiform, lowest in 2s or 3s, the longest 1.5–9cm, naked in lower half. Spikelets 2.6–3.2mm. Glumes unequal; the lower purple, 2.6–3.2mm, lanceolate, acuminate, keel hispid; the upper shorter (2.3–2.6mm), more oblong, margins ciliate near apex. Callus minutely hairy at base of lemma margins. Lemma awned, 1.5–1.9mm, broadly elliptic, truncate, surface sometimes minutely rough; awn arising from half-way or above, 1.2–1.5 + 1.8–2.3mm. Palea absent or extremely small (to 0.3mm). Anthers 0.6–0.9mm.

Bhutan: C — Thimphu (above Talukah Gompa, above Phajoding, Shodu to Barshong, hill above Thimphu Hospital) and ?Sakden (near Nyak Ching La) districts; N — Upper Mo Chu district (Yale La, Ngile La, E bank of Tharizam Chu); **Sikkim** (Dzongri to Prek Chhu, Changu, Tuko La, Jelep La, Neerkhola, Lingmuthang, Chamnago, Lachung, Yumthang, Lachen, S of Thangshing). Open, wet moorland and grassland; on banks and by paths in *Abies/Rhododendron* forest, (2440–)3050–4570m. July–October.

11. *A. vinealis* Schreber; *A. canina* L. subsp. *montana* (Hartman) Hartman. Eng: *brown bent*. Fig. 26d.

Differs from *A. hookeriana* as follows: rhizomatous; awn weaker and shorter, arising from lower half of lemma.

Darjeeling (Darjeeling). Habitat not recorded, 2130–2190m. May–July.

Three old, inadequate specimens appear to belong to this species, but differ from typical material in having larger paleas (to 1mm). More collections are required. Probably introduced.

12. *A. ushae* Noltie. Fig. 26e.

Differs from alpine forms of *A. hookeriana* as follows: culm leaf blades wider (over 2mm); infl. branches stiffly appressed at anthesis so infl. dense and spike-like (thus resembling *A. inaequiglumis*); glumes broader; awn of lemma inserted below halfway.

Sikkim (Upper Lasha Chhu valley). Shallow runnels at edge of stream, 4545m. July.

13. *A. pilosula* Trinius; *Calamagrostis pilosula* (Trinius) Hook. f. Sikkim name (?Lepcha): *pandaysibchay*. Fig. 26f–h.

Slender, tufted perennial. Culms 7–66cm. Culm leaf blades 2.8–37cm, 1.8–5.5mm wide, linear-lanceolate, acute, glabrous; sheaths smooth; ligule truncate-lacerate, 1.4–3mm. Infl. brownish, greenish or dark purple, 4.5–23cm, branches spreading at anthesis so infl. laxly pyramidal, branches filiform, lowest in 2s, 3s or more, the longest 2–12.5cm, naked in lower $\frac{1}{3}$ or $\frac{1}{2}$. Spikelets 2–3.7mm. Glumes subequal; the lower often purple, 2–3.7mm, lanceolate, acuminate, margins minutely ciliate near apex, keel hispid; the upper similar (1.9–3.4mm). Callus glabrous. Lemma awned, 1.5–2.3mm, widely lanceolate to broadly oblong, subacute to truncate, surface covered with long, white hairs; awn arising from below halfway, 1–1.5 + 1.7–3.6mm. Palea 0.4–0.8mm, less than half length of lemma. Anthers 0.5–1mm.

Bhutan: C — Ha (W side of Chelai La), Thimphu (hill above Thimphu Hospital, Phajoding, Chelai La), Punakha (Wacha to Nobding), Bumthang (Kitiphu, Thangbi) and Mongar (near Mongar, Yonko La to Namning)

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districts; N — Upper Mo Chu (Laya, Jangothang, SW of Lingshi Dzong) and Upper Pho Chu (Cheriphu) districts; **Darjeeling** (Toong Soong), **Sikkim** (Lachen, Lachung, Dzungri, Yumthang, Yume Samdong, Domang, Karponang, Tsomgo, Tukola, Kopup, Yakla, Neebay). Cliffs and rock-ledges; alpine pasture; open, blue pine and fir forest; river bank under *Salix*, 1800–4880m. July–October.

A very variable species occurring over a wide altitudinal range. Bor divided Himalayan material into four varieties, but there are problems with his nomenclature. The majority of our specimens would fall under his 'var. *royleana*' and those with very large infls. (Fig. 26h) from Neebay (*Clarke* 25340, E) and Mongar district (*Wood* 6004; *NPSW* 206, E) to his 'var. *pilosula*'. The most distinctive form is that from high altitude with a short, lax, pyramidal infl. with stiffly spreading branches and very small, purple spikelets which Bor mistakenly called 'var. *wallichiana*'.

Doubtfully recorded species:

A. gigantea Roth

Recorded for Darjeeling (Darjeeling, 2000m, Ghum-Kurseong, 2200m) in F.E.H.1, but no specimens seen. This species might well occur as an introduction. It is similar to *A. stolonifera* but differs in being rhizomatous and having the infl. open after anthesis. Similar also to *A. capillaris*, from which it differs in having culm leaves with longer ligules.

41. CALAMAGROSTIS Adanson (incl. *Deyeuxia* Clarion ex P. Beauvois)

Tufted perennials, sometimes rhizomatous or stoloniferous. Basal leaves flat or inrolled. Culms erect or geniculately ascending, leafy, leaf blades flat or inrolled; ligule membranous. Infl. a panicle, branches \pm whorled, spreading or appressed. Spikelets usually over 4mm, gaping, disarticulating above glumes, floret 1, callus hairy, hairs shorter than to exceeding lemma, penicillate rachilla rudiment sometimes developed. Glumes equalling or shorter than spikelet, \pm lanceolate, equal to unequal, keeled, papery; the lower 1-veined; the upper commonly 3-veined. Lemma usually shorter than glumes, \pm lanceolate, strongly convex, apex commonly irregularly toothed, weakly 5-veined, glabrous or scabrid, awned or unawned, hyaline or papery; awn geniculate or straight. Palea 2-keeled, hyaline.

A difficult genus – the species are polymorphic and merge into each other, especially species 6–11. In other parts of the world difficulties arise from hybridisation, polyploidy

and apomixis, which no doubt also occur in Bhutan. The generic limits with *Agrostis* are also problematic.

Care is needed in distinguishing between callus hairs and hairs on the rachilla rudiment; in young florets the rachilla is appressed to the palea and may be hidden by the margins of the lemma. The measurement of the rachilla rudiment is taken from the base to the tip of the longest apical hair.

1. Lemmas unawned; glumes shorter than lemma **12. C. treutleri**
+ Lemmas awned; glumes longer than lemma 2
2. Penicillate rachilla rudiment present 3
+ Penicillate rachilla rudiment absent 5
3. Awn longer than callus hairs and exerted from spikelet (longer than lower glume) 4
+ Awn about equalling callus hairs, not exerted from spikelet (shorter than lower glume) **2. C. pseudophragmites**
4. Spikelets over 5mm; awn slender (little thicker than callus hairs); anthers over 0.7mm **1. C. emodensis**
+ Spikelets under 4.5mm; awn stouter (distinct from callus hairs); anthers c.0.5mm **3. C. debilis**
5. Glumes hairy **4. C. tibetica**
+ Glumes glabrous 6
6. Awn inserted on lower part of lemma 7
+ Awn inserted about middle of lemma or above 10
7. Dwarf alpine plant (culms under 20cm); panicle usually linear **5. C. nivicola**
+ Robust plant (culms over 40cm); panicle narrowly cylindrical or with spreading branches 8
8. Infl. dense, branches appressed; spikelets over 5.5mm **9. C. arundinacea**
+ Infl. lax, branches spreading; spikelets under 5.3mm 9
9. Callus hairs almost equalling lemma **10. C. elatior**
+ Callus hairs less than half length of lemma **11. C. nagarum**

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10. Awn stout, curved or geniculate; ligule of culm leaves over 4 (to 7)mm. 11
 + Awn weak, \pm straight; ligule usually under 4mm 12
11. Glumes very scabrid all over surface, margins usually ciliate
8. *C. scabrescens*
 + Glumes smooth or scabrid only on veins near apex, margins never
 ciliate 11. *C. nagarum*
12. Panicle dense (Fig. 27i) 6. *C. lahulensis*
 + Panicle lax (Fig. 27k) 7. *C. filiformis*

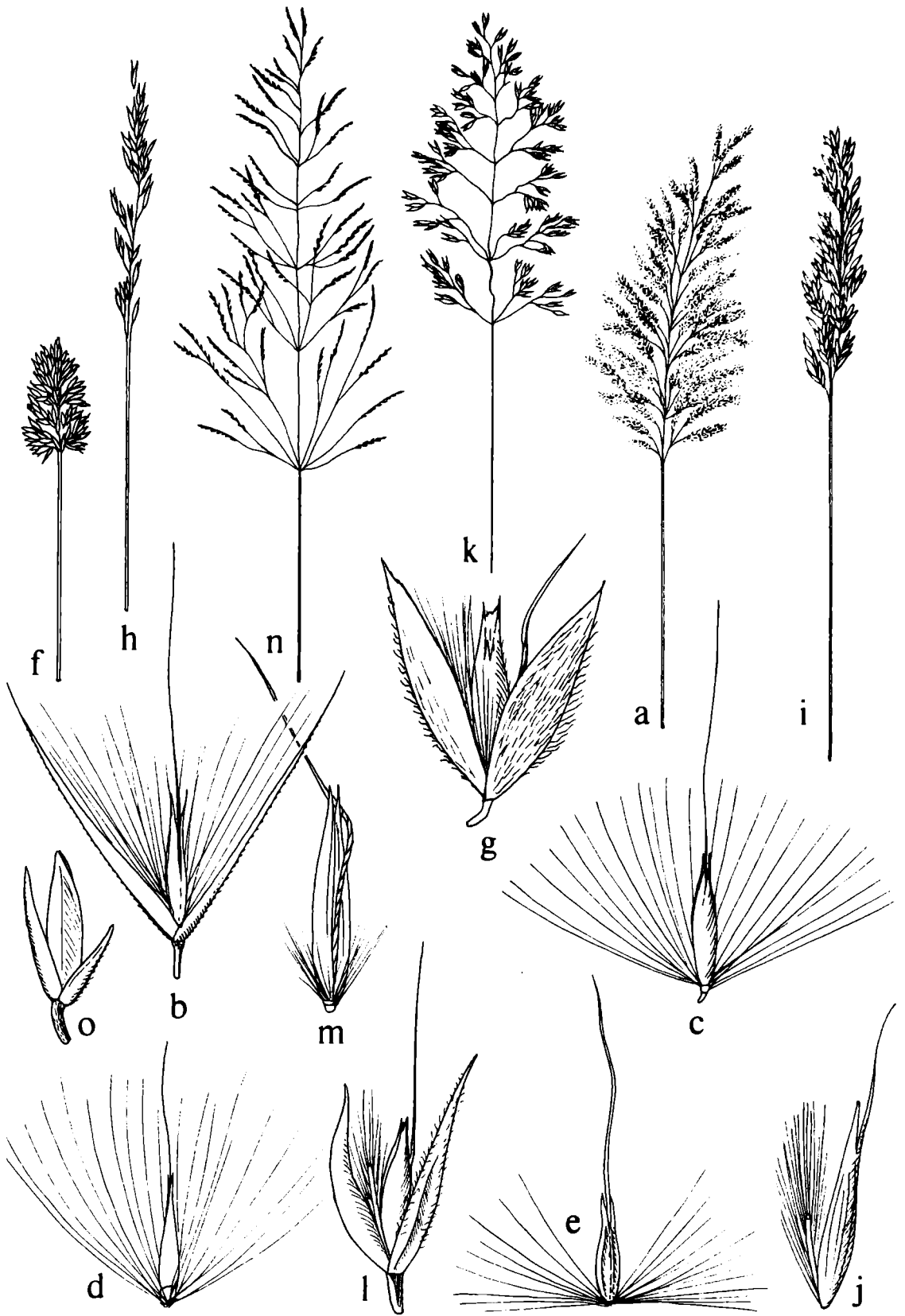
1. *C. emodensis* Grisebach. Fig. 27a-c.

Rhizomatous. Culms 55–111cm, geniculately ascending, stout (to 0.5cm wide near base), leafy; leaf blades 27–52 × 0.4–1.2cm, flat, narrowly oblong, acute, scabrid on veins especially above; sheaths scabrid on veins; ligule 1.5–5mm, truncate or rounded, denticulate. Infl. greenish turning purple, finally plumose from white callus hairs, drooping, 14–26.5cm, widely cylindrical to slightly pyramidal, dense, branches slender, naked near base, lowest whorl of 3–10 branches, the longest 9–14cm. Spikelets (5–)5.5–7.4mm. Glumes unequal, linear, finely acuminate, sides hyaline or tinged purple, keel green, hispid, surface scabrid; the lower (5–)5.5–7.4mm, 1-veined; the upper (4.2–)4.7–6.2mm, 3-veined. Callus hairs 4.1–5.1mm, exceeding lemma; rachilla rudiment absent, or minute and glabrous (0.1–0.4mm). Lemma awned, (2.1–)2.3–2.7mm, oblong, glabrous, hyaline, apex deeply notched (apical teeth 0.9–1.3mm); awn arising from apical notch, 4.5–8mm, exceeding lower glume, slender, \pm straight. Palea (1.4–)1.6–2.3mm, linear, acute, keels scabrid near apex. Anthers 0.7–1mm.

Bhutan: S — Chukka district (above Gedu); C — Thimphu (Paro, Dotena), Punakha (E side of Dochu La), Tongsa (W side of Yuto La), Bumthang (E side of Yuto La) and Mongar (E side of Thrumsing La) districts; N — Upper Mo Chu (on way to Laya, N of Kohina) and Upper Kuru Chu (Julu) districts; **Sikkim** (Nathang, Lachung, Karponang, Yumthang, Tsomgo). Common on

FIG. 27.

a-c, *Calamagrostis emodensis*: a, infl. ($\times \frac{1}{4}$); b, spikelet ($\times 6$); c, floret ($\times 6$). d, *C. pseudophragmites*: floret ($\times 6$). e, *C. debilis*: floret ($\times 6$). f-g, *C. tibetica*: f, infl. ($\times \frac{2}{3}$); g, spikelet ($\times 6$). h, *C. nivicola*: infl. ($\times \frac{2}{3}$). i-j, *C. lahulensis*: i, infl. ($\times \frac{2}{3}$); j, floret ($\times 6$). k, *C. filiformis*: infl. ($\times \frac{1}{3}$). l, *C. scabrescens*: spikelet ($\times 6$). m, *C. arundinacea*: floret ($\times 6$). n-o, *C. treutleri*: n, infl. ($\times \frac{1}{4}$); o, spikelet ($\times 6$). Drawn by Louise Olley.



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landslides in the fir zone; wet cliffs and streamsides in *Tsuga*/broad-leaved and *Abies*/rhododendron/birch forest; banks and gravel by rivers, 2590–3660m. August–November.

A small, glabrous rachilla rudiment is sometimes present - such specimens have been separated as *C. garwhalensis* Hubbard & Bor, but are not worth recognising.

2. *C. pseudophragmites* (Haller f.) Koeler; *C. littorea* P. Beauvois. Fig. 27d.

Similar to *C. emodensis*, but differs as follows: ligule longer (6–13mm); glumes wider (the lower c.0.9mm wide); awn shorter (1.7–3.3mm), scarcely exceeding the callus hairs, very slender, shorter than lower glume; apical teeth of lemma shorter, 0.2–0.5mm; palea shorter (1.3–1.8mm), truncate; anthers longer, 1–1.8mm.

Bhutan: C — Thimphu (Drukyl, common around Thimphu), Tongsa (Chendebi), Bumthang (Bumthang) and Tashigang (Yondiri Bridge, Yonphu La) districts; **Darjeeling** (above Mungpo, Tukvar Road, Darjeeling); **Sikkim** (Lachen, Myang Chu). Common at mid-altitudes in open places: banks and field borders; low-lying grassy area; gravel by river; wet cliffs and marshes, 1615–2600m. July–November.

3. *C. debilis* Hook. f.; *Agrostis debilis* (Hook. f.) Bor; *A. neodebilis* Bennet & Raizada. Fig. 27e.

Presumably rhizomatous. Culms 18–27.5cm, \pm erect, slender (c.1mm wide near base), sparsely leafy; leaf blades 2–4.2cm, flat, linear, acute; sheaths glabrous, minutely scabrid on veins above; ligule 1.6–2.1mm, truncate-lacerate. Infl. light purplish-brown, erect, 3.5–10.5cm, narrowly cylindrical, branches slender, erect, naked near base, lowest whorl of 2–5 branches, the longest 2.5–3cm. Spikelets c.4.2mm. Glumes subequal, lanceolate, acuminate, 1-veined, sides papery, tinged purple, keel hispid above; the lower c.4.2 \times 1.1mm; the upper c.4 \times 0.9mm. Callus hairs to 3.7mm, exceeding lemma; rachilla rudiment absent. Lemma awned, c.2.2mm, broadly lanceolate, glabrous, hyaline, apex minutely toothed; awn inserted just below apex, c.1.2 + 4.2mm, exserted, geniculate. Palea c.2mm, linear-lanceolate, acute. Anthers small, c.0.5mm.

Sikkim (Chola). Habitat not recorded, 3350m. November.

Known only from the type collected by Hooker.

4. *C. tibetica* (Bor) G. Singh; *Deyeuxia tibetica* Bor. Fig. 27f–g.

Rhizomes slender, spreading. Leaves mainly basal, blades 3.5–8cm, erect, linear, blunt, inrolled (0.7–2mm wide), hispid on veins above and beneath; sheaths papery, persistent. Culms 8–19cm, erect, slender, usually 2-leaved;

leaf blades small, 1–3.7cm, inrolled, 0.6–1mm wide, hispid beneath; sheaths inflated, shortly hairy; ligule 1.6–4.5mm, shortly hairy on back. Infl. dark purple, tips of spikelets silvery, erect, 1.5–2.5 × 1.2–1.4cm, densely cylindric, branches congested, not distinct, all about equal (to 0.7cm). Spikelets c.4.3mm. Glumes 4.3–4.5 × 1.3–1.5mm, subequal, oblong-elliptic, submucronate, keels long-ciliate around middle, sides papery, dark purple, scabrid, margins hyaline or golden; the lower 1-veined; the upper 3-veined. Callus hairs to 2.4mm, shorter than lemma; rachilla rudiment penicillate, 3.5–3.9mm. Lemma awned, streaked purple, c.3.4mm, oblong-lanceolate, glabrous, papery, apex truncate-erose; awn inserted 0.3–0.6mm above base, 1.7–2 + 2.6–2.7mm, exserted, stout, geniculate, column twisted. Palea streaked purple, 2.6–3.1mm, oblong, keels produced into minute points. Anthers c.2mm.

Sikkim (Chakalung La, Chholhamoo). Habitat not recorded, [presumably sandy/gravelly plains], 4880–5140m. August–September.

5. *C. nivicola* (Hook. f.) Handel-Mazzetti; *Deyeuxia nivicola* Hook. f. Fig. 27h.

Rhizomes slender, spreading. Leaves mainly basal, blades erect, 3–12.5cm, flat or inrolled (to 1.4mm wide), linear, blunt, margins hispid, minutely scabrid on veins above. Culms 5–20cm, erect, slender, 2–3-leaved; leaf blades small, 1.5–6cm, inrolled, 0.4–1.2mm wide, scabrid on veins above; sheaths narrow, glabrous; ligule 1.7–3mm, blunt, sometimes shortly hairy on back. Infl. dark purple and green, erect, 2.5–7.1 × 0.5–1cm, linear (occasionally narrowly cylindric), branches short, erect, lowest in whorls of 2–6, the longest 1.3–2.2cm. Spikelets 4.7–7.3mm. Glumes dark purple, unequal, sides papery, minutely scabrid above; the lower 4.7–7.3mm, narrowly lanceolate, acuminate, 1-veined; the upper 4.6–6.6mm, oblong-lanceolate, acute, 1-veined. Callus hairs short, 0.7–1.1mm; rachilla rudiment penicillate, 2.2–3.1mm. Lemma awned, 3.1–4.2mm, oblong-lanceolate, thickly herbaceous, surface scabrid, apex 4-toothed; awn inserted 0.2–0.4mm above base, 2.6–3.5 + 2.8–4.2mm, usually exserted, stout, geniculate, column twisted. Palea 1.9–2.6mm, linear-lanceolate, apex 2-toothed. Anthers 0.7–0.8mm.

Bhutan: C — Thimphu district (above Phajoding Monastery, mountain E of Thimphu, Chelai La); **Sikkim** (Jelep La, Kopup, Chugya). Open, dry, grassy mountain-tops, 3500–4880m. July–September.

6. *C. lahulensis* G. Singh; *C. pulchella* Grisebach, non Sauter ex Reichenbach; *Deyeuxia pulchella* Hook. f. Fig. 27i–j.

Rhizomes slender, spreading. Leaves mainly basal, blades erect, 3–13cm, 0.5–3mm wide, inrolled or sometimes flat, linear, acute, minutely scabrid on veins; sheaths papery, persistent. Culms 7–60cm, erect, slender (1–2mm wide near base), 2–3-leaved; leaf blades small, 1.9–9cm, 0.7–2.6mm wide, inrolled

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or sometimes flat, scabrid on veins; sheaths narrow, scabrid on veins; ligule 2–4.2mm, blunt, sometimes scabrid on back. Infl. dark purple (becoming plumose from white callus hairs), erect, 3.3–10(–19) × 1–3.5cm, narrowly cylindrical, dense, branches short, erect, naked for less than half length, often bearing spikelets to base, lowest in whorls of 1–5, the longest 1–5.4cm. Spikelets 3.7–5.7mm, hyaline-tipped. Glumes dark purple, equal or subequal, lanceolate, acuminate, 1-veined, surface sometimes minutely scabrid above, margins hyaline, sides papery; the lower 3.7–5.7mm; the upper 3.5–5.5mm. Callus hairs 0.9–2.3mm; rachilla rudiment penicillate, 3.4–5.5mm. Lemma awned, 2.8–4.8mm, lanceolate, papery, surface sometimes scabrid, apex irregularly 4-toothed; awn commonly subapical (sometimes inserted as low as half-way), 1.7–5mm, slender, exerted, scarcely curved. Palea 2–3.2(–3.5)mm, linear, blunt. Anthers 1.4–2.3mm.

Bhutan: C — Ha (W side of Chelai La), Thimphu (Chelai La, Phajoding, hill E of Thimphu), Mongar (near Trimpen La) and Sakden (Meesa Valley, Dammonchung) districts; N — Upper Mo Chu (Ngile La, Jangothang, Yale La, Lingshi, E bank of Tharizam Chu, Laya, Timuzam to Phoudingi) and Upper Pho Chu (Cheriphu) districts; **Darjeeling** (Sandakphu); **Sikkim** (Yume Samdong, Kankola, Lachen, Yumthang, Kongra Lama, Dzungri, Yakla, Lhonak, Thanka La, Kopup, Natu La, Jelep La, above Sebu Chho); **Chumbi.** Alpine meadows and hill-tops, sometimes among scrub (incl. juniper); moraine ridge and river shingle; moorland bog, (2380–)3050–4830m. July–October.

When placed in *Calamagrostis* a name change regrettably becomes necessary; the epithet is unfortunate given the wide distribution of this Sino-Himalayan species.

Forms in which the spikelets are infected with the nematode *Anguina agrostis* have abnormally large floral parts (lower glume 5.8–7.8mm; upper glume 6.6–9.3mm; lemma 7–8.5mm) and an almost glabrous callus. These have been recorded from Sikkim: Dzungri (Clarke 25767, K) and Samiti Lake (ESIK 676, E).

A very polymorphic species which grades into *C. scabrescens*. A specimen from Upper Pho Chu district (Gafoo La, 4420m. LSH 16761, E, BM) differs in having very short (c.0.5mm) lemma awns.

7. C. filiformis Grisebach; *C. scabrescens* var. *humilis* Grisebach; *D. pulchella* var. *laxa* P.C. Kuo & S.L. Lu. Fig. 27k.

Resembles *C. lahulensis* in its spikelets (size and slender awn) but differs as follows: panicle lax, the longest of the lower branches naked for more than half length; leaf blades often flat.

Also resembles *C. scabrescens* from which it differs in having smaller, narrower glumes with hyaline, glabrous margins.

Bhutan: C — Thimphu district (Dotena to Barshong); **Sikkim** (Lachen,

Yume Samdong, Tsomgo, Thanggu, Phune, Dzongri, Jamlinghang to Bikbari, S of Thangshing). Heathy banks and stony slopes, often among scrub; stream- and riversides in fir zone, 3350–4000m. July–October.

A problematic taxon, easily recognised (at least in the herbarium) by its lax infl. In many ways it is intermediate between *C. lahulensis* and *C. scabrescens* which are, in any case, separated with difficulty. Specimens with long, cylindric infls. and green spikelets agree with the type of *C. scabrescens* var. *humilis*, but their spikelets are closer to *C. lahulensis*. Specimens with shorter, more pyramidal infls. match the type of *C. filiformis* (which was separated on the trivial character of the shape of the lemma apex); these commonly have dark purple glumes and are distinguishable from *C. lahulensis* only on infl. shape. Further work is clearly required (for example to determine if hybridisation is occurring), but it seems best in the meanwhile to treat them as distinct taxa.

A distinct form of this lax-panicked form with very small spikelets (lower glume 3.3–3.5mm; upper glume 3.4–3.5mm; lemma 2.9–3mm; callus hairs (0.5–0.9mm) and rachilla rudiment (3–3.1mm) shorter) has been seen from Punakha (S of pass between Nobding and Phubjikah, 3000m, *Wood* 6720, E) and Upper Mo Chu (S side of Pari La, 3270m, *Sinclair & Long* 5058, E, K) districts. It probably represents an undescribed species.

8. *C. scabrescens* Grisebach; *Deyeuxia scabrescens* (Grisebach) Duthie. Nep: *thampo*. Fig. 27l. Plate 4.

Differs from *C. lahulensis* as follows: culms stouter (1.4–3mm wide at base); basal leaves longer, almost equalling culms, 11–54cm, usually flat (1.5–6.5mm wide); sheaths stout; ligules of culm leaves longer (4–7mm); infl. larger (8.5–16cm long); glumes densely scabrid on surface, with at least some marginal cilia, usually larger (lower 4.1–7mm; upper 4.1–6.3mm); callus hairs shorter (0.5–1.5mm); lemma usually longer (3.1–5.2mm), awn 4–6.7mm, stouter, strongly curved, commonly inserted at about the middle.

Bhutan: C — Thimphu (above Phajoding, Chelai La, below Shodu, Begana Bridge), Bumthang (Kitiphu, below Chudrag Gompa, W side of Thrumsing La), Mongar (Namning) and Sakden (Orka La) districts; **Darjeeling** (Sandakphu); **Sikkim** (Lachen, Yumthang, Chola, Yume Samdong, Dzongri, Phullalong, Fienngong, Tsomgo, Kyanglasha, Karponang, Kopup, Bikbari, Jamlinghang); **Chumbi**. Gravel by rivers; acid cliff; alpine pasture and shrub covered boulder slopes; bank in *Abies* forest, 2590–4000m. June–November.

Not always easily separated from *C. lahulensis*: the position of awn insertion, used by Bor, is not reliable.

9. *C. arundinacea* (L.) Roth. Fig. 27m.

Tufted; rhizomes short. Basal leaves few, to 40cm long, inrolled, scabrid

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on veins; sheaths papery, persistent. Culms 91–200cm, erect, slender to stout (1.5–3.5mm wide near base), 3-leaved; leaf blades 13–29.5cm, 1.2–7.5mm wide, inrolled, linear, scabrid on veins; sheaths narrow, scabrid on veins; ligule 6–7mm, blunt, scabrid on back. Infl. green, tinged brownish-purple, erect, 17–24 × 1.5–3cm, narrowly cylindrical, dense, branches short, erect, lowest in whorls of 3–6, the longest 4.8–7.5cm, bearing spikelets to base or naked in lower half. Spikelets 5.7–6.3mm. Glumes tinged purple, unequal, lanceolate, acuminate, thickly herbaceous, keels hispid, sides smooth or minutely scabrid; the lower 5.7–6.3mm, 1-veined; the upper 5.2–5.7mm, 3-veined. Callus hairs 1.9–2.5mm, almost half length of lemma; rachilla rudiment penicillate, 3–4mm. Lemma awned, 4.1–4.7mm, lanceolate, papery, apex 2-toothed; awn inserted on lower third (to 1.1mm from base), 1.7–2 + 4.8–5.3mm, stout, exserted, geniculate, column twisted. Palea 3.2–4mm, linear, acute or notched. Anthers 1.3–2mm.

Bhutan: C — Thimphu district (Thimphu, hill above Thimphu hospital, Yosepang, near Dobji Dzong). Clearings in *Picea* woodland; weed of potato-field; by track in blue pine forest, 2350–2900m. June–October.

Differs from European material in having longer callus hairs. The specimen from above Thimphu hospital (*Wood* 5690, E) is a monstrous form in which a second floret is developed.

10. *C. elatior* (Grisebach) A. Camus; *C. scabrescens* var. *elatior* Grisebach; *Deyeuxia elatior* (Grisebach) Hook. f. Plate 4.

Rhizomes spreading. Basal leaves sparse, 40–80 × 0.5–0.7cm, flat, scabrid on veins beneath, sparsely hairy above; sheaths papery, persistent. Culms 90–200cm, erect, stout; leaf blades to 36cm, 6–9mm wide, similar to basal ones; sheaths narrow, the lower sparsely hairy; ligule 4.5–5.5mm, blunt. Infl. pale greyish-purple, erect, 23–42 × 9–16cm, broadly cylindrical, lax, branches long, ascending, lowest in whorls of 3–6, the longest 8–16cm. Spikelets 4.9–5.1mm. Glumes tinged purple, unequal, lanceolate, acuminate, thickly herbaceous, keels hispid, sides minutely scabrid; the lower 4.9–5.1mm, 1-veined; the upper 4.5–4.8mm, 3-veined. Callus hairs 2.4–3mm, more than half length of lemma; rachilla rudiment penicillate, 3.3–4mm. Lemma awned, 3.7–4.3mm, lanceolate, papery, apex toothed; awn inserted below halfway, c.2 + 4–4.7mm, stout, exserted, geniculate, column twisted. Palea 3.1–3.5mm, linear, toothed. Anthers 1.5–2mm.

Bhutan: C — Tongsa district (around Tongsa). Scrub on steep slope in dry, open forest; damp roadside banks, 2000–2200m. September–October.

11. *C. nagarum* (Bor) G. Singh; *Deyeuxia nagarum* Bor

Similar to *C. elatior*, but differs as follows: plant more slender; culms to

95cm; leaf sheaths usually glabrous; infl. narrower (to 7cm); spikelets smaller (4.5–4.8mm); callus hairs less than half length of lemma (1.2–1.6mm). Note: the position of the awn is variable and it can be inserted either above or below halfway. Infl. and spikelets also very similar to *C. scabrescens* from which it differs in having \pm smooth glumes.

Bhutan: C — Ha (Ha to Damthang), Thimpu (above Motithang, 4km N of Chapcha) and Bumthang (2km N of Byakar Dzong) districts. Damp shady cliff in blue pine/oak forest; river bank among scrub, 2400–2840m. July–September.

12. *C. treutleri* (Kuntze) U. Shukla; *Aulacolepis treutleri* (Kuntze) Hackel; *Deyeuxia treutleri* (Kuntze) Stapf; *Aniselytron treutleri* (Kuntze) Soják; *Neoaulacolepis treutleri* (Kuntze) Rauschert. Fig. 27n–o.

Stoloniferous. Culms 47–100cm, geniculately ascending, relatively stout (to 2mm wide near base), leafy; leaf blades dull glaucous in life, drying dark green, 10.5–26 \times 0.4–1.2cm, flat, narrowly oblong, acute, scabrid on veins above and beneath; sheaths scabrid on veins; ligule 2–5mm, truncate or rounded, scabrid on back. Infl. green, 14.5–24.5 \times 7–14cm, erect, widely cylindrical to slightly pyramidal, effuse, whorls distant, branches slender, spreading at anthesis, naked near base, lowest whorl of 3–6 branches, the longest 5–13cm. Spikelets 2.3–2.9mm, glumes shorter than lemma. Glumes unequal, lanceolate, acuminate, 1-veined, keel green, hispid, sides hyaline, scabrid; the lower 1.4–2mm; the upper 2–2.7mm. Callus hairs minute, 0.1–0.3mm; rachilla rudiment 0.2–0.8mm, glabrous. Lemma unawned, 2.3–2.7mm, oblong, apex rounded, slightly apiculate, strongly 5-veined, scabrid near apex and on veins, thickly herbaceous. Palea 2.1–2.6mm, oblong, subacute, keels green, ciliate near apex, back and sides hyaline, scabrid above. Anthers 0.7–1.1mm.

Bhutan: C — Thimphu (Gidakom Valley), Punakha (pass between Nobding and Phubjikah) and Mongar (Sengor) districts; **Darjeeling** (Tonglu); **Sikkim** (Dzongri). Mixed *Quercus semecarpifolia* forest; *Abies* woodland, 2440–3660m. August–October.

As can be seen from the synonymy, this plant is difficult to place generically; it looks very different to all other species of *Calamagrostis*, and there seems much to be said for placing it in *Aniselytron* as suggested by Korthof and Veldkamp (1985). However, it seems pragmatic to follow Clayton & Renvoize (1986), and Shukla (1996) who made the required combination.

Doubtfully recorded species:

C. gigantea Roshevitz

A C Asian species with very large glumes and a dense, erect infl. Recorded for Sikkim in Jain & Srivastava (1988), but no specimens have been seen and the record seems very unlikely.

42. POLYPOGON Desfontaines

Tufted annuals. Culms ascending from decumbent base, leafy. Leaf blades flat; ligule membranous. Infl. a dense, spike-like, to slightly interrupted, panicle, branched to 3 orders, branches whorled. Spikelets deciduous as a whole, laterally compressed, floret 1. Glumes equalling spikelet, subequal, \pm oblong-elliptic, conduplicate, 1-veined, weakly keeled, thinly herbaceous, apex acute, notched, with slender, straight, scabrid awn in sinus, surface scabrid. Lemma hyaline, shining, shorter than glumes, widely elliptic, strongly convex, weakly 5-veined, apex truncate, with weak, scabrid, central awn and 4 small teeth. Palea narrowly oblong, hyaline, apex with 2 teeth.

1. Glume awns to 2.7mm, about equalling glume body 1. **P. fugax**
 + Glume awns usually over 4.5mm, more than twice length of glume
 body 2. **P. monspeliensis**

1. **P. fugax** Nees ex Steudel; *P. littoralis* sensu F.B.I., non Smith. Fig. 24f–g.

Culms 9.5–50cm. Leaf blades 1.8–12.5 \times 0.2–0.8cm, linear-lanceolate, acute, scabrid on veins above and beneath; ligule 3.5–9mm, truncate-lacerate, minutely hairy on back. Infl. 4–11 \times 0.8–4.5cm, cylindric, spike-like, lower whorls sometimes slightly distant, longest brach of lowest whorl 0.8–3.5cm. Spikelets (excl. awns) 1.8–2.4mm. Glumes greenish flushed purple, scabrid on back, margins ciliate, awns shorter than or slightly longer than body (to 1.5 \times length); the lower 1.8–2.3 \times 0.8–0.9mm, awn 1.2–2.7mm; the upper 1.8–2.1 \times 0.7–0.9mm, awn 0.8–2mm. Lemma 1.1–1.4mm, awn 0.6–1.2mm, sometimes deciduous. Palea 1–1.1 \times 0.3–0.5mm. Anthers 0.6–0.8mm.

Bhutan: C — Thimphu (Thimphu, Babesa), Punakha (Lobesa, Wangdi Phodrang, Heso Thangkha), Tongsa (Dung Dung), Bumthang (Byakar Valley) and Mongar (Tangmachu, Lhuntse Dzong, Zimgaon) districts. Weed of wheat and rice; by streams and ditches; marshes, 1050–2700m. March–June.

Parker (1992) recorded it as a weed in all districts [with cultivation] over 1000m, and that it can be a problem in fallow after rice harvest. Recorded for Kalimpong in F.E.H.1, but one of the two specimens cited in the same work for Sikkim is *P. monspeliensis*.

2. **P. monspeliensis** (L.) Desfontaines. Eng: *annual beard-grass*. Fig. 24h.

Differs from *P. fugax* in having longer glume awns; awns over (2.9–)4.5mm, more than 2 \times the length of the glume body.

Darjeeling (Jepi); **Sikkim** (Yoksam; unlocalised Treutler specimen). Weed of millet, 1800m. March–May.

Probably native of the Mediterranean region, but widely naturalised in warm parts of the world.

43. CYATHOPUS Stapf

Tufted, scabrid perennial. Culms erect, leafy, unbranched. Leaf blades flat; ligule membranous. Infl. paniculate, lax, branches whorled, distant, naked in lower part. Spikelets falling as a whole, borne on cup shaped tips of hispid pedicels, floret 1; minute rachilla rudiment vestige sometimes present. Glumes equalling spikelet, \pm equal, lanceolate, convex, abruptly, bluntly acuminate, 3-veined, margins narrowly hyaline. Lemma slightly shorter than glumes, lanceolate, convex, subacute, weakly 5-veined, papery. Palea narrowly lanceolate, acute, back narrow, 2-keeled, sides widely incurved. Lodicules large.

1. *C. sikkimensis* Stapf. Fig. 24i-j.

Culms to 82cm, relatively stout, scabrid. Culm leaf blades to 21cm, to 7.4mm wide, oblong, acute, scabrid on veins above and beneath; sheaths scabrid on veins; ligule to 9mm, truncate-lacerate. Infl. green, to 23cm, lowest whorl with 5 branches, the longest to 9.5cm. Spikelets 2.1–3.1mm. Glumes green, 2–3 \times c.0.8mm, scabrid on back and veins. Rachilla rudiment to 0.3mm. Lemma cream-coloured, shining, 1.7–2.4mm, minutely hispid near apex, glabrous in lower part. Palea 1.65–2.2. Anthers c.0.9mm.

Bhutan: C — Thimphu district (above Hongsu); **Sikkim** (Kankola [Lachung]). By stream in clearings in *Abies* forest, 3200–3600m. August.

Reported here from Bhutan for the first time; previously known only from Sikkim.

44. ALOPECURUS L.

Tufted annuals or perennials. Culms leafy. Leaf blades flat; ligule membranous. Infl. dense, cylindric, spike-like. Spikelets laterally compressed, falling as a whole, floret 1, epaleate. Glumes slightly shorter than spikelet, subequal, conduplicate, keeled, 2(–3)-veined, asymmetric, sides \pm oblong, papery, blunt, margins overlapping, connate at base. Lemma thinly herbaceous, slightly exceeding glumes, widely oblong-elliptic, conduplicate, keeled, blunt, weakly (3–)5-veined, margins connate below, awned from below middle of back.

1. Spikelets under 3mm; lemma awn weak, straight even when dry; infl. to 5mm wide 1. *A. aequalis*
- + Spikelets over 4mm; lemma awn strong, curved when dry; infl, usually over 5mm wide 2. *A. pratensis*

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1. **A. aequalis** Sobolewsky; *A. geniculatus* sensu F.B.I. (at least in part), non L. Eng: *orange fox-tail*. Fig. 24k–l.

Usually a tufted annual. Culms 8.5–27cm, bearing 2–4 leaves, geniculately ascending, branched near base, sometimes rooting from lower nodes. Culm leaf blades glaucous, 1.6–8.1cm, 1.5–4mm wide, linear-lanceolate, acute, minutely hispid on veins above, glabrous beneath; sheaths slightly inflated; ligule 2–5mm, blunt. Infl. green, 3–7.3cm, 4–5mm wide. Spikelets 2.1–2.6mm. Glumes 1.9–2.3mm, sides \pm oblong, 0.5–0.7mm wide, apex subacute, one side white, un-veined, other side with a prominent green, hairy lateral vein, keel ciliate, cilia 0.6–0.7mm. Lemma 2.1–2.5mm, each side narrowly lanceolate, c.0.8mm wide, apex blunt, hyaline; awn 1.7–2.4mm, weak, straight, minutely scabrid. Anthers 2–3, 0.5–0.7mm, orange.

Bhutan: S — Deothang district (Raidong); C — Thimphu (below Taba, Babesa, Thimphu, Drukyl Dzong), Punakha (above Tinlegang, Mengdegong) and Mongar (Lingitsi) districts. Damp places, e.g. river banks; rice, mustard and wheat fields; ditches, 1250–2450m. March–June.

According to Parker (1992) common above 1000m, and occurring in most districts [with cultivation]; an important weed of rice and other cereals.

2. **A. pratensis** L. Eng: *meadow fox-tail*

Differs from *A. aequalis* as follows: culms erect, more robust and taller (usually over 30cm); infl. usually longer and wider; spikelets 4–6mm; awn c. twice length of lemma, curved and spreading when dry.

Bhutan: C — Bumthang district (Batpalathang). Improved pasture, 2650m. July.

A recent introduction.

45. PHLEUM L.

Shortly rhizomatous perennials. Culms leafy. Leaf blades flat; ligule membranous. Infl. dense, cylindrical, spike-like. Spikelets laterally compressed, disarticulating above glumes, floret 1. Glumes equalling spikelet, subequal, conduplicate, keeled, 3-veined, sides \pm oblong, papery, abruptly contracted into short, stout, herbaceous mucro, margins overlapping, free to base. Lemma shorter than glumes, widely oblong, strongly convex, \pm truncate, weakly 5-veined, hyaline. Palea almost equalling lemma, narrowly oblong, hyaline, weakly two-keeled.

1. Spikelets over 4mm (incl. mucro); spikes broadly cylindric (c.10mm wide) **1. *P. alpinum***
 + Spikelets to 4mm (incl. mucro); spikes narrowly cylindric (to 7mm wide) **2. *P. bertolonii***

1. *P. alpinum* L. Eng: *alpine cat's-tail*. Fig. 24m–n.

Culms 7–36.5(–61)cm, bearing 2–3 leaves, geniculately ascending, branched near base. Leaf blades 3.2–16.5cm, 3–7mm wide, linear-lanceolate, acute, glabrous; ligule 2.2–2.4mm, truncate, apex minutely ciliate. Infl. dark purplish, 2–4 × c.1cm. Spikelets (incl. mucros) 4–5.2mm. Glumes greenish flushed purple, sides scabrid, lateral veins shortly hispid above, keels pectinately ciliate, cilia 0.6–1.3mm, mucros curved; body of the lower 2.9–3.5mm, each side 0.6–0.8mm wide, mucro 0.8–1.5mm; body of the upper 3–3.8mm, each side 0.8–1mm wide, mucro 1–1.5mm. Lemma 2–2.2 × 1.2–1.6mm, midrib sometimes minutely hispid and sometimes slightly excurrent. Palea 1.8–2 × 0.4–0.5mm, keels minutely hispid. Anthers 0.9–1.5mm.

Bhutan: N — Upper Bumthang Chu (Ju La) and Upper Kulong Chu (Me La) districts; C — Sakden district (Mera); **Sikkim** (Lachen, Thanggu, Tallam, Phune). Peaty soil and wet alpine pasture; sandy river bank; stony stream bed, 3350–4270m. June–August.

2. *P. bertolonii* DC.

Differs from *P. alpinum* as follows: culms taller (to 80cm); ligule of culm leaves longer (c.4mm); infl. narrowly cylindric (4.2–7 × 0.7cm); spikelets smaller; anthers longer, c.1.7mm.

Bhutan: C — Mongar district (Sengor). Improved grassland, 3000m. September.

No doubt a recent introduction. A small (diploid) relative of the widespread and commonly cultivated *P. pratense* L. (Eng: *timothy grass*), which has also apparently been introduced.

Doubtfully recorded species:

Koeleria argentea Grisebach

Recorded for Sikkim (Dzongri-Olothang, 3900–4000m) in F.E.H.1, but no specimens seen. Although this species occurs in Tibet to the north of Bhutan (Gyantse), the Sikkim record is more likely to be a misidentification for *Trisetum spicatum*, which is common in this locality and superficially very similar to *K. argentea*. The latter can be distinguished in having the culms glabrous beneath the infls. and lemmas with shorter (to 2mm) awns.

Tribe VII. BROMEAE Dumortier

46. BROMUS L.

(by A.C. Broome & H.J.N.)

Annuals or shortly rhizomatous perennials. Culms erect, leafy. Leaf blades linear, flat, sometimes auriculate at base; sheath margins connate for most of length, usually hairy; ligule membranous. Infl. an open or contracted panicle. Spikelets cuneate to ovate, laterally compressed, disarticulating above glumes and between florets, apical florets usually sterile. Glumes unequal, shorter than spikelet. Lemmas sometimes with hyaline margins, entire or bidentate to bilobed, short- to long-awned, the awns subapical though sometimes minutely so. Paleas \pm oblong, keels ciliate. Ovary with a hairy, terminal appendage, stigmas thus appearing lateral.

1. Perennials; auricles present at base of culm leaf blades; spikelets gaping 2
- + Annuals; auricles absent from base of leaf blades; spikelets usually not gaping 5

2. Lemmas rounded on back, thin-textured, awns 4.3–17.9mm 3
- + Lemmas sharply keeled, thick-textured, awns 0.5–2mm **3. B. catharticus**

3. Awns equal to, or shorter than, lemmas (to 11mm), drying straight; spikelets narrowly lanceolate **2. B. staintonii**
- + Awns equal to, or longer than, lemmas (over 11mm), drying curved; spikelets oblong to elliptic 4

4. Lemmas hairy only on margins; lower glume usually under 10mm, upper usually under 12.5mm **1. B. himalaicus** var. **himalaicus**
- + Lemmas hairy all over; glumes longer, the lower over 10mm, the upper over 14mm **1. B. himalaicus** var. **grandis**

5. Upper glume 3–5-veined; spikelets cuneate; infl. one-sided **4. B. tectorum**
- + Upper glume 7(+) -veined; spikelets ovate to lanceolate or oblong to elliptic; infl. not one-sided 6

6. Ligule acute; panicles effuse, over 10cm, branches 7–13cm, drooping
5. B. pectinatus
- + Ligule truncate or rounded; panicles contracted, under 10cm,
 branches 0.3–2.5cm, erect 7
7. Lemmas hairy; spikelets elliptic to oblong, 3.5–4.2mm wide
6. B. hordeaceus
- + Lemmas glabrous; spikelets ovate to lanceolate, 2.1–2.8mm wide
7. B. racemosus

1. B. himalaicus Stapf var. **himalaicus**

Tufted perennial. Culms 25–83cm, glabrous. Culm leaf blades 10–31cm, 3–7.5mm wide, glabrous beneath, with spreading hairs on veins above; basal auricles pointed, occasionally with long silky hairs; sheaths glabrous or with deflexed hairs; ligule 1–3.4mm, dark brown, rounded, lacerate. Panicles 11–27cm, branches drooping, lowest node with 1–3 branches, the longest 3–10cm, bearing 1–3 spikelets. Spikelets 1.2–2.8cm, oblong to elliptic, gaping, fertile florets 6–12. Glumes often purplish, glabrous or sometimes hairy; the lower 5.5–10.2mm, lanceolate, acute to aristate, 1-veined; the upper 6–12.3(–14.5)mm, lanceolate or narrowly elliptic, 3-veined, midrib often continued as a short awn. Lemmas narrowly elliptic, rounded on back, acute, 5–6-veined, hairy near margins, herbaceous; awns recurved on drying. Lowest floret: lemma 10–13.6mm, awn 10.3–17.9mm; palea 9–9.5mm, $\frac{2}{3}$ or equalling lemma. Anthers 2.2–3.1mm.

Bhutan: C — Thimphu (above Phajoding, E side of Chelai La) and Bumthang (Kitiphu, W side of Thrumsing La) districts; N — Upper Bumthang Chu district (Domchen); **Darjeeling** (Phalut, Tonglu, Phullalong); **Sikkim** (Kyangosala, Tsomgo, Natu La, Islumbo, Nathang, Lachen, Lachung, Singalila); **Chumbi.** Rough grassy slopes with boulders; margins of fir and blue pine forest, 2740–4270m. June–October.

var. **grandis** Stapf; *B. grandis* (Stapf) Melderis, non (Shear) Hitchcock, *B. porphyranthos* Cope. Fig. 28a–b.

Differs from var. *himalaicus* as follows: glumes commonly hairy, longer, the lower 10–13(–18.5)mm, the upper 14–15.8(–20)mm; lemmas densely hairy all over.

Bhutan: N — Upper Mo Chu district (Soe/Lingshi/Yale La, Lingshi Dzong, Jangothang, Laya); **Sikkim** (Thanggu, Lasha Chhu, Lingmuthang). Alpine pasture, 3050–4050m. July–September.

Dunbar noted on a specimen ‘one of the most common grasses in NW and W Bhutan between [3048 and 3962m]’; therefore important as summer fodder.

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Cope (1982) and Melderis (in E.F.N.) treat var. *grandis* as a distinct species, but to us the differences seem slight, and it is better treated at varietal rank. Further work, however, is required on the group throughout the Sino-Himalaya.

2. *B. staintonii* Melderis; *B. ramosus* auct., non Hudson; *B. asper* sensu F.B.I., non Murray. Fig. 28e. Plate 7.

Tufted, shortly rhizomatous perennial. Culms 43–150cm, shortly decumbent at base and rooting from lower nodes, glabrous. Culm leaf blades 17–44cm, 3–9mm wide, glabrous beneath, with dense spreading hairs on veins above; basal auricles pointed, ciliate; sheaths shortly, densely hairy; ligules 0.9–2mm, dark brown, truncate, lacerate. Panicles 18–37cm, lax, branches drooping, basal node with 2–5 branches, the longest to 23cm, bearing 4–7 spikelets. Spikelets 1.5–3cm, narrowly lanceolate, fertile florets 4–8. Lower glume 7–9mm, subulate, 1-veined; upper glume 9–12mm, lanceolate, acute, 3-veined, midrib continued as short awn. Lemmas tinged purple, oblong, rounded on back, 5–6-veined, appressed hairy along margins or only at base, herbaceous; awns slender, remaining straight on drying. Lowest floret: lemma 9–12.5mm, awn 4.3–11mm; palea 7.4–8.2mm, c.2mm shorter than lemma. Anthers 1.8–3.2mm.

Bhutan: C — Thimphu (Thimphu, 4km N of Chapcha, Simtokha to Taluka), Punakha (Nobding to Phubjikah, below Pele La), Tongsa (Chendebi), Bumthang (Tang-Tal, Lame Gompa, Kitiphu, Kempfu) and Tashigang (Yonphu La, Kengthongmani) districts; **Sikkim** (Tsoka, Lachung, Dzongri, Islumbo). Damp, shady places in broad-leaved forest and blue pine zone, 1730–3660m. July–October.

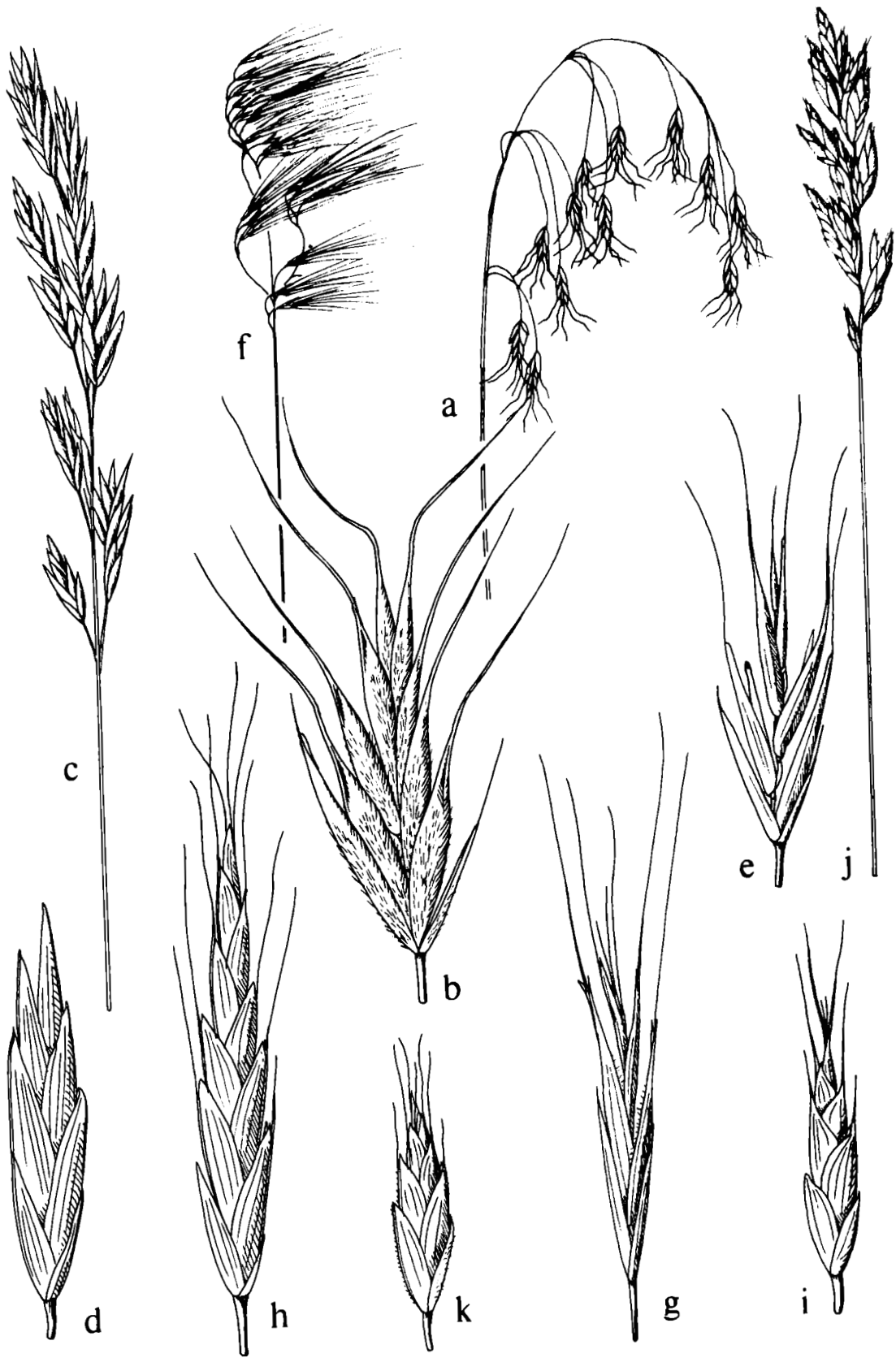
The specimens belong to var. *pilosiusculus* Melderis.

3. *B. catharticus* Vahl; *B. uniolooides* Kunth. Eng: *rescue grass*, *prairie grass*. Fig. 28c–d.

Tufted perennial. Culms 9–59cm, glabrous. Culm leaf blades 5–10cm, 4–5mm wide, shortly hairy on veins above, glabrous or scabrid on veins beneath; basal auricles pointed; sheath surface and margins with deflexed hairs; ligule 3.8–4.7mm, hyaline, acute, lacerate. Panicles 10–20cm, oblong to

FIG. 28.

a–b, ***Bromus himalaicus*** var. ***grandis***: a, infl. ($\times \frac{1}{3}$); b, spikelet ($\times 2$). c–d, ***B. catharticus***: c, infl. ($\times \frac{2}{3}$); d, spikelet ($\times 2$). e, ***B. staintonii***: spikelet ($\times 2$). f–g, ***B. tectorum***: f, infl. ($\times \frac{1}{3}$); g, spikelet ($\times 2$). h, ***B. pectinatus***: spikelet ($\times 2$). i, ***B. racemosus***: spikelet ($\times 2$). j–k, ***B. hordeaceus***: j, infl. ($\times \frac{2}{3}$); k, spikelet ($\times 2$). Drawn by Louise Olley.



VII. BROMEAE

triangular in outline, branches drooping in life (\pm erect when dry), lowest node with 2–3 branches, the longest 4–10cm, bearing 3–4 spikelets. Spikelets 2–2.5cm, oblong to lanceolate, florets c.8. Glumes lanceolate to oblong, acute; the lower 7.2–14.5mm, 5–9-veined; the upper 9.4–11.9mm, 8–11-veined. Lemmas lanceolate, blunt to acute, sharply keeled, midrib continued as a short, stout mucro, 10–11-veined, minutely scabrid especially on veins, thickly herbaceous. Lowest floret: lemma 13.6–17.9mm, mucro 0.5–1.3mm; palea c. $\frac{2}{3}$ length of lemma. Anthers c.0.6mm.

Bhutan: C — Thimphu (Thimphu, Taba) and Bumthang (Swiss Project) districts; **Darjeeling** (Rungbee). Roadside bank; in garden, 2250–2610m. June–September.

Native of S America, but widely introduced for fodder –probably recently in Bhutan, but as early as 1869 in Darjeeling.

4. *B. tectorum* L. Eng: *drooping brome*. Fig. 28f–g.

Tufted annual. Culms 17–30cm, glabrous. Culm leaf blades 6–19cm, 4–6mm wide, margins with long, spreading hairs, shortly hairy on veins, hairs longer on upper surface; basal auricles absent; sheaths with short, deflexed hairs; ligule 1.7–3mm, hyaline, truncate, lacerate. Panicles 4–9cm, one-sided, rather dense, branches slender, nodding, lowest node with 3 or more branches, the longest 4.5–5cm, branched, bearing up to 8 spikelets. Spikelets 1.4–1.7cm, cuneate, florets 5–9. Lower glume 7.6–9mm, narrowly lanceolate, 1–3-veined; upper glume 10.2–11.6mm, lanceolate, 5-veined. Lemmas narrowly elliptic, rounded on back, 7-veined, minutely hairy, herbaceous, apex bifid, margins broadly hyaline; awn subapical, straight. Lowest floret: lemma 12–15mm, awn 10.1–13mm; palea 9.5–10.5mm, keels long ciliate. Anthers c.0.5mm.

Bhutan: N — Upper Mo Chu district (Lingshi); **Chumbi**. Weed of cultivation (incl. barley); sand in river bed, 3050–3960m. May–July.

No recent specimens seen; probably a casual introduction.

5. *B. pectinatus* Thunberg; incl. *B. pseudojaponicus* H. Scholz; *B. patulus* Mertens & Koch var. *falconeri* Stapf. Fig. 28h.

Tufted annual. Culms 16.5–44cm, glabrous. Culm leaf blades 4.5–17cm, 1–4mm wide, shortly hairy on both surfaces; basal auricles absent; sheaths densely hairy, hairs short, deflexed; ligules 2.1–3.4mm, hyaline, acute, lacerate. Panicles 11–23cm, effuse, branches elongate, flexuous, probably drooping, lowest node with 3–5 branches, the longest 7–13cm, bearing 1–3 spikelets. Spikelets 25–34 \times 4–6mm, oblong to narrowly elliptic, fertile florets 9–11. Lower glume 3.8–9.8mm, lanceolate, acute, 1–3-veined; upper glume 5.5–11mm, narrowly elliptic, blunt, 5–7-veined. Lemmas rounded on back,

8–10-veined, minutely hairy, apex bifid, margins hyaline; awn inserted below sinus, \pm straight. Lowest floret: lemma 9.1–10.4mm, apical teeth subacute (0.4–1.3mm), awn 4–5mm; palea 9–9.4mm, equalling lemma. Anthers 1–1.2mm.

Bhutan (unlocalised Griffith specimen [probably *Griffith* 987, fields near Olaka (Thimphu district)]).

As not collected since 1838, probably a casual agricultural introduction.

Scholz (1981a) distinguished several segregate Himalayan taxa from the African one, and cited a duplicate of one of the Griffith specimens as belonging to her *B. pseudo-japonicus*; however, her key is unconvincing and we prefer to retain *B. pectinatus* in a broad sense.

6. *B. hordeaceus* L.; *B. mollis* L. Eng: *soft brome*. Fig. 28j–k.

Tufted annual. Culms erect, 9–28cm, hairy with short, deflexed hairs. Culm leaf blades 3–15cm, 1.7–3.5mm wide, shortly hairy beneath, with long hairs on veins above; basal auricles absent; sheaths with short, deflexed hairs; ligule c.0.7mm, hyaline, truncate, lacerate. Panicles 4–7.5cm, dense, ovoid to cylindrical, branches erect, longest of lowest node 0.3–1cm, bearing c.3 spikelets. Spikelets 9.8–12.6 \times 3.5–4.2mm, elliptic to oblong, fertile florets c.8; pedicels shorter than spikelets. Glumes hairy; the lower 3.5–4.8mm, lanceolate, acute, 5-veined; the upper 4.8–5.2mm, ovate, acute to acuminate, 8–9-veined. Lemmas ovate, rounded on back, 9-veined, covered with short, appressed hairs, herbaceous, apex bifid, margins narrowly hyaline; awn \pm straight. Lowest floret: lemma c.6.3mm, teeth 0.3–0.4mm, acute, awn inserted 0.9–1.4mm from apex, c.4.7mm; palea equalling grain, shorter than lemma. Anthers 0.3–0.7mm.

Bhutan: C — Thimphu (Wangchutaba near Thimphu) and Bumthang (Byakar) districts. Dry roadside bank near cultivation; disturbed ground in experimental farm, 2300–2700m. May–June.

No doubt a recent introduction from Europe; probably only casual, and not persisting.

7. *B. racemosus* L. Fig. 28i.

Similar to *B. hordeaceus* in being a tufted annual with an erect infl., but differs as follows: pedicels of spikelets longer (equalling or longer than spikelets); lemmas glabrous; anthers larger (c.1.5mm).

Bhutan: C — Thimphu district (Thimphu). Stony roadside bank, 2300m. May.

No doubt a recent introduction from Europe; probably only casual and not persisting.

Tribe VIII. TRITICEAE Dumortier

1. Spikelets in 2s or 3s at infl. nodes 2
- + Spikelets single at infl. nodes 3

2. Spikelets with several florets, in groups of 2, or if 3 then one reduced; glumes glabrous, not awned; wild plants **47. Elymus** p.p.
- + Spikelets with a single floret, in groups of 3, all similar; glumes hairy, long awned; cultivated plants **49. Hordeum**

3. Cultivated annual **50. Triticum**
- + Wild perennials 4

4. Spikelets sessile; lemmas coriaceous, opaque, veins obscure **47. Elymus** p.p.
- + Spikelets shortly pedicelled; lemmas herbaceous, translucent, veins obvious **48. Brachypodium**

47. ELYMUS L.

Perennials, tufted or with spreading rhizomes. Culms erect, leafy; leaf blades flat or inrolled; ligule membranous, short, truncate. Infl. a spike-like panicle, usually narrow, sometimes broad, rachis tough, internodes flattened, hispid on angles. Spikelets gaping, appressed, borne singly or in groups of 2–3, alternating on opposite sides of the rachis, subsessile, disarticulating above glumes and between florets; florets 2–7, bisexual, similar, or terminal one reduced; callus oblique, commonly shortly hairy; rachilla internodes commonly shortly hairy, falling with florets. Glumes opposite or borne side by side, narrowly lanceolate to oblong, convex, sometimes awned, unequal or subequal, shorter than spikelet, thickly herbaceous, margins narrowly hyaline; the lower 3(–5)-veined; the upper commonly longer and wider, 3–5-veined. Lemmas lanceolate, gradually narrowed above into awn, strongly convex, 5-veined, coriaceous (opaque); awn hispid, straight or strongly curved. Paleas narrowly oblong, 2-keeled, blunt or emarginate, coriaceous, margins inflexed, keels hispid.

There has been much discussion over the delimitation of *Elymus* and related genera. Here I basically follow Melderis (1978a, b), including *Clinelymus* Nevski, *Roegneria* C. Koch, *Elytrigia* Desvaux and most species of *Agropyron* (excepting those with keeled glumes and pectinately arranged spikelets). Even within this definition, however, it is difficult to delimit species, due in part to hybridisation; another problem arises

from the difficulty of matching cytologically and morphologically defined taxa. An overall revision of the genus (s.l.) is much needed.

Bor (1973) restricted *Elymus* to the taxa with several spikelets per infl. node, a character which has proved not to be significant; the other species he placed in *Agropyron*. Chinese authors (e.g. Liou Liang, 1987) similarly delimited *Elymus*, but split the taxa with single spikelets into two genera: *Elytrigia* (including *E. repens*) and *Roegneria* (including most of the other species with single spikelets treated here under *Elymus*).

1. Spikelets in 2s or 3s at infl. nodes 2
- + Spikelets borne singly at infl. nodes 4

2. Infl. lax, drooping or curved; lemma awns long (over 12mm), usually curved **1. E. nutans**
- + Infl. dense, stiffly erect; lemma awns short (to 8mm), straight 3

3. Spikelets in 3s (one reduced); spikelets small (the larger of each group under 15mm long excl. awns) **2. E. dahuricus**
- + Spikelets in 2s; spikelets larger (the larger of each pair over 17mm long excl. awns) **3. E. tangutorum**

4. Lemmas densely villous; infl. almost as wide as long **10. E. thoroldianus**
- + Lemmas glabrous or with short hairs; infl. linear, much longer than wide 5

5. Awns of lemmas slender, straight 6
- + Awns of lemmas stout, curved 8

6. Awns of lemmas under 3mm; rhizomes creeping **6. E. repens**
- + Awns of lemmas over 8mm; plants tufted 7

7. Glumes small (lower to 8.2mm, upper to 8.9mm), narrowly lanceolate-triangular, the lower much shorter than lowest lemma, usually 3-ribbed **4. E. sikkimensis**
- + Glumes large (lower over 10mm, upper over 11mm), broadly oblong, the lower almost equalling lowest lemma, strongly 5-ribbed
5. E. tibeticus

8. Glumes awned **8. E. himalayanus**
- + Glumes not awned 9

9. Spikelets to 20mm (excl. awns); glumes glabrous; lemmas glabrous or hispid; anthers under 2.5mm; usually occurring at high altitudes (over 3600m) **7. E. schrenkianus**

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- + Spikelets over 20mm (excl. awns); glumes hairy on veins; lemmas densely hairy between veins, especially near margins; anthers c.4mm; dry valley at 2600m **9. E. duthiei**

1. E. nutans Grisebach; incl. *E. sibiricus* sensu Bor & F.B.I., non L. Eng: *native wild rye-grass* (Miller, undated). Fig. 29a–b.

Tufted. Culms 20–79cm, relatively stout, geniculately ascending from base. Leaf blades 4–15 × 0.3–0.8cm, linear, acute, glabrous; sheaths glabrous; ligule c.0.2mm. Infl. usually tinged dark purplish, 7–19 × 1.5–3cm (incl. awns), drooping, curved or flexuous, rachis ± glabrous (angles sometimes minutely hispid), spikelets borne in pairs (very occasionally singly), not tightly appressed. Larger spikelet of pair 21.6–30mm incl. awns, 12.2–17.2 excl. awns, fertile florets 2–4, sometimes with a reduced terminal one. Glumes side by side, linear-lanceolate, finely acuminate, hispid on veins, (1–)3-veined; the lower 3.7–7.5 × 0.7–0.9mm; the upper 4.1–6 × 0.7–1mm, occasionally with an awn to 4.3mm. Lowest floret: lemma 8–11 × 1.7–2.5mm, hispid on veins, especially above, minutely hispid between veins, awn 12–17.5mm, hispid, usually curved; palea 7.4–11.2 × 1.1–1.6mm, apex usually truncate, keels occasionally minutely excurrent; anthers 1.4–2mm. Rachilla internodes shortly hairy, that bearing second floret 1.8–2.5mm.

Bhutan: C — Thimphu (W of Barshong, hill above Thimphu hospital, valley below Lunama Tso) and Bumthang/Mongar (Thrumsing La) districts; **N** — Upper Mo Chu district (Lingshi, Laya, Gasa, Soi Yaksa); **Sikkim** (Samiti Lake, Chugya, Lingmuthang, Lachen, Pheedung, Lasha Chhu); **Chumbi.** Alpine grassland, especially near yak herders' encampments; open, rocky slopes, 2740–4570m. June–October.

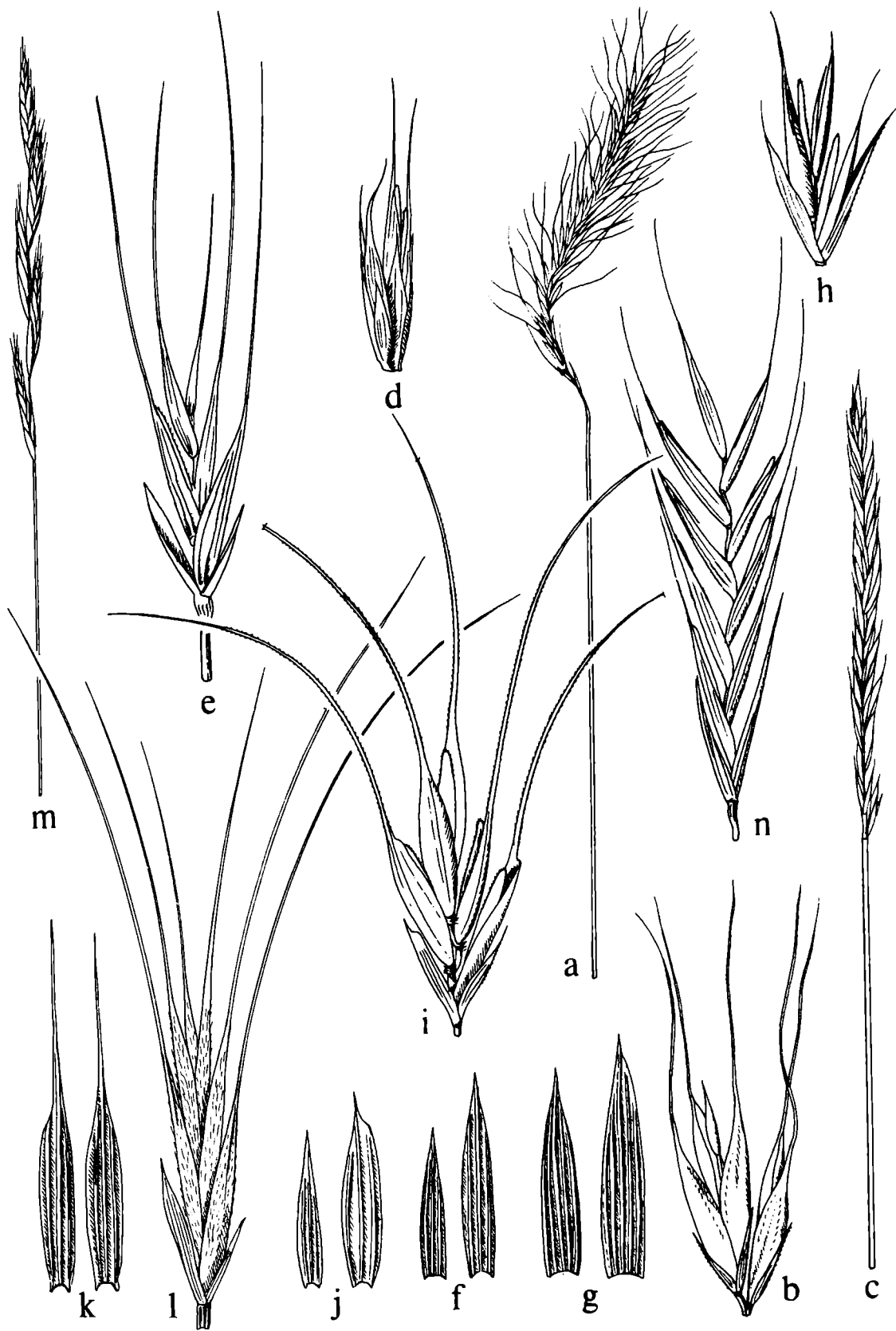
An important component of alpine grazing lands, thus important as fodder for yak.

2. E. dahuricus Turczaninow. Fig. 29c–d.

Tufted. Culms 36–123cm, stiffly erect, nodes usually shortly hairy. Leaf blades 17–26 × 0.3–0.8cm, narrowly oblong, acute, glabrous; sheaths usually

FIG. 29.

a–b, **Elymus nutans**: a, infl. (× ¼); b, spikelet pair (× 2). c–d, **E. dahuricus**: c, infl. (× ⅔); d, spikelet pair (× 2). e–f, **E. sikkimensis**: e, spikelet (× 2), f, glumes (lower left, upper right) (× 3). g, **E. tibeticus**: glumes (lower left, upper right) (× 3). h, **E. repens**: spikelet (× 2). i–j, **E. schrenkianus**: i, spikelet (× 2); j, glumes (lower left, upper right) (× 3). k, **E. himalayanus**: glumes (lower left, upper right) (× 3). l, **E. duthiei**: spikelet (× 2). m–n, **Brachypodium sylvaticum**: m, infl. (× ⅔); n, spikelet (× 2). Drawn by Louise Olley.



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minutely hairy on veins; ligule 0.6–1mm. Infl. 8–12 × 0.5–1cm (incl. awns), stiffly erect, rachis usually minutely hairy, angles shortly hispid, spikelets appressed, borne in 3s, two subequal, one reduced. Largest spikelet of group 13.3–20mm incl. awns, 9.2–14.6 excl. awns, fertile florets 2–4, sometimes with a reduced terminal one. Glumes side by side, narrowly oblong-ob lanceolate, finely acuminate, sometimes with a subapical tooth on one side, hispid on veins; the lower 7.5–9.5 × 1–1.4mm, 3-veined; the upper 8.4–10.4 × 1.1–1.6mm, 3–5-veined. Lowest floret: lemma 8–10 × 2.2–2.5mm, hispid on veins, especially above, minutely pubescent between veins, awn 3.8–8mm, hispid, weak, ± straight; palea 8.1–9.7 × 1.2–1.5mm, apex rounded to weakly emarginate; anthers 2.2–2.7mm. Rachilla internodes shortly hairy, that bearing second floret 2.8–3mm.

Bhutan: C — Thimphu (W of Barshong, hill above Thimphu hospital) and Bumthang (Bumthang) districts; N — Upper Mo Chu district (Soi Yaksa). Lush weedy/grass communities around yak herders' encampments, 2620–3800m. July–October.

3. *E. tangutorum* (Nevski) Handel-Mazzetti

Differs from *E. dahuricus* as follows: plant more robust (leaves to 0.9cm wide); spikelets in pairs, the larger (c.17.5mm excl. awns); lower glume c.10.1 × 1.4mm; upper glume c.11 × 1.9mm; lemma c.10.5 × 2.9mm, awn c.8.2mm; palea c.10.4 × 1.5mm).

Bhutan: N — Upper Mo Chu district (E bank of Tharizam Chu). Grassy hillside among scrub, 4080m. September.

Probably only a robust form of *E. dahuricus* (of which it was originally described as a variety).

4. *E. sikkimensis* (Melderis) Melderis; *Agropyron sikkimense* Melderis. Fig. 29e–f.

Tufted. Culms 36–118cm, stiffly erect, slender, nodes glabrous. Leaf blades 7.5–22 × 0.15–0.6cm, linear-lanceolate, flat or inrolled, acute, glabrous beneath, scattered-hairy above; sheaths glabrous; ligule 0.3–0.5mm, minutely ciliate. Infl. 12–18 × 0.7–1cm (incl. awns), erect, slightly flexuous, rachis glabrous, angles hispid, spikelets just overlapping, appressed, borne singly. Spikelets 34–39.5mm incl. awns, 15–23.4mm excl. awns, fertile florets 4–7, sometimes with a reduced terminal one. Glumes opposite, narrowly triangular, acuminate, hispid on veins; the lower 5–8.2 × 0.9–1.1mm, 3–4(–5)-veined; the upper 6.4–8.9 × 1.2–1.6mm, (4–)5(–7)-veined. Lowest floret: lemma 8.5–11.5 × 2.2–2.6mm, glabrous, or minutely hispid on veins especially above and occasionally with a few spicules between veins, awn 15.5–24mm, rough,

straight; palea 8.1–10 × 1.4–1.6mm, apex truncate to weakly emarginate, keels occasionally minutely excurrent; anthers 2.1–2.7mm. Rachilla internodes shortly hairy, that bearing second floret 2–2.7mm.

Bhutan: S — Deothang district (Wamrung); C — Thimphu (common around Thimphu), Tongsa (above Rukubji, Chendebi), Bumthang (common) and Mongar (Sengor) districts; **Sikkim** (Lema, Lachung, Lachen). Damp ground by stream; weed of fields; dry trackside and wasteground; meadows, 2200–3120m. June–September.

5. *E. tibeticus* (Melderis) G. Singh. Fig. 29g.

Differs from *E. sikkimensis* as follows: leaf blades densely short-hairy beneath, densely long-hairy above; sheaths minutely hairy; glumes larger, almost equalling lowest floret, broadly oblong, the lower 10–10.9 × c.1.8mm, 5-veined, the upper 11.3–11.7 × 1.8mm, 6-veined. Anthers 2–2.3mm.

Bhutan: C — Thimphu (near Tashichho Dzong) and Bumthang (near bridge over Bumthang Chu, Byakar, Dahan Pelrithang) districts. Dry roadside bank near cultivation; wasteground, 2300–2830m. June–September.

Two of the Bumthang specimens were determined by B. Salomon. To me this species seems doubtfully distinct from the variable *E. semicostatus* (Nees ex Steudel) Melderis, which Salomon (1994) recorded only as far east as Nepal. *E. tibeticus* is supposed to have small anthers and paleas equalling the lemmas, whereas *E. semicostatus* should have long (3–6mm) anthers and paleas shorter than the lemmas. Our specimens agree with *E. tibeticus* in having small anthers, but one of them has paleas distinctly shorter than the lemmas.

6. *E. repens* (L.) Gould; *Agropyron repens* (L.) P. Beauvois. Eng: *couch grass*. Fig. 29h.

Spreading by creeping rhizomes. Culms to 45(–120)cm, nodes glabrous, bases decumbent and rooting from nodes. Leaf blades to 30 × 0.8cm, narrowly oblong, flat, acute, glabrous beneath, with short, sparse hairs on veins above; sheaths glabrous; ligule c.0.2mm. Infl. to 13.5 × 0.9m (incl. awns), dense, stiffly erect, rachis glabrous, angles hispid, spikelets strongly overlapping, appressed, borne singly. Spikelets c.16mm (incl. awns), fertile florets 4. Glumes opposite, narrowly lanceolate, acuminate into short, rough awns, margins widely hyaline, hispid on veins; the lower c.10.1 (incl. awn) × 1.4mm, 3-veined, awn c.2.5mm; the upper c.10.3 (incl. awn) × 1.8mm, 5-veined, awn c.2.4mm. Lowest floret: lemma c.13.1 (incl. awn) × 2.5mm, glabrous, awn c.2.9mm, rough, straight; palea c.8.1 × 1.2mm, apex truncate to weakly emarginate; anthers c.3.4mm. Rachilla internodes ± glabrous, that bearing second floret c.2.5mm.

Darjeeling (Darjeeling). Garden weed, 2100m. August.

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Probably a recent introduction. The above description refers to the single specimen seen, which is a form with shortly awned glumes and lemmas; unawned forms are also to be expected.

7. *E. schrenkianus* (Fischer & C.A. Meyer) Tsvelev; *Agropyron schrenkianum* (Fischer & C.A. Meyer) Drobov. Fig. 29i–j.

Tufted. Basal leaf blades 4–6.5 × 0.1–0.2cm, linear, acute, inrolled, usually densely hairy above and beneath, hairs longer above; sheaths hairy. Culms 16–85cm, relatively stout, geniculately ascending from base; culm leaves less hairy than the basal ones; sheaths glabrous; ligule c.0.4mm, minutely ciliate. Infl. usually tinged dark purplish, 5–16 × 2.5–3.5cm (incl. awns), drooping, curved or flexuous, rachis ± glabrous (angles sometimes minutely hispid), spikelets borne singly, overlapping. Spikelets 32–40mm incl. awns, 14–19.8mm excl. awns, fertile florets 4–6, sometimes with a reduced terminal one. Glumes side by side, narrowly oblong-lanceolate, acuminate, midrib obscurely hispid; the lower (2.8–)4.9–6.1 × 0.9–1.2mm, 3(–4)-veined; the upper (4.6–)6.3–8.2 × 1.2–1.5mm, (3–)4(–5)-veined. Lowest floret: lemma 9.1–11.2 × 2.4–2.7mm, hispid on veins, especially above, minutely hispid between veins below, awn 18–26.4mm, hispid, stout, curved; palea 6.8–9.3 × 1.2–1.6mm, apex usually truncate, back minutely hairy at apex; anthers 1.2–1.7(–2.5)mm. Rachilla internodes shortly hairy, that bearing second floret 2–3.2mm.

Bhutan: C — Ha (W side of Chelai La), Thimphu (hill above Thimphu Hospital) and Tongsa (Chendebi) districts; N— Upper Mo Chu district (Jangothang, Laya, Soe/Lingshi/Yale La); **Sikkim** (Chugya, Gongchung, Kongra Lama); **Chumbi**. Alpine slopes, (2450–)3300–5430m. June–September.

The Chendebi specimen is probably an introduction and brought accidentally from high altitude by a pilgrim to the chorten – it was growing on a disturbed roadside bank.

8. *E. himalayanus* (Nevski) Tzvelev; *Agropyron himalayanum* (Nevski) Melderis. Fig. 29k.

Differs from *E. schrenkianus* as follows: glumes long-awned (awn of the lower c.8mm, awn of the upper c.10.2mm); awns of lemmas longer (to 61mm).

Sikkim (Yumkhu). Habitat not recorded, 5170m. August.

9. *E. duthiei* (Melderis) G. Singh; *Agropyron duthiei* Melderis. Fig. 29l.

Differs from *E. schrenkianus* as follows: culms more slender; infl. narrower; spikelets longer, c.22mm excl. awns, c.52mm incl. awns; glumes with widely hyaline margins, veins hairy (the lower c.5.3 × 1.2mm, 3-veined; the upper c.7.3 × 1.8mm, 6-veined); lemmas densely long-hairy between veins, especially near margins (c.10.2 × 2.9mm, awn c.31mm); anthers c.4mm.

Bhutan: C — Thimphu district (Ginnekah). Open, stony, dry hill with scattered *Pinus wallichiana*, 2600m. September.

Previously known only from the W Himalaya, and not from Nepal, so this new record for Bhutan represents a considerable disjunction. The only way in which the Bhutan specimen differs from the W Himalayan ones is in being generally more hairy (with pilose lemmas and glumes, and hairy leaf sheaths).

10. *E. thoroldianus* (Oliver) G. Singh; *Agropyron thoroldianum* Oliver. Fig. 30a–b.

Densely tufted. Culms to 14cm, slightly curved. Leaf blades 1.7–9 × 0.1–0.25cm, linear, acute, inrolled, with scattered, long hairs above, glabrous beneath; sheaths glabrous, striate, slightly inflated; ligule c.0.3mm, minutely ciliate. Infl. pale yellowish-brown, 2–3 × 1.5–2cm, curved, broadly cylindric, rachis internodes extremely short, spikelets borne singly, overlapping, spreading. Spikelets to 11.2 × 10.5mm, fertile florets to 5, sometimes with a reduced terminal one. Glumes side by side, lanceolate, acuminate into short, stout, glabrous mucro; the lower c.5 × 1.2mm, asymmetric, 2-veined, the larger vein more prominent (forming a weak keel), coriaceous, densely villous in upper half, less so in lower; the upper c.6.2 × 1.7mm, symmetric, 3-veined, midrib prominent, densely villous in upper half, subglabrous below, margins hyaline. Lowest floret: lemma c.8.4 × 2.6mm, lanceolate, acuminate into short, stout, glabrous mucro, densely villous all over back, 4(–5)-veined, coriaceous; palea c.7 × 1.5mm, oblong-elliptic, apex emarginate, back minutely hairy, keels pectinately ciliate (cilia to 1mm); anthers c.0.8mm. Rachilla internodes glabrous, that bearing second floret c.0.7mm.

Sikkim (Yumechu). Habitat not recorded, 4860m. August.

48. BRACHYPODIUM P. Beauvois

Tufted perennial. Leaf blades flat or inrolled; ligule membranous. Infl. linear, spike-like, rachis tough, internodes flattened. Spikelets borne singly, alternating on opposite sides of rachis, shortly pedicelled, disarticulating above glumes and between florets; florets 5–12, bisexual, similar, or terminal one(s) reduced; rachilla internodes glabrous, falling with florets. Glumes opposite, unequal, shorter than spikelet, narrowly lanceolate to oblong, convex, thinly herbaceous, margins narrowly hyaline; the lower 4–5-veined; the upper longer and wider, sometimes mucronate, 6–8-veined. Lemmas narrowly oblong-lanceolate, strongly convex, gradually narrowed above into awn, 7–9-veined, thinly herbaceous (translucent), veins appearing as double green lines; awn

hispid, straight, slender. Paleas narrowly oblong-elliptic, truncate, hyaline, 2-keeled, keels pectinately hispid above, margins inflexed.

1. *B. sylvaticum* (Hudson) P. Beauvois. Eng: *false brome*. Fig. 29m–n. Plate 5.

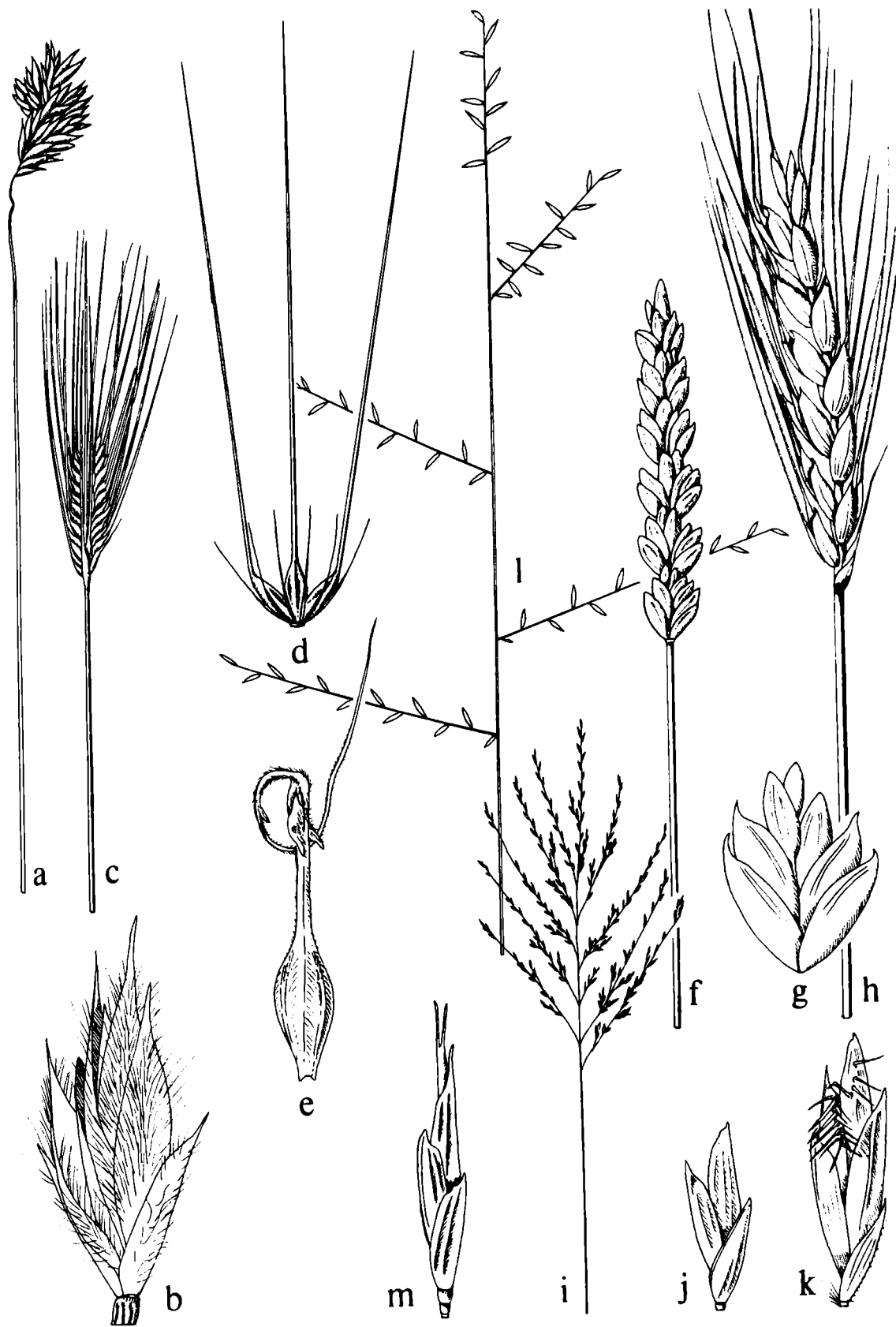
Culms 44–90cm, geniculately ascending from base, very slender, nodes hairy. Leaf blades 7.5–17.5 × 0.25–0.9cm, linear-lanceolate, flat or inrolled, acute, usually hairy, with long, spreading hairs, denser above than beneath, sometimes glabrous; sheaths usually with long, spreading hairs, sometimes glabrous; ligule (0.5–)1.5–2mm, minutely hairy on back, apex truncate, lacerate or sometimes ciliate. Infl. 6–16.5cm (incl. awns), erect, slightly flexuous, rachis glabrous, angles minutely hispid, spikelets overlapping or not. Spikelets appressed or spreading horizontally, 22–37(–42)mm incl. awns, 14–28(–37)mm excl. awns, gaping only at anthesis, fertile florets 5–12(–17); pedicels 0.5–1.4(–5)mm, minutely pubescent. Glumes usually glabrous, sometimes minutely hispid or with long (to 1mm) hairs between veins; the lower 3.2–6.2 × 0.9–1.2mm, narrowly lanceolate-triangular, acuminate, blunt, (3–)4–5-veined; the upper 5.9–9.3 × 1.2–1.7mm, similar or more oblong, sometimes mucronate (mucro to 0.7mm), (5–)7–8(–9)-veined. Lowest floret: lemma 7.5–11.8 × 2–2.5mm, usually glabrous, or sometimes with long (to 1mm) hairs between veins, or only between veins near margins, awn 0.6–5.4mm; palea 6.5–9.5 × 0.9–1.5mm; anthers 1.9–2.8(–3.5)mm. Lemmas of upper florets usually with veins hispid near apex and awn longer (6.3–10.6mm), glabrous or hairy between veins. Rachilla internode bearing second floret 1.2–2mm.

Bhutan: C — Ha, Thimphu, Tongsa, Bumthang, Mongar and Tashigang districts; N — Upper Mo Chu (above Gaza Dzong, Laya); ? district (Minde La); **Darjeeling** (Sukia Pokhri to Manibhanjang); **Sikkim** (Lachen, Thanggu, Yakche to Lachung, 10km S of Rabangla, Tsomgo, Chumunko, Tukola, Phullalong). Grassy clearing in juniper/rhododendron scrub; streamside in *Abies*, *Tsuga* and broad-leaved forest; sides of ditches and roads; weed of fields and apple orchard, 1550–4270m. June–October.

Two rather distinct forms of this very variable and widely distributed species occur.

FIG. 30.

a–b, ***Elymus thoroldianus***: a, infl. (× ½); b, spikelet (× 4). c–d, ***Hordeum vulgare***: c, infl. (× ¼); d, trio of spikelets (× ⅔). e, ***H. vulgare*** var. ***trifurcatum***: lemma (× 2). f–h, ***Triticum aestivum***: f, infl. of awnless form (× ½); g, spikelet of awnless form (× 2); h, infl. of awned form (× ⅔). i–k, ***Centotheca lappacea***: i, infl. (× ¼); j, spikelet before fertilisation (× 6); k, spikelet after fertilisation (× 6). l–m, ***Lophatherum gracile***: l, infl. (× ½); m, spikelet (× 5). Drawn by Louise Olley.



VIII. TRITICEAE

The commoner form in Bhutan (but not seen from Sikkim) tends to occur at lower altitudes and in disturbed habitats. It is very robust, with densely hairy spikelets, lemmas with spreading hairs and commonly 9-veined, and at first sight looks very like a species of *Elymus*. Such forms perhaps merit subspecific recognition, but occur sporadically throughout the range of the species. The less common form in Bhutan (but the only one seen from Sikkim) tends to occur at higher altitudes and has spreading, \pm glabrous spikelets (if hairs present on lemmas, then appressed). This latter form was referred (questionably in my opinion) by Veldkamp & van Scheindelen (1989) to var. *pseudo-distachyon* Hook. f. (syn. var. *luzoniense* (Hackel) Hara). Both of our forms tend to have shorter lemmas and awns, and smaller anthers than European material, and further work is clearly required.

49. HORDEUM L.

Tufted annual. Culms erect. Leaf blades flat; ligule membranous, truncate. Infl. a narrow, spike-like panicle, rachis tough, internodes short, flattened, hairy on angles. Spikelets gaping, appressed, borne in groups of 3 (all similar), alternating on opposite sides of rachis (so infl. '6-rowed'), subsessile, not disarticulating; floret single, bisexual; short, hairy rachilla present at base of floret. Glumes borne side by side, linear, tapered into awn, flat, subequal, shorter than spikelet, densely hairy, 3-veined, herbaceous. Lemmas broadly elliptic, gradually narrowed above into awn, strongly convex, 5-veined, coriaceous; awn flat, hispid, straight. Paleas narrowly oblanceolate, subacute, coriaceous, 2-keeled, keels glabrous, margins very broad, inflexed.

Further work is needed on the cultivated barleys of Bhutan and the following account is based on very few collections. Nakao & Nishioka (1984) suggested that the cultivated barleys of Bhutan originated in Tibet.

1. *H. vulgare* L. var. *coeleste* L. Dz: *na*; name at Rukubi *ka*; Sha: *kar feymong, shopa*; Lep: *kutcher zu*; Eng: *barley*. Fig. 30c-d.

Culms 65–110cm, relatively stout, hollow. Leaf blades 9.5–23 × 1.1–1.6cm, narrowly lanceolate, acute, glabrous; sheaths glabrous; ligule c.1.5mm. Infl. 3.5–8 (excl. awns) × 1.5–2cm; rachis internodes c.2.5mm. Spikelets 10–11mm excl. awns. Glumes 4.5–5.5 (excl. awn) × 0.6–0.7mm, awns c.10mm. Lemma c.10 (excl. awn) × 3–4.5mm, hispid on veins, especially above; awn over 9cm, gradually attenuate to fine apex; palea 10–11mm, the back 1.1–2mm wide, the margins c.1.5mm wide; anthers 2.3–2.5mm. Rachilla 3.5–4.1mm (excl. hairs).

Bhutan: C — Ha, Thimphu, Tongsa and Bumthang districts; N — Upper Mo Chu and Upper Pho Chu districts; **Darjeeling; Sikkim; Chumbi.** Cultivated, 1220–3840m. February–October.

Var. *coeleste* is characterised by having 'naked' grains (i.e. the grain is free from the palea and lemma). Nakao & Nishioka (1984) illustrated 'an undescribed new variety' with black grains from Kikhar, Shemgang.

An important cereal at high altitudes and the only grain that can be grown above 3500m. Grown irrigated or dry, sometimes as a second crop after rice (Roder & Gurung, 1990). In Bhutan mainly used for brewing chang, less so for roasting as tsampa (Dz: *kabche*); the varieties grown are still the traditional 'native' ones (W. Roder, pers. comm.). In NW Bhutan it is grown for hay-making (Miller, 1987a) and the straw is used to feed livestock in winter.

var. **trifurcatum** (Schlechtendal) Alefeld; *H. aegiceras* Nees ex Royle. Fig. 30e.

Differs from var. *coeleste* as follows: awn of lemma curiously modified, bearing a hooded structure with 3 downward-pointing triangular lobes enclosing a rudimentary 'glume', apical portion of awn recurved, sometimes bearing a vestigial floret.

Bhutan: C — Bumthang (Byakar Valley) and Mongar (near Mongar Dzong (Nakao & Nishioka, 1984)) districts; ?**Darjeeling**; **Sikkim**. Occasionally cultivated, 1700–2700m. February–October.

Von Bothmer *et al.* (1991) treated this as a forma of var. *coeleste*, and certainly the Bhutan specimen (the only one with ripe seed) has naked grains.

50. TRITICUM L.

Tufted annual. Culms erect. Leaf blades flat; ligule membranous, truncate. Infl. a narrow spike, rachis tough, internodes flattened, widened above, margins ciliate. Spikelets borne singly, alternating on opposite sides of rachis, appressed, sessile, laterally compressed, gaping, disarticulating slowly above glumes and between florets; florets 3–6, bisexual, lower two sessile, the terminal reduced. Glumes opposite, equal, shorter than spikelet, asymmetrically conduplicate, coriaceous, keeled, larger half \pm oblong, \pm truncate, keel produced into stout, rough mucro, veins obscure, numerous, margins hyaline. Lemmas broadly lanceolate, strongly convex, slightly keeled above, c.9-veined, coriaceous; awned or not, awn hispid, straight or curved. Paleas oblong to elliptic, 2-keeled, subacute or bidentate, thinly herbaceous, margins broadly inflexed, keels winged, hispid.

VIII. TRITICEAE

There are very few herbarium collections of wheat from Bhutan and it has not been possible to assign varietal names to any of them. Further studies are required and no doubt some interesting local races will be found.

1. *T. aestivum* L.; *T. vulgare* Villars. Dz: *ka*; Sha: *bong*; Eng: *bread wheat*. Fig. 30f–h.

Culms 60–113cm, relatively stout, hollow. Leaf blades 16.5–21 × 0.6–1.4cm, narrowly lanceolate, acute, glabrous; sheaths glabrous; ligule 1.2–2mm. Infl. 7.5–13 (excl. awns) × c.1.5cm; rachis internodes 3.5–7mm. Spikelets 12.7–15mm excl. awns. Glumes 8.4–9.3mm (excl. mucro), the wider side 3.4–4.1mm wide, glabrous or hairy, mucro 0.6–2.9mm. Lemma 9.5–11.3mm (excl. awn), each half 3–4mm wide, glabrous or hairy near margins; awn 0.4–62mm; palea 9.3–10.1 × 3.3–4mm; anthers 2.3–3mm. Rachilla internode bearing third floret 1.3–2.5mm.

Bhutan: S — Samchi district (Buduni); C — Ha (Ha valley (Nakao & Nishioka, 1984)), Thimphu (Olaka, Lagay), Punakha (Lometsawa, Toiberong Chu) and Tongsa (Shemgang (Nakao & Nishioka, 1984)) districts; **Darjeeling** (Kalimpong; Palmajua to Rimbick (F.E.H.1)); **Sikkim** (Padamchen); **Chumbi**. Cultivated, 350–3000m.

Of the three recent specimens seen from Bhutan three are awned (bearded) and one unawned (beardless), all have glabrous glumes; the Griffith specimen is bearded and glabrous; the 19th century specimens from Sikkim/Darjeeling are as follows: a distinctive beardless form with hairy glumes (Kalimpong and Padamchen); a bearded, glabrous form (Kalimpong and Padamchen) and a bearded, hairy form (Padamchen). Nakao & Nishioka (1984) stated that the Bhutanese wheat varieties originally came from Tibet, but these traditional varieties are now largely replaced by improved ones from India (W. Roder, pers. comm.).

The third most important cereal in Bhutan (after rice and maize). Used for roasting and making into tsampa (Dz: *kabche*), or ground into flour (*kapta*) for making flat bread; less so for alcohol production (brewed as *chang* or distilled as *ara*). It is grown either as a main crop or after rice, or maize, depending on altitude. Also grown as a winter fodder crop or for hay-making (Roder & Gurung, 1990).

Additional cultivated species:

Secale cereale L. (Eng: *rye*) has apparently been cultivated for the last 20 years in Bumthang and Phobjikha, but has not been very successful as it flowers in the monsoon which, as an obligate outcrosser, has an inhibiting effect on seed-set (W. Roder, pers. comm.). No specimens have been seen; it is superficially similar to *Hordeum*, but has singly inserted spikelets. It differs from *Triticum* in having 2-flowered spikelets, subulate glumes and spinulose lemma keels.

Tribe IX. CENTOTHECEAE Ridley

1. Spikelets small (to 6mm); fertile florets 2–3; lowest lemma not apiculate, the upper with deflexed, apical spines **51. Centotheca**
 + Spikelets large (over 7mm); fertile floret 1; lowest lemma apiculate, the upper reduced, lacking spines **52. Lophatherum**

51. CENTOTHECA Desvaux

Tufted perennial. Culms commonly unbranched. Leaf blades flat, narrowly elliptic, cross-veinlets often visible when dry, upper ones \pm clasping, lower ones narrowed into petiole-like base; ligule membranous. Infl. a panicle, branched to 2 orders, branches inserted singly or in pairs, overlapping, ascending. Spikelets borne singly, pedicelled, laterally compressed, disarticulating slowly above glumes and between florets, terminated by rachilla with a minute vestigial floret, pedicels hispid; florets 2–3, bisexual, dissimilar. Glumes rather distant, oblong-lanceolate, minutely apiculate, unequal, shorter than spikelet, weakly conduplicate, keeled, 3-veined, herbaceous, margins hyaline; lowest lemma oblong, blunt, minutely apiculate, weakly conduplicate, glabrous, 5–7-veined, herbaceous; palea linear-oblongate, blunt, 2-keeled, keels minutely hispid, margins inflexed; upper lemma(s) similar in shape to lower but smaller and bearing stout, deflexed, tubercle-based, spine-like cilia near margins above.

1. C. lappacea (L.) Desvaux. Fig. 30i–k.

Culms 29–66cm, geniculately ascending to erect. Leaf blades 7–15.5 \times 1.1–2.7cm, narrowly elliptic, acuminate, glabrous or with a few sparse hairs above, margins sometimes crisped, long-ciliate at extreme base, cross-veinlets often visible when dry; sheaths glabrous, margins densely ciliate; ligule 1–1.5mm, blunt, erose. Infl. greenish, 9.5–23cm, branches bearing numerous, densely arranged, appressed spikelets, lowest branch 3–14cm. Spikelets 5–5.9mm, florets 2(–3), pedicels 1–3mm. Lower glume 2.1–2.6 \times 0.9–1.1mm, apiculus to 0.3mm; upper glume 3.1–3.2 \times 1.1–1.3mm. Lowest floret: lemma 3.6–4.1 \times 1.5–1.8mm; palea 2.6–2.8 \times 0.5mm; anthers c.1mm. Upper floret(s) borne on rachilla internode 1.1–1.5mm; lemma 3–3.8 \times 1.2–1.4mm, spines 0.7–1mm; palea 2.2–3.1 \times 0.3–0.4mm; anthers 0.6–1mm. Terminal rachilla rudiment 1.5–1.7mm.

Bhutan: S — Chukka (Khurul Pokhari, c.3km W of Kalikhola) and Sarbhang (Phipsoo) districts; **Terai** (Sivoke, Sukna); **Darjeeling** (Mungpo); **Sikkim** (Soke). Wet grassland by jungle pool; sal/teak forest, 150–610m. October–February.

The spines on the lemma are an adaptation for animal dispersal.

52. **LOPHATHERUM** Brongniart

Tufted perennial. Culms commonly unbranched. Leaf blades flat, broadly lanceolate, narrowed into petiole-like base, cross-veinlets often visible when dry; sheaths keeled; ligule a very short, minutely ciliate rim. Infl. a lax panicle, branches distant, inserted singly, spreading obliquely at maturity. Spikelets lanceolate, borne singly on primary branches, sessile, laterally compressed, falling entire; fertile floret 1, with c.3 reduced, sterile florets at apex of rachilla. Glumes not distant, unequal, the upper longer, both shorter than spikelet, weakly conduplicate, keeled, blunt, 5–7-veined, thickly herbaceous, margins hyaline. Fertile floret: lemma oblong-lanceolate, weakly conduplicate, stoutly apiculate, glabrous, 7–9-veined, thickly herbaceous; palea linear-oblong, blunt, 2-keeled, keels narrowly winged, margins inflexed. Sterile florets epaleate, lemmas similar in shape to fertile, but much smaller, tightly appressed to fertile floret, but with apiculi protruding.

1. **L. gracile** Brongniart. Fig. 30l–m.

Culms 20–44cm, geniculately ascending to erect. Leaf blades 12–21 × 1.3–3.6cm, broadly lanceolate, acute, glabrous or with a few sparse hairs above, cross-veinlets often visible when dry; sheaths glabrous, margins glabrous; ligule c.0.2mm. Infl. greenish, 17–30cm, branches few, distant, lowest 9.5–11cm. Spikelets 7–8.6mm (incl. apiculi). Lower glume 3.3–3.9 × 1.6–2mm, oblong, apex minutely ciliate; upper glume 4.7–5 × 2–2.5mm, oblong, apex minutely ciliate. Fertile floret: lemma 4.9–5.5 (excl. apiculus) × 2.1–2.8mm, apiculus c.1mm, stout, rough; palea 3.8–5.2 × 0.4–0.6mm; anthers 1.1–1.5mm. Upper florets borne on rachilla internode 2–3.1mm, lowest to 4.5mm, all apiculate.

Terai (Dulkajhar). Habitat not recorded, 150m. October.

Tribe X. **ARUNDINEAE** Dumortier

1. Plants not reed-like, culms usually under 50cm; panicles not plumose 2
- + Plants reed-like, culms usually over 200cm; panicles plumose 3

2. Infl. spike-like, narrowly cylindrical; lemma awns curved, not twisted below **53. Elytrophorus**
- + Infl. a lax panicle or raceme; lemma awns geniculate, the column twisted **54. Danthonia**

- 3 Lemmas with long hairs near margin **55. Arundo**
 + Lemmas glabrous, long hairs present on rachilla internodes
56. Phragmites

53. ELYTROPHORUS P. Beauvois

Tufted annual. Culms geniculately ascending, branched near base. Leaf blades flat, oblong; sheaths glabrous; ligule membranous, truncate-fimbriate. Infl. an interrupted, spike-like raceme, spikelets borne in dense, sessile clusters, subtended by glume-like bracts with long, aristate apices. Spikelets laterally compressed, gaping, disarticulating above glumes and between florets; florets 3–5, bisexual. Glumes keeled, conduplicate, subequal, almost equalling spikelet, 1-veined, midrib green, hispid, produced as long mucro, margins hyaline; lemmas oblong-lanceolate, conduplicate, 3-veined, midrib produced as long, curved mucro, margins narrowly hyaline; palea cuneate, conduplicate, apex trifid, hyaline, keels green, broadly winged.

1. ***E. spicatus*** (Willdenow) A. Camus; *E. articulatus* P. Beauvois. Fig. 31a–b.

Culms 1.5–13cm, upper part appressed-hispid. Leaf blades 6–16 × 0.2–0.3cm, tapering from base to acute apex, minutely hispid on veins above; sheaths glabrous; ligule c.0.5mm. Infl. 3–12.5 × 0.5–0.7cm, axis appressed-hispid. Spikelets 1.6–2.5mm (excl. awns). Lower glume 1.1–1.5mm (excl. awn), hyaline sides 0.25–0.4mm wide, ciliate above, awn 0.3–0.9mm; upper glume similar, usually slightly wider and awn slightly longer. Lowest floret: lemma 1.1–1.5mm (excl. awn), each half c.0.4mm wide, hyaline margins ciliate above, veins minutely hispid, awn 1–2.1mm; palea 1.1–1.6mm, apical teeth ciliate; anthers 0.2–0.4mm.

Bhutan: C — Punakha district (Khuru); unlocalised *Griffith* specimen; **Darjeeling** (Katambari). Rice paddies and wet places, [150–]1250m. July–November.

54. DANTHONIA DC.

Tufted perennial, rhizomes short. Culms unbranched. Leaf blades inrolled, filiform; sheaths glabrous; ligule a ciliate rim. Infl. a terminal panicle or raceme. Spikelets borne singly, pedicelled, gaping, disarticulating above glumes and between florets, rachilla internodes persistent with florets; florets 3–6, bisexual, uppermost sometimes reduced, callus hairy. Glumes oblong-lanceolate, exceeding spikelet (excl. awns), subequal, 3-veined for most of length (with short, subsidiary veins near base), papery; lemmas lanceolate,

X. ARUNDINEAE

rounded on back, apex bifid, lobes with slender awns, stout geniculate awn arising from sinus, with hairs in band at apex, along margins and sometimes all over back, c.7-veined, chartaceous; palea oblong, 2-keeled, back concave, margins inflexed.

1. **D. cumminsii** Hook. f. *D. cachemyriana* sensu F.B.I. (incl. var. *minor* Hook. f.); *D. jacquemontii* Bor; *D. schneideri* Pilger. Eng: *native oat-grass* (Miller, undated). Fig. 31c–d. Plate 5.

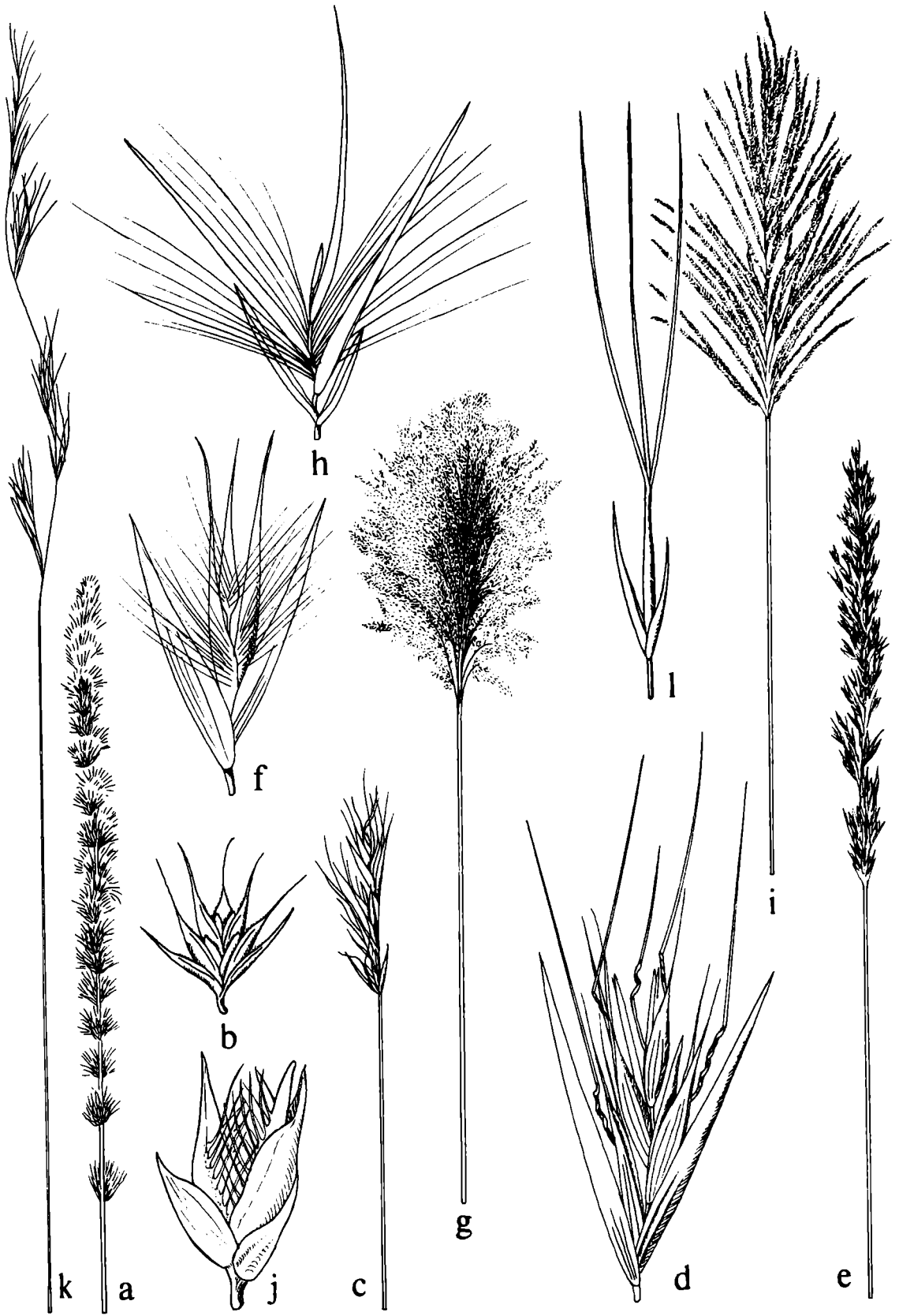
Culms 10–45(–100)cm. Leaf blades 5–23cm, filiform, \pm erect, 0.3–0.6mm wide, glabrous above, glabrous or with short, spreading, bristle-like hairs beneath; sheaths glabrous, usually with tuft of hairs at truncate apex; ligule c.0.4mm. Infl. 2.5–17cm, racemose, or a narrow panicle, with ascending branches. Spikelets 3–30(–60), variable in size, the lowest (largest) 9.4–19(–24)mm, florets 3–4(–6). Glumes purplish or green, sometimes hairy, apex variable, subacute, very acute and bifid, or awn-like; the lower 9–18(–22) \times 1.7–3.3(–3.8)mm, oblong-lanceolate; the upper similar but usually slightly wider. Lowest floret: lemma 4.2–8(–9)mm (to base of central awn), (5–)7(–9)-veined, margins hairy in lower half, with band of hairs around base of awn, central awn 1.5–4.5 + 9.5–23(–29)mm, lateral lobes 5.8–17(–20)mm; palea 6.4–10.7(–12.5) \times 0.7–1.1(–1.3)mm, apex rounded or bifid; anthers 2.6–4.3(–4.7)mm; callus hairs 1.5–4(–6)mm.

Bhutan: S — Sankosh (N side of Daga La) and Deothang (Deothang to Wamrung) districts; C — Ha (Chelai La), Thimphu (Lawgu to Daga Chu, above Phajoding, Chelai La, above Ginekah, hill E of Thimphu) and Sakden (Mera) districts; N — Upper Mo Chu (Laya) and Upper Kulong Chu (Me La to Cho La) districts; **Sikkim** (Nathang, Yumthang, Kopup, Chola, Tsomgo, Jelep La, Thanggu). Alpine pasture; open rocky slopes and cliffs; dry forest (incl. blue pine and *Quercus semecarpifolia*), 2000–4270m. July–November.

An important component of alpine pasture. A very variable species on which further work is required.

FIG. 31.

a–b, **Elytrophorus spicatus**: a, infl. ($\times \frac{2}{3}$); b, spikelet ($\times 5$). c–d, **Danthonia cumminsii**: c, infl. ($\times \frac{2}{3}$); d, spikelet ($\times 3$). e–f, **Arundo donax**: e, infl. of starved form ($\times \frac{1}{4}$); f, spikelet ($\times 4$). g–h, **Phragmites karka**: g, infl. ($\times \frac{1}{9}$); h, spikelet ($\times 4$). i–j, **Thysanolaena latifolia**: i, infl. ($\times \frac{1}{4}$); j, spikelet ($\times 16$). k–l, **Aristida adscensionis**: k, infl. ($\times \frac{2}{3}$); l, spikelet ($\times 3$). Drawn by Louise Olley.



55. ARUNDO L.

Stout, rhizomatous perennial. Culms massive, reed-like, hollow, unbranched or with bamboo-like clusters of slender branches from nodes. Leaf blades flat, oblong-lanceolate, narrowed at extreme base; ligule membranous, truncate, apex minutely fimbriate. Infl. a dense, several times compound, plumose panicle. Spikelets laterally compressed, borne singly, pedicelled, gaping, disarticulating above glumes and between florets, rachilla internodes glabrous, persistent with florets; florets 2–3(–?), bisexual, similar, callus hairy. Glumes subequal, almost equalling spikelet, lanceolate, back \pm rounded, 3–4-veined, papery; lemmas lanceolate-acuminate, rounded on back, apex obscurely bifid, apical lobes with minute, filiform awns, lower part bearing long, silky hairs, c.5-veined, midrib continued as stout apiculus from sinus, thinly herbaceous; palea much shorter than lemma, oblong, 2-keeled, keels densely, short-ciliate, margins inflexed.

1. *A. donax* L. Fig. 31e–f.

Culms to 2(–6)m, stout, 9–15mm wide; lateral branches slender (c.2mm wide). Leaf blades to 45 \times 1–2cm, tapering from just above base to very acute apex, glabrous, occasionally with lateral, basal tufts of hairs at junction with ligule; sheaths glabrous, apex drawn into short auricles either side of leaf blade; ligule 1–1.2mm. Infl. 15–61cm, \pm cylindrical, branches fascicled, overlapping, ascending, the lowest 4.5–26cm, glabrous at base. Spikelets 10.5–12.4mm, florets 2–3. Glumes purplish; the lower 8.6–10.6 \times 1.3–1.8mm, lanceolate, very acute; the upper similar, but usually slightly shorter. Lowest floret: lemma 9.5–10.5 \times 0.8–1.8mm, hairy in lower third, hairs to 5.5mm, (4–)5(–6)-veined, apiculus 1.9–2.7mm, lateral awns to 0.8mm; palea 3.2–4.4 \times 0.7–1mm, usually with some hairs in lower half on back; anthers 2–2.3mm; callus hairs to 2mm; rachilla internode 1.3–1.6mm.

Bhutan: S — Chukka district (c.8km S of Chukka); C — Punakha (Wangdi Phodrang to Samtengang, Ratsoo to Samtengang, Samtengang to Chusom (F.E.H.2)) and Tashigang (c.1km above Tashiyangtse) districts; **Sikkim** (Lingcham, Gangtok). Rocky bank by river; steep rocky slope with scrub, 1220–2000m. October–November.

56. PHRAGMITES Adanson

Stout, rhizomatous perennial. Culms massive, reed-like, hollow, unbranched. Leaf blades flat, oblong-lanceolate, narrowed at extreme base; ligule a fringe of dense, very short cilia. Infl. a dense, several times compound, plumose panicle. Spikelets borne singly, pedicelled, gaping, disarticulating

above glumes and between florets, rachilla internodes with long, silky hairs; florets dissimilar, the lowest male, the upper 2–4 bisexual, uppermost often reduced. Glumes unequal, shorter than spikelet, lanceolate, \pm rounded on back, 3-veined (the upper more strongly), thinly herbaceous, apex hyaline; lowest lemma narrowly lanceolate, rounded on back, very acute, glabrous, 3-veined, thinly herbaceous; palea much shorter than lemma, narrowly oblong, acute, 2-keeled, keels minutely rough, margins inflexed; upper lemmas finely caudate-acuminate, glabrous, 1-veined.

1. ***P. karka*** (Retzius) Trinius ex Steudel. Lep: *langming*. Fig. 31g–h.

Culms to 3(–7)m, stout, 6–19mm wide. Leaf blades 35–50 \times 1–2cm, tapering from just above base to very acute apex, glabrous, with lateral, basal tufts of hairs at junction with ligule; sheaths glabrous, apex drawn into short auricles either side of leaf blade; ligule 0.2–0.5mm. Infl. 30–47cm, broadly cylindrical, branches fascicled, overlapping, ascending, the lowest 17–26cm, silky-hairy at base. Spikelets 9.8–12.5mm, fertile florets 2–4. Glumes purplish drying brown; the lower 2.4–4.2 \times 0.8–1mm, oblong-lanceolate, subacute; the upper 4.1–5.2 \times 0.8–1.2mm, narrowly oblong-lanceolate, acute. Lowest (male) floret: lemma 8.2–9.6mm \times c.1mm; palea 2.4–3 \times 0.4mm; anthers c.13mm. Lowest bisexual floret: lemma 8.5–10.2 \times 0.5–0.8mm; palea similar to that of lower floret; anthers c.1mm. Rachilla internodes 0.6–1mm, hairs to 8mm.

Bhutan: C — Thimphu (Isuna), Punakha (Punakha to Lobesa) and Tashigang (Bomdeling) districts; **Terai** (Dulkajhar, Garidura); **Darjeeling** (Rom Tal). Rough scrub by streams between rice-fields; in ponds and lakes, 150–2250m. September–October.

Veldkamp (1992) argued that the correct name for this is *P. vallatoria* (L.) Veldkamp; however, the identity of the pre-Linnaean basionym of this taxon seems rather too uncertain to warrant the replacement of a well-known name.

Tribe XI. THYSANOLAENEAE C.E. Hubbard

57. THYSANOLAENA Nees

Stout, rhizomatous perennial. Culms reed-like, pith-filled, unbranched. Leaf blades flat, broadly oblong-lanceolate, acuminate, base rounded, abruptly contracted into short, petiole-like base; ligule a truncate, membranous rim. Infl. a dense panicle, branched to 4 orders, branchlets appressed to primary branches. Spikelets small, borne singly, aggregated on short, secund, ultimate

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branchlets, pedicelled, laterally compressed, gaping, falling with pedicels; florets 2(-3), dissimilar, the lowest sterile, epaleate, the upper bisexual, sometimes a reduced terminal one present. Glumes shorter than spikelet, unequal, the lower slightly smaller than the upper, ovate-lanceolate, back \pm rounded, subacute to sharply acuminate, 1-veined, thinly herbaceous, margins hyaline; lowest lemma equalling spikelet, oblong-lanceolate, strongly convex, acuminate to apiculate, glabrous, very weakly 3-veined, thinly herbaceous; upper lemma lanceolate, conduplicate, keeled, acute, 3-veined, with row of long, rigid cilia near margin; palea minute, oblong, keels minutely ciliate.

1. *T. latifolia* (Roxb. ex Horneman) Honda; *T. maxima* (Roxb.) Kuntze; *T. agrostis* Nees. Sha: *tsakusha*, *beyshawa*; Lep: *pushok-tim*, *pachyor*; Nep: *amliso*, *phul jharu*. Fig. 31i-j. Plate 6.

Culms to 3m, c.0.5cm wide, often arching. Leaf blades (9-)24-59 \times (0.9-)3-6.5cm, glabrous, coriaceous, petiole-like base to 0.5cm, usually dark-coloured; sheaths glabrous, rigid, margins occasionally ciliate near apex; ligule c.1.3mm. Infl. purplish-brown, drying pale brown, (13-)22-76cm, broadly cylindrical, branches suberect, borne singly or fascicled, overlapping, shortly hairy at base on upper side, the lowest 19-56cm. Spikelets 1.4-1.9mm. Lower glume 0.6-0.9 \times 0.4-0.6mm; upper glume 0.8-1.1 \times 0.4-0.7mm. Sterile floret: lemma 1.3-1.8mm \times c.0.7mm, margins occasionally minutely ciliate. Fertile floret: lemma 1.3-1.6mm, each half c.0.4mm wide, cilia to 1mm; palea 0.4-0.7 \times 0.1-0.2mm, oblong, apex truncate or slightly notched; anthers 0.4-0.9mm.

Bhutan: S — Samchi (Kharpage Hill), Phuntsholing (Phuntsholing), Sarbhang (Burborte Khola) and Gaylegphug (Gaylegphug, c.12km N of Gaylegphug, above Shamkhara) districts; C — Tongsa district (Berthi (M.F.B.)); **Darjeeling** (Lebong to Badamtam, Little Rangit, Tista, Bamunpokri); **Sikkim** (near Yoksam, Gangtok, Rungbi). Banks in subtropical forest, often disturbed places (e.g. roadsides); cliffs in disturbed scrub; sometimes cultivated in gardens, 200-1800m. December-August.

Infls. used for making brooms. Also used medicinally in Sikkim: roots used dry or fresh to make a paste to apply to boils and root extract used as a mouth-wash (Rai & Sharma, 1994).

Tribe XII. ARISTIDEAE C.E. Hubbard

58. ARISTIDA L.

Tufted annual. Culms slender, branched below. Leaf blades inrolled, linear, acute; ligule membranous, truncate-ciliate. Infl. a narrow, flexuous panicle,

branched to 2 orders, branches ascending. Spikelets borne singly, pedicelled, gaping, disarticulating above glumes; floret 1, bisexual. Glumes persistent, shorter than spikelet, linear-lanceolate, back \pm rounded, unequal, 1-veined, thinly herbaceous. Lemma equalling spikelet, narrowly cylindrical, very strongly convex, with 3 apical awns, glabrous, weakly 3-veined, coriaceous; palea minute, oblong, obscurely 2-keeled; callus sharp, hairy.

1. **A. adscensionis** L. Fig. 31k-l.

Culms to 55cm, ascending. Leaf blades to 7cm, to 1.6mm wide, glabrous beneath, hispid on veins above, margins wide, glabrous; sheaths glabrous, weakly keeled; ligule c.0.4mm. Infl. drying greenish-white, to 18 \times 2cm, narrow, flexuous, branches suberect, borne singly, overlapping, the lowest to 4cm. Spikelets c.7mm (excl. awns). Lower glume purplish, c.4.4 \times 0.8mm, very acute, weakly keeled, keel minutely hispid; upper glume c.6.5 \times 0.9mm, not keeled, midrib \pm smooth, sometimes minutely excurrent. Lemma dark purplish, c.6.3 (excl. awns) \times 0.4mm, narrowly cylindrical, passing smoothly into terminal awns, midrib minutely hispid, awns flattened, margins hispid, the central one c.14.5mm, the laterals c.12.6mm; palea c.0.8 \times 0.2mm, oblong, apex blunt; callus c.0.4mm, hairs to 0.9mm.

Bhutan: C — Tashigang district (Manas Valley below Tashigang). Dry, gravelly roadsides, 800m. October.

Tribe XIII. ERAGROSTIDEAE Stapf

- | | |
|---|---------------------------|
| 1. Infl. of digitately arranged spikes | 2 |
| + Infl. paniculate or a single spike | 3 |
| 2. Midrib of spike rachis bearing a terminal spikelet; upper glume not mucronate | 64. Eleusine |
| + Midrib of spike rachis ending in a sharp, sterile point; upper glume mucronate | 65. Dactyloctenium |
| 3. Infl. a single spike | 4 |
| + Infl. paniculate, though sometimes narrowly so | 5 |
| 4. Lemmas with midrib extended into long awn and lateral veins into shorter awns; if not awned then spikelet with c.2 florets ... | 61. Tripogon |
| + Lemmas awnless; spikelets with 9 or more florets | 63. Eragrostiella |
| 5. Lemmas awned or mucronate | 6 |
| + Lemmas not awned | 7 |

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6. Tall reed-like grass, culms stout; florets several **59. Neyraudia**
+ Culms slender; floret single **67. Muhlenbergia**
7. Floret single **66. Sporobolus**
+ Florets several 8
8. Lemmas appressed-hairy both sides of midrib and between lateral
veins and margins; ligule membranous **60. Leptochloa**
+ Lemmas glabrous; ligule a ciliate rim **62. Eragrostis**

59. NEYRAUDIA Hook. f.

Stout, reed-like, shortly rhizomatous perennials. Culms erect, branched, solid. Leaf blades flat; sheaths glabrous; ligule a minute, ciliate rim, with a line of long cilia behind. Infl. a plumose panicle, branched to several orders, primary branches \pm whorled. Spikelets borne singly, gaping at maturity, disarticulating above the sterile floret and between the fertile florets. Glumes subequal, shorter than spikelet, lanceolate, subacute, 1-veined, thinly herbaceous; lowest floret consisting of a sterile, persistent, glume-like, epaleate lemma, or fertile and paleate; upper florets 5–7, fertile, the uppermost sometimes reduced and sterile, others all similar, bisexual; lemmas lanceolate, gradually drawn into mucro, 3-veined, long-hairy on margins, herbaceous; paleas narrowly oblong, apex notched, 2-keeled, hyaline.

Often confused with *Arundo* or *Phragmites* because of its habit and plumose panicles; from both of these it differs in its much smaller glumes, and in having a line of short cilia at the junction between the underside of the leaf blade and sheath. From *Arundo* it differs in having lemmas hairy only on the margins (rather than on the back), and from *Phragmites* in having lemmas with long marginal hairs (rather than glabrous, but with long hairs on the rachilla internodes).

1. Lowest floret sterile, palea absent, lemma glabrous; glumes acuminate, equal **1. N. arundinacea** var. **zollingeri**
+ Lowest floret fertile, palea present, lemma hairy on margins; glumes blunt, unequal **2. N. curvipes**

1. N. arundinacea (L.) Henrard var. **zollingeri** (Büse) Henrard; *N. reynaudiana* (Kunth) Keng ex Hitchcock; *N. madagascarensis* (Kunth) Hook. f. var. *zollingeri* (Büse) Hook. f. Sha: *khangru*; Nep: *situ*, *siku*, *ghungring*. Fig. 32a–b.

Very variable in stature and leaf width. Culms 0.85–3m, 2–10mm in diameter. Leaf blades to 70cm, 0.3–2.2cm wide, many-veined, glabrous;

mature leaf sheaths straw-coloured, glabrous, shining, with line of short cilia at junction with underside of leaf blade, apex oblique, with tuft of long cilia at either side of leaf blade; ligule with minute (c.0.1mm), white, terminal cilia, dorsal cilia long, 2–5mm, brownish. Infl. pale purplish, 8–70 × 2–16cm, nodding to one side; primary branches to 25cm, slender, branched to 3 orders. Spikelets 6.1–9.3mm, fertile florets 4–6; pedicels slender. Glumes 1.7–2.7 × 0.4–0.8mm; sterile lemma 2.4–3.4 × 0.6–0.9mm, persisting with glumes. Lowest fertile floret: lemma 3.5–5.3 × 0.8–0.9mm, mucro 0.3–1.3mm, recurved when dry, hairs on margins white, c.2.5mm; palea 2.2–3.1 × 0.3–0.5mm; anthers 1–1.6mm.

Bhutan: S — Samchi (Chenari Khola, Daina Khola), Phuntsholing (Phuntsholing), Chukka (Gedu to Kharbandi, Kyacha), Gaylegphug (Betni) and Deothang (between Polytechnic and Deothang village) districts; C — Punakha (Lobesa to Tinlegang), Tongsa (below Shemgang, Tongsa) and Tashigang (1km NE of Tashigang, Kiri) districts; **Terai** (Balasun); **Darjeeling** (Sureil, Mungpo, Selim, Ryang, Tista Bridge, Rishap, Kurseong, ?Kyel, Ramman, Badamtam, Darjeeling, Rungbee, Great Rangit valley, Bamunpokri); **Sikkim** (Yoksam, Gangtok). Banks and cliffs in warm broad-leaved and subtropical forest; banks in dry scrub, 200–1830(–2100)m. October–April.

Poisonous to buffalo according to note on a Gamble specimen.

2. *N. curvipes* Ohwi. Fig. 50a.

Culm leaf blades twisted at base, so upper and lower surfaces 'reversed', the abaxial glabrous, the adaxial sparsely hairy, glaucous. Infl. similar to *N. arundinacea* var. *zollingeri*, but differing as follows: spikelets with fewer (c.4) florets; glumes oblong-elliptic, blunt, very unequal, the lower 2.6–2.8mm, the upper 3.7–4mm, curved; lowest floret fertile, deciduous, the lemma 5–5.8mm, margins long-hairy towards base, palea present.

Bhutan: S — Deothang district (S of Riserboo). Dry roadside banks and cliffs; broad-leaved forest, 2150–2300m. Winter-flowering.

60. LEPTOCHLOA P. Beauvois

Annual. Culms simple or with few, suberect branches. Leaf blades flat; ligule membranous, truncate-ciliate. Infl. a lax panicle, branches ± whorled, axis three-angled, hispid. Spikelets borne singly on one side of branches, laterally compressed, shortly pedicelled, disarticulating between florets, glumes persistent; florets several, bisexual. Glumes shorter than lowest lemma, unequal, hyaline; the lower lanceolate, keeled, 1-veined, keel minutely hispid;

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the upper oblong-elliptic, keeled, 1-veined. Lemmas oblong-elliptic, blunt or emarginate, keeled, 3-veined, thinly herbaceous. Paleas falling with lemmas, narrowly oblong, 2-keeled, hyaline, keels minutely hispid, margins inflexed.

1. *L. chinensis* (L.) Nees. Fig. 32c–d.

Culms to 40(–70)cm, erect, or base decumbent and rooting from nodes. Leaf blades to 17 × 0.7cm, oblong, acute, glabrous; sheaths glabrous; ligule c.0.8mm, cilia to 1.7mm. Infl. to 23(–30) × 6cm, cylindric, branches to 7cm, obliquely ascending. Spikelets brownish-green flushed purplish, c.3.6 × 0.7mm, florets c.5; pedicels c.0.5mm. Lower glume c.1.2 × 0.4mm, lanceolate, acute, keel hispid; upper glume c.1.6 × 0.7mm, oblong-elliptic, subacute, midrib minutely excurrent. Lowest floret: lemma c.1.6 × 1mm, oblong-elliptic, blunt or minutely emarginate, shortly appressed-hairy between lateral veins and margin and either side of midrib; palea c.1.6 × 0.5mm, narrowly oblong-elliptic, truncate, keels extremely minutely hispid, back appressed-hairy; anthers c.0.3mm; grain c.0.7 × 0.3mm, oblong in outline, slightly compressed in section, narrowed to base, minutely rough.

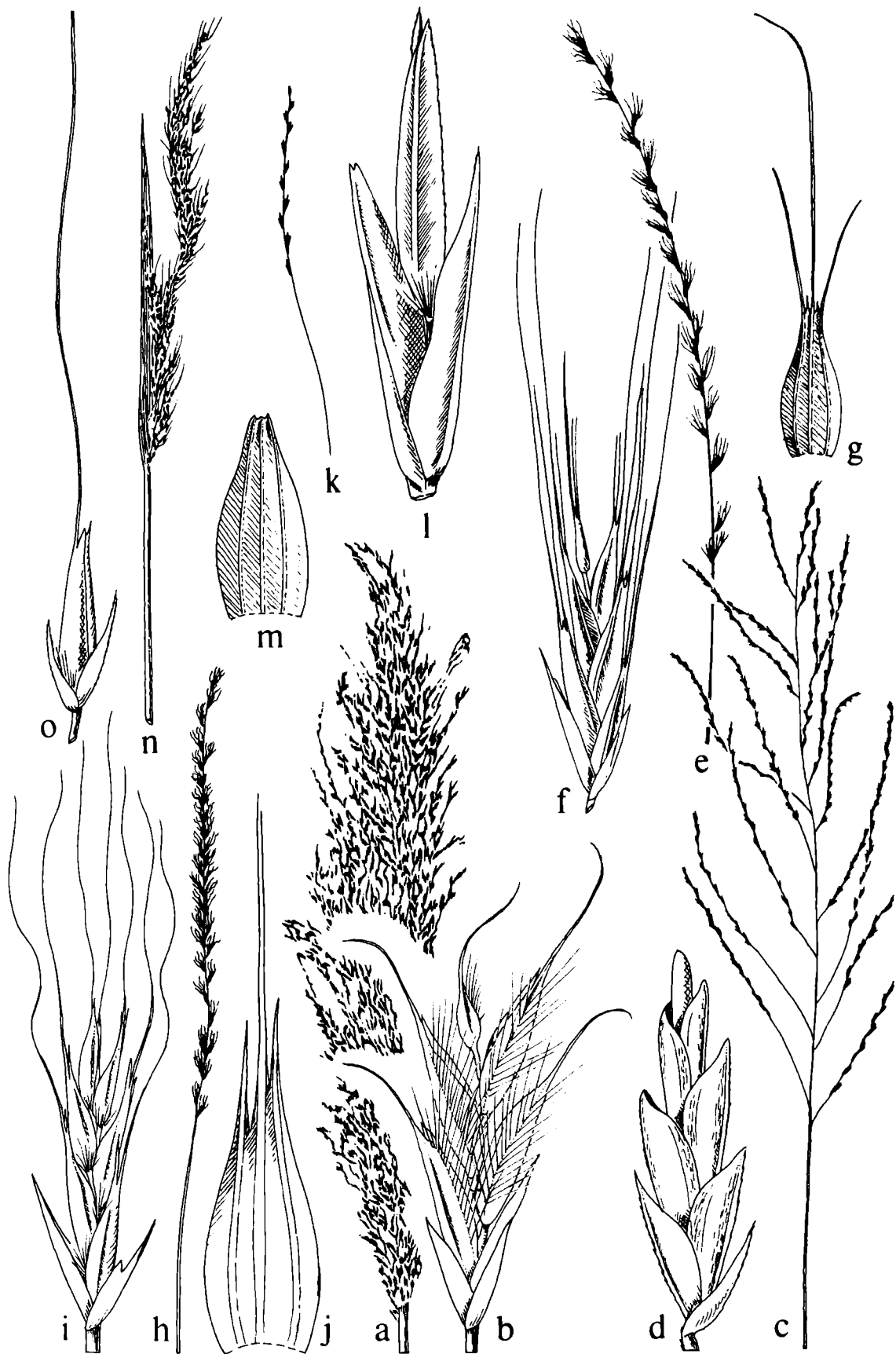
Bhutan: S — Deothang district (slopes of Diu Ri valley). By footpath in partially cleared jungle, 1000m. June.

61. *TRIPOGON* Roemer & Schultes

Tufted perennials. Culms unbranched, erect. Leaf blades filiform, inrolled; sheaths glabrous; ligule a minute, truncate-fimbriate rim. Infl. a linear, spike-like raceme. Spikelets laterally compressed, sessile, borne singly, sunk into rachis, disarticulating above glumes and between florets, florets several, similar, bisexual (uppermost sometimes reduced); callus hairy. Glumes unequal, dissimilar, 1-veined; the lower lanceolate, sides hyaline, sometimes asymmetric with one side deeply toothed; the upper oblong-lanceolate, midrib usually slightly excurrent. Lemmas lanceolate, convex, 3-veined, veins produced into points or awns to various degrees at apex, sometimes with teeth between outer points and central awn, herbaceous. Paleas narrowly oblong to oblanceolate, blunt, hyaline, 2-keeled, margins incurved.

FIG. 32.

a–b, *Neyraudia arundinacea* var. *zollingeri*: a, infl. (× ¼); b, spikelet (× 6). c–d, *Leptochloa chinensis*: c, infl. (× ½); d, spikelet (× 12). e–g, *Tripogon filiformis*: e, infl. (× ⅔); f, spikelet (× 6); g, lemma (× 6). h–j, *T. trifidus*: h, infl. (× ¼); i, spikelet (× 4); j, lemma (× 8). k–m, *T. purpurascens*: k, infl. (× ⅔); l, spikelet (× 12); m, lemma (× 8). n–o, *Muhlenbergia huegelii*: n, infl. (× ⅓); o, spikelet (× 6).
Drawn by Louise Olley.



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1. Spikelets not awned 3. **T. purpurascens**
+ Spikelets awned 2

2. Apex of lemmas with lobes between the points/awns produced from each of the three veins; spikelets small (lower glume to 3mm; upper glume to 4.5mm; lowest lemma to 3mm (to base of central awn))

1. T. filiformis

- + Apex of lemmas with no intermediate lobes between central and lateral awns; spikelets larger (lower glume over 3.5mm; upper glume over 5mm; lowest lemma over 4mm (to base of central awn))

2. T. trifidus

1. T. filiformis Nees ex Steudel. Sikkim name: *lobaygyam*. Fig. 32e-g.

Culms 4–20cm, slender, erect. Leaf blades 6–12cm, filiform (0.4–1mm wide), inrolled, glabrous beneath, upper surface with sparse, long cilia; sheaths glabrous; ligule truncate-fimbriate, c.0.1mm. Infl. (2–)9–24cm, very variable, spikelets scarcely overlapping and spreading obliquely, or densely overlapping and suberect. Spikelets (excl. awns) 3.6–7.5mm, fertile florets 4–5(–10), sometimes with a small, terminal, sterile one. Lower glume 2.4–2.9 × 0.5–0.9mm, marginal tooth not reaching halfway; upper glume 3.1–4.3 × 0.5–1mm, mucro to 0.8mm. Lowest floret: lemma 2–3 (to base of central awn) × 0.7–1.4mm, with 2 short, hyaline teeth between the awns continuing the midrib and outer veins; central awn (2.3–)4–7mm, often recurved; lateral awns (0–)1.5–3.5mm; intermediate teeth 0.1–0.7mm; palea 1.9–2.8 × (0.2–)0.5–0.6mm, oblanceolate; anthers 0.6–0.9mm.

Bhutan: S — Chukka (Chapcha to Bunakha) and Deothang (Kheri Gompa, Riserboo to Wamrong) districts; C — Ha, Thimphu, Punakha, Tongsa, Bumthang, Mongar and Tashigang districts; N — Upper Mo Chu district (below Gangyuel); **Darjeeling** (Dumsong, Ghoom to Sukia Pokhri); **Sikkim** (near Yoksam, Lachen, Lachung, Domang, Bakhim, Rishi, Pemayangtse); **Chumbi**. Very common on dry rocks and walls (also chortens); steep grassy hillside, 1170–3740m. June–October.

Further work is required on this variable species. Specimens from low altitudes (under 1900m) from the dry Mongar and Tashigang valleys and Rishi have lemmas lacking, or with very short, lateral awns. Alpine forms (over 3500m) have shorter, denser infls. and lemmas sometimes with relatively short central awns. The form with slender spikes and small spikelets described as var. *tenuispica* Hook. f. and recorded for Sikkim, however, is not worth recognising.

2. T. trifidus Munro ex Stapf. Fig. 32h-j.

Differs from *T. filiformis* as follows: plant stouter, culms to 30cm; leaf

blades glabrous, to 2.6mm wide; spikelets longer (c.10mm); lower glume longer (c.3.8mm), marginal tooth reaching above halfway; upper glume longer (c.5.1mm); lemmas longer (c.4mm to base of central awn), lacking hyaline teeth between central awn and those produced from lateral veins; central awn longer (c.11mm), lateral awns c.1.3mm; palea longer and wider (c.3.8 × 0.7mm).

Bhutan: S — Chukka district (c.2km below Chimakothi); ?**Sikkim** (Lachung). Seasonally dripping, open rock-ledges, in scrubland, 1800–1950m. August–September.

There is some doubt if the Hooker specimen from Sikkim (a syntype) bears the correct label, since all other specimens from Lachung are *T. filiformis* and the other syntypes are from Khasia.

3. *T. purpurascens* Duthie. Fig. 32k–m.

Densely tufted, forming tough clumps. Culms to 6cm, filiform. Leaf blades 2–4cm, filiform (c.0.3mm wide), inrolled, glabrous beneath, upper surface densely covered with short, appressed hairs and with longer cilia near margins; sheaths glabrous, with tufts of white cilia at apex; ligule c.0.15mm, truncate-fimbriate, with line of cilia (to 0.9mm) behind, at junction with leaf blade. Infl. 2.5–4.5cm, linear, spikelets scarcely overlapping. Spikelets purplish, c.4.4mm, florets 2. Lower glume c.2.2 × 0.3mm, narrowly triangular, symmetrical, very acute, keel minutely hispid; upper glume c.3.4 × 0.7mm, oblong-lanceolate, acute. Lowest floret: lemma c.3 × 1mm, oblong-elliptic, apex minutely bifid, midrib minutely produced, not exceeding lateral lobes; palea c.2.6 × 0.5mm, narrowly oblong.

Bhutan: C — Thimphu district (between Shaba and Chuzom). Steep gullies/water-courses (rapidly drying) on open, stony hillsides with poor grassland, 2200m. August.

62. ERAGROSTIS N.M. Wolf

Tufted annuals or perennials. Culms simple or with few, suberect branches. Leaf blades flat or inrolled, margins sometimes glandular; ligule a small, ciliate rim. Infl. a compound panicle, usually branched to 2 orders, branches sometimes short, when infl. spike-like. Spikelets laterally compressed, borne singly, disarticulating between florets and above and beneath glumes (spp. 1–4) or rachilla persistent, with glumes and lemmas deciduous from base upwards (spp. 5–15); florets bisexual; pedicels sometimes glandular. Glumes lanceolate, shorter than lowest lemma, usually unequal with the upper larger, keeled, 1-veined, hyaline, keel minutely hispid, margins usually glabrous. Lemmas

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lanceolate to ovate, keeled, 3-veined, herbaceous (sometimes thinly), margins usually glabrous. Paleas deciduous or persistent, narrowly oblong to oblanceolate, 2-keeled, hyaline, margins inflexed, keels minutely hispid to long-ciliate.

1. Spikelet axis fragile, disarticulating, florets falling from apex downwards; palea keels often long-ciliate 2
- + Spikelet axis tough, persistent, florets falling from base upwards; palea keels never long-ciliate 5

2. Spikelets 1–2.1(–2.5)mm; panicles very lax, branches distinct, slender 3
- + Spikelets 2.2–4.8mm; panicles densely cylindric, branches very short ... 4

3. Keels of palea long-ciliate (cilia c.0.2mm) **1. E. tenella**
- + Keels of palea minutely hispid (hairs under 0.1mm) **2. E. japonica**

4. Margins of glumes and lemmas minutely ciliate, at least near base
3. E. coarctata
- + Margins of glumes and lemmas not ciliate **4. E. viscosa**

5. Pedicels and/or leaf margins glandular—glands raised and circular, or a broad band differing in colour and texture from rest of pedicel ... 6
- + Pedicels and leaf margins eglandular 8

6. Plant lacking raised glands, pedicels with a smooth, pale glandular band; perennial **8. E. ferruginea**
- + Plant with raised, crater-like glands on leaf margins, usually also on pedicels; annual 7

7. Spikelets small (to 6.3 × 2mm), equal **5. E. minor**
- + Spikelets large, rather unequal in size throughout infl., the larger to 7 × 2.5mm **6. E. cilianensis**

8. Spikelets over 5mm, over 1.5mm wide 9
- + Spikelets under 5mm, under 1.2mm wide (if occasionally to 1.7mm, then blackish) 12

9. Pedicels long (longest over 10mm), filiform; grain subglobose; axils of infl. branches with long hairs; paleas persistent **9. E. tremula**
- + Pedicels short (longest under 10mm); grain distinctly longer than wide; axils of infl. branches glabrous; paleas persistent or deciduous..... 10

10. Infl. branches and pedicels very short, so spikelets clustered; grain widely oblong in outline (c.0.5 × 0.4mm); paleas persistent
12. E. zeylanica
- + Infl. branches and pedicels developed, so spikelets not clustered; grain narrowly oblong-elliptic in outline; paleas deciduous 11
11. Spikelets over 2.3mm wide, whitish flushed purplish-pink; annual or short-lived perennial, culms to 40cm **10. E. unioloides**
- + Spikelets under 2.4mm wide, greenish-grey; perennial, culms to 88cm
11. E. atrovirens
12. Spikelets blackish, over 1.2mm wide; grain grooved along one of long edges **7. E. nigra**
- + Spikelets under 1.2mm wide, not blackish; grain not grooved 13
13. Branches single or paired; lemmas herbaceous (opaque) **13. E. gangetica**
- + Branches ± whorled; lemmas very thinly herbaceous (semi-transparent) 14
14. Axils of infl. branches and apex of leaf sheaths with tufts of long hairs; culms usually over 10cm; infl. very effuse, lowest branch over 4cm **14. E. pilosa**
- + Axils of infl. branches and apex of leaf sheaths glabrous; culms usually under 10cm; infl. compact, lowest branch under 1.5cm **15. E. multicaulis**

1. E. tenella (L.) P. Beauvois ex Roemer & Schultes. Fig. 33a-c.

Tufted annual. Culms 5–31cm, simple or sparingly branched, leafy throughout. Leaf blades 1.7–6 × 0.2–0.5cm, flat or inrolled, narrowly lanceolate, acute, glabrous except for tuft of long hairs at extreme base; sheaths glabrous except for line of long hairs at junction with underside of leaf blade; ligule a line of cilia 0.2–0.4mm. Infl. 2.5–11 × 1–3.5cm, cylindric, effuse, branches inserted singly or lowest paired, glabrous or with hairs in axils, the lowest 0.7–3cm. Spikelets whitish or purplish, 1.3–2.1 × 0.9–1.6mm, florets 3–7, disarticulating from above, glumes eventually falling. Lower glume 0.6–0.8 × 0.4–0.5mm, ovate, blunt; upper glume 0.7–1 × 0.5–0.6mm, ovate, acuminate. Lowest floret: lemma 0.9–1 × 0.6–0.7mm, ovate, subacute, glabrous; palea 0.8–1 × 0.2–0.4mm, oblanceolate, truncate, keels long-ciliate, cilia c.0.2mm; anthers c.0.2mm; grain c.0.5 × 0.25, oblong-ellipsoid, round in section.

Bhutan: C — Punakha (near Punakha Dzong, Baso Chu to Ruri Chu), Mongar (Mongar to Kuru Chu) and Tashigang (Tashigang) districts; **Darjeeling** (Rayang); **Sikkim** (Rongni Chhu above Singtam, Rangpo); **Terai**

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(Balasun). Open grassland on silty soil near river; disturbed places (e.g. paths, gardens); roadside in chir pine forest, 150–1300m. April–October.

2. *E. japonica* (Thunberg) Trinius; *E. interrupta* sensu F.B.I.; *E. diarrhena* (Schultes) Steudel; *E. diplachnoides* Steudel. Fig. 33d–f.

Tufted annual. Culms 2–62cm, usually with ascending branches, leafy throughout. Leaf blades 4–31 × 0.3–0.6cm, flat, narrowly oblong, very acute, glabrous; sheaths glabrous; ligule c.0.5mm, truncate-ciliate. Infl. 9–56 × 2–4cm, cylindrical, effuse, branches inserted in slightly interrupted whorls of 2–6, glabrous in axils, the lowest 2–6.5cm. Spikelets brownish or greenish (occasionally slightly purplish), 1–1.5 × 1–1.5mm, florets 2–5, disarticulating from above, glumes persistent. Lower glume 0.6–0.8 × 0.4–0.5mm, ovate, acute; upper glume 0.7–0.8 × 0.5–0.6mm, oblong-ovate, subacute. Lowest floret: lemma 0.8–1 × 0.4–0.8mm, oblong, blunt, glabrous; palea 0.7–0.8 × 0.2–0.3mm, oblong, blunt, keels minutely hispid (hairs under 0.1mm); anthers c.0.2mm; grain c.0.5 × 0.25, oblong-ellipsoid, round in section.

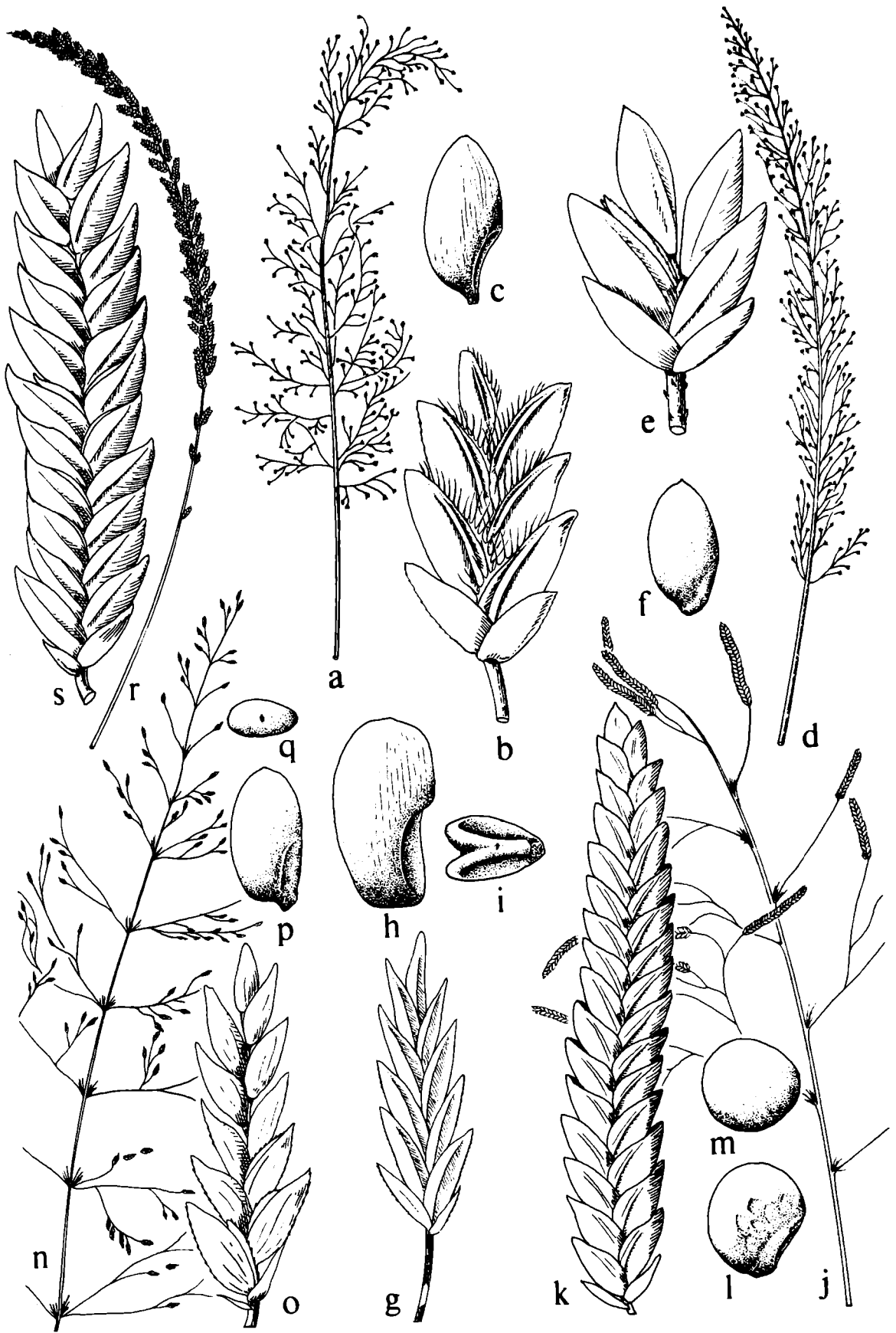
Bhutan: S — Samchi (Dwarapani) and Phuntsholing (Phuntsholing) districts; **Terai** (Balasun, Siliguri, Jalpaiguri). Habitat not recorded [presumably river banks, ditches etc.], 90–300m. October–March.

3. *E. coarctata* Stapf. Fig. 34a–e.

Tufted perennial. Culms 6.5–57cm, simple or branched, erect or bases decumbent and rooting from nodes. Leaf blades 2.5–19 × 0.3–0.4cm, flat or inrolled, narrowly oblong, acute, glabrous; sheaths glabrous except for line of long hairs at junction with underside of leaf; ligule 0.1–0.3mm, truncate-ciliate. Infl. 2.5–18.5 × 0.6–2cm, densely cylindrical, spike-like, branches scarcely developed, the lowest 0.5–2.2cm. Spikelets purplish, 2.2–4.8 × 1–1.8mm, florets 4–10, disarticulating very slowly from above, glumes eventually falling. Lower glume 1.1–1.4 × 0.5–0.7mm, oblong-lanceolate, subacute, margins minutely ciliate; upper glume 1.3–1.5 × 0.5–0.8mm, oblong-lanceolate, acute, gland-dotted, margins ciliate below. Lowest floret: lemma 1.4–2 × 0.8–1mm, oblong-lanceolate, acute, margins ciliate; palea 1.1–1.4 × 0.3–0.4mm, oblong,

FIG. 33.

a–c, ***Eragrostis tenella***: a, infl. (× ½); b, spikelet (× 20); c, grain (× 40). d–f, ***E. japonica***: d, infl. (× ½); e, spikelet (× 20); f, grain (× 40). g–i, ***E. ferruginea***: g, spikelet showing gland on pedicel (× 5); h, grain from side (× 20); i, grain from bottom showing lateral groove (× 20). j–m, ***E. tremula***: j, infl. (× ½); k, spikelet (× 4); l, grain from side (× 20); m, grain from top (× 20). n–q, ***E. pilosa***: n, infl. (× ½); o, spikelet (× 10); p, grain from side (× 20); q, grain from top (× 20). r–s, ***Eragrostiella nardoides***: r, infl. (× ½); s, spikelet (× 6.6). Drawn by Louise Olley.



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blunt, keels long-ciliate, cilia 0.3–0.5mm; anthers 0.3–0.5mm; grain 0.6–0.7 × 0.3–0.4, oblong-ellipsoid, round in section.

Bhutan: S — Samchi (Samchi High School) and Phuntsholing (Torsa River at Phuntsholing) districts; **Terai** (Siliguri); **Darjeeling** (junction of Great and Little Rangit Rivers, Tista Valley). River shingle; rough grassland, 200–500m. August–May.

4. *E. viscosa* (Retzius) Trinius; *E. tenella* (L.) P. Beauvois ex Roemer & Schultes var. *viscosa* (Retzius) Stapf. Fig. 34f–g.

Similar to *E. coarctata* in its spikelets and dense, spike-like panicle, but differs as follows: glumes smaller, margins glabrous; lemmas smaller (lowest c.1 × 0.6mm), margins glabrous; cilia on palea keels shorter (c.0.2mm). Differs from *E. tenella* in its denser panicle and larger spikelets.

Bhutan: S — Phuntsholing district (Torsa River above Phuntsholing). River shingle, 230m. October.

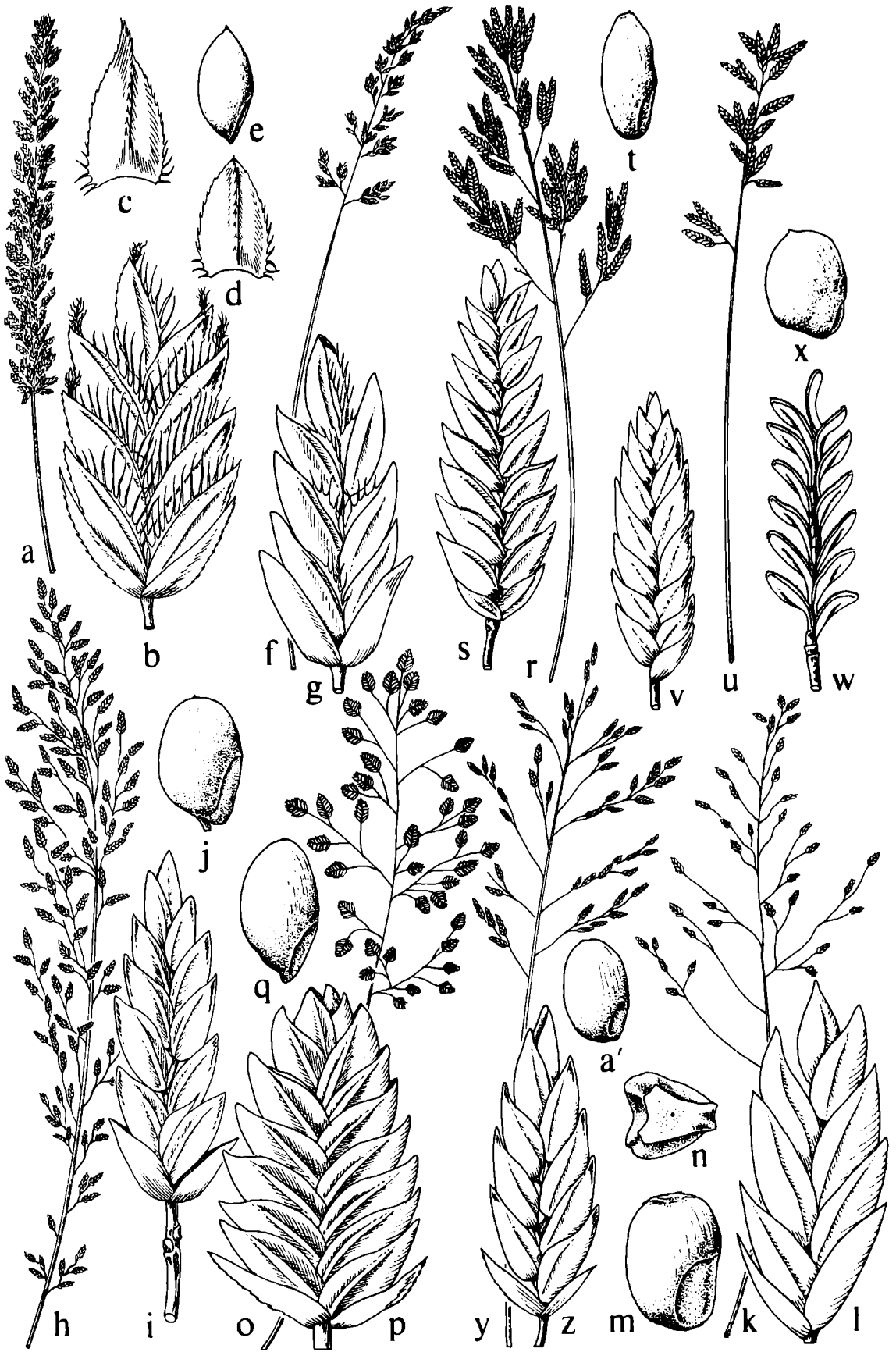
Apparently viscid in life, but impossible to tell from herbarium specimens.

5. *E. minor* Host; *E. poaeoides* P. Beauvois. Fig. 34h–j.

Tufted, glandular annual. Culms 10–20cm, ± erect, simple or with few, erect branches. Leaf blades 6.5–10 × 0.2–0.3cm, flat or inrolled, narrowly oblong, acute, margins with raised, circular glands, with sparse, long, spreading hairs above and sometimes also beneath; sheaths with sparse hairs along margins and at apex, margins with raised, circular glands; ligule densely ciliate, cilia 0.3–0.7mm. Infl. 10–16 × 2–4.5cm, widely cylindric, lax, branches single or paired, ascending, with a few hairs in axils, the lowest 2.7–4.5cm; pedicels bearing raised, circular glands. Spikelets purplish-grey, 3.4–6.3 × 1.5–2mm, florets 6–12, glumes and lemmas deciduous from base upwards, paleas persistent on rachilla. Lower glume 1–1.2 × 0.6–0.8mm, narrowly ovate, acuminate,

FIG. 34.

a–e, *Eragrostis coarctata*: a, infl. (× 2/3); b, spikelet (× 10); c, lower glume (× 12); d, upper glume (× 12); e, grain (× 16). f–g, *E. viscosa*: f, infl. (× 2/3); g, spikelet (× 16). h–j, *E. minor*: h, infl. (× 2/3); i, spikelet showing glands on pedicel (× 6.6); j, grain from side (× 20). k–n, *E. nigra*: k, infl. (× 2/3); l, spikelet (× 10); m, grain from side (× 20); n, grain from bottom showing lateral groove (× 20). o–q, *E. unioides*: o, infl. (× 2/3); p, spikelet (× 10); q, grain from side (× 20). r–t, *E. atrovirens*: r, infl. (× 2/3); s, spikelet (× 5); t, grain (× 16). u–x, *E. zeylanica*: u, infl. (× 2/3); v, spikelet (× 6.6); w, spikelet showing persistent paleas (× 6.6); x, grain (× 20). y–a', *E. gangetica*: y, infl. (× 2/3); z, spikelet (× 5); a', grain (× 20). Drawn by Louise Olley.



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keel with large, circular glands, surface minutely glandular; upper glume similar to lower, slightly larger. Lowest floret: lemma 1.5–1.6 × 1.1–1.3mm, widely elliptic, acute, minutely glandular; palea 1.1–1.3 × 0.5–0.6mm, oblanceolate, blunt, keels minutely hispid; anthers 0.2–0.3mm; grain 0.5–0.7 × 0.4–0.5mm, widely oblong, truncate, slightly compressed in section.

Bhutan: S — Chukka district (Chapcha to Bunakha); C — Thimphu (Gidakom, Ramtokto) and Punakha (Punakha Dzong, Baso Chu to Ruri Chu) districts. Open grassy places (incl. apple orchard); dry roadsides in blue pine/oak forest, 950–2300m. June–September.

6. *E. cilianensis* (Allioni) Vignolo ex Janchen; *E. major* Host. Fig. 50b–c.

A tufted annual with glandular leaves, differing from *E. minor* as follows: plants larger, culms to 54cm; pedicels eglandular; spikelets grey, oblong, very unequal in size within infl., the larger to 7 × 2.5mm.

Bhutan: C — Punakha district (Lobesa). Roadside verge, 1460m. September.

Probably a recent introduction.

7. *E. nigra* Nees ex Steudel. Fig. 34k–n.

Tufted perennial. Culms 10–52cm, stout, erect, simple. Leaf blades 3.5–25 × 0.1–0.5cm, flat or inrolled, narrowly oblong, finely acuminate, with sparse, long, spreading hairs above, glabrous beneath; sheaths glabrous, with line of long hairs at junction with underside of leaf blade; ligule a minute ciliate rim to 0.2mm. Infl. 9.5–45 × 4–15cm, widely rhombic in outline, very effuse, branches single, spreading at anthesis, glabrous in axils, the lowest 3.5–13cm; pedicels filiform, flexuous, eglandular. Spikelets blackish-grey, 3.5–4.6 × 1.2–1.7mm, florets 5–7, glumes and lemmas deciduous from base upwards, paleas falling after lemmas. Lower glume 1.2–1.5 × 0.4–0.6mm, lanceolate, acute, surface minutely glandular; upper glume 1.5–1.9 × 0.5–0.7mm, otherwise similar to lower. Lowest floret: lemma 1.6–2.1 × 1–1.1mm, ovate, subacute, minutely glandular; palea 1.5–1.7 × 0.5mm, oblong, blunt, keels minutely hispid; anthers c.0.5mm; grain 0.6–0.9 × 0.3–0.5mm, widely oblong, truncate, slightly compressed in section, faces reticulately pitted, one long side grooved.

Bhutan: S — Chukka (Raidak Valley, Marichong) and Deothang (Wamrong) districts; C — Thimphu (very common in Thimphu valley, Paro Valley), Punakha (Tinlegang, Mo Chu Valley), Tongsa (Tongsa, c.5km S of Shemgang), Bumthang (Lame Gompa, Kiki La), Mongar (Sengor), Tashigang (common) and Sakden (Gibson, 1991) districts; **Darjeeling** (Darjeeling, Kurseong, Mungpo, Kalimpong, Rimbick, Sureil); **Sikkim** (Chungthang,

Yoksam, Bakhim, Domang). Roadsides, derelict fields, waste places, grassy banks; wet oak forest, 1070–3100m. May–October.

8. *E. ferruginea* (Thunberg) P. Beauvois. Fig. 33g–i.

Similar to *E. nigra* in its blackish spikelets, but differing as follows: pedicels with smooth, pale, glandular band; spikelets larger (6.5–8.2 × 1.5–2.2mm); glumes longer (lower 1.6–1.9mm, upper 2–2.4mm); lemmas longer (lowest 2.4–2.8mm); paleas longer (lowest 2.1–2.4mm); grains more elongate (0.9–1.1 × 0.4–0.7mm), not pitted.

Bhutan: C — Thimphu (very common in Thimphu valley, Drukyel Dzong to Gunisawa), Bumthang (Lame Gompa, Kiki La) and Mongar (Sengor) districts; **Sikkim** (Lachung, Gangtok); **Chumbi**. Grassland, disturbed places, field edges, etc., 2300–3000m. June–September.

9. *E. tremula* Hochstetter ex Steudel. Fig. 33j–m.

Tufted annual. Culms (16–)47cm, ± erect, simple or with few, erect branches. Leaf blades (6.5–)16 × 0.3cm, flat or inrolled, narrowly oblong, very acute, with sparse, long, spreading hairs above, densely hairy at base, glabrous beneath; sheaths glabrous; ligule a minute ciliate rim, c.0.2mm. Infl. (11–)20 × (5.5–)15cm, widely triangular in outline, very lax, branches single, spreading, with tufts of long hairs in axils, the lowest (5.5–)12cm; pedicels filiform, flexuous, eglandular, the longest over 10mm. Spikelets whitish, to 19 × 2.4mm, florets to 40, glumes and lemmas deciduous from base upwards, paleas persistent on rachilla. Lower glume c.1.4 × 0.5mm, lanceolate, acute, surface smooth; upper glume similar to lower, slightly wider. Lowest floret: lemma c.1.6 × 1.3mm, widely ovate, subacute, smooth; palea c.1.3 × 0.5mm, oblanceolate, truncate, keels hispid; anthers c.0.2mm; grain c.0.5 × 0.5mm, subglobose, smooth, round in section.

Terai (Siliguri). Habitat not recorded, [c.100m]. October.

10. *E. unioides* (Retzius) Nees ex Steudel; *E. amabilis* sensu F.B.I. Sha: *ribangogti*. Fig. 34o–q. Plate 6.

Tufted annual or short-lived perennial. Culms 4.5–41cm, erect, or base decumbent and rooting from nodes, simple or with few, erect branches. Leaf blades 3.7–14 × 0.2–0.5cm, flat or inrolled, narrowly oblong, acute, with sparse, long, spreading hairs above, glabrous beneath; sheaths glabrous; ligule a minute ciliate rim, c.0.2mm. Infl. 3.5–20 × 1–6cm, ± cylindrical, moderately dense, branches single, ascending, glabrous in axils, the lowest 1.3–4cm; pedicels slender, eglandular, under 10mm. Spikelets whitish flushed purplish-pink,

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5.2–14 × (1.8–)2.3–3.2mm, lateral veins of lemmas raised so spikelets rather fat in cross-section, florets (8–)19–69, glumes, lemmas and paleas deciduous from base upwards, persistent rachilla conspicuously zigzag. Lower glume (1.1–)1.4–1.6 × 0.4–0.5mm, lanceolate, acuminate; upper glume 1.4–2.2 × 0.6–0.8mm, oblong-lanceolate, subacute. Lowest floret: lemma 1.4–2.3 × 0.7–1.2mm, oblong-lanceolate to ovate, shortly acuminate, surface papillose, lateral veins conspicuously raised; palea 1.4–1.8 × 0.6–0.9mm, narrowly elliptic, truncate, keels hispid; anthers 0.2–0.5mm; grain 0.6–0.7 × 0.3–0.5mm, oblong-elliptic, smooth, slightly compressed in section.

Bhutan: S — Samchi (Chamarchi Khola, Samchi to Chengmari, Samchi), Phuntsholing (Phuntsholing, Torsa River), Gaylegphug (Bhur) and Deothang (Lamsarong) districts; C — Punakha (Chusom, Tikizampa), Tongsa (above Tintinbi, Bubja to Kinga Rapten) and Tashigang (Kanglung to Tashigang, Manchudrang) districts; **Terai** (Jalpaiguri, Balasun, Phansidowa); **Darjeeling** (Punkabari, Kalimpong, Lebong, Kurseong, junction of Great and Little Rangit Rivers); **Sikkim** (NW of Singtam, Tumlong). Grassy swamp; roadsides; river banks; paddy-fields; marsh by stream; gardens, 230–1900m. February–December.

11. *E. atrovirens* (Desfontaines) Trinius ex Steudel; *E. elegantula* sensu F.B.I. Fig. 34r–t.

Tufted perennial. Culms 11–88cm, ± erect, simple or with few, erect branches, upper part leafless. Leaf blades 4–18 × 0.1–0.2cm, inrolled, linear, very acute, with sparse, long, spreading hairs above, glabrous beneath; sheaths glabrous; ligule a minute ciliate rim, c.0.2mm. Infl. 5.5–14 × 1–5cm, triangular in outline, moderately dense, spikelets upward-pointing, branches single, ascending at anthesis, glabrous in axils, the lowest 3–8cm, branches occasionally not developed so spikelets clustered; pedicels slender, eglandular, under 10mm. Spikelets greyish-green, 4.9–12 × 1.7–2.1(–2.4)mm, florets 9–30, glumes, lemmas and paleas deciduous from base upwards. Lower glume 1–1.6 × 0.6–0.7mm, lanceolate, acuminate, minutely gland dotted; upper glume similar, slightly longer and wider. Lowest floret: lemma 1.6–2.2 × 1.1–1.2mm, widely lanceolate, bluntly acuminate, minutely gland dotted, lateral veins slightly raised; palea 1.4–2 × 0.4–0.5mm, narrowly oblong-oblancheolate, acute, keels hispid; anthers 0.7–0.9mm; grain 0.7–0.9 × 0.4mm, oblong-elliptic, ± smooth, round in section.

Bhutan: S — Samchi (near Samchi, Chamarchi Khola, Daina Khola), Phuntsholing (Torsa River) and Gaylegphug (Gaylegphug, Gaylegphug River) districts; C — Tongsa district (Bubja to Kinga Rapten); **Terai** (Siliguri to Garidora); **Darjeeling** (Great Rangit opposite Manjitar, junction of Great and

Little Rangit Rivers); **Sikkim** (Gangtok, above Raniphul). Damp ground by river; sandy river bank; marshy roadside, 230–1900m. March–December.

12. ***E. zeylanica*** Nees & E. Meyer; *E. elongata* sensu F.B.I. Fig. 34u–x.

Differs from *E. atrovirens* as follows: lateral branches of panicle very short (lowest under 15mm) so spikelets \pm clustered; paleas persistent; anthers smaller (c.0.2mm); grains shorter and fatter (c.0.5 \times 0.4mm), slightly compressed.

Bhutan: S — Gaylegphug district (Gaylegphug River). Seasonally flooded, stony river bed, 400m. May.

The Bhutan plant has small spikelets and lemmas and is the form sometimes separated as *E. cumingii* Steudel.

13. ***E. gangetica*** (Roxb.) Steudel. Fig. 34y–a'.

Slender, tufted annual or short-lived perennial. Culms 5–19(–31)cm, simple or with few, erect branches, base slightly decumbent, upper part leafless. Leaf blades 1.7–8 \times 0.1–0.2cm, inrolled, linear, very acute, with sparse, long, spreading hairs above, densely hairy at base, glabrous beneath; sheaths glabrous; ligule a minute ciliate rim, c.0.2mm. Infl. 3.5–7.5(–12.5) \times 1–4(–6.5)cm, broadly cylindrical, moderately lax, spikelets upward-pointing, branches single or paired, spreading at anthesis, glabrous in axils, the lowest 1.6–2.5(–4)cm; pedicels slender, eglandular, under 10mm. Spikelets greyish-green, 2.2–7.8 \times c.1mm, florets 5–22, glumes, lemmas and paleas deciduous from base upwards (paleas sometimes falling after lemmas). Glumes subequal; lower c.0.9 \times 0.4mm, lanceolate, acuminate, blunt; upper c.1.2 \times 0.5mm, oblong-lanceolate, acute, minutely gland-dotted. Lemmas herbaceous (opaque). Lowest floret: lemma c.1.2 \times 0.7mm, lanceolate, abruptly acuminate, minutely gland dotted, lateral veins not prominent; palea 0.8–1 \times 0.3mm, oblong-ob lanceolate, truncate, keels hispid; anthers c.0.2mm; grain c.0.5 \times 0.4mm, widely oblong-elliptic, smooth, slightly compressed in section, base \pm truncate.

Bhutan: C — Chukka (Sankosh River, Kalikhola) and Gaylegphug (Gaylegphug River towards Norboling) districts. Silt and shingle by river, 300–400m. May.

14. ***E. pilosa*** (L.) P. Beauvois. Fig. 33n–q.

Slender, tufted annual. Culms 12–55cm, erect, simple or with few, erect branches. Leaf blades 8–13 \times 0.2–0.3cm, inrolled or flat, linear, very acute, glabrous above and beneath, veins on upper surface minutely, densely hispid; sheaths glabrous, with tuft of long hairs at apex; ligule c.0.5mm, densely ciliate. Infl. 9–24 \times 2–5cm, broadly cylindrical, very lax, branches very slender, \pm whorled, spreading at anthesis, with tufts of long hairs in axils, the lowest

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4–8cm; pedicels filiform, eglandular. Spikelets purplish-grey, $2.6\text{--}4.9 \times 0.6\text{--}0.7\text{mm}$, florets 5–11, glumes, lemmas and paleas deciduous from base upwards. Glumes very unequal; lower $c.0.4 \times 0.2\text{mm}$, oblong, blunt; upper $c.1 \times 0.5\text{mm}$, lanceolate, subacute. Lemmas very thinly herbaceous (transparent). Lowest floret: lemma $c.1.5 \times 1.1\text{mm}$, widely oblong-lanceolate, subacute, smooth; palea $c.1.1 \times 0.4\text{mm}$, narrowly oblong, blunt, keels hispid; anthers $c.0.2\text{mm}$; grain $0.7\text{--}0.8 \times 0.3\text{--}0.35\text{mm}$, narrowly oblong in outline, slightly rough, slightly compressed in section, base drawn into point beneath basal pits.

Bhutan: C — Punakha district (Chuzomsa to Wangdi Phodrang, Punakha Dzong). Roadside ditch in dry valley; garden weed, 1100–1200m. June–August.

15. *E. multicaulis* Steudel

Differs from *E. pilosa* in being much smaller (culms to 10cm); leaf sheaths glabrous at apex; infl. more compact (to $7 \times 3\text{cm}$), lowest branch to 1.5cm; grain more widely oblong ($c.0.6 \times 0.4\text{mm}$), smooth.

Sikkim (Gangtok). On paths, 1830m. June.

Probably introduced.

Doubtfully recorded species:

E. nutans (Retzius) Nees ex Steudel

Recorded for Sikkim (Gangtok, 1600m) in F.E.H.1, but no specimen seen and it is more likely to be either *E. atrovirens* or *E. gangetica*. *E. nutans* differs from both of these in having persistent paleas; from the former it also differs in having narrower (1–1.5mm) spikelets which dry pale brown; from the latter it differs in having larger spikelets ($5\text{--}12 \times 1\text{--}1.5\text{mm}$) and in being a relatively stout perennial.

63. ERAGROSTIELLA Bor

Differs from *Eragrostis* as follows: infl. linear, spike-like, spikelets sessile, secund; palea keels narrowly winged.

1. *E. nardoides* (Trinius) Bor; *Eragrostis nardoides* Trinius. Fig. 33r–s.

Tufted wiry perennial. Culms 20–30cm, erect, unbranched. Leaf blades to 30cm, exceeding culms, filiform ($c.0.5\text{mm}$ wide), inrolled, minutely scabrid beneath, with scattered long hairs above; sheaths usually minutely scabrid, with tuft of long hairs at apex; ligule a minute ciliate rim $c.0.1\text{mm}$. Infl. 11–19cm, curved. Spikelets whitish tinged brown or puplish, $5.1\text{--}11 \times$

1.2–1.9mm, florets 9–22. Glumes unequal; lower 1–1.5 × 0.3–0.5mm, narrowly lanceolate, subacute, keeled, keel hispid; upper 1.5–2.1 × 0.8–0.9mm, oblong-lanceolate, acute, keel minutely hispid at apex. Lemmas thinly herbaceous. Lowest floret: lemma 1.6–2.1 × 1.2–1.3mm, oblong-ovate or ovate, blunt, smooth, lateral veins very weak, keel minutely hispid near apex; palea 1.6–1.9 × 0.6–0.7mm, oblong-lanceolate, truncate, keel wings very narrow, densely, shortly ciliate; anthers c.0.7mm.

Bhutan: S — Chukka district (c.3km W of Kalikola); C — Punakha (above Chuzomsa), Mongar (between Mongar and the Kuru Chu) and Tashigang (below Yadi) districts. Around rocks on open, grassy hillsides; rocky ground and cliffs in subtropical and chir pine forest, 500–1200m. September–October.

64. ELEUSINE Gaertner

Tufted annuals. Culms branched, ± erect. Leaf blades linear, flat or folded, inserted regularly along culm; sheaths compressed; ligule membranous, truncate, erose or ciliate. Infl. digitate, or lowest raceme slightly distant; racemes oblong, spikelets sessile, borne singly, on lower side of flattened axis, alternate on opposite sides of rachis midrib, rachis terminated by a spikelet. Spikelets laterally compressed, florets 3–8, bisexual, similar (or uppermost reduced), persistent, or disarticulating above persistent glumes. Glumes shorter than spikelet, unequal, conduplicate, keeled, keels green, hispid, margins hyaline; lower glume lanceolate, acute, keel 1-veined; upper glume longer, oblong-lanceolate, subacute, keel 5-veined. Lemmas lanceolate, conduplicate, acute, herbaceous, keel hispid. Paleas oblong-elliptic, apex notched, back flat, 2-keeled, margins incurved, keels winged, hispid. Grain with free, membranous pericarp.

1. Wild plant; spikelets disarticulating; racemes narrow (0.3–0.5cm in fr.); grain oblong; lemmas narrowly lanceolate (lowest with each side 0.7–0.9mm); palea narrowly winged; ligule erose **1. E. indica**
- + Cultivated plant; spikelets not disarticulating; racemes broad (0.8–1.3cm in fr.); grain globose; lemmas broadly lanceolate (lowest with each side 1–1.5mm); palea broadly winged; ligule long-ciliate
2. E. corocana

1. E. indica (L.) Gaertner. Dz: *cholop*; Sha: *kongpu ngoon*; Nep: *shade jhar, daday, kodho jhar*. Fig. 35a–b.

Culms 13–45cm. Leaf blades 7–24 × 0.2–0.6cm, abruptly contracted to acute apex, midrib conspicuous, glabrous; sheaths ciliate on margins at apex; ligule 0.5–1mm, truncate-erose. Infl. digitate, or with lowest raceme distant by 1–3cm. Racemes (2–)3–5(–11), 3.5–9 × 0.3–0.5cm, rachis flattened.

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Spikelets 4.4–5.4mm, florets 4–5. Lower glume 2–2.3mm, each half 0.3–0.6mm wide; upper glume 2.7–3, each half 0.7–0.8mm wide. Lowest floret: lemma 3.1–3.7mm, each half 0.7–0.9mm wide; palea 2.4–3 × 0.6–0.9mm, keels very narrowly winged; anthers 0.5–0.8mm; grain oblong in outline, 1.5–1.8 × 0.8–1mm.

Bhutan: S — Samchi, Phuntsholing, Gaylegphug and Deothang districts; C — Thimphu, Punakha, Tongsa, Bumthang, Mongar and Tashigang districts; **Darjeeling** (Rangpo to Tista Bazaar (F.E.H.1)); **Sikkim** (Selim, Yoksam). Common in waste and cultivated places in subtropical and temperate zones (e.g. paddy field, weedy lawn, roadside); sandy river bank; stony bushland, 300–2610m. May–December.

Wood 6022 (E) and *Pradhan* TG 168 (E), both garden weeds from Thimphu district, are atypical: ligule long-ciliate (as in *E. corocana*), racemes very robust; lemma and palea shape as in *E. indica* but much larger (6.7–7.5mm). They are perhaps hybrids with *E. corocana* or a polyploid form of *E. indica*.

Parker (1992) recorded this species as a common weed of all altitudes and districts [with cultivation]: frequent in dryland crops and occasionally dominant.

2. *E. corocana* (L.) Gaertner. Dz: *memja, menja*; Sha: *kompa, kong pu*; Nep: *kodo*; Lep: *maung zo*; Eng: *finger millet*. Fig. 35c–d.

Differs from *E. indica* (from which it is derived) as follows: racemes broader (0.8–1.3cm in fr.), curved in fruit; spikelets not disarticulating, sometimes with more florets (3–8); lemmas wider (each half 1–1.5mm); paleas wider ((0.9–)1.3–1.6mm), keels often widely winged; grain subglobose.

Bhutan: S — Samchi, Phuntsholing, Chukka, Sarbhang and Gaylegphug districts; C — Thimphu, Tongsa, Mongar and Tashigang districts; **Terai; Sikkim.** Cultivated throughout Sikkim and Bhutan from the terai to 2600m; also occurring as an escape (e.g. on river shingle). February–November.

The grain is fermented into *chang* (*tongba*) and is also used by the poor for flour; grown as a winter crop in subtropical parts and in summer at higher altitudes.

FIG. 35.

a–b, **Eleusine indica**: a, infl. (× 2/3); b, spikelet (× 6). c–d, **E. corocana**: c, infl. (× 2/3); d, spikelet (× 6). e–f, **Dactyloctenium aegyptium**: e, infl. (× 2/3); f, spikelet (× 6). g–i, **Sporobolus fertilis**: g, infl. (× 1/2); h, spikelet (× 18); i, grain (× 20). j–l, **S. diander**: j, infl. (× 1/2); k, spikelet (× 18); l, grain (× 20). m–o, **S. piliferus**: m, infl. (× 1/2); n, spikelet (× 18); o, grain (× 20). Drawn by Louise Olley.

PLATES

PLATES

Plate 1

Grasses wild and cultivated: *Saccharum spontaneum* in foreground, fields of *Oryza sativa* in background. Below Lobesa (1300m).

Plate 2

Above: low-altitude alluvial grassland, with *Cymbopogon jwarancusa*, *Eragrostis* spp. and *Panicum walense*. Torsa River, Phuntsholing (400m).

Below: temperate grassland in blue-pine zone, with *Themeda triandra* var. *laxa*, *Schizachyrium delavayi*, *Cymbopogon khasianus* and *Heteropogon contortus*. Pama, below Ginnekah, Wang Chu valley (2450m).

Plate 3

Top left: chir pine grassland. Manas valley below Tashigang (1500m).

Top right: roadside grasses in temperate zone, with *Cymbopogon khasianus*, *Bothriochloa ischaemum* and *Pennisetum flaccidum*. Sisina, Wang Chu valley (2250m).

Bottom left: meadow in upper temperate zone, with *Helictotrichon virescens*, *Brachypodium sylvaticum*, *Agrostis zenkeri*, *Elymus sikkimensis* and *Festuca rubra* subsp. *clarkei*. Rukubji (3120m).

Bottom right: subalpine pasture, with *Yushania microphylla*, *Agrostis pilosula*, *Festuca polycolea*, *F. wallichiana*, *Poa ludens*, *Stipa koelzii* and *Helictotrichon parviflorum*. Kitiphu, Bumthang (3750m).

Plate 4

Top left: 'red rice' (*Oryza sativa*, form with red pericarp). Thimphu Market.

Top right: *Stipa roylei*. Yuto La (3150m).

Bottom left: *Calamagrostis scabrescens*. Namning (2700m).

Bottom right: *Poa pagophila*. Jemathang, Sikkim (4500m).

Plate 5

Above: *Brachypodium sylvaticum* (robust, hairy form). Taba (2500m).

Below: *Danthonia cumminsii*. Chelai La (3600m).

Plate 6

Above: *Eragrostis unioloides*. Kinga Rapden (1900m).

Below: *Thysanolaena latifolia*. Deban, Arunachal Pradesh (450m).

Plate 7

Top left: *Bromus staintonii*. Lame Gompa, Bumthang (2900m).

Top right: *Chloris virgata*. Wangdi Phodrang (1250m).

Bottom left: *Echinochloa crus-galli*. Below Nobding (1730m).

Bottom right: *Isachne albens*. Tongsa (2120m).

Plate 8

Top left: *Arundinella bengalensis*. Lobesa (1460m).

Top right: oil extraction from *Cymbopogon bhutanicus* by steam distillation. Mongar.

Bottom left: *Cymbopogon bhutanicus* (habit). Yadi, Tashigang (1000m).

Bottom right: *Cymbopogon bhutanicus* (infl.). Yadi, Tashigang (1000m).





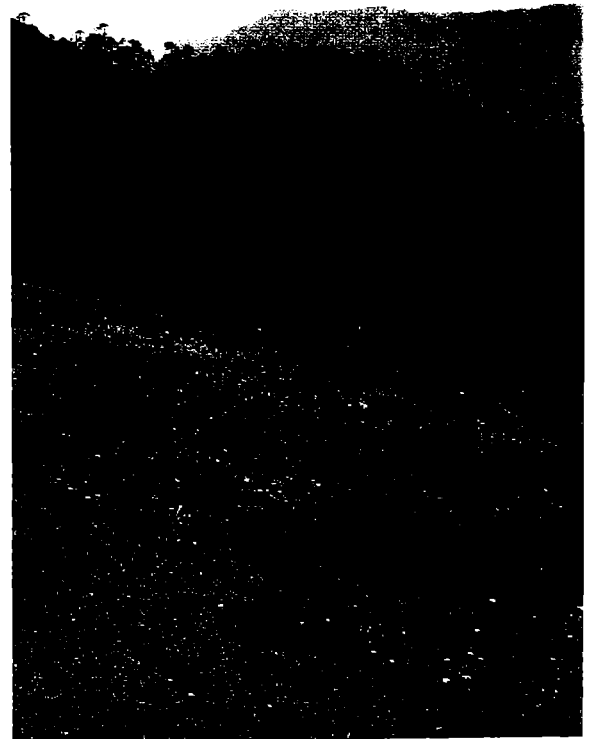
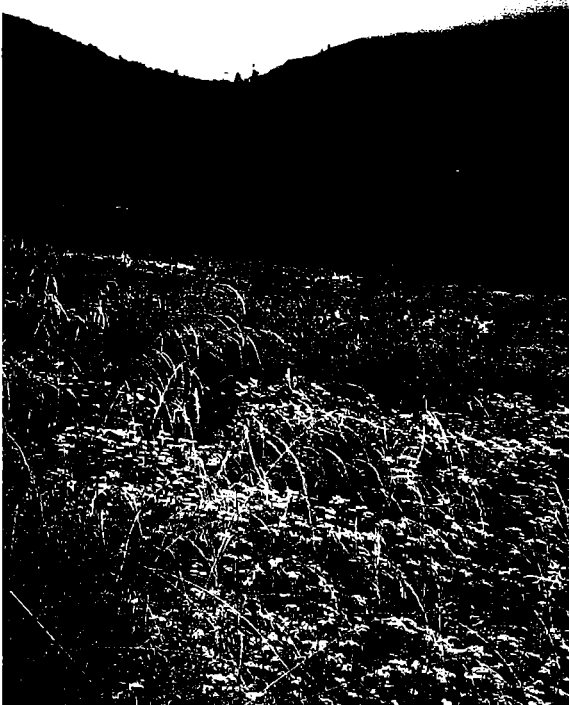
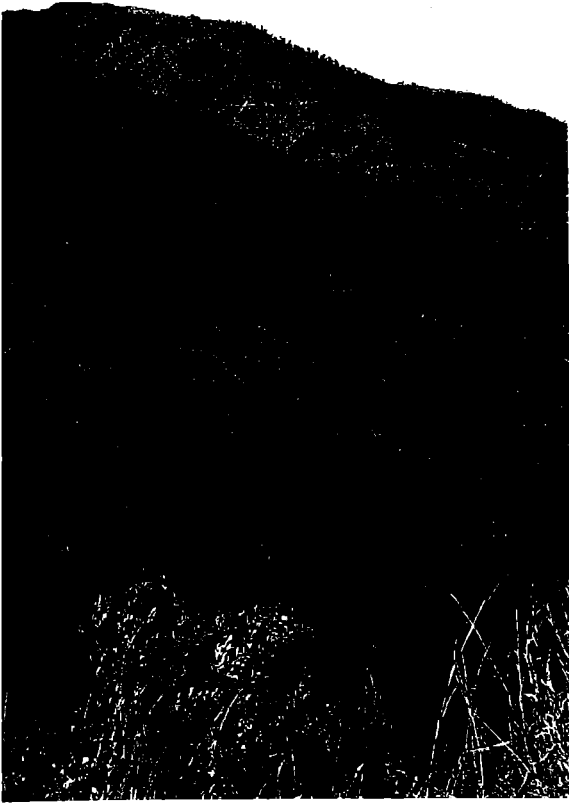


Plate 4

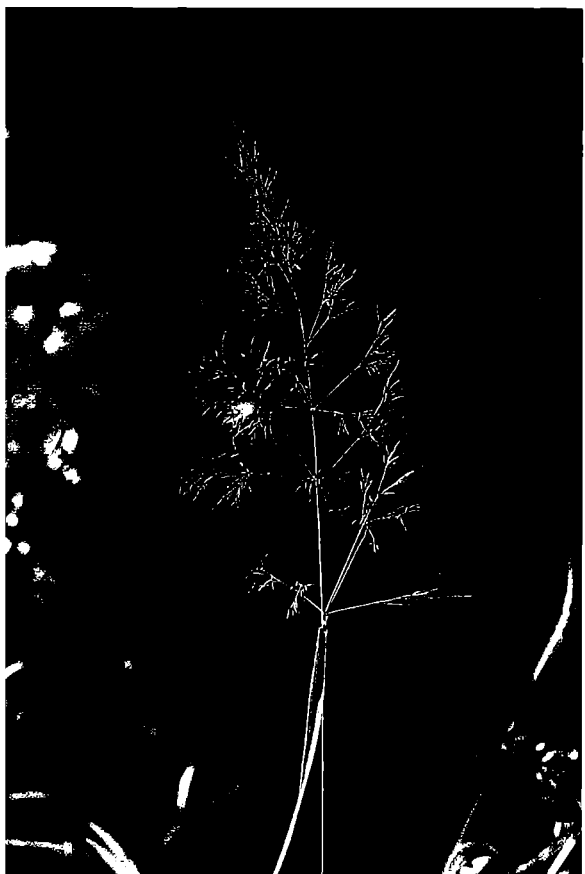


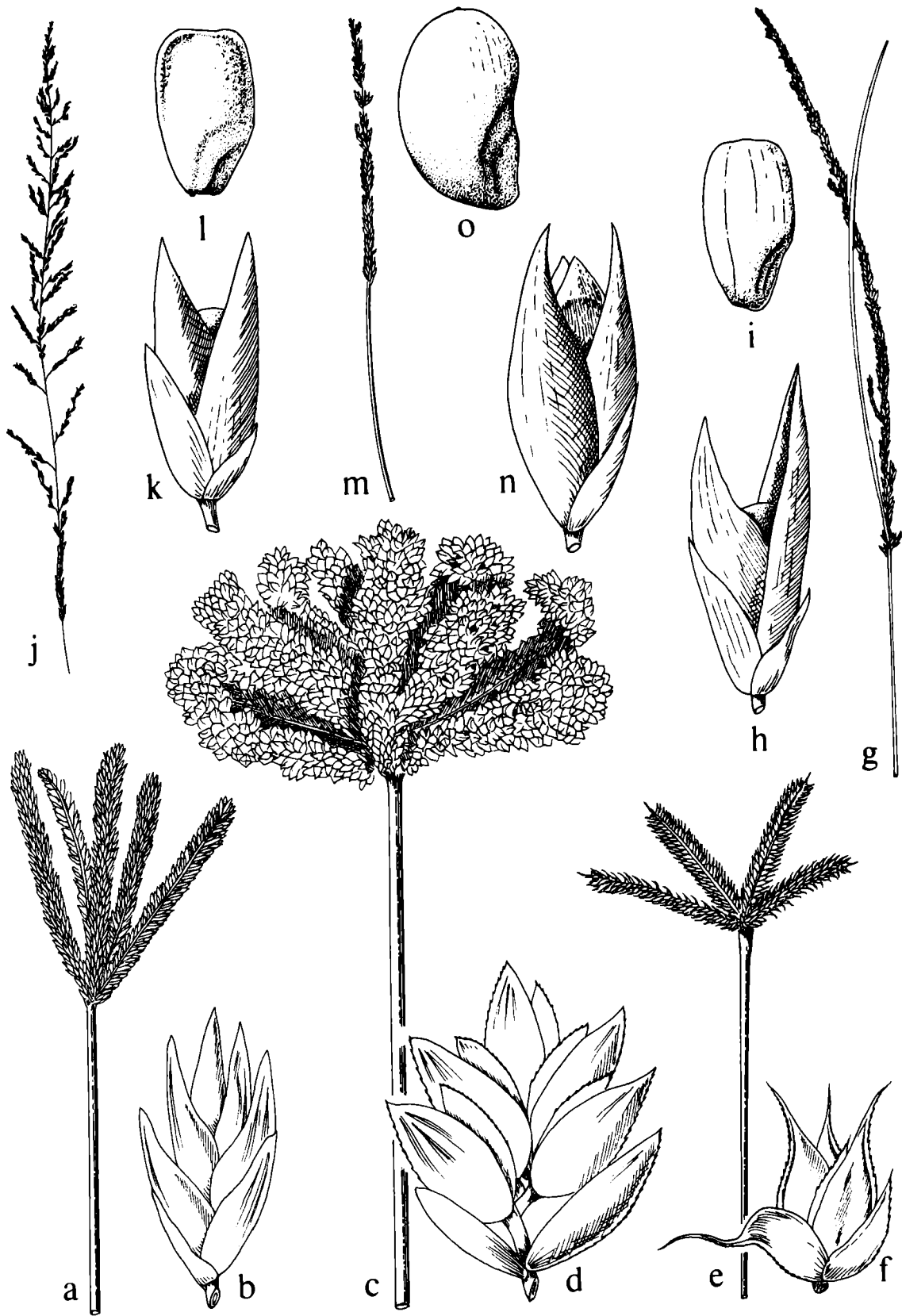


Plate 6









65. DACTYLOCTENIUM Willdenow

Stoloniferous annual. Culms branched. Leaf blades linear, flat, inserted regularly along culm; sheaths keeled; ligule membranous, truncate-ciliate. Infl. digitate; racemes oblong, spikelets sessile, borne singly on lower side of axis, alternate on opposite sides of rachis midrib, rachis triangular in section, extended to form a terminal, sterile point. Spikelets laterally compressed, with 2–4 bisexual florets, and a terminal, sterile lemma, disarticulating as a whole above persistent glumes. Glumes shorter than spikelet, dissimilar, conduplicate, keeled, keels green, hispid, margins hyaline; lower glume lanceolate, acute; upper glume with oblong, hyaline body, keel continued into curved mucro. Lemmas lanceolate, conduplicate, gradually narrowed to acute, curved apex, herbaceous, keel hispid; palea lanceolate, apex notched, back concave, 2-keeled, margins widely inflexed, keels winged, hispid. Grain rugose.

1. **D. aegyptium** (L.). P. Beauvois; *Eleusine aegyptia* (L.) Desfontaines. Fig. 35e–f.

Stolons creeping. Culms ascending, upper parts \pm erect, 20–40cm. Leaf blades 5.5–18 \times 0.3–0.5cm, finely tapered to acute apex, with stiff, tubercle-based hairs along veins especially on upper surface and near margins, margins ciliate near base; sheaths glabrous; ligule 0.3–1mm. Racemes 3–6, 1.2–4.5 \times 0.5–0.8cm, angles of rachis hispid, apical point c.2mm. Spikelets 3.5–4mm, fertile florets 2–4. Lower glume 2–2.9mm, lanceolate, each half 0.8–1mm wide; body of upper glume greyish or purplish, 2.7–3, each half oblong-elliptic, 0.7–0.9mm wide, mucro 1.2–1.8mm. Lowest floret: lemma 3.2–3.5mm, each half whitish, c.1mm wide; palea 2.2–2.6 \times 0.9–1.5mm; anthers c.0.5mm.

Bhutan: S — Chukka (Kalikola), Phuntsholing (Phuntsholing) and Deothang (Samdrup Jongkhar) districts; C — Punakha (below Baso Chu), Mongar (between Mongar and the Kuru Chu) and Tashigang (Tashigang) districts, **Darjeeling** (Great Rangit opposite Manjitar); **Sikkim** (above Singtam). Disturbed places (e.g. fields, river shingle, roadsides) in warm areas, 300–1300m. June–October.

66. SPOROBOLUS R. Brown

Tufted annuals or short-lived perennials. Culms erect, simple or with few, erect branches. Leaf blades flat or inrolled; ligule a small, truncate, erose or ciliate rim. Infl. a compound panicle, usually branched to 2 orders, branches sometimes short, when infl. spike-like. Spikelets gaping, pedicelled, borne singly, floret 1, bisexual, deciduous. Glumes deciduous, unequal, veinless, hyaline; lower \pm flat, much shorter than spikelet; upper convex, shorter than

or equalling spikelet. Lemmas lanceolate to elliptic, convex, veins inconspicuous, thinly herbaceous. Paleas similar to lemmas or wider, weakly 2-keeled, with widely inflexed margins and grooved back, hyaline. Stamens 2–3. Grain with free, transparent pericarp.

1. Leaves and sheaths hairy; upper glume almost or equalling spikelet; grain elliptic, apex rounded **3. S. piliferus**
- + Leaves and sheaths glabrous; upper glume much shorter than spikelet; apex of grain truncate **2**
2. Infl. dense, spike-like, branches appressed (when dry); spikelets 1.7–2.2mm; palea shorter than lemma; grain c.1mm **1. S. fertilis**
- + Infl. effuse, branches spreading (when dry); spikelets to 1.6mm; palea and lemma subequal; grain c.0.8mm **2. S. diander**

1. S. fertilis (Steudel) Clayton; *S. indicus* sensu F.B.I., non (L.) R. Brown. Nep: *zarkharey*. Fig. 35g–i.

Stout, tufted perennial. Culms 22–56cm. Leaf blades 5–29 × 0.2–0.6cm, flat or inrolled, linear to oblong, very acute, glabrous; sheaths glabrous, margins sometimes minutely ciliate above; ligule 0.2–0.3mm. Infl. 10–60 × 0.5–1.5cm, narrowly cylindrical, spike-like, branches appressed, overlapping, bearing spikelets to base, the lowest 1.7–6.5cm, slightly distant. Spikelets silvery-grey, 1.7–2.2mm. Lower glume 0.6–0.9 × 0.5mm, oblong-ovate, apex ± blunt, irregularly erose; upper glume similar to lower but larger (1–1.3 × 0.5–0.6mm). Lemma 1.7–2.1 × 0.5–0.7mm, narrowly lanceolate, acute, veinless, granular. Palea 1.5–1.9 × 0.6–1mm, broadly oblong-lanceolate, truncate to emarginate, back channelled, granular. Anthers 3, (0.5–)0.7–0.9mm. Grain 0.9–1.1 × 0.5–0.7mm, oblong in outline, apex truncate.

Bhutan: S — Samchi, Phuntsholing, Chukka, Gaylegphug and Deothang districts; C — Thimphu, Punakha, Tongsa, Bumthang and Tashigang districts; **Darjeeling** (Mungpo); **Sikkim** (Yoksam, Chungthang, Lingcham). Very common in disturbed places (e.g. roadsides, pathsides, scrub) in subtropical and temperate areas, 300–2860m. March–December.

2. S. diander (Retzius) P. Beauvois. Fig. 35j–l.

Slender, tufted perennial. Culms 9–33(–54)cm. Leaf blades 2–17 × 0.2–0.3cm, flat or inrolled, linear-lanceolate, glabrous; sheaths glabrous; ligule 0.2–0.3mm. Infl. 9–21 × 1.5–3.5cm, cylindrical, effuse, branches spreading, distant, usually not bearing spikelets to base, the lowest 1.5–6.5cm. Spikelets silvery-grey, 1.4–1.6mm. Lower glume 0.4–0.6 × 0.3mm, oblong, blunt; upper glume 0.7–1 × 0.4–0.6mm, oblong-ovate, subacute. Lemma 1.4–1.6 ×

XIII. ERAGROSTIDEAE

0.5–0.6mm, narrowly lanceolate, acute, veinless, granular. Palea 1.3–1.6 × 0.5mm, similar to lemma. Anthers 2, 0.5–0.6(–0.8)mm. Grain c.0.8 × 0.5mm, oblong in outline, apex truncate.

Bhutan: **S** — Samchi (Dhoankhola), Phuntsholing (Phuntsholing, Phuntsholing to Kharbandi), Chukka (Sankosh River, Kalikhola), Gaylegphug (near Mao River Bridge) and Deothang (Deothang to Samdrup Jongkhar) districts; **C** — Punakha (Punakha), Tongsa (below Refe), Mongar (between Mongar and the Kuru Chu) and Tashigang (Kanglung to Tashigang, Manas River below Tashigang) districts; **Darjeeling** (Rangit). Open grassy and rocky places (e.g. roadsides, river shingle, by footpath), 200–1900m. May–December.

3. *S. piliferus* (Trinius) Kunth. Fig. 35m–o.

Slender, tufted annual. Culms 5–25cm. Leaf blades 2–7.5 × 0.1–0.2cm, linear-lanceolate, the lower with some long, scattered hairs above and beneath, margins with long, tubercle-based bristles on margin especially near base; sheaths with long hairs near margin and at mouth; ligule c.0.2mm. Infl. 2.7–12.5 × 0.4–0.8cm, narrowly cylindrical, spike-like, branches erect, overlapping, bearing spikelets to base, the lowest 0.4–1.2cm. Spikelets olive-brown, 1.6–2mm. Lower glume 0.6–1.2 × 0.2–0.45mm, lanceolate, acuminate, subacute; upper glume 1.5–2 × 0.7–1mm (usually equalling spikelet), broadly lanceolate, subacute, weakly veined. Lemma 1.5–1.9 × 0.5–0.9mm, narrowly elliptic, subacute, weakly veined. Palea 1.4–1.8 × 0.6–0.8mm, broadly oblong, truncate to emarginate, splitting down groove along back, margins widely inflexed. Anthers 3, c.0.6mm. Grain 0.8–1 × 0.5–0.65mm, elliptic in outline, apex rounded.

Bhutan: **S** — Chukka district (Chapcha to Bunakha); **C** — Thimphu (hill above Thimphu hospital, Babesa, Drukyel Dzong) and Punakha (Wangdi Phodrang) districts; **Darjeeling** (Kurseong); **Sikkim** (Kaysing). Sandy hollows among dry scrub; edge of paddy field; open, grassy places, 1400–2300m. August–October.

67. MUHLENBERGIA Schreber

Rhizomatous perennials. Culms much branched, bases decumbent and rooting from nodes. Leaf blades flat; ligules membranous, truncate-ciliate. Infls. terminal on ends of branches, dense, flexuous panicles, branches borne in distant fascicles, ascending, overlapping. Spikelets pedicelled, borne singly, lanceolate, floret 1, bisexual, deciduous; callus hairy; pedicels slender, scabrid. Glumes persistent, shorter than spikelet, subequal, usually 1-veined, keeled, hyaline, keel minutely hispid. Lemma lanceolate, convex, 3-veined, midrib

produced from just below apex into long, filiform, minutely hispid awn, thinly herbaceous. Palea lanceolate, convex, weakly 2-keeled, thinly herbaceous. Stamens 3.

Superficially very similar to *Garnotia* but that differs in having more rigid infls., the spikelets subtended by stiff hairs and deciduous glumes.

1. Awn over 10mm, apex filiform and flexuous; glumes under $\frac{2}{3}$ lemma, often unveined 1. *M. huegelii*
- + Awn to 8.5mm, apex not flexuous; glumes c. $\frac{2}{3}$ lemma, midrib strong
2. *M. himalayensis*

1. *M. huegelii* Trinius; *M. viridissima* Nees ex Steudel. Fig. 32n-o.

Culms weak, often scrambling, to 160cm (Bor, 1940). Leaf blades 5.5–13 × 0.2–0.6cm, oblong, acute, scabrid above and beneath; sheaths glabrous, scabrid near margins; ligule 0.4–0.7mm. Infl. purplish, 8.5–25 × 1–3.5cm. Spikelets 2.3–3.2mm (excl. awn). Glumes less than $\frac{2}{3}$ lemma, 1.1–1.5(–2.2)mm, narrowly lanceolate, subacute to finely acuminate, midrib usually lacking, sometimes present, when hispid and sometimes minutely excurrent. Lemma 2.3–3mm, lanceolate, very acute, minutely hispid on back and veins, with tuft of white hairs either side of midrib and on margins at base; awn 11.5–15.5mm, apex filiform, flexuous. Palea 2.3–2.8mm, narrowly lanceolate, very acute. Anthers 0.6–0.9mm.

Bhutan: S — Chukka district (below Chapcha); C — Thimphu district (above Thimphu hospital, Taba); **Darjeeling** (Darjeeling, Kurseong, Mungpo, Sureil, Rungirun); **Sikkim** (Lachung, Karponang, Yoksam). In tall grass around maize-fields; grassy bank in scrub, 910–2590m. August–January.

2. *M. himalayensis* Hackel ex Hook. f.

Differs from *M. huegelii* as follows: culms to 50cm; leaves narrower (to 2.7mm wide); infl. narrower, with shorter, stiffer branches; spikelets often larger (2.8–3.2mm); glumes 1.8–2.4mm, c. $\frac{2}{3}$ length of lemma, midribs strong; awn shorter (5.9–8.4mm), apex not flexuous.

Bhutan: C — Thimphu (below Changri Monastery), Tongsa (Chendebi Chorten) and Bumthang (below Tarpaling Gompa, Kiki La) districts; **Chumbi**. Shady pathside in blue pine forest; on old wall; grassy meadow, 2450–3660m. June–September.

The two species are not clearly distinct in our area and are very variable in terms of size and glume venation.

XIV. CYNODONTEAE

Tribe XIV. CYNODONTEAE Dumortier

1. Infl. of digitately arranged spikes 2
- + Infl. a single spike 3

2. Spikelets awned; florets several, the lowest fertile, the upper 1 or 2 male or sterile, differing in shape from the lowest **68. Chloris**
- + Spikelets awnless; floret single **70. Cynodon**

3. Glumes not awned; spike secund, linear, spikelets tightly appressed **69. Microchloa**
- + Glumes awned; spike not secund, cylindric, spikelets spreading **71. Perotis**

68. CHLORIS Swartz

Perennials. Culms unbranched. Leaf blades linear, flat; basal sheaths compressed; ligule membranous, truncate-ciliate. Infl. digitate; racemes secund, spikelets shortly pedicelled, borne singly, alternate on opposite sides of rachis. Spikelets laterally compressed, florets 2–3, dissimilar, disarticulating above persistent glumes. Glumes unequal, lanceolate, conduplicate, keeled, 1-veined, hyaline; the upper longer, midrib excurrent. Lower floret bisexual; lemma exceeding upper glume, convex to conduplicate, awned from below apex, 3-veined, herbaceous or chartaceous; palea oblong-elliptic, apex notched, 2-keeled. Second floret pedicelled, resembling lower but male, or reduced, sterile and epaleate. Third floret when present long-pedicelled, reduced and sterile.

1. Racemes linear (c.2mm wide); spikelets not gaping (very narrow); awn of sterile floret c. $\frac{1}{3}$ length that of fertile floret; lower lemma herbaceous **3. C. dolichostachya**
- + Racemes oblong (over 3mm wide); spikelets gaping; awns of lemmas subequal; lower lemma chartaceous 2

2. Racemes short (to 4.5cm); culms short (to 47cm); hairs on lemmas long (2–3mm) **1. C. virgata**
- + Racemes longer (5–8cm); culms tall (usually over 100cm); hairs on lemmas short (under 1mm) **2. C. gayana**

1. *C. virgata* Swartz. Fig. 36a–d. Plate 7.

Tufted ?perennial. Culms 17–47cm, \pm erect. Leaves mainly basal, with

several evenly inserted along culm; blades 5–15 × 0.3–0.5mm, very acute, upper surface minutely hispid, glabrous beneath, margins minutely serrate; sheaths glabrous; ligule brownish, 0.5–1mm. Racemes 6–9, 3.5–4.5 × c.0.3cm, rachis triangular in section, hispid. Spikelets 2.8–3.5mm (excl. awns), gaping; florets 2, the lower bisexual, the upper sterile, both awned; pedicels hairy. Lower glume 1–2mm, subacute, each half 0.2–0.4mm wide, keel serrate; upper glume 2.5–3.2 × 0.6–0.8mm, mucro 0.5–0.9mm, sides minutely hispid, marked with purple. Lower floret: lemma cream coloured, chartaceous, 2.7–3.2mm, each half narrowly rhombic, acute, 0.9–1mm wide, margins ciliate below, with subapical shoulder bearing long cilia 2–3mm, awn 5.5–7.5mm; palea 2.2–3 × c.0.6mm; anthers c.0.5mm; callus hairs c.0.5mm. Upper floret consisting of a sterile lemma, lemma 1.7–2mm, similar in texture to the lower, each half triangular 0.5–0.7mm wide, apex truncate, glabrous, awn 5.4–7.5mm.

Bhutan: C — Thimphu (Tashichho Dzong, Paro) and Punakha (Wangdi Phodrang, Chuzomsa, Punakha) districts. Waste places in dry valleys (silty bank above river), 1200–2550m. June–October.

2. *C. gayana* Kunth. Eng: *Rhodes grass*. Fig. 36e–i.

Differs from *C. virgata* as follows: much larger and more robust (culms to 120cm); row of long cilia (to 6mm) present at base of leaf blade adjacent to ligule; racemes c.9, longer (c.8cm); florets (2–)3; awn of lower lemma shorter (c.2.6mm), hairs of subapical tuft shorter (to 0.6mm); second floret fertile (male), paleate, anthers longer (c.1.6mm), awn shorter (c.1mm), usually tightly enclosing a long-pedicelled, sterile floret consisting of a minute (c.0.6mm), empty, awnless lemma.

Bhutan: S — Gaylegphug district (Bhur); **Sikkim** (Gangtok). Improved pasture in subtropical areas, 500–1830m. July–September.

Introduced for fodder; native of tropical and southern Africa.

3. *C. dolichostachya* Lagasca. Fig. 36j–m.

Perennial. Culms to 100cm, base sometimes decumbent and rooting from nodes. Leaves inserted along culm; blades to 33 × 0.8mm, upper surface with scattered, long, spreading hairs, shortly appressed hairy beneath; sheaths sparsely hairy; ligule c.0.4mm, with dense fringe of long cilia (c.3mm) behind, at junction with blade. Racemes c.6, 16(–22) × c.0.2cm, rachis triangular in section, hispid. Spikelets c.5.5mm (excl. awns), linear, not gaping; florets 2, the lower bisexual, the upper very reduced, sterile, both awned, but awns very unequal; pedicels glabrous. Lower glume c.1.7mm, each half c.0.2mm wide, keel ± smooth; upper glume c.4.4 × 0.8mm, midrib wide, shortly (0.3–1mm)

XIV. CYNODONTEAE

excurrent, glabrous. Lower floret: lemma herbaceous, c.4.8 × 0.6mm, narrowly oblong-lanceolate, convex, weakly keeled, lateral veins minutely hispid, otherwise glabrous, awn c.10.4mm; palea c.4.4 × c.0.6mm; anthers c.1.7mm; callus hairs c.1mm. Upper floret minute, consisting of a reduced, sterile lemma c.0.9 × 0.2mm, awn c.3.6mm; pedicel c.2mm.

Bhutan: S — Chukka district (by Kalikhola river, c.1km W of Kalikhola). Open bushland, 300m. October

69. MICROCHLOA R. Brown

Slender, tufted perennial. Culms wiry, unbranched. Leaf blades narrow, inrolled; ligule a ciliate rim. Infl. a single, linear, curved, spike-like, secund raceme, the spikelets sessile, borne singly on lower side of rachis. Spikelets dorsally compressed, floret 1, bisexual, shorter than glumes, disarticulating above persistent glumes. Glumes equalling spikelet, subequal, 1-veined, backs flat; lower asymmetric, margins widely inflexed; upper symmetric, margins narrowly inflexed. Lemma elliptic, folded around palea, hairy on back, hyaline. Palea 2-keeled, hairy on keels.

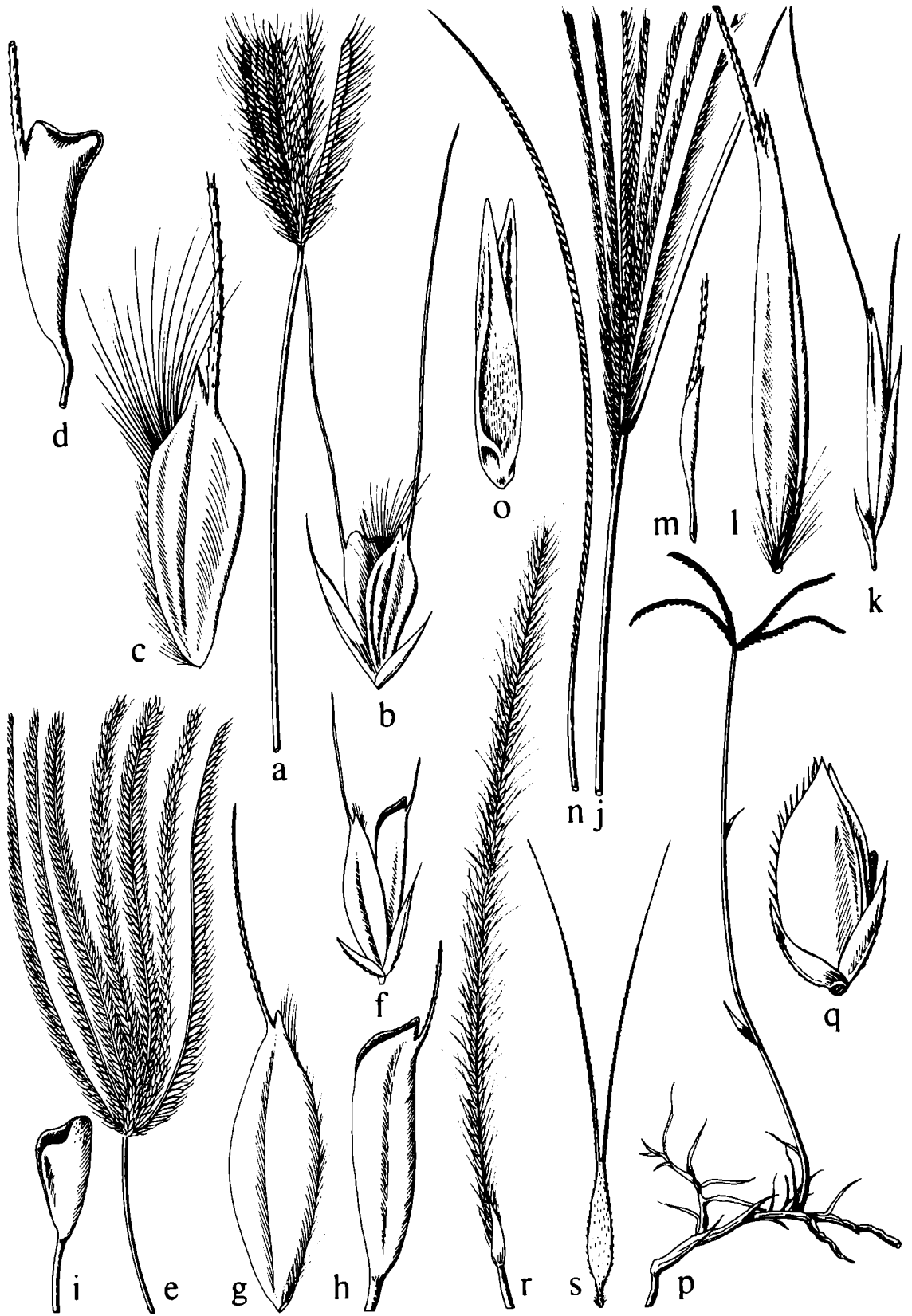
1. *M. kunthii* Desvaux. Fig. 36n–o.

Culms 5–40cm. Leaves borne on lower part of culm; blades 4.5–6.5 × 0.3–0.7mm, upper surface minutely hispid and with scattered, long hairs; sheaths glabrous, sometimes with tuft of hairs at junction with blade, margins hyaline; ligule 0.2–0.3mm. Infl. 6.5–23cm, rachis c.0.4mm wide, hispid on margins. Spikelets 2.8–3.3mm, callus shortly hairy. Lower glume 2.7–3.2 × 0.5mm, narrowly oblong-lanceolate, curved, acute, margins hyaline, streaked purple; upper glume 2.4–2.9 × 0.6mm, narrowly lanceolate, acute, margins hyaline, streaked purple. Lemma 1.5–1.7 × 0.6–1mm, truncate, minutely apiculate. Palea 1.5 × 0.3mm, linear-lanceolate, acute. Anthers 0.8–1.1mm.

Bhutan: C — Thimphu (near Dobji Dzong, hill above Thimphu Hospital), Punakha (Punakha, Chuzomsa to Samtengang, Chuzomsa to Wacha) and Tongsa (3km W of Tongsa) districts. Dry valley (bare, sandy ground by track;

FIG. 36.

a–d, *Chloris virgata*: a, infl. (× 2/3); b, spikelet (× 6); c, lower floret (× 12); d, upper floret (× 12). e–i, *C. gayana*: e, infl. (× 2/3); f, spikelet (× 6); g, lowest floret (× 12); h, middle floret (× 12); i, upper floret (× 12). j–m, *C. dolichostachya*: j, infl. (× 1/3); k, spikelet (× 6); l, lower floret (× 12); m, upper floret (× 12). n–o, *Microchloa kunthii*: n, infl. (× 2/3); o, spikelet (× 12). p–q, *Cynodon dactylon*: p, habit (× 1/2); q, spikelet (× 12). r–s, *Perotis indica*: r, infl. (× 2/3); s, spikelet (× 6). Drawn by Louise Olley.



XIV. CYNODONTEAE

open rock in chir pine woodland); rock-crevices on dry hill, 1200–2500m. July–October.

70. CYNODON Richard

Perennials, usually stoloniferous. Culms leafy throughout, much branched, commonly decumbent and rooting, the nodes each bearing 2–3 leaves. Leaf blades linear, flat; sheaths keeled; ligule membranous, truncate-ciliate. Infl. digitate; racemes linear, secund, spikelets sessile, borne singly, alternate on opposite sides of rachis. Spikelets laterally compressed, floret 1, bisexual, with a minute, vestigial, terminal pedicel, disarticulating above persistent glumes. Glumes shorter than spikelet, subequal, lanceolate, keeled, conduplicate, 1-veined, hyaline. Lemma lanceolate, conduplicate, acute, 3-veined, herbaceous. Palea oblong-elliptic, apex notched, 2-keeled.

1. Leaves to 2mm wide; racemes 3–4(–5), 2.5–5cm, erect, purplish

1. *C. dactylon*

+ Leaves c.5mm wide; racemes 5(+), 5–7cm, spreading, green

2. *C. radiatus*

1. *C. dactylon* (L.) Persoon. Dz: *rampa*; Sha: *aram*; Nep: *dubo*; Eng: *Bermuda grass*. Fig. 36p–q.

Extensively creeping perennial. Erect part of culms 10–19cm. Leaf blades 1.7–4.5 × 0.1–0.2mm, glabrous; sheaths glabrous, apex truncate with fringe of long cilia either side of blade; ligule c.0.2mm, with fringe of cilia (c.1mm) behind, at junction with blade. Racemes commonly purplish, 3–4(–5), 2.5–5 × 0.1–0.2cm, erect, stiffly curved, rachis triangular in section, hispid. Spikelets 1.9–2.7mm. Lower glume 1–1.9mm, subacute, each half c.0.2mm wide, keel minutely serrate; upper glume 1.1–2.2, each half 0.2–0.3mm wide. Lemma 1.7–2.5mm, each half semi-lanceolate, acute, 0.6–0.8mm wide, keel ciliate, stopping just below apex. Palea 1.5–2 × 0.3–0.5mm; anthers c.1.1mm. Vestigial rachilla 0.5–1.2mm, sometimes slightly widened at apex.

Bhutan: S — Phuntsholing, Chukka and Deothang districts; C — Thimphu, Punakha, Tongsa, Mongar and Tashigang districts; **Darjeeling** (Barnesbeg, Lebong); **Sikkim** (Yoksam). Common in waste and cultivated places (e.g. roadsides, weedy lawns), 840–2600m. March–September.

Parker (1992) recorded this as a major weed of annual and perennial crops, and of less well flooded rice, mainly at lower altitudes below 2500m, and occurring in all districts [with cultivation].

2. *C. radiatus* Roth ex Roemer & Schultes; *C. arcuatus* J. Presl

Differs from *C. dactylon* as follows: leaf blades wider (c.5mm), lacking cilia at junction with ligule; apex of leaf sheaths glabrous; racemes commonly 5 or more, longer (5–7cm), spreading, greenish.

Bhutan: S — Deothang district (Deothang to Samdrup Jongkhar); C — Mongar (W of Mongar) and Tashigang (Manchudrang) districts. Grassy roadside in dry bushland; abandoned settlement by river, 500–1600m. September–October.

No doubt a recent introduction and likely to spread.

71. PEROTIS Aiton

Tufted, probably short-lived perennial. Culms unbranched. Leaf blades lanceolate, flat; ligule a truncate-erose, membranous rim. Infl. a terminal, spike-like raceme, spikelets borne singly, sessile, finally spreading horizontally. Spikelets laterally compressed, deciduous as a whole, floret 1, bisexual. Lower glume equalling spikelet, oblong-lanceolate, awned, conduplicate, folded around upper glume, 1-veined, margins \pm hyaline; upper glume similar to lower, slightly smaller. Lemma glabrous, hyaline. Palea glabrous, hyaline.

1. *P. indica* (L.) Kuntze; *P. hordeiformis* Nees ex Hooker & Arnott; *P. latifolia* Aiton. Fig. 36r–s.

Culms 16–33cm, bases decumbent, but not rooting. Leaves borne on lower part of culm; blades 2.5–4 × 0.4–1mm, glabrous, margins pectinate; sheaths glabrous; ligule 0.2–0.4mm. Infl. purplish, 10.5–19cm. Spikelets 2–2.3 (excl. awns) × 0.3–0.4mm; pedicels 0.2–0.4mm, shortly hairy. Lower glume 2–2.3mm, abruptly contracted into awn, each half 0.3–0.4mm wide, narrowly oblong-lanceolate, shortly hispid, keel hispid, awn 5.3–8.8mm; upper glume 1.6–1.9mm, awn 3.5–6.5mm. Lemma c.0.9 × 0.3mm, narrowly lanceolate, acute, glabrous. Palea 0.6–0.8 × 0.15–0.2mm, narrowly oblong, subacute. Anthers c.0.35mm.

Bhutan: S — Chukka district (Sankosh river); C — Punakha (Ruri Chu to Pinsa) and Mongar (below Mongar) districts; **Darjeeling** (Great Rangit opposite Manjitar). Sandy river shingle; by sandy track in chir pine forest, 300–700m. May–November.

There seems no justification for separating *P. hordeiformis* on the characters of a short callus and the hairs on the glumes being in straight lines.

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Doubtfully recorded species:

Crypsis schoenoides (L.) Lamarck (syn. *Heleochoa schoenoides* (L.) Host)

A Griffith specimen (HEIC 6452, K, E) is labelled 'Darjeeling', but as suggested in F.B.I. this is almost certainly due to a label switch; in the subcontinent the species occurs only in NW India.

Tribe XV. PANICEAE R. Brown

1. Creeping, much branched grass; infls. hidden within leaf sheaths, only the whitish stigmas and stamens exerted (Fig. 46e-f)
88. **Pennisetum clandestinum**
+ Plant otherwise; infls. obvious 2
2. Spikelets small (c.2mm); lower glume minute; lower lemma long-awned; upper lemma not crustaceous; plant strongly smelling of linseed oil (Fig. 41i-j) 86. **Melinis**
+ Not as above 3
3. At least some spikelets in infl. subtended by a single bristle attached to the pedicel, commonly subtended by an involucre of numerous bristles 4
+ Spikelets not subtended by one or more bristles 5
4. Pedicels and bristles persistent, spikelets usually deciduous ... 84. **Setaria**
+ Involucre of bristles deciduous with spikelets 88. **Pennisetum**
5. Infl. densely cylindric, partial infls. not obvious, either \pm sessile (infl. spike-like) or erect and strongly overlapping 6
+ Infl. not densely cylindric, partial infls. obvious, spreading to some degree 8
6. Spikelets over 5.5mm; upper glume aristate; lower floret distinctly stalked 76. **Hymenachne**
+ Spikelets under 4mm; upper glume acute; lower floret sessile 7
7. Lateral partial infls. obvious, erect 75. **Panicum auritum**
+ Lateral partial infls. densely congested, so infl. spike-like 77. **Sacciolepis**
8. Upper glume bearing stout hairs which become hooked after fertilisation 72. **Pseudechinolaena**
+ Upper glume lacking hooked hairs 9

9. Glumes long-aristate, arista bristle-like, sticky or hispid **73. Oplismenus**
 + Glumes not long-aristate 10
10. Panicles effuse, branches not bearing spikelets to base; spikelets distinctly pedicelled 11
 + Infl. various, but branches bearing spikelets to base; pedicels very short 12
11. Spikelets not laterally compressed, not conspicuously asymmetric in outline; upper lemma lacking subapical crest **75. Panicum**
 + Spikelets strongly laterally compressed, conspicuously asymmetric (D-shaped) in outline; upper lemma with subapical crest (differing in colour/texture from rest of lemma) **78. Cyrtococcum**
12. Lower glume absent or very small; racemes linear, rachis usually flattened, spikelets densely arranged, small, scarcely wider than the rachis, racemes subequal, usually digitately arranged 13
 + Lower glume conspicuous, usually about half length of spikelet which it encircles; racemes oblong or linear, if linear then spikelets rather laxly arranged and conspicuously wider than the rachis, racemes inserted along elongate axis 15
13. Upper lemma not crustaceous, the margins widely inflexed so almost covering palea; spikelets paired or in groups of 3 (or more) **87. Digitaria**
 + Upper lemma crustaceous, the margins narrowly inflexed, clasping only edges of palea; spikelets single or paired 14
14. Racemes 2–4-rowed, with spikelets inserted singly or in pairs either side of rachis midrib **82. Paspalum**
 + Racemes 1-rowed, with spikelets inserted singly **83. Axonopus**
15. Upper glume conspicuously exceeding lemmas; upper lemma with sides at base drawn down to form hyaline margins to a stipe-like base; spikelets gaping **74. Ichnanthus**
 + Upper glume shorter than to equalling lemmas; sides of upper lemma not drawn down at base; spikelets not gaping 16
16. Glumes and lower lemma with conspicuous, laterally compressed (as though pinched) apiculus (Fig. 39i) **79. Acroceras**
 + Glumes and lower lemma not as above 17
17. Racemes short, oblong, inserted distantly along axis so not overlapping; spikelets glabrous, to 3mm **85. Paspalidium**

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- + Racemes oblong or linear, overlapping at least in upper part of infl.; spikelets hispid or hairy, if glabrous then over 3.2mm 18
- 18. Spikelets hispid; upper glume cuspidate, lower lemma cuspidate to aristate **80. Echinochloa**
- + Spikelets softly hairy or glabrous; upper glume and lower lemma subacute or acute **81. Urochloa**

72. PSEUDECHINOLAENA Stapf

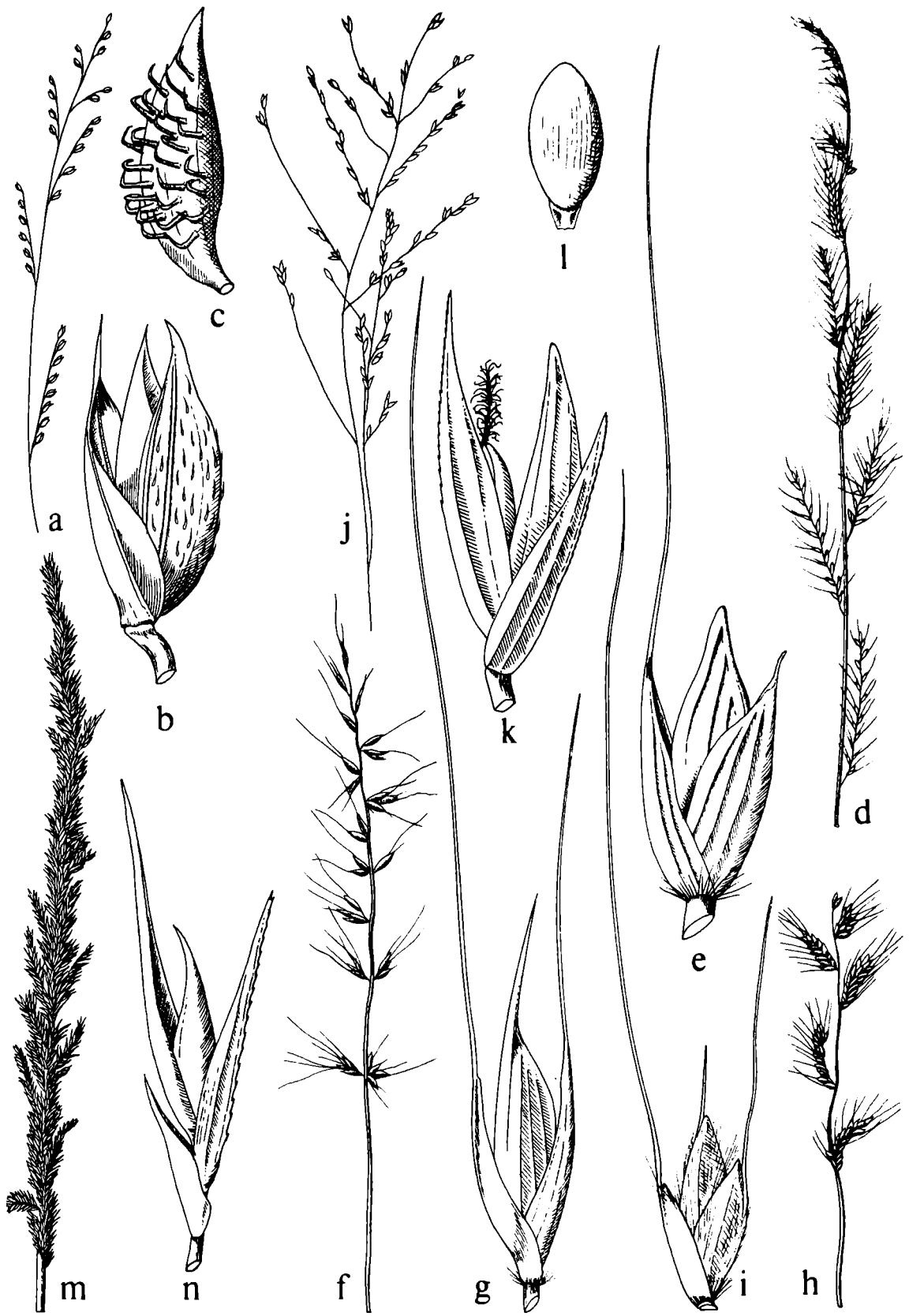
Perennial. Culms leafy, branched below, base decumbent and rooting from nodes. Leaf blades flat, \pm lanceolate; ligule membranous. Infl. terminal, a lax panicle, lateral branches few, ascending. Spikelets borne singly (but with minute spikelet vestige at base of pedicel), falling entire, asymmetrically lanceolate; florets 2; pedicels persistent, apex cup-shaped. Glumes equalling spikelet; the lower apiculate, herbaceous, smooth, margins widely hyaline; the upper strongly convex, herbaceous, hairs between veins elongating and becoming hooked after fertilisation. Lower floret sterile; lemma with central groove on back, herbaceous, margins widely hyaline; palea equalling lemma, hyaline, margins infolded. Upper floret bisexual; lemma narrowly lanceolate, convex, tightly enclosing the palea, thinly coriaceous, shining; palea similar to lemma, narrower, margins inflexed; stamens 3.

1. *P. polystachya* (Kunth) Stapf; *Panicum uncinatum* Raddi. Fig. 37a–c.

Culms 24–48cm. Leaf blades 3.2–6.3 \times 0.8–1cm, undulate in life, lanceolate, finely acuminate, usually with scattered, tubercle-based hairs above; sheaths with short, appressed hairs, margins densely ciliate; ligule 1.6–2mm, truncate-ciliate. Infl. 10–18cm, lateral branches 3–6, distant, inserted singly, the longest 2.5–5.5cm; pedicels 1.5–2.7mm, slender, hispid, bent at apex.

FIG. 37.

a–c, **Pseudechinolaena polystachya**: a, infl. ($\times \frac{1}{3}$); b, spikelet ($\times 8$); upper glume at maturity ($\times 8$). d–e, **Oplismenus compositus**: d, infl. ($\times \frac{1}{3}$); e, spikelet ($\times 10$). f–g, **O. undulatifolius**: f, infl. ($\times \frac{2}{3}$); g, spikelet ($\times 8$). h–i, **O. burmannii**: h, infl. ($\times \frac{2}{3}$); i, spikelet ($\times 8$). j–l, **Ichnanthus pallens**: j, infl. ($\times \frac{1}{3}$); k, spikelet ($\times 8$); l, upper lemma ($\times 8$). m–n, **Hymenachne acutigluma**: m, infl. ($\times \frac{1}{3}$); n, spikelet ($\times 8$). Drawn by Louise Olley.



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Spikelets 3.5–4.4 × 1.5–2.1mm, gaping. Lower glume 3.7–4.4 × 1.2–2mm, lanceolate, 3-veined, apiculus 0.3–0.6mm; upper glume 3.4–4.4mm, 7-veined, each half semi-lanceolate, acuminate, hooks 0.3–1mm. Lower floret: lemma 2.9–4 × 1.7–2mm, (4–)5(–7)-veined, sometimes granular on back; palea 3–4.1 × 0.4–0.6mm, linear-lanceolate, very acute, granular. Upper floret: lemma 2.5–3 × 0.9–1mm, narrowly lanceolate, apiculate; palea 2.3–2.8 × 0.8–1mm; anthers c.1.5mm.

Bhutan: S — Samchi (Malbashi Hill), Phuntsholing (Kamji to Suntlakha), Chukka (Kyacha near Gedu), Samchi (Sarbhong to Doracha Pass) and Gaylegphug (Sureylakha) districts; **C**— Mongar district (Saleng); **Darjeeling** (Rishap); **Sikkim** (Tumlong, Gangtok, Kabi Forest, Tashiding to Legship road). Wet broad-leaved forest, 550–1730m. July–January.

The hooks on the upper glume are an adaptation to animal dispersal.

73. OPLISMENUS P. Beauvois

Usually sprawling perennials. Culms leafy, branched below, base decumbent and rooting from nodes. Leaf blades flat, ± lanceolate, undulate in life; ligule membranous, ciliate. Infl. terminal, paniculate, racemes secund, ascending, distant. Spikelets borne in pairs, lanceolate, slightly compressed, falling entire; florets 2; pedicels very short, ciliate at apex. Glumes subequal, shorter than spikelet, long aristate, margins ciliate. Lower floret sterile or male, equalling spikelet; lemma convex, awned or not, margins widened and inflexed above; palea small and hyaline or absent. Upper floret bisexual; lemma cream, lanceolate, convex, tightly enclosing the palea, coriaceous, shining; palea similar to lemma, narrower, margins inflexed; stamens 3.

- 1. Spikelets small (2.4–3mm excl. awns); awns of glumes and lemma antorsely scabrid, very slender **3. O. burmannii**
- + Spikelets larger (2.7–4.5mm excl. awns); awns of glumes (and lemma) smooth, sticky, stout **2**
- 2. Racemes developed (the lowest over 37mm) **1. O. compositus**
- + Racemes contracted (the lowest to 5.5mm, the upper not developed, so spikelets borne in clusters along infl. axis) **2. O. undulatifolius**

1. O. compositus (L.) P. Beauvois var. **compositus**. Fig. 37d–e.

Culms 25–63cm. Leaf blades 6.5–16 × 1.3–2cm, lanceolate, finely acuminate, margins thickened, hispid, sometimes with long cilia near base, base narrowed or rounded, surfaces usually minutely hispid (sometimes smooth),

glabrous, or with scattered hairs (hairs bristle-like, or soft and spreading), shortly hairy at junction with sheath beneath, cross-veinlets sometimes conspicuous; sheaths glabrous, or with short, soft, spreading hairs, margins densely ciliate; ligule 1–1.3mm, truncate, cilia 1.2–1.5mm. Infl. 12–23cm, axis stout, glabrous; racemes 5–10, the lowest 3.7–8cm, axis triquetrous, glabrous or very shortly hairy. Spikelets 3.7–4mm. Lower glume 3.3–3.5 × 1.2–1.5mm, lanceolate, tapered upwards, sparsely hairy near margins, 5(–6)-veined, awn 6–8.4mm; upper glume 2.6–3.2 × 1.3–1.5mm, elliptic, acute, hairy near margins or subglabrous, (5–)7-veined, awn 0.8–5.5mm. Lower floret: lemma 3.4–3.6 × 1.5–1.8mm, broadly lanceolate, bluntly acuminate, hairy on upper part of margins, 9-veined; palea usually absent or linear-lanceolate, 2.7 × 0.8mm; anthers 1.2mm. Upper floret: lemma 2.8–3.2 × 0.9–1.3mm, oblong-lanceolate, acute; palea 2.5–2.9 × 0.8–1.1mm; anthers c.1.1mm.

Bhutan: S — Chukka district (near Gedu); C — Punakha (near Punakha Dzong, Mo Chu) and Tashigang (E side of Kori La) districts; N — Upper Mo Chu district (Gasa); **Darjeeling** (Rungnoo Valley, above Mungpo, Ghumpahar, Kurseong, Lebong, Little Rangit); **Sikkim** (Nathang). Mixed evergreen forest; oak forest; open bushland on river silt, 1090–2440m. August–December.

Includes Hooker's 'var. 4' and part of his 'var. 1' (F.B.I.). The specimen from Little Rangit (*Hooker* s.n., K) and one from Kurseong (*Meebold* s.n., BM) are very hairy (leaf sheaths with long, spreading tubercle-based hairs; leaf margins with sparse, long cilia; infl. axis with short, spreading hairs; raceme axes with short, spreading hairs and long cilia).

var. **rariflorus** (C. Presl) U. Scholz

Differs from var. *compositus* in being a more slender plant: leaves commonly shorter and narrower (5.3–11 × 0.7–1.8cm), usually with conspicuous, long, marginal cilia at base of blade; infl. shorter, racemes more slender (the lowest 2.5–5(–7.5)cm, spikelets smaller (2.7–3.1mm), spikelet parts all smaller (awn of lower glume 5–5.9mm; lower lemma 2.6–3.1mm).

Bhutan: S — Samchi (Changtar, Soureni Gari), Phuntsholing (Phuntsholing), Chukka (near Kalikhola, below Chimakothi), Sarbhang (between Sarbhang and Toribari) and Gaylegphug (Gaylegphug) districts; C — Punakha (Chuzomsa) and Tashigang (between Kanglung and Tashigang) districts; **Terai** (Jalpaiguri Duars); **Darjeeling** (Mungpo, Ryang, Maligodam to Mungpo, Great Rangit, Little Rangit, Rangirun forest, Kurseong, Darjeeling); **Sikim** (Yoksam). Scrubby slope near stream; evergreen and lowland (incl. sal) forest; swamp, 300–1830m. September–April.

Includes Hooker's 'var. 5' and part of his 'var. 1' (F.B.I.). Hairy forms seem to be

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commoner than in var. *compositus*, and are variable in the degree of hairiness. The ones from Chimakothi, Maligodam, Great Rangit and Yoksam have long, spreading hairs on the leaf sheaths, infl. and raceme axis, and softly pubescent leaves; in those from Darjeeling, Ryang and Chuzomsa, the infls. are less hairy.

Field records, not assigned to variety, from Deothang, Tongsa and Mongar districts.

2. *O. undulatifolius* (Arduino) P. Beauvois var. **undulatifolius**. Fig. 37f–g.

Differs from *O. compositus* as follows: racemes short (lowest to 5.5mm, the upper not developed so spikelets clustered on infl. axis); some spikelets in lowest raceme reduced, consisting mainly of (glume) awns.

Culms to 49cm. Leaf blades 4.7–8 × 1–1.5cm, lanceolate, finely acuminate, margins thickened, with a few long cilia near base, base rounded, surfaces with scattered, soft hairs; sheaths with spreading, tubercle-based hairs, margins densely ciliate; ligule 0.8mm, cilia 1mm. Infl. 9.5cm, axis with long, spreading, tubercle-based hairs; racemes c.11, the upper consisting of sessile spikelet clusters, the lowest with a very short axis (to 5.5mm) and some spikelets reduced to awns. Spikelets 3.5mm. Lower glume 2.7 × 1mm, 3-veined, awn 11.4mm; upper glume 3.4 × 1.2mm, 5-veined, awn 6mm. Lower floret: lemma 3.4 × 2mm, 7-veined; palea 1.3 × 0.2mm. Upper floret: lemma 3 × 1mm; palea 2.9 × 0.7mm.

Bhutan: C — Thimphu district (Gidakom). Dry, deciuous woodland, 2200m. August.

var. **japonicus** (Steudel) Koidzumi

Differs from var. *undulatifolius* as follows: leaf sheaths glabrous; infl. axis glabrous; spikelets larger (4.5mm).

Bhutan: C — Punakha (above Lometsawa) and Tashigang (E side of Kori La) districts. Moist oak forest, 2200m. September.

Scholz (1981b) treated both these varieties as subsp. of the American/African species *O. hirtellus* (L.) P. Beauvois; however, they seem to me to be far closer to *O. compositus*.

Field record, not assigned to variety, from Chukka district.

3. *O. burmannii* (Retzius) P. Beauvois. Fig. 37h–i.

Culms 22–56cm, slender. Leaf blades 2.5–5.7 × 0.7–1.4cm, narrowly ovate, acuminate, margins minutely hispid, with a few cilia near base, base rounded, surfaces with scattered, slender, spreading, tubercle-based hairs; sheaths with spreading, tubercle-based hairs, margins ciliate; ligule 0.6–1mm, truncate, cilia 0.2–0.5mm. Infl. 3–9cm, axis flexuous, triquetrous, angles ciliate; racemes 5–9, dense, the lowest 1–1.5cm, axis bearing long cilia. Spikelets 2.4–3mm. Lower glume 1.7–2.2 × 0.7–1mm, lanceolate, narrowed to blunt apex, 3(–5)-veined, margins densely ciliate, awn 7.1–12.5mm, subterminal,

minutely antrorsely scabrid; upper glume 1.8–2.2 × 0.9–1.2mm, elliptic, narrowed to subacute apex, 5-veined, margins densely ciliate, back hairy, awn 3.4–5mm. Lower floret: lemma 2.4–3 × 0.9–1.1mm, lanceolate, acuminate, long- and short-hairy on upper part of margins, 7–11-veined, awn 0.4–0.9mm; palea usually absent or linear-ob lanceolate, 2.1 × 0.3mm. Upper floret: lemma 2.2–2.6 × 0.7–0.9mm, narrowly lanceolate, acute; palea 2–2.4 × 0.6–0.8mm; anthers 0.6–1.1mm.

Bhutan: S — Chukka district (below Chimakothi); C— Punakha (near Punakha Dzong, Baso Chu to Ruri Chu), Tongsa (Bubja to Kinga Raptan), Mongar (Yonko La) and Tashigang (Tashi Yangtshi, Rongthong) districts; **Darjeeling** (Punkabari, Kurseong); **Sikkim** (Kulhait Valley, Yoksam, Gangtok, Selim). Open bushland on river silt; shady bank by road; disturbed places (e.g. orange orchard, shady wall, gardens), 610–1950m. January–October.

74. ICHNANTHUS P. Beauvois

Sprawling, perennial. Culms leafy, branched below, base decumbent and rooting from nodes. Leaf blades flat, lanceolate; ligule membranous, ciliate. Infls. terminal and axillary, paniculate, racemes slender, ascending. Spikelets borne singly, gaping, falling entire, laterally compressed; florets 2; pedicels slender. Glumes unequal, keeled, thinly herbaceous, the lower shorter than spikelet, the upper equalling spikelet. Lower floret male; lemma lanceolate, convex, thinly herbaceous; palea hyaline; stamens 3. Upper floret bisexual; lemma oblong-elliptic, convex, coriaceous, shining, tightly enclosing the palea, lower margins drawn down to form hyaline margins to stipe-like base; palea similar to lemma, narrower, margins inflexed; stamens 3.

1. **I. pallens** (Swartz) Munro ex Bentham; *I. vicinus* (F.M. Bailey) Merrill. Fig. 37j–l.

Culms to 22–55(+?)cm. Leaf blades 4.5–8 × 1–1.9cm, lanceolate, asymmetric, abruptly acuminate, bases rounded, slightly clasping, with soft, spreading, tubercle-based hairs on both surfaces; sheaths glabrous or sparsely hairy, margins densely ciliate; ligule 0.4–1mm, cilia 0.5–1mm. Terminal infl. 3.5–20cm, lowest raceme 2.6–11cm. Spikelets 4.4–4.6mm. Lower glume 3–3.1 × 1.2–1.3mm, oblong-lanceolate, acuminate into short, minutely hispid apiculus (c.0.5mm), sparsely hairy on back and upper margins, 3-veined; upper glume 4.1–4.5 × 1.2–1.6mm, narrowly oblong-lanceolate, finely acuminate, 5(–6)-veined, keel minutely hispid. Lower floret: lemma 3.5 × 1.4mm, lanceolate, acute, 5-veined; palea 2.2–2.7 × 0.6–0.9mm, oblong, truncate, keels and apex shortly ciliate; anthers 0.5–1.2mm. Upper floret: lemma 1.8–2 ×

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0.9–1mm, oblong-elliptic, convex, smooth, blunt, base c.0.5mm; palea 2–2.2 × 0.6–0.8mm, narrowly oblong; anthers 0.9mm.

Darjeeling (Rishap; unlocalised Hooker specimen from 'tropical Sikkim'). [Along paths and in clearings in [broad-leaved] forest according to Bor], 1070m. August.

Steiber (1987) cited the Hooker specimen as 'tending towards' var. *majus* (Nees) Steiber. Both specimens that have been seen appear to be identical and agree with this variety which differs from the typical one in having larger spikelets (4.5–)5–6.5mm, and the apex of the lower glume long-attenuate.

75. PANICUM L.

Annuals or perennials (sometimes sprawling). Culms branched or unbranched. Leaf blades flat, linear-lanceolate or occasionally ± ovate; ligule membranous, truncate, usually ciliate, the membranous part sometimes absent. Infl. terminal, paniculate. Spikelets usually biconvex, occasionally plano-convex, falling entire; florets 2. Glumes herbaceous, the lower encircling the spikelet, usually shorter than, sometimes subequalling, the upper, the upper equalling spikelet. Lower floret sterile or male; lemma similar to upper glume; palea hyaline, sometimes absent. Upper floret bisexual; lemma convex, tightly enclosing the palea, coriaceous, usually smooth, sometimes transversely rugose; palea similar to lemma, narrower, margins inflexed; stamens 3.

1. Infl. axis with spreading hairs; pedicels and infl. branches viscid, so infl. tangled, very dense, ellipsoid **2. P. incomtum**
- + Infl. axis glabrous or minutely hispid; pedicels and infl. branches not viscid, infl. not tangled, lax, or if dense, then narrowly cylindrical 2
2. Glumes subequal 3
- + Lower glume distinctly shorter than upper 4
3. Leaf blades ovate, asymmetric; spikelets plano-convex in side-view
1. P. brevifolium
- + Leaf blades linear, symmetric; spikelets biconvex in side-view
11. P. notatum
4. Spikelets under 2mm; small slender annual **8. P. walense**
- + Spikelets over 2.3mm; if annual then stouter 5
5. Upper lemma transversely rugose **4. P. maximum**
- + Upper lemma smooth 6

6. Glumes cuspidate 7
 + Glumes subacute or acute 8
7. Infl. drooping, dense; spikelets over 3.9mm; cultivated .. **3. P. miliaceum**
 + Infl. erect, lax; spikelets to 3.4mm; wild **7. P. curviflorum**
8. Spikelets over 3.3mm; lower glume \pm truncate (slightly 3-lobed)
5. P. paludosum
 + Spikelets to 2.8mm; lower glume not truncate 9
9. Infl. narrowly cylindrical, branches erect, spikelets densely crowded
6. P. auritum
 + Infl. wider, branches spreading, spikelets not crowded 10
10. Plant annual **9. P. psilopodium**
 + Large, straggling perennial **10. P. khasianum**

1. P. brevifolium L.; *P. ovalifolium* Poiret. Fig. 38a–b.

Culms 36–41cm, branched below, base decumbent and rooting from nodes. Leaf blades 4.6–8.5 \times 1.1–2.5cm, asymmetrically, narrowly ovate, abruptly acuminate, margins sometimes long-ciliate near base, rounded and clasping at base, with short scattered hairs beneath and sometimes above. Sheaths with ciliate margins; ligule c.0.2mm, truncate. Panicle 10–14.5 \times 4.5–9cm, rhombic in outline, primary branches spreading obliquely. Spikelets dark green or purplish, 2–2.1 \times 0.8–0.9mm, plano-convex, elliptic, not gaping, acute, hispid with short, spreading hairs; pedicels filiform, \pm terete, minutely hispid. Lower glume whitish or tinged purple, 1.7–2.1 \times 0.5–0.6mm, oblong-lanceolate, subacute, flat, base scarcely clasping, hairy near margins, (1–)3-veined; upper glume 1.7–1.9mm, ovate, deeply convex, broadly acuminate, back hairy, 5-veined. Lower floret: lemma 1.7–1.9mm, elliptic, acute, back flat, \pm glabrous, 5-veined, hyaline between veins, margins inflexed; palea 1.5–1.8 \times 0.4–0.6mm, oblong-lanceolate, acute, margins broadly inflexed, keels minutely hispid. Upper floret: lemma 1.4–1.5 \times 0.7–0.8mm, elliptic, convex, subacute, coriaceous, smooth, shining, margins incurved; palea 1.3–1.4 \times 0.6–0.8mm, elliptic, blunt, margins widely inflexed, hyaline, scarcely widened below; anthers c.0.8mm, yellow.

Bhutan: S — Phuntsholing (above Kharbandi) and Gaylegphug (c.2km E of Lodrai, Zurphe) districts; **Darjeeling** (Sittong, Kurseong); **Sikkim** (Yoksam, Dikchu, Gangtok). Subtropical forest: margins, by streams and on bare ground in damp, shaded places, 300–1800m. May–January.

2. **P. incomtum** Trinius; *P. sarmentosum* sensu F.B.I., non Roxb. Fig. 38c-d.

Culms extensively scrambling (to 15m, according to Bor, 1940), branched below. Leaf blades to 20×1.4 cm, linear-lanceolate, finely tapered to very acute apex, narrowly rounded at base, with fine, spreading hairs above and beneath. Sheaths with fine, spreading hairs; ligule c.0.7mm, truncate-ciliate. Panicle 13-17 \times 6-7cm, elliptic in outline, very dense, axis hairy, branches viscid, becoming tangled. Spikelets dark olive green, 1.8-1.9 \times 1-1.1mm, elliptic, not gaping, blunt, viscid; pedicels filiform, \pm terete, viscid. Lower glume 1.3-1.6 \times 0.9-1mm, ovate, convex, blunt, strongly 3-veined, apex minutely ciliate, margins hyaline; upper glume 1.8-1.9mm, elliptic, deeply convex, apex hooded, minutely hairy near apex, 5-veined, margins hyaline. Lower floret: lemma 1.6-1.7mm, similar to upper glume; palea 1.4-1.5 \times 0.5-0.6mm, oblong to oblanceolate, apex narrowed. Upper floret: lemma 1.3-1.5 \times 0.9mm, elliptic, convex, acute, crustaceous, shining, margins incurved; palea 1.4 \times 0.7mm, narrowly elliptic, blunt, margins widely inflexed, widened and hyaline below; anthers c.0.8mm, orange.

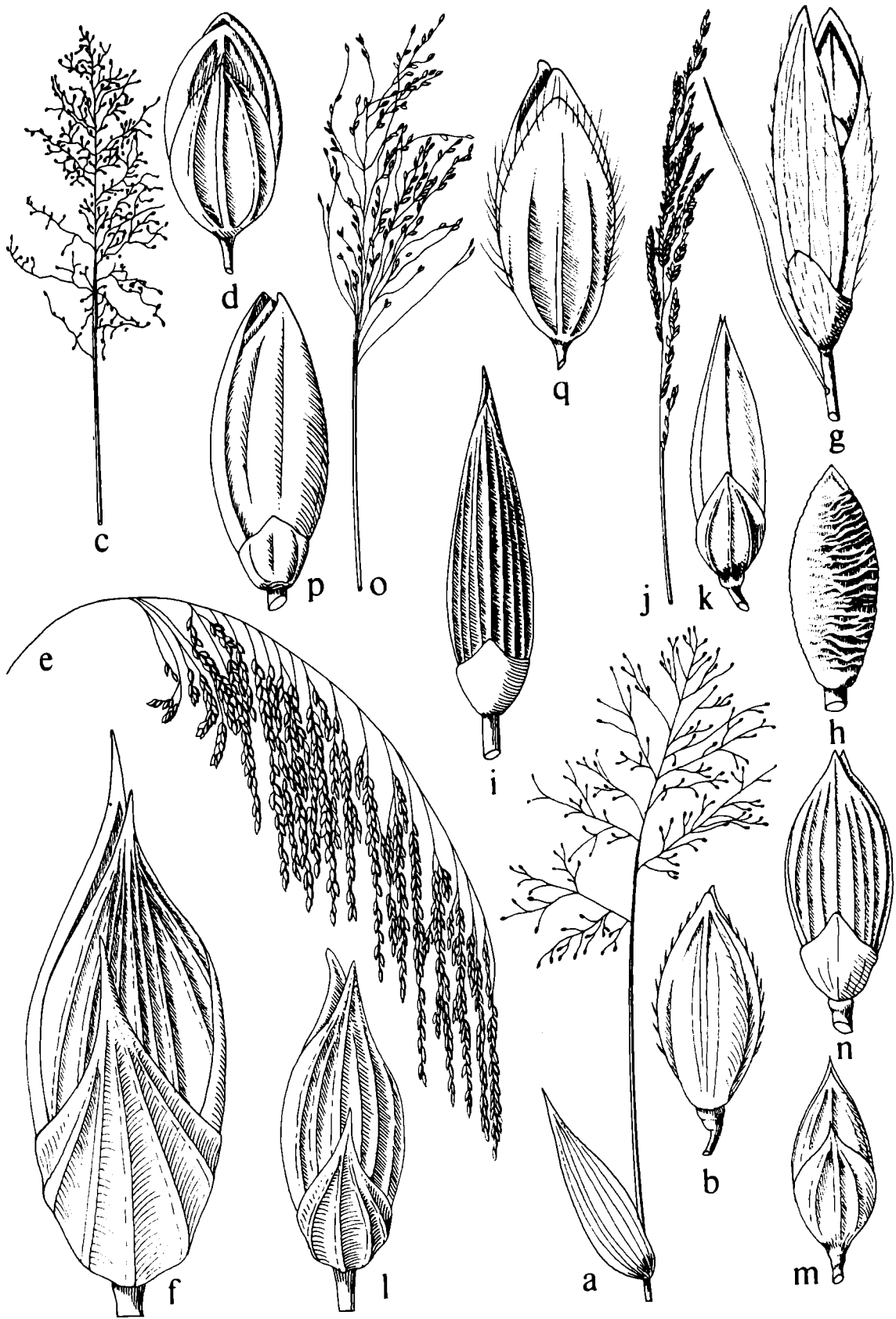
Bhutan: S — Samchi (Changtar) and Gaylegphug (Gaylegphug) districts. [Subtropical forest], 300-460m. December.

3. **P. miliaceum** L. Sha: *chheyra*; Eng: *common* or *proso millet*. Fig. 38e-f.

Tufted annual. Culms to 120cm (Bor, 1940), stout, erect, unbranched. Leaf blades to 50×2.5 cm (Bor, 1940), linear-lanceolate, very acute, rounded at base, with long, scattered hairs above and beneath. Sheaths densely covered with stout, tubercle-based hairs; ligule c.1mm, truncate-ciliate. Panicle 26-30cm, branches ascending, whole infl. drooping in fruit. Spikelets green, 3.9-5.5 \times 1.5-2mm, oblong-elliptic, not gaping, abruptly apiculate, glabrous; pedicels stout, trigonous, angles hispid. Lower glume 2.8-3.2 \times 2-2.5mm, ovate, acuminate, acute to very acute, 5-7-veined, sometimes slightly keeled, keel minutely hispid; upper glume 3.9-5mm, narrowly lanceolate, back convex, acuminate into broad apiculus, 11-veined, margins incurved. Lower floret: lemma 3.7-4.8mm, similar to upper glume; palea 1-2 \times 0.6-1mm, oblong-elliptic, retuse. Upper floret: lemma finally brown, 2.6-3.5 \times 1.5-1.8mm, oblong-elliptic, convex, subacute, coriaceous, smooth, shining, margins

FIG. 38.

a-b, **Panicum brevifolium**: a, infl. ($\times \frac{1}{3}$); b, spikelet ($\times 12$). c-d, **P. incomtum**: c, infl. ($\times \frac{1}{3}$); d, spikelet ($\times 12$). e-f, **P. miliaceum**: e, infl. ($\times \frac{1}{3}$); f, spikelet ($\times 12$). g-h, **P. maximum**: g, spikelet ($\times 12$); h, upper lemma ($\times 12$). i, **P. paludosum**: spikelet ($\times 12$). j-k, **P. auritum**: j, infl. ($\times \frac{1}{3}$); k, spikelet ($\times 12$). l, **P. curviflorum** ($\times 12$). m, **P. walense**: spikelet ($\times 12$); n, **P. psilopodium**: spikelet ($\times 12$). o-p, **P. khasianum**: o, infl. ($\frac{1}{3}$); p, spikelet ($\times 12$). q, **P. notatum**: spikelet ($\times 12$). Drawn by Louise Olley.



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inflexed; palea 2.6–3.3 × 1.2–1.5mm, narrowly elliptic, subacute, margins incurved, widened above base; anthers c.2mm, brown.

Bhutan: C — Tongsa district (Dummong, Shemgang (Nakao & Nishioka, 1984)); **Sikkim** (Keadom). Cultivated, 1100–2130m. October.

According to Nakao & Nishioka (1984) seldom cultivated in Bhutan, though Roder & Gurung (1990) record it as widespread. Presumably used mainly for brewing.

4. *P. maximum* Jacquin. Eng: *Guinea grass*. Fig. 38g–h.

Tufted perennial. Culms 60–200cm, erect, usually branched, nodes sometimes bearded. Leaf blades to 60 × 0.6(–2)cm, linear-lanceolate, very acute, margins hispid, narrowed to base, with scattered hairs above and beneath, densely hairy above and beneath at junction with sheath. Sheaths glabrous or with long, soft, spreading, tubercle-based hairs; bases of basal sheaths sometimes woolly; ligule extremely short, long-ciliate. Panicle 15–23.5 × 5–10cm, pyramidal, branches spreading obliquely. Spikelets green or purple, 2.5–3.6 × 1–1.1mm, narrowly oblong, not gaping, subacute; pedicels slender, ± terete, minutely hispid. Lower glume 0.6–1.6 × 1.5mm, ovate, subacute, glabrous or with short, spreading hairs, 3-veined, margins widely hyaline; upper glume 2.3–3.8mm, narrowly oblong, back convex, acute, glabrous or with short, spreading hairs, 5-veined, margins incurved. Lower floret: lemma 2.5–3.6mm, similar to upper glume; palea 2–3.2 × 0.5–0.8mm, narrowly oblanceolate, blunt. Upper floret: lemma pale green, 1.9–2.3 × 0.8–0.9mm, oblong-elliptic, convex, acute, coriaceous, transversely rugose, margins inflexed; palea 1.7–2.1 × 0.8–0.9mm, narrowly elliptic, subacute, back rugose, margins incurved, hyaline, widened in lower half.

Bhutan: S — Samchi district (Samchi to Chengmari); C — Punakha (near Punakha Dzong), Mongar (Lingmethang) and Tashigang (Tashigang) districts; **Sikkim** (at least formerly cultivated, introduced c.1940 (Gould, 1957, p. 181)). Cultivated and sometimes becoming naturalised on banks or in ditches, 400–1300m. May–September.

Native of tropical Africa, but widely grown in the tropics as a fodder grass.

5. *P. paludosum* Roxb.; *P. proliferum* sensu F.B.I., non Lamarck. Fig. 38i.

Tufted perennial. Culms 18–50cm, soft, unbranched, base decumbent and rooting from nodes. Leaf blades 5–20 × 0.4–0.7cm, linear-lanceolate, acute, truncate at base, glabrous, margins hispid. Sheaths glabrous; ligule extremely short, long-ciliate. Panicle 6–12 × 8.5–10cm, widely pyramidal, branches spreading. Pedicels trigonous, angles hispid. Spikelets green, 3.3–3.7 × 1–1.1mm, narrowly lanceolate, not gaping, very acute, glabrous. Lower glume whitish, 0.8–0.9 × 1.3–1.8mm, transversely oblong-ovate, slightly 3-lobed to

truncate, veins (3) scarcely visible; upper glume 3.3–3.8mm, narrowly lanceolate, convex, very acute, glabrous, strongly (8–)9-veined. Lower floret: lemma 3.3–3.6mm, similar to upper glume; palea 0.9–1.5(–2.2) × 0.3–0.4(–0.6)mm, narrowly oblong to narrowly elliptic, blunt or subacute, sometimes absent. Upper floret: lemma cream, 2.2–2.3 × 0.8–1mm, oblong, convex, shortly acuminate, coriaceous, smooth, margins inflexed; palea 2–2.2 × 0.7–1mm, oblong, acute, margins inflexed, widened above base; anthers c.1.2mm, orange.

Bhutan: S — Samchi (Samchi to Chengmari), Phuntsholing (Phuntsholing), Chukka (Khurul Pokhari) and Gaylegphug (Gaylegphug) districts; **Sikkim** (1km above Raniphul). Wet places: marshy roadsides, beside pool in forest, open grassy swamp, 300–1000m. May–October.

6. **P. auritum** Presl ex Nees. Fig. 38j–k.

Slender perennial. Culms 62(–200)cm, soft, unbranched, base decumbent and rooting from nodes. Leaf blades to 21(–40) × 1.2(–4)cm, linear-lanceolate, very acute, margins minutely hispid, rounded and slightly clasping at base, glabrous, with a few long cilia at extreme base. Sheath margins ciliate; ligule c.0.4mm, membranous, truncate. Panicle 12–36 × 1.5–4cm, narrowly cylindrical, very dense, branches erect. Spikelets greyish-purple, c.2.5 × 1mm, oblong-lanceolate, not gaping, acute, glabrous; pedicels slender, hispid. Lower glume c.1.2 × 1mm, broadly, asymmetrically ovate, blunt, strongly 3-veined, slightly keeled, keel minutely hispid; upper glume c.2.5mm, lanceolate, convex, slightly keeled, very acute, glabrous, strongly 5-veined, keel minutely hispid. Lower floret: lemma c.2.4mm, similar to upper glume, but not keeled; palea 1.1–1.5 × 0.4mm, narrowly oblong to oblanceolate, blunt or subacute. Upper floret: lemma cream, c.2.1 × 0.9mm, lanceolate, convex, finely acuminate, very thinly coriaceous, smooth, margins incurved; palea 1.8–2 × 0.6–0.8mm, lanceolate, acute, margins inflexed.

Bhutan: S — Chukka (Khurul Pokhari) and Sarbhang (Phipsoo) districts; **Terai** (Siliguri). Marshy grassland, by pool in clearing in broad-leaved forest; sal/teak forest, 200–400m. July–February.

Rather different in appearance to other species of *Panicum* and sometimes placed in *Sacciolepis* or *Hymenachne*.

7. **P. curviflorum** Horneman; *P. trypheron* Schultes. Fig. 38l.

Tufted annual. Culms 8–24cm, unbranched, leaves mainly basal. Leaf blades to 6.5–8.5 × 0.3–0.5cm, linear-lanceolate, acute, truncate at base, with dense, spreading, tubercle-based hairs beneath. Sheaths with scattered, tubercle-based hairs, margins ciliate; ligule a rim of hairs c.0.6mm. Panicle 7–15 × 5–7cm, pyramidal, lax, branches distant, spreading to obliquely erect.

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Spikelets purplish, 3–3.4 × 0.8–1.1mm, compressed, widely gaping at maturity, finely acuminate, glabrous; pedicels slender, trigonous, angles hispid. Lower glume 1.7–2.3 × 1.3–1.5mm, ovate, acuminate, apiculate, strongly 3-veined, slightly keeled, keel and apiculus minutely hispid; upper glume 3–3.5mm, lanceolate, convex, acuminate, glabrous, strongly 7-veined. Lower floret: lemma 2.4–2.9mm, similar to upper glume, but 9-veined; palea 1.5–1.9 × 0.7–0.9mm, narrowly lanceolate, blunt. Upper floret: lemma cream, 1.9 × 1–1.2mm, oblong-elliptic, convex, blunt, smooth, margins inflexed; palea 1.6–1.9 × 0.9–1mm, narrowly oblong-elliptic, blunt, margins inflexed, widened at base; anthers 1–1.2mm.

Bhutan: S — Phuntsholing (Torsa River) and Deothang (Deothang to Samdrup Jongkhar) districts; C — Punakha (Pinsa) and Tashigang (Tashigang to Kanglung) districts; **Terai** (Siliguri); **Darjeeling** (Great Rangit opposite Manjitar). Damp places: sandy river shingle; roadside ditch, 400–1200m. May–October.

8. *P. walense* Mez; *P. humile* Nees ex Steudel; *P. austroasiaticum* Ohwi. Fig. 38m.

Slender, tufted annual. Culms 2–20cm, branched. Leaf blades 1.5–17cm, 1.9–3.4mm wide, linear-lanceolate, acute, narrowly rounded at base, glabrous, with tuft of hairs at junction with sheath. Sheaths glabrous, margins ciliate; ligule c.0.2mm, truncate-ciliate. Panicle 1.5–20 × 1–9cm, pyramidal, dense, branches spreading. Spikelets purplish, c.1.7 × 0.7mm, oblong-elliptic, gaping at maturity, finely acuminate, glabrous; pedicels slender, trigonous, angles hispid. Lower glume 1.3–1.5 × 0.8mm, ovate, finely acuminate, strongly 3-veined; upper glume c.1.5mm, ovate, convex, finely acuminate, glabrous, 5-veined (the outer pair very weak). Lower floret: lemma 1.3–1.5mm, similar to upper glume, but 3-veined and bluntly acuminate; palea c.1 × 0.5mm, narrowly elliptic, blunt. Upper floret: lemma cream, c.1.2 × 0.7mm, elliptic, convex, blunt, smooth, margins inflexed; palea c.1.1 × 0.6mm, narrowly elliptic, blunt, margins inflexed, widened at base.

Bhutan: S — Phuntsholing district (Torsa River); **Terai** (Phansidowa). Among scrub in seasonally flooded, sandy river bed, 150–400m. September–December.

9. *P. psilopodium* Trinius. Fig. 38n.

Tufted annual. Culms 5–60cm, usually unbranched. Leaf blades 14.5–45 × 0.4–0.7cm, linear-lanceolate, very acute, narrowly rounded at base, glabrous. Sheaths glabrous; ligule c.0.5mm, membranous, truncate, shortly ciliate. Panicle 7–37 × 7–12cm, pyramidal or broadly cylindrical, lax, branches spreading or obliquely erect. Spikelets purple, 2.5–2.8 × 0.9–1.1mm, oblong, not

gaping, acuminate, glabrous, apex bluntly apiculate; pedicels slender, trigonous, angles hispid. Lower glume 0.9–1.3 × 1.5–1.8mm, widely ovate, acuminate, obscurely veined, midrib usually distinct; upper glume 2.6–3mm, narrowly lanceolate, convex, acute, glabrous, 11-veined, margins inrolled. Lower floret: lemma 2.5–2.8mm, similar to upper glume, but 9-veined; palea 2.3–2.5 × 0.6–0.8mm, oblong-lanceolate, blunt. Upper floret: lemma cream, 2.1–2.2 × 0.9–1mm, narrowly elliptic, convex, apiculate, smooth, margins inflexed; palea 2–2.1 × 0.8–0.9mm, narrowly elliptic, acute, margins inflexed, widened at base; anthers c.1.2mm, purple.

Bhutan: C — Punakha district (Punakha to Rimchu); **Darjeeling** (Rungbee, Great Rangit valley, Kurseong to Punkabari, Ging). Disturbed roadsides, 305–1270m. May–September.

Sometimes (e.g. Veldkamp *et al.*, 1989) sunk under *P. sumatrense* Roth ex Roemer & Schultes, a cultivated species.

10. *P. khasianum* Munro ex Hook. f. Fig. 38o–p.

Large perennial. Culms to 2m, branched, decumbent and almost woody below. Leaf blades 16–24 × 1.8–3.3cm, lanceolate, acute, margins hispid, rounded at base, glabrous, or sometimes with tubercle-based hairs above. Sheaths glabrous or sometimes with spreading, tubercle-based hairs, margins ciliate; ligule c.0.4mm, membranous, truncate, shortly ciliate. Panicle 24–33 × 6–26cm, broadly obovoid, lax, branches ascending. Spikelets green or more commonly purple, 2.3–2.8 × 0.9–1.2mm, oblong, not gaping, subacute; pedicels trigonous, angles hispid. Lower glume 0.7–1.1 × 0.9–1.1mm, ovate, blunt, obscurely veined, margins membranous; upper glume 2.3–2.8mm, oblong-lanceolate, convex, acute, 5-veined, margins inrolled. Lower floret: lemma 2.2–2.7mm, similar to upper glume, or slightly smaller; palea absent. Upper floret: lemma cream with green tip, 2–2.4 × 0.9–1mm, oblong-elliptic, convex, subacute, smooth, sometimes hairy at apex, margins inflexed, widened in middle; palea 1.9–2.3 × 0.7–1mm, narrowly elliptic, acute, margins inflexed, widened in middle; anthers 1–1.1mm.

Bhutan: S — Chukka district (S of Gedu, Gedu to Chukka); C — Tashigang district (Tashi Yangtshi to Bomdeling); **Darjeeling** (Darjeeling, Rungbee, Jalapahar). Roadside banks; margins and rough grassland cleared from broad-leaved (incl. *Quercus/Schima*) forest, 1500–2175m. July–November.

11. *P. notatum* Retzius; *P. montanum* Roxb. Fig. 38q.

Large perennial. Culms to 1.5m, branched, decumbent and almost woody below. Leaf blades 11–19 × 1.5–2.8cm, lanceolate, acuminate, margins

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long-ciliate near base, cordate at base, with tubercle-based hairs above and beneath, and long hairs at base above. Sheaths glabrous or with few, short, spreading, tubercle-based hairs above, margins ciliate; ligule c.0.2mm, membranous, truncate, shortly ciliate. Panicle 17–36 × 14–27cm, broadly cylindrical, lax, branches spreading or obliquely ascending. Spikelets usually green, 2.3–2.7 × 0.8–1.2mm, oblong-elliptic, not gaping, subacute or blunt; pedicels slender, terete, not hispid. Lower glume 1.9–2.6 × 1–1.5mm, subequalling to equalling spikelet, ovate, blunt, strongly 3-veined, back sometimes hairy near apex, margins long ciliate; upper glume 2.2–2.5mm, ovate-elliptic, convex, acute to blunt, 5-veined, back usually shortly hairy, margins inrolled. Lower floret: lemma 2–2.4mm, similar to upper glume, or slightly smaller but usually glabrous; palea absent. Upper floret: cream, lemma 2–2.2 × 0.7–1.1mm, narrowly elliptic, convex, acute, smooth, margins inflexed; palea 1.9–2 × 0.6–1mm, narrowly elliptic, acute, margins inflexed, broadly hyaline; anthers c.0.7mm.

Bhutan: C — Mongar district (near Mongar, below Namning); **Terai** (Balasun, Garidoora); **Darjeeling** (Great Rangit, Rishap, Mungpo); **Sikkim** (below Martam, Dikeeling). Scrubby roadside in damp, cultivated areas; degraded subtropical vegetation with scrub and *Mikania*; wet cliff in broad-leaved forest, 150–2340m. May–December.

76. HYMENACHNE P. Beauvois

Aquatic perennial. Culms leafy, base spongy, decumbent, rooting from nodes. Leaf blades flat, linear-lanceolate; ligule membranous. Infl. terminal, spike-like, densely cylindrical, lateral branches short, ascending. Spikelets borne singly, widely gaping, falling entire; florets 2. Lower glume encircling spikelet, shorter than upper, hyaline; upper glume borne on short stipe, shorter than spikelet, strongly convex, prominently ribbed, thinly herbaceous. Lower floret borne on short stipe, sterile; lemma similar to upper glume, but longer (equaling spikelet); palea absent. Upper floret bisexual; lemma convex, membranous, margins incurved but not enclosing palea; palea similar to lemma, narrower, margins inflexed; stamens 3.

1. **H. acutigluma** (Steudel) Gilliland; *H. pseudointerrupta* C.H. Müller; *H. myurus* sensu F.B.I., non Lamarck. Fig. 37m–n.

Culms to 2m (Bor, 1940), unbranched. Leaf blades 11–32 × 0.5–1.2cm, finely acuminate, rounded and slightly clasping at base, glabrous; sheaths glabrous, margins ciliate; ligule c.1mm, rounded, blunt. Infl. 18–27 × 1–2.5cm. Spikelets 5.9–6.5mm. Lower glume c.2 × 1.1mm, ovate, acuminate, 1-veined; upper glume 4–4.4 × c.0.8mm, linear-lanceolate, acuminate into

hispid, aristate apex, 5-veined, the three central veins thickened, hispid; stipe c.0.4mm. Lower floret: lemma 5.4–5.7 × c.0.9mm, similar to upper glume. Upper floret: lemma c.3.3 × 0.9mm, lanceolate, acuminate; palea c.3.2 × 0.6mm, narrowly oblong-lanceolate; anthers c.1.1mm.

Terai (Jalpaigui, Siliguri). [Wet places, 150m]. June–October.

77. SACCIOLEPIS Nash

Tufted annuals or perennials. Culms leafy. Leaf blades flat, ± oblong; ligule membranous. Infl. terminal, spike-like, densely cylindric, lateral branches short, fused to main axis. Spikelets borne singly, falling entire, asymmetrically lanceolate; florets 2; pedicels short, persistent, apex cup-shaped. Lower glume encircling spikelet, shorter than upper, ± ovate, margins widely hyaline; upper glume equalling spikelet, strongly convex, becoming swollen at base, prominently ribbed, thinly herbaceous. Lower floret sterile; lemma similar to upper glume; palea small, hyaline, margins infolded. Upper floret bisexual; lemma cream, lanceolate, convex, tightly enclosing the palea, coriaceous, shining; palea similar to lemma, narrower, margins inflexed; stamens 3.

1. Spikelets under 3mm; tufted annual **1. S. indica**
 + Spikelets over 3.5mm; perennial **2. S. interrupta**

1. S. indica (L.) Chase; *Panicum indicum* L. Fig. 39a–b.

Tufted annual. Culms 15–70cm, in large forms base decumbent and rooting from nodes. Leaf blades 4–16 × 0.1–0.8cm, oblong, finely acuminate, glabrous, shortly hairy at junction with ligule; sheaths keeled, glabrous, margins ciliate; ligule c.0.7mm, erose-truncate, back hairy. Infl. 2.5–12 × 0.5–0.7cm. Spikelets often purplish, 2.1–2.5(–2.9) × 0.9–1.2mm, usually glabrous; pedicels 0.7–2mm, slender. Lower glume 1.5–2 × 1–1.4mm, ovate, apiculate to acute, 3–5-veined; upper glume 2.1–2.6(–2.9) × 0.6–1mm, oblong-ovate, acute, prominently (8–)9-veined, margins and apex narrowly hyaline. Lower floret: lemma 1.7–2.6 × 0.7–1.1mm, similar to upper glume but (7–)8-veined, occasionally hispid above; palea 0.7–1.4 × 0.2–0.4mm, linear-lanceolate. Upper floret: lemma 1.1–1.5 × 0.5–0.8mm, lanceolate, bluntly apiculate; palea 1.1–1.5 × 0.5mm, narrowly elliptic; anthers 0.4–1mm.

Bhutan: **S** — Chukka (Khurul Pokhari) and Deothang (Riserboo to Wamrong) districts; **C** — Thimphu (Motithang), Punakha (Mo Chu, Chuzomsa to Samtengang), Tongsa (Tongsa), Mongar (between Mongar and the Kuru Chu) and Tashigang (Kanglung to Tashigang) districts; **Darjeeling** (Sureil, Great Rangit opposite Manjitar, Mungpo, Little Rangit, Kurseong);

Sikkim (below Rumtek Monastery). Marshes and wet places (e.g. pools by paths and by pond in forest clearing), 300–2550m. July–October.

2. *S. interrupta* (Willdenow) Stapf; *Panicum interruptum* Willdenow. Fig. 39c.

Differs from *S. indica* as follows: a taller, stouter perennial; infl. larger, 10.5–16.5 × c.0.9cm; spikelets larger, 3.6–4.2 × 1.1–1.5mm.

Terai (Jalpaiguri, Siliguri). Marshes, 75m. November–December.

78. CYRTOCOCCUM Stapf

Perennial. Culms leafy, much branched, base decumbent and rooting from nodes. Leaf blades flat, ± lanceolate; ligule membranous. Infl. terminal, a lax or dense panicle, several times compound. Spikelets borne singly, falling entire, laterally compressed, gaping, asymmetrically obovate; florets 2; pedicels persistent, usually slender, long or short, apex cup-shaped. Glumes conduplicate, hyaline; the lower encircling spikelet, shorter than upper, ± ovate, keeled, 3-veined; the upper shorter than spikelet, boat-shaped, hooded. Lower floret sterile; lemma strongly convex, blunt, 5-veined, margins hyaline; palea absent or reduced. Upper floret bisexual; lemma cream, conduplicate, tightly enclosing the palea, keeled, coriaceous, ± smooth, shining, each side half-ovate, apex of keel thickened, green; palea oblong, convex, keeled, coriaceous, margins widely hyaline; stamens 3.

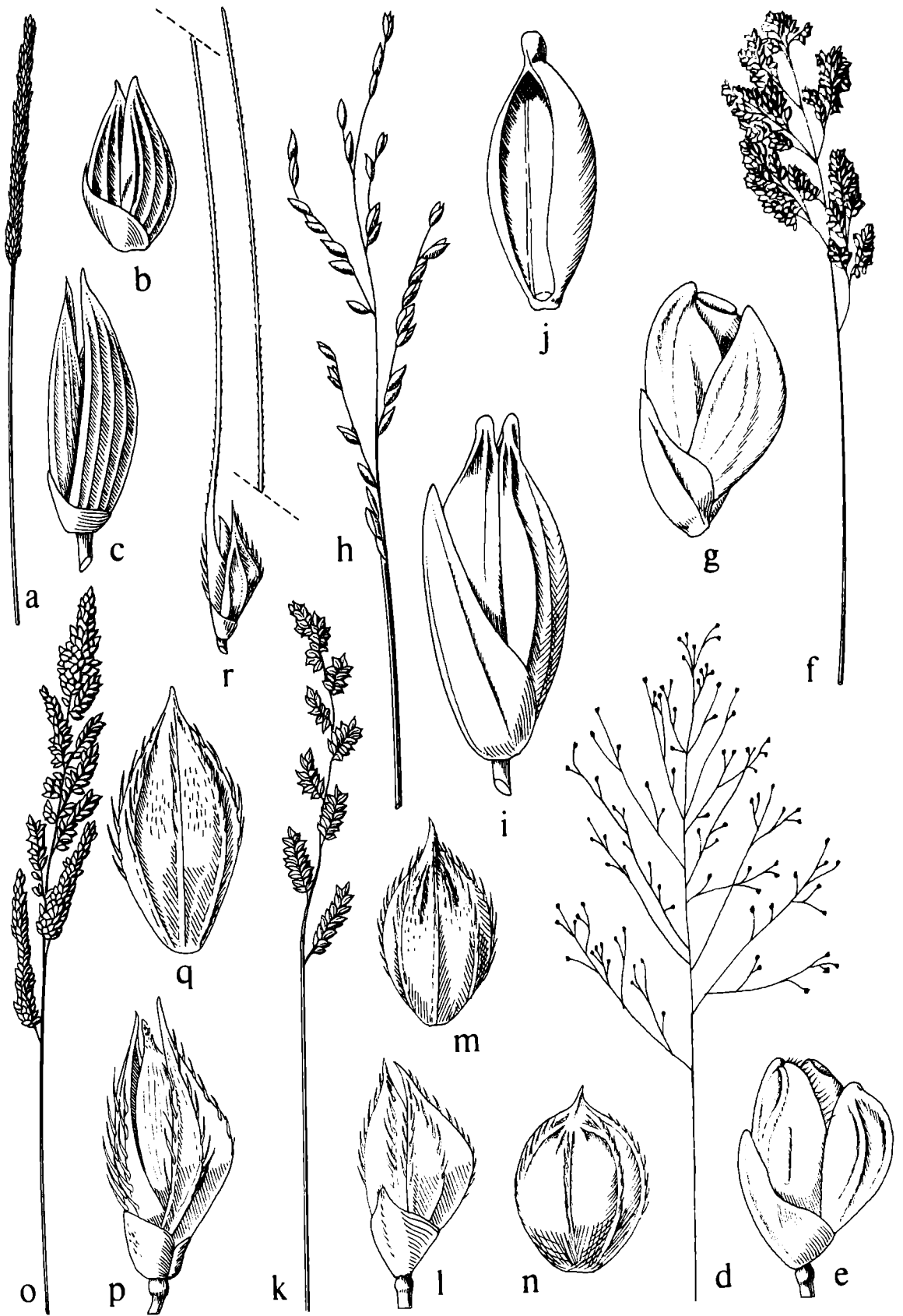
1. Infl. very lax, branches glabrous, pedicels long (the shortest 1.5mm, the longest to 12.3mm); spikelets dark purplish **1. *C. patens***
- + Infl. dense, branches with some long hairs, pedicels short (the shortest 0.3mm, the longest 1.2mm); spikelets orange-brown ... **2. *C. oxyphyllum***

1. *C. patens* (L.) A. Camus; *C. accrescens* (Trinius) Stapf; *Panicum patens* L. Fig. 39d–e.

Culms to 14–47cm. Leaf blades 3–10.5 × 0.5–1.5cm, lanceolate, finely acuminate, rounded at base, appressed hairy above and beneath or glabrous,

FIG. 39.

a–b, ***Sacciolepis indica***: a, infl. (× 2/3); b, spikelet (× 8). c, ***S. interrupta***: spikelet (× 8). d–e, ***Cyrtococcum patens***: d, infl. (× 1/2); e, spikelet (× 16). f–g, ***C. oxyphyllum***: f, infl. (× 2/3); g, spikelet (× 16). h–j, ***Acroceras zizanioides***: h, infl. (× 2/3); i, spikelet (× 8); j, upper floret (× 8). k–m, ***Echinochloa colona***: k, infl. (× 1/2); l, spikelet (× 8); m, upper glume (× 8). n, ***E. frumentacea***: upper glume (× 8). o–r, ***E. crus-galli***: o, infl. (× 1/2); p, unawned spikelet (× 8); q, upper glume (× 8); r, awned spikelet (× 4). Drawn by Louise Olley.



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margins with long, tubercle-based cilia at base; sheaths with scattered, spreading, tubercle-based hairs or glabrous, margins ciliate; ligule 0.6–1.3mm, blunt. Panicle 6–25cm, very lax, branches ascending, borne singly, distant, the lowest 4.5–12cm; pedicels very unequal, 1.5–12.3mm, filiform. Spikelets purplish, 1.4–1.6 × 0.8–1.2mm, usually glabrous; lower glume 0.9–1.2mm, apiculate to acute, each side half oblong-lanceolate, 0.3–0.5mm wide, keel minutely hispid; upper glume 1.2–1.5mm, each side oblanceolate, c.0.5mm wide, occasionally hispid above. Lower floret: lemma 1.4–1.5mm, each side oblanceolate, c.0.5mm wide, occasionally hispid above, margins ciliate near apex; palea sometimes present, 0.5–0.8 × 0.2–0.4mm, oblong, blunt. Upper floret: lemma 1.2–1.4mm, each side half ovate, 0.6–0.8mm wide, narrowed to base; palea 0.9–1.3mm; anthers 0.5–0.9mm.

Bhutan: S — Samchi, Phuntsholing, Chukka, Sarbhang, Gaylegphug and Deothang districts; C — Punakha (above Ruri Chu), Mongar (above Lingmethang) and Tashigang (below Yadi) districts; **Terai** (Siliguri); **Darjeeling** (Sivok, Great Rangit, Kurseong, Mungpo); **Sikkim** (Soke, Gangtok). Subtropical and warm broad-leaved forest (often in disturbed areas e.g. beside tracks); swampy grassland by pool in subtropical forest, 200–1720m. February–December.

Although Bor tried to distinguish *C. accrescens*, it seems to be only a form of *C. patens* with a laxer infl.; they are connected by intermediates and it is not worth maintaining in the absence of any other distinguishing characters.

2. *C. oxyphyllum* (Hochstetter ex Steudel) Stapf; *Panicum pilipes* Nees & Arnott ex Büse. Fig. 39f–g.

Differs from *C. patens* as follows: leaf sheaths when hairy with short, appressed hairs; infl. very dense, shorter (4.5–7.5cm), lowest branch 1.5–2.8cm, the branches bearing long, scattered hairs; spikelets orange-brown, shining, longer (1.9–2.1mm); pedicels stout, very short (0.3–1.2mm); upper lemma more abruptly contracted to stipe-like base.

Bhutan: S — Sarbhang district (Burborte Khola); **Terai** (Dulkajhar); **Darjeeling** (Sivok Hills). Ravine in subtropical forest, 150–280m. October–March.

79. ACROCERAS Stapf

Perennial. Culms leafy, base decumbent and rooting from nodes. Leaf blades flat, ± lanceolate; ligule short, truncate, ciliate. Infl. terminal, paniculate, axis triquetrous, racemes linear. Spikelets laterally compressed, gaping, in unequally pedicelled pairs, secund on lower side of triquetrous rachis; florets

2. Glumes compressed, thickly hyaline, keeled, keel apex crested, to form a 'pinched', green apiculus; the lower encircling spikelet, shorter than upper; the upper equalling spikelet. Lower floret sterile; lemma equalling and similar to upper glume; palea smaller, thinly hyaline. Upper floret bisexual; lemma apiculate, back convex, thinly chartaceous, \pm smooth, margins incurved, tightly enclosing the palea; palea thinly chartaceous, back flat, margins inrolled, widened into flaps in middle; stamens 3.

1. **A. zizanioides** (Kunth) Dandy; *Panicum latifolium* sensu F.B.I., p.p., non L. Fig. 39h-j.

Culms to 25(-120)cm. Leaf blades 8.8(-12.5) \times 1.2(-2)cm, lanceolate, finely tapered to very acute apex, abruptly contracted at base, glabrous, margins scabrid, lower surface with conspicuous, thickened, transverse and oblique cross-veinlets; sheaths keeled, drawn upwards into short auricles, glabrous, margins densely ciliate above; ligule c.0.3mm. Infl. 12(-25)cm; racemes 5(-7), \pm erect, the lowest 5.5(-12)cm. Spikelets 5.2(-7.5) \times (2.3-)2.5mm, glabrous; longer pedicels to 5.3mm, shorter pedicels to 1.8mm. Lower glume 4.4(-4.7)mm, apiculate, 3-veined, each side half-lanceolate, 1.2(-1.4)mm wide; upper glume 5.2(-5.3)mm, 5-veined, each side half-oblong-elliptic, 1.1(-1.5)mm wide, apiculus c.0.7mm. Lower floret: lemma 5(-5.2)mm, 5-veined, apiculus 0.3(-0.5)mm; palea c.3.2 \times 1.1mm, elliptic, apex twisted, subacute, margins thickened, minutely hispid. Upper floret: lemma 4.3(-4.5) \times (1.5-)1.8mm, apiculus 0.5mm; palea 3.6(-4) \times (1.4-)1.5mm, oblong elliptic, apiculus twisted; anthers c.1.5mm.

Bhutan: S — Chukka district (Khurul Pokhari, 3km W of Kali Khola). Marshy ground by jungle pool, 400m. October.

Only a single specimen seen from our area; measurements in brackets are from Assam specimens and the description in Bor (1940).

80. ECHINOCHLOA P. Beauvois

Annuals or perennials. Culms branched. Leaf blades flat, linear-lanceolate, margins thickened, hispid; sheaths glabrous; ligule not membranous, a smooth, glabrous or minutely hairy band, or long ciliate. Infl. terminal, paniculate. racemes lax below, congested above; spikelets secund, on lower side of racemes in groups of 2 or 3 on alternate sides of rachis. Spikelets plano-convex, falling entire; florets 2. Glumes herbaceous, long hispid on veins, short hispid between veins; the lower widely ovate, acuminate, encircling spikelet, shorter than upper; the upper equalling spikelet (excepting awn of lower lemma when present), usually cuspidate. Lower floret sterile or male; lemma similar to

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upper glume, apiculus sometimes developed into long awn; palea oblong-lanceolate, hyaline, margins minutely ciliate. Upper floret bisexual; lemma elliptic, convex, tightly enclosing the palea, with short, green apiculus, coriaceous, smooth; palea similar to lemma, but narrower, flat, the margins inflexed; stamens 3.

1. Spikelets to tip of upper glume (i.e. excl. awn of lower lemma) over 4.8mm; ligule a fringe of long (over 1.5mm) cilia **4. E. picta**
+ Spikelets to tip of upper glume to 4.5mm; ligule a smooth band, glabrous or minutely hairy (hairs c.0.2mm) 2
2. Upper floret 1.9–2mm wide in fr.; upper glume with wavy, transverse veinlets joining main veins just below apex; racemes usually incurved; plants cultivated **2. E. frumentacea**
+ Upper floret 1–1.7mm wide in fr.; upper glume lacking subapical transverse veinlets; racemes not curved; plants wild 3
3. Spikelets 2.5–3mm, never awned; veins of upper glume usually 6–8; lowest raceme usually under 2cm **1. E. colona**
+ Spikelets 3.2–4.5mm, lower lemma sometimes awned; veins of upper glume 5; lowest raceme usually over 3cm **3. E. crus-galli**

1. E. colona (L.) Link; *Panicum colonum* L. Sha: *chok chokpa ngyon*; Dz: *jam, jama*; Nep: *sama, molera*. Fig. 39k–m.

Annual. Culms 15–100cm, branched below, erect or sometimes decumbent at base. Leaf blades 8–15 × 0.4–0.9cm, linear-lanceolate, very acute, glabrous; ligule glabrous or minutely pubescent. Infl. 4.5–11cm; racemes suberect, all except uppermost rather distant, the lowest 1.2–2(–2.9)cm, axis straight, minutely hispid, sometimes also with long cilia. Spikelets 2.5–3mm. Lower glume 1.4–1.5mm, ovate, acuminate, 3(–4)-veined; upper glume 2.5–3mm, oblong-lanceolate, shortly cuspidate, 5–8-veined. Lower floret: lemma 2.2–2.9mm, ovate, acuminate, 7-veined; palea 1.8–2.2 × 0.8–1.1mm, oblong-elliptic. Upper floret: lemma 1.9–2.4 (excl. apiculus) × 1–1.5mm, narrowly elliptic, apiculus c.0.2mm; palea 1.6–2 × 1–1.3mm; anthers c.0.8mm.

Bhutan: S — Samchi (Dwarapani), Phuntsholing (Phuntsholing) and Deothang (7km above Samdrup Jongkhar) districts; C — Punakha (Hesothangkha, Punakha, 0.5km N of Punakha Dzong), Tongsa (below Refe), Mongar (Lingmethang, Yonkola) and Tashigang (W bank of Dangme Chu) districts; **Darjeeling** (Peshok). Ditches, marshes, roadsides, weed of cultivated ground (incl. rice paddies), 400–1500m. June–December.

Parker (1992) recorded it as a common weed of dryland crops and rice occurring up to 2000m in all districts [with cultivation].

2. *E. frumentacea* Link; *Panicum crus-galli* L. var. *frumentaceum* sensu F.B.I. Fig. 39n.

Differs from *E. colona* as follows: a stouter, cultivated plant; culms to 150cm; leaves 1.5–2cm wide; racemes usually incurved; upper glume with wavy, transverse veinlets joining main veins just below apex; upper floret (enclosing grain) wider (c.2mm).

Darjeeling (Kalimpong); **Sikkim** (Chakung). Cultivated, 1220m. July–November.

No recent records, so perhaps no longer cultivated.

3. *E. crus-galli* (L.) P. Beauvois; *Panicum crus-galli* sensu F.B.I, p.p. Dz: *jam, jama*; Sha: *chhera ngon*; Nep: *sama, molera*; Eng: *cockspur grass, barnyard millet*. Fig. 39o–r. Plate 7.

Tufted annual. Culms 18–100cm, stout, erect, branched below. Leaf blades 7–33 × 0.3–1.5cm, linear-lanceolate to lanceolate, very acute, glabrous or sometimes hispid on veins above; ligule glabrous or minutely pubescent. Infl. 4.5–20cm; racemes suberect, occasionally branched, the upper crowded, the lower distant, the lowest (2–)3–6cm, axis straight, minutely hispid, and with numerous long cilia. Spikelets 3.2–4.5mm. Lower glume 1–2mm, widely ovate, acuminate, 3-veined; upper glume 3.4–4mm, oblong-lanceolate, apiculate, 5-veined, apiculus 0.3–0.6mm. Lower floret: lemma 3–4.5mm, oblong-lanceolate, cuspidate, 7-veined; palea 1.8–2.4 × c.1.2mm, oblong-elliptic. Upper floret: lemma 2.4–2.7 (excl. apiculus) × 1.4–1.7mm, narrowly elliptic, apiculus 0.2–0.5mm; palea 2.2–2.8 × 1.1–1.4mm; anthers 0.5–0.9mm.

Bhutan: S — Chukka and Gaylegphug districts; **C** — Thimphu, Punakha, Bumthang, Mongar and Tashigang districts; **Darjeeling** (Ryang, Darjeeling, Sitong, Selim). A very common weed of fields (incl. rice) and wet places, 305–2610m. May–October.

Parker (1992) recorded it as a common weed of rice and dryland crops at a wide range of altitudes and in all districts [with cultivation].

Very variable; the following two forms are easily recognisable but of doubtful taxonomic status.

i. awned form. Fig. 39r.

Apiculus of upper lemma of some spikelets developed into a long (2–4cm) awn. Very common and under-recorded: specimens seen from Thimphu, Punakha, Tashigang and Upper Mo Chu districts.

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ii. 'glabrescens' form (*E. glabrescens* Munro ex Hook. f.)

Lower lemma coriaceous, shining. Parker (1992) recorded that this form was believed to be quite common: specimens seen from Thimphu and Tashigang districts, and Darjeeling.

4. *E. picta* (J. König) P.W. Michael; *E. stagnina* (Retzius) P. Beauvois; *Panicum crus-galli* sensu F.B.I, p.p.

Perennial. Culms 30–70cm, decumbent at base. Leaf blades 13–15 × 0.5–0.8cm, linear-lanceolate, very acute, glabrous or shortly appressed-hispid above and with long and short, spreading hairs beneath; ligule a fringe of stiff, erect cilia (1.5–1.9mm). Infl. 4.5–19cm; racemes suberect, the upper crowded, the lower distant, the lowest 2.5–6cm, axis straight, coarsely hispid, and with some long cilia. Spikelets (to tip of upper glume) 4.8–6mm. Lower glume 2.3–3.2mm, widely ovate, acuminate, (3–)5-veined; upper glume 2.3–3.2mm, oblong-lanceolate, apiculate, 8–11-veined, apiculus c.1mm. Lower floret: lemma 4–4.4mm, oblong-lanceolate, aristate, 7-veined, arista 1.8–5.7mm, hispid; palea 3.5–4 × 1.5–1.8mm, oblong-elliptic. Upper floret: lemma 3.9–4.8 (excl. apiculus) × c.2.2mm, elliptic, apiculus 0.5–0.7mm; palea 3.4–3.8 × 1.9–2.2mm.

Bhutan: S — Samchi (Dwarapani (M.F.B.)) and Phuntsholing (Phuntsholing) districts; **Terai** (Sukna); **Sikkim** (Sitong). Bunds of rice paddies, 150–910m. November–December.

81. UROCHLOA P. Beauvois

Annuals or perennials. Culms leafy, branched, base decumbent and rooting from nodes. Leaf blades flat, ± lanceolate; ligule truncate, extremely short, consisting mainly of fringe of hairs. Racemes linear, lower axillary, the terminal in a pedunculate panicle. Spikelets adaxial (lower glume facing rachis) or abaxial, secund on lower side of slender, triquetrous, or flattened rachis, borne singly or in pairs, plano-convex or turgid, shortly pedicelled; florets 2(–3). Lower glume short, encircling spikelet; upper glume equalling spikelet. Lower floret sterile, epaleate, lemma equalling upper glume, semi-herbaceous. Sterile middle floret present in one species; lemma like that of lower floret; palea hyaline. Upper floret bisexual, compressed; lemma crustaceous, back convex, margins incurved, tightly enclosing the palea; palea crustaceous, back flat, margins inrolled, widened into flaps in middle, stamens 3.

1. Spikelets large (over 4.5mm); introduced fodder grasses 2
+ Spikelets smaller (to 4mm); native 3

2. Lower glume much shorter than spikelet; upper glume hairy only at apex; lower lemma lacking cross-veins, hairy only at apex
6. **U. brizantha**
- + Lower glume almost equalling spikelet; upper glume hairy all over; lower lemma with strong, ladder-like cross-veins, hairy all over
7. **U. dictyoneura**
3. Spikelets with 3 florets 3. **U. supervacua**
+ Spikelets with 2 florets 4
4. Upper lemma abruptly contracted into short, needle-shaped mucro (c.0.5mm) 1. **U. panicoides**
+ Upper lemma not mucronate 5
5. Spikelets glabrous, over 3.2mm 5. **U. subquadripara**
+ Spikelets hairy, under 3mm 6
6. Spikelets broadly elliptic (1.4mm wide); upper lemma transversely rugulose 2. **U. ramosa**
+ Spikelets narrowly elliptic (to 1.2mm wide); upper lemma not rugulose 4. **U. villosa**

1. **U. panicoides** P. Beauvois; *Panicum javanicum* sensu F.B.I. Fig. 41a–b.

Probably annual. Culms to 40(+ ?)cm. Leaf blades 5–12 × 0.7–1.3cm, lanceolate, very acute, rounded and clasping at base, sparsely hairy near margins above and on veins beneath, margins thickened, ciliate, cilia tubercle-based; sheaths with dense, spreading hairs; ligule hairs to 1mm. Panicle 3–6cm; racemes 3–5, stiffly suberect, inserted singly, the lowest 1.7–5.5cm, axis flattened, margins minutely hispid, spikelets borne singly in 2 rows. Spikelets c.3.5mm, hairy; pedicels short, c.0.5mm, bearing long, apical cilia. Lower glume c.1.1 × 1.7mm, widely oblong-ovate, weakly 3-lobed, minutely hairy, 3-veined, thinly herbaceous; upper glume c.3.7mm, ovate, convex, broadly apiculate, densely hairy, hairs short, spreading, 7-veined, herbaceous. Lower floret: lemma c.3.5mm, similar to upper glume, but 5-veined; palea c.3.2mm, elliptic, broadly apiculate, hyaline. Upper floret: lemma cream, c.2.6 (excl. mucro) × 1.7mm, elliptic, abruptly contracted into needle-shaped mucro c.0.5mm, rugulose; palea c.2.7mm, elliptic, blunt.

Bhutan: C — Punakha district (Bajo). Dry roadside verge beside river, 1200m. September.

The single specimen seen belongs to var. *pubescens* (Kunth) Bor.

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2. *U. ramosa* (L.) T.Q. Nguyen; *Brachiaria ramosa* (L.) Stapf. Nep: *pashipang*. Fig. 40a–c.

Perennial. Culms to 20–66cm. Leaf blades 6–13.5 × (0.6–)1.1–1.5cm, lanceolate, very acute, glabrous, base rounded, clasping, margins thickened, scabrid, ciliate at base; sheaths with spreading, tubercle-based hairs near apex, margins ciliate; ligule hairs 1–1.3mm. Panicle 5–17cm; racemes to 20, oblique, inserted singly or some ± whorled, the lowest 2.2–5cm, axis triquetrous, shortly hairy and with long cilia, spikelets borne in pairs. Spikelets 2.7–3 × 1.4–1.6mm, hairy; pedicels unequal, the longer 1.3–1.5mm, long-ciliate. Lower glume 1–1.5 × 1–1.4mm, oblong-orbicular, truncate to rounded, 3–6-veined, hyaline; upper glume 2.7–3mm, oblong-elliptic, convex, subacute, densely hairy, 7-veined, thinly herbaceous, margins incurved. Lower floret: lemma 2.6–3mm, similar to upper glume, but 5-veined; palea 2–2.1 × 0.4–0.9mm, lanceolate, blunt, hyaline. Upper floret: lemma 2.4–2.6 × 1.3–1.4mm, elliptic, apiculate, transversely rugulose; palea 1.9–2.1mm, elliptic, blunt; anthers c.0.8mm.

Bhutan: S — Chukka district (Kalikhola); C — Punakha (Wangdi Phodrang), Mongar (Lingmethang) and Tashigang (Parker, 1992) districts; **Darjeeling** (Pankchilla); **Sikkim** (1km N of Singtam). Banks and scrub at field edges; abandoned maize field; roadside, 300–1250m. May–September.

Parker (1992) recorded it as an aggressive weed in E Bhutan and sometimes dominant in maize crops.

3. *U. supervacua* (C.B. Clarke) Noltie; *Panicum supervacuum* C.B. Clarke. Fig. 40d.

Perennial. Culms to 13–28cm. Leaf blades 4.5–12 × 0.5–0.7cm, narrowly lanceolate, very acute, narrowed or slightly clasping at base, densely hairy above and beneath, hairs short, silky, margins thickened, scabrid; sheaths densely, shortly hairy all over; ligule hairs c.0.7mm. Panicle 5.5–9.5cm; racemes 4–8, suberect, inserted singly, the lowest 2–4.2cm, axis triquetrous, angles scabrid, spikelets inserted singly, rather lax. Spikelets 3.4–3.7mm, hairy; pedicels c.0.6mm, long-ciliate. Lower glume 1.8–2.3 × 1.5–2.2mm, broadly ovate, apiculate, hairy, 5–7-veined, hyaline; upper glume 3.1–3.6 ×

FIG. 40.

a–c, *Urochloa ramosa*: a, infl. (× 2/3); b, spikelet (× 12); c, upper lemma (× 12). d, *U. supervacua*: spikelet (× 8). e–f, *U. villosa* var. *villosa*: e, infl. (× 2/3); f, spikelet (× 12). g, *U. villosa* var. *barbata*: spikelet (× 12). h, *U. subquadripara*: spikelet (× 12). i–k, *Axonopus compressus*: i, habit (× 1/3); j, infl. (× 2/3); k, spikelet (× 16). l, *A. affinis*: spikelet (× 16). Drawn by Louise Olley.



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0.9–1.6mm, narrowly elliptic, convex, apiculate, hairy, (5–)7-veined, thinly herbaceous, apiculus pinched, margins incurved. Lower floret: lemma whitish-hyaline, $3\text{--}3.6 \times 1.1\text{--}1.5\text{mm}$, oblong-elliptic, convex, apiculate, 5(–6)-veined, apiculus pinched, margins inrolled; palea usually absent. Middle floret: lemma whitish-hyaline, $2.9\text{--}3.2 \times 1.1\text{--}1.6\text{mm}$, oblong-elliptic, apiculate, hairy, 5-veined, apiculus pinched, margins clasping palea; palea $2.4\text{--}2.7 \times 0.6\text{--}0.8\text{mm}$, linear, hyaline. Upper floret: lemma $2.3\text{--}2.7 \times 1.2\text{--}1.3\text{mm}$, oblong, apiculate, apiculus pinched; palea $2\text{--}2.2\text{mm}$, oblong, margins thickened; anthers 1–1.2mm.

Bhutan: C — Punakha (near Punakha Dzong, Bajo), Mongar (Yayung, Lingmethang) and Tashigang (near Kanglung, below Tashigang, Manchudrang) districts; **Terai** (Balasun, Siliguri). Cultivated ground incl. rice paddies; roadside ditches; scrub on river silt, 120–1700m. May–October.

4. U. villosa (Lamarck) T.Q. Nguyen var. **villosa**; *Brachiaria villosa* (Lamarck) A. Camus. Fig. 40e–f.

Annual. Culms to 16–63cm. Leaf blades $15\text{--}65 \times 6\text{--}10\text{mm}$, lanceolate, acute, densely hairy above and beneath, margins scabrid; sheaths with spreading, tubercle-based hairs; ligule hairs 0.5–0.7(–1.8)mm. Infl. axis 1–10cm; racemes 7–16, suberect, the lowest 0.4–2.3cm, axis slender, 0.2–0.4mm wide, zigzag, \pm triquetrous, spikelets borne singly, alternate. Spikelets $2.3\text{--}2.8 \times 1\text{--}1.2\text{mm}$, glabrous or hairy; pedicels 0.4–0.9mm. Lower glume $1\text{--}1.4 \times 1.1\text{--}1.3\text{mm}$, ovate, blunt, 3-veined, hyaline; upper glume 2.1–2.7mm, narrowly elliptic, convex, acute, 5(–7)-veined, thinly herbaceous, margins incurved. Lower floret: lemma 2.1–2.6mm, narrowly elliptic, acute, 5-veined, thinly herbaceous, back \pm flat, margins inrolled; palea $1.8\text{--}2.1 \times 0.5\text{--}1.3\text{mm}$, oblong, hyaline. Upper floret: lemma $1.8\text{--}2 \times 0.8\text{--}1\text{mm}$, narrowly elliptic, acute, punctate; palea 1.5–1.8mm, back punctate; anthers c.1mm.

Bhutan: C — Thimphu (Taba, Thimphu), Punakha (Chuzomsa), Tongsa (3km W of Tongsa), Mongar (Lingmethang) and Tashigang (2km from Kanglung) districts; **Darjeeling** (Badamtam); **?Sikkim** (Siriong). Dry, disturbed ground (e.g. by paths, wasteground, roadsides, areas cleared from forest); open, damp grassy places, 900–2500m. August–October.

var. **barbata** (Bor) Noltie. Fig. 40g.

Differs from var. *villosa* in having a subterminal tuft of hairs on the lower lemma which overtops the spikelet.

Bhutan: C — Thimphu (Gidakom), Punakha (Wangdi Phodrang) and Tashigang (Rangthangwong) districts; **Darjeeling** (Great Rangit opposite Manjitar, Ging). *Pinus roxburghii* forest; damp sandy shingle by river; dry banks by streams and paths, 440–2200m. August–October.

5. *U. subquadrifera* (Trinius) R.D. Webster; *Brachiaria subquadrifera* (Trinius) Hitchcock; *Panicum distachyum* sensu F.B.I., p.p. Fig. 40h.

Perennial. Culms to 56cm. Leaf blades 14–100 × 4–7.3mm, narrowly lanceolate, very acute, usually with spreading, tubercle-based hairs above and beneath, sometimes glabrous, margins thickened, scabrid above, long-ciliate at base; sheaths usually with spreading, tubercle-based hairs; ligule hairs c.1mm. Terminal panicle 2.8–5.5cm; racemes 2–3, spreading obliquely, the lowest 2–5cm, axis flattened, 0.7–0.9mm wide, margins and midrib scabrid, spikelets borne singly, alternate. Spikelets 3.2–4 × 1.3–1.4mm, glabrous; pedicels c.0.5mm. Lower glume 1.4–2.1 × 2–2.5mm, broadly ovate, bluntly acuminate, 9–11-veined, semi-hyaline; upper glume 3–4mm, narrowly elliptic, convex, acuminate, 7(–8)-veined, thinly herbaceous, margins incurved. Lower floret: lemma 2.8–3.4mm, oblong-elliptic, acuminate, 5-veined, thinly herbaceous, back ± flat, margins inrolled; palea usually absent, if present, oblong, hyaline. Upper floret: lemma 2.3–2.9 × 1.1–1.3mm, oblong-elliptic, blunt, minutely papillose; palea 2.3–2.5mm, back minutely papillose; anthers c.0.9mm.

Bhutan: S — Samchi (Chamarchi Khola), Phuntsholing (Torsa River) and Gaylegphug (Gaylegphug Town) districts; C — Punakha district (Wacha to Chuzomsa, Lobesa, Baso Chu to Ruri Chu); **Darjeeling** (Little Rangit). Dry roadside in hot valley with scattered *Pinus roxburghii*; sandy river bank, 330–1460m. May–December.

6. *U. brizantha* (Hochstetter ex A. Richard) R.D. Webster; *Brachiaria brizantha* (Hochstetter ex A. Richard) Stapf (incl. *U. decumbens* (Stapf) R.D. Webster; *Brachiaria decumbens* Stapf. Eng: *Surinam grass*). Eng: *palisade grass*. Fig. 41c–d.

Tufted perennial. Culms c.80cm, erect, base perhaps sometimes decumbent and rooting from nodes. Leaf blades 20–25 × 0.5–1cm, linear-lanceolate, acute, with spreading hairs above and beneath, margins thickened, ciliate; sheaths with dense, spreading hairs; ligule c.0.4mm. Infl. axis 5–8.5cm; racemes 2–3, curved, axis flattened or curved, c.1.5mm wide, spikelets inserted singly in 1 or 2 rows. Spikelets c.4.6mm, hairy; pedicels c.0.5mm, glabrous. Lower glume 2–2.5 × c.3.8mm, widely rhombic, glabrous, c.9-veined, thinly herbaceous; upper glume 4–4.6 × c.2.5mm, widely elliptic, convex, broadly apiculate, long hairy in upper quarter, 7-veined, herbaceous. Lower floret: lemma c.3.9 × 4.4mm, similar to upper glume, but 5-veined, minutely crested on midrib at apex; palea c.3.7 × 2mm, oblong, blunt. Upper floret: lemma 3.9–4.2 × c.1.8mm, narrowly elliptic, subacute, rugulose; palea 3.3–3.5 × c.1.6mm.

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Bhutan: S — Gaylegphug district (Bhur); C — Mongar district (Lingmethang). Improved pasture, becoming naturalised on roadside, 500–840m. September.

Two extremely similar African species have been widely introduced as tropical forage grasses. As intermediates occur there seems much sense in uniting them following the treatment of Veldkamp (1996) for Malesia.

7. *U. dictyoneura* (Figari & De Notaris) Veldkamp (incl. *U. humidicola* (Rendle) Morrone & Zuloaga). Fig. 41e.

Similar to *U. brizantha* vegetatively, but differs as follows: leaves glabrous; sheaths subglabrous; rachis of racemes \pm triquetrous; pedicels long ciliate; lower glume about equalling spikelet (c.5 \times 2.5mm), prominently ribbed; upper glume hairy all over back; lower lemma with prominent cross-veins making a ladder-like pattern; upper lemma apiculate.

Bhutan: S — Gaylegphug district (Bhur). Improved pasture, 500m. September.

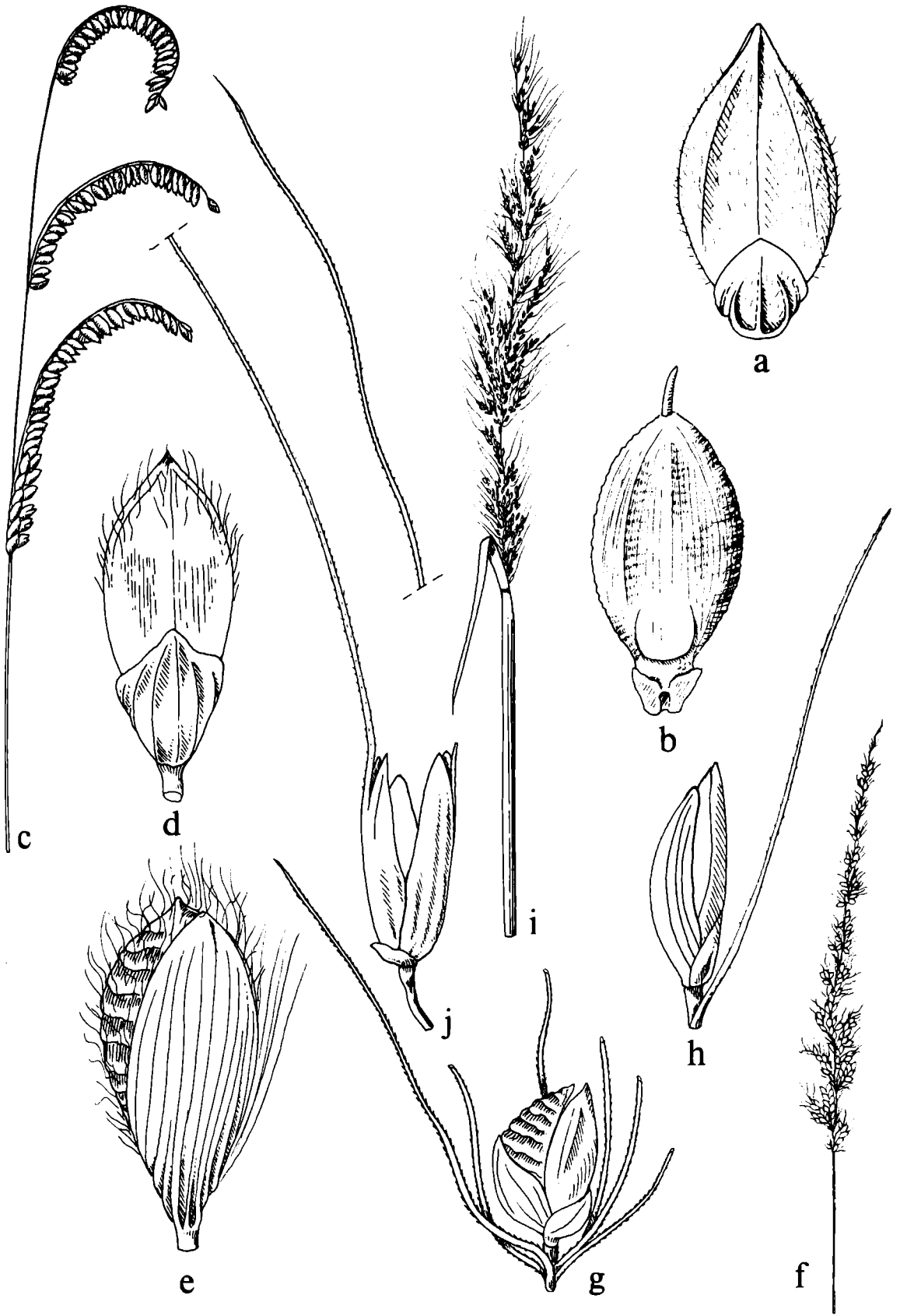
As with species 6, two closely related African species have been widely introduced in the tropics and it seems sensible to unite them.

82. PASPALUM L.

Perennials or annuals, tufted or spreading by creeping rhizomes or stolons. Leaf blades flat, linear; ligule membranous, truncate. Infl. of 2–5, linear racemes, the upper usually paired, the lower distant; spikelets secund on lower side of flattened rachis, borne singly or in pairs either side of the rachis midrib; florets 2. Spikelets plano-convex, shortly pedicelled, lower glume absent or very reduced, the convex upper glume equalling spikelet, facing rachis. Lower floret sterile consisting of a single lemma; lemma facing away from rachis, equalling upper glume, compressed, semi-herbaceous. Upper floret bisexual, compressed; lemma crustaceous, back convex, margins incurved, tightly enclosing margins of palea; palea crustaceous, back flat, margins inrolled, widened into flaps in middle, stamens 3.

FIG. 41.

a–b, *Urochloa panicoides*: a, spikelet (\times 10); b, upper lemma (\times 10). c–d, *U. brizantha*: c, infl. (\times $\frac{2}{3}$); d, spikelet (\times 8). e, *U. dictyoneura*: spikelet (\times 8). f–g, *Setaria intermedia*: f, infl. (\times $\frac{2}{3}$); g, spikelet (\times 10). h, *S. homonyma*: spikelet (\times 10). i–j, *Melinis minutiflora*: i, infl. (\times $\frac{1}{2}$); j, spikelet (\times 12). Drawn by Louise Olley.



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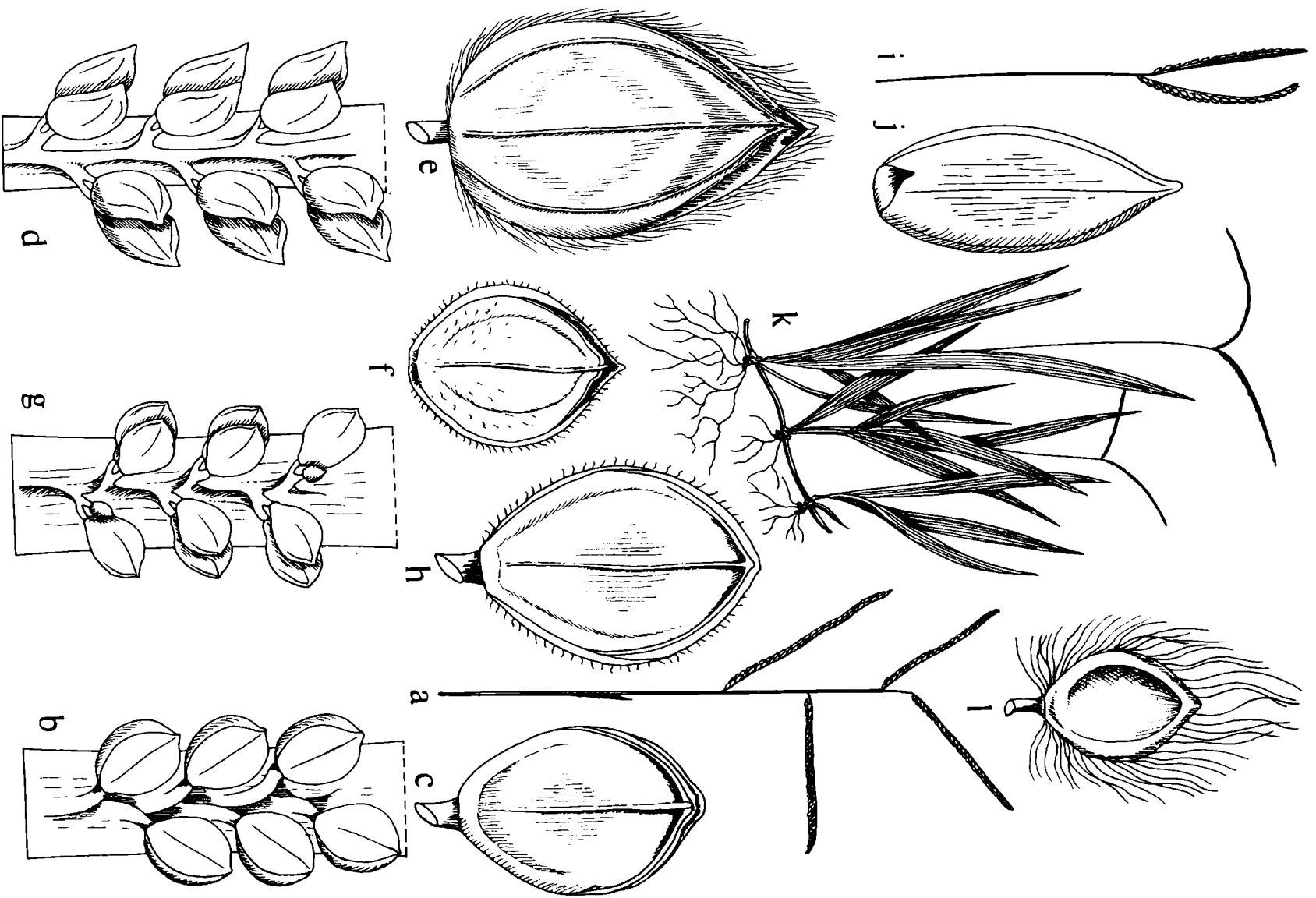
1. Spreading by extensively creeping stolons or rhizomes 2
+ Tufted, rhizomes if present short and stout 3
2. Spikelets over 3mm, acute; margins of glume glabrous, or with some extremely short hairs **6. P. distichum**
+ Spikelets under 2mm, blunt; margins of glume long-ciliate (cilia c.1mm) **7. P. conjugatum**
3. Glume with long-ciliate margins (cilia c.1mm) **3. P. dilatatum**
+ Glume margins glabrous, or with very short, spreading hairs 4
4. Spikelets in 3–4 rows, paired each side of the rachis midrib though one spikelet of each pair sometimes very reduced 5
+ Spikelets in 2 rows, borne singly each side of rachis midrib 6
5. Surfaces of leaf blades glabrous; spikelets c.2mm **4. P. longifolium**
+ Surfaces of leaf blades (sometimes also sheaths) hairy; spikelets over 2.5mm **5. P. thunbergii**
6. Racemes usually 3 or more; spikelets to 2.5mm **1. P. scrobiculatum**
+ Racemes 2; spikelets over 3mm **2. P. notatum**

1. P. scrobiculatum L.; *P. orbiculare* G. Forster; *P. commersonii* Lamarck. Eng: *khodo millet*. Fig. 42a–c.

Tufted, annual or perennial. Culms 10–72cm, ± erect, branched below, leafy throughout, nodes glabrous. Leaf blades 4.2–24.5 × 0.4–1cm, oblong, gradually tapered to acute apex, glabrous, or hairy above, sometimes long-ciliate at base; sheaths glabrous or hairy; ligule 0.3–1.2mm, truncate. Racemes (2–)3–5, the lower distant, lowest 2.4–7.7cm; rachis 1.5–1.9mm wide. Spikelets 1.9–2.2(–2.4)mm; pedicels 0.3–0.6mm. Upper glume 1.9–2.2(–2.4) × 1.5–1.8(–2.1)mm, broadly elliptic, convex, blunt or subacute, glabrous, (3–)5(–7)-veined, thinly herbaceous, margins incurved. Lower lemma 1.9–2.2(–2.4) × 1.5–1.7(–1.9)mm, broadly elliptic, blunt, flat, glabrous,

FIG. 42.

a–c, **Paspalum scrobiculatum**: a, infl. (× 1/3); b, schematic section of raceme showing spikelets in 2 rows; c, spikelet (× 12). d–e, **P. dilatatum**: d, schematic section of raceme showing spikelets in 4 rows; e, spikelet (× 12). f, **P. longifolium**: spikelet (× 12); g–h, **P. thunbergii**: g, schematic section of raceme showing spikelets in 3–4 rows; h, spikelet (× 12). i–j, **P. distichum**: i, infl. (× 1/3); j, spikelet (× 12). k–l, **P. conjugatum**: k, habit (× 1/4); l, spikelet (× 12). Drawn by Louise Olley.



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3–7-veined, thinly herbaceous, margins inrolled. Upper floret: lemma 1.7–2(–2.2) × 1.4–1.8mm, broadly elliptic, convex, blunt, crustaceous, smooth, margins inrolled, clasping palea; palea 1.6–1.8(–2.1) × 1.2–1.5mm, crustaceous, back flat, margins inflexed, expanded in middle; anthers 0.7mm.

Bhutan: S — Phuntsholing (Torsa River), Chukka (Chapcha to Bunakha) and Gaylegphug (Bhur to Toribari) districts; C — Thimphu (Babesa), Punakha (Upper Gaseloo, Lobesa), Mongar (Lingmethang), Tongsa (Kinga Rapten) and Tashigang (below Yadi, Rangthangwoong) districts; **Terai** (Jalpaiguri Duars); **Darjeeling** (Ging, Lebong); **Sikkim** (Yoksam, Gangtok). Rather scattered: a weed of lawns, roadsides, fields (incl. rice paddies); seasonally burnt scrub; roadside in chir pine forest, 300–2300m. April–October.

An extremely variable species over its wide distribution. Forms with hairy leaf sheaths and upper leaf surfaces occur in dry valleys (e.g. around Tongsa and Tashigang); these tend to have short culms, with tough, almost woody bases, and narrower, more acute spikelets. Similar forms have been seen from NE India, Burma and S China and perhaps merit some form of recognition. *P. scrobiculatum* is cultivated as a grain crop in India.

2. *P. notatum* Flüggé. Eng: *Bahia grass*

Differs from *P. scrobiculatum* as follows: rhizomatous; rhizomes short, stout, clothed with remains of old leaf bases; racemes paired; spikelets large (over 3mm).

Bhutan: S — Gaylegphug district (Bhur). Improved pasture, 500m. September.

Native of C and S America, but widely grown as a tropical fodder grass; recently introduced to Bhutan.

3. *P. dilatatum* Poiret. Nep: *bunso*; Eng: *Dallis grass*. Fig. 42d–e.

Differs from *P. scrobiculatum* as follows: bases of lowest leaf sheaths appressed-hairy; spikelets in 4 rows, larger (3.3–3.9mm); margins of glume (and sometimes lower lemma) long ciliate (the longest cilia 0.9–2mm), glume ovate (3.3–3.9 × 2.2–2.6mm), apiculate; upper lemma 2.4–2.5 × 2–2.3mm, much shorter than glume and lower lemma.

Bhutan: S — Chukka (Gedu) and Gaylegphug (Bhur) districts; C — Thimphu (Thimphu Town), Punakha (Lobesa) and Mongar (Mongar Town) districts; **Darjeeling** (Jalapahar); **Sikkim** (Mangan, Gangtok). A weed of roadsides, gardens; improved pasture, 500–2160m. July–September.

Native of S America, introduced for fodder some time prior to 1982 in Bhutan and apparently spreading.

4. ***P. longifolium*** Roxb. Fig. 42f.

Differs from *P. scrobiculatum* as follows: leaf sheaths often with spreading hairs; spikelets in 3–4 rows, the spikelets paired on each side of the rachis midrib though one of pair sometimes very reduced; glume apiculate, with short, spreading hairs at least on margins; lower lemma sometimes also hairy.

Bhutan: S — Chukka district (Khurul Pokhari). Moist shaded ground around jungle lake, 400m. October.

5. ***P. thunbergii*** Kunth ex Steudel. Nep: *dharkharay*. Fig. 42g–h.

Resembles *P. longifolium* in having spikelets in pairs each side of the rachis midrib, though one of each pair sometimes reduced, so apparently 2- or 3-rowed; differs in having leaves with scattered, silvery, spreading hairs on upper and lower leaf surfaces, sometimes also on sheaths; spikelets larger (2.6–3mm); the glume shortly hairy only on the margins.

Bhutan: C — Tongsa (Chendebi), Bumthang (Thangbi) and Tashigang (below Yadi, Yondiri Bridge) districts; **Darjeeling** (Dingle); **Sikkim** (Yoksam, Domang). Disturbed grassy places (incl. lawn); marshes, 1410–3060m. July–September.

Possibly introduced.

6. ***P. distichum*** L.; *P. vaginatum* Swartz. Dz: *jagarampa*; Sha: *reebang*; Nep: *chittrey*; Eng: *water couch*. Fig. 42i–j.

Rhizomatous, rhizomes extensively spreading. Culms 9–82cm, branched below, nodes glabrous. Leaf blades 5–14.8 × 0.2–0.6cm, linear, gradually narrowed to fine, blunt apex, glabrous, margins ciliate at extreme base; sheaths glabrous, margins sparsely ciliate especially above; ligule 0.8–1mm, rounded. Racemes paired (occasionally 3), 3–7cm, the lower slightly longer and curved, the upper shortly peduncled; rachis 1.1–2mm wide. Spikelets 3–3.4mm; pedicels 0.2–0.5mm. Lower glume present, reduced, 0.4–1.5 × 0.2–0.5mm, triangular; upper glume 3–3.4 × 1–1.2mm, oblong-elliptic, convex, bluntly acuminate, appressed-hairy, 3-veined, thinly herbaceous, margins incurved. Lower lemma 2.8–3.3 × 1.2–1.4mm, oblong-elliptic, acuminate, flat, glabrous, 3-veined, thinly herbaceous, margins inrolled. Upper floret: lemma pale green, 2.5–3 × 1.2–1.4mm, oblong-elliptic, convex, blunt, with apical tuft of hairs, crustaceous, smooth, margins inrolled, clasping palea; palea 2.1–2.5 × 1.1–1.2mm, crustaceous, back flat, margins inflexed; anthers 1.5mm.

Bhutan: S — Phuntsholing, Chukka and Deothang districts; C — Thimphu, Punakha, Tongsa and Tashigang districts; **Sikkim** (Phodong Gompa, Mangan). Common in wet places in subtropical and temperate areas (roadside ditches, paddy-fields, marshy meadows), 400–2300m. July–October.

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Parker (1992) recorded it as a common weed of wet places, up to 2500m, in all districts [with cultivation].

7. *P. conjugatum* Bergius. Nep: *bonso jhar, hathi doubo*; Eng: *signal grass, sour grass*. Fig. 42k-l.

Stolons spreading, flattened. Culms 11–46cm, bearing leaves on lower part, nodes glabrous. Leaf blades 3.5–8 × 0.4–0.9cm, oblong-lanceolate, very acute, glabrous beneath, upper surface with scattered, short hairs and line of long hairs at extreme base, margins ciliate; sheaths glabrous, keeled, compressed, with transverse line of hairs at apex, margins long-ciliate at least near apex; ligule 0.2–0.7mm, truncate. Racemes paired, 4–10.2cm; rachis 0.4–0.8mm wide. Spikelets 1.5–1.8mm; pedicels hooked, c.0.4mm. Glume 1.5–1.8 × 1–1.4mm, elliptic, convex, acute to apiculate, very thinly hyaline, margins thickened, long-ciliate, cilia 1–1.8mm. Lower lemma 1.5–1.8 × 1–1.3mm, elliptic, acute to apiculate, very thinly hyaline, margins thickened. Upper floret: lemma 1.4–1.8 × 1–1.3mm, elliptic, apiculate, crustaceous, convex, smooth, pale green midrib sometimes slightly raised, margins inrolled, clasping palea; palea 1.4–1.8 × 0.9–1.1mm, crustaceous, back flat, margins thickened, inrolled; anthers c.0.5mm.

Bhutan: S — Samchi (Dwarapani, Soureni Gari, Sibus), Phuntsholing (Druk Hotel, Toribar), Chukka (Kalikhola), Gaylegphug (Gaylegphug) and Deothang (Deothang Polytechnic) districts; **Darjeeling** (Selim); **Sikkim** (below Raniphul). Wet places (ditches around rice fields, marshy roadside); garden weed; wasteground; short turf, 300–1000m. August–December.

Parker (1992) recorded it as a very common weed, up to 1000m in all districts [with cultivation].

83. AXONOPUS P. Beauvois

Stoloniferous perennials, stolons spreading, compressed. Culms short, erect, with a single node; leaves sub-basal, blades flat, oblong, blunt; sheaths compressed, keeled; ligule short, truncate, membranous, shortly ciliate. Infl. of 1–3, unequally peduncled, ± digitate partial infls., the shorter enclosed in the long sheath of the terminal leaf-like bract. Racemes linear, spikelets borne singly, alternate on opposite sides of the triquetrous rachis. Spikelets ± sessile, compressed; florets 2. Glume single (the lower absent), facing away from rachis, back flat, 5-veined, semi-herbaceous. Lower floret sterile, epaleate; lemma similar to and about equalling glume, lacking midrib, semi-herbaceous. Upper floret bisexual, compressed; lemma crustaceous, back flat, punctate, margins incurved, tightly enclosing the palea; palea flat-backed, crustaceous; stamens 3.

1. Leaves over 6mm wide, margins long-ciliate; culm nodes hairy; spikelet usually over 2mm, apex of glume acute, not overtopped by hairs; longest raceme bearing spikelets to base **1. A. compressus**
- + Leaves under 5mm wide, margins lacking long cilia; culm nodes glabrous; spikelets under 2mm, apex of glume blunt, overtopped by hairs; base of longest raceme devoid of spikelets **2. A. affinis**

1. A. compressus (Swartz) P. Beauvois. Nep: *chaparey jhar*; Eng: *broad-leaved carpet grass*. Fig. 40i–k.

Mat-forming. Culms 2.5–6cm, the node appressed-hairy. Blades of sub-basal leaves 4.5–11.2 × 0.7–1cm, margins with widely spaced, long, tubercle-based cilia; sheaths glabrous, margins ciliate; ligule c.0.3mm. Sheath of upper leaf 6–11.5cm, concealing longest peduncle. Longest peduncled partial infl. with 3 racemes, the lowest slightly distant, 3.5–6cm, the upper paired, sessile. Spikelets 2–2.5mm. Glume 2–2.5 × 0.8–1mm, oblong, acuminate, back flat, veins appressed-hairy, with long, woolly hairs on incurved sides below and at truncate base; lower lemma 1.8–2.2 × 0.7–0.9mm, oblong-lanceolate, acuminate to apiculate, back 4-veined, flat, margins incurved; upper lemma pale green, 1.6–1.7 × 0.8–1mm, compressed, oblong-elliptic, blunt, with apical tuft of cilia, crustaceous; palea 1.5–1.6 × 0.7–0.8mm, similar to palea, but glabrous.

Bhutan: S — Samchi, Phuntsholing, Chukka, Sarbhang and Deothang districts; C — Punakha, Tongsa, Mongar and Tashigang districts; **Sikkim** (1km above Raniphul, Bop). Weed of roadsides and wasteground (neglected garden, orchards), 400–2100m. July–December.

Native of tropical America but widely introduced pantropically. First recorded in Bhutan in 1991, and spreading.

2. A. affinis Chase. Eng: *narrow-leaved carpet grass*. Fig. 40l.

Very similar to *A. compressus*, but differs as follows: culm node glabrous; peduncle long exerted from upper leaf sheath; leaf blades narrower (to 4.9mm wide), margins glabrous; longest raceme with bare section at base; spikelets smaller (to 2mm); the glume ± blunt, overtopped by hairs, veins below apex shortly hairy.

Bhutan: S — Deothang district (Deothang Polytechnic, Wamrong). Grassy sward; roadside, 1000–2300m. September–October.

Native of tropical America but widely introduced pantropically. First recorded in 1987 and will no doubt spread.

84. SETARIA P. Beauvois

Annuals or perennials, tufted or rhizomatous. Culms often decumbent at base. Leaf blades oblong to elliptic, sometimes plicate (folded like a fan); ligule a fringe of hairs sometimes fused into a short, truncate membrane at base. Infl. paniculate, branches distant and lax, or very short when infl. cylindric and spike-like, at least some spikelets subtended by one or more bristles, bristles antrorsely or retrorsely scabrid. Spikelets borne singly; florets 2. Glumes unequal, hyaline, the upper shorter than or equalling spikelet. Lower floret male or sterile; lemma hyaline; palea hyaline, equalling or smaller than lemma; stamens 0 or 3. Upper floret bisexual; lemma crustaceous, convex, smooth or rugose, tightly enclosing the palea; palea flat-backed, crustaceous; stamens 3.

1. Infl. an uninterrupted, cylindric, or slightly lobed, spike-like panicle; bristles in clusters of 6 or more 2
- + Infl. obviously branched, partial panicles distant; bristles borne singly 7
2. Bristles with backward-pointing hairs **3. S. verticillata**
- + Bristles with forward-pointing hairs 3
3. Upper glume shorter than the transversely rugose upper lemma 4
- + Upper glume equalling the \pm smooth upper lemma 6
4. Infl. rather lax; spikelets under 2mm **6. S. intermedia**
- + Infl. densely cylindric; spikelets over 2mm 5
5. Annual or short-lived perennial; culms to 75cm; infl. to 11cm; leaf sheaths not keeled **4. S. pumila**
- + Stout perennial; culms over 100cm; infl. over 20cm; leaf sheaths keeled
5. S. sphacelata
6. Spikelets deciduous from cup-like apices of pedicels **1. S. viridis**
- + Spikelets persistent **2. S. italica**
7. Bristles stiff, stout; leaves lanceolate to oblong, not plicate
10. S. forbesiana
- + Bristles flexuous, slender; leaves elliptic, plicate 8
8. Upper glume almost equalling upper lemma; spikelets blunt; annual
8. S. homonyma
- + Upper glume distinctly shorter than upper lemma; spikelets apiculate; usually perennial 9

9. Leaves plicate at base; infl. dense; spikelets to 2.6mm; upper lemma finely, transversely rugose 7. **S. barbata**
 + Leaves plicate throughout; infl. lax; spikelets over 2.8mm; upper lemma commonly \pm smooth 9. **S. palmifolia**

1. **S. viridis** (L.) P. Beauvois. Eng: *green bristle-grass*. Fig. 43a–c.

Tufted annual. Culms 60–85cm, stiffly erect. Leaf blades 16–26 \times 0.6–1.2cm, \pm oblong, gradually tapered to apex, veins rough above and beneath, margins serrate; sheaths hairy near margins; ligule with truncate, membranous base 0.5–0.7mm and dense fringe of hairs 1.2–1.5mm. Panicle 7–17cm, nodding, 7.5–11mm wide (excl. bristles), cylindric, axis tomentose, spikelets borne in clusters of 3–5 on main axis or on short, appressed lateral branches to 9mm, each cluster subtended by 6–14 purplish, antrorsely scabrid bristles. Spikelets deciduous, 2–2.2mm; pedicels with cup-like apex. Glumes hyaline; the lower 0.7–1mm, broadly ovate, clasping, 3-veined; the upper 1.9–2.2mm, oblong-elliptic, convex, 5-veined. Lower floret male or sterile; lemma 2–2.2mm, oblong-elliptic, blunt, 7-veined, hyaline, back flat, margins incurved; palea reduced, c. half length of lemma. Upper floret bisexual; lemma pale green, 1.9–2 \times 0.9–1mm, narrowly elliptic, strongly convex, blunt, crustaceous, \pm smooth; palea crustaceous, back flat, margins inrolled.

Bhutan: C — Thimphu district (Thimphu, Taba, Ramtokto, Paro). A weed of gardens, apple orchards, roadsides, 2300–2350m. July–September.

The specimens from Ramtokto and Thimphu are particularly robust, with very large panicles and superficially resemble *S. italica*. They have, however, the diagnostic deciduous spikelets of *S. viridis*; it is possible that there has been introgression from the former.

2. **S. italica** (L.) P. Beauvois. Sha: *yangra*; name at Dobji: *thre*; Lep: *kumduk zu, tanduk zu*; Eng. *fox-tail millet*. Fig. 43d–e.

Differs from *S. viridis* as follows: larger, more robust (culms to 1.5m; leaf blades 1–3cm wide, panicles (6.5–)14–18 \times (1–)1.5–5cm); lateral partial panicles longer, so panicle lobed at maturity; spikelets persistent, bristles hidden when grains mature.

Bhutan: S — Deothang district (12km N of Deothang); **C** — Thimphu (Babesa, near Dobji), Tongsa (Shamgong (Nakao & Nishioka, 1984)) and Tashigang (Tashi Yangtsi) districts; **Darjeeling** (Kalimpong, Mungpo); **Sikkim** (Lachen, Keadom). Cultivated, 610–2600m. June–October.

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Grown as a crop by poor people – used for brewing, and roasted and ground as flour. Also used as a food for pigs.

3. *S. verticillata* (L.) P. Beauvois. Eng: *rough bristle-grass*

Very similar to *S. viridis*, but differing in the bristles which are conspicuously retrorsely scabrid.

Sikkim (unlocalised Treutler specimen). January.

Probably a casual introduction.

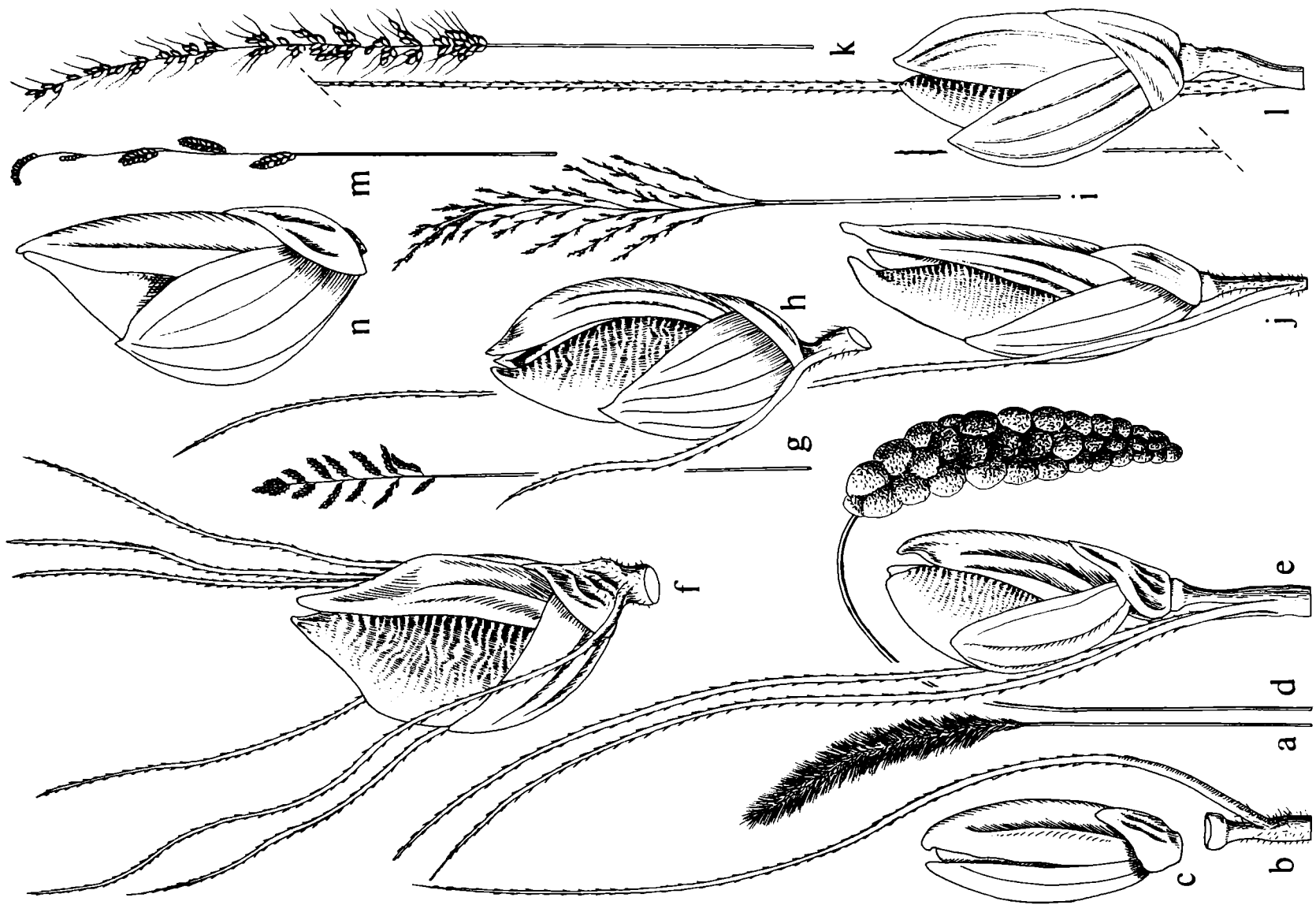
4. *S. pumila* (Poiret) Roemer & Schultes; *S. glauca* auct.; incl. *S. parviflora* (Poiret) Kerguelen (*S. pallide-fusca* (K. Schumann) Stapf & Hubbard). Sha: *yangra bang*; Nep: *bala bansu*, *gogey banso*; Eng: *yellow bristle-grass*. Fig. 43f.

Tufted annual, or short-lived perennial with short rhizomes. Culms 10–75cm, curved at base, sometimes rooting from lower nodes. Leaf blades 3.5–17cm, 3.1–6.5mm wide, \pm oblong, gradually tapered to apex, usually with some long, scattered hairs on upper surface at base; sheaths glabrous, flattened, keeled; ligule a fringe of hairs 0.9–1.3mm. Panicle 1.2–11cm, 4.5–7mm wide (excl. bristles), cylindric, axis tomentose; spikelets borne singly (or sometimes with a very reduced, sterile subsidiary spikelet), deciduous, bristles golden or sometimes purplish, 10–12, antrorsely scabrid. Spikelets (1.9–)2.5–3.1mm. Glumes broadly ovate, hyaline; lower (0.7–)1–1.9mm, 3-veined; upper (1.2–)1.6–2.5mm, 5-veined. Lower floret male or sterile; lemma (1.8–)2.3–2.9mm, elliptic, 3-veined, hyaline, back flat, margins incurved; palea elliptic, 2-veined, hyaline. Upper floret bisexual; lemma pale green, (1.9–)2.5–3.2 \times (0.8–)1.3–2mm, elliptic, strongly convex, acute, crustaceous, transversely rugose; palea crustaceous, back flat, margins hyaline, inrolled.

Bhutan: S — Samchi, Phuntsholing, Chukka and Deothang districts; C — Thimphu, Punakha, Tongsa, Mongar and Tashigang districts; **Darjeeling;** **Sikkim.** An extremely common weed of grassy places, roadsides, fields and disturbed places, 300–2700m. March–December.

FIG. 43.

a–c, *Setaria viridis*: a, infl. ($\times \frac{1}{3}$); b, apex of persistent pedicel + bristle ($\times 16$); c, deciduous spikelet ($\times 16$). d–e, *S. italica*: d, infl. ($\times \frac{1}{3}$); e, pedicel + non-deciduous spikelet ($\times 16$). f, *S. pumila*: spikelet ($\times 16$). g–h, *S. barbata*: g, infl. ($\times \frac{1}{3}$); h, spikelet ($\times 16$). i–j, *S. palmifolia*: i, infl. ($\times \frac{1}{15}$); j, spikelet ($\times 16$). k–l, *S. forbesiana*: k, infl. ($\times \frac{1}{3}$); l, spikelet ($\times 16$). m–n, *Paspalidium flavidum*: m, infl. ($\times \frac{1}{3}$); n, spikelet ($\times 16$). Drawn by Louise Olley.



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Forms with short rhizomes and a tendency to root from the decumbent lower nodes are recorded from all districts. Such forms tend to be more robust, with longer panicles and have been referred (e.g. Clayton, 1979) to *S. gracilis* Kunth (*S. geniculata* auct.). They intergrade, however, into *S. pumila*, except in the single character of perennation, which is by no means easy to determine, and are almost certainly better treated as a form of *S. pumila*.

Veldkamp (1994) distinguished *S. parviflora* (syn. *S. pallide-fusca*) as having smaller (1.9–2.4mm) spikelets than *S. pumila* (2.8–3.5mm); on these measurements, the majority of our specimens are referable to the latter, but the variation is continuous.

Parker (1992) recorded it as a common weed of almost all altitudes and districts [with cultivation] and very widespread in dryland crops.

5. *S. sphacelata* (Schumacher) Moss; *S. anceps* Stapf

Differs from perennial forms of *S. pumila* as follows: more robust, culms usually over 100cm, with more than 5 nodes; leaf sheaths keeled; infl. longer (over 20cm).

Bhutan: S — Gaylegphug district (Bhur); C — Punakha (Chuzomsa) and Mongar (Yonkola) districts. Improved pasture and becoming naturalised, 500–1800m. August–September.

Native of Africa, but widely grown in the tropics for fodder; introduced into Bhutan some time prior to 1982. The introduced form can, perhaps, be referred to var. *sericea* (Stapf) Clayton.

6. *S. intermedia* Roth ex Roemer & Schultes; *S. tomentosa* (Roxb.) Kunth. Fig. 41f–g.

Differs from *S. pumila* in having smaller spikelets and a laxer spike.

Bhutan: C — Punakha district (beside Punakha Dzong). Wasteground, 1200m. September.

Possibly only a casual introduction.

7. *S. barbata* (Lamarck) Kunth; *Panicum flavescens* sensu F.B.I., non Swartz. Fig. 43g–h.

Sprawling perennial, sometimes annual. Culms 2–80cm, decumbent, rooting from lower nodes. Leaf blades 3–11 × 0.5–1.9cm, elliptic, finely acuminate, plicate at base, with sparse, tubercle-based, spreading hairs above and beneath; leaf sheaths keeled, margins long-ciliate; ligule with truncate, membranous base 0.2–0.4mm, cilia 0.7–1mm. Panicle 1.7–9cm, axis with short hairs and long white cilia; branches persistent, 0.6–2cm, suberect, wavy, hairy and ciliate, bearing short lateral branches with clusters of spikelets; bristles weak, wavy, 3–5mm, antrorsely scabrid, borne singly, mainly on lower part

of branches. Spikelets 2.5–2.6mm. Glumes hyaline; lower 0.7–1mm, broadly ovate, blunt, clasping, 3-veined; upper 1.8–2mm, broadly elliptic, convex, 7-veined. Lower floret male; lemma 2.2–2.6mm, broadly elliptic, convex, apiculate, 7-veined, hyaline; palea 2.1–2.6mm, narrowly elliptic, 2-veined, flat. Upper floret bisexual; lemma pale green, 2.3–2.5 × 1–1.2mm, narrowly elliptic, strongly convex, acute to apiculate, crustaceous, finely transversely rugose; palea 2–2.1mm, crustaceous, back flat, margins hyaline, inrolled.

Bhutan: S — Samchi (Samchi High School) and Phuntsholing (Phuntsholing) districts; **Sikkim** (Jorethang). Wasteground; overgrown ditch, 200–400m. October–February (winter-flowering).

8. *S. homonyma* (Steudel) Chiovenda; *Panicum rhacotrichum* Hochstetter. Fig. 41h.

Vegetatively similar to *S. barbata* (annual; leaf blades elliptic, acuminate, plicate at base), but differs as follows: spikelets blunt; upper glume almost equalling upper lemma; upper lemma less strongly rugose.

Darjeeling (Darjeeling). Habitat not recorded, 1830m. September.

A single 19th century specimen seen, no doubt a casual introduction.

9. *S. palmifolia* (J. König) Stapf; *S. paniculifera* (Steudel) Hemsley; *Panicum plicatum* sensu F.B.I. Nep: *doti sara* (this also applies to *Molinaria* spp.). Fig. 43i–j.

Stout perennial; rhizome woody, knotted. Culms 41–200cm, lower part decumbent and rooting from nodes. Leaf blades 11–43 × (0.7–)1–6cm, elliptic, plicate, abruptly acuminate, abruptly contracted at base, glabrous or with scattered, tubercle-based hairs above and beneath; sheaths glabrous or hispid, with stout, tubercle-based hairs, margins ciliate; ligule a fringe of hairs 1–1.9mm. Panicle 8–73cm, cylindrical to pyramidal, axis minutely hispid, sometimes also with a few spreading cilia, branches again branched, or sometimes simple, single or whorled, rather distant, the lowest 1.4–50cm, spikelets borne singly, the lower ones subtended by a weak, antrorsely scabrid bristle (2–)6–11.5mm. Spikelets 2.8–3.5mm. Glumes hyaline; lower 1–1.5mm, broadly ovate, blunt, clasping, 3(–5)-veined; upper 1.7–2.6mm, elliptic, convex, apiculate, 5–7-veined. Lower floret male; lemma 2.8–3.5mm, elliptic, apiculate, convex, 5-veined, hyaline; palea reduced, 1.6–2.5mm, lanceolate, flat. Upper floret bisexual; lemma pale green, 2.6–3.3 × 1.2–1.4mm, lanceolate, strongly convex, apiculate, crustaceous, smooth, punctate or finely transversely rugose; palea 2.3–3mm, crustaceous, back flat, margins thickened, inrolled.

Bhutan: S — Samchi, Phuntsholing, Chukka, Sarbhang, Gaylegphug and

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Deothang districts; **C** — Punakha (c.20km S of Wangdi Phodrang, Chuzomsa), Tongsa (below Tongsa Dzong, Tama), Mongar (N of Lhuntse, Yonkola) and Tashigang (between Kanglung and Tashigang) districts; **N** — Upper Mo Chu district (Goen Gaza); **Terai** (Jalpaiguri Duars); **Darjeeling** (Darjeeling, Barnesbeg, Kurseong, above Mungpo, Badamtam, Ging, Little Rangit, Lebong); **Sikkim** (Gangtok, Karponang, Chakung). Not uncommon on shady banks in broad-leaved forest; damp scrub around fields and by streams, 200–2850m. May–February.

Small forms with narrow, thin-textured leaves and narrow panicles grade into the doubtfully distinct *S. plicata* (Lamarck) T. Cooke.

10. *S. forbesiana* (Nees ex Steudel) Hook. f. Fig. 43k–l.

Perennial. Rhizome woody, knotted. Culms to 1m, ascending. Leaf blades 19–32 × 0.9–1.4cm, ± oblong, glabrous; margins of sheaths long ciliate; ligule with truncate, membranous base c.0.3mm, cilia c.2.5mm. Panicle 14–40 × 0.6–3.5cm, narrowly cylindric, axis hispid, branches rather distant, very short, bearing 3–6(–14) spikelets, each spikelet subtended by a stiff, antrorsely scabrid bristle 8.8–13.5mm. Spikelets 2.8–3.2mm. Glumes hyaline; lower 1.2–1.9mm, broadly ovate, clasping, 3–4-veined; upper 2–2.8mm, broadly elliptic, convex, 7–9-veined. Lower floret male; lemma 2.7–3.3mm, elliptic, convex, acute, 5–7-veined, hyaline; palea 2.4–3mm, elliptic, flat, margins inflexed. Upper floret bisexual; lemma 2.6–3.1 × 1.1–1.6mm, narrowly elliptic, strongly convex, acute, crustaceous, ± smooth or minutely rugose; palea 2.3–2.7mm, crustaceous, back flat, margins inrolled.

Bhutan: **S** — Chukka district (Chukka Bridge); **C** — Punakha (c.8km above Chuzomsa, Punakha to Lobesa), Tongsa (near Bjeezam Bridge) and Mongar (Yonko La) districts; **Darjeeling** (?Rummuk). Banks at edge of broad-leaved forest; rough scrub and relict forest, 1200–2000m. August–October.

85. *PASPALIDIUM* Stapf

Tufted perennial. Culms decumbent at base. Leaf blades oblong; sheaths compressed, keeled; ligule a fringe of hairs. Infl. paniculate, racemes spike-like, distant, spikelets borne singly on opposite sides of flattened, zigzag axis. Spikelets plano-convex; florets 2. Glumes hyaline, shorter than the spikelet, unequal, the lower 3-veined, the upper 7-veined. Lower floret male or sterile; lemma 5-veined, hyaline, flat on back, margins incurved; palea equalling lemma, hyaline, back flat, margins inflexed; stamens 0 or 3. Upper floret bisexual; lemma convex, tightly enclosing the palea, crustaceous, smooth; palea crustaceous, flat-backed; stamens 3.

1. **P. flavidum** (Retzius) A. Camus; *Panicum flavidum* Retzius. Fig. 43m-n.

Culms 37–94cm. Leaves inserted evenly along culm; blades 7.5–14.5 × 0.3–0.8cm, glabrous, apex blunt, base truncate, long-ciliate; sheaths glabrous; ligule c.0.3mm. Racemes 4–9, distant (not overlapping), sessile, the lowest (0.6–)1.1–2.5cm, sometimes shortly peduncled. Spikelets 2.6–3mm. Lower glume 1.3–1.5 × 1.2–1.4mm, broadly obovate, blunt, clasping; upper glume 2–2.3 × 0.9–1.9mm, orbicular, convex, apiculate. Lower floret: lemma 2.5–2.8 × 1.4–1.6mm, elliptic, acute, hyaline; palea 2.3–2.5 × 1.2–1.5mm, elliptic. Upper floret: lemma pale green, 2.5–2.7 × 1.4–1.6mm, lanceolate, strongly convex, apiculate, crustaceous, smooth; palea 2.1–2.3 × 1.1–1.3mm, crustaceous, back flat, margins thickened, inrolled.

Bhutan: S — Phuntsholing (Phuntsholing), Chukka (Kalikhola) and Deothang (7km above Samdrup Jonkhar) districts; C— Punakha (Wangdi Phodrang) and Mongar (Lingmithang) districts; **Darjeeling** (Mukherjee, 1988); **Sikkim** (Rangpo). Uncommon: paddy-fields; short grassland and roadsides, 270–1250m. April–September.

Veldkamp (1994) sunk this genus under *Setaria*, and made the combination *S. flavida* (Retzius) Veldkamp; but as it has a very different appearance it is maintained as a separate genus here.

86. MELINIS P. Beauvois

Perennial. Culms decumbent at base, rooting from lower nodes. Leaf blades flat, linear-lanceolate; ligule a fringe of hairs. Infl. a dense panicle, branches whorled, erect, slender, branched, spikelets borne singly. Spikelets laterally compressed, pedicels filiform. Lower glume very reduced; upper glume equalling spikelet, bilobed, 7-veined, thickly herbaceous. Lower floret sterile; lemma equalling spikelet, bilobed, awned in sinus, 5-veined, thickly herbaceous; palea absent. Upper floret bisexual, compressed; lemma and palea similar, lanceolate, subacute, hyaline.

1. **M. minutiflora** P. Beauvois. Eng: *molasses grass*. Fig. 41i-j.

Plant strongly scented (smelling of linseed oil), sticky when fresh. Culms to 120cm. Leaf blades 3–18 × 0.7–1cm, with slender, spreading hairs above and beneath, especially on veins, margins ciliate; sheaths densely hairy, hairs spreading; ligule hairs c.1mm. Infl. purplish, 9–21 × 2–3.5cm, longest branch of lowest whorl to 7cm. Lower glume c.0.2mm; upper glume c.2 × 1mm, oblong, conduplicate, apex notched, lobes rounded, sometimes mucronate in notch, strongly ribbed, minutely granular. Lower lemma c.2 × 0.7mm, lobes acute, awn c.10mm. Upper floret c.1.7mm.

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Bhutan: S — Gaylegphug district (Bhur). Improved pasture, 500m. September.

Native to Africa, but recently introduced as a fodder plant into subtropical parts of Bhutan. Flowering specimens not seen from Bhutan; measurements above taken from Burmese and Indian specimens.

87. DIGITARIA Haller

Perennials, or annuals. Culms commonly decumbent at base and rooting from lower nodes, even in annuals. Leaf blades flat, linear; ligule membranous, blunt. Infl. of linear racemes, racemes digitate or inserted along a short axis, occasionally with short basal branches; raceme rachis broadly winged and \pm flat, or narrowly winged and \pm triquetrous. Spikelets borne in pairs or groups of 3–5 on lower side of rachis, upper glume adjacent to rachis, plano-convex, florets 2, unequally pedicelled. Pubescence of glumes and lower lemma in species with spikelets in 3s of varying types: ‘verrucose’ with swellings along length of hair, or ‘clavate’ with swollen tips. Lower glume small or absent; upper glume usually smaller than upper lemma, 0-, 3- or 5-veined. Lower floret sterile; lemma equalling or shorter than upper lemma, flat, commonly hairy between lateral veins, sometimes also with tubercle-based, stiff, marginal bristles, conspicuously 5–7-veined, semi-herbaceous. Upper floret bisexual, compressed; lemma convex, coriaceous, margins inflexed, broad, almost completely covering palea; palea similar in shape to lemma, coriaceous, back flat, margins inrolled, widened into flaps in middle, stamens 3.

There is still much confusion in this difficult genus; the species are extremely difficult to identify in the field due to the size of the spikelets. The taxa are very unevenly circumscribed – some (e.g. *D. ciliaris*) very broadly, others (e.g. *D. sanguinalis*) based more or less on a single character. Hooker (F.B.I.) reduced most taxa with paired-spikelets to varieties of *Paspalum sanguinale*, but synonymy for these is not given as his taxa do not always coincide with presently recognised ones. The following account mainly follows Veldkamp’s account for Malesia (1973).

- | | |
|---|---|
| 1. Spikelets over 2mm | 2 |
| + Spikelets under 1.8mm | 9 |
| 2. Spikelets inserted in 3s or 4s | 3 |
| + Spikelets inserted in 2s | 4 |

3. Spikelets greenish, sparsely appressed-hairy, hairs not obviously clavate; lower racemes usually spreading horizontally **11. D. ischaemum**
 + Spikelets silvery, densely covered with spreading, obviously clavate hairs; racemes \pm erect **13. D. ternata**
4. Wings of raceme rachis smooth; racemes to 3, closely appressed, erect; small, decumbent plant; leaves short, \pm elliptic **6. D. radicata**
 + Wings of raceme rachis spinulose; racemes commonly more than 3, divergent to spreading obliquely; plant often larger; leaves \pm linear ... 5
5. Lower glume absent 6
 + Lower glume present, though sometimes very small (c.0.2mm) 7
6. Upper glume 0.6–1.1mm, ciliate; lateral veins of lower lemma lacking spicules **4. D. setigera**
 + Upper glume 0.2–0.4mm, glabrous; spicules present on lateral veins of lower lemma near apex **5. D. compacta**
7. Upper glume usually under half length of upper lemma, blunt; upper lemma conspicuously apiculate, exceeding lower lemma; spikelet to 2.9(–3.3)mm; racemes inserted along elongate infl. axis (0.4–5cm) **3. D. cruciata**
 + Upper glume over half length of upper lemma, subacute; upper lemma not conspicuously apiculate, equalling lower lemma; spikelet usually over 3mm; racemes digitate or inserted along short infl. axis (to 1.3cm) 8
8. Lateral veins of lower lemma lacking spicules near apex **1. D. ciliaris**
 + Spicules present on lateral veins of lower lemma near apex **2. D. sanguinalis**
9. Racemes usually 2; spikelets under 1.3mm 10
 + Racemes usually 3 or more; spikelets over 1.3mm 11
10. Spikelets hairy **8. D. longiflora**
 + Spikelets glabrous **9. D. fuscescens**
11. Apex of pedicels with corona of spicules; upper glume very short **12. D. stricta**
 + Apex of pedicels lacking spicules; upper glume about equalling spikelet 12
12. Rachis narrowly triangular in section **7. D. abludens**
 + Rachis distinctly winged **10. D. violascens**

1. **D. ciliaris** (Retzius) Koeler; *D. adscendens* (Kunth) Henrard. Dz: *tampula*; Nep: *chittrey banso* [these names recorded by Parker (1992) probably also refer to the other weedy species with large, paired spikelets]; Eng: *crab grass*. Fig. 44a–b.

Annual. Culms 8–80cm, erect or base decumbent and rooting from nodes. Leaf blades 1.2–10 × 0.2–0.6cm, oblong-lanceolate, acute, minutely hispid on veins above and beneath, sometimes also with tubercle-based bristles above and/or beneath, margins hispid; sheaths glabrous or with spreading, tubercle-based bristles; ligule c.1mm. Infl. axis 0.8–1.3cm. Racemes (2–)3–6(–8), digitate or lower 2–3 slightly distant, the lowest 2.5–10(–13.5)cm; rachis flattened, winged, margins hispid. Spikelets paired, unequally pedicelled, 2.8–3.4 × 0.8–1mm, lanceolate, acute. Lower glume small, 0.25–0.4, ± triangular, glabrous; upper glume 1.5–1.8 × 0.4–0.5mm (more than half spikelet length), lanceolate, acute, 3-veined, margins long-ciliate. Lower lemma equalling spikelet, 2.8–3.4 × 0.8–1mm, lanceolate, acuminate, 5(–7)-veined, outer 2 pairs close to margin, internerve spaces next to midrib broad, appressed long-hairy (occasionally almost glabrous) between outer veins. Upper floret: lemma cream-coloured, 2.6–3.1mm, narrowly oblong-lanceolate, acuminate; palea 2.5–3mm; anthers c.0.9mm.

Bhutan: S — Phuntsholing, Gaylegphug and Deothang districts; C — Thimphu, Punakha, Tongsa, Mongar and Tashigang districts; **Darjeeling** (Little Rangit, Punkabari). A common weed of crops (maize, rice) and disturbed places (roadsides etc.), 300–2300m. May–December.

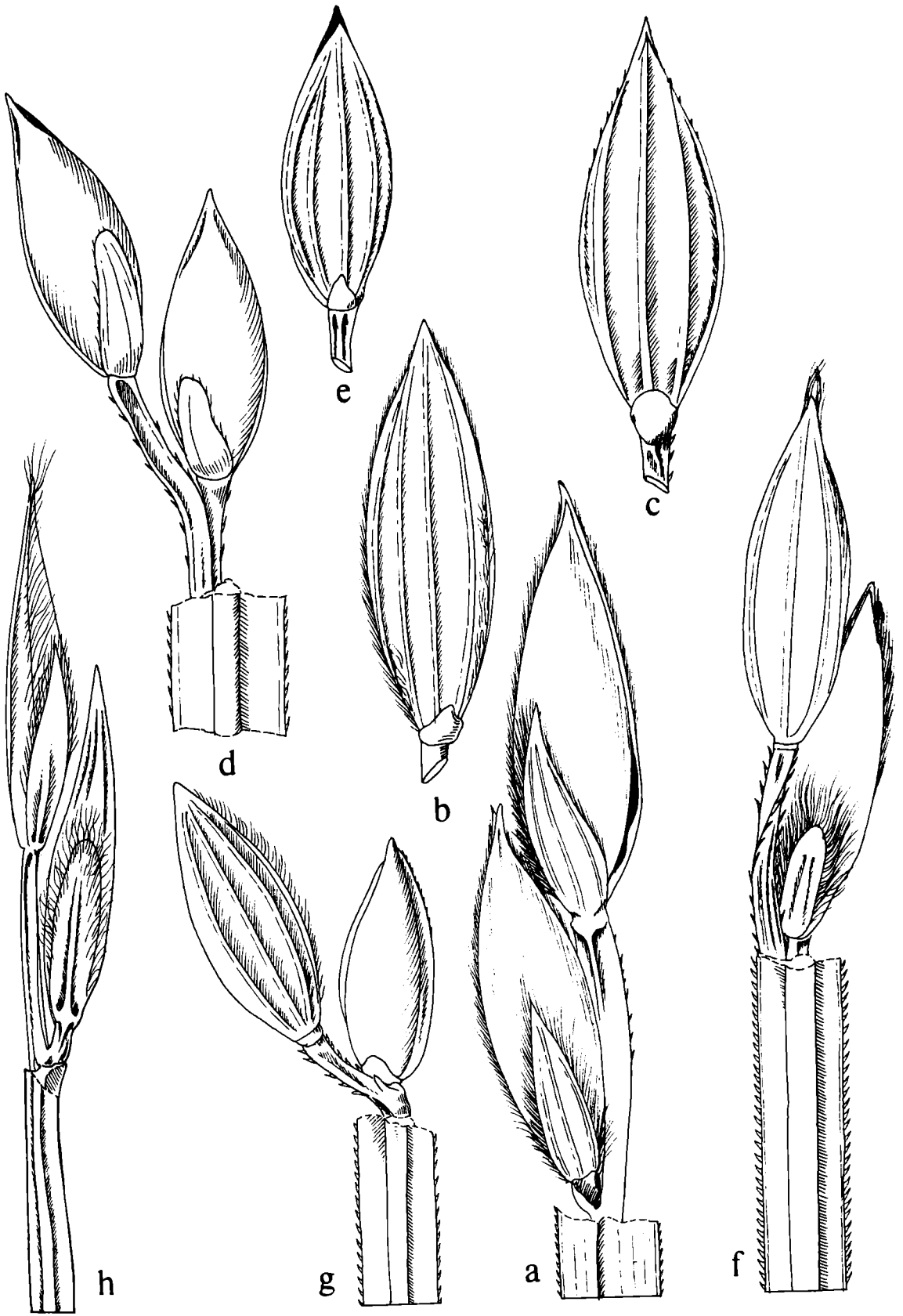
Recorded by Parker (1992) as one of the commonest and most important weeds of annual and perennial dryland crops in Bhutan, mainly above 1000m and occurring in all districts [with cultivation]; he did not, however, segregate *D. cruciata*.

2. **D. sanguinalis** (L.) Scopoli. Eng: *hairy finger-grass*. Fig. 44c.

Scarcely distinguishable from *D. ciliaris*, but usually a more robust plant with longer leaves (blade 5.5–20 × 0.5–1.1cm); ligule longer (c.2mm); racemes 5–10, the lowest 4.5–14.5cm; upper glume intermediate in length and shape

FIG. 44.

a–b, **Digitaria ciliaris**: a, spikelet pair (× 24); b, spikelet showing lower lemma and lower glume (× 24). c, **D. sanguinalis**: spikelet showing apical scabridities on veins of lower lemma (× 24). d–e, **D. cruciata**: d, spikelet pair (× 24); e, spikelet showing apiculus of upper lemma protruding beyond lower lemma (× 24). f, **D. setigera**: spikelet pair (× 24). g, **D. compacta**: spikelet pair (× 24). h, **D. radicata**: spikelet pair showing smooth rachis margins (× 24). Drawn by Louise Olley.



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between that of *D. ciliaris* and *D. cruciata*; outer nerves of lower lemma hispid at least near apex.

Bhutan: C — Thimphu (Chapcha, hill above Thimphu hospital) and Bumthang (Tangphomrong) districts; **Sikkim** (Yoksam). Weed of maize and potato; field borders, 1820–2600m. July–August.

3. *D. cruciata* (Nees ex Steudel) A. Camus; *Paspalum sanguinale* (L.) Lam. var. *cruciatum* (Nees ex Steudel) Hook. f. Sikkim name: *matab*. Fig. 44d–e.

Differs from *D. ciliaris* in being more robust; leaves usually longer (to 14 × 1.2cm); ligule longer (2–3.5mm); infl. laxer, with a terminal pair and 1–3 single or paired racemes inserted along an elongate axis 0.5–5cm; spikelets usually shorter and wider, oblong-elliptic, 2.1–2.9(–3.3) × 0.8–1.2mm; upper glume usually less than half spikelet length, blunt; apex of upper lemma abruptly apiculate and protruding above lower lemma.

Bhutan: S — Chukka and Deothang districts; C — Thimphu, Punakha, Tongsa, Bumthang, Mongar and Tashigang districts; N — Upper Mo Chu district (Gasa to Goen Gaza); **Darjeeling** (Darjeeling, Mungpo, Ghumpahar, Kurseong), **Sikkim** (Yoksam, Lachung, Chungthang, Domang). Very common as a weed (potato, apple orchards, maize, wheat) and in disturbed grassy places in broad-leaved and blue pine zones, (1220–)1820–3060m. July–October.

Generally occurring at higher altitudes than *D. ciliaris*. Parker (1992) did not distinguish this species from *D. ciliaris*. One specimen has bristles on the margins of the lower lemma of the upper spikelet, in addition to appressed hairs.

Some specimens are difficult to assign to *D. cruciata*, *D. sanguinalis* or *D. ciliaris*: one of the Lachung specimens has apiculate, overtopping upper lemmas like *D. cruciata*, but a long upper glume, as in *D. ciliaris*; it could equally well be a form of *D. sanguinalis* with smooth lemma nerves. An unlocalised Hooker specimen from Sikkim has apiculate, overtopping upper lemmas but the nerves of the lower lemma are conspicuously hispid, thus linking *D. cruciata* with *D. sanguinalis*.

4. *D. setigera* Roth ex Roemer & Schultes; *D. microbachne* (J. Presl) Henrard. Nep: *banso*. Fig. 44f.

Annual. Culms 20–80cm, base decumbent and rooting from lower nodes. Leaf blades 5–11 × 0.5–0.9cm, oblong-lanceolate, acute, minutely hispid on veins above and beneath, sometimes also with tubercle-based bristles beneath or at extreme base above, margins hispid; sheaths glabrous or with spreading, tubercle-based bristles; ligule 1.5–2.5mm. Infl. axis (0–)0.9–2.4cm. Racemes (3–)4–10, digitate or the lower slightly distant, the lowest 4–12cm; rachis flattened, winged, margins hispid. Spikelets paired, unequally pedicelled, 2.6–3 × 0.7–0.9mm, narrowly lanceolate, acute. Lower glume absent; upper glume

0.6–1.1 × 0.3–0.4mm, less than half spikelet length, oblong-lanceolate, blunt to subacute, overtopped by cilia, obscurely or not veined, margins long-ciliate. Lower lemma 2.6–3 × 0.7–0.9mm, equalling spikelet, narrowly lanceolate, acuminate, 7-veined, outer 3 pairs close to margin, internerve spaces next to midrib broad, appressed long-hairy (occasionally almost glabrous) between outer veins. Upper floret: lemma cream-coloured, 2.5–2.7mm, narrowly oblong-lanceolate, acuminate; palea 2.3–2.5mm; anthers 1–1.3mm.

Bhutan: S — Samchi (Changtar), Phuntsholing (Phuntsholing), Gaylegphug (Gaylegphug) and Deothang (7km above Samdrup Jongkhar) districts; C — Punakha (Wangdi Phodrang, 20km S of Wangdi Phodrang) and Mongar (Zimgaon) districts; **Darjeeling** (Selim, Great Rangit). Weed in subtropical zone (gardens, maize-fields, orange orchards, roadsides), 300–1250m. April–December.

All our specimens have a conspicuous, hairy upper glume. For this reason Parker (1992) identified and illustrated it as *D. timorensis*. One of the Punakha specimens is extremely robust with very stout vegetative parts and 12 long racemes (to 18cm), whorled along an elongate (6.2cm) axis that is bristly at the nodes.

5. *D. compacta* (Roth ex Roemer & Schultes) Veldkamp; *Panicum corymbosum* Roxb. Fig. 44g.

Differs from *D. setigera* in having smaller spikelets (1.9–2.5 × 0.7–0.9mm); upper glume minute (0.2–0.4mm), glabrous; lower lemmas corrugated, veins 5, ± evenly spaced, with spicules on outer nerves towards apex, margins glabrous.

Bhutan: C — Punakha (Wangdi Phodrang), Mongar (near Autsho) and Tahsigang (below Rangjung) districts; **Darjeeling** (Ging, Great Rangit). Weed of maize; roadside, 610–1250m. June–September.

Because of the very small upper glume this species was identified and illustrated by Parker (1992) as *D. microbachne*. As with *D. setigera*, massive forms occur.

6. *D. radicata* (J. Presl) Miquel; *D. timorensis* (Kunth) Balansa. Fig. 44h.

Differs from *D. setigera* and *D. ciliaris* in having racemes with smooth rachis margins. From *D. setigera* it also differs as follows: culms much branched, slender, decumbent, the erect part 15–26cm; leaves narrowly elliptic, shorter (2.2–4.2 × 0.3–0.4cm); racemes 2(–3), very slender, erect, 3.5–6.5cm; spikelets narrower (0.6–0.7mm wide); lower glume present, small (0.2–0.3mm).

Bhutan: S — Samchi (Soureni Gari), Phuntsholing (Phuntsholing), Chukka (Kalikhola) and Deothang (Deothang Polytechnic) districts; C — Mongar district (near Autsho); **Darjeeling** (Punkabari, Mungpo). Weed of

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rice (sometimes maize) fields; grass lawn; weedy wasteground with millet cultivation in evergreen forest, 300–1100m. April–December.

Many of Parker's specimens labelled *D. timorensis* have been re-determined as *D. ciliaris*, so probably not so common as he suggested (Parker, 1992).

7. *D. abludens* (Roemer & Schultes) Veldkamp; *D. granularis* (Trinius) Henrard; *Paspalum pedicellare* Trinius ex Steudel. Fig. 45a.

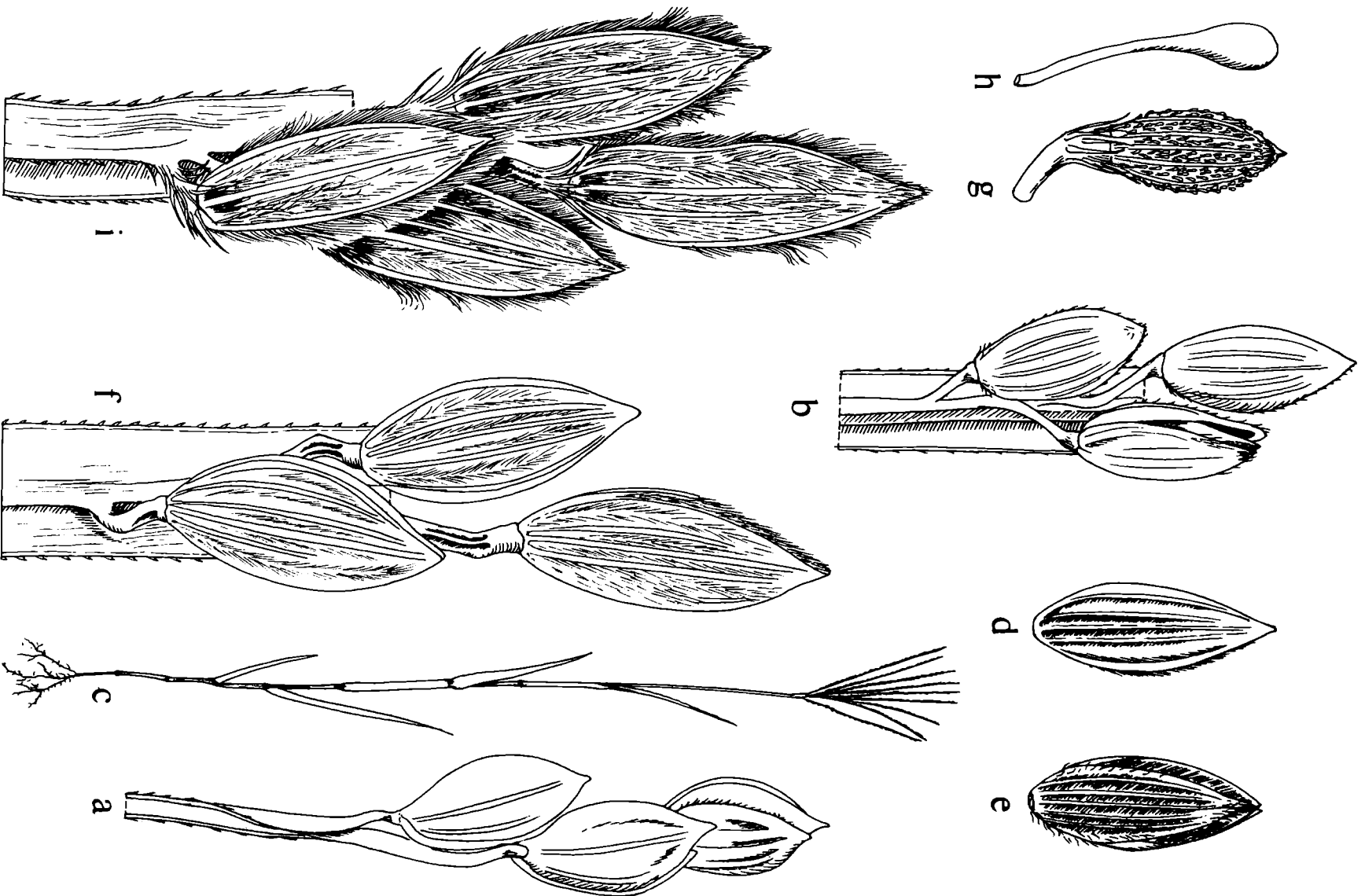
Slender annual. Culms 11–30cm, erect, not rooting from lower nodes. Leaf blades 6–9 × 0.2–0.3cm, linear, acute, minutely hispid on veins above and beneath, sometimes also with sparse tubercle-based bristles beneath, margins hispid; sheaths glabrous or with spreading, tubercle-based bristles; ligule 1.5–1.8mm. Infl. axis 1.6–4cm. Racemes (3–)4–5, the lower with short branches near base, the lowest 2–8.5cm; rachis triangular in section, very narrowly winged, margins hispid. Spikelets in groups of (2–)3–4, unequally pedicelled, 1.4–1.6 × 0.5–0.7mm, oblong-elliptic, apiculate; pedicels elongate, slender, spreading. Lower glume absent; upper glume 1.2–1.45 × 0.5–0.7mm, almost equalling spikelet, oblong-lanceolate, subacute, strongly (3–)5-veined, margins ciliate. Lower lemma 1.3–1.4 × 0.5–0.7mm, slightly shorter than spikelet, oblong-elliptic, subacute, 7-veined, veins equally spaced, but usually appressed-hairy between outer veins, so only midrib conspicuous, hairs obscurely clavate, sometimes subglabrous. Upper floret: lemma yellow- to fuscous-brown, 1.4–1.6mm, equalling spikelet, elliptic, apiculate; palea 1.2–1.4mm; anthers 0.5–0.7mm.

Bhutan: S — Phuntsholing (Sorchen) and Gaylegphug (Gaylegphug to Tori Bari) districts; C — Thimphu (above Thimphu Hospital, Motithang), Punakha (c.5km above Punakha, Ruri Chu to Pinsa), Mongar (between Mongar and the Kuru Chu) and Tashigang (below Yadi) districts; **Terai** (Siliguri). Disturbed ground in chir pine and blue pine forest; wasteground; moist hollows in seasonally burnt bushland, 300–2450m. May–September.

Forms with long pedicels look very distinct.

FIG. 45.

a, ***Digitaria abludens***: spikelet trio (× 24). b, ***D. longiflora***: spikelet trio (× 24). c–e, ***D. violascens***: c, habit (× 1/3); d, spikelet showing lower lemma (lower glume absent) (× 24); e, spikelet showing upper glume and dark upper lemma (× 24). f, ***D. ischaemum***: spikelet trio (× 24). g–h, ***D. stricta***: g, spikelet showing hairs at apex of pedicel (× 24); h, clavate hair (× 333). i, ***D. ternata***: spikelet trio (× 24). Drawn by Louise Olley.



8. *D. longiflora* (Retzius) Persoon; *Paspalum longiflorum* Retzius. Fig. 45b.

Usually perennial (in Bhutan). Culms often woody at base, erect or much branched and decumbent, erect part 6–27cm. Leaf blades 1.3–3.7 × 0.3–0.4cm, narrowly lanceolate, acute, glabrous, occasionally with sparse tubercle-based bristles beneath, margins hispid; sheaths glabrous or sometimes densely hairy, hairs slender, woolly; ligule c.1mm. Racemes 2(–3), digitate, 2.5–7cm, slender, arching at maturity; rachis flattened, winged, margins hispid. Spikelets in groups of 3, but upper 2 (unequal) pedicels fused to axis, so appearing single or paired, 1.2–1.3 × 0.6–0.7mm, oblong-elliptic, subacute. Hairs verrucose. Lower glume absent; upper glume equalling spikelet, 1.2–1.3 × 0.6–0.7mm, oblong-elliptic, subacute, 3–5-veined, hairy between veins, margins ciliate, cilia overtopping apex. Lower lemma 1.2–1.3 × 0.6–0.7mm, equalling spikelet, oblong-elliptic, subacute, 7-veined, veins ± equally spaced, but often only midrib conspicuous, appressed-hairy between outer veins. Upper floret: lemma yellowish-green, 1.2–1.3mm, elliptic, acuminate; palea 1.1–1.2mm; anthers c.0.6mm.

Bhutan: S — Gaylegphug district (W of Bhur); C — Punakha (Wangdi Phodrang, 20km S of Wangdi Phodrang, near Punakha Dzong), Tongsa (below Refe), Mongar (between Mongar and the Kuru Chu) and Tashigang (2km from Kangling) districts; **Darjeeling** (Rangpo to Tista Bazaar (F.E.H.1)). Roadsides; silty soil near river; seasonally burnt bushland, 400–1900m. April–September.

9. *D. fuscescens* (J. Presl) Henrard

Differs from *D. longiflora* as follows: upper glume and lower lemma glabrous; upper lemma slightly exceeding lower and therefore minutely exerted.

Darjeeling (Rangit). Habitat not recorded, 610m. June.

Given the variability of other species, there seems little justification for maintaining this at more than varietal rank.

10. *D. violascens* Link. Fig. 45c–e.

Annual or perennial. Culms 16–54cm, erect, or sometimes decumbent. Leaf blades 4–22 × 0.3–0.5cm, linear, acute, glabrous, occasionally with tubercle-based bristles at base above, margins hispid; sheaths glabrous; ligule 1.5–2.6mm. Infl. axis 0.7–2.2cm. Racemes (2–)3–15, erect, the upper digitate, the lower slightly distant, lowest 4–11.2cm; rachis flattened, winged, margins hispid. Spikelets in groups of 3–4, 1.4–1.8 × 0.6–0.75mm, oblong-lanceolate, subacute, pedicels unequal. Hairs verrucose, sometimes hook-tipped. Lower glume absent; upper glume 1.2–1.6 × 0.4–0.6mm, shorter than or almost equalling spikelet, lanceolate, acute or blunt, (2–)3-veined, veins usually

strong, hairy between veins, margins ciliate. Lower lemma equalling spikelet, 1.4–1.8 × 0.6–0.75mm, oblong-lanceolate, subacute, (5–)7-veined, veins ± equally spaced, appressed-hairy between outer veins. Upper floret: lemma yellowish-brown or dark purplish-brown, 1.4–1.8mm, oblong-lanceolate, acuminate; palea 1.3–1.6mm; anthers c.0.5mm.

Bhutan: S — Samchi (Chamarchi Khola) and Gaylegphug (Gaylegphug to Bhur) districts; C — Punakha (Bajo) and Tashigang (below Yadi) districts; **Terai** (Siliguri); **Darjeeling** (Darjeeling); **Sikkim** (Lachung, Gangtok). Sandy river bank; dry bank in chir pine forest; grassland around fields in terai, 300–1830m. May–December.

There appear to be two forms – one with the upper lemma yellowish-brown and upper glume long; the other (typical) with the upper lemma fuscous and upper glume shorter. The Gaylegphug and Bajo specimens are decumbent and mat-forming and appear to be perennial.

11. *D. ischaemum* (Schreber) Schreber ex Muhlenberg. Fig. 45f.

Differs from *D. violascens* in being stouter (leaf blades 3–6.5 × 0.5–0.7cm); racemes inserted along a more elongate axis (1–2cm), the lower ones spreading horizontally at maturity; spikelets larger (over 2mm).

Bhutan: C — Bumthang district (Tangphomrong). Weed of buckwheat, 2600m. August.

Probably introduced recently as a result of Swiss farming activities in Bumthang. The hairs on the only specimen are atypical in having straight (rather than hooked) apices.

12. *D. stricta* Roth ex Roemer & Schultes; *Paspalum royleanum* Nees ex Hook. f. Fig. 45g–h.

Annual. Culms 11–52cm, erect or base sometimes decumbent and rooting from nodes. Leaf blades 9.5–24 × 0.2–0.5cm, linear, very acute, glabrous or sometimes densely hairy, with tubercle-based hairs above, margins hispid; sheaths glabrous or sometimes with weak, spreading bristles; ligule 1.8–2.2mm. Infl. axis 0.5–3.5cm. Racemes (2–)3–12, erect, the upper digitate, the lower slightly distant, lowest 4.3–9cm; rachis narrowly winged, not flattened, margins hispid. Spikelets in groups of 3, 1.3–1.6 × 0.6–0.7mm, elliptic, apiculate, densely hairy; pedicels unequal, hispid, with a corona of long spicules at apex overlapping base of spikelet. Hairs clavate. Lower glume absent; upper glume occasionally absent, 0.4–1.1 × 0.4–0.5mm, shorter than spikelet, rather irregular, ± oblong, blunt, densely clavate-hairy, (2–)3-veined, veins obscure. Lower lemma 1.2–1.5 × 0.6–0.7mm, slightly shorter than spikelet, elliptic, blunt, 3–5-veined, veins ± equally spaced, densely clavate-hairy between veins. Upper floret: lemma dark purplish-brown, 1.3–1.6mm, equalling spikelet, elliptic, apiculate; palea 1.1–1.4mm.

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Bhutan: C — Thimphu (below Motithang) and Punakha (Chusom, Wangdi Phodrang) districts; **Sikkim** (Rishee, Kaysing). Open areas among grassland in blue pine forest; chir pine forest, 1200–2550m. May–October.

13. *D. ternata* (A. Richard) Stapf; *Paspalum ternatum* (A. Richard) Hook. f. Fig. 45i.

Annual. Culms erect, 10–88cm, hairy above. Leaf blades 6.6–33 × 0.4–0.8cm, oblong, acute, base truncate, with few, long hairs scattered above and tuft of long hairs at extreme base above, margins smooth; sheaths glabrous; ligule 1.3–2.3mm. Infl. axis (0–)0.7–3cm. Racemes (2–)3–5, silvery, erect, digitate, the lowest 10–22cm, sometimes slightly distant; rachis flattened, margins hispid. Spikelets in groups of 3–4, 2.2–2.7 × 0.8–1.1mm, lanceolate, acute, densely hairy, hairs overtopping spikelet; pedicels unequal, hispid, with a corona of long spicules at apex overlapping base of spikelet. Hairs clavate. Lower glume absent; upper glume 1.6–2.1 × 0.4–0.7mm, shorter than spikelet, lanceolate, subacute, overtopped by hairs, densely clavate-hairy, 3-veined. Lower lemma 2.2–2.7 × 0.8–1.1mm, equalling spikelet, oblong-lanceolate, acute, overtopped by hairs, 5(–7)-veined, veins ± equally spaced, glabrous either side of midrib, densely clavate-hairy between other veins. Upper floret: lemma dark purplish-brown, 2.1–2.4mm, lanceolate, acute; palea 2–2.3mm; anthers 0.6–0.9mm.

Bhutan: S — Deothang district (Riserboo to Wamrong); C — Punakha (Khuru, Chuzomsa to Samtengang, Lobesa), Tongsa (3km W of Tongsa), Mongar (Lingmethang) and Tashigang (Tashi Yangtshi, above Yadi) districts; **Darjeeling** (Ging). Disturbed, trampled, damp grassy places (roadsides, etc.), 750–2120m. July–October.

There are two rather distinct forms of this species: a large form, with many long racemes; a smaller form with fewer, shorter racemes and shorter leaves. They are probably environmentally induced states.

Doubtfully recorded species:

D. eriantha Stuedel

Recorded (F.E.H.1) under the name of *D. pentzii* Stent for Darjeeling (Rangpo to Tista Bazaar, 350–300m). This African species has been widely introduced as a tropical fodder grass and may well occur, but no specimens have been seen. It differs from any of the above species with large, paired spikelets in being a stoloniferous perennial, with silky-hairy, basal, bladeless scale leaves. Two other African species now included under *D. eriantha* (*D. smutsii* Stent and *D. setivalva* Stent) have been tried for fodder in Bhutan, but seem not to have become established.

D. preslii (Kunth) Henrard

There is an unlocalised record for Bhutan (M.F.B.), but no specimens have been seen. The specimen was most likely to have been a hairy, perennial form of *D. longiflora* under which this species has been sunk by Veldkamp (1973).

D. wallichiana (Wight & Arnott) Stapf.

A single remounted sheet at BM (ex herb. R.H. Beddome) bears a label 'Sikkim'. As this species is only known from S India and Sri Lanka, it seems that there must have been a label switch when the specimen was remounted.

88. PENNISETUM Richard ex Persoon

Rhizomatous perennials or annuals. Culms simple or branched, sometimes prostrate and mat-forming. Leaf blades flat, linear-lanceolate, apex very acute; ligule a fringe of hairs or truncate-ciliate. Infl. terminal and spike-like or concealed in leaf sheaths; if spike-like then cylindrical, with spikelets inserted singly or in groups (to 3 or more) surrounded at base by an involucre of bristles, the whole involucre deciduous, spikelets similar or sometimes some male only, bristles usually unbranched, scabrid or variously hairy, one usually longer than rest. Spikelets lanceolate in outline, florets 2. Lower glume shorter than upper or absent; upper glume commonly lanceolate, usually shorter than spikelet, hyaline. Lower floret usually male; lemma often equalling spikelet, lanceolate-acuminate or oblong with 3-toothed apex (sp. 3), convex, thinly herbaceous, dull; palea oblong, keels usually minutely hispid, back flat, margins inflexed. Upper floret bisexual; lemma and palea similar to lower floret or (sp. 3) whole floret smaller, deciduous, the lemma shining, tightly enclosing the palea. Stamens 3, anthers sometimes with apical tuft of hairs.

1. Mat-forming; infl. hidden within leaf sheaths – only stigmas and stamens emerging **4. P. clandestinum**
+ Not mat-forming; infls. conspicuous, spike-like 2
2. Infl. axis hairy 3
+ Infl. axis glabrous 4
3. Spikelets borne in groups (usually 2–3); lower glume present; involucre bristles pale or purplish; anthers not bearded **2. P. orientale**
+ Spikelets borne singly; lower glume absent; involucre bristles golden; anthers bearded **5. P. purpureum**

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4. Involucral bristles scabrid or occasionally sparsely ciliate near base

1. *P. flaccidum*

+ Involucral bristles woolly, the wool corrugated and concealing the

spikelets 3. *P. pedicellatum*

1. *P. flaccidum* Grisebach. Dz: *jillijum*. Fig. 46a–b.

Perennial; rhizomes long, creeping. Culms 26–200cm, erect, branched near base. Leaf blades 11–44 × 0.2–1.1cm, glabrous or with scattered, long, tubercle-based hairs above, margins sometimes with long cilia at base; sheaths densely long-ciliate on margins and at apex; ligule to 3mm, truncate-ciliate. Infl. whitish, 8–18 × c.1cm, cylindric, axis glabrous; spikelets, sessile, borne singly, or occasionally with a subsidiary, pedicelled, smaller spikelet of two male florets; bristles ascending, scabrid (occasionally sparsely ciliate near base), the longest 13.5–21mm. Spikelets 5.2–7.4mm. Lower glume 1–1.7 × 0.7–1.1mm, oblong to ovate, truncate or irregularly toothed; upper glume 2.3–4.4 × 1.1–1.8mm, oblong-elliptic, acuminate to mucronate (to 0.3mm), usually 3-veined, midrib often purple. Lower floret: lemma 5–7mm, equalling spikelet, lanceolate, finely acuminate, 5–9-veined; palea 3.8–5.6 × 0.7–1.3mm, narrowly lanceolate, apex minutely bifid, occasionally absent; anthers 1.7–3.5mm. Upper floret: lemma 4.8–6.1mm, similar to lower; palea 4.2–5.2 × 0.7–1.4mm, similar to lower; anthers 2–3mm, not bearded.

Bhutan: C — Thimphu (very common in Thimphu and Paro valleys) and Bumthang (Bumthang, Jambelakha) districts. Weed of wheat and other crops; apple orchards; margins of rice-fields, roadsides, 2200–2620m. July–September.

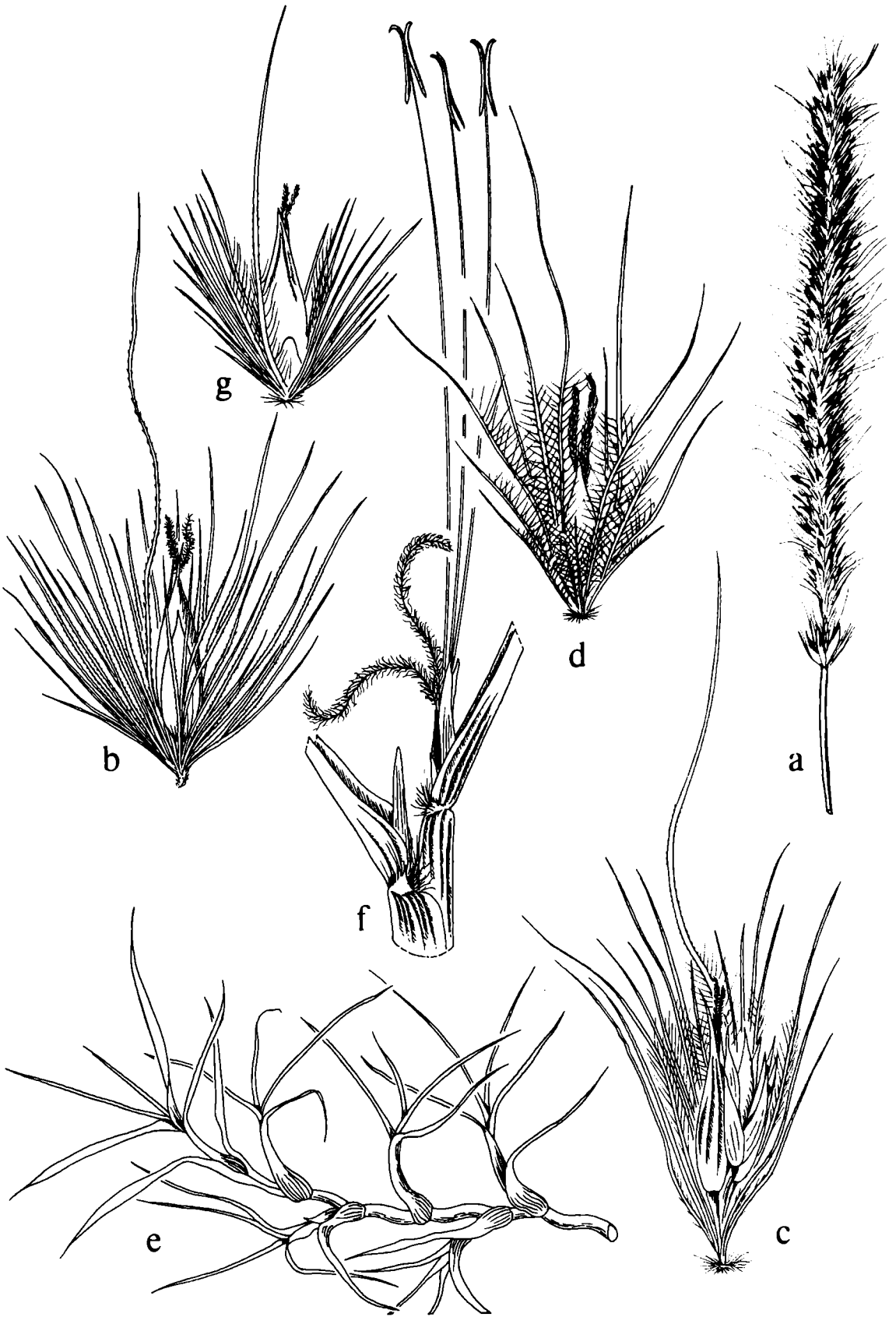
Parker (1992) recorded it as a patchy weed of cereals and other dryland crops and apple orchards.

2. *P. orientale* Richard. Fig. 46c.

Rhizomatous perennial. Culms 24–100cm, erect, branched near base. Leaf blades 10–40 × 0.2–0.8cm, usually with scattered, short, tubercle-based hairs above and beneath and long hairs at extreme base above; sheaths sparsely ciliate on margins; ligule a fringe of hairs 0.4–0.7mm. Infl. purplish, 7–23 ×

FIG. 46.

a–b, *Pennisetum flaccidum*: a, infl. (× 2/3); b, single spikelet subtended by bristles (× 3). c, *P. orientale*: spikelet cluster subtended by bristles (× 3). d, *P. pedicellatum* subsp. *unispiculum*: single spikelet subtended by bristles (× 3). e–f, *P. clandestinum*: e, habit (× 1/2); f, spikelet emerging from leaf sheath (× 3). g, *P. purpureum*: single spikelet subtended by bristles (× 3). Drawn by Louise Olley.



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1–2cm, cylindrical, axis densely, shortly hairy; spikelets borne in groups of (1–)2–3(–6), pedicels 0.6–1.7mm, bristles purple, ascending, with long, tubercle-based cilia (to 3mm), longest bristle 13.2–20mm. Spikelets 4.5–7.7mm. Lower glume 1.6–2.3 × c.0.7mm, oblong to lanceolate, truncate to subacute; upper glume 3–4.7 × 0.7–1.3mm, oblong-lanceolate, finely acuminate, usually 3-veined. Lower floret: lemma 4.5–6.5mm, equalling spikelet, lanceolate, finely acuminate, mucronate (mucro 0.4–1mm), 4–5-veined; palea 3.6–5.5 × 0.7–1mm, narrowly oblong-lanceolate, apex minutely bifid, occasionally absent; anthers c.1.9mm. Upper floret: lemma 4.3–5.6mm, similar to lower; palea 4.1–5.6 × 0.7–1.1mm, narrowly lanceolate; anthers 1.6–2.6mm, not bearded.

Bhutan: C — Punakha (Wangdi Phodrang to Chuzom, Wangdi Phodrang) and Mongar (Lhuntse) districts. Red soil in chir pine forest; rocky bank in dry valley; field edges, 1100–1400m. August–October.

3. *P. pedicellatum* Trinius subsp. *pedicellatum*

Stout, tufted annual. Culms 20–150cm, erect, much branched. Leaf blades 18–30 × 0.6–1cm, with dense, spreading, tubercle-based hairs above and beneath, margins with long cilia at base; margins of sheaths densely short-ciliate; ligule truncate-ciliate, membranous base to 1.2mm, cilia 0.2–1mm. Infl. purplish, 6–13.5 × 1–1.5cm, cylindrical, axis glabrous, with short decurrent wings from scars of fallen involucre; spikelets borne in groups of (1–)3, unequally pedicelled, pedicels 0.8–2.7mm, bristles purple, ascending, with long, woolly hairs which form corrugated masses between the bristles and hide the spikelets, longest bristle 17–25mm. Spikelets 3.3–4.7mm. Lower glume 1–1.8 × 0.3–0.8mm, lanceolate, acuminate, often asymmetrically toothed, long-woolly on back at base, shortly hairy above; upper glume 3.1–4.8 × 1.2–1.8mm, equalling spikelet, oblong-lanceolate, mucronate, 5-veined. Lower floret: lemma c.3.3mm, oblong, apex 3-toothed, 5–7-veined, thinly herbaceous, dull; palea c.2.7 × 0.6mm, narrowly oblong, apex minutely bifid, occasionally absent; anthers c.2mm, not bearded. Upper floret deciduous; lemma 2.2–2.7 × 0.6–1mm, lanceolate, shining, clasping the similar palea.

Bhutan: S — Samchi district (Chamarchi Kholā); **Darjeeling** (Jalapahar (Mukherjee, 1988)). Roadside; sandy river bank, 330m. December.

Possibly introduced.

subsp. *unispiculum* Brunken. Fig. 46d.

Differs from subsp. *pedicellatum* as follows: perennial; spikelets always single within the involucre; lower glume very reduced, apex long-ciliate. The single specimen seen has a dark purple infl.

Bhutan: S — ?Sarbhong district (just above checkpoint, Sarbhong River). Stony banks around millet-fields, 300m. October.

Possibly introduced; there has been a mix up with labels and it is not completely certain that this is the correct locality.

According to Brunken (1979) this subsp. might derive from hybridisation with *P. polystachion* (L.) Schultes. Our specimen resembles this latter species (which might be expected to occur in lower areas) in having smaller, spreading involucre. *P. polystachion* can be distinguished by its singly-borne, sessile spikelets.

4. *P. clandestinum* Hochstetter ex Chiovenda. Eng: *kikuyu grass*; Nep: *hatie dubo*. Fig. 46e–f.

Rhizomatous perennial. Culms much branched, decumbent and rooting at nodes so mat-forming. Leaf blades 3.5–11 × 0.2–0.5cm, apex subacute, glabrous or with few, short, tubercle-based hairs above and beneath; sheaths with sparse or dense, spreading, tubercle-based hairs, margins usually glabrous; ligule a fringe of hairs c.1.2mm. Infls. concealed in upper leaf sheaths, with 2–3 spikelets on short (c.5mm) axis, only stigmas and stamens emerging from top of leaf sheaths. Spikelets whitish, subtended by a tuft of weak bristles, longest bristle c.10mm, scabrid. Spikelets 12.5–17.7mm. Glumes absent in specimens seen (according to Bor the upper sometimes present, to 6mm). Lower floret sterile; lemma 12–15mm, compressed, lanceolate, acute, 9–11 veined, veins strong; palea absent. Upper floret: lemma similar to lower, 12.5–17.7mm; palea similar to lemmas, 12–15mm, 2–4-veined; anthers c.3.2mm, not bearded, bases deeply sagittate.

Bhutan: S — Samchi, Chukka and Deothang districts; **C** — Thimphu, Punakha, Tongsa, Bumthang, Mongar and Tashigang districts; **Sikkim** (Yoksam, Phodong Gompa, Gangtok); **Darjeeling** (Darjeeling to Ghoom). Dry disturbed areas (e.g. roadsides, by railway, field edges); marshy meadow, 500–2600m. July–December.

Native of Africa but widely introduced in warm temperate regions for fodder and stabilising roadsides. In Sikkim first introduced via an experimental grass farm in Gangtok c.1940 (Gould, 1957, pp. 175, 181). First recorded in Bhutan at Tala in 1987 (Miller, 1987c) and rapidly spreading along roads.

Parker (1992) recorded it as useful for cattle fodder and binding paddy banks, but tending to become a weed of annual crops and orchards; occurring in all areas [with cultivation], mainly over 1000m.

5. *P. purpureum* Schumacher. Eng: *elephant grass*, *Napier grass*. Fig. 46g.

Rhizomatous perennial. Culms to 200(–300)cm, erect, branched, branches erect. Leaf blades to 48(–75) × 1.6(–2.5)cm, upper surface rough, glabrous,

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with long, tubercle-based hairs on both sides at extreme base. Sheaths glabrous; ligule a fringe of hairs to 3.5mm. Infl. golden, 14.5(–30) × 1.5cm, cylindric, dense, axis densely, shortly hairy; spikelets borne singly, (according to Bor sometimes with 1–3, subsidiary, pedicelled spikelets), pedicel very short (c.0.2mm), bristles golden, spreading, with slender, white hairs below, longest bristle c.12mm. Spikelets c.5.2mm. Lower glume absent; upper glume c.1.4 × 0.9mm, ovate, subacute, 1-veined. Lower floret: lemma c.4.1mm, equalling spikelet, lanceolate, acuminate, 3-veined, midrib hispid, margins ciliate near apex; palea c.3.7 × 0.9mm, narrowly lanceolate, apex truncate-ciliate; anthers c.1.8mm. Upper floret: lemma c.5.1mm, lanceolate, finely acuminate, 7-veined; palea c.4.7 × 0.9mm, narrowly lanceolate, finely acuminate; anthers c.2.1mm, bearded at apex.

Bhutan: S — Samchi district (Samchi); C — Punakha (Lobesa) and Mongar (Lingmethang) districts; **Sikkim** (Mangan). Improved pasture, becoming naturalised (e.g. field margins), 460–1460m. July–September.

Native of Africa, but widely introduced for fodder. Introduced to Sikkim via an experimental grass farm in Gangtok c.1940 (Gould, 1957, p. 181). Introduced more recently in Bhutan (see Chhetri *et al.*, 1987).

Doubtfully recorded species:

Eriochloa procera (Retzius) C.E. Hubbard.

A single remounted specimen at BM (ex herb. R.H. Beddome) bears a label 'Sikkim'; as no other specimens seen it seems very doubtful and the label was probably switched when the specimen was remounted. It differs from any other of our Panicoid grasses in having the spikelet borne on a narrow, collar-like structure borne on the apex of the pedicel.

Alloteropsis semialata (R. Brown) Hitchcock

Recorded for Sikkim in F.B.I., but no specimens have been seen, although a possibility on distributional grounds. A densely tufted perennial; the upper glume with stout, marginal bristles and the thinly coriaceous upper lemma is awned.

Tribe XVI. ISACHNEAE Bentham

1. Upper floret ± sessile; at least the upper lemma crustaceous **89. Isachne**
+ Upper floret distinctly pedicelled; lemmas not crustaceous **90. Coelachne**

89. ISACHNE R. Brown

Usually perennial. Leaf blades flat, linear; ligule a fringe of hairs. Infl. a lax, pyramidal panicle, primary branches inserted singly, spikelets borne singly. Spikelets deciduous, glumes and florets falling separately, bi-convex, florets 2; pedicels slender, glandular or eglandular. Glumes shorter than, to slightly exceeding spikelet, convex on back, herbaceous, margins inflexed, usually hyaline; lower 7-veined; upper sometimes slightly wider, 7-9-veined. Lower floret male; lemma about equalling upper lemma, herbaceous or crustaceous, margins clasping edge of palea; palea flat, similar in texture to lemma, narrower. Upper floret very shortly stalked, bisexual; lemma crustaceous, back convex, margins inflexed, clasping edge of palea; palea coriaceous, back flat, similar in shape to lemma, margins inrolled, widened into flaps in middle; stamens 3.

- | | |
|---|--------------------------|
| 1. Florets differing in texture, the lower herbaceous, the upper crustaceous | 3. I. globosa |
| + Florets both crustaceous | 2 |
| 2. Pedicels with glandular (usually pale coloured) bands | 4. I. himalaica |
| + Pedicels eglandular | 3 |
| 3. Spikelets to 1.8mm; glumes usually with a few apical hairs; panicle large | 1. I. albens |
| + Spikelets 2mm or more; glumes glabrous or hispid all over; panicle small | 4 |
| 4. Leaf blades hairy; glumes subequal, glabrous | 2. I. sikkimensis |
| + Leaf blades glabrous; glumes unequal, the upper much wider than lower, hispid | 5. I. dimyloides |

1. **I. albens** Trinius; *I. clarkei* Hook. f., p.p (Sikkim plants). Lep: *tza duk*. Fig. 47a-b. Plate 7.

Perennial, usually robust. Culms 12-60(-130)cm, branched, erect or decumbent at base. Leaf blades (3-)4.5-27 × (0.3-)0.4-2.4cm, oblong to narrowly lanceolate, acute, hispid on both surfaces and margins, veins conspicuous beneath; sheath margins ciliate; ligule hairs 0.5-1mm. Infl. (5-)9-32cm, 5-23cm wide at anthesis, very lax, branched to 3 orders. Spikelets 1.2-1.8mm; pedicels eglandular. Lower glume 1.2-1.8mm, equalling spikelet (occasionally slightly longer), back narrowly elliptic, bluntly acuminate, minutely hispid at apex, (5-)7-veined, herbaceous, sides inflexed, hyaline;

upper glume similar to lower, slightly wider and shorter (1.1–1.6mm). Lower floret: lemma cream, 1.1–1.7 × 0.6–0.9mm, oblong-elliptic, blunt, usually minutely hispid near apex, crustaceous, shining; anthers 0.5–0.9mm. Upper floret: lemma 1–1.4 × 0.6–0.8mm, elliptic, hairy at least on margins, crustaceous; anthers c.0.4mm.

Bhutan: S — Phuntsholing (Gedu to Kharbandi), Chukka (below Chimakothi, 2km N of Jumudag, Gedu) and Deothang (Riserboo to Wamrong) districts; C — Punakha (c.8km above Wacha, Lometsawa to Menhuanang), Tongsa (below Tongsa), Mongar (Namning) and Tashigang (Yondiri Bridge) districts; **Darjeeling** (Darjeeling, Kurseong, Sureil, Rungbee, Rangirun); **Sikkim** (S of Rabangla, Lachen, Lachung, Karponang, between Mintok and Paha Kholas, Rishee, Gangtok). Damp, shady broad-leaved forest (incl. *Schima* and evergreen oak); open marsh in scrub, 1500–2590m. July–February.

For note on *I. clarkei* see under *I. sikkimensis*.

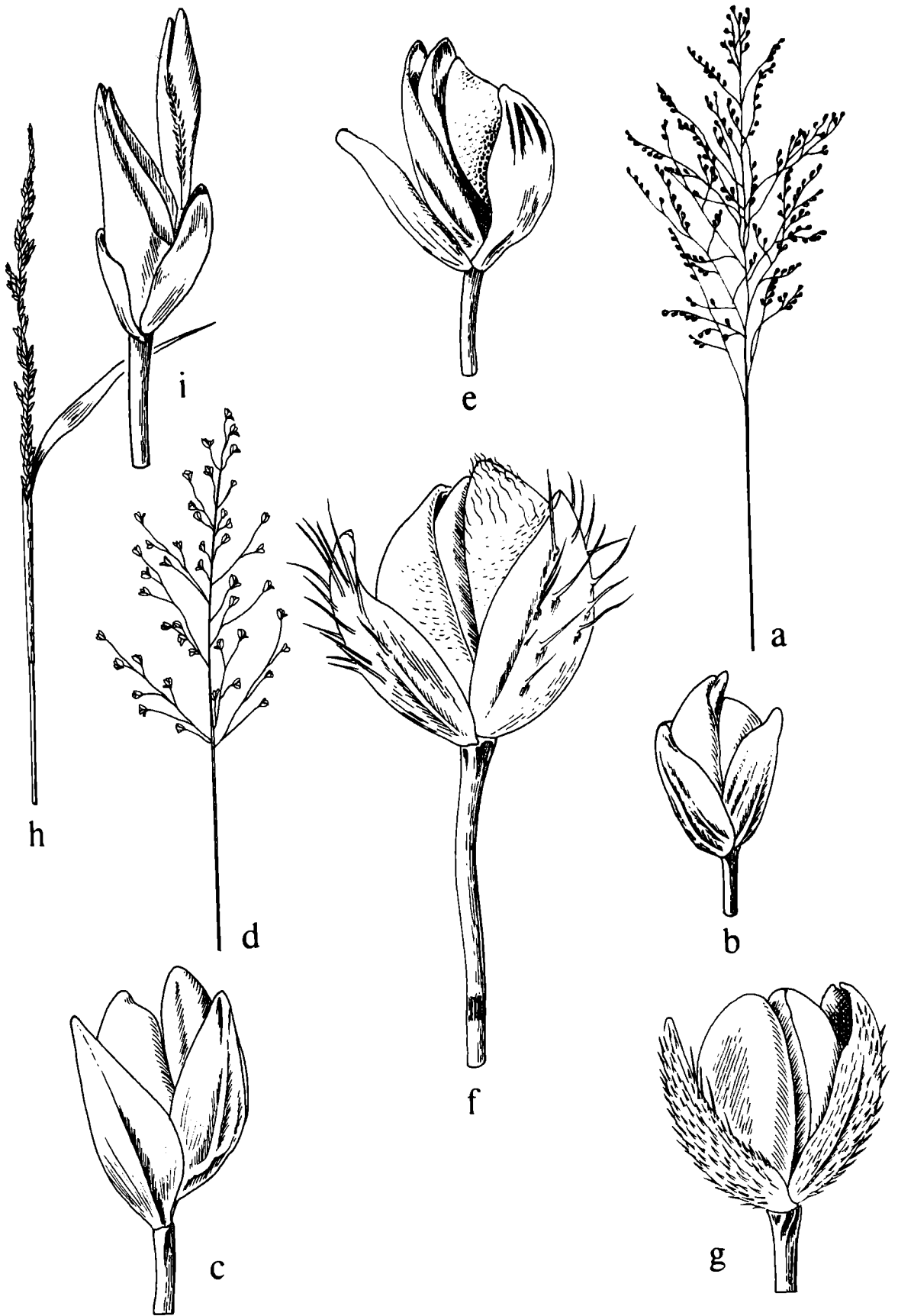
2. *I. sikkimensis* Bor. Fig. 47c.

Slender perennial. Culms 10–25cm, base decumbent and rooting from nodes. Leaf blades 2.4–7.5 × 0.4–0.7cm, narrowly lanceolate, acute, densely covered on both surfaces with spreading, tubercle-based hairs; sheaths with spreading hairs or glabrous, margins ciliate above; ligule hairs 1.3–1.5mm. Infl. 5.3–8cm, 3.5–4.5cm wide at anthesis, branched to 2 orders. Spikelets 2–2.5mm; pedicels eglandular. Lower glume 1.8–2.5mm, shorter, to slightly longer than, spikelet, back oblong-elliptic, bluntly apiculate, glabrous, 7(–9)-veined, herbaceous, sides inflexed, hyaline; upper glume similar to lower. Lower floret: lemma cream, 1.6–1.8 × 0.7–1mm, oblong-elliptic, blunt, glabrous or sometimes minutely hispid, crustaceous, shining; anthers 0.5–0.9mm. Upper floret: lemma 0.9–1.7 × 0.5–0.9mm, similar to lower, but narrower, glabrous or sometimes minutely hairy, crustaceous; anthers c.0.5mm.

Bhutan: C — Thimphu district (Thimphu Valley); **Darjeeling** (Ghoom to Tiger Hill, Senchal); **Sikkim** (Fambong Lho, Karponang, Lachung). Damp turf by stream; damp grassy places by path in degraded evergreen oak forest; roadside, 2100–2730(–3350)m. July–August.

FIG. 47.

a–b, *Isachne albens*: a, infl. (× 1/3); b, spikelet (× 16). c, *I. sikkimensis*: spikelet (× 16). d–e, *I. globosa*: d, infl. (× 2/3); e, spikelet showing florets of different textures (× 16). f, *I. himalaica*: spikelet showing glandular pedicel (× 16). g, *I. dimyloides*: spikelet (× 16). h–i, *Coelachne simpliciuscula*: h, infl. (× 2/3); i, spikelet (× 16). Drawn by Louise Olley.



XVI. ISACHNEAE

When Bor described *I. sikkimensis* he included specimens from Sikkim that were syntypes of Hooker's *I. clarkei*, thereby restricting the use of the latter name to Clarke collections from the Naga Hills. The Lachung specimens, however, differ from the type of *I. sikkimensis* and are merely a dwarf state of *I. albens*.

3. *I. globosa* (Thunberg) Kuntze; *I. miliacea* Roth; *I. australis* R. Brown; *I. dispar* Trinius. Fig. 47d–e.

Slender perennial. Culms 10–25cm, base decumbent and rooting from nodes. Leaf blades 1.5–3.6 × 0.3–0.6cm, lanceolate, subacute, hispid on both surfaces and margins; sheaths glabrous, margins ciliate; ligule hairs 0.8–1.2mm. Infl. 2–6cm, 1.5–4cm wide at anthesis, branched to 2 orders, branches with glandular bands. Spikelets 1.7–2.1mm; pedicels with glandular bands. Lower glume 1.4–1.8mm, shorter than spikelet, narrowly oblong-elliptic, bluntly apiculate, glabrous, or with short bristles, obscurely 7-veined, herbaceous, sides not inflexed, very narrowly hyaline; upper glume wider than lower. Lower floret: lemma 1.6–1.9 × 0.9–1mm, oblong-elliptic, weakly convex, blunt, glabrous, thinly herbaceous; anthers 1–1.4mm. Upper floret: lemma 1.4–1.5 × 1–1.2mm, elliptic, strongly convex, glabrous or hairy, crustaceous.

Bhutan: S — Samchi (Samchi to Chengmari), Chukka (Khurul Pokhari 3km W of Kalikhola) and Gaylegphug (Gaylegphug) districts; C — Tongsa district (25km N of Shemgang); **Terai** (Jalpaiguri, Dulkajhar). Wet places (among jute, swamps, by pool in forest, marsh by roadside), 90–1325m. May–October.

4. *I. himalaica* Hook. f. Fig. 47f.

Resembles *I. globosa* in infl. shape, glandular pedicels and spikelet size, but differs as follows: plant stouter (culms to 50cm); vegetative shoots very stiff; leaf blades linear (to 6cm); glumes wider (widely elliptic, sometimes bristly); lower floret crustaceous.

Bhutan: C — Thimphu (Damgi near Paro, Isuna, near Drukyel Dzong) and Punakha (near Lobesa) districts. Banks of rice paddy; marsh in open bushland; edge of shallow pool, 1300–2580m. July–October.

5. *I. dimyloides* Bor. Fig. 47g.

Slender perennial. Culms 15–25cm, base decumbent and rooting from nodes. Leaf blades 2–3.2 × 0.5–0.8cm, lanceolate, subacute, glabrous, midrib conspicuous beneath; sheaths glabrous, margins ciliate; ligule hairs 1–2mm. Infl. 1.7–2.4cm, 1–1.5cm wide at anthesis, compact, branched to 2 orders. Spikelets c.2mm; pedicels relatively stout, hispid on angles, eglandular. Lower glume c.2mm, equalling spikelet, narrowly oblong-elliptic, blunt, hispid, 7-veined, herbaceous, sides inflexed, very narrowly hyaline; upper glume

obovate, conspicuously wider than lower, hispid. Lower floret: lemma c.1.7 × 1.3mm, compressed, elliptic, blunt, hairy on margins, crustaceous. Upper floret similar to lower, but minutely hairy on back.

Terai (Dulkajhar). Habitat not recorded, 150m. October.

Known only from the type.

90. COELACHNE R. Brown

Slender rhizomatous ?perennial. Leaf blades flat, lanceolate; ligule a fringe of hairs. Infl. a linear panicle, primary branches short, congested, erect, spikelets borne singly or in pairs. Spikelets gaping, deciduous, glumes and florets falling separately, florets 2, sessile or on slender pedicels. Glumes shorter than spikelet, herbaceous, margins widely hyaline; lower 3-veined; upper wider, 5-veined. Lower floret bisexual, larger than upper; lemma convex, thinly herbaceous, margins narrowly inflexed; palea flat, similar in texture and shape to lemma, narrower; stamens 3. Upper floret stalked and exerted, female; lemma hyaline; palea similar in shape to lemma, hyaline.

1. **C. simpliciuscula** (Steudel) Bentham; *C. pulchella* sensu F.B.I. var. *simpliciuscula* Steudel. Fig. 47h-i.

Mat-forming. Culms 5–20cm, erect or decumbent, nodes hairy. Leaf blades 0.7–2.8 × 0.1–0.5cm, lanceolate, subacute, glabrous; sheaths glabrous; ligule hairs 0.1–0.6mm. Infl. purplish, 2–7.5cm. Spikelets 2.3–2.7mm. Lower glume 0.9–1.2 × 0.8–1mm, ovate, convex, blunt, glabrous, 3-veined, herbaceous, margins widely hyaline; upper widely ovate, truncate, glabrous, 5-veined. Lower floret: lemma 2–2.3 × 1.2mm, lanceolate, subacute, glabrous or minutely hairy on back; palea 1.9–2.3 × 0.9–1mm, lanceolate, truncate, glabrous, hyaline; anthers c.0.5mm. Upper floret: stipe 0.6–0.8mm; lemma 1.6–1.7 × 0.8mm, lanceolate, blunt, hairy on back and margins, hyaline; palea similar to lemma.

Bhutan: S — Chukka district (Bunakha); C — Thimphu (Simtokha to Dochu La), Punakha (Tinlegang to Lometsawa, Rimchu) and Tashigang (Yondiri Bridge) districts; **Sikkim** (Gangtok (F.E.H.1)). Marshes in forest clearings (including pine), 1300–2700m. June–October.

Tribe XVII. ARUNDINELLEAE Stapf

1. Spikelets with two florets **91. Arundinella**
 + Spikelets with one floret **92. Garnotia**

91. ARUNDINELLA Raddi

Perennials; rhizomes commonly short, so plant tufted. Culms erect, simple or branched. Leaf blades \pm linear, flat; ligule a short, truncate, membranous rim, with fringe of long cilia behind at base of blade. Infl. paniculate, branches inserted singly or \pm whorled; spikelets borne in unequally pedicelled pairs. Spikelets lanceolate, gaping, slightly laterally compressed, florets 2, the upper early deciduous, the lower \pm persistent. Glumes persistent, thickly herbaceous; the lower lanceolate, acuminate, 3-veined; the upper longer-acuminate, 5-veined. Lower floret male or sterile; lemma oblong-lanceolate, compressed laterally at apex, 3-veined, herbaceous; palea oblong-lanceolate, acuminate, hyaline, back flat, margins inflexed, widened into flaps near base. Upper floret bisexual; lemma narrowly lanceolate, minutely hispid, thinly coriaceous, margins incurved, with or without geniculate awn, if awned, then awn sometimes flanked by 2 setae; palea similar in shape to lower palea, but back coriaceous.

1. Upper lemma with stout awn over 3.4mm 2
+ Upper lemma with weak (often deciduous) awn to 2.7mm, or awnless..... 4
2. Glumes with long, tubercle-based bristles 1. **A. hookeri**
+ Glumes glabrous (hispid on keels) 3
3. Upper lemma with apical setae either side of awn; spikelets over 5.5mm 5. **A. setosa**
+ Upper lemma lacking apical setae; spikelets to 5.3mm .. 6. **A. nepalensis**
4. Glumes glabrous; plant massive (culms to 2m or more, 3–5mm wide at apex) 3. **A. decempedalis**
+ Glumes hispid; plant not massive (culms to 1m, 1–3mm wide at apex) 5
5. Lower glume shorter than lower lemma; spikelets to 3.5mm 2. **A. bengalensis**
+ Lower glume longer than lower lemma; spikelets 3.5–4mm 4. **A. dagana**

1. **A. hookeri** Munro ex Keng; *A. villosa* Arnott ex Steudel var. *himalaica* Hook. f. Eng: *false cock's-foot* (Miller, undated). Fig. 48a–b.

Tufted; rhizomes short. Culms 12–75cm. Leaf blades 2.6–13 \times 0.3–0.5cm, narrowly triangular, widest at base, acute, densely covered with spreading, tubercle-based hairs above and beneath; sheaths hairy; ligule c.0.5mm, minutely fimbriate, with fringe of long cilia behind. Infl. dark purplish, 3.2–16.5cm, pyramidal to cylindric, angles of axis shortly ciliate, branches

5–16, stiff, inserted singly, long ciliate at base, lower distant, upper crowded, spreading at anthesis, the lowest 1–3.5cm, spikelets borne on lower side of branches. Spikelets 4.6–5.5mm; pedicels with long bristles. Glumes covered with long (1.2–1.6mm), tubercle-based bristles; the lower 3.6–4.6mm; the upper 4.6–5.3mm. Lower floret: lemma 3.8–4.3 × 0.8–1mm, abruptly acuminate to blunt, laterally compressed apex; palea 3–3.5 × 0.8–1mm; anthers 1.4–2mm. Upper floret: callus long-ciliate; lemma 2.5–2.8 × 0.5–0.8mm, acute, minutely hispid, awn 1.1–1.7 + 1.7–2.9mm; palea 2.4–2.8mm; anthers c.2mm.

Bhutan: C — Thimphu, Punakha, Tongsa, Bumthang, Mongar, Tashigang and Sakden districts; N — Upper Mo Chu district (Tamji to Goen Gaza); **Darjeeling** (Dumsong, Darjeeling, Lepcha Jogat); **Sikkim** (Lachen, Lachung, Bakhim, near Yoksam); **Chumbi**. Common in temperate and alpine zones: meadows and grassy places (e.g. roadside, apple orchard); *Quercus semecarpifolia* scrub; open bank in oak forest, 1829–3660m. June–October.

Not very palatable to livestock, so becoming commoner in over-grazed pastures.

2. A. bengalensis (Sprengel) Druce; *A. wallichii* Nees ex Steudel. Nep: *phurki*, *darkharey*. Fig. 48c. Plate 8.

Rhizomes creeping. Culms 50–100cm, 1–3mm wide at apex. Leaf blades 6–32 × 0.5–1.2cm, lanceolate, acute, densely covered with semi-appressed, tubercle-based hairs above and beneath or glabrous; sheaths hairy or glabrous, margins densely ciliate; ligule a minute rim (c.0.2mm), cilia of fringe 1.5–6mm. Infl. dark purplish, 6.5–28cm, densely cylindric, angles of axis hispid, branches stiff, numerous, spirally inserted or subwhorled, spreading at anthesis, the lowest 1–7cm, slightly distant; spikelets borne on lower side of branches. Spikelets 2.9–3.5mm; pedicels hispid. Lower glume 1.9–2.8mm, usually glabrous, sometimes with a few, short bristles, veins hispid; upper glume 2.7–3.3mm, usually with short (0.3–0.5mm) bristles between veins, sometimes glabrous. Lower floret: lemma 2.6–3 × 0.6–0.8mm, acute; palea 2–2.7 × 0.6–0.7mm; anthers 0.8–1.6mm. Upper floret: callus shortly ciliate; lemma 1.9–2.1 × 0.3–0.6mm, truncate, minutely hispid, awn usually absent, a weak one sometimes present in some spikelets within an infl., 0.5–0.8 + 0.6–0.7mm; palea 1.7–2mm; anthers 0.8–1.2mm.

Bhutan: S — Samchi (Daina Khola, Chamarchi Khola), Phuntsholing (c.10km N of Phuntsholing) and Gaylegphug (Bhur) districts; C — Punakha (Wangdi Phodrang, Chuzomsa to Samtengang, 1km N of Punakha Dzong), Tongsa (Tongsa) and Tashigang (Kanglung to Tashigang) districts; **Terai** (Bamunpokri, Jalpaiguri); **Darjeeling** (Kurseong to Punkabari, Rangit,

Lebong). Common in subtropical zone: disturbed places (margins of paddy-fields, roadsides, river bank); open hillsides; chir pine forest, 90–1920m. July–November.

3. **A. decempedalis** (Kuntze) Janowski; *A. clarkei* Hook.f. Nep: *phurki*. Fig. 48d.

Differs from *A. bengalensis* in being much taller and stouter (culms to 2m or more, 3–5mm wide at apex); leaf blades to 2cm wide; infl. larger (37–67cm), branches more obviously whorled, the longest 12–31cm, sometimes again branched; spikelets longer ((3.2–)3.6–4.2mm), glabrous; lower lemma commonly 5(–7)-veined; if weak awn present on upper lemma, then larger (0.9–1.2 + 0.8–1.5mm).

Terai (Jalpaiguri, Bamunpokri, Dulkajhar, Sivok, between Gareedora and Kuprail). Savannah, 90–305m. October–December.

No recent collections seen.

4. **A. dagana** Noltie. Fig. 48e.

Like a small, but robust, densely hairy form of *A. bengalensis* from which it differs as follows: spikelets larger (3.5–4mm); lower glume larger (3–3.2mm), bristly, exceeding lower lemma; upper glume larger (3.2–3.8mm); lower floret smaller (lemma 2.5–3 × 0.6–0.8mm; palea 1.7–1.9mm); upper lemmas of all spikelets with an exserted, non-deciduous awn (0.8–1 + 1.3–1.5mm); anthers smaller (0.7–0.9mm).

Bhutan: S — Sankosh district (Daga Dzong). Grassy banks around fields, 1600m. August.

Apparently endemic to Bhutan.

5. **A. setosa** Trinius. Fig. 48f.

Tufted; rhizomes short, woody. Culms to 1m, slender. Leaf blades to 10.5

FIG. 48.

a–b, **Arundinella hookeri**: a, infl. (× 2/3); b, spikelet (× 8). c, **A. bengalensis**: spikelet (× 8). d, **A. decempedalis**: spikelet (× 8); e, **A. dagana**: spikelet (× 8). f, **A. setosa**: spikelet (× 8). g–h, **A. nepalensis**: g, infl. (× 1/4); h, spikelet (× 8). i–k, **Garnotia polyogonoides**: i, infl. (× 2/3); j, spikelet (× 4); k, spikelet (awns chopped) showing apical setae of lemma and twisted awn base (× 12). l–m, **G. acutigluma**: l, spikelet (× 4); m, spikelet (awns chopped) showing untwisted awn base (× 12). Drawn by Louise Olley.



× 0.4cm, oblong, acute, densely covered with slender, spreading, tubercle-based hairs above and beneath; sheaths hairy; ligule short, c.0.5mm, truncate-fimbriate. Infl. purplish-brown, 11–15.5cm, lax, angles of axis smooth, branches 8–9, slender, ascending, inserted singly, the lowest 7.5–9cm; spikelets erect. Spikelets 5.6–6.5mm; pedicels to 3.5mm, slender, with a few long cilia at apex. Lower glume 3.6–4.4mm, glabrous, veins hispid; upper glume 5.3–6mm, drawn into very long point, glabrous. Lower floret: lemma 3.2–3.4 × 0.7–0.8mm; palea 2.7–3.1 × 0.6–0.7mm. Upper floret: callus long ciliate; lemma 2.1–2.2 × 0.5mm, narrowly lanceolate, minutely hispid, at apex drawn into two fine setae (2–2.8mm) either side of stout awn, awn 2.3–2.7 + 4.6–6.2mm; palea 2.1–2.3mm; anthers c.1.5mm.

Bhutan: C — Mongar (between Mongar and the Kuru Chu) and Tashigang (near Yadi) districts. Dry hill-slope with scrub; chir pine forest, 1200–1500m. September–October.

6. *A. nepalensis* Trinius. Fig. 48g–h.

Tufted; rhizomes short, woody. Culms to 1.5m, slender or stout, sometimes branched. Leaf blades very variable, 18–33 × 0.3–2.1cm, oblong, gradually narrowed to very acute apex, glabrous or densely covered with slender, spreading, tubercle-based hairs above and beneath, in narrow forms, blades becoming inrolled; sheaths glabrous, or occasionally hairy, margins ciliate; ligule short, truncate, minutely fimbriate, c.0.2mm. Infl. purplish, 15–45cm, rather densely cylindrical, angles of axis minutely hispid, branches numerous, ± whorled, slender, ascending, the lowest 3.5–16cm, sometimes again branched; spikelets erect. Spikelets (3.6–)4–5mm; pedicels to 3mm, slender, hispid. Lower glume (2.6–)2.9–3.4mm, glabrous, veins hispid; upper glume (3.4–)3.8–4.8mm, glabrous. Lower floret: lemma (2.3–)2.7–3.6 × 0.6–1mm; palea (2–)2.2–3 × 0.4–0.9mm; anthers c.1.6mm. Upper floret: callus long ciliate; lemma (1.7–)1.8–2.5 × 0.3–0.5mm, narrowly lanceolate, acute, minutely hispid, awn 1.2–2.1 + 2.2–3.3mm; palea (1.5–)1.7–2.5mm; anthers 0.7–1.1mm.

Bhutan: S — Samchi (Dorokha forest (M.F.B.)), Chukka (3km S of Chimakothi, 8km S of Chukka, 3km W of Kalikhola), Sarbhang (Sarbhang to Toribari, Phipsoo) and Deothang (Samdrup Jongkhar to Deothang) districts; C — Tongsa (Tongsa, Shemgang), Mongar (between Mongar and the Kuru Chu) and Tashigang (Rangthangwoong to Tashigang, 2km from Kanglung towards Tashigang) districts; **Darjeeling** (Dumsong, Rangit); **Sikkim** (Lachung, Changachelling, Gangtok, Soke, Chakung, below Rumtek). Very common in warm parts in damp, rocky places (banks, cliffs, by water-courses) in open, or among scrub, 200–1920m. October–February.

Extremely variable in stature, hairiness of leaf blades and sheaths, and degree of

compactness of the infl. A form common in E Bhutan (Tongsa, Tashigang and Deothang districts) has smaller panicles, and the infl. axis with hispid angles. It often grows on rocks and occurs to higher altitudes (1950–2400m) than the normal form. These specimens can, perhaps, be referred to *A. intricata* Hughes, but it is doubtful if this is worthy of specific rank.

92. GARNOTIA Brongniart

Slender, tufted annuals or perennials. Culms erect, simple. Leaf blades \pm linear, flat, becoming inrolled; ligule short, membranous, truncate-ciliate. Infl. paniculate, branches inserted singly, suberect, spikelets borne in unequally pedicelled pairs. Spikelets falling entire, subtended by stiff hairs, narrowly lanceolate, floret 1. Glumes thinly herbaceous; the lower oblong-lanceolate, convex, acute, usually awned, 3-veined; the upper similar or slightly longer, back \pm flat, awn sometimes longer. Floret bisexual; lemma shorter than or about equalling longer glume, oblong-lanceolate, convex, acute to deeply bidentate, with terminal awn, herbaceous, awn straight and terete, or geniculate, with the lower part flat and twisted; palea oblong-lanceolate, acute, hyaline, back flat, margins inflexed, widened into flaps near base.

Superficially similar to *Muhlenbergia* which differs in having laxer infls., the spikelets not subtended by stiff hairs and persistent glumes.

1. Awns of glumes long (that of lower 9.5–14mm); apex of lemma with two setose points (0.7–1.9mm) either side of awn; callus hairs long
1. G. polypogonoides
- + Awns of glumes short (that of lower 0.2–1.5mm); apex of lemma shallowly bifid (points to 0.5mm); callus hairs short 2
2. Awn of lemma not geniculate, lower part not twisted .. **2. G. acutigluma**
- + Awn of lemma geniculate, lower part twisted **3. G. tenella**

1. G. polypogonoides Munro ex Oliver; *G. emodi* sensu Bor, ?non (Arnott & Nees) Janowski. Fig. 48i–k.

Culms 10–30cm, slender, nodes glabrous. Leaf blades 11–21 \times 0.15–0.6cm, linear, becoming inrolled, gradually narrowed to very acute apex, with scattered, spreading, bristle-like, tubercle-based hairs above (especially at base and near margins) and in a line each side of midrib beneath; sheaths with spreading tubercle-based hairs, appressed-hairy at apex; ligule c.0.2mm. Infl. purplish, 5–13cm (excl. awns), lanceolate in outline, lowest branch 1.5–6cm (excl. awns), sometimes again branched. Spikelets 5–5.6mm (excl. awns); callus hairs 1.3–1.5mm. Lower glume 3.1–4.6mm (to tip of awn),

narrowly lanceolate, gradually narrowed into awn, veins 2(-3), keel minutely hispid, awn 9.5–14mm; upper glume 5–5.6mm, similar to lower, 3-veined, awn 10–22mm. Floret: lemma dark purplish-brown, 2.8–3.6 (to base of setae) \times c.0.5mm, linear-lanceolate, narrowed to 2 long apical setae 0.7–1.6mm, lower part of awn 1.7–2.1mm, flat, twisted, brown, upper part 14–25mm; palea 2.8–3.1 \times 0.3–0.5mm, linear-lanceolate; anthers 1.3–1.5mm.

Bhutan: S — Chukka district (c.1km S of Awaka); C — Thimphu (Drukyel Dzong), Punakha (Wacha to Nobding), Bumthang (near Thangbi) and Mongar (Yonko La to Namning) districts; **Sikkim** (Neebay, Chungthang, Gangtok, Ratong River). Cliffs and rock-ledges in blue pine and cool broad-leaved (incl. oak) forest, 1700–2730m. September–October.

The type of *G. emodi* (Royle 33) cannot be found, and there is doubt as to the identity of the plant from its protologue; Gould (1972) therefore recommended using the later name.

2. *G. acutigluma* (Steudel) Ohwi; *G. stricta* sensu F.B.I. and Bor, non Brongniart; *G. himalayensis* Santos; *G. himalayensis* var. *sikkimensis* Santos; *G. khasiana* Santos f. *mucronata* Santos. Fig. 481–m.

Culms 12–35cm, nodes hairy. Leaf blades 3.5–12 \times 0.3–1.1cm, lanceolate, with short, scattered, spreading hairs above, glabrous beneath; sheaths glabrous, appressed-hairy at apex, margins ciliate; ligule 0.4–0.6mm. Infl. greenish, 11–18cm (excl. awns), lanceolate in outline, lowest branch 4.5–5.5cm (excl. awns), much branched at base. Spikelets 3.2–4.1mm (excl. awns); callus hairs 0.3–0.9mm. Lower glume 3.1–4.1mm (to base of awn), narrowly lanceolate, apex very acute or minutely bifid and shortly awned, veins 3, hispid, awn 0.2–1.5mm; upper glume 3.2–3.8mm, similar to lower, 3-veined, veins hispid only near apex, awn 0.3–2.3mm. Lemma 3.2–3.9 (to base of awn) \times c.0.5mm, linear lanceolate, narrowed to apex, awn purplish, 6.7–14.5mm, not geniculate, terete to base, sometimes weakly twisted below; palea 2.5–3.1 \times 0.3–0.5mm, linear-lanceolate; anthers 0.7–1.1mm.

Bhutan: S — Phuntsholing (above Phuntsholing, Gedu to Kharbandi) and Deothang (N of Deothang) districts; **Darjeeling** (Darjeeling, Rishap, Kurseong); **Sikkim** (Rungbee, Yoksam). Cliffs in warm broad-leaved forest, 910–1830m. August–November.

3. *G. tenella* (Arnott ex Miquel) Janowski

Differs from *G. acutigluma* in having the majority of the lemmas within the infl. with strongly geniculate awns, the lower part strongly twisted, usually brown, the upper part paler.

Bhutan: C — Punakha (12km below Nobding), Tongsa (4km E of Tashithingkha) and Mongar (Yonko La to Namning) districts; **Darjeeling**

(Darjeeling, Sureil, Kurseong). Cliff-ledges in cool broad-leaved (incl. oak) forest, 1520–2340m. September–October.

Doubtfully distinct from *G. acutigluma*, differing only in the twisted base to the geniculate lemma awn; however in some specimens this character varies even within a single infl. Gould (1972) gave the habit as differing: annual in *G. tenella*, perennial in *G. acutigluma*, but the *G. acutigluma* specimens from our area seem to be annual.

Tribe XVIII. ANDROPOGONEAE Dumortier

Due to the size of this tribe, the key to genera has been broken down into five sections, based on infl. type, in order to make it easier to use.

INFL. TYPE 1 (e.g. Fig. 64)

Racemes of two types (dimorphic), predominantly unisexual

1. Infl. mixed, a compound panicle; the short male racemes emerging from the mouth of a white or grey, swollen utricle, which completely conceals the female spikelets **125. Coix**
- + Infl. clearly separated into two parts: a terminal panicle of male racemes and lateral spike-like racemes of at least predominantly female spikelets **2**
2. Cultivated annual; female raceme with massive axis, floral parts very reduced, revealing large ovary **123. Zea**
- + Wild plants; female raceme with slender axis, floral parts well developed, concealing small ovary **124. Polytoca**

INFL. TYPE 2 (e.g. Fig. 49a, Fig. 51a)

Panicle plumose, callus (and/or internodes) with long, soft hairs, sometimes very narrow and spike-like; racemes inserted along a distinct axis

1. Racemes longer than infl. axis **2**
- + Racemes shorter than infl. axis **3**
2. Callus long-hairy **95. Miscanthus**
- + Callus short-hairy, long hairs borne on internodes and glumes
97. Eulalia fastigiata

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3. Infl. obviously compound, the racemes evident though sometimes appressed **94. Saccharum**
 + Infl. spike-like, the racemes not obvious, concealed by long hairs from callus and back of glumes **96. Imperata**

INFL. TYPE 3 (e.g. Fig. 57)

Panicle much branched, the nodes subtended by bladeless bracts (spathes and spatheoles)

1. Racemes borne singly; plants never aromatic 2
 + Racemes borne in pairs, or occasionally clusters (digitate); plants usually aromatic **111. Cymbopogon**
2. Raceme reduced to a single triad, subtended by a boat-shaped spathe (one of pedicelled spikelets very reduced); spikelets small ... **110. Apluda**
 + Raceme with two basal pairs of awnless, male spikelets and an awned terminal triad (sometimes with an additional spikelet pair); spikelets large **115. Themeda**

INFL. TYPE 4 (e.g. Fig. 54c)

Terminal infl. a cluster of \pm digitately arranged racemes (sometimes only 2, the 2 sometimes appressed and appearing as one); lateral infls. sometimes also present

1. Pedicelled spikelet lacking (pedicel present or absent) 2
 + Pedicelled spikelet present (sometimes reduced and consisting only of glumes) 3
2. Sessile spikelet unawned **101. Apocopis**
 + Sessile spikelet awned **113. Arthraxon** p.p.
3. Spikelets awnless; lower glume of sessile spikelet with prominent, green transverse veinlets just below apex; raceme internodes swollen above **100. Microstegium vimineum** (some forms)
 + At least sessile spikelet awned; lower glume of sessile spikelet lacking green, transverse veinlets; raceme internodes not swollen above (if wider above, then flat) 4
4. Pedicelled spikelet unawned 5
 + Pedicelled spikelet awned 7

- 5. Pedicel with purple median band **108. Bothriochloa**
- + Pedicel lacking distinct median band 6

- 6. Apex of lower glume of sessile spikelet blunt, long-ciliate
106. Dichanthium
- + Apex of lower glume of sessile spikelet not blunt, not long-ciliate
113. Arthraxon p.p.

- 7. Lower glume of sessile spikelet crustaceous, usually rugose or sculpted
109. Ischaemum
- + Lower glume of sessile spikelet not crustaceous 8

- 8. Base of leaf sheaths covered in white wool; upper glume of sessile
 spikelet aristate **99. Eulaliopsis**
- + Base of leaf sheaths not woolly; if upper glume of spikelets aristate,
 then both spikelets of pair pedicellate 9

- 9. Lower glume of sessile spikelet long-hairy on back; plants tufted,
 erect; leaf blades linear **97. Eulalia**
- + Lower glume of sessile spikelet glabrous; plants scrambling; leaf blades
 \pm lanceolate **100. Microstegium**

INFL. TYPE 5 (e.g. Fig. 55a, Fig. 63a)

Racemes linear borne singly on a peduncle, peduncles usually terminal and axillary, the axillary single or fascicled, the terminal often whorled.

- 1. Spikelets unawned 2
- + Spikelets awned 10

- 2. Leaf petiolate, blade deeply sagittate at base **93. Spodiopogon**
- + Leaf not petiolate, blade not sagittate at base 3

- 3. Lower glume of sessile spikelet \pm globose, crustaceous, deeply pitted
120. Hackelochloa
- + Lower glume of sessile spikelet not as above 4

- 4. Infl. a terminal panicle, with whorled branches 5
- + Infl. with terminal and lateral partial infls 6

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5. Lower glume of sessile spikelet spiny **104. Vetiveria**
 + Lower glume of sessile spikelet not spiny **116. Phacelurus**
6. Lateral racemes densely fascicled 7
 + Lateral racemes single or in small groups 8
7. Spikelets borne in pairs (sessile and pedicelled) **118. Coelorachis**
 + Spikelets borne singly (sessile) **121. Ophiuros**
8. Pedicelled spikelets absent, sessile spikelets paired on opposite sides
 of raceme (sometimes single above) **122. Mnesithea**
 + Pedicelled spikelets present (pedicel and raceme internodes fused),
 sessile spikelets borne singly 9
9. Raceme internodes not stout, \pm angled; leaf sheaths glabrous
117. Hemarthria
 + Raceme internodes stout, cylindric; leaf sheaths hispid **119. Rottboellia**
10. Racemes elongate, usually with 6 or more spikelet pairs and a ter-
 minal triad 11
 + Racemes very short, with up to 4 spikelet pairs and a terminal triad..... 17
11. Racemes whorled along an elongate infl. axis 12
 + Racemes borne singly (terminal and usually also lateral) 13
12. Lower glume of sessile spikelet glabrous on back, unpitted; pedicel
 lacking purple central band **103. Pseudosorghum**
 + Lower glume of sessile spikelet hairy on back, often pitted; pedicel
 with central purple band and green margins ... **108. Bothriochloa bladhii**
13. Small annuals; infl. terminal 14
 + Stout perennials, if annual then leaves oblong and with many lat-
 eral infls. 15
14. Pedicelled spikelet awned **100. Microstegium p.p.**
 + Pedicelled spikelet unawned **113. Arthraxon microphyllus**
15. Lower part of raceme consisting of awnless, persistent, homogamous
 spikelets; awn very stout, over 4cm **114. Heteropogon**
 + All spikelets similar, awned; awn slender, under 2cm 16

16. Glumes of sessile spikelet long ciliate at apex, the upper aristate **98. Pogonatherum**
 + Glumes of sessile spikelet not ciliate at apex, the upper not aristate **112. Schizachyrium**
17. Sessile spikelets unawned **102. Sorghum**
 + Sessile spikelet awned 18
18. Pedicels lacking median band **105. Chrysopogon**
 + Pedicels with purple median band **107. Capillipedium**

93. **SPODIOPOGON** Trinius

Tufted perennial. Base of leaf blades deeply sagittate, with sharp, downward-pointing lobes either side of a petiole-like stalk. Infl. paniculate, branches in whorls, slender, each with a single terminal raceme; racemes bearing pairs of sessile and pedicelled spikelets, axis disarticulating (tough in some other species). Spikelets similar; florets 2, the lower sterile, epaleate; pedicel similar to raceme internodes, flat, margins setose. Glumes subequal, as long as spikelet, ribbed, hairy. Lower floret sterile, consisting of lemma and palea. Upper floret fertile, lemma deeply bifid, with geniculate awn in sinus.

1. **S. lacei** Hole. Fig. 49a-d.

Culms stiffly erect, 1(-3)m. Leaf blade 1.1(-3)cm wide, widest about middle, narrowed gradually towards apex and base, sparsely pilose on both surfaces, hairs whitish, tubercle-based, basal lobes to 2cm; petioles of lower culm leaves to 13cm; sheaths glabrous, apex produced upwards into 2 erect auricles, hairy on adaxial surface. Panicle (10-)18(-23)cm, rather dense, lanceolate in outline, panicle branches persistent, slender, swollen at apex, unequal, longest of lowest whorl c.5cm. Racemes to 1.5cm; pedicels and raceme axis segments c.3mm, flattened, broadened upwards to cup-like apex, margins setose-ciliate, setae purplish. Sessile spikelet: lower glume 5.5mm, narrowly lanceolate, rounded on back, acute, emarginate, setose, strongly 6-ribbed; upper glume 5mm, narrowly lanceolate, acute, emarginate, strongly keeled, smooth, hairy only at base; lower lemma 4.9mm, lanceolate, acute, hyaline; palea 3mm, oblong; upper lemma 4.9mm, lower part of awn 10mm, twisted, upper part 6mm; palea 3.1mm; anthers 3.2mm, reddish-brown. Pedicelled spikelet similar to sessile, but both glumes like lower glume of sessile spikelet.

Bhutan: C — Mongar district (between Mongar and Kuru Chu). Steep scrubby bank in chir pine forest, 1000m. October.

Not previously recorded from Bhutan; measurements in brackets are from Burmese specimens.

94. SACCHARUM L.

(incl. *Narenga* Bor and *Erianthus* Michaux)

Stout to massive, rhizomatous perennials. Culms solid. Leaves inserted along culm, blades flat, margins serrate, lamina sometimes very narrow; ligule membranous, ciliate. Infl. paniculate, often decompound, plumose; hairs arising from callus, raceme axis and usually pedicels; racemes bearing pairs of sessile (sometimes shortly pedicelled) and pedicelled spikelets, axis disarticulating. Spikelets identical (except sometimes in indumentum); florets 2, the lower sterile, epaleate. Glumes \pm equal, about as long as spikelet, hyaline or chartaceous, the lower \pm flat on back, 2-keeled, the upper 1-keeled; lower lemma silvery-hyaline; upper lemma silvery-hyaline, awned or awnless, sometimes reduced and linear; palea silvery, ciliate, sometimes reduced or absent.

- | | |
|--|----------------------------------|
| 1. Spikelets unawned | 2 |
| + Spikelets awned from upper lemma | 4 |
| 2. Hairs on callus and pedicels about equalling spikelets; infl. purplish | |
| | 3. <i>S. narenga</i> |
| + Hairs on callus and internodes greatly exceeding spikelets; infl. white/
silvery plumose | 3 |
| 3. Glumes thin-textured, greenish-silver, the lower hairy; culms glabrous
below infl. | 1. <i>S. arundinaceum</i> |
| + Glumes thickened below, hyaline above, golden- to reddish-brown
below, glabrous; culms silky-hairy below infl. | 2. <i>S. spontaneum</i> |
| 4. Sessile spikelet under 4mm; infl. purplish or whitish | 4. <i>S. rufipilum</i> |
| + Sessile spikelet over 5mm; infl. golden brown | 5 |

FIG. 49.

a-d, ***Spodiopogon lacei***: a, infl. ($\times \frac{1}{3}$); b, raceme internode ($\times 6$); c, spikelet pair ($\times 6$); d, leaf base ($\times \frac{2}{3}$). e-g, ***Miscanthus nepalensis***: e, infl. ($\times \frac{1}{3}$); f, raceme internode ($\times 8$); g, spikelet pair ($\times 8$). h, ***M. nudipes***: spikelet pair ($\times 8$). Drawn by Louise Olley.



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5. Awns over 10mm; panicle broad, racemes flexuous ... **5. *S. longesetosum***
+ Awns under 6mm; panicle narrow, racemes stiffly erect . **6. *S. sikkimense***

1. *S. arundinaceum* Retzius (incl. *S. procerum* Roxb.). Bhutanese name (Shemgang): *gengmi*; Nep: *chokti-phul*, *kans*, *tolu kans*. Fig. 50d–e.

Tufted; culms massive, 2–4(–6)m, glabrous. Leaf blades to 1.5m, 2–4(–5)cm wide, tapered to very acute apex; midrib channelled, wider than lamina at base, with long, dense, felty cream hairs towards base; sheath margins ciliate; ligule truncate, to 2mm. Panicle 30–85cm, silvery-grey, very open, primary branches whorled, much branched. Racemes relatively tough, internodes 5.5–8mm; callus, internode and pedicel hairs slender, silvery, spreading, greatly exceeding spikelets. Sessile spikelet 3.5–4mm; lower glume silvery-greenish, marked purplish above, 3.5–4mm, oblong-lanceolate, rounded on back, acuminate, apex sometimes out-curved, hairy on back, hairs to 8mm, 2(–3)-veined, thin-textured; upper glume 2.7–3.6mm, oblong-lanceolate, acuminate, glabrous, margins ciliate above; lower lemma 2.2–3.3mm, narrowly lanceolate, margins ciliate near apex; upper lemma 2.1–3mm, keeled, midrib sometimes very shortly excurrent; palea c.1mm, narrowly ovate. Pedicelled spikelet similar, but both glumes hairy; pedicel 2–4mm. Anthers 1.5–2mm.

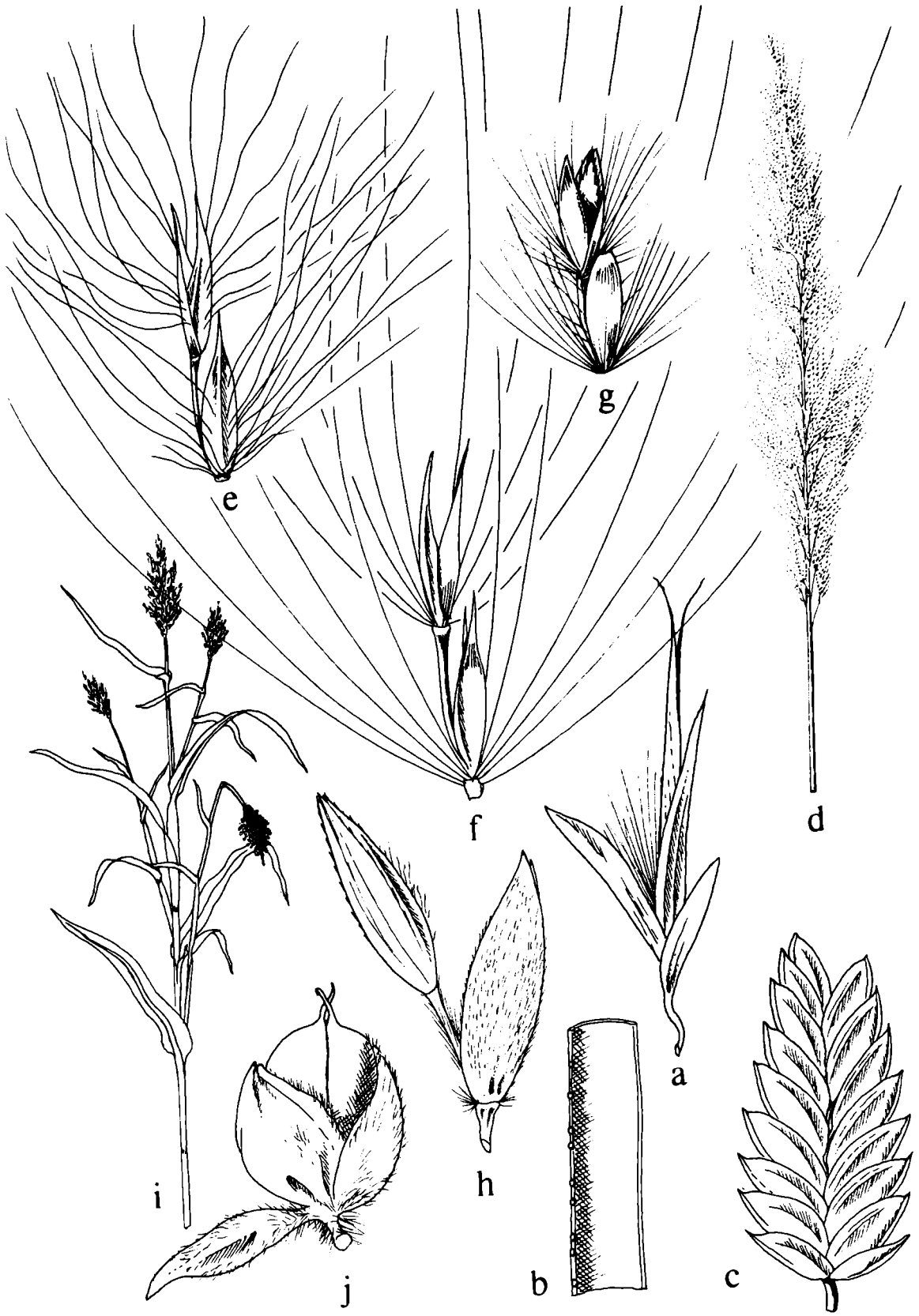
Bhutan: S — Phuntsholing district (Phuntsholing); C — Tongsa district (S of Shemgang, below Dakpai); **Terai** (Bamunpokri, Jalpaiguri Duars, Balasun); **Darjeeling** (Badamtam, Rumman, Selim, Rangit, Rungbee). Dry, rocky roadside bank; dry, scrubby slopes; terai grassland, 90–1930m. Fl. (June–)October–December.

Culms used to make arrows by children in Bhutan, a use also recorded by Hooker in Sikkim. According to Bor (1973) used in constructing hut walls and of some medicinal value according to Hole (1911). Sometimes cultivated.

It seems impossible to separate *S. procerum* from *S. arundinaceum*. Bor (1940, 1973) followed Parker (1930) in distinguishing the latter by its shorter raceme-internodes and pedicels (giving it a denser panicle) and in flowering during, rather than after, the rains. However, Parker's observations seem to have been based on a small sample of cultivated material, and another of his characters (the length of the hairy part of the

FIG. 50.

a, *Neyraudia curvipes*: spikelet ($\times 6$). b–c, *Eragrostis cilianensis*: b, leaf margin ($\times 6$); c, spikelet ($\times 6$). d–e, *Saccharum arundinaceum*: d, infl. ($\times \frac{1}{10}$); e, spikelet pair ($\times 6$). f, *S. spontaneum*: spikelet pair ($\times 6$). g, *S. narenga*: spikelet pair ($\times 6$). h, *Sorghum arundinaceum*: spikelet pair ($\times 6$). i–j, *S. bicolor*: i, habit ($\times \frac{1}{30}$); j, spikelet pair ($\times 6$). Drawn by Louise Olley.



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midrib) seems not to be reliable. Further work is required, but *S. procerum* is unlikely to merit more than subspecific rank at most.

Nearly all specimens seen from our area would fall into *S. procerum*. However, three specimens (Balasun, *Hooker* s.n.; Mongpu, *Clarke* 11931; Rungnoo Valley, *Treutler* 128, all K) differ in flowering time (May–July), in having smaller panicles (25–35cm), being presumably smaller plants, the upper glume of some sessile spikelets hairy, the glumes more mucronate, and at least some raceme internodes shorter (3.5(–8)mm). These are, perhaps, referable to Bor's concept of *S. arundinaceum*, but the atypical characters might well be explained by the fact that all three specimens are infected by a smut.

2. *S. spontaneum* L. Nep: *sanu kans, kush, kash*; name in terai: *bhabnee*. Fig. 50f. Plate 1.

Rhizomatous, extensively spreading, forming clumps/swards. Culms to 1.1–5m, sometimes branched below, with appressed, silky hairs below infl. Leaf blades 1.3–6mm wide, linear, tapered to very acute apex, lamina of culm leaves sometimes scarcely developed; sheaths glabrous (lower sometimes hairy), long ciliate at apex; ligule \pm truncate, 2–3.5mm, long-ciliate. Panicle 20–38cm, white, broadly cylindric in life, narrow when dry, primary branches whorled, branched at base. Racemes very fragile, internodes (2.3–)3.4–4.5mm; long, flexuous, white silky hairs borne on internodes and callus. Sessile spikelet (2–)3–3.3mm; lower glume (2–)3–3.2mm, narrowly to oblong-lanceolate, finely acuminate or apex sometimes rounded, glabrous, 2-veined, lower part golden- to reddish-brown, thickened, upper part silver-hyaline, margins ciliate below apex; upper glume (1.8–)2.7–3.3mm, lanceolate, acuminate, glabrous, margins fimbriate; lower lemma (1.2–)2.6–3mm, lanceolate, margins ciliate; upper lemma reduced, filiform, (1–)1.4–2.6mm; palea absent or small, 0–0.9mm. Pedicelled spikelet similar; pedicel (1.1–)1.5–2.2mm, scabrid. Anthers (0.7–)1.4mm.

Bhutan: S — Samchi, Phuntsholing and Chukka districts; C — Punakha, ?Tongsa, Mongar and Tashigang districts; **Terai** (Jalpaiguri); **Darjeeling** (Junction of Great and Little Rangit, Bamunpokri); **Sikkim** (below Rumtek). Common in warm parts (no doubt under-recorded): silt and shingle by rivers; damp ground around rice-fields, 90–1520m. June–January.

Specimens from Bamunpokri (*Gamble* 3316A, K) and Deothang (*NPSW* 195, E) have extremely small spikelets (measurements in brackets above). The name *S. semidecumbens* Roxb. applies to such forms (e.g. *Wallich* 8854A, *Buchanan Hamilton* 227 [= *Wallich* 8854F]); however the species is extremely polymorphic and these forms probably do not merit formal recognition.

A good fodder; the culms are used for thatching and the construction of hut walls in southern Bhutan. This grass is also of religious significance (see p. 469).

3. **S. narenga** (Nees ex Steudel) Hackel; *Narenga porphyrocoma* (Hance ex Trimen) Bor. Nep: *urlu*. Fig. 50g.

Rhizomes stout. Culms to 2.5(-4.8)m, silky-hairy below infl. and on nodes. Leaf blades dark green, to 2cm wide, widest about middle, gradually tapered to very acute apex, sparsely hairy above, hairs tubercle-based, glabrous beneath; midrib pale, channelled above. Sheaths hairy above, margins ciliate above, mouth densely long-ciliate; ligule to 1.5(-3)mm, rounded. Panicle purplish or greyish, 30-45cm, narrow, primary branches whorled, stiffly erect, with many erect branches near base. Racemes relatively tough, internodes 1.7-2.5mm, trigonous; straight hairs borne on internodes, pedicels and callus. Sessile spikelet golden brown, 2.3-2.6mm; callus hairs white, stiff, the longest 2-4mm; lower glume 2.2-2.5mm, oblong, apex rounded or bidentulate, back 3-veined, with long hairs, thick-textured, prominently 2-keeled, keels scabrid; upper glume 1.9-2.5mm, oblong-lanceolate, subacute, glabrous, margins ciliate above; lower lemma 2.1-2.3mm, oblong-lanceolate, bidentulate, 2-keeled, sides ciliate; upper lemma 1.7-2.2mm, oblong, emarginate-fimbriate, sometimes minutely awned (to 0.7mm); palea 0.7-1.1mm, oblong, emarginate-fimbriate. Pedicelled spikelet similar, 2.1-2.7mm; pedicel 1.7-2.3mm. Anthers 1.2-2.8mm.

Terai (Sukna, Jalpaiguri Duars); **Darjeeling** (Bamunpokri). Terai forest and grassland, 90-305m. October-December

The culms and leaves are used for thatching and for making screens in India (Hole, 1911).

4. **S. rufipilum** Steudel; *Erianthus rufipilus* (Steudel) Grisebach; *E. fulvus* Nees ex Hackel. Darjeeling name: *chuktubang*. Fig. 51a-b.

Tufted; culms 0.5-2m, silky-hairy below panicle and sometimes on nodes. Leaf blades greyish, 1-1.5cm wide, tapered to very acute apex, glabrous; sheaths glabrous or sometimes appressed-hairy above; ligule truncate, 1-1.5mm, long-ciliate. Panicle purplish-silver, (10-)17-40cm, densely cylindrical, primary branches bearing many racemes near base. Racemes to 4cm, very fragile, internodes 1.5-2.5mm; long, straight, silver flushed purple hairs borne on internodes, pedicels and callus. Sessile spikelet 2.6-3.7mm, callus hairs 6-11mm; lower glume golden brown, with subapical purple markings, 2.5-3.7mm, lanceolate, back \pm rounded, acuminate, glabrous, 3-veined, margins fimbriate, apex hyaline; upper glume 2.6-3.8mm, lanceolate, acuminate, glabrous, margins fimbriate; lower lemma flushed purple, 2-3mm, oblong-lanceolate, sometimes produced into awn 1.5-1.8mm, margins ciliate; upper lemma with very narrow hyaline margins at base, consisting mainly of awn 8-11mm; palea small (0.5-0.9mm) or absent. Pedicelled spikelet similar but lower glume with long marginal hairs; pedicel 1.5-2.5mm. Anthers 0.9-1.1mm.

Bhutan: S — Phuntsholing, Chukka and Deothang districts; C — Thimphu, Punakha, Tongsa, Mongar and Tashigang districts; **Darjeeling** (Mongpu, Siri, Labha); **Sikkim** (Lingcham, Chungthang, Bop, Chalisay). Common on open banks and roadsides; also in warm, mixed broad-leaved and chir pine forest, 1220–2400m. January–December.

5. *S. longesetosum* (Andersson) V. Narayanaswami var. ***hookeri*** (Hackel) Bor; *Erianthus hookeri* Hackel. Fig. 51c–e.

Tufted; culms 0.6–3m, stout, sometimes branched below, shortly hairy below infl. Leaf blades 1–3.7cm wide, widest at middle, acuminate, glabrous or sparsely hairy beneath; sheaths glabrous or hairy above, pilose at apex; ligule rounded, 2.3–2.5mm. Panicle golden brown, 15–39cm, primary branches paired or fascicled, branched in lower part. Racemes to 10cm, relatively tough, internodes 2.5–4.5mm; long, straight, silvery hairs borne on internodes, pedicels and callus. Sessile spikelet 5–6.5mm; callus hairs 6–8.5mm; lower glume golden brown, 5–6.2mm, oblong-lanceolate, apex bidentulate, hairy on back below, hairs equalling glume, 2(–3)-veined, margins fimbriate above; upper glume 5–6mm, oblong-lanceolate, finely acuminate, with very few hairs on middle of back, margins fimbriate above; lower lemma 4.1–5.5mm, oblong-lanceolate, margins ciliate above; upper lemma 3–5.2mm, apex bidentate with midrib developed as long awn 1.3–2.4cm; palea 1.3–3mm, oblong, ciliate. Pedicelled spikelet similar but glumes with more veins, the upper more hairy; pedicel 2–3.7mm. Anthers 3–3.6mm.

Bhutan: S — Phuntsholing (N side of Phuntsholing, above Rinchending), ?Sankosh (Chirang Road) and Deothang (Deothang) districts; C — Punakha (Wangdi Phodrang to Damphu) and Tongsa (S of Shemgang) districts; **Bhutan?** (Reelee); **Darjeeling** (above Sivok, Tista Valley, Panchkilla, Riag, Great Rangit, ?Bandeijhole). Steep scrubby bank; dry chir pine forest; among shrubs in secondary, subtropical forest, 200–1300m. December–April.

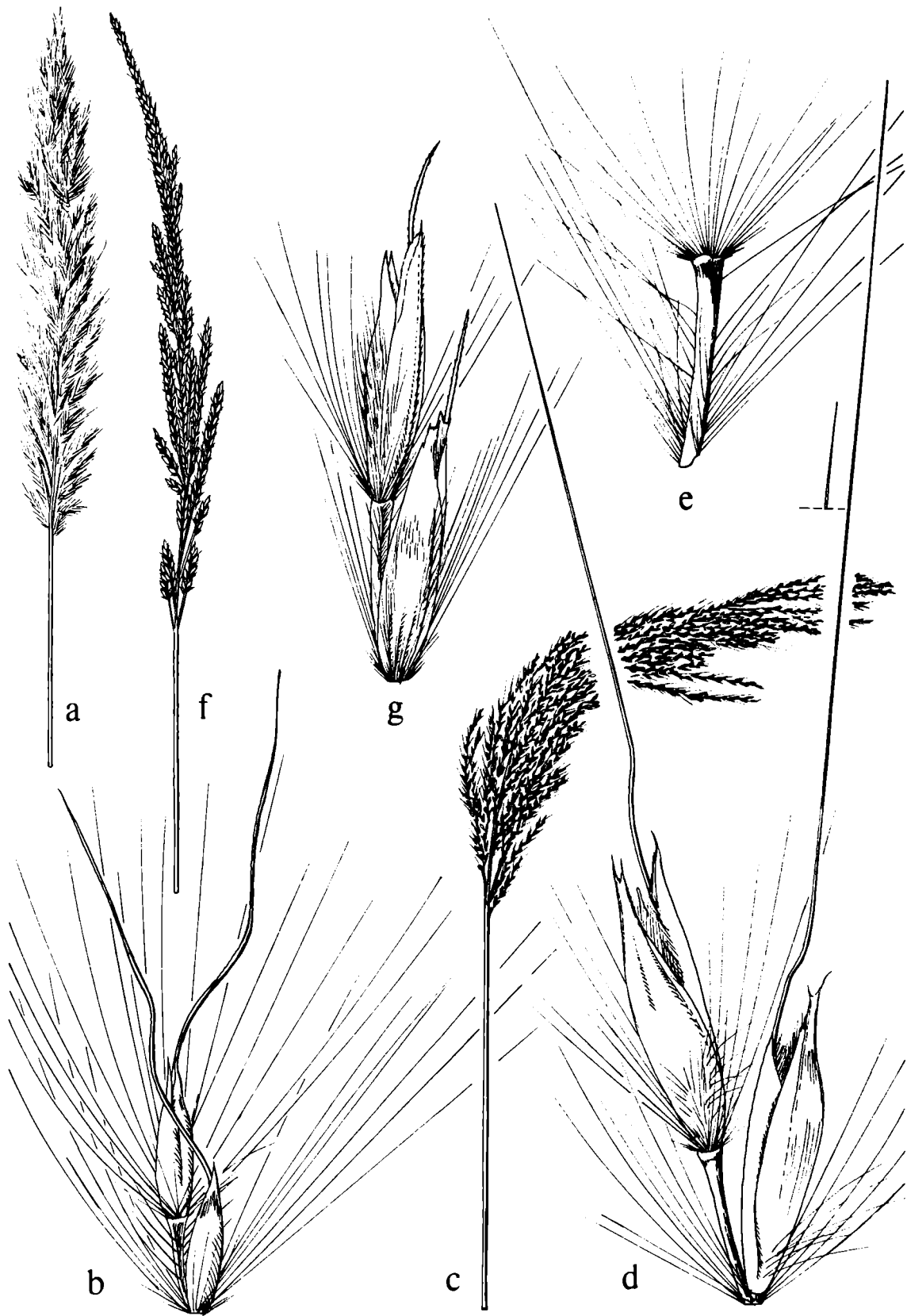
var. ***longesetosum***; *Erianthus longesetosus* Andersson

Differs from var. *hookeri* as follows: spikelets usually smaller (to 5mm); palea smaller (1mm); lower glume of sessile spikelet glabrous.

Bhutan: S — Samchi district (Chamarchi Forest). Habitat not recorded, 150m. December.

FIG. 51.

a–b, ***Saccharum rufipilum***: a, infl. ($\times \frac{1}{3}$); b, spikelet pair ($\times 6$); c–e, ***S. longesetosum*** var. ***hookeri***: c, infl. ($\times \frac{1}{4}$); d, spikelet pair ($\times 6$); e, raceme internode showing hairy margins and callus hairs ($\times 6$). f–g, ***S. sikkimense***: f, infl. ($\times \frac{1}{3}$); g, spikelet pair ($\times 6$). Drawn by Louise Olley.



6. *S. sikkimense* (Hook. f.) V. Narayanaswami; *Erianthus sikkimensis* Hook. f. Fig. 51f–g.

Densely tufted. Culms 0.9–2m, stout, silky-hairy below infl. Leaves grey-green, blades linear, to 6.2mm wide, sparsely hairy beneath; midrib pale, channelled above, margins hairy on upper surface, densely so at base. Sheaths hairy above, marked with red below, margins ciliate above, mouth densely long-ciliate; ligule to 4.5mm, truncate. Panicle pinkish-grey, 25–28cm, axis stout, silky-hairy, primary branches single or paired, stiffly erect, with many, short branches along entire length. Racemes relatively tough, internodes 3–5.8mm; straight hairs borne on internodes, pedicels and callus. Sessile (sometimes shortly pedicelled) spikelet 5.2–5.9mm; callus hairs white sometimes marked purple, the longest 4.5–6mm; lower glume golden brown turning reddish-brown, 4.5–5.5mm, oblong-elliptic, apex bidentulate, back 4-veined, minutely hispid, prominently 2-keeled, keels scabrid, sides long-hairy; upper glume 5–5.5mm, lanceolate, acute or shortly mucronate, glabrous, margins ciliate above; lower lemma 4.9–5.4mm, narrowly lanceolate, very acute, keeled, margins ciliate above; upper lemma 3.8–4.8mm, narrowed into long, scabrid awn (1.5–)3.5–5.5mm; palea 3.6–4mm, linear-lanceolate, ciliate. Pedicelled spikelet similar, but sides of lower glume sometimes more densely hairy and back sometimes hairy near apex; pedicel 3.3–4.3mm. Anthers 2.1–2.5mm.

Bhutan: C — Thimphu (common around Thimphu and Paro), ?Punakha (on way to Chirang), Tongsa (Tsangkha), Bumthang (Karsumphe Guest House, Kiki La) and Tashigang (Yonphu La) districts; **Sikkim** (Lachen). River edge; streamside in paddy-fields; marsh, 1830–2900m. July–January.

Cultivated species:

S. officinarum L. Dz: *guchu*, *gunchha*; Sha: *khomin*; Nep: *ukhu*; Eng: *sugar cane*

Resembles *S. arundinaceum* vegetatively, but differs from it in having glabrous glumes; however, it seldom, if ever, flowers in our area.

A rough sugar extract is used in certain religious ceremonies (see p. 469); according to Roder & Gurung (1990) this may account for its widespread, but small-scale cultivation – as seen in fields and gardens in Deothang, Punakha, Tashigang and Mongar districts. Cultivated commercially around Gaylegphug for alcohol production (Roder & Gurung, 1990). Shoots and culms are chewed for their sweet juice, and sugar is extracted commercially at Nanong (Tashigang district).

Doubtfully recorded species:

Erianthus versicolor Nees ex Steudel

Recorded for Sikkim in F.B.I. but no specimens determined by Hooker have been seen. Hackel (1889) gave it only for 'Nepal' (Royle 195) and 'Massuri' (i.e. W Himalaya). Bor (1973), however, treated it as a synonym of *E. rufipilum*.

95. MISCANTHUS Andersson

Tufted perennials. Culms stiffly erect. Leaf blades flat; ligule membranous, apex ciliate. Infl. paniculate, appearing subdigitate with racemes arranged in half-whorls along a short, stout axis; raceme bearing pairs of unequally pedicelled spikelets, axis not breaking up. Spikelets similar, subtended by involucre of callus hairs; florets 2, the lower sterile, epaleate. Glumes 2, subequal; lower lemma lanceolate; upper lemma with bifid apex and terminal awn; palea lanceolate.

1. Spikelets under 3.2mm, callus hairs greatly exceeding spikelets; leaves \pm glabrous 1. **M. nepalensis**
+ Spikelets over 4.3mm, callus hairs about equalling spikelets; leaves and sheaths pilose 2. **M. nudipes**

1. **M. nepalensis** (Trinius) Hackel. Fig. 49e-g.

Culms 20–150cm, stout, with long, appressed, white, silky hairs below infl. Leaf blades 2–10mm wide, \pm glabrous; leaf sheath hairy at apex; ligule 1–3mm, apex rounded, adaxial surface hairy. Infl. nodding, golden brown, plumose, 7–24cm, axis shorter than racemes. Spikelets 1.8–3.2mm (excl. awn); callus hairs grey, 7.2–12mm; lower glume golden brown, sometimes with purple subapical markings, 1.5–2.8mm, oblong-lanceolate, subacute, emarginate, obscurely 3-veined, margins long-ciliate near base, apex hyaline; upper glume 1.8–3.2mm, longer than lower, lanceolate, acute or minutely mucronate, margins glabrous; lower lemma 1.3–2.7mm, lanceolate, acute, hyaline; upper lemma 1.4–2.5mm, hyaline, awn 11.5–12.3mm, straight, scabrid, sometimes purplish; palea 0.8–1.5mm, lanceolate; grain c.1.5mm, purplish-brown. Longer pedicel 1.7–5.5mm; shorter pedicel 0.9–3mm.

Bhutan: S — Phuntsholing (Gedu to Kamji), Chukka (Jumudag to Chasilakha, Gedu to Kharbandi), Gaylegphug (W bank of Chabley Khola) and Deothang (Raidong) districts; C — Thimphu (Begana Bridge), Punakha (Tinlegang to Lometsawa), Tongsa (S of Shamgong, Chendebe, W of Yuto La), Mongar (Namning) and Tashigang (E side of Kori La) districts;

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Darjeeling (Darjeeling, Kurseong, Sukia Pokhri to Manibhanjang, Siri, Ghoom; Batasi to Palmajua (F.E.H.1)); **Sikkim** (Gangtok, Lachung, Phadamchen, Soreng, Chungthang to Lachen, Kabi to Shotok). Roadside cliffs/banks and clearings/scrub in broad-leaved forest, 1220–2740m. February–December.

2. *M. nudipes* (Grisebach) Hackel. Fig. 49h.

Culms 45–97cm, silky-hairy below infl. Leaf blades 3–5mm wide, pilose, especially beneath, hairs tubercle-based; leaf sheaths \pm pilose, densely so above; ligule 1–1.5mm, apex rounded, adaxial surface hairy. Infl. nodding, coppery-purple in life, greyish-brown when dry, plumose, 9–15cm, axis shorter than racemes. Spikelets 4.3–5.2mm (excl. awn); callus hairs white, 4.8–6.5mm. Longer-pedicelled spikelet: lower glume golden brown, 3.8–5mm, oblong-lanceolate, truncate, emarginate (weakly bidentate) or apiculate, long-hairy on back and margins, strongly 5–8-veined, apex hyaline; upper glume 4.2–5.5mm, longer than lower, lanceolate, acute or minutely mucronate, hairy on back; lower lemma 3.9–5.5mm, lanceolate, acute, hyaline; upper lemma 3.3–4.5mm, hyaline, awn 6–11mm, slightly twisted, scabrid; palea 3–3.8mm, lanceolate. Longer pedicel 2–5mm; shorter pedicel 1–2mm.

Bhutan: C — Bumthang (Bumthang, Badar La) and Mongar (Sengor) districts; **Sikkim** (Lachen, Thanggu, Tallam, Lachung); **Chumbi**. Dry grassy hillside; cliffs by road; wet water-course, 2640–3550m. June–October.

96. IMPERATA Cirillo

Perennial, spreading by extensively creeping rhizomes, forming dense swards. Leaf blades flat; ligule membranous. Infl. a dense silvery, spike-like panicle; silvery hairs arising from callus, back of glumes and nodes of raceme axis, greatly exceeding spikelets; racemes short, appressed, bearing single and unequally pedicelled, paired spikelets; axis tough, hairy only at nodes. Spikelets similar; florets 2, the lower sterile, epaleate; pedicels swollen at apex. Glumes slightly unequal, upper as long as spikelet, hyaline, silky hairy on back; lower lemma hyaline; upper lemma small, hyaline, awnless; palea very wide, encircling ovary.

1. *I. cylindrica* (L.) Räschel; *I. arundinacea* Cirillo. Dz: *becho*; Bhutanese name (Tongsa): *teo posem*; Nep: *siru, khar*. Fig. 53a–b.

Leaves mainly basal and sub-basal. Culm 11–63(–100)cm, nodes bearded or not; upper leaves reduced. Leaf blades stiffly erect, shorter than culm, 1.6–8mm wide, glabrous or occasionally with scattered tubercle-based hairs

on upper surface; sheaths glabrous, occasionally sparsely hairy, margins sometimes long-ciliate, especially at apex; ligule very short (to 0.5mm), apex blunt, denticulate. Infl. 3–11cm. Shorter pedicelled spikelet 2.5–3.6mm: lower glume (excl. terminal cilia) 2.2–3.3mm, oblong-lanceolate, rounded on back, apex subtruncate-ciliate, 6-ribbed; upper glume longer, 2.5–3.6mm, lanceolate, conduplicate, acuminate; lower lemma 1–2mm, ovate-acuminate, hyaline, margins minutely ciliate above; upper lemma 0.6–1.3mm, oblong to lanceolate; palea 0.6–1 × 0.8–1.4mm, apex blunt, denticulate; pedicel 0.4–0.9mm. Longer-pedicelled spikelet similar, but glumes equal; pedicel 1.2–2.5mm. Anthers 2.2–2.6mm, orange.

Bhutan: S — Phuntsholing (Phuntsholing), Gaylegphug (Gaylegphug to Toribari) and Deothang (Deothang to Samdrup Jongkhar) districts; C — Thimphu (above Thimphu Public School, Simtokha), Punakha (Choojom to Mishina, Tinlegang (F.E.H.2)), Tongsa (Tongsa), Mongar (Lingmethang), Tashigang (Tashi Yangtshi Dzong) and Sakden (Phakaling) districts; **Terai** (Jalpaiguri Duars); **Darjeeling** (Rungnoo Valley, Samsing Forest); **Sikkim** (near Yoksam, Tumloong, Dentam, Gyalshing, Gangtok, Chuthen; Pamianchi to Tingling Bridge (F.E.H.1)). Dry, disturbed and cultivated places, field edges, roadsides, seasonally burnt bushland, open hillsides, 250–2450m. April–November.

No doubt under-recorded. Parker (1992) recorded it as common at lower altitudes and probably occurring in all districts [with cultivation]; useful in stabilising field banks and used for thatching, but can prove a troublesome weed of both annual and perennial crops. Young shoots are said to be eaten in E Bhutan.

Indian material has been referred to var. *major* (Nees) Hubbard ex Hubbard & Vaughan, characterised by its small spikelets and anthers. The above description refers to the commonest form from disturbed habitats, however a larger form is distinguishable, at least in the herbarium, and was included under *I. arundinacea* var. *latifolia* by Hooker (F.B.I.). It differs in being much larger; culms stouter, to (45–)73–87(–?)cm; leaves 1.5–2.4cm wide; panicles 14–25cm; spikelets (3–)3.5–5mm; anthers (2–)2.7–3.2mm. Specimens have been seen from Sikkim (Chungtam) and the Terai (Bamunpokri, Punkabari), 250–2440m. It is probably just a habitat form and was not considered worthy of taxonomic recognition by Hubbard (1944) who restricted the use of var. *latifolia* to specimens from NW India.

97. EULALIA Kunth

(incl. *Pseudopogonatherum* A. Camus)

Perennials, usually tufted, sometimes rhizomatous, rarely annuals. Culms simple. Leaf blades flat, linear, margins thickened; ligules very short, membranous, truncate, ciliate. Infl. a single terminal fascicle of racemes (digitate) or

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of several whorls on a short axis; racemes bearing pairs of sessile (occasionally pedicelled) and pedicelled spikelets, axis breaking up or occasionally \pm persistent, triangular in section, hairy on angles; pedicels flattened, hairy on angles. Spikelets similar; florets 2, the lower sterile, epaleate; glumes equaling spikelets, \pm coriaceous, the lower oblong-lanceolate, acute or bidentulate, flat or slightly concave on back, 2-keeled, the upper 1-keeled, narrowly lanceolate, sometimes aristate; lower lemma hyaline; upper lemma composed mainly of awn, basal margins hyaline, usually bidentate at apex, awn geniculate, twisted; palea small, hyaline or absent.

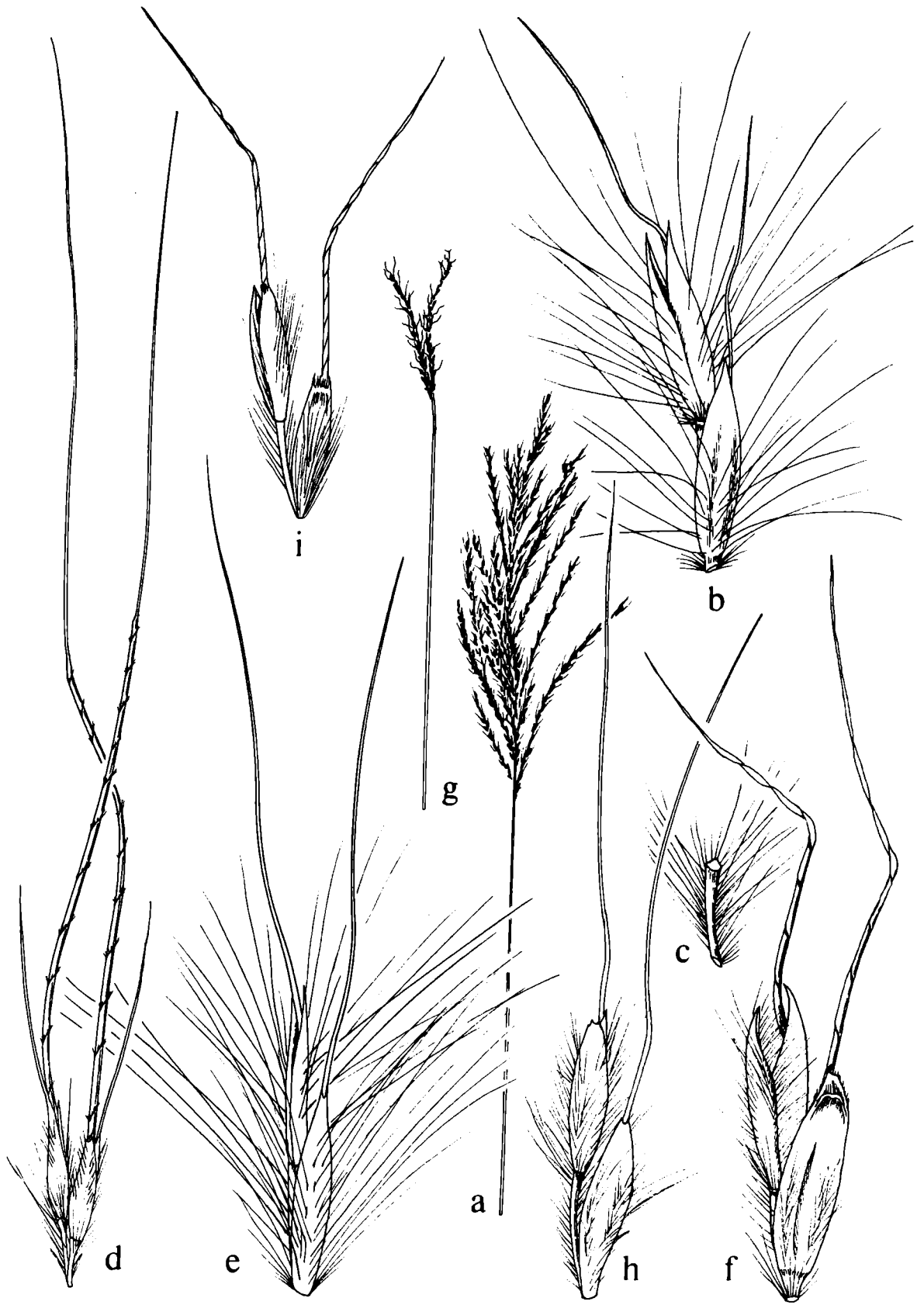
1. Racemes whorled along a short axis **1. E. fastigiata**
 + Racemes digitate in a single fascicle 2
2. Upper glume (of both spikelets) aristate; both spikelets pedicelled
2. E. contorta
 + Upper glume (of both spikelets) not aristate; one spikelet sessile, the other pedicelled 3
3. Hairs on raceme internodes and pedicels longer than spikelets; awn weak, \pm erect **3. E. mollis**
 + Hairs on raceme internodes and pedicels shorter than spikelets; awn stout, geniculate 4
4. Sessile spikelets over 5.5mm **4. E. quadrinervis**
 + Sessile spikelets under 5mm 5
5. Sessile spikelets over 3.5mm, hairs on raceme internodes, pedicels and callus whitish **5. E. trispicata**
 + Sessile spikelets c.2.5mm, hairs on raceme internodes, pedicels and callus brown **6. E. leschenaultiana**

1. E. fastigiata (Nees) Haines; *Erianthus fastigiatus* (Nees) Hackel. Fig. 52a-c.

Spreading by stout rhizomes. Culms stiffly erect to 2.4m, with appressed, silky hairs beneath infl. Leaf blades to 5.5mm wide, glabrous. Sheaths sparsely

FIG. 52.

a-c, **Eulalia fastigiata**: a, infl. ($\times \frac{1}{2}$); b, spikelet pair ($\times 6$); c, raceme internode ($\times 4$). d, **E. contorta**: spikelet pair ($\times 6$). e, **E. mollis**: spikelet pair ($\times 6$). f, **E. quadrinervis**: spikelet pair ($\times 6$). g-h, **E. trispicata**: g, infl. ($\times \frac{1}{2}$); h, spikelet pair ($\times 6$). i, **E. leschenaultiana**: spikelet pair ($\times 6$). Drawn by Louise Olley.



hairy above, mouth with a few long cilia; ligules c.0.5mm, minutely ciliate. Infl. 12.5–24.5cm, racemes 17 or more, borne in pairs or half-whorls along short, hairy axis to 5.5cm. Racemes to 16cm, internodes 2.2–3.7mm, hairs silver, about equalling spikelets. Sessile spikelet 3.9–4.7mm; callus hairs to 2mm; lower glume dark brown below, golden above, 3.5–4.4mm, with few, long, spreading hairs on keels near base (occasionally glabrous); upper glume 3.6–4.5mm, glabrous, margins long-ciliate above; lower lemma 2.8–3.5mm, linear-lanceolate, finely acuminate, margins ciliate above; upper lemma 1.6–2mm, awn 5.8–8.5mm, weak \pm straight; palea 0.5–0.9mm, widely oblong to oblong-ovate, truncate to subacute. Pedicelled spikelet 3.7–4.6mm, similar to sessile but lower glume densely hairy on keels and sides, upper glume hairy on keel; pedicel 2.1–3.5mm. Anthers 1.6–2.5mm.

Bhutan: C — Tongsa district (below Dakpai); **Terai** (Siliguri, Phansidowa); **Darjeeling** (Rangit). Dry, rough bushland, 150–1500m. October–December.

2. **E. contorta** (Brongniart) Kuntze; *Pseudopogonatherum contortum* (Brongniart) A. Camus; *Pollinia articulata* Trinius. Fig. 52d.

Tufted annual. Culms slender, 25–47cm, glabrous. Leaf blades linear, to 1.5mm wide, becoming inrolled, sparsely hairy on upper surface near base. Sheaths glabrous; ligule c.2mm, densely ciliate. Infl. 5–7cm. Racemes (1–)2–8(–20), axis persistent, internodes 1.3–1.8mm, hairs silver, shorter than spikelets. Spikelets pale golden brown, both pedicelled. Shorter pedicelled spikelet 1.8–2.2mm; callus hairs 0.9–1.1mm; lower glume 1.8–2.2mm, with few short hairs on back; upper glume 1.7–2.4mm, shortly hairy on keel above, keel continued as filiform awn 1–2.6mm; lower lemma reduced, c.0.9mm, oblong, blunt to subacute; upper lemma 1.2–1.7mm, awn 18–20mm, stout, flexuous, lower part hairy; palea absent; pedicel c.0.9mm. Longer pedicelled spikelet 2–2.3mm, similar to lower; pedicel 1.1–1.3mm.

Bhutan: C — Punakha district (above Chuzomsa); **Darjeeling** (Rangit, Balasun Valley). Slightly disturbed slopes in partial shade on dry, grassy hillside, 610–1100m. October–November.

3. **E. mollis** (Grisebach) Kuntze; *Pollinia mollis* (Grisebach) Hackel. Fig. 52e.

Tufted perennial. Culms 26–50cm, appressed-hairy below infl. Leaf blades flat, 2.6–5mm wide, glabrous or sparsely hairy, hairs tubercle-based. Sheaths glabrous or sparsely hairy above, mouth and junction with blade densely long-ciliate; ligule c.0.1mm. Infl. 4.5–9.5cm. Racemes 4–7, densely hairy, pinkish-silvery, axis breaking up, internodes 2–3mm, bearing sessile and pedicelled spikelet pairs, hairs silver flushed violet, longer than spikelets. Sessile spikelet 4–4.8mm; callus hairs 2.5–4mm; lower glume 3.8–4.5mm, long-hairy from keels and sides; upper glume 3.9–4.5mm, keel appressed-hairy above; lower

lemma 3.4–4.3mm, linear-lanceolate, sides hairy at apex; upper lemma 1.4–2.2mm, awn 10–15mm, weak, \pm straight; palea 0.7–1.6, ovate to broadly ovate, apex fimbriate (occasionally linear, acute). Pedicelled spikelet 2.9–4.1mm, similar to sessile, but upper glume with more, longer hairs; pedicel 2–2.7mm. Anthers 1–2.2mm.

Bhutan: C — Thimphu (N of Dechencholing) and Tongsa (Chendebe) districts; **Darjeeling** (Darjeeling, Sandakphu); **Sikkim** (Lachung). Dry grassy hillsides in cleared areas or under open *Pinus wallichiana* forest, 1830–2740m. August–October.

4. *E. quadrinervis* (Hackel) Kuntze; *Pollinia quadrinervis* Hackel. Fig. 52f.

Tufted perennial. Culms 60–102cm, stout, usually shortly hairy below infl. Leaf blades slightly glaucous, 4–6mm wide, flat, densely appressed-hairy beneath, sparsely hairy above, hairs tubercle-based. Sheaths densely hairy above, mouth and junction with blade densely long-ciliate; ligule c.0.3mm. Infl. 10–24cm, of 3–7 racemes inserted singly or in pairs on short (to 2cm) axis. Racemes golden brown or purplish-hairy, axis breaking up, internodes 3.3–5mm, bearing sessile and pedicelled spikelet pairs, hairs silver flushed violet, shorter than spikelets. Sessile spikelet 5.5–6.1mm; callus hairs 1.3–2.6mm; lower glume 5–6mm, densely long-hairy from keels, back often with two green veins, anastomosing below apex; upper glume 5–5.8mm, glabrous, margins ciliate; lower lemma 3.7–4.4mm, narrowly lanceolate, margins ciliate near apex; upper lemma 1.6–2.2mm, awn 13–17mm, stout, upper part spreading; palea 1.2–1.9mm, lanceolate to rhombic, subacute; anthers 2.9–3.4mm. Pedicelled spikelet 5–5.5mm, similar to sessile, but lower glume with sides and keel densely hairy; pedicel 2.2–3.5mm.

Bhutan: S — Deothang district (Mukazor to Ngangshing); C — Thimphu (hill above Thimphu Hospital), Punakha (above Wache, above Chuzomsa, Lometsawa to Menhuanang), Tongsa (Chendebe, near Bubja) and Tashigang (Kanglung, Yonphu La) districts; **Sikkim** (Lachung, Rishie). Coarse grassland on steep, dry, open slope; well-drained slopes in broad-leaved forest; chir pine forest; rocky bank among cultivation, 1100–2740m. September–October.

The above description includes specimens with violet hairs, villous keels and obscurely veined lower glumes which key out as *E. hirtifolia* (Hackel) A. Camus in Bor (1973); they do not merit specific recognition.

5. *E. trispicata* (Schultes) Henrard; *Pollinia argentea* Trinius. Fig. 52g–h.

Tufted perennial. Culms 50–82cm, glabrous, slender. Leaf blades flat, 2.5–4mm wide, densely pilose above, glabrous beneath. Sheaths glabrous, mouth long-ciliate; ligule c.0.2mm, densely ciliate. Infl. 4–7(–9)cm, a single fascicle of racemes. Racemes 2–4, golden brown, axis breaking up, internodes

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1.7–2.5mm, densely hairy, bearing sessile and pedicelled spikelet pairs, hairs silver, shorter than spikelets. Sessile spikelet 3.5–4.2(–5)mm; callus hairs 2–3.5mm; lower glume 3.2–4.2(–5)mm, oblong-ob lanceolate; keels and sides densely long-hairy; upper glume 3.5–4.2(–5)mm, hispid at apex and on sides above; lower lemma 3.5–4.5mm, narrowly lanceolate, sides and upper margins hispid; upper lemma 1.2–2(–2.8)mm, awn 12–17(–20)mm, stout, upper part spreading; palea absent. Pedicelled spikelet 3–4(–4.3)mm, similar to sessile, but upper glume with a few hairs on back; pedicel 1.7–2.2(–2.8)mm.

Bhutan: C — Thimphu (near Drukyel Dzong), Punakha (Chuzomsa to Samtengang), Tongsa (Tongsa, near Langtel, Shemgang) and Mongar (Mongar to Kuru Chu) districts. Dry grassland on open hillside; dry stony bank with open scrub, 900–2580m. September–November.

6. *E. leschenaultiana* (Decaisne) Ohwi; *E. cumingii* (Nees) A. Camus. Fig. 52i.

Differs from *E. trispicata* as follows: hairs on pedicels, raceme internodes and callus brown; spikelets smaller (c.2.5mm); lower floret (lemma) absent; awn of (upper) lemma shorter (7–9mm).

Terai (Dulkajhar, between Titalya and Dank Nuddee). In long grass, 150m. October.

No recent records. The two 19th century specimens seen have small spikelets and belong to the form described as *Pollinia cumingii* var. *parviflora* Hackel; similar specimens have been seen from Nepal and Dehra Dun.

Additional species:

Eulalia sp.

A single old specimen (*Gamble* 334, K), probably from our area ('Dumdumma Jhar, Terai'), is similar to the above form of *E. leschenaultiana*, but differs in having shorter, whitish hairs on the pedicels and raceme internodes, the hairs on the lower glume more or less restricted to the keels, and a lower floret (lemma) present. It probably represents an undescribed species, but further collections are required.

98. POGONATHERUM P. Beauvois

Densely tufted perennials. Culms sometimes becoming woody below, much branched, branches stiffly erect, again branched. Leaf blades flat; ligules short, membranous, truncate, minutely ciliate. Racemes borne singly at end of branches on slender peduncles, bearing pairs of sessile and pedicelled spikelets; axis breaking up, internodes \pm trigonous in section, angles green, one of them long-hairy. Spikelets \pm similar. Sessile spikelet: florets 1–2, the lower (when

present) male, the upper bisexual, both paleate; callus hairy; glumes almost equalling spikelets, the lower oblong, \pm rounded on back, apex ciliate, \pm truncate, slightly 2–3-lobed, the upper lanceolate, strongly 1-keeled, apex bifid, long aristate; lemma and palea of lower floret silver-hyaline; lemma of bisexual floret mainly consisting of long awn, margins silver hyaline, apex bifid. Pedicelled spikelet smaller than sessile, floret 1, usually female; pedicel \pm flat, angles green, long-hairy.

The two species are extremely hard to tell apart in the field so no field records have been included; both are common and under-recorded.

1. Sessile spikelet 2.4–3mm, usually with 2 florets, the upper (or only) floret with 2 stamens; callus hairs shorter than spikelet .. **1. P. paniceum**
 + Sessile spikelet 1.6–2mm, floret always single, stamen 1; callus hairs longer than spikelet **2. P. crinitum**

1. P. paniceum (Lamarck) Hackel; *P. saccharoideum* P. Beauvois. Fig. 53c–e.

Culms 7–100cm, reddish. Leaf blades 3–5cm, 1.8–3.3mm wide, finely acuminate, surfaces sometimes hispid, with few long hairs near base above. Sheaths persistent on old culms, reddish-brown, glabrous, or with long hairs on margin above, with long hairs at apex; ligule 0.3mm. Raceme golden brown, 2–3cm, internodes 1.2–1.7mm. Sessile spikelet 2.4–3mm; callus hairs shorter than spikelet; glumes greenish-hyaline flushed purple, the lower 1.9–2.6mm, the upper 2.4–3mm, awn 11–20mm; lower lemma 2.1–2.6mm, oblong-lanceolate, apex minutely ciliate, acute; palea 1.7–2.3mm, oblong, apex truncate, ciliate; stamens 2; upper lemma 2–2.5mm, awn 13–21mm; palea 1.6–2.5mm, oblong-lanceolate, apex ciliate; stamens 2, anthers 1.4–2mm. Pedicelled spikelet 1.4–1.8(–2.5)mm; pedicel 1.3–1.7mm.

Bhutan: S — Samchi (Samchi), Phuntsholing (above Phuntsholing), Gaylegphug (above Shershong Bridge, W bank of Chabley Khola) and Deothang (Deothang) districts; C — Punakha (N of Punakha Dzong, Chuzomsa to Samtengang) and Mongar (Lhuntse Dzong) districts; **Terai** (Siliguri); **Darjeeling** (Great Rangit, Garidoora, Pharing, Peshok, Palmajua to Rimbick, Lepcha Jagat, Happy Valley, Roy Villa). Wet cliffs/rocks; stony stream- and riversides; steep open slopes on exposed, slightly eroded hillside; roadside banks/cuttings, 150–2050m. February–July.

A sterile specimen from Kanglung (Tashigang district) for which the Nepali name *karuki* is recorded almost certainly belongs to this species.

2. *P. crinitum* (Thunberg) Kunth. Fig. 53f.

Differs from *P. paniceum* as follows: smaller (culms never more than 30cm); spikelets always with 1 floret, smaller (sessile spikelet 1.6–2mm; lower glume 1–1.4mm; upper glume 1.5–1.9mm; lemma 1–1.4mm; palea 0.7–1.2mm; stamen single, anther (0.2–)0.8–1.1mm); callus hairs exceeding spikelet (2–3.3mm).

Bhutan: S — Samchi (Soureni Gari) and Deothang (1km N of Deothang) districts; C — Tongsa (Kinga Rapden) and Tashigang (between Kanglung and Tashigang) districts; **Darjeeling** (Little and Great Rangit, Tista, Kalimpong, Sonada); **Sikkim** (Mangan). Heathy bank; wet banks, rock-faces and walls often by roads, 335–2300m. May–December.

99. EULALIOPSIS Honda

Densely tufted perennial; basal sheaths swollen, tough, woolly. Culms simple. Leaf blades flat, becoming inrolled; ligules very short, membranous, truncate, ciliate. Infl. with terminal, \pm digitate racemes on a slender peduncle, and lateral racemes arising from slightly swollen sheathing, leaf-like bracts; racemes bearing pairs of sessile and pedicelled spikelets, axis breaking up, internodes flattish, glabrous. Spikelets similar; florets 2, the lower sterile (or male), paleate, the upper bisexual; callus long-hairy; glumes almost equalling spikelets, chartaceous, the lower with tridentate apex, the upper with bifid apex, mucronate to aristate; lower lemma and palea silver-hyaline; upper lemma mainly consisting of long awn, margins silver-hyaline.

1. *E. binata* (Retzius) Hubbard; *Ischaemum angustifolium* (Trinius) Hackel. Fig. 53g.

Wool on sheath bases cream-coloured. Culms 38–55(–90)cm, slender, glabrous. Leaves 1.5–3mm wide, glabrous. Sheaths glabrous, mouth with long hairs; ligule c.0.2mm. Lateral partial infls. 3 or more, scattered along culm. Racemes pale golden, to 2–5cm, in 2s or 3s on very short axis; raceme internodes 2–2.5mm. Sessile spikelet 2.7–5mm (excl. mucros and/or awn); callus hairs golden, 3–3.8mm, just shorter than spikelet; lower glume 2.6–4mm, oblong, apex usually 3-toothed, back flat above, 1-keeled at base, strongly

FIG. 53.

a–b, *Imperata cylindrica*: a, infl. ($\times \frac{1}{3}$); b, spikelet pair ($\times 6$). c–e, *Pogonatherum paniceum*: c, habit ($\times \frac{1}{3}$); d, spikelet pair ($\times 8$); e, raceme internode ($\times 12$). f, *P. crinitum*: spikelet pair ($\times 8$). g, *Eulaliopsis binata*: spikelet pair ($\times 8$). Drawn by Louise Olley.



XVIII. ANDROPOGONEAE

5–7-ribbed, long hairy on margins and on keel near base; upper glume 2.7–4.5mm, oblong-lanceolate, apex bifid, with mucro or short awn (0.2–1.8mm) in sinus; lower lemma 2.6–4.4mm, oblong-lanceolate, subacute, margins ciliate above; palea 1.2–4.4mm, narrowly oblong, apex long-ciliate; upper lemma 2.9–3.8mm, tapered into awn, awn 4–6.5mm; palea widely oblong-lanceolate, apex long ciliate. Pedicelled spikelet 3.9–5mm, similar to sessile, but lower glume narrowly lanceolate, acute, more hairy; pedicel 1.6–2.5mm, flattened, glabrous. Anthers c.2.3mm.

Bhutan: S — Sankosh district (N of Sankosh, Sankosh to Tshokana); **Darjeeling** (Rangit). Seasonally burnt, dry grassy hillsides and slopes under chir pine; dry sal forest, 460–1300m. April–June.

The tough, persistent basal sheaths make it resistant to burning.

100. MICROSTEGIUM Nees

Sprawling perennials, or delicate, tufted annuals. Culms usually much-branched and rooting from lower nodes, or slender and erect. Leaf blades flat, narrowly elliptic to linear, narrowed at base, with pale, reflective band around midrib in life; ligules membranous, truncate. Infl. of terminal, ± digitate (sometimes reduced to 1) racemes, lateral infls. sometimes also present; racemes bearing pairs of sessile and pedicelled spikelets, axis breaking up or not, internodes clavate or flattish and winged. Spikelets similar; florets 1–2, the lower when present male or sterile, consisting of a palea, the upper bisexual; glumes equalling spikelets, the lower oblong-lanceolate, grooved or concave on back, usually bidentate, 2-keeled, margins inflexed, the upper narrowly lanceolate, sometimes aristate, 1-keeled; (upper) lemma composed mainly of awn, basal margins hyaline, usually bidentate at apex, awn geniculate, twisted; palea small, hyaline or absent. Anthers 2–3, sometimes very small.

1. Raceme single, not disarticulating, internodes glabrous, flat; plant small, very slender **5. M. falconeri**
- + Racemes digitate, disarticulating, internodes hairy, or if glabrous then either filiform or swollen upwards; plant more robust 2

2. Awn of sessile spikelet brown, stout, strongly geniculate, or else absent; lower glume with prominent green cross-veins ... **3. M. vimineum**
- + Awn slender, not geniculate; cross-veins not prominent on lower glume 3

3. Awn over 10mm, apex thread-like; racemes very slender, spreading horizontally **4. M. nudum**
 + Awn usually under 10mm, apex not thread-like; racemes stouter, not spreading **4**
4. Lower glume linear; anthers under 1.4mm **1. M. ciliatum**
 + Lower glume oblong; anthers over 2mm **2. M. vagans**

1. M. ciliatum (Trinius) A. Camus; *Pollinia ciliata* Trinius. Fig. 54a–b.

Culms wiry, to 120cm. Blades of culm leaves 5–16 × 0.6–1.6cm, narrowly elliptic, finely acuminate, sparsely hairy above, hairs tubercle-based, glabrous beneath, base lacking long hairs; sheaths hairy; ligule c.0.8mm. Infl. 5–10cm; racemes 6–25, internodes 2.4–3.2mm, ± flat, angles long-hispid throughout. Sessile spikelet 3.5–4.7mm; callus hairs 1.5–2mm; lower glume pale green, 3.1–4.3mm, linear-lanceolate, apex hyaline, sharply bidentate, back grooved, sometimes hispid, sometimes 2-veined, keels hispid, sides with few long hairs above; upper glume 2.8–4.1mm, lanceolate, apiculate, apiculus 0.5–1.6mm, margins and sides ciliate above; lower palea 2.1–2.8mm, narrowly oblong, acute, sometimes absent; lemma 0.4–1.2mm, awn 9–11.7mm; upper palea 0.4–1.2mm. Pedicelled spikelet 3–4.1mm, similar to sessile; pedicel 2–2.7mm, angles hispid. Anthers 3, 1–1.4mm.

Bhutan: S — Deothang district (15km N of Deothang); **Darjeeling** (Darjeeling, Mongpu, Rungneet, Rishi to Rinchingpong, Sureil); **Sikkim** (Lachung). Steep, wet roadside banks in wet forest, 610–2000m. August–October.

A variable species, most specimens from our area have a lower floret present, but those from Deothang and Lachung lack it (as in the isotypes of *P. wallichiana* Nees and *P. laxa* Nees, which are generally regarded as synonyms, and which Hackel treated as varieties, of *P. ciliata*).

Bor (1973) treated *M. monanthum* (Nees ex Steudel) A. Camus as a synonym of *M. ciliatum*; it differs however in its much smaller spikelets (under 3mm) and is recorded for the Sikkim Terai in F.B.I., but no specimens have been seen.

2. M. vagans (Nees ex Steudel) A. Camus; *Pollinia vagans* Nees ex Steudel; *Pollinia grata* Hackel. Nep: *bonsu*. Fig. 54c–d.

Differs from *M. ciliatum* as follows: plant stouter; base of leaf blade usually with tuft of long hairs; ligule longer (1.2–1.7mm); lower glume wider; upper glume shortly mucronate; anthers smaller.

Sessile spikelet 3–4.8mm; callus hairs (0.7–)1–2mm; lower glume oblong-elliptic, shortly bidentate, 3–3.6(–4.2)mm; upper glume 3–3.7mm, mucro to 0.5; lower floret usually absent; lemma 0.2–0.7mm, awn 7.5–10.5mm; upper

palea 0.6–0.9mm. Pedicelled spikelet 2.5–3.4mm, similar to sessile; pedicel 2–2.6mm. Anthers 3, 2–2.5mm.

Bhutan: S — Samchi (Soureni Gari) and Phuntsholing (Phuntsholing to Kharbandi) districts; **Darjeeling** (Great Rangit valley, Bamunpokri); **Sikkim** (Chungthang, Chakung). Scrubby banks by road; evergreen forest, 240–1000m. October–December.

The type has the lower floret represented by a large palea, but our specimens all lack a lower floret, with the exception of one with a dubious label ('Darjiling Nepal *Griffith*') and one from Chungtam.

3. *M. vimineum* (Trinius) A. Camus; *Pollinia imberbis* Nees ex Steudel. Fig. 54e–f.

Culms to 68–120cm, slender. Blades of culm leaves 3.5–16.5 × 0.6–1.6cm, narrowly elliptic, finely acuminate, glabrous or sparsely hairy above and/or beneath, hairs tubercle-based; margins of sheaths hairy; ligule 0.5–1mm, truncate, ciliate, hairy on back. Terminal racemes (1–)2–6, 5–9cm, internodes 3–4.9mm, swollen above, 3-angled, two angles ciliate, faces ribbed; lateral infls. also present. Sessile spikelet 4.5–5.6(–6.2)mm; callus hairs (0–)0.4–0.7mm; lower glume pale green, 4.5–5.6(–5.9mm), oblong-lanceolate, bidentulate, sometimes minutely hispid on veins and lamina, keels ciliate, back 4-veined, veins linked by prominent green, transverse veinlets; upper glume 4.3–5.3(–5.5)mm, lanceolate, acuminate, keel minutely hispid; lower palea 3.3–3.5mm, oblong, or absent; lemma (occasionally absent) 0.8–1.3mm, awn 3–8.5mm, exerted or not; upper palea (0.6–)0.8–1.5mm. Sessile spikelets of two kinds: cleistogamous with 3 minute, persistent, unequal anthers, one usually larger (0.2–0.6mm) than other two; chasmogamous with 3 deciduous, equal anthers (c.2.2mm). Pedicelled spikelet 4.1–5.8mm, similar to sessile, sometimes absent; pedicel 2.4–3.1mm, flat, angles long-ciliate.

Bhutan: S — Deothang district (1km N of Deothang); C — Thimphu (near Sisina, Taba), Punakha (Lometsawa, Rimchu to Tashitang), Tongsa (Tongsa to Bubja, 3km W of Tongsa) and Tashigang (Tashi Yangtshi, Bomdeling) districts; **Darjeeling** (Darjeeling); **Sikkim** (Chakung, Lachung, Chungthang,

FIG. 54.

a–b, ***Microstegium ciliatum***: a, spikelet pair (× 6); b, raceme internode (× 6). c–d, ***M. vagans***: c, infl. (× 2/3); d, spikelet pair (× 6). e–f, ***M. vimineum***: e, spikelet pair (× 6); f, raceme internode (× 6). g–h, ***M. nudum***: g, spikelet pair (× 6); h, raceme internode (× 6). i–k, ***M. falconeri***: i, infl. (× 3); j, spikelet pair (× 6); k, raceme internode (× 6). l–n, ***Apocopis paleaceus***: l, infl. with racemes appressed (× 2/3); m, infl. with racemes separated (× 2/3); n, spikelet 'pair' (× 6). Drawn by Louise Olley.



Yoksam). Shady banks in broad-leaved forest; by stream in damp, grassy scrub; semi-shaded ditch by road in damp forest; wet meadow, (1000–)1500–2100m. September–October.

Two distinct forms occur. These were recognised by Hackel as varieties under *Pollinia imberbis* as 'var. *genuina*' and 'var. *willdenowiana*' (based on *Microstegium willdenowianum*; Wallich 8838). One of the Bhutan collections consists of a mixture of the two, which suggests that they grow together, and that varietal rank is therefore appropriate, though the nomenclature would need to be resolved. 'Var. *willdenowiana*' has reduced floral parts: in the sessile spikelet the lemma of the single floret is not developed and, if present, the awn is not exerted; the spikelet tends to be larger (figures in brackets above); the pedicelled spikelet is sometimes not developed, though the pedicel is present. In the typical variety the sessile spikelet is variable, with usually only a single bisexual floret, though a lower floret (male) with well developed lemma-like palea is sometimes present, the awn of the lemma of the upper floret is well developed and exerted.

4. *M. nudum* (Trinius) A. Camus; *Pollinia nuda* Trinius. Fig. 54g–h.

Culms slender, 50–90cm. Blades of culm leaves 3.5–5.5 × 0.5–0.8cm, lanceolate, acuminate, glabrous or sparsely hairy; sheaths sparsely hairy, long-hairy at mouth; ligule truncate, 0.6mm, hairy on back. Racemes 2–7, lower spreading at right-angles to axis, 5–7cm; internodes 3.9–10mm, slender, 2–3-angled, glabrous. Sessile spikelet 3.5–5.2mm; callus hairs 1–1.3mm; lower glume pale green, 3.2–5.1mm, narrowly lanceolate, sharply bidentate, keels minutely hispid, margins ciliate near apex, back shallowly concave, sometimes minutely hispid, sometimes 2-veined; upper glume 3.2–4.5mm, narrowly lanceolate, finely acuminate, margins ciliate; lower palea, 2.6–3.8mm, narrowly oblong, subacute, ciliate above; lemma 2–2.9mm, awn 10.2–10.8mm, thread-like, knotted; upper palea absent. Pedicelled spikelet 3.5–5.1mm, similar to sessile; pedicel 1.8–3mm, flat, glabrous. Anthers 2, 0.6–0.9mm.

Bhutan: S — Chukka (Gedu to Tala) and Deothang (1km N of Deothang) districts; C — Thimphu, Punakha, Tongsa, Bumthang, Mongar and Tashigang districts; N — Upper Mo Chu district (Tamji to Goen Gaza); **Sikkim** (Yoksam, Lachung, Mintagong, Gangtok). Common on banks in temperate broad-leaved (incl. oak) and blue pine forest, (1000–)1800–2740m. July–October.

5. *M. falconeri* (Hook. f.) Clayton; *Ischnochloa falconeri* Hook. f. Fig. 54i–k.

Slender annual; culms to 7(–20)cm, filiform. Blades of culm leaves 0.7(–2) × 0.2(–0.6)cm, narrowly elliptic, acute, with spreading hairs above and beneath, margins ciliate; sheaths hairy; ligule c.0.2mm. Raceme single, not disarticulating, 1.5(–3.5)cm, internodes c.2.2mm, flattish, narrowly winged, glabrous. Sessile spikelet c.2.8mm; callus hairs to 1mm; lower glume c.2.7mm,

linear-lanceolate, \pm truncate, back \pm flat, 3-grooved, keels and veins minutely hispid; upper glume c.2.6mm, linear-lanceolate, mucronate, keel minutely hispid, clasping upper lemma; lower palea c.0.7mm, linear; lemma c.0.7mm, with two filiform terminal lobes c.0.2mm, awn c.7mm, weakly geniculate; anthers 3, c.0.4mm. Pedicelled spikelet similar.

Bhutan: C — Tongsa district (near Shemgang). Habitat not recorded [in W Himalaya on mossy rocks, c.2000m].

Only a single specimen seen; measurements in brackets from W Himalayan specimens.

101. APOCOPIS Nees

Perennial. Leaf blades flat; ligules membranous, truncate. Infl. of 1–4, terminal, erect racemes; racemes bearing single spikelets, the pedicelled one usually reduced, represented by a ciliate pedicel, axis breaking up, internodes short, ciliate. Spikelets with 2 florets, the lower male, the upper bisexual; glumes equalling spikelets, unequal, the lower larger, back \pm flat, the upper narrowly lanceolate, 2-keeled, margins inflexed; lower lemma and palea similar, hyaline; upper lemma hyaline, linear-lanceolate, bidentate, awned or not; palea hyaline. Stamens 2.

1. **A. paleaceus** (Trinius) Hochreutiner; *A. royleanus* Nees. Fig. 541–n.

Rhizomes creeping. Culm 13–27cm, glabrous, leafy near base. Leaf blade 2.6–6.5 \times c.0.4cm, widest near base, acute, sparsely hairy above and beneath at least at base, hairs tubercle-based; sheath hairy above; ligule c.0.8–1.7mm. Racemes 1–3, 2–4.5cm, internodes c.1.8mm, D-shaped in section, two angles long-ciliate. Callus hairs c.1.5mm. Lower glume brown, shining, 4.5–5 \times 1.7–2mm, broadly oblong, 7-ribbed, apex with 3 points, paler; upper glume brown, 4–4.7mm, narrowly oblong-lanceolate, 2-keeled, back \pm flat, 1-veined; lower lemma 3.4–4.1mm, lanceolate, hyaline; palea 3.2–4.2mm, lanceolate, hyaline; anthers c.3mm; upper lemma 3.7–3.9mm, linear-lanceolate, apex emarginate, ciliate, midrib broad (apparently sometimes developed as awn); palea 2–2.5mm, broadly oblong, hyaline, apex truncate, ciliate. Pedicel 1.3–2mm, hairs equalling pedicel.

Bhutan (unlocalised Griffith specimen); **Terai** (Siliguri, Titalya). Gravel by river, [open hillsides, 610–1520m in Assam]. May–September.

None of the few specimens seen from our area have awned lemmas.

102. SORGHUM Moench

Annual or perennial; rhizomatous or not. Leaf blades flat, linear or oblong; ligule membranous, \pm truncate. Infl. of terminal and lateral panicles, sometimes very dense, branches persistent; racemes bearing pairs of sessile and pedicelled spikelets, axis fragile or (in cultivated species) not; internodes and pedicels filiform. Spikelets dissimilar. Sessile spikelet: florets 2, the lower male or sterile, epaleate, the upper bisexual; glumes thickly herbaceous, sometimes hardened; lower lemma hyaline; upper lemma often awned; palea reduced or absent; stamens 3. Pedicelled spikelet: upper (fertile) floret male.

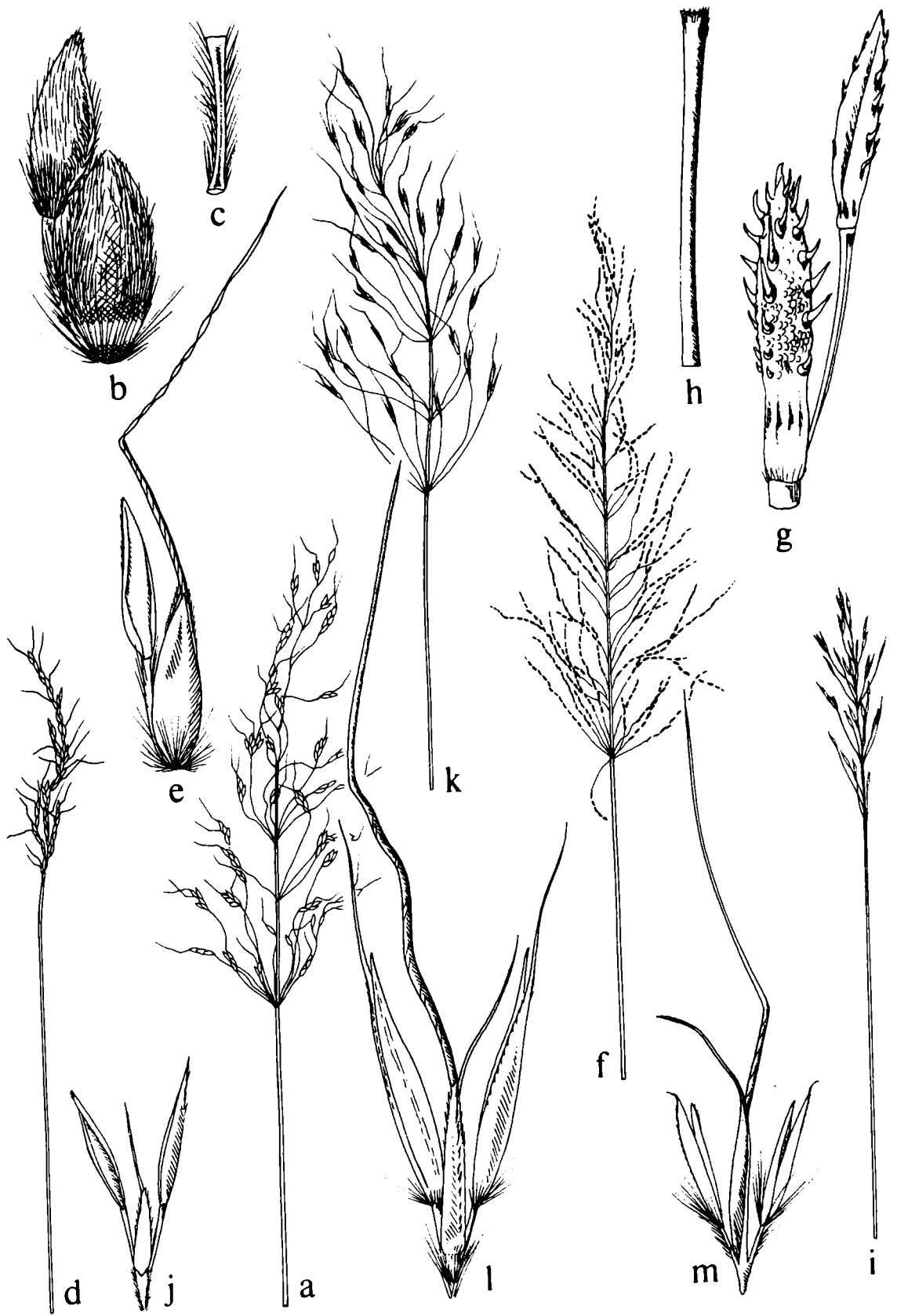
1. Cultivated plant; culms very tall (over 3m), leaves wide; raceme axis not disarticulating; grains spherical **3. S. bicolor**
+ Wild or naturalised plants; culms to 2m, leaves narrow; raceme axis disarticulating, though sometimes slowly; grains ovoid 2
2. Perennial; culms slender, nodes bearded; spikelets dark brown, shining **1. S. nitidum**
+ Tufted annual; culms stout, nodes not bearded; spikelets pale
2. S. arundinaceum

1. S. nitidum (Vahl) Persoon; *Andropogon serratus* Thunberg. Fig. 55a-c.

Tufted perennial to 1m. Culms bearded at nodes, leaves evenly spaced. Leaf blades to 34×0.8 cm, \pm glabrous or hairy, sometimes densely so beneath, with tuft of long hairs at base; sheaths glabrous; ligule c.2mm, truncate-ciliate. Infl. 12-16cm, open, lanceolate in outline, branches simple, whorled, flexuous, racemes borne at ends of branches, with 2-4-spikelet pairs, axis fragile, internodes 1.9-3mm, \pm flat, angles ciliate, cup shaped at apex. Sessile spikelet 3.6-4.4mm; lower glume dark purplish-brown, shining, $3.3-4.2 \times c.1.4$ mm, narrowly ovate, acute, appressed-hispid; upper glume similar in colour and texture to lower, $c.4.1 \times 1.4$ mm, oblong-lanceolate, slightly keeled, appressed-hairy above; lower lemma 3.2-3.6mm, lanceolate, acute, hyaline,

FIG. 55.

a-c, **Sorghum nitidum**: a, infl. ($\times \frac{1}{3}$); b, spikelet pair ($\times 6$); c, raceme internode ($\times 6$). d-e, **Pseudosorghum fasciculare**: d, infl. ($\times \frac{1}{3}$); e, spikelet pair ($\times 6$). f-h, **Vetiveria zizanioides**: f, infl. ($\times \frac{1}{4}$); g, spikelet pair ($\times 8$); h, raceme internode ($\times 8$). i-j, **Chrysopogon aciculatus**: i, infl. ($\times \frac{1}{2}$); j, spikelet triad ($\times 3$). k-l, **C. gryllus**: k, infl. ($\times \frac{1}{3}$); l, spikelet triad ($\times 3$). m, **C. serrulatus**: spikelet triad ($\times 3$). Drawn by Louise Olley.



margins long ciliate above; upper lemma 1.7–2.1mm, ovate, acuminate, margins long-ciliate, awned or not; anthers c.2.3mm. Pedicelled spikelet 3–3.7mm, glumes brown only at base, greenish above, not shining; pedicel 2.2–2.6mm, flattened, margins long-hispid.

Bhutan: C — Punakha (Wangdi Phodrang, Chuzomsa to Samtengang) and Mongar (between Mongar and the Kuru Chu) districts. Dry grassland on open, steep hillside; chir pine forest, 1180–1300m. September–October.

2. *S. arundinaceum* (Desvaux) Stapf. Fig. 50h.

Tufted annual. Culms to 2m, nodes glabrous. Leaf blades to 40 × 2.2cm, glabrous, densely hairy at junction with ligule; sheaths glabrous; ligule c.1.5mm, truncate-ciliate. Infl. c.25cm, open, branches whorled, branched again, not flexuous, racemes of 1–3 spikelet pairs and a terminal triad, axis disarticulating slowly, internodes c.3mm, ± flat, angles ciliate, apex cup-shaped. Sessile spikelet c.5mm; lower glume cream-coloured, c.4.2 × 1.7mm, oblong-elliptic, subacute, appressed-hispid, hairs tinged purple; upper glume c.4.8 × 1.1mm, narrowly lanceolate, acute, slightly keeled, keel hairy below; lower lemma hyaline, c.4.2mm, lanceolate, acute, margins ciliate above; upper lemma c.3mm, ovate, acute, unawned, margins ciliate. Pedicelled spikelet c.4.4mm, glumes flushed purple; pedicel c.2.3mm, flattened, margins ciliate.

Bhutan: C — Punakha district (Bajo). Edge of field near agricultural research station, 1200m. September.

Probably a form reverted from *S. × drummondii* (Nees ex Steudel) Millspaugh & Chase (syn. *S. sudanense* (Piper) Stapf; Eng: *Sudan grass*) which has been grown experimentally as a fodder crop.

3. *S. bicolor* (L.) Moench. Dz: *shingra*; Sha: *phinang*; Eng: *giant millet*. Fig. 50i–j.

Massive annual; culms over 4m; partial infls. dense, reddish-brown; racemes not disarticulating; glumes coriaceous, grains spherical.

Bhutan: S — Sarbhang district (Chirang (Roder & Gurung, 1990)); C — Punakha district (Punakha to Rimchu). Cultivated in small field, 1270m. September.

Still occasionally grown, the grain being used for brewing. Also grown recently as an experimental fodder crop. Snowden (1936) reported *S. miliiforme* (Hackel) Snowden vars. *miliiforme* and *sikkimense* Snowden, and *S. roxburghii* Stapf var. *hians* Stapf for Darjeeling/Sikkim; these three taxa would all now be placed under *S. bicolor*. The single specimen seen most closely resembles var. *sikkimense*.

103. PSEUDOSORGHUM A. Camus

Annual. Leaf blades flat, linear; ligule membranous. Infls. terminal and lateral, densely paniculate; racemes sessile, fascicled at nodes, sometimes branched, bearing numerous pairs of sessile and pedicelled spikelets, axis fragile; internodes and pedicels filiform, not furrowed, angles with long, white cilia. Spikelets dissimilar. Sessile spikelet awned; glumes not thickened; lower lemma lanceolate, hyaline; lower palea absent; upper lemma hyaline, stoutly awned; palea reduced or absent; stamens 3. Pedicelled spikelet unawned, floret single, male, glumes narrower than those of sessile, lemma linear, palea usually absent.

1. *P. fasciculare* (Roxb.) A. Camus; *Andropogon fascicularis* Roxb.; *Sorghum gangeticum* (Hackel) Stapf ex Haines. Fig. 55d-e.

Culms leafy throughout, simple or branched below, to 0.6–1.8m, nodes glabrous. Leaf blades to 50 × 1cm, faces and margins minutely hispid; sheaths usually with spreading hairs especially above; ligule subacute, hairy, 2–4mm. Infl. 5–10cm, racemes to 5cm, internodes 2.2–2.5mm. Sessile spikelet 3.8–4.7mm; lower glume pale green, shining, 3.8–4.3 × 1.1–1.3mm, oblong-lanceolate, truncate or bidentulate, back flat, 6-veined; upper glume lanceolate, acute, 5-veined, shining; lower lemma 3.5–4.2mm, lanceolate, acute, margins ciliate near apex; upper lemma 1.4–1.8mm, deeply bifid, ciliate at apex, awn twisted, geniculate, 11.5–16mm; anthers c.1.5mm. Pedicelled spikelet 3.8–4.5mm; lower glume 3.8–4.5mm, narrowly lanceolate; upper glume 3.9–4.3mm, narrowly lanceolate; lemma 2.8–3.6mm, linear, hyaline; palea (0–)2.5mm; pedicel 2.3–2.5mm.

Terai (Siliguri); **Sikkim** (Dikeeling, Selim). Habitat not recorded, 610–910m. October.

104. VETIVERIA Bory

Tufted perennial; rhizomes short. Culms stout. Leaf blades flat; basal sheaths compressed; ligule a fringe of short hairs. Infl. a panicle, branches whorled, each bearing a single raceme; racemes narrow, elongate, bearing pairs of sessile and pedicelled spikelets, axis breaking up. Spikelets dissimilar; florets 2, epaleate. Sessile spikelet unawned, lower floret sterile, upper floret bisexual; lower glume hardened, 2-keeled, back spinulose, margins incurved; upper glume 1-keeled, keel spinulose, margins broadly hyaline, ciliate; lower lemma hyaline, 2-keeled with ciliate margins; upper lemma hyaline, 1-keeled; anthers 3. Pedicelled spikelet unawned, similar in shape to sessile, smaller, upper floret male; anthers 3.

XVIII. ANDROPOGONEAE

1. **V. zizanioides** (L.) Nash; *Andropogon squarrosus* sensu F.B.I., non L. f. Fig. 55f–h.

Culms 1.2–1.5(–2)m, glabrous, unbranched. Leaf blades to 90 × 1cm, glabrous beneath, scattered long-hairy above especially near base; sheaths glabrous, lower compressed, keeled. Panicle to 33cm, branches filiform, racemes to 6cm, linear, internodes c.4mm, flattened below, swollen, triangular in section above, margins very minutely hispid. Sessile spikelet c.3.9mm; callus truncate, c.0.4mm, callus hairs white, to 0.5mm; lower glume c.3.4 × 0.7mm, oblong, subacute, hardened above, with translucent depression near base, spines on back with pyramidal bases and transparent, acute tips; upper glume c.3.5mm, oblong, acute; lower lemma c.2.5mm, broadly lanceolate; upper lemma c.2.2mm, midrib minutely excurrent; anthers 1.6mm. Pedicelled spikelet c.3.2mm; lower glume c.3.2mm; upper glume c.3.1mm; lower lemma c.2.7mm; anthers c.1.2mm; pedicel c.2.4mm, margins very minutely hispid.

Terai (Jalpaiguri). [Wet areas, 150m]. August.

The aromatic roots are the source of vetiver oil, used in the manufacture of perfumes. Recently grown at the research centre at Lingmethang for potential use as a soil binder.

105. CHRYSOPOGON Trinius

Perennials; tufted or with spreading rhizomes. Leaf blades flat; ligule a ring of short hairs. Infl. paniculate, branches whorled, filiform, persistent, apex oblique, bearded, usually bearing a single triad of 1 sessile and 2 pedicelled spikelets. Spikelets purple, differing. Sessile spikelet awned, florets 2, the lower male or sterile, paleate or not, the upper bisexual, palea reduced or absent; callus acute; glumes hardened or not, the lower 2-keeled, keels hispid or tuberculate, back slightly rounded or ± flat, mucronate or awned, margins inrolled, the upper 1-keeled; lower lemma hyaline; upper lemma hyaline, stoutly awned; stamens 3. Pedicelled spikelet awned or not, florets 1 or 2, the lower (when present) sterile, the upper male; lower glume ± 1-keeled, sometimes awned; lower lemma hyaline; upper lemma hyaline; palea present or absent; stamens 3; pedicel flattened.

1. Upper glume of sessile spikelet mucronulate; panicle contracted (branches ± erect when dry so spikelets overlapping); plant extensively creeping, sward-forming 1. **C. aciculatus**
- + Upper glume of sessile spikelet awned; panicle very lax (branches ± spreading when dry so spikelets not overlapping); plant tufted 2

2. Keels of lower glume of sessile spikelet hispid-tuberculate; pedicels glabrous; pedicelled spikelets over 7.7mm (excl. awn) **2. C. gryllus**
- + Keels of lower glume of sessile spikelet not hispid; pedicels hairy on one face; pedicelled spikelets to 6mm (excl. awn) 3
3. Pedicels less than half length of sessile spikelet; pedicelled spikelets c.5mm, awn c.3mm; awn of upper lemma of sessile spikelet slender, under 20mm **3. C. serrulatus**
- + Pedicels more than half length of sessile spikelet; pedicelled spikelets over 6mm, awn to 5mm; awn of upper lemma of sessile spikelet stout, over 25mm **4. C. lancearius**

1. C. aciculatus (Retzius) Trinius; *Andropogon aciculatus* Retzius. Fig. 55i-j.

Rhizomes stout, spreading, much-branched, sward-forming. Culm 15–45cm. Leaves mainly basal, blades 3–7 × 0.2–0.5cm, oblong, apex rounded, glabrous, margins minutely serrate; sheaths glabrous, or with margins ciliate above. Culm leaves with reduced blades. Panicle 5–10cm, dense, narrowly lanceolate in outline, whorls close, branches erect when dry, simple, short, overlapping, filiform at base, upper part triangular in section, with one face hairy. Sessile spikelet 3.1–4mm (excl. awn); callus short, hairs golden, the longest 0.5–0.9mm; glumes membranous, the lower 3.1–3.8 × c.0.7mm, narrowly oblong-lanceolate, apex bidentulate, back ± flat, not veined, keels tuberculate-hispid above; upper glume narrowly lanceolate, apex mucronulate (0.2–0.4mm), keel minutely ciliate above, margins widely hyaline; lower lemma 2.5–3mm, linear-lanceolate, acute; palea 1.6–1.8mm, oblong, rounded often absent; upper lemma 2.2–2.9mm, awn 3.5–5.7mm; anthers c.1.4mm. Pedicelled spikelets subequal, 4.6–5.7mm; lower glume 4.5–5.7mm, narrowly oblong-lanceolate, acuminate, midrib minutely hispid above, keels smooth; upper glume 3.8–4.7mm, narrowly oblong-lanceolate, acuminate, margins ciliate; lower lemma 2.9–3.5mm, oblong, minutely apiculate, margins ciliate; palea 1.4–2.1mm, linear, acute; upper lemma similar to lower; anthers c.2mm; pedicels subequal, 2–3.8mm, ± flat, one face concave, glabrous.

Bhutan: S — Phuntsholing (garden of Druk Motel), Gaylegphug (Gaylegphug) and Deothang (above Lamsarong) districts; C — Thimphu (Thimphu), Punakha (near Punakha Dzong), Tongsa (below Refe), Mongar (between Mongar and the Kuru Chu) and Tashigang (2km from Kanglung, Gamri Chu) districts; **Terai** (Jalpaiguri); **Darjeeling** (Tista, Farseng, junction of Great and Little Rangit, Samsing); **Sikkim** (18km W of Rabong La, Rangpo, Melli, Chhuzachen, Raniphul). Roadsides; wasteground; pasture; open grassland by river, 90–2300m. April–November.

XVIII. ANDROPOGONEAE

Not particularly common in central Bhutan, though will no doubt spread; very common on roadside verges in the Terai and Darjeeling. Can withstand trampling, so sometimes used for lawns in tropical countries.

The specimen from Rangit is infected with the ascomycete fungus *Balansia andropogonis* Sydow; the infl. resembles that of an *Alopecurus*, as the branches are suppressed.

2. *C. gryllus* (L.) Trinius; *Andropogon gryllus* L. Name at Tongsa: *pir*. Fig. 55k-l.

Culms 0.4–1.5m, unbranched. Leaves mainly basal, \pm distichous, bases compressed, blades to 35cm, 0.3–0.6cm wide, sparsely short- or long-hispid above and beneath; sheaths glabrous. Panicle 14–28cm, branches very slender, the lower again branched. Sessile spikelet 6.2–8mm (excl. awn); callus (1.1–)1.3–1.7mm, hairs golden, the longest (2.7–)3.5–5mm; glumes hardened, the lower 5.3–6.3 \times 0.7–1mm, narrowly lanceolate, apex bidentulate-ciliate, back rounded, 3-veined, keels tuberculate-hispid below, ciliate above, margins narrowly hyaline; upper glume narrowly lanceolate, apex bidentate, midrib broad, green, produced into awn, 1.5–5mm, keel minutely ciliate above; lower lemma (4–)4.4–5.2mm, oblong, blunt, margins inrolled, ciliate; upper lemma 4–5mm, awn 24–37mm; palea (2–)2.3–3mm, linear; anthers c.2.3mm. Pedicelled spikelets 7.7–10.5mm (excl. awn); lower glume 8–10.3mm, narrowly lanceolate, gradually narrowed into filiform awn (4.5–7mm), keels minutely hispid; upper glume 7.5–9.5mm, narrowly lanceolate, acute to finely acuminate; lemma 5.3–6.2mm, oblong, blunt, margins ciliate; palea (2.1–)4.2–6mm, linear, acute; anthers 3.2–4.1mm; pedicels (2.5–)3.2–4.6mm, \pm flat, widened above, glabrous.

Bhutan: S — Chukka (3km S of Chimakothi) and Deothang (above Narfong) districts; C — Punakha (Wangdi Phodrang to Chusom, Punakha to Lobesa), Tongsa (Tongsa), Mongar (between Mongar and the Kuru Chu) and Tashigang (Yadi) districts; **Sikkim** (Rishee, Lachung, Chungthang, Bop, Lueng Basti area). Rocky banks and cliffs; steep slopes in open scrub, 1200–2130m. July–November.

3. *C. serrulatus* Trinius; *Andropogon monticola* Schultes var. *trinii* Hook. f. Fig. 55m.

Similar to *C. gryllus* in its lax panicle but differs as follows: culms branched below; panicle smaller (7–10cm); sessile spikelet smaller (c.6mm), back of lower glume rounded, keels glabrous, awn of upper glume longer (5.6–6.6mm), awn of upper lemma shorter (18–20mm); pedicelled spikelets smaller (c.5mm); pedicels less than half length of sessile spikelet, hairy on one face.

Bhutan: C — Mongar (between Mongar and the Kuru Chu) and Tashigang (around Tashigang, Kiri) districts. Common in the dry eastern valleys: on dry banks/cliffs and under chir pine, 850–1500m. September.

4. **C. lancearius** (Hook. f.) Haines; *Andropogon lancearius* Hook. f.

Similar to *C. gryllus* in its lax panicle, but differs as follows: sessile spikelet smaller (c.5.5mm); lower glume awned, awn c.8mm, back rounded, keels not hispid; pedicels with rusty hairs on one face; pedicelled spikelet 6–9mm (excl. awn), awn 2.6–5mm.

Differs from *C. serrulatus* as follows: pedicels longer (more than half length of sessile spikelet); pedicelled spikelets longer; awn of upper lemma of sessile spikelet longer, stouter.

Darjeeling (Punkabari). Habitat not recorded. October.

106. DICHANTHIUM Willemet

Tufted perennial. Leaf blades flat; ligule membranous. Infl. digitate, of usually more than one, very shortly peduncled raceme; racemes bearing pairs of sessile and pedicelled spikelets, axis breaking up, internodes \pm flat, not channelled, margins ciliate. Spikelets dissimilar. Sessile spikelet awned, florets 2, the lower sterile, the upper bisexual, both epaleate; callus truncate; glumes membranous, the lower \pm flat on back, 2-keeled, prominently veined, margins inflexed, the upper 1-keeled; lower lemma hyaline; upper lemma consisting entirely of a twisted, geniculate awn; stamens 3. Pedicelled spikelet unawned, florets 2, the lower sterile, the upper male, both epaleate; lower glume similar to sessile; upper glume \pm flat on back; lower lemma narrow; upper lemma very reduced; pedicel \pm flat, not channelled, margins ciliate.

1. **D. annulatum** (Forsskål) Stapf; *Andropogon annulatus* Forsskål. Fig. 56a–c.

Culms slender, to 50(–100)cm, simple or with several, simple, erect infl.-bearing branches arising within upper sheaths, nodes bearded. Leaves mainly basal, with some evenly scattered along culm; blades glaucous, rather short, finely acuminate, to 3.5mm wide, sparsely hairy above; sheaths glabrous; ligule c.0.8mm, truncate, ciliate. Racemes 3–5, 3–4cm, internodes 1.1–1.2mm, apex cup-shaped, margins with long, white cilia. Sessile spikelet c.3mm; callus hairs 0.3–0.7mm; lower glume 2.6–2.9 \times 1mm, oblong, blunt, 5–7-veined, margins long ciliate above, shortly so below, cilia tubercle-based; upper glume 2.9–3mm, narrowly lanceolate, acute, margins ciliate above; lower lemma 2.3–2.5mm, narrowly lanceolate, acute, minutely ciliate near apex, awn 12.7–14.5mm. Pedicelled spikelet 3–3.3mm; lower glume 7–9-veined; lower lemma 2.6–3mm; upper lemma 1.1–2.4mm; anthers c.1.6mm; pedicel 1–1.4mm, margins long-white-ciliate.

Terai (Mahanudee; unlocalised Treutler 'Sikkim' specimen). Habitat not recorded. March–May.

107. CAPILLIPEDIUM Stapf

Tufted perennials. Culms erect or long and scrambling, simple or branched. Leaf blades flat; ligule membranous, truncate, short. Infl. paniculate, branched to 2 or more orders; primary branches slender, whorled, ultimate branches filiform, persistent, the apex swollen, truncate, glabrous, each bearing a single raceme; racemes short, bearing several pairs of sessile and pedicelled spikelets and a terminal triad, or reduced to a single triad of 1 sessile and 2 pedicelled spikelets. Spikelets differing. Sessile spikelet awned, florets 2, the lower sterile, the upper bisexual, both epaleate; callus truncate; glumes membranous, the lower 2-keeled, keels ciliate, back slightly convex or channelled, blunt to acute, margins shortly inflexed, the upper 1-keeled, sides channelled; lower lemma small, blunt, hyaline; upper lemma consisting entirely of an awn; stamens 3. Pedicelled spikelet awnless, floret single, male, epaleate; lower glume \pm flat, strongly ribbed; lemma hyaline, blunt; stamens 3; pedicel flattened, margins thickened, central zone channelled, purple.

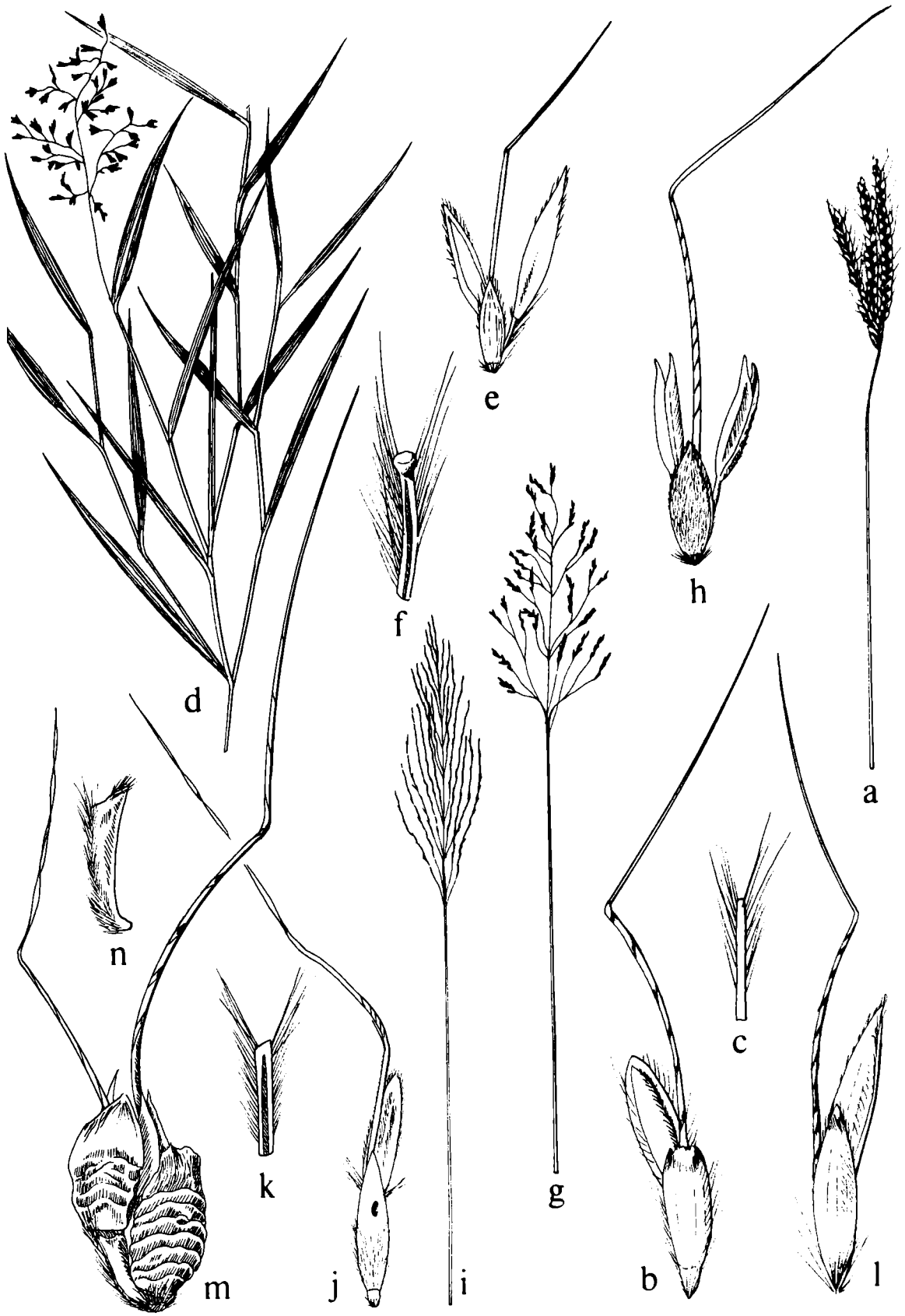
1. Plant scrambling, stems much branched; pedicelled spikelets exceeding sessile; pedicels long-ciliate on both margins throughout; racemes usually with several spikelet pairs below terminal triad **1. C. assimile**
- + Plant tufted, erect, culms not branched; pedicelled spikelets shorter than sessile; pedicels shortly ciliate at extreme base on one side; racemes reduced to a single triad **2. C. parviflorum**

1. C. assimile (Steudel) A. Camus; *Andropogon assimilis* Steudel. Nep: ?*murse karuki*, *hati khurki*. Fig. 56d–f.

Scrambling; culms to 1.5m, glabrous, woody at base, nodes bearing clusters of branches. Leaf blades to 12 × 0.7cm, finely acuminate, tapered to base, with scattered hairs above, more densely hairy beneath; sheaths glabrous, finally shining, with tuft of long cilia at apex; ligule c.0.7mm. Infl. 3.5–11cm, pyramidal, racemes of 0–2 paired and a terminal triad of spikelets, internodes 1–2mm, margins with long, white cilia. Spikelets flushed pinkish. Sessile spikelet 2.1–2.9mm; callus hairs 0.5–1mm; lower glume 2–2.7 × 0.5–0.8mm,

FIG. 56.

a–c, **Dichanthium annulatum**: a, infl. ($\times \frac{2}{3}$); b, spikelet pair ($\times 5$); c, raceme internode ($\times 12$). d–f, **Capillipedium assimile**: d, habit ($\times \frac{1}{3}$); e, spikelet triad ($\times 6$); f, raceme internode showing central channel ($\times 10$). g–h, **C. parviflorum**: g, infl. ($\times \frac{1}{3}$); h, spikelet triad ($\times 6$). i–k, **Bothriochloa bladhii**: i, infl. ($\times \frac{1}{3}$); j, spikelet pair ($\times 5$); k, raceme internode ($\times 6$). l, **B. ischaemum**: spikelet pair ($\times 5$). m–n, **Ischaemum rugosum**: m, spikelet pair ($\times 5$); n, raceme internode ($\times 5$). Drawn by Louise Olley.



oblong-elliptic, acute, truncate or bidentulate, back slightly convex, 5-veined, keels long-hispid in upper half, back sometimes minutely hispid on surface; upper glume 2.1–2.9mm, oblong-lanceolate, acuminate, keel minutely hispid above; lower lemma (0.7–)1–1.8mm, lanceolate, subacute, margins ciliate near apex; awn (upper lemma) 8–17mm; anthers c.1.3mm. Pedicelled spikelet 2.8–4.2mm; lower glume 2.8–4.2mm, prominently (5–)7(–9)-ribbed; upper glume 2.5–3.8mm, like that of sessile spikelet but margins ciliate above; lemma 1.6–3.2mm; anthers 1.2–2mm; pedicel 1.1–1.6mm, with long (over 1mm) white hairs on both margins, throughout.

Bhutan: S — Samchi (Chamurchi Khola, Soureni Gari), Phuntsholing (Phuntsholing), Chukka (Chimakothi to Chukka Bridge), Sarbhang (Shamkhara) and Deothang (Wamrong) districts; C — Punakha (around Lomitsawa, near Wache), Tongsa (below Shamgong), Mongar (Yonkola) and Tashigang (Yondiri Bridge) districts; **Darjeeling** (below Sureil, Mungpo, Kurseong, Bamunpokri, Great Rangit Valley, Kalimpong); **Sikkim** (Gangtok, below Rumtek Monastery, Soke). Roadside and river banks; scrubby slopes in evergreen forest; low cliff in dry valley, 240–2300m. June–December.

2. *C. parviflorum* (R. Brown) Stapf; *Andropogon micranthus* Kunth. Fig. 56g–h.

Differs from *C. assimile* as follows: densely tufted; culms unbranched; leaf blades truncate at base; racemes reduced to a single triad; spikelets often dark purplish; pedicelled spikelets shorter than sessile; pedicels shortly ciliate at extreme base on one side.

Sessile spikelet 2.5–2.8mm; lower glume 2.3–2.7 × 0.8–1.1mm, oblong-elliptic, blunt, back shortly hispid, 2(–5)-veined, channelled between 2 central veins, shortly hispid below, long-hispid near apex; upper glume 2.1–2.8mm, elliptic, acute, keel minutely hispid at apex; lower lemma 0.9–1.2mm, oblong-lanceolate, blunt, glabrous, awn 10.6–16mm; anthers c.1.6mm. Pedicelled spikelet 2.2–2.5mm; lower glume 2.2–2.5mm, prominently 5–7-ribbed; upper glume 2.1–2.4mm, 3-veined; lemma 1.3–2.3mm; anthers c.1.4mm; pedicel 1.6–1.9mm.

Bhutan: C — Thimphu (hill above Thimphu Hospital), Punakha (Punakha, Wangdi Phodrang to Chirang, Chuzomsa), Tongsa (3km W of Tongsa), Mongar (between Mongar and the Kuru Chu) and Tashigang (below Yadi) districts. Dry grassland under *Pinus roxburghii*; dry, open grassland on exposed ridge, 1000–2600m. August–October.

108. BOTHRIOCHLOA Kuntze

Tufted perennials. Leaf blades flat; ligule membranous. Infls. with racemes digitate or whorled along an axis, racemes bearing sessile and pedicelled

spikelets, axis breaking up. Spikelets usually differing. Sessile spikelet awned, florets 2, the lower male, the upper bisexual, both epaleate; callus truncate; glumes membranous, the lower with concave, often pitted back, 2-keeled, margins inflexed, the upper 1-keeled; lower lemma hyaline; upper lemma consisting entirely of a twisted, geniculate awn; stamens 3. Pedicelled spikelet unawned, sometimes of glumes only, with lemma reduced or absent; pedicel flat, margins green thickened, central channel often purple.

1. Racemes whorled along an elongate axis (over 5cm); sessile spikelets under 4.5mm, very narrow (usually under 1mm wide), lower glumes usually pitted **1. B. bladhii**
- + Racemes digitate; sessile spikelets over 5mm, broader (usually over 1mm wide), lower glumes not pitted **2. B. ischaemum**

1. B. bladhii (Retzius) S.T. Blake; *B. intermedia* (R. Brown) A. Camus; *Andropogon intermedius* R. Brown. Fig. 56i–k.

Culms 43–80cm, unbranched, glabrous or appressed-hairy on nodes, leafy in lower half. Leaf blades to 19 × 0.5cm, scattered long-hairy, densely so at base of upper surface, margins serrate; sheaths glabrous; ligule c.1mm, truncate-ciliate. Infl. 7–14cm, main axis 5–12cm; racemes whorled on slender branches, to 6cm, internodes 2.2–2.8mm, channelled, margins with long, white cilia. Sessile spikelet 3.2–3.8(–4.5)mm; callus truncate, hairs to 0.6–1.5mm; lower glume green, flushed purple around margins, 3.2–3.7(–4) × 0.8–0.9(–1.1)mm, narrowly oblong-elliptic, acute to bidentulate, keels stiffly hispid above, back 5–7-veined, concave, often with pit at or above middle, lower half long-hairy, membranous in texture; upper glume 3–3.8(–4.3)mm, lanceolate, acuminate, margins fimbriate above; lower lemma 2.3–2.6(–3.2)mm, narrowly lanceolate, acute, margins or apex fimbriate; awn (upper lemma) 10–13mm; anthers 1.5mm. Pedicelled spikelet commonly purple, 2–3.5(–4.2)mm, usually reduced to the (occasionally pitted) lower glume; upper glume and awnless lemma variously developed or not; pedicel 2–2.5(–2.9)mm, margins with long, white cilia.

Bhutan: C — Thimphu (very common in Thimphu valley), Punakha (above Tikizampa), Tongsa (3km W of Tongsa, Chendebi), Mongar (Lingmethang) and Tashigang (Kanglung to Tashigang) districts; **Sikkim** (Gangtok). Weed of disturbed and cultivated places; grassy hillsides; wet oak forest, 950–2450m. June–October.

This species is known to hybridise extensively with other species and genera (Cope, 1982). The Ramtokto specimen has some spikelets in triads, perhaps suggesting introgression from *Capillipedium*.

XVIII. ANDROPOGONEAE

Forms with pitted glumes have been recognised under *B. intermedia* as var. *punctata* (Roxb.) Keng, however, the presence or absence of the character is inconstant even within a single infl. in some of our specimens.

2. *B. ischaemum* (L.) Keng; *Andropogon ischaemum* L. Fig. 56l.

Differs from *B. bladhii* as follows: racemes digitate (c.8), not inserted along an axis; spikelets larger, the sessile over 5mm, awn over 15mm; glumes not pitted; pedicelled spikelet well developed, male, over 4.5mm.

Bhutan: C — Thimphu district (common in Thimphu and Paro valleys). Dry stony hillsides; roadsides, 2130–2250m. July–September.

109. ISCHAEMUM L.

Annuals or perennials. Leaf blades flat; ligule membranous. Infls. of paired (sometimes single) terminal and axillary, pedunculate racemes; racemes bearing sessile and pedicelled spikelets, axis breaking up. Spikelets usually dissimilar (sometimes similar). Sessile spikelet awned, florets 2, the lower male, the upper bisexual, both paleate; callus truncate; lower glume thickened below, back convex, often rugose, 2-keeled, margins inflexed; upper glume 1-keeled, not thickened; lower lemma and palea similar, hyaline, unawned; upper lemma bifid, awned in sinus; upper palea hyaline; stamens 3. Pedicelled spikelet similar to sessile, or consisting only of glumes; pedicel inflated, hollow, three angled, inner face hyaline, rigidly fused to callus.

1. *I. rugosum* Salisbury. Fig. 56m–n.

Tufted annual. Culms 35–68(–100)cm, nodes shortly appressed-hairy, branched within sheaths. Leaf blades to 19 × 0.5–1cm, oblong to lanceolate, finely acuminate, sparsely hairy above and beneath, with tuft of hairs at junction with ligule; sheaths glabrous; ligule 3–6mm, acute, hairy. Axillary infls. often subtended by bladeless, spathe-like sheaths. Racemes paired, to 7cm, internodes 3.1–3.3mm, one angle with long, white cilia. Sessile spikelet 4.5–5mm; callus 0.3–0.5mm, hairs 0.9–1.7mm; lower glume 3.8–4.5 × 2–2.2mm, oblong, apex rounded, lower part thickened, with 4–5 strong ridges, upper part unthickened, with anastomosing green veins, c.11-veined; upper glume 4.5–5mm, oblong-lanceolate, acute, keel 3-veined above; lower lemma 3.8–4.2mm, oblong-elliptic to lanceolate, subacute, margins ciliate near apex; palea 3.6–4mm; anthers 0.9–1.2mm; upper lemma brown below, pale above, 3.2–3.6mm, awn 15–20cm, strongly twisted and geniculate; palea 2–3.5mm; anthers 1.1–1.5mm. Pedicelled spikelet 2.5–4mm; like sessile or reduced to empty glumes; pedicel 1.7–3.2mm, one angle ciliate.

Bhutan: S — Samchi (Samchi, Dwarapani) and Phuntsholing

(Phuntsholing) districts; C — Punakha District (near Punakha Dzong). Weed in irrigated rice-fields; bunds of rice-fields, 305–1100m. October–December.

The Punakha specimen has fully developed pedicelled spikelets and is referable to var. *rugosum*; the others have reduced pedicelled spikelets and are referable to var. *segetum* Hackel.

Doubtfully recorded species:

I. barbatum Retzius (syn. *I. aristatum* sensu F.B.I.)

Recorded for 'Sikkim' in F.B.I. This record is perhaps based on a rather mixed Griffith sheet (K) on which one specimen bears a 'Darjeeling' label; the label, however, is likely to have been misplaced, as the other specimens are from Khasia. This species differs from *I. rugosum* in having larger (to 8cm), stouter spikes, larger spikelets (the sessile one over 5mm) and the lower glume of the sessile spikelet rugose only on the margins.

I. hubbardii Bor

A Bor specimen at Kew is labelled 'Phalut'. However, the species is known only from Khasia and no species of *Ischaemum* is likely to occur at such a high altitude as Phalut (c.3500m), so it is probably mis-labelled. This species has large (over 6mm) sessile spikelets and the lower glume with narrowly incurved margins, a smooth back and keels winged above.

I. ciliare Retzius (syn. *I. indicum* auct.)

Recorded for the Lower Himalaya, 'from Nepal to Assam' in F.B.I., but no specimens have been seen from our area. It is likely to occur and differs from any of the above species as follows: sessile spikelets small (c.3mm); lower glume with margins expanded below the middle, apex emarginate, back smooth, keels broadly winged above.

110. APLUDA L.

Perennial. Culms woody, scrambling, much branched. Leaf blades flat; ligule membranous. Infl. a many-times compound panicle, racemes reduced to a single triad of spikelets tightly encircled by a spatheole, spatheoles often clustered, triads, borne on a swollen, hollow callus. Spikelets dissimilar. Sessile spikelet awned or not; florets 2, the lower male, the upper bisexual, both paleate; lower glume herbaceous, back convex, keels not distinct, margins not inflexed; upper glume hyaline, 1-keeled; lower lemma and palea subequal, hyaline; upper lemma often awned; upper palea small. Pedicelled spikelets of

a triad, unawned, dissimilar; one well developed, with 2, usually male florets on a concave pedicel; the other reduced to a single, minute glume on a flat pedicel.

1. **A. mutica** L.; *A. varia* Hackel. Nep: *karuki*. Fig. 57a–c.

Culms to 1.5(–2.5)m, glabrous, base decumbent, rooting from nodes. Leaf blades oblong, 0.3–1.9cm wide, finely acuminate, sparsely hairy on veins, or glabrous; sheaths glabrous, sparsely hairy at apex; ligule 2–2.5mm, truncate, erose. Spatheole 3.5–5.7 × 2.1–3.6mm, ovate, truncate, apiculate, finely parallel-veined, margins hyaline, apiculus 0.9–1.7mm. Sessile spikelet 3.2–6.9mm; lower glume 3.1–6.1 × 0.8–1.5mm, oblong to narrowly elliptic, bidentate, (7–)13-veined; upper glume 3.4–6.9mm, gradually narrowed into fine apiculus, 2–5-veined, each side half-ovate; lower lemma 2.7–4.8mm, lanceolate to ovate, acute or blunt; lower palea 2.7–4.3mm, narrowly oblong, acute, 2-keeled; upper lemma 2.3–4.3mm, deeply bidentate, lobes acute, awned in sinus, awn twisted, 4.2–10mm; upper palea 1.1–2.2mm; anthers yellow, 1.3–3.3mm. Reduced pedicelled spikelet: vestigial glume 0.6–1.6mm; pedicel 2.2–3.8 × 0.6–1mm, flat, 3-veined, curved, margins sometimes ciliate near apex. Developed pedicelled spikelet 3.2–6.2mm, similar to sessile but both florets usually male (lower sometimes sterile, upper occasionally bisexual) and lemma of upper floret unawned (occasionally with a minute awn); pedicel 2.2–3.8mm, margins sometimes ciliate above.

Bhutan: S — Sarbhang district (Phipsoo); C — Punakha (Punakha to Lobesa, Wangdi Phodrang to Chirang, Chuzomsa), Tongsa (Tongsa), Mongar (Thitangbi) and Tashigang (Kanglung to Tashigang, Gamri Chu, Kiri) districts; **Terai** (Jalpaiguri Duars); **Darjeeling** (Great Rangit and Tista Valleys, Darogadam, Bamunpokri); **Sikkim** (Selim, Jorethang, Melli). Dry hillsides; among boulders on river bank; chir pine forest, 200–1900m. June–January.

All except two specimens have aristate sessile spikelets and thus belong to var. *aristata* (L.) Pilger; the two awnless specimens (var. *mutica*) are from the Terai (Tista and Jalpaiguri Duars).

FIG. 57.

a–c, **Apluda mutica**: a, infl. (× 1/3); b, spikelet pair (× 8); c, lower glume of sessile spikelet (× 8). d–e, **Cymbopogon khasianus**: d, raceme pair (× 8); e, spikelet pair (× 8). f–g, **C. flexuosus** var. **sikkimensis**: f, infl. (× 1/3); g, spikelet pair (× 8). h: **C. pendulus**: spikelet pair (× 8). i–j, **C. bhutanicus**: i, infl. (× 1/3), j, spikelet pair (× 8). Drawn by Margaret Tebbs.



111. CYMBOPOGON Sprengel

Tufted, usually strongly aromatic (lemon-scented) perennials. Culms unbranched, glabrous, sometimes with a flat or concave face. Leaf blades flat or inrolled; leaf sheaths drawn upwards into auricles; ligule membranous. Infl. a many-times compound panicle, branches subtended by spathe-like bracts, ultimate branches bearing unequally peduncled, commonly deflexed raceme pairs subtended by a spatheole. Short-peduncled raceme with a basal, homogamous pair of awnless, male spikelets, several fertile spikelet pairs and a terminal, fertile triad; long-peduncled raceme similar but lacking basal homogamous pair. Raceme internodes and pedicels \pm flat, with toothed apical cup, margins densely ciliate. Sessile spikelet awned, florets 2, the lower sterile, the upper bisexual, both epaleate; lower glume chartaceous, back flat, concave or deeply channelled, sometimes with depressions, keels pronounced, sometimes winged above, margins inflexed; upper glume chartaceous, 1-keeled; lower lemma hyaline; upper lemma deeply divided into two subulate teeth, awned from sinus. Pedicelled spikelet unawned, floret 1, male, epaleate; lower glume \pm flat on back, many-veined; lemma hyaline.

The *lemon grasses* (Eng) are of economic importance as a source of aromatic oils. A taxonomically difficult genus on which much further work is required.

1. Leaves over 2cm wide, base cordate; lower glume of sessile spikelet oblong-lanceolate with deep, narrow groove in lower half
9. C. martinii
 - + Leaves narrower, base not cordate; lower glume not deeply grooved, or if so then linear and grooved for whole length 2
2. Lower glume of sessile spikelet linear, deeply grooved throughout length, hairy in groove; leaf sheaths sharply keeled 3
 - + Lower glume lanceolate or oblanceolate, lacking a hairy groove; leaf sheaths not keeled 4
3. Sessile spikelet over 5mm; pedicels and joints of raceme not swollen
5. C. munroi
 - + Sessile spikelet under 4mm; pedicels and joints of raceme swollen
6. C. microtheca
4. Sessile spikelet not awned; infl. very dense, racemes scarcely distinguishable; plant cultivated **7. C. nardus**
 - + Sessile spikelet awned; infl. lax, racemes very obvious; plants wild 5

5. Hairs on pedicels and raceme internodes exceeding sessile spikelet (infl. appearing plumose); bases of leaf sheaths persistent, spirally twisted **8. C. jwarancusa**
- + Hairs on pedicels and raceme internodes shorter than sessile spikelet (infl. not appearing plumose); leaf sheath bases not spirally twisted 6
6. Lower glume of sessile spikelet thin, back wrinkled, with 2–3 depressions; plants not strongly aromatic 7
- + Lower glume of sessile spikelet coriaceous, back shallowly convex with shallow groove near base; plants strongly aromatic 8
7. Partial infls. short, dense, erect; keels of lower glume of sessile spikelet winged above (wing over 0.1mm wide); awn over 8.5mm; ligule short (under 2.5mm) **1. C. khasianus**
- + Partial infls. long, lax, pendent; keels of lower glume of sessile spikelet scarcely winged above (wing under 0.1mm wide); awn to 8.8mm; ligule usually over 3.5mm **2. C. flexuosus** var. **sikkimensis**
8. Leaves 7–14mm wide, not inrolled; ligule short (under 2mm) **3. C. pendulus**
- + Leaves under 9.8mm wide, but inrolled on drying so appearing much narrower; ligule over 3.5mm **4. C. bhutanicus**

Although species 1–3 can usually be distinguished, they are linked by intermediates.

1. C. khasianus (Munro ex Hackel) Stapf ex Bor; *Andropogon nardus* L. var. *khasianus* Munro ex Hackel. Fig. 57d–e.

Faintly aromatic (tasting of lovage). Culms 0.5–2m, sometimes slightly flattened on one side above. Leaf blades slightly glaucous, 0.4–0.9(–1.1)cm wide; sheath apex appressed-hairy at junction with underside of leaf blade; ligule truncate-ciliate, 1.5–2.5mm, shorter than wide. Infl. 22–49(–102)cm, very dense, narrow; spatheoles wine-red in life (drying pale orange), 12.4–18mm, narrow. Racemes often dark purplish; the short-peduncled 11.3–13mm; the long-peduncled 12.5–15mm, with 2–3(–5) spikelet pairs and a triad; internodes 1.7–2.9mm, hairs 1.2–1.7mm. Sessile spikelet 4–5.4mm; lower glume 3.9–4.9 × 0.9–1.1mm, oblong-lanceolate, apex bifid, back flat or slightly convex in upper half, with 2–5 intercarinal veins, lower half shallowly concave, with two shallow depressions, keels winged above, wings 0.1–0.3mm wide, minutely serrate; upper glume 3.7–4.7mm, acuminate, strongly keeled, faces half-lanceolate, keel narrowly winged above, margins ciliate; lower lemma 3.2–4.1mm, linear-lanceolate, acute, margins inrolled, ciliate; upper lemma base oblong, 1–1.5mm, teeth 0.8–1.6mm, ciliate, awn

XVIII. ANDROPOGONEAE

8.5–11.2mm, strong, geniculate; anthers 1.5–2mm, orange. Pedicelled spikelet 3.2–5mm; anthers 1.8–2.1mm; pedicel 1.9–2.5mm.

Bhutan: C — Thimphu (common in Thimphu and Paro valleys), Punakha (Lobesa to Tinlegang, Wangdi Phodrang to Chusom, 0.5km N of Punakha Dzong) and Tongsa (N of Shemgang, Tongsa, Bubja to Kinga Rapden) districts. Common on roadsides, dry rocky banks and bushland, etc.; in *Eucalyptus* plantation; margin of paddy field, 1270–2740m. August–October.

Rather variable in terms of spikelet size, and width of keel wings and number of intercarinal veins of the lower glume. Differs from Khasian specimens in having fewer intercarinal veins, but this seems to be a variable character even within a single infl. and therefore of relatively small taxonomic importance.

Forms intermediate with *C. pendulus* occur (e.g. *Miller 277A, K*). The Tongsa specimens are very tall, with large panicles and are intermediate with *C. flexuosus* var. *sikkimensis*.

2. *C. flexuosus* (Nees ex Steudel) J.F. Watson var. *sikkimensis* Bor. Fig. 57f–g.

Similar to *C. khasianus* but usually occurring at lower altitudes; differs as follows: ligule usually longer (3.5–8mm), longer than wide; panicles larger, laxer, the primary branches again branched, with long, slender, pendulous secondary branches; hairs on raceme internodes and pedicels shorter (usually c.0.8mm) and sparser; racemes narrower, not flushed dark purple; awn of lemma of sessile spikelet weaker, shorter (6.3–8.8mm).

Bhutan: S — Samchi distrit (Dhamdum (M.F.B.)); C — Punakha district (Lobesa); **Terai** (Kynanooka, Sivok Forest); **Sikkim** (above Lagyap, Rangpo, Rishee); **Darjeeling** (between Badamtam and Rangit, Takvar, Tista River). On rocks, 370–1520m. September–November.

According to a note on a specimen by Burkill 'smell pleasant – not of citronella, but possibly of it mixed with coumarin'. The Lobesa specimen is atypical in having short ligules.

Soenarko (1977) did not treat this taxon, but identified one of the syntypes as *C. microstachys* (Hook. f.) Soenarko, thus implying that this variety should be sunk into that species which she considered to be intermediate between *C. flexuosus* and *C. khasianus*. The spikelet measurements do not agree with those she gives for *C. microstachys* and I think it best to keep var. *sikkimensis* as a distinct taxon for the time being; it is probably not related to *C. flexuosus* (a widespread SE Asian species, the source of 'oil of lemon grass'). Further work is needed, and all three taxa (*C. microstachys*, *C. khasianus* and *C. sikkimensis*) should probably be treated within a single species.

3. **C. pendulus** (Nees ex Steudel) J.F. Watson; *A. nardus* L. var. *grandis* Hackel, p.p. Names in Terai: *baid ghas*, *gandari*. Fig. 57h.

Lemon-scented. Culms 0.9–3m, grooved or flattened on one side in upper part. Leaf blades glaucous, 0.7–1.4cm wide; sheath apex glabrous; ligule truncate-ciliate, 1.7–2mm, shorter than wide. Infl. 31–113cm, rather lax, spreading; spatheoles drying pale orange, 20–27mm, rather wide. Racemes never dark purplish, the short-peduncled 17–19.6mm; the long-peduncled 18–22mm, with (3–)4–5 spikelet pairs and a triad; internodes 1.8–2.7(–3)mm, densely hairy, hairs 3–4mm. Sessile spikelet 5.3–6.3(–7.3)mm; lower glume (4.9–)5.2–5.9(–6.5) × 1.2–1.4(–1.6)mm, oblong to oblanceolate, apex bifid, back flat or slightly convex in upper third, with 1–3 intercarinal veins, lower half strongly concave nearly always lacking depressions, sometimes with a shallow but distinct central groove extending into upper part, keels winged above, wings often drying reddish, 0.2–0.3mm wide, minutely serrate; upper glume 5–5.2(–6.5)mm, acuminate, strongly keeled, faces half-lanceolate, keel narrowly winged above, margins usually glabrous; lower lemma 4.4–4.7(–5.8)mm, linear-lanceolate, acute, margins usually glabrous; upper lemma base oblong, 1.2–1.9mm, teeth 0.8–1.2mm, ciliate, awn 10.4–16.5(–18.1)mm, strong, geniculate. Pedicelled spikelet, 5–6(–7)mm; anthers 2.4–3.6(–4)mm, orange; pedicel 2.3–3.5mm.

Bhutan: S — Samchi (Chenari Khola) and Sankosh (Tshokana to Sankosh) districts; C — Punakha district (Wangdi Phodrang, 20km S of Wangdi Phodrang); **Terai** (Dulkajhar, Baradighi Railway Station, Banarhat, Sivok to Siliguri, Tondu Forest, by Tista River); **Darjeeling** (Punkabari, Debiganj to Bhatgaon, Tista Valley, Matigera to Naxalbari). Dry hillsides; rough scrub and banks around cultivated ground in dry valley; edge of sal forest; rocky river bank, 150–2000m. August–January.

According to a note on a specimen by Burkill ‘plucked and put into the house because it smells nice, but not otherwise used’.

Some specimens from Punkabari have small racemes and spikelets and are intermediate with *C. flexuosus* var. *sikkimensis*; the species also grades into *C. khasianus*.

4. **C. bhutanicus** Noltie. Sha: *solo baang*. Fig. 57i–j. Plate 8.

Very strongly lemon-scented; similar to *C. pendulus* from which it differs as follows: leaves narrower (to 8.8(–9.8)mm wide), inrolled; sheath apex hairy at junction with underside of leaf blade; ligule over 3.5mm, longer than wide; hairs on pedicels and raceme internodes shorter (1.5–2.5mm), so spikelets appearing less hairy; lower glume of sessile spikelet densely covered in small oil glands, shallowly grooved in lower half, between the 2(–3) intercarinal veins, keels not winged.

Bhutan: C — Mongar and Tashigang districts. Very common on dry rocky banks in chir pine forest, 700–1400m. September–October.

This species is of great economic importance and appears to be the only one used in Bhutan for oil extraction. According to an article in *Kuensel* (14 iii 1987) Tashi Industries established a Lemon Grass oil distillation unit in Kurizampa (Mongar) in 1981, with numerous, smaller satellite plants. The oil is exported to India and is used in making medicines, perfumes and soaps. Two forms occur, which differ in the yield and chemical composition of their oil; the valuable one (known locally as '*C. flexuosus*') produces a lower yield of oil rich in citral. The other form (known locally as '*C. distans*') produces a higher yield of oil which is rich in piperitone and therefore unsaleable. The two forms are distinguishable in the living state, but not in the herbarium.

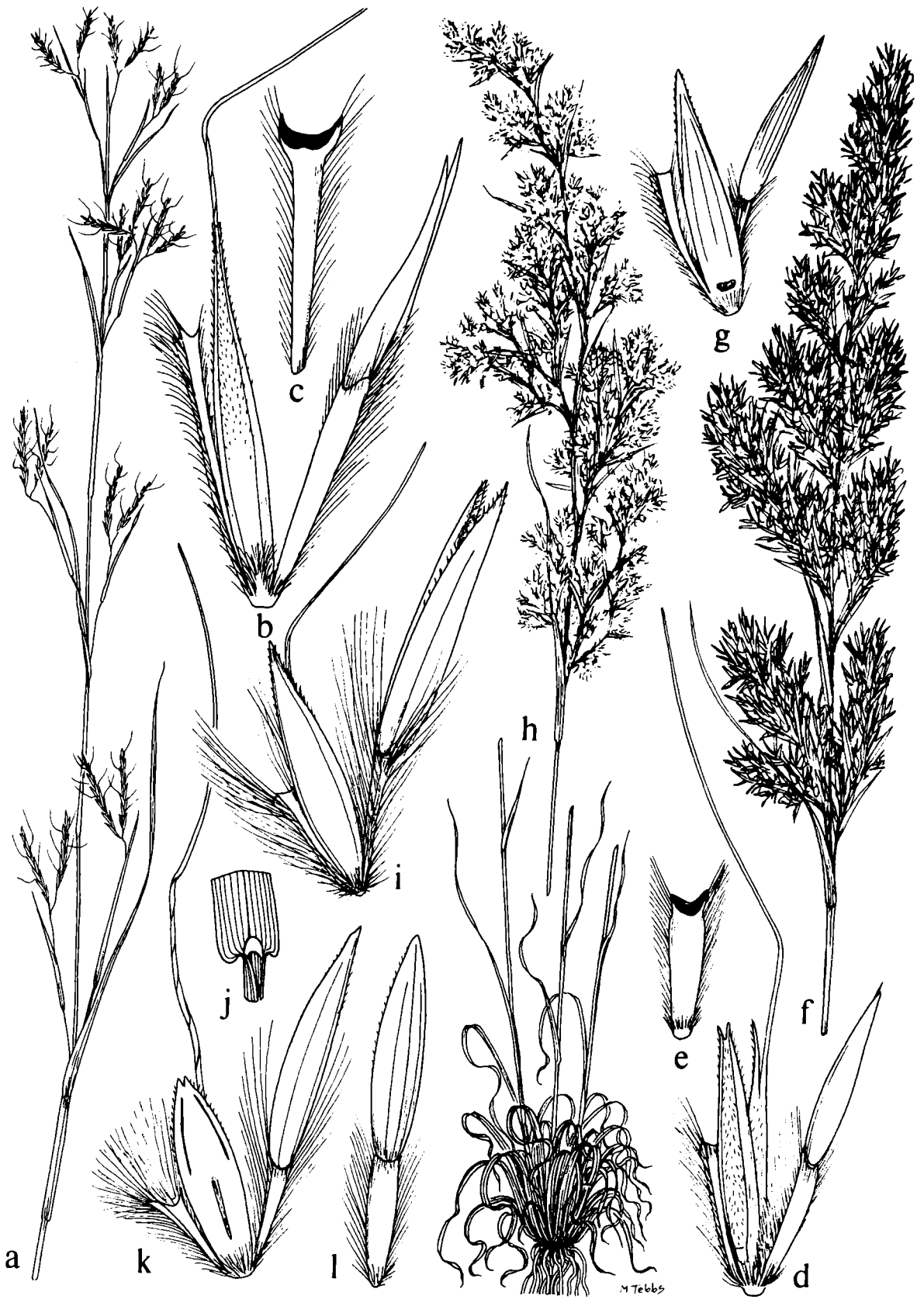
5. *C. munroi* (C.B. Clarke) Noltie; *C. hookeri* (Munro ex Hackel) Stapf ex Bor; *Andropogon hookeri* Munro ex Hackel. Fig. 58a–c.

Non-aromatic. Culms (10–)40–150cm, compressed. Leaves mainly basal, ± distichous, blades 2–5mm wide, glabrous or sparsely long-hairy above; sheaths sharply keeled; ligule subacute, c.3.5mm. Infl. 24–78cm, rather lax, narrow, primary branches stiffly erect, not overlapping; spatheoles drying brown, 23–40mm, narrow. Racemes paired, or terminal ones of branches sometimes in groups of 3 or more, erect or deflexed, dark purplish, the short-peduncled 17–30mm; the long-peduncled 17–39mm, with 4–7 spikelet pairs and a triad; internodes 2.5–4.1mm, margins long-ciliate, hairs 1–2mm. Sessile spikelet 4.5–6.7mm; lower glume 4.2–6.1 × 0.5–0.7mm, narrowly oblong-triangular, sharply bidentate, keels wide, smooth below, minutely hispid towards apex, deeply grooved between keels, groove usually densely puberulous; upper glume 4.2–6.1mm, narrowly oblong-lanceolate, apiculate (0.6–0.9mm); lower lemma 3.4–5mm, oblong-triangular, acute, 2-keeled; upper lemma with hyaline base 1.3–3.8mm, drawn upwards into 2 long, filiform points, awned in sinus, awn twisted, geniculate, 11.1–15.6mm; anthers yellow, c.1mm. Pedicelled spikelet 4–5mm; anthers c.1.9mm; pedicel 2–3.8mm, flat, margins long-ciliate.

Bhutan: S — Chukka (c.8km S of Chukka) and Deothang (Moshi to Mukazor) districts; **C** — Thimphu (Confluence), Tongsa (Tongsa, Bubja to

FIG. 58.

a–c, *Cymbopogon munroi*: a, infl. (× 1/3); b, spikelet pair (× 8); c, raceme internode (× 8). d–e, *C. microtheca*: d, spikelet pair (× 8); e, raceme internode (× 8). f–g, *C. nardus*: f, infl. (× 1/3); g, spikelet pair (× 8). h–i, *C. jwarancusa*: h, habit (× 1/3), i, spikelet pair (× 8). j–l, *C. martinii*: j, leaf base (× 1/3); k, spikelet pair (× 8); l, lowest pedicelled spikelet of raceme showing swollen pedicel (× 8). Drawn by Margaret Tebbs.



Kinga Raptan), Mongar (Mongar to Kuru Chu) and Tashigang (below Yadi) districts. Steep, rocky slope with scrub; chir pine forest, 1100–2160m. September–October.

6. *C. microtheca* (Hook. f.) A. Camus; *A. microtheca* Hook. f. Nep: *salim*. Fig. 58d–e.

Differs from *C. munroi* as follows: infl. denser; racemes reddish-brown, shorter, the long-peduncled 8.5–9mm, with 2 spikelet pairs and a triad; sessile spikelet smaller (3.5–3.9mm); pedicel conspicuously widened upwards, one face conspicuously convex.

Darjeeling (Nandunga, Tarkhola to Rangpo, Tista); **Sikkim** (Ratey Pani, Lueng Basti area). On rocks, with *Erioscirpus comosus*, 210–1500m. September–January.

7. *C. nardus* (L.) Rendle; *Andropogon nardus* L. Fig. 58f–g.

Culms to 80cm. Leaf blades glaucous, c.1.5cm wide, margins sharply serrate; sheath apex appressed-hairy at junction with underside of leaf blade; ligule truncate-ciliate, c.3mm, shorter than wide. Infl. c.30cm, extremely dense, the small racemes scarcely noticeable among spathes and spatheoles; spatheoles dark brown, c.1cm, filiform. Racemes pale brown, the short-peduncled c.6.5mm; the long-peduncled c.10.3mm, with c.2 spikelet pairs and a triad; internodes c.2.7mm, triangular in section, hairy on angles, hairs to 1mm. Sessile spikelet c.4.4mm, unawned; lower glume c.4 × 0.9mm, oblong-lanceolate, apex acute, back slightly convex, with c.3 intercarinal veins, keels narrowly winged above, wings c.0.1mm wide, minutely serrate; upper glume c.3.8mm, lanceolate, acute, keeled, keel minutely hispid above, margins hyaline, inflexed, ciliate; lower lemma c.3.6mm, oblong-lanceolate, acute, margins inflexed, ciliate; upper lemma linear, c.2.4mm, with shortly excurrent (0.2mm) midrib, margins ciliate above; anthers c.1.4mm, yellow. Pedicelled spikelet c.3.7mm; anthers c.1.5mm; pedicel c.2.1mm, flat, margins ciliate.

Darjeeling (below Takvar). Cultivated on roadside banks in tea gardens, 1250m. August.

Native of S India and Sri Lanka, but cultivated elsewhere in the tropics for its oil. According to Soenarko (1977) the oil (used for scenting soap, disinfectants and sprays) is known as citronella oil and the plant is known as *new citronella grass*.

8. *C. jwarancusa* (Jones) Schultes; *Andropogon jwarancusa* Jones. Fig. 58h–i.

Aromatic. Culms 44–120cm. Leaf blades inrolled, much shorter than culms, filiform, under 2mm wide; sheath apex glabrous, bases persistent, dull, pale brown, to 0.6cm wide, spiralling on drying; ligule truncate-ciliate, 0.7–1mm, shorter than wide. Infl. 12–32cm, narrowly cylindrical, partial infls.

not overlapping; spatheoles drying cream, 1.4–2cm, narrow. Racemes pale, plumose, the short-peduncled 12–14mm, lacking basal homogamous pair; the long-peduncled 13–15mm, with 3–4 spikelet pairs and a triad; internodes 1.5–2.1mm, hairs 4–5mm (i.e. longer than sessile spikelet). Sessile spikelet 4.1–4.7mm; lower glume 3.9–4.3 × 0.7mm, oblong-ob lanceolate, apex bidentulate, back deeply concave, un veined, keels scarcely winged above, minutely serrate; upper glume 3.7–4mm, oblong-lanceolate, acute, sharply keeled, keel minutely excurrent, margins hyaline, inflexed; lower lemma 3.1–3.5mm, linear-lanceolate, blunt, margins inflexed, ciliate above; upper lemma 6.3–7mm (incl. awn), with narrow, hyaline base gradually tapered into weak, scarcely geniculate awn; anthers 1.5–2.6mm. Pedicelled spikelet 4–5.1mm; anthers c.2mm; pedicel 1.7–2.2mm.

Bhutan: S — Phuntsholing district (bed of Torsa River, Phuntsholing); C — Punakha district (Punakha, 25km S of Wangdi Phodrang). Dry, open bushland on silty soil; ridges in river bed, 400–1370m. August–January.

9. C. martinii (Roxb.) J.F. Watson. Fig. 58j–l.

Aromatic. Culms to 100cm, leafy. Leaf blades to 27 × 2.5cm, flat, oblong-lanceolate, bases cordate, clasping; sheath apex glabrous; ligule c.6mm, shorter than wide, rounded, brown. Infl. c.26cm, narrowly cylindrical, greenish; spatheoles drying green, c.15mm, narrow. Racemes greenish, the short-peduncled c.10mm, the long-peduncled c.15mm, with c.3 spikelet pairs and a triad; internodes c.2mm, margins long-ciliate, hairs white, to 3mm. Sessile spikelet c.3.7mm; lower glume c.3.5 × 0.9mm, oblong-lanceolate, back flat, with central groove in lower half, keels narrowly winged above, wings c.0.1mm, minutely hispid; upper glume strongly keeled, keel winged near apex, margins ciliate, hairy about middle in lower half; lower lemma c.3.2mm, margins ciliate; upper lemma base c.0.8mm, teeth c.0.5mm, awn c.14mm, strong, geniculate. Pedicelled spikelet c.3.9mm; anthers c.2.5mm, yellow; pedicel c.1.8mm, the lowest pedicel of each raceme swollen.

Bhutan: C — Mongar (Lingmethang) and Tashigang (below Yadi) districts. Cultivated.

Introduced from India and grown on a small scale for extraction of geraniol. The form grown is presumably the one known in India as *motia* or *palmarosa*. However, confusingly, it is also known in Bhutan as *ginger grass*. Ginger grass oil, which has a lower geraniol content, is extracted from the form of *C. martinii* known as *sofia*.

Doubtfully recorded species:

C. flexuosus var. *flexuosus*

Recorded for the Confluence in M.F.B., but from the locality this almost certainly refers to *C. khasianus*. *C. flexuosus* var. *flexuosus* is mainly a Peninsular Indian taxon (though widely cultivated as the source of lemon grass oil).

112. SCHIZACHYRIUM Nees

Perennials or annuals. Leaf blades flat; ligule membranous, ciliate. Infl. of singly-borne, terminal and axillary, pedunculate racemes; racemes bearing sessile and pedicelled spikelets and a terminal triad; internodes and pedicels \pm flat, with toothed apical cup. Spikelets dissimilar. Sessile spikelet awned, bisexual, florets 2, the lower sterile, epaleate, the upper bisexual, palea reduced or absent; lower glume semi-chartaceous, back slightly convex to flat, 2 keeled, margins inflexed; upper glume semi-chartaceous, 1-keeled; lower lemma hyaline; upper lemma deeply divided into two subulate teeth, awned from sinus, awn geniculate. Pedicelled spikelet awned or unawned, sometimes reduced to a single glume, if more fully developed then male, with 2 glumes and a hyaline lemma.

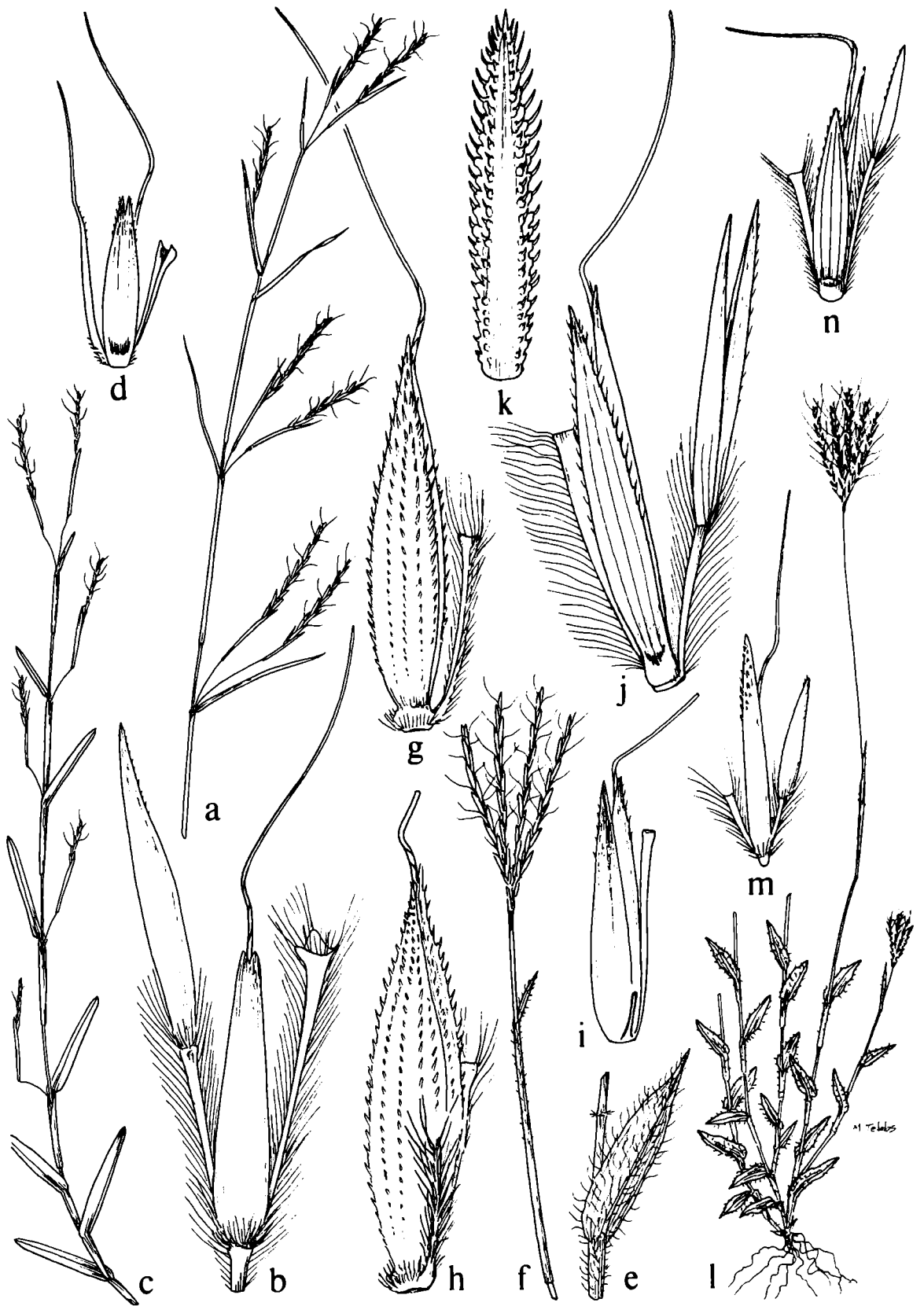
1. Stout perennial; leaves finely tapered to apex; pedicelled spikelet unawned, well developed, male 1. **S. delavayi**
 + Slender annual; leaves blunt; pedicelled spikelet awned, sterile consisting of a single, reduced glume 2. **S. brevifolium**

1. **S. delavayi** (Hackel) Bor; *Andropogon bootanensis* Hook. f. Fig. 59a–b.

Clump-forming, shortly rhizomatous. Culms 50–150cm, unbranched, wiry, erect. Leaf blades to 22cm long, 2–2.7mm wide, gradually tapered to very acute apex, densely appressed-hairy beneath; sheaths appressed-hairy; ligule subacute, c.1mm. Peduncles borne in groups of 1–3 in leaf axils. Racemes often purplish, 22–40 \times 2–4.5mm, spikelet pairs 5–11, internodes 1.8–2.8mm, margins ciliate, hairs white, 1.5–2.5mm. Sessile spikelet 4.4–4.9mm; callus hairs 0.5–1mm; lower glume 3.6–4.7 \times 1–1.2mm, oblong-lanceolate, apex \pm

FIG. 59.

a–b, **Schizachyrium delavayi**: a, infl. ($\times \frac{1}{3}$); b, spikelet pair and raceme internode ($\times 8$). c–d, **S. brevifolium**: c, habit ($\times \frac{2}{3}$); d, spikelet pair and raceme internode ($\times 8$). e–h, **Arthraxon hispidus**: e, culm leaf ($\times \frac{2}{3}$), f, infl. ($\times \frac{2}{3}$); g, back of spikelet and raceme internode ($\times 8$); h, front of spikelet and ciliate pedicel rudiment ($\times 8$). i, **A. quartinianus**: front of spikelet showing glabrous raceme internode and pedicel rudiment ($\times 8$). j–k, **A. prionodes**: j, spikelet pair and raceme internode of temperate form ($\times 8$); k, back of sessile spikelet of subtropical form ($\times 8$). l–m, **A. lancifolius**: l, habit ($\times \frac{2}{3}$); m, spikelet pair and raceme internode ($\times 8$). n, **A. microphyllus**: spikelet pair and raceme internode ($\times 8$). Drawn by Margaret Tebbs.



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truncate, 2–3-toothed, back 4–6-veined, keels narrowly winged in upper half, wings hispid-ciliate; upper glume 4–4.5 × 0.8–1mm, narrowly lanceolate, acute, margins inflexed, hyaline and ciliate below apex; lower lemma 3–3.6 × 0.8–1.2mm, oblong-lanceolate, ciliate on margins below apex and sparsely so on back; upper lemma with oblong, hyaline base 1.7–2.1mm, teeth 0.4–1mm, awn 6.1–11.3mm; anthers 2.1–2.3mm; palea minute (0.4–1.1mm), triangular, margins ciliate. Pedicelled spikelet 4.5–5mm; lower glume 4.2–4.8 × 1–1.2mm, oblong-lanceolate, back 3–4-veined, keels ciliate near apex; upper glume 4–4.5 × 0.8–1mm, like that of sessile spikelet; lemma 2.6–3.5 × 0.6–1.1mm, oblong to lanceolate, blunt to subacute, ciliate near apex; anthers 1.8–2.3mm; pedicel 2–2.5mm, margins ciliate, hairs white, 1.5–2.4mm.

Bhutan: **S** — Chukka district (Chapcha to Bunakha); **C** — Thimphu (very common in Thimphu and Paro valleys), Tongsa (Rukubji), Bumthang (on way to Thangbi, Bumthang), Tashigang (Tashi Yangtshi) and Sakden (Gibson, 1991) districts; **Chumbi.** Dry, open hillsides, 1920–2900(–3350)m. June–September.

2. *S. brevifolium* (Swartz) Nees ex Büse. Fig. 59c–d.

Tufted annual. Culms 3–45cm, bearing many slender, lateral infl. branches. Leaves 8–30 × 1–4.7mm, narrowly oblong, blunt; sheaths keeled; ligule c.0.8mm, truncate. Racemes 8–15mm, very slender (c.0.7mm wide), spikelet pairs 2–6, internodes 1.7–2.6mm, abaxial face concave, gradually widened upwards, margins minutely hispid. Sessile spikelet 2.4–3.5mm; callus hairs 0.6–1mm; lower glume 2.2–3.2 × c.0.6mm, oblong-lanceolate, apex bidentate, back 3-veined, hispid, keels not winged, minutely hispid; upper glume 2.1–3.1 × c.0.5mm, narrowly lanceolate, acute, strongly keeled, keel minutely hispid, margins narrowly inflexed, ciliate below apex; lower lemma 1.8–2.2 × 0.3–0.7mm, oblong-lanceolate, ciliate on margins below retuse apex; upper lemma divided almost to base, teeth 1.6–2.2mm, awn with dark coloured column 2.6–3.7mm, apex pale, 3.1–5mm, hispid; anthers c.0.7mm. Pedicelled spikelet consisting of a reduced, awned lower glume, 0.5–1 × 0.2–0.5mm, awn 1.9–2.5mm, slender, straight, hispid; pedicel 1.8–2.5mm, margins minutely hispid.

Bhutan: **C** — Thimphu (near Drukyel Dzong), Punakha (Wangdi Phodrang, Chuzomsa to Samtengang), Tongsa (Bubja to Kinga Raptan), Bumthang (Thangbi), Mongar (between Mongar and the Kuru Chu) and Tashigang (Rangthangwong) districts; **Darjeeling** (Balasun Valley). Bare patches on eroded, scrub-covered ridge and in blue pine and chir pine forest, 750–2700m. September–November.

113. ARTHRAXON P. Beauvois

Perennials or annuals. Culms usually branched. Leaf blades flat, \pm lanceolate, base cordate, clasping culm, the basal auricles commonly with long, tubercle-based cilia; sheaths with ciliate margins; ligule membranous, truncate-ciliate. Infl. of terminal and axillary, digitately arranged racemes, racemes bearing pairs of sessile and pedicelled spikelets, the pedicelled sometimes reduced or absent, axis fragile, internodes \pm flattened, angles commonly ciliate. Sessile spikelet awned, florets 2, the lower sterile, the upper bisexual, epaleate; lower glume herbaceous, oblong-lanceolate, usually bidentate, back flat to convex, margins inflexed or not; upper glume narrowly lanceolate, conduplicate with rounded, herbaceous keel, margins broadly hyaline; lower lemma \pm oblong, hyaline; upper lemma hyaline, lanceolate, back flattened against a basally inserted, geniculate awn; anthers 2–3. Pedicelled spikelet absent, sterile (consisting only of lower glume) or if well-developed, then awnless, male, with 2 lemmas similar to lower lemma of sessile spikelet and 2–3 anthers.

Superficially similar to, and sometimes confused with, *Microstegium* from which it differs especially in its clasping leaf bases and in having pedicelled spikelets awnless or absent.

1. Small, tufted annuals; culms slender, commonly under 20cm; leaf blades very small (usually under 1.5×0.5 cm); sessile spikelets small (usually under 3mm) 2
- + Usually perennials, habit untidy and sprawling; culms stout, usually over 20cm; leaf blades usually over 2×0.6 cm; sessile spikelets large (over 3.8 and usually over 5mm) 3
2. Lower glume of sessile spikelet \pm smooth 4. **A. lancifolius**
- + Lower glume of sessile spikelet deeply 3–5-grooved .. 5. **A. microphyllus**
3. Pedicelled spikelet rarely developed; anthers to 1mm; lower glume of sessile spikelet strongly convex (almost conduplicate), lacking lateral keels, margins not inflexed, veins on back all hispid, at least near apex 4
- + Pedicelled spikelet nearly always developed; anthers over 2mm; lower glume of sessile spikelet flattish on back, with inflexed margins, lateral keels spinose at least near apex, veins on back glabrous or if hispid then the keel spines with stout, swollen bases 3. **A. prionodes**

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4. Pedicels over 1mm, ciliate; sessile spikelets over 5.5mm; raceme internodes ciliate **1. *A. hispidus***
+ Pedicels minute (under 0.5mm), glabrous; sessile spikelets under 5mm; raceme internodes glabrous **2. *A. quartinianus***

1. *A. hispidus* (Thunberg) Makino; *A. hookeri* (Hackel) Henrard. Sikkim name: *charay naten*. Fig. 59e–h.

Usually perennial. Culms 15–77cm, much branched, sprawling and rooting from lower nodes. Leaf blades 2–4.2 × 0.6–1.2cm, lanceolate to narrowly ovate, abruptly acuminate, usually pilose beneath, basal auricles with setae on margin; sheaths glabrous or with tubercle-based hairs above; ligules 0.8–1.5mm. Racemes 4–8, 2.5–5.5cm, internodes (2–)2.6–3.9mm, margins sparsely ciliate. Sessile spikelet (4.5–)5.5–6.8mm; lower glume (3.9–)4.9–6.3 × (0.7–)0.9–1.2mm, linear-lanceolate, acute, back strongly convex, (7–)9–13-veined, veins hispid, margins not inflexed; upper glume (4.3–)5.1–6.6mm, each half 0.6–1.1mm wide, keel hispid, margins sometimes ciliate above; lower lemma (2–)2.8–3.3 × (0.6–)0.8–1.2mm, oblong-lanceolate, acute; upper lemma blade (2.2–)2.7–3.3mm, lanceolate, subacute, awn (6.4–)10.4–13.2mm; anthers 2, (0.8–)1.2–1.5mm. Pedicel 1–2.5mm, minutely ciliate, spikelet only very occasionally developed.

Bhutan: C — Tongsa (Tongsa to Bubja), Bumthang (Thangbi, Bumthang) and Tashigang (Tashi Yangtshi to Bomdeling, Yonphu La) districts; **Darjeeling** (Mungpo, Jalapahar, Kurseong); **Sikkim** (Domang, Dubdi). Damp, disturbed habitats (roadsides, fields), 1220–3060m. August–October.

2. *A. quartinianus* (A. Richard) Nash. Fig. 59i.

Differs from *A. hispidus* as follows: infl. often dark-coloured; pedicels reduced to minute, glabrous points, under 0.5mm; sessile spikelets under 5mm; awn of upper lemma shorter (4.6–11.5mm); raceme internodes slender, curved, completely glabrous; leaf blades glabrous beneath.

Bhutan: S — Samchi and Chukka districts; C — Thimphu, Tongsa, Bumthang, Mongar and Tashigang districts. Common in damp, disturbed habitats (roadsides, fields), 500–2650m. June–December.

Parker (1992) recorded it as a weed of dryland and irrigated crops, especially in E Bhutan.

Van Welzen (1981) lumped many species (including *A. quartinianus*) under *A. hispidus*; however in Bhutan two very distinct forms occur and it seems pointless not to recognise these. The names, however, are of very uncertain application as there has been so much confusion. I am using the name *A. quartinianus* as it has generally been understood, though it is probably not the earliest.

3. **A. prionodes** (Steudel) Dandy; *A. lanceolatus* auct., non (Roxb.) Hochstetter. Fig. 59j–k.

Rhizomatous perennial, forming dense clumps. Culms 20–53cm. Leaf blades 2.7–6.5 × 0.5–0.7cm, glabrous, margins finely serrate or pectinate, with stout setae; sheaths usually glabrous; ligules c.0.5mm. Racemes 2–4, 4.5–6cm, internodes 3.3–4.6mm, margins densely ciliate, cilia 1.8–2.7mm, white. Sessile spikelet 5.4–6.5mm; lower glume 5.1–5.9 × 0.5–0.7mm, linear-lanceolate, back slightly convex, 5-veined, lateral and sometimes submarginal veins spinose, spines tubercle-based, other veins smooth or hispid, margins inflexed; upper glume 4.7–6.2mm, each half 0.5–1.1mm wide, margins ciliate above; lower lemma 2.1–3.1 × 0.4–0.7mm, oblong, blunt; upper lemma blade 3.4–4mm, narrowly lanceolate, finely acuminate, awn 9.4–11.3mm; anthers 3, 2.6–3.1mm. Pedicelled spikelet 2.6–5mm; lower glume 2.6–5.1 × 0.4–0.8mm, linear-lanceolate, 7-veined, lateral veins hispid; upper glume 3.7–4.7 × c.0.6, pubescent; lemmas 2, like lower palea of sessile spikelet, 2.3–3mm; anthers 3, 2–2.2mm; spikelet sometimes reduced, consisting only of lower glume; pedicel 1.5–2.7mm.

Bhutan: C — Thimphu (Simtokha to Namselling, Thimphu, Taba, Motithang, Drukyl Dzong), Punakha (Chuzomsa) and Tongsa (3km W of Tongsa, Bubja to Kinga Rapten) districts. Sandy or gravelly banks of roadsides, hillsides; open blue pine forest, 1200–2600m. August–September.

Included by van Welzen (1981) under *A. lanceolatus* (Roxb.) Hochstetter, but I agree with Bor in restricting this latter name to plants from S India. The Thimphu plants (from 2200–2600m) are very distinct from those of lower altitudes (1200–2120m) in Punakha and Tongsa. The former have narrow leaves and rather weak marginal spines on the lower glumes; the latter have wider leaves, with strong cilia and very strong marginal and submarginal spines on the glumes and thus approach var. *echinatus* (Nees) Hackel.

4. **A. lancifolius** (Trinius) Hochstetter. Fig. 59l–m.

Slender, tufted annual. Culms 7–25cm, slender, ascending from base. Leaf blades 0.7–2.4 × 0.3–0.6cm, pilose above and beneath, margins minutely serrate, with some long cilia on basal auricles; ligule c.0.5mm. Racemes 7–12, 1.2–2.5cm, internodes 1–1.5mm, margins densely ciliate, cilia 1.2–2.2mm, white. Sessile spikelet 2.4–3mm; lower glume 2.3–3 × 0.1–0.3mm, linear, back slightly convex, smooth, 5-veined, veins conspicuously hispid, sharply bidentate, margins not inflexed; upper glume 2.2–2.9mm, conduplicate, each half 0.3–0.4mm wide, finely acuminate into short apiculus (to 0.6mm), keel hispid; lower lemma 0.8–1.2 × 0.1–0.2mm, oblong, subacute; upper lemma with blade 0.9–1.4mm, narrowly lanceolate, acute, awn 4.1–7.7mm; anthers 2, c.0.4mm. Pedicelled spikelet present or not, male or sterile, 1.2–1.7 × 0.3–0.4mm; lower glume 1.4–1.7 × 0.3–0.4mm, lanceolate, acuminate,

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5-veined, veins minutely hispid; upper glume 1.3–1.6 × 0.2–0.4, glabrous (sometimes absent); lemma 0.8–1.2 × 0.2–0.3mm; pedicel 0.6–0.8mm.

Bhutan: S — Deothang district (Wamrong); C — Thimphu (Paro Dzong to Paro Museum, near Tashichho Dzong), Punakha (Punakha to Lobesa, Wangdi Phodrang), Tongsa (Bubja to Kinga Rapten) and Tashigang (2km from Kanglung) districts; **Darjeeling** (Darjeeling, Kurseong); **Sikkim** (Kaysing, Rinchingpong to Gassing). Banks and cliffs in chir pine, blue pine and oak zones; on masonry of old bridge, (760–)1070–2500m. September–October.

5. *A. microphyllus* (Trinius) Hochstetter; *A. sikkimensis* Bor. Fig. 59n.

Similar to *A. lancifolius* in being a small, slender, tufted annual, but differs as follows: raceme internodes longer (2.2–2.4mm), with shorter cilia (1.1–1.3mm); sessile spikelet longer (3.5–4.5mm), the lower glume deeply 3–5-grooved, wider (0.5–0.8mm), 7-veined; hyaline blade of upper lemma longer (1.9–2.2mm), awn longer (8.3–10.5mm) and stouter; pedicelled spikelet linear, consisting only of ribbed lower glume 1.7–2 × 0.2–0.3mm; pedicel longer (1.5–2.1mm).

Bhutan: S — Deothang district (Ngangshing to Narfong); C — Thimphu (below Phajoding), Punakha (S side of pass between Nobding and Phobjikha), Tongsa (Tongsa to Tsangkha), Bumthang (Thangbi) and Tashigang (Yonphu La) districts; **Sikkim** (Lachung, Yakla). Banks and cliffs in broad-leaved, blue pine and fir zones; banks in yak pasture, 2380–3350m. August–October.

114. HETEROPOGON Persoon

Tufted perennials. Leaf blades flat; sheaths keeled; ligule membranous, truncate-ciliate. Infl. of terminal and lateral, singly borne, pedunculate racemes, peduncles inserted singly or in groups in axils of culm leaves. Racemes: lower part composed of persistent, similar (homogamous) spikelet pairs, internodes minutely ciliate; upper part composed of deciduous, dissimilar (heterogamous) spikelet pairs, internodes concealed by dense reddish-brown hairs. Homogamous spikelets unawned, florets 2, male, the lower sterile, epaleate, the upper male, paleate; lower glume chartaceous, back ± flat, finely veined, 2-keeled, keels asymmetrically winged, one throughout, the other only near apex, wings hyaline, ciliate-hispid; upper glume 1-keeled, margins long-ciliate; lower lemma hyaline; upper lemma lanceolate, hyaline; palea small. Sessile spikelet of heterogamous pair awned, florets 2, the lower sterile or male, the upper bisexual, both epaleate; lower glume chartaceous, dark brown, back strongly convex, hispid; upper glume linear, central keel brown, hispid, margins hyaline clasping awn; lower lemma hyaline; upper

lemma with a linear, hyaline base drawn upwards into stout awn, awn geniculate, appressed ciliate on column, hispid above. Pedicelled heterogamous spikelets similar to the homogamous, unawned.

1. **H. contortus** (L.) P. Beauvois ex Roemer & Schultes; *Andropogon contortus* L. Sha: *khendangbu*; Eng: *black spear grass*. Fig. 62a–b.

Culms 23–60cm, compressed, glabrous, simple. Leaf blades to 40cm (shorter than culms), narrowly oblong, 3–5mm wide, apex rounded or acute, glabrous or with sparse, tubercle-based hairs above and beneath; sheaths usually with long hairs at apex; ligule 0.7–1mm. Peduncles 12–20cm. Racemes 35–65mm, awns twisting into a tail when dry; homogamous pairs 6–9, internodes 2.1–3.8mm; heterogamous pairs c.8 (+ terminal triad), internodes 2–3mm. Sessile homogamous spikelet 6.5–10mm; lower glume 6.5–9 × 1.3–1.8mm, wing 0.2–0.5mm, back narrowly oblong lanceolate, glabrous or with spreading, tubercle-based bristles; upper glume 6.4–9.3 × 0.8–1.7mm, linear-lanceolate; lower lemma 5.5–7.6 × 0.8–1.2mm, linear-lanceolate, ciliate at apex; upper lemma 5–6.5 × 0.5–1.9mm, linear, margins ciliate above; palea 0.8–1.7mm or absent; anthers 2.6–3.9mm. Pedicelled homogamous (and heterogamous) spikelets similar to sessile, but upper glume exceeding lower. Sessile heterogamous spikelet 4.3–6mm; callus very acute; lower glume 4.3–6 × 0.7–1.1mm, oblong; upper glume 4–6.2 × 0.5–0.7mm, linear; lower lemma 3.3–3.7 × 0.7–1mm, oblong, blunt, ciliate or glabrous; hyaline base of upper lemma 3.7–5.5mm, awn 47–80mm.

Bhutan: C — Thimphu (Shaba to Chuzom, Paro), Punakha (Samtengang, Wangdi Phodrang, Chuzomsa) and Tashigang (Tashigang to Yadi) districts. Dry, stony hillsides; old cultivation, 720–2200m. August–October.

115. THEMEDA Forsskål

Tufted, perennials. Culms unbranched, glabrous, often tall. Leaf blades flat; leaf sheaths keeled; ligule membranous. Infl. an often much branched panicle, branches subtended by spathe-like bracts, the branches bearing single or clustered racemes each subtended by a spatheole. Raceme consisting of usually two pairs of persistent, basal ('involucral'), homogamous spikelets, a terminal triad and usually one or more spikelet pairs; callus densely hairy. Homogamous spikelets unawned, florets 2, the lower sterile, the upper male, both usually epaleate; lower glume chartaceous, many-veined, ± flat on back, margins inflexed and keeled, keels of different widths on the two sides; upper glume membranous, 1–3-veined, margins incurved, ciliate above; lower lemma hyaline, margins ciliate; upper lemma similar; palea usually absent. Sessile spikelet awned, florets 2, the lower sterile, the upper bisexual, both usually

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epaleate; lower glume usually hardened (brittle), back strongly convex, often densely strigose, margins incurved; upper glume with hardened, strigose keel which clasps awn of upper lemma (when present), margins herbaceous, inrolled; lower lemma hyaline; upper lemma hyaline, similar to lower or with a long, geniculate, minutely hispid awn; palea absent or reduced. Pedicelled spikelets similar to homogamous; pedicels \pm flat, margins usually ciliate.

1. Lower glume of homogamous spikelets densely covered with long, spreading, golden, tubercle-based hairs 2
- + Lower glume of homogamous spikelets glabrous or with minute, appressed hairs or with few tubercle-based hairs near apex 4
2. Sessile spikelets awnless **6. T. intermedia**
- + Sessile spikelets awned 3
3. Racemes with 1–2 spikelet pairs and a terminal triad; column of awn to 25mm **4. T. subsericans**
- + Racemes consisting of a single triad; column of awn over 40mm
5. T. arundinacea
4. Glumes of homogamous spikelets minutely pubescent; glumes of sessile spikelets densely strigose (hairs usually brown) 5
- + Glumes of homogamous spikelets with some long, tubercle-based hairs in upper half or smooth and glabrous; glumes of sessile spikelets shortly hairy only in upper half 7
5. Racemes consisting of a single triad; awn of upper lemma massive (column over 60mm); lower homogamous spikelet over 16mm
9. T. longispatha
- + Racemes with 1–2 spikelet pairs in addition to a triad; awn of upper lemma absent or slender (column to 20mm); lower homogamous spikelet to 15.5mm 6
6. Upper lemma usually awnless or with short awn (column shorter than raceme) **7. T. villosa**
- + Upper lemma with column of awn exceeding raceme **8. T. caudata**
7. Glumes of homogamous spikelets with scattered, long, tubercle-based hairs at least near apex; racemes to 14mm 8
- + Glumes of homogamous spikelets glabrous; racemes over 18mm
3. T. hookeri

8. Homogamous spikelets over 7mm, hairs on glumes slender, erect

1. **T. triandra** var. **laxa**

+ Homogamous spikelets to 6mm, hairs on glumes stout, spreading

2. **T. quadrivalvis**

1. **T. triandra** Forsskål var. **laxa** (Andersson) Noltie; *Anthistiria imberbis* Retzius var. *roylei* Hook. f.; *T. laxa* (Andersson) A. Camus. Fig. 60a–d.

Perennial; rhizome short, knotty. Culms 20–80cm, bearing evenly spaced leaves throughout. Leaf blades shorter than culms, widest (2.7–4.2mm) at truncate base, with few long hairs especially on margins near base, margins serrate above; sheaths with few long hairs near apex; ligule c.1mm, obliquely truncate, ciliate. Infl. 4–40cm, narrow; racemes borne singly or in clusters of 2–3, ± erect; spathes with hairy margins; spatheoles 15–24mm, glabrous. Racemes 8–14mm (excl. awns), with 4 homogamous spikelets, and a triad. Lowest homogamous spikelet 7.5–9.5mm; lower glume 7.1–9.1 × 1.1–2mm, narrowly oblong-lanceolate, c.8-veined, with few long, tubercle-based hairs near apex; upper glume 6.5–8.6mm, narrowly oblanceolate, acute, 1-veined; lower lemma 5.5–7.8mm, similar to upper glume, but margins glabrous; upper lemma reduced to a minute awn 1.3–4.7mm; anthers 3.4–4.1mm. Sessile spikelet (incl. short callus) 6–6.7mm; callus hairs 2.8–4.5mm; lower glume 5–5.9 × 1.5(–2.2)mm, lanceolate, truncate, back c.7-veined, shortly hairy near apex; upper glume 5–5.5mm, oblong, truncate, shortly hairy near apex; lower lemma 3.2–4.2mm, elliptic, blunt, margins glabrous; upper lemma with base 2.3–3.5mm, awn column 15–20mm, tip 11–15mm; anthers 2.5–3.1mm. Larger pedicelled spikelet 7.1–9.4mm; pedicels 1.7–2.2mm.

Bhutan: S — Chukka district (Chukka to Chimakothi); C — Ha (Ha (M.F.B.)), Thimphu (common around Thimphu, Drukyl Dzong), Punakha (Samtengang, Wangdi Phodrang, Lobesa), Mongar (N of Lhuntse) and Tashigang (Tashi Yangtse) districts. Oak/pine and spruce forest; seasonally wet, scrubby grassland on thin soil; apple orchards, 1400–3200m. July–October.

2. **T. quadrivalvis** (L.) Kuntze; *Anthistiria ciliata* L. f. Fig. 60e.

Differs from *T. triandra* var. *laxa* as follows: annual; racemes and other floral parts smaller: racemes to 8mm; homogamous spikelets to 5.8mm, lower glumes with stout, spreading, bristle-like hairs with large, tuberculate bases; sessile spikelet c.5.2mm; pedicelled spikelets to 5.3mm, sterile, consisting only of glumes.

Sikkim (Mangan). Habitat not recorded, c.1250m. October.

3. **T. hookeri** (Grisebach) A. Camus; *Anthistiria hookeri* Grisebach. Fig. 60f.

Differs from *T. triandra* var. *laxa* as follows: racemes all borne singly, longer (18–20mm), consisting of one spikelet pair in addition to a triad (i.e. with two awned sessile spikelets); homogamous spikelets longer (lowest 11.7–13.5mm), glumes completely glabrous.

Sikkim (Domang, Chungthang, Lachung). Habitat not recorded, 1830–3060m. August–October.

4. **T. subsericans** (Nees ex Steudel) Ridley; *Anthistiria subsericans* Nees ex Steudel. Sha: *pili*. Fig. 60g–h.

Culms to 3m. Leaves distichous, mainly basal, blades widest (0.6–1.3cm) in upper half, midrib wide, lamina gradually narrowed to base, with scattered, long, tubercle-based hairs especially beneath, margins serrate; sheaths glabrous, the basal ones very long, margins narrowly brown-hyaline; ligule c.1mm, acute, ciliate. Infl. to 49cm, much branched, drooping; racemes borne singly; spathes and spatheoles glabrous. Racemes 23–25mm (excl. awns), consisting of 4 homogamous spikelets, 1–2 spikelet pairs and a triad. Lowest homogamous spikelet 11.8–13.3mm; lower glume 11.5–12.5 × c.1.5mm, linear-lanceolate, finely acuminate, 7-veined, with many, spreading, long, golden, tubercle-based hairs all over back; upper glume 10.1–10.6mm, linear-lanceolate, acuminate, 3-veined, back glabrous; lower lemma 8.3–9.9mm, linear-lanceolate; upper lemma 8.2–8.5mm, linear-oblancheolate; anthers c.5.1mm. Sessile spikelet c.7mm; callus 2.2–2.5mm, hairs 2.5–3mm; lower glume 7.2 × 1.5–2mm, oblong-lanceolate, truncate-ciliate, back 5-veined, with central channel, densely appressed-strigose all over, hairs rusty-red; upper glume 7.2–7.8mm, oblong, subacute, appressed-strigose near apex; lower lemma 6.1–6.5mm, linear-lanceolate, acute, margins glabrous; upper lemma with base 3–4.3mm, gradually tapered into awn, awn column 22–25mm, tip 15–17mm; anthers c.2.1mm. Lowest pedicelled spikelet 13.1–14.4mm; pedicels 1.5–2mm.

Bhutan: C — Punakha (1km above Wache) and Mongar (Lingitsi, above Yonko La) districts. Rocky bank among cultivation; streamside; cliff in mixed, broad-leaved forest, 1520–1800m. September–October.

Bor (1973) speculated that this might be an awned hybrid form between *T. arundinacea* and *T. villosa*, but this seems unlikely as they do not appear to grow together. It is

FIG. 60.

a–d, **Themeda triandra** var. **laxa**: a, habit (× ½); b, raceme (× 4); c, homogamous spikelets (× 4); d, spikelet triad (× 4). e, **T. quadrivalvis**: raceme (× 4). f, **T. hookeri**: raceme (× 4). g–h, **T. subsericans**: g, raceme (× 2), h, spikelet pair (× 4). Drawn by Margaret Tebbs.



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more likely to be an 'upland' form of *T. arundinacea* from which it differs in having smaller homogamous spikelets, usually (but not in the type) more than one bisexual (i.e. awned) spikelet per raceme, and shorter, weaker awns.

5. *T. arundinacea* (Roxb.) Ridley; *Anthistiria gigantea* Cavanilles subsp. *arundinacea* (Roxb.) Hook. f.; Eng: *tiger grass* (Gamble); Nep: *artuni*. Fig. 61a.

Differs from *T. subsericans* as follows: plant larger (culms 4.5–6m); racemes consisting of a single triad; homogamous spikelets larger (lowest 18.3–20mm); sessile spikelets larger (lower glume 8.5–9.5 × 1.8mm, upper glume 8.7–9.5mm); lower lemma 7.2–8.5mm; base of upper lemma c.5.5mm), awn much longer with column 40–57mm, tip 21–37mm.

Terai (Tondu Forest, Bamunpokri, Sukna, Selim). [Presumably terai grassland], 150–610m. October–December.

6. *T. intermedia* (Hackel) Bor; *Anthistiria gigantea* Cavanilles subsp. *intermedia* (Hackel) Hook. f. Fig. 61b.

Differs from *T. subsericans* as follows: sessile spikelet with smaller glumes (lower c.6.8mm, upper c.7mm); upper lemma small (c.5mm), lanceolate, hyaline, awnless.

Bhutan: C — Punakha district (Punakha to Lobesa). Grassy banks around rice-fields, 1300m. October.

Probably only an awnless form of *T. subsericans*; Bor (1973) speculated that it might be an awnless hybrid between *T. arundinacea* and *T. villosa*.

7. *T. villosa* (Poiret) A. Camus; *Anthistiria gigantea* Cavanilles subsp. *villosa* (Poiret) Hook. f. Nep: *tulu artuni*. Fig. 61c–d.

Culms to 3.5m. Leaf blades widest (1.4–2cm) in upper half, midrib wide, lamina gradually narrowed to base, upper surface glabrous, minutely hispid on veins, occasionally moderately densely hairy, with tubercle-based hairs, glabrous beneath, margins serrate; sheaths glabrous, margins narrowly brown-hyaline, drawn up into very short auricles; ligule very short (c.1mm), rounded, ciliate. Infl. 40–62cm, much branched, drooping; racemes borne singly; spathes and spatheoles minutely hispid on veins. Racemes 19–27mm, consisting of 4 homogamous spikelets, (1–)2 spikelet pairs and a triad. Lowest homogamous spikelet 9.5–14(–15.5)mm, sometimes sterile. Lowest homogamous spikelet:

FIG. 61.

a, ***Themeda arundinacea***: raceme (× 3). b, ***T. intermedia***: raceme (× 3). c–d, ***T. villosa***: c, habit; d, raceme (× 3). e–f, ***T. caudata***: e, raceme (× 3); f, spikelet pair (× 3). g, ***T. longispatha***: raceme (× 3). Drawn by Margaret Tebbs.



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lower glume 9.8–13.3(–15.5) × 1.2–1.7mm, linear-lanceolate, acute, c.13-veined, very shortly hairy all over back, hairs not tubercle-based; upper glume 8–12.2(–13.2)mm, linear-lanceolate, minutely bifid, back flat, glabrous, with two parallel veins in centre; lower lemma 5–11mm, oblong, blunt; upper lemma 4.6–10.3(–11)mm, oblong, blunt; anthers 1.9–6.3mm. Sessile spikelet 6.5–8.2(–8.7)mm; callus 0.9–2.2mm, hairs 2–3mm; lower glume 6.4–7.5(–8) × 1.5–2mm, oblong-lanceolate, subacute, back 5-veined, with central channel, densely appressed-strigose all over, hairs rusty-red; upper glume 6.2–7.5(–8.2)mm, oblong-lanceolate, acute, appressed-strigose all over keel; lower and upper lemmas usually similar, 4.3–5.6(–6.9)mm, lanceolate, blunt, margins glabrous; upper lemma occasionally linear, produced into short (column shorter than to equalling raceme) awn; anthers 2–3.1mm. Lowest pedicelled spikelet 11–14.8(–15.4)mm; pedicels 1.4–2.2(–2.5)mm.

Bhutan: S — Samchi district (Dhoankhola); **Terai** (Tondu Forest, Bamunpokri); **Darjeeling** (below Darjeeling, Kurseong, Mungpo); **Sikkim** (on way to Mirik, Chakong, Rhenok Upper, Chalisay). [Open grassy banks in E Nepal], 370–1220m. September–December.

The Samchi specimen is large, with shortly awned lemmas, but appears to be a large form of *T. villosa*. The distinction between this and the following species is by no means clear.

8. *T. caudata* (Nees) A. Camus; *Anthistiria gigantea* Cavanilles subsp. *caudata* (Nees) Hook. f. Fig. 61e–f.

Differs from *T. villosa* as follows: racemes usually with only one spikelet pair (in addition to a triad); sessile spikelet with upper lemma strongly awned (lemma base c.4.5mm, apex bifid with ciliate teeth, awned in sinus, awn stout, column exceeding raceme).

Bhutan: C — Punakha (above Awakha Bridge) and Tongsa (Bubja to Kinga Raptan) districts; **Sikkim/Darjeeling** (unlocalised Hooker specimen). Dry roadside banks, 1650–1950m. September.

Hackel (1889) recorded a Hooker and Thomson specimen from 'Sikhim' but I cannot find one with a field ticket at Kew. The specimen cited above is merely a duplicate and lacks a locality.

9. *T. longispatha* (Hackel) Raizada & Jain; *Anthistiria gigantea* Cavanilles var. *longispatha* (Hackel) Hook. f. Eng. *tiger grass* (Gamble). Fig. 61g.

Differs from *T. villosa* as follows: spikelets larger (the lower homogamous one over 16mm); sessile spikelet strongly awned.

From *T. caudata* it differs as follows: spikelets larger (the sessile one c.9.5mm); awn much more massive (column c.63mm, tip c.35mm).

From both of these it differs in the raceme being reduced to a single triad. **Terai** (Bamunpokri). Habitat not recorded. December.

Possibly a form of *T. arundinacea* which it resembles especially in its massive awns, and from which it differs chiefly in lacking the tubercle-based hairs on the lower glume of the homogamous spikelets.

116. PHACELURUS Grisebach

Stout perennial. Leaf blades flat; sheaths keeled; ligule truncate-ciliate. Infl. a terminal panicle, branches \pm whorled, each bearing a single raceme; racemes bearing pairs of sessile and pedicelled spikelets, internodes inflated, widened upwards, curved, glabrous. Spikelets similar, florets 2, the lower sterile, epaleate, the upper bisexual, paleate. Lower glume thinly chartaceous, oblong-ovate, back flat, 2-keeled, keels narrowly winged, wings hispid-ciliate, margins narrowly inflexed; upper glume thinly chartaceous, narrowly lanceolate, 1-keeled, conduplicate; lower lemma \pm oblong, semi-hyaline; upper lemma hyaline, lanceolate, keeled, conduplicate; palea narrowly elliptic, margins inflexed; anthers 3. Pedicelled spikelet slightly smaller than sessile; pedicel similar to raceme internode, but shorter.

1. **P. zea** (C.B. Clarke) Clayton; *Thyrsia zea* (C.B. Clarke) Stapf; *Rottboellia zea* C.B. Clarke. Fig. 62c-e.

Culm to 1.5m, stout, nodes appressed-hairy. Leaf blades 0.9(-1.2)cm wide, narrowed to base, hairy at junction with ligule on upper surface, margins long-ciliate near base; sheaths keeled, long, covering lower part of culm; ligule c.1.4mm. Infl. 19(-34)cm, racemes stiff, appressed, those of lowest whorls peduncled, the upper \pm sessile, to 8(-10)cm, internodes (2.6-)4.3mm. Sessile spikelet (3-)4mm; lower glume c.3.3 \times 1.7mm, wings brown; upper glume c.3.5mm, keel hispid, each side c.0.9mm wide; lower lemma c.3.1 \times 0.9mm; upper lemma c.3.1 \times 1; palea c.2.8 \times 0.9; anthers c.2.1mm. Pedicelled spikelet (2.7-)3(-3.5)mm; pedicel (1.7-)2.2mm.

Terai (Katambari). Habitat not recorded, [150m]. November.

117. HEMARTHRIA R. Brown

Perennials. Culms branched, bases decumbent and rooting from nodes. Leaves evenly distributed along culm, blades flat; sheaths keeled; ligule truncate-ciliate. Infl. of singly borne, pedunculate racemes, peduncles terminal and in axillary groups, racemes linear, bearing pairs of sessile and pedicelled spikelets, internodes stout, \pm 3-angled, fused to pedicels, breaking up tardily.

Spikelets unawned, \pm similar, the sessile sunk into a cavity in the raceme internode, the pedicelled slightly spreading, florets 2, the lower sterile, epaleate, the upper bisexual, paleate. Lower glume thinly chartaceous, back flat, 2-keeled, keels narrowly winged, wings hispid-ciliate, margins narrowly inflexed; upper glume semi-hyaline, narrowly lanceolate, 1-keeled, conduplicate, adhering to internode; lower lemma sterile, hyaline; upper lemma similar to lower; palea small, hyaline; anthers 3. Pedicelled spikelet longer and narrower than sessile and differing in shape of glumes, otherwise similar.

1. Sessile spikelet to 4mm; upper glume of pedicelled spikelet acute or with apiculus to 1.8mm; joints of raceme internodes \pm transverse, fragile **1. *H. compressa***
- + Sessile spikelet over 5mm; upper glume of pedicelled spikelet with long apiculus (over 2mm); joints of raceme internodes strongly oblique, very tough **2. *H. protensa***

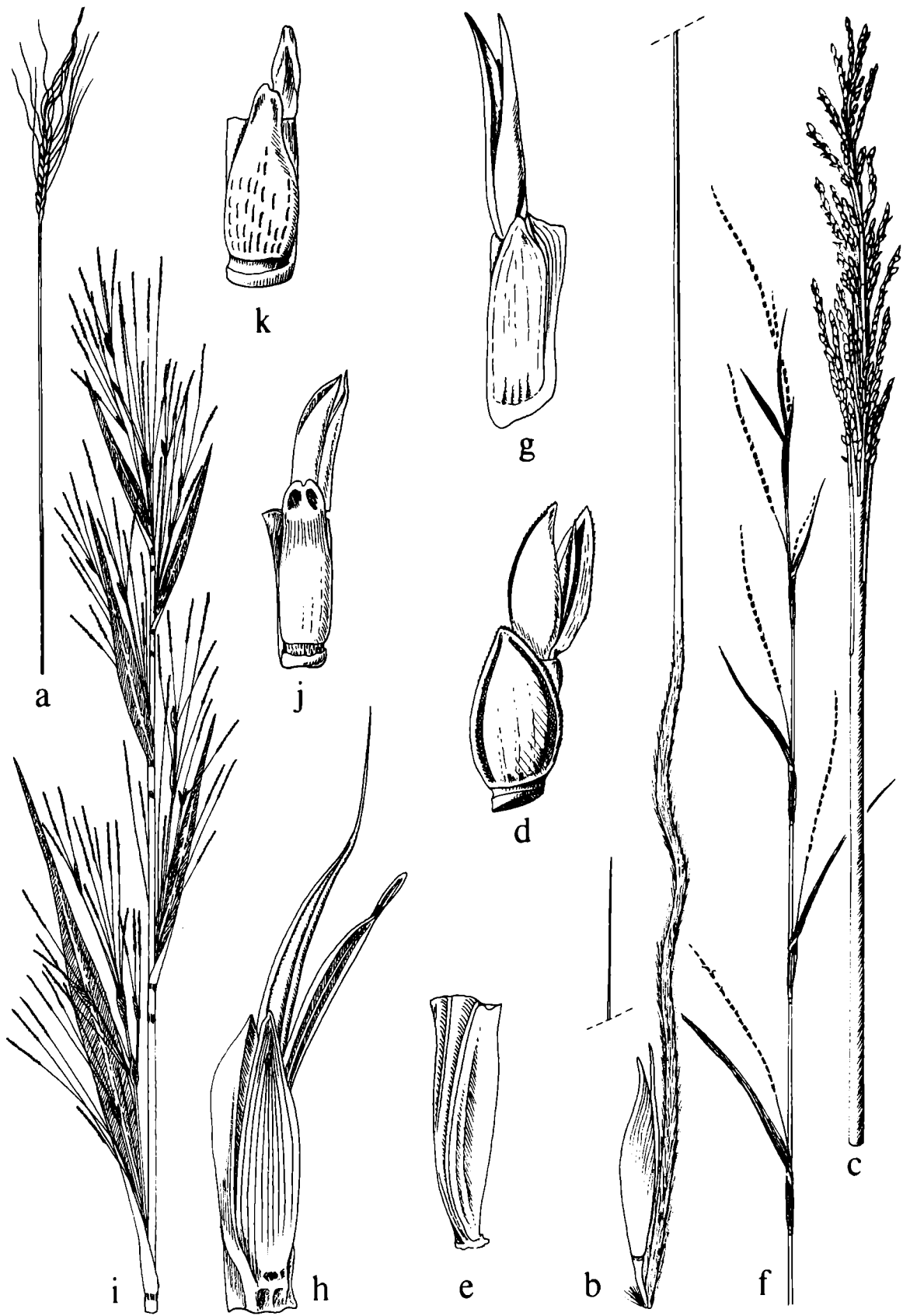
1. *H. compressa* (L. f.) R. Brown; *Rottboellia compressa* L. f. Fig. 62f–g.

Culms with long decumbent bases, rooting from nodes. Leaf blades linear, 7–13 \times 0.2–0.3cm, with sparse, appressed, tubercle-based bristles above; sheaths short, glabrous, margins ciliate above; ligule c.0.3mm. Racemes 3.5–6cm; internode/pedicels 2.5–4 \times 1.2–1.7mm. Sessile spikelet 2.9–4mm; lower glume 2.9–3.7 \times 1.1–1.3mm, oblong, abruptly contracted below truncate to shallowly retuse apex, keels narrowly winged near apex, back obscurely 5-veined; upper glume 2.9–3.5 \times 1–1.2mm, narrowly oblong-oblancheolate, apex a short, triangular apiculus; lower lemma 2.5–3.3 \times 0.8–1.1mm, oblong, blunt; upper lemma 2–3 \times 0.7–1mm, similar to lower, palea 0.9–1.4mm, linear; anthers 1.3–1.5mm. Pedicelled spikelet 3.3–5.1mm; lower glume 3–4.5 \times 0.7–0.9mm, narrowly oblong-triangular, narrowly winged on one side near apex; upper glume 3.4–5 \times 0.7–0.8mm, lanceolate, acute or shortly apiculate (apiculus to 1.8mm), keel narrowly winged, wing minutely hispid; lemmas, palea and anthers similar to sessile spikelet but smaller.

Bhutan: S — Samchi district (Samchi); **Darjeeling** (Kurseong to Punkabari, Badamtam, Great Rangit opposite Manjitar); **Sikkim** (Burtuk Basti, Rongli Khola). Sandy shingle by river; roadside, 400–1100m. June–September.

FIG. 62.

a–b, ***Heteropogon contortus***: a, infl. (\times $\frac{1}{3}$); b, spikelet pair (\times 3). c–e, ***Phacelurus zea***: c, infl. (\times $\frac{1}{3}$); d, spikelet pair (\times 6); e, raceme internode (\times 6). f–g, ***Hemarthria compressa***: f, infl. (\times $\frac{1}{3}$); g, spikelet pair (\times 6). h, ***H. protensa***: spikelet pair (\times 6). i–j, ***Coelorachis khasiana***: i, infl. (\times $\frac{1}{8}$); j, spikelet pair (\times 6). k, ***C. striata***: spikelet pair (\times 6). Drawn by Louise Olley.



2. *H. protensa* Steudel; *Rottboellia protensa* (Steudel) Hackel. Fig. 62h.

Differs from *H. compressa* as follows: leaf blades often wider (over 4mm); racemes longer (to 15cm); spikelets longer (sessile c.5.8mm, pedicelled (incl. apiculus) c.6.5); lower glume of sessile spikelet oblong-lanceolate, gradually tapered to rounded apex, back prominently 7-veined; lemmas larger (lower c.3.8mm, upper c.3.5mm), more acute; anthers longer (c.3mm) and especially in the upper glume of the pedicelled spikelet which is extended into a long (c.2.3mm), minutely hispid apiculus.

Bhutan: C — Gaylegphug district (Gaylegphug to Bhur). In shallow pond, 300m. May.

118. COELORACHIS Brongniart

Perennials. Culms branched. Leaf blades flat, broad; ligule membranous, truncate. Infl. of singly borne, unequally peduncled racemes, peduncles in axillary clusters, subtended by spathe-like bracts, sometimes branched, racemes linear, bearing pairs of sessile and pedicelled spikelets, internodes \pm flat, expanded into cup at apex, fragile, breaking horizontally. Spikelets similar, or the pedicelled reduced. Sessile spikelet unawned, florets 2, the lower sterile or male, the upper bisexual, both paleate; lower glume chartaceous, back flat, usually grooved, grooves interrupted by tubercles, 2-keeled, keels narrowly winged near apex, margins narrowly inflexed; upper glume thinly chartaceous, conduplicate, keeled, keel winged near apex; lower lemma lanceolate, hyaline; palea similar, smaller; anthers 3; upper lemma hyaline, lanceolate, 1-keeled, conduplicate; palea lanceolate, hyaline; anthers 3. Pedicelled spikelet similar to sessile, though with narrower glumes, or consisting only of reduced glumes; pedicel free or fused to raceme internode in lower part, flattened, with 2 green, submarginal veins.

1. Margins of leaf blades not ciliate; sessile spikelets under 4mm; pedicelled spikelet over 2mm, usually well developed **1. *C. khasiana***
- + Margins of leaf blades ciliate; sessile spikelets over 4mm; pedicelled spikelet to 1.6mm, consisting of reduced glumes **2. *C. striata***

1. *C. khasiana* (Hackel) Stapf ex Bor; *Rottboellia striata* Nees ex Steudel subsp. *khasiana* Hackel. Fig. 62i-j.

Culms to 3m, leafy throughout. Leaf blades 2–4.2cm wide, lanceolate, finely acuminate, glabrous or with scattered, tubercle-based hairs above; sheaths glabrous; ligule c.1.5mm. Raceme internodes 3.1–3.4(–3.7)mm. Sessile spikelet 3.3–3.9mm; lower glume 3.2–3.9 × 0.9–1.2mm, oblong, abruptly contracted into apiculus, apiculus winged so apex commonly truncate or

retuse, back 2–5-grooved, occasionally smooth; upper glume 2.9–3.4 × 0.8–1.1mm, lanceolate, finely acuminate; lower lemma 2.6–3 × 0.7–1mm, narrowly lanceolate, acute, margins inflexed; lower palea 0.9–1.5(–2.6) × 0.1–0.3(–0.5)mm, lanceolate, acute; upper lemma 2.3–2.9mm, each side 0.5–0.7mm wide, lanceolate; upper palea 1.5–2.5 × 0.4–0.7mm, lanceolate, acuminate; anthers 1.1–1.5mm. Pedicelled spikelet 3.4–3.6mm, similar to sessile; lower glume 3.5–3.7 × 0.7–1.2mm, narrower and more acuminate than that of sessile; upper glume 3.1–3.5 × 0.8–1.2mm; lower floret epaleate; upper floret usually paleate, male; pedicel 2.8–3.3mm. If pedicelled spikelet reduced, then c.2.4mm and consisting of two small, empty glumes.

Darjeeling (Ryang, Sivok, Mungpo, Bamunpokri); **Sikkim** (Lingcham). Habitat not recorded, 300–1520m. October–November.

One of the Hooker specimens is viviparous, with the spikelets proliferating vegetatively.

2. C. striata (Nees ex Steudel) A. Camus; *Rottboellia striata* Nees ex Steudel. Fig. 62k.

Differs from *C. khasiana* as follows: margins of leaf blades and sheaths long-ciliate, sheaths and blades often densely hairy; sessile spikelets longer (c.4.2mm); lower glume wider (c.1.4mm), narrowly ovate; pedicel longer (c.3.7mm); pedicelled spikelet reduced, c.1.6mm, consisting only of small glumes.

Terai (Dulkajhar). Habitat not recorded, 150m. October.

119. ROTTBOELLIA L. f.

Large annual. Culms branched. Leaf blades flat, broad; sheaths bristly; ligule truncate-ciliate. Infl. of singly borne, terminal and axillary, pedunculate racemes, racemes linear, the upper internodes slender, herbaceous, bearing subsimilar, reduced, herbaceous spikelet pairs, the lower part of raceme bearing pairs of sessile and pedicelled spikelets, internodes crustaceous, stout, ± cylindrical, fused to pedicels, fragile, breaking ± horizontally. Lower spikelets of raceme dissimilar. Sessile spikelet sunk into a deep cavity in the raceme internode, unawned, florets 2, the lower male, epaleate, the upper bisexual, paleate; lower glume thickly coriaceous, back flat, 2-keeled, keels narrowly winged near apex, margins narrowly inflexed; upper glume chartaceous; lower lemma lanceolate, hyaline; palea lanceolate, thinly chartaceous; anthers 3; upper lemma hyaline, subovate; palea broadly lanceolate, hyaline; anthers 3. Pedicelled spikelet spreading, unawned, green, herbaceous, florets 2, the upper male.

1. *R. cochinchinensis* (Loureiro) Clayton; *R. exaltata* L. f. Fig. 63a–b.

Culms to 1.5m, supported at base by stilt roots, densely leafy. Leaf blades oblong, 1.1–1.8cm wide, with sparse, appressed, tubercle-based bristles above, margins serrate; sheaths covered with sharp, spreading, tubercle-based bristles, margins glabrous; ligules 1.2–1.7mm. Racemes 5.5–9cm; internodes 5.9–6.9 × 2.5–2.9mm. Sessile spikelet 4.5–4.8mm; lower glume 3.9–4.6 × 1.8–2.4mm, oblong, abruptly contracted below truncate to shallowly retuse apex, keels minutely hispid, narrowly winged near apex, back obscurely c.15-veined, papillose; upper glume 4.2–4.4 × 2.2–2.5mm, subovate, apex broadly apiculate, keel winged near apex, minutely ciliate; lower lemma 3.6–4 × 1.3–1.6mm, lanceolate, acute, 1-veined; palea 3.4–3.8 × 1.4–1.6mm, lanceolate, acute, 2-veined; anthers 1.8–2.7mm; upper lemma 3–3.7 × 1.3–2mm, broadly ovate, strongly concave; palea 3–3.4 × 1.4–1.7mm, ovate, acuminate; anthers c.2.1mm. Pedicelled spikelet 4.4–4.9mm; lower glume 4.4–5.1 × 1.4–1.8mm, shape as for sessile spikelet; upper glume 3.4–4.3 × 1–1.4mm, narrowly lanceolate, asymmetrically keeled, keel winged throughout length; lemmas reduced; paleas with broadly inflexed margins; anthers 1.6–2.1mm; pedicel 2.5–3mm.

Bhutan: C — Punakha district (Wangdi Phodrang to Chirang); **Sikkim** (unlocalised Hooker and Cave specimens which may be from the Terai). Dry bushland in open chir pine country, 300–900m. October.

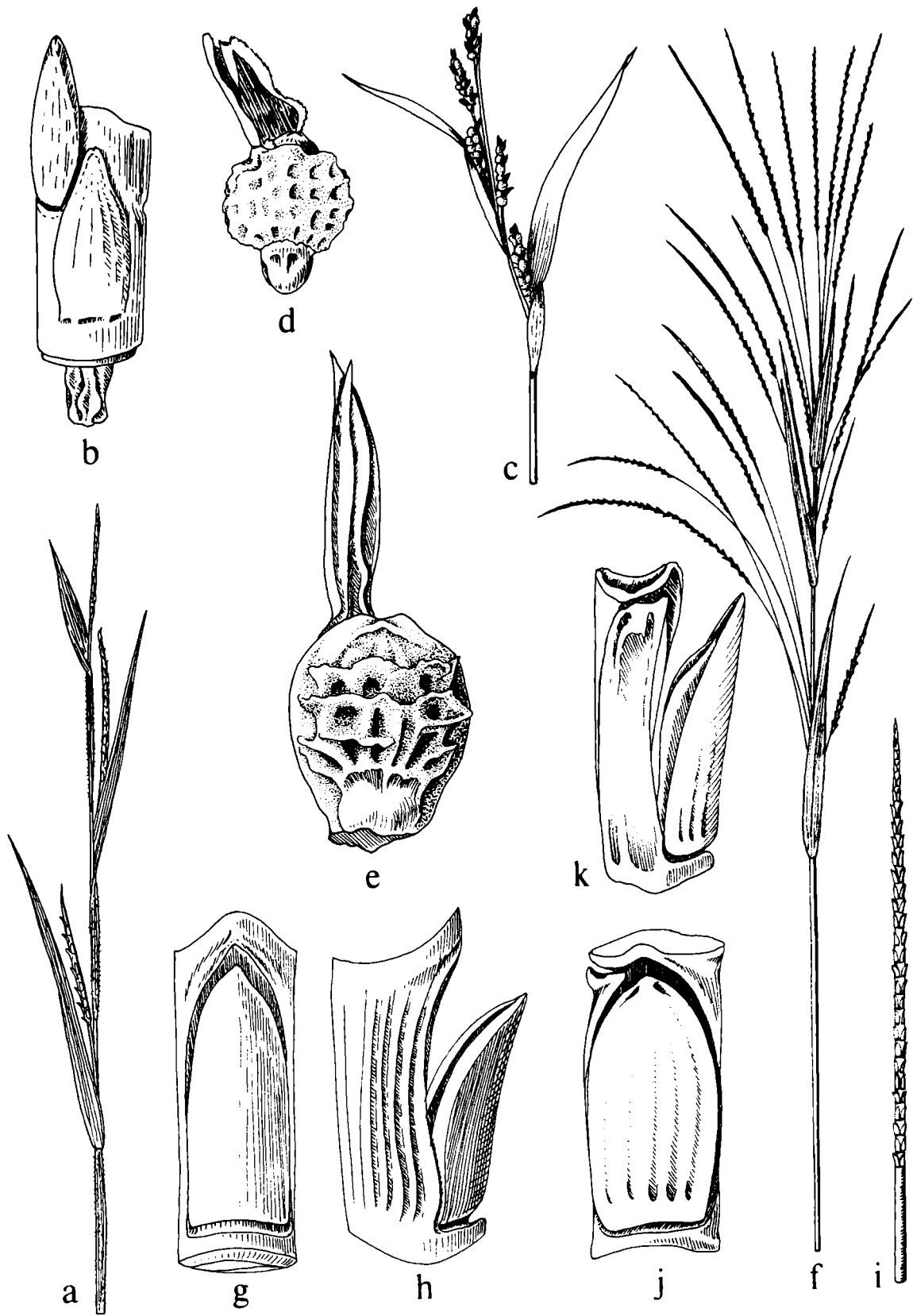
The hairs on the sheaths cause irritation and the plant should be handled with caution.

120. *HACKELOCHLOA* Kuntze

Tufted annuals. Culms branched near base. Leaves inserted regularly along culm, blades flat; ligule membranous, ciliate. Infl. of singly borne, pedunculate racemes, peduncles borne in axillary clusters; racemes bearing pairs of sessile and pedicelled spikelets and a terminal triad, internodes flat, concave, fused to pedicels, glabrous. Spikelets dissimilar, unawned. Sessile spikelet with 2 florets, the lower sterile, epaleate, the upper bisexual, paleate or not; lower glume crustaceous, pitted, strongly concave, narrowed into stipe-like base; upper glume membranous, 3-veined, sunk into cavity of internode; lower

FIG. 63.

a–b, *Rottboellia cochinchinensis*: a, infl. (× ¼); b, raceme internode and spikelet pair (× 5). c–d, *Hackelochloa granularis*: c, infl. (× 1); d, spikelet pair (× 12). e, *H. porifera*: spikelet pair (× 12). f–h, *Ophiuros megaphyllus*: f, infl. (× ⅓); g & h, raceme internode and spikelet (× 12). i–k, *Mnesithea laevis*: i, infl. (× ⅔); j & k, raceme internode and spikelet (× 12). Drawn by Louise Olley.



lemma hyaline; upper lemma hyaline; palea similar to upper lemma or absent; stamens 3. Pedicelled spikelet sterile or male; lower glume herbaceous, back flat, margins incurved, one side hyaline-winged, wing ciliate; upper glume strongly keeled, keel hyaline winged, wing ciliate; florets absent or if present then lower a sterile, hyaline lemma and upper male with a hyaline lemma and palea; anthers 3, larger than those of sessile spikelet.

1. Lower glume of sessile spikelet to 1.7mm, shallowly pitted, ribs between pits broad, rounded, stipe inconspicuous, under 0.5mm, much narrower than upper part; racemes to 12.5mm **1. *H. granularis***
- + Lower glume of sessile spikelet over 2mm, deeply pitted, ribs between pits narrow, sharp, stipe conspicuous, c.0.7mm, almost as broad as upper part, smooth; racemes over 20mm **2. *H. porifera***

1. *H. granularis* (L.) Kuntze; *Manisuris granularis* (L.) L. f. Fig. 63c–d.

Culms 6–69cm. Leaf blades to 15.5 × 1cm, much shorter than culms, widest near auriculate base, apex subacute, with scattered, spreading, tubercle-based hairs above and beneath; sheaths with spreading, tubercle-based hairs; ligule rounded-ciliate, c.1mm. Racemes 6.3–12.5mm, with 4–8 spikelet pairs; internodes/pedicels 1–1.5mm. Sessile spikelet drying cream or pale brown, 1.3–1.7mm; lower glume 1.3–1.7 × 1.1–1.4mm, upper part ± globose, shallowly pitted, ribs between pits broad, rounded; upper glume 0.9–1.1mm, oblong, blunt, concave, 3-veined; upper and lower lemmas similar (lower broader), c.1mm, blunt, ± oblong; palea when present similar to upper lemma; anthers 0.3–0.5mm. Pedicelled spikelet herbaceous, green, often flushed brown, 1.5–2.2mm; lower glume 1.5–2.2 × 0.6–1.3mm, lanceolate; upper glume 1.4–2mm; lemmas c.1.4mm, palea c.1mm; anthers c.0.7mm.

Bhutan: C — Punakha (c.5km N of Punakha, Wangdi Phodrang) and Tashigang (Yadi Zig) districts; **Darjeeling** (Darjeeling, Rangit); **Sikkim** (unlocalised Cave and Hooker specimens). Disturbed ground in open, dry chir pine forest, 610–1400m. August–September.

2. *H. porifera* (Hackel) Rhind; *Manisuris porifera* Hackel. Fig. 63e.

Differs from *H. granularis* as follows: larger; racemes over 20mm; glumes of sessile spikelet c.2.2mm, scarcely narrowed into conspicuous, smooth stipe c.0.7mm, upper part deeply pitted with sharp, narrow ribs between rectangular pits; internodes of racemes over 2mm; pedicelled spikelets over 3mm, the lower glume longer and narrower (c.3.1 × 0.7mm).

Sikkim (Dikeeling). Habitat not recorded, 910m. October.

121. OPHIUROS Gaertner

Perennials. Culms branched. Leaf blades flat; ligules membranous, truncate. Infl. of singly borne, pedunculate racemes, peduncles borne in axillary fascicles subtended by spathe-like bracts; racemes linear, bearing single, sessile spikelets, internodes cylindrical, ribbed, fragile, breaking obliquely. Spikelets sunk into hollows of raceme internodes. Spikelets with 2 florets, the lower male, the upper bisexual, both paleate; lower glume convex on back, margins not inflexed; upper glume strongly convex, weakly keeled; lower lemma hyaline, 2-veined; palea hyaline; anthers 3; upper lemma hyaline, margins inflexed; palea hyaline; anthers 3.

1. *O. megaphyllus* Stapf ex Haines. Fig. 63f-h.

Culms to 2(-4)m, swollen at base, leafy throughout. Leaf blades oblong, 1.6-1.8cm wide, slightly clasping at base, margins ciliate with tubercle-based cilia, with sparse tubercle-based hairs on surface at least near base; sheaths hairy above; ligule 0.8-1mm. Racemes to 15cm, stiffly curved, internodes c.3.1mm. Spikelets c.2.5mm; lower glume c.2.6 × 1.1mm, oblong, blunt, chartaceous, with a line of shallow depressions near each margin; upper glume c.2.8 × 1mm, oblong, subacute, thinly chartaceous; lower lemma c.2.6 × 1.5mm, broadly elliptic, apex rounded; palea c.2.7 × 0.8mm, oblong-lanceolate, blunt; anthers c.1.6mm; upper lemma c.2.6 × 1, lanceolate, blunt; palea c.2.4 × 0.7mm, oblong-lanceolate; anthers c.2mm.

Darjeeling (Sivok). Habitat not recorded. October.

Included under *O. corymbosus* (L. f.) Gaertner in F.B.I., but differs in being a stouter plant with wider, more hairy leaves.

122. MNESITHEA Kunth

Perennials. Culms slender, leafy. Leaf blades linear; ligule membranous, truncate. Infl. of singly borne, terminal and axillary, pedunculate racemes, racemes linear, bearing pairs of sessile spikelets in lower $\frac{2}{3}$, and single sessile ones in the slender, tapering upper $\frac{1}{3}$ (occasionally whole raceme of singly borne, sessile spikelets), internodes fragile, breaking horizontally. Spikelets sunk into hollows on opposite sides of the raceme internodes. Spikelets unawned, florets 2, the lower sterile, epaleate, the upper bisexual, paleate or not; lower glume chartaceous, back ± flat, margins not inflexed; upper glume ± hyaline, convex, 1-veined; lower lemma hyaline, margins inflexed; upper lemma hyaline, margins inflexed; palea, when present, hyaline; anthers 3.

1. *M. laevis* (Retzius) Kunth; *Rottboellia perforata* Roxb. Fig. 63i–k.

Culms to 83cm, slender, commonly unbranched. Leaf blades 2.6–3.4mm wide, glabrous; sheaths glabrous, long-hairy at mouth; ligule c.1mm. Racemes to 11cm, internodes c.3.5mm, wall between spikelet pair often perforated. Sessile spikelet c.3mm; lower glume c.3 × 1.4mm, oblong, blunt, obscurely ribbed, with shallow depressions at base of ribs; upper glume c.2.7 × 0.4mm, oblong-elliptic; lower lemma c.2.6 × 1.2mm, oblong, blunt; upper lemma 2.6 × 1.2mm, oblong-elliptic.

Terai (Phansidoora). Habitat not recorded, 150m. December.

The single specimen seen is depauperate and the spikelets are borne singly throughout the raceme.

123. ZEA L.

Massive annual. Culms unbranched. Leaves inserted regularly along culm, blades flat, wide; ligule membranous, ciliate. Monoecious. Male infl. a terminal panicle composed of many ascending, spike-like racemes; female infl. densely cylindrical, enclosed in spathe-like bracts in axils of middle culm leaves. Male infl.: racemes very dense, with spikelets borne in ± unequally pedicelled, similar pairs, internodes stout, not disarticulating. Sessile/shortly-pedicelled spikelet with 2 florets, usually both fertile; glumes herbaceous; lemmas and paleas hyaline; stamens 3. (Longer-)pedicelled spikelet similar. Female infl.: spikelets borne in dense rows, partly sunk into stout axis, florets 2, the lower sterile; glumes encircling spikelet, thickened below, hyaline above; lemmas and paleas hyaline, encircling ovary; stigmas long, silky, emerging from bracts as a 'tassel'; grain becoming hardened; fruiting infl. the familiar corn 'cob'.

1. *Z. mays* L. Dz: *geza*; Sha: *ashom*; Keng: *domba*; Nep: *makai*; Eng: *maize, corn*. Fig. 64a–d.

Culms to 2.1(–?3)m, stout, solid. Leaves to 8cm wide, auricled at base, scattered shortly hairy above, margins ciliate; sheaths hairy near margins at apex; ligule c.5mm, ± truncate. Male infl. to 30 × 23cm; lower glume 6.6–10 × 2.5–3.3mm, lanceolate, keels ciliate, margins inflexed, back c.4-veined,

FIG. 64.

a–d, *Zea mays*: a, habit (× 1/30); b, female infl. (× 1/3); c, male infl. (× 1/3); d, male spikelet pair (× 4). e–h, *Polytoca digitata*: e, infls. (male terminal, female axillary) (× 1/3); f & g, female spikelet pair (× 6); h, male spikelet pair (× 3). i, *P. wallichiana*: male spikelet pair (× 3). j–k, *Coix lachryma-jobi*: j, infl. (× 1/4); k, partial infl., female enclosed in utricle, male spikelets above (× 1.5). Drawn by Louise Olley.



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shortly hispid; upper glume 7–10 × 1.9–3mm, narrowly lanceolate, keels shortly ciliate, margins inflexed, back 2-veined; lower lemma 5.1–8 × 2–3.5mm, oblong to oblong-rhombic, truncate-ciliate, c.4-veined; palea 6.4–9.2 × 1.8–2mm, lanceolate, 2-keeled, margins inflexed; upper lemma 6–8.5 × 1.4–1.7mm, similar to lower palea; palea 4–7.2 × 0.4–0.9mm, ± linear; anthers 4.5–5.6mm. Pedicelled spikelet 7–10.2mm; pedicel 1–4.7mm. Female infl.: glumes 2–3 × 5mm, transversely oblong, concave, truncate-ciliate.

Bhutan (presumably in all cultivated areas in C and S— 1200–1800(–2900)m); **Darjeeling**; **Sikkim** (to 2130m).

Native of C America, but widely cultivated in warm temperate and tropical parts of the world. In terms of area under cultivation, the major grain crop of Bhutan, and in which the country is self sufficient (G.B. Chettri, pers. comm.). In 1984 it occupied 37% of the cultivated land and accounted for 47% of the total food-grain production. The main area of cultivation is in the east of the country, below 2500m. The varieties grown are local races and it is mainly grown un-irrigated, often intercropped, or occasionally double-cropped in some low areas. Maize is eaten in two ways – *kharang*, coarse-milled granules boiled and eaten like rice, or *bohpi*, ground as flour and eaten as dough (Roder & Gurung, 1990); a substantial proportion is used for alcohol production (W. Roder, pers. comm.). It is not known when maize was first introduced to Bhutan, though it was present by Bogle's visit in 1774.

Infls. sometimes mixed, with some female spikelets among the male infl. or with a section of male spikelets among the female.

124. POLYTOCA R. Brown

Perennials. Culms branched. Leaves inserted along culm, blades flat; ligule membranous, truncate-ciliate. Infls. lateral and terminal; the lateral borne singly, composed of spike-like racemes, female below, male above; the terminal a panicle of digitately arranged, male racemes; racemes bearing sessile and pedicelled spikelet pairs, axis fragile (especially the female). Spikelets dissimilar, unisexual; pedicel free or fused along one margin to adjacent raceme internode. Female sessile spikelet with 2 florets, the lower sterile, epaleate, the upper fertile, paleate or not: lower glume thickly chartaceous, enclosing whole spikelet ('fruit case'), with basal cavity, above which a platform bearing other floral parts, body oblong, abruptly contracted into winged, apical beak; upper glume chartaceous, body oblong, caudate; lower lemma similar to upper glume; upper lemma (and palea when present) lanceolate, hyaline. Female pedicelled spikelet sterile, usually consisting only of the lower glume; glume herbaceous, asymmetric, long attenuate, broadly winged on one side; pedicel fused to internode, combined structure flattened, ciliate. Male sessile spikelet

with 2 florets, both fertile, paleate: lower glume chartaceous or herbaceous, \pm lanceolate, sometimes winged above; upper glume \pm hyaline; upper lemmas and paleas hyaline; stamens 3. Pedicelled male spikelet similar to sessile except for the long-attenuate, symmetric or asymmetrically winged lower glume; pedicel free or fused.

1. Sessile female spikelet over 9.5mm; lower glume of sessile male spikelet chartaceous, margins broadly winged in upper half; pedicels of male spikelets fused to broad, flat raceme internodes **1. *P. digitata***
- + Sessile female spikelet under 9mm; lower glume of sessile male spikelet herbaceous, unwinged; pedicels of male spikelets free, slender
2. *P. wallichiana*

1. *P. digitata* (L. f.) Druce; *P. bracteata* R. Brown. Fig. 64e–h.

Culms to 4.5m, flat on one side, nodes appressed-hispid. Leaf blades 24–42mm wide, margins serrate; sheaths usually sparsely hairy, hairs tubercle-based, upward pointing; ligule c.2mm. Female racemes to 12cm, internode/pedicels 5.5–6mm, margins ciliate, back hispid. Female sessile spikelets 9.6–10.6mm; lower glume 8.9–10 \times 3–4.1mm, back shortly hairy, with tufts of longer hairs at apex of body on both sides, beak 3–3.5mm, wings 1–1.2mm wide; upper glume glabrous, body 4.7–5.3 \times 2.8–3.5mm, apiculus 2.1–2.5mm; lower lemma 5.1–6.3 \times 2.3–2.9mm; upper lemma 4.3–6 \times 1.3–2.5mm; palea 3–4.6 \times 0.7–1mm. Female pedicelled spikelet: lower glume, 19.3–21.8mm, wing 1.2–2.7mm wide. Male racemes 4–10cm, internode/pedicels 2.8–3.3mm, completely fused on abaxial face, partially fused on adaxial, margins ciliate. Male sessile spikelets 9–10.1mm; lower glume 8.5–10 \times 2–3mm, body chartaceous, convex, c.6-veined, narrowly lanceolate, acuminate into short apiculus, broadly, symmetrically winged in upper half, wing reticulately veined, 0.5–1mm wide; upper glume 7.1–7.5 \times 1.5–1.7mm, semi-hyaline, narrowly lanceolate, acute; lower lemma 6.4–7.2 \times 1.2–1.5mm; palea 6.5–7.2 \times 1–1.2mm; anthers 3.8–4.5mm; upper lemma 5.7–6.5 \times 1–1.4mm; palea 5.6–6.5 \times 0.8–1mm. Male pedicelled spikelet like female; glume 8.5–11 (excl. apiculus) \times 1.6–3mm, apiculus 1.8–3.8mm.

Terai (Jalpaiguri Duars, Bamunpokri, Balasun, Sukna). Habitat not recorded, 150m. October–December.

2. *P. wallichiana* (Nees) Benth. Fig. 64i.

Differs from *P. digitata* as follows: plant shorter and more slender; leaf blades narrower (8–19mm wide), sheaths usually glabrous; female spikelets smaller (sessile 6.7–8.8mm, pedicelled 11.6–17mm), palea of upper floret absent; male infl.: pedicels and internodes free, slender (internodes 3.2–5.5mm,

pedicels 2.6–4.5mm); sessile spikelets smaller (6.1–8.8mm), lower glume herbaceous, unwinged, margins ciliate near apex; pedicelled spikelet fertile, similar to sessile except for lower glume, lower glume 7.1–9 × 1.2–1.5mm, unwinged, finely acuminate into apiculus 1–4(or more?)mm.

Bhutan: S — Samchi district (Dwarapani); **Terai** (unlocalised Clarke and Hooker specimens). Habitat not recorded [aquatic in Bangladesh], 150–300m. June–December.

125. COIX L.

Perennials or annuals. Culms branched. Leaves inserted along culm, blades flat; ligule membranous. Infls. of unequally peduncled axillary clusters, peduncles flattened each bearing a monoecious partial infl. of 2 sexes, the base surrounded by a hardened ‘utricle’ (modified leaf base). Female infl. sessile, enclosed within utricle (except stigmas), spikelets 3, the outer 2 sterile, of reduced, chartaceous, tubular glumes, the central fertile, stipitate. Fertile female spikelet with 2 florets, the lower sterile, epaleate, the upper fertile, paleate, all floral parts abruptly acuminate into ± chartaceous apiculus; lower glume with subglobose, hyaline base encircling other parts; upper glume narrower with prominent central keel; lower lemma lanceolate, hyaline; upper lemma and palea broadly lanceolate; stigmas long, exerted from utricle. Male raceme pedunculate, exerted from utricle, deciduous as a whole, bearing pairs or triads of spikelets, sessile and pedicelled similar, or the pedicelled sometimes reduced, internodes ± flat, margins thickened. Male spikelets with 2 florets, both fertile, paleate; glumes herbaceous, the lower with sharply inflexed margins, keels prominently winged, the upper glume with prominent central keel; lemmas and paleas hyaline; stamens 3.

Further work is required on this genus. Bor’s (1973) treatment, which largely followed that of Watt (1904), is not really satisfactory, and when looking at the variability of *C. lachryma-jobi* in other parts of SE Asia it is difficult to believe that the Indian taxa are anything other than varieties of a single, polymorphic species. The typifications of Roxburgh’s *C. gigantea* and *C. aquatica* are, in any case, uncertain and the characters used by Bor and others (e.g. utricle shape, width of wing of lower male glume, leaf base, leaf width) to separate these from *C. lachryma-jobi* are neither clearcut, nor consistently correlated. The most distinct forms are ones with tubercle-based hairs on the upper leaf surface which seem always to grow in wet habitats; these are provisionally retained here under *C. aquatica*.

1. Upper leaf surface glabrous, or if hispid, then hairs not tubercle-based; male spikelets mainly in pairs 1. *C. lachryma-jobi*
 + Upper leaf surface with conspicuous, tubercle-based hairs, the tubercles persistent; male spikelets mainly in triads 2. *C. aquatica*

1. *C. lachryma-jobi* L. Nep: *garday mala*, *ghanrey mala*; Eng: *Job's tears*. Fig. 64j–k.

Culms 70–210cm, sometimes becoming woody. Leaf blades 1.5–4cm wide, very acute, base usually auriculate, margins hispid, upper surface hispid, but hairs not tubercle-based; sheaths glabrous; ligule 0.6–1.2mm, truncate-ciliate. Utricles 7–14.7 × 4.3–8mm, ovoid, or truncate-subglobose (var. *monilifer* Watt), finally hard and shining, bluish or white, or remaining soft and striate (var. *ma-yuen* (Romanet du Caillaud) Stapf ex Hook. f.). Female infl.: sterile florets 5.6–15.7mm, apices protruding from oblique utricle mouth; fertile floret 7.5–14.2mm; lower glume 7.4–11 × 5–5.5mm; upper glume 7–11 × 2.7–4mm, lanceolate; lower lemma 6.2–10 × 2.6–3.5mm, lanceolate; upper lemma 6–9.3 × 2.3–3.5mm, lanceolate; palea 5–8.5 × 2–3mm. Male raceme 16–33mm, with 3–6 nodes, internodes 3–3.3mm, terminal spikelets in 3s, the lower paired and sometimes with one or more in 3s; sessile spikelet 6.7–9.1mm; lower glume 6.7–9.1 × 2.3–4mm, body rounded, finely c.17-veined, lanceolate, acute, lateral keels winged in upper half, wings 0.4–0.7mm wide, minutely ciliate; upper glume 6.5–8.7 × 1.7–2.6mm, narrowly lanceolate, acute; lower lemma 6.3–8.2 × 1.6–3mm; palea 5.9–8.2 × 1.5–2.2mm; anthers 2.8–4.1mm; upper lemma 5.4–7.5 × 1.2–1.8mm; palea 5–6.2 × 0.7–1.7mm; anthers 5–5.6mm; pedicelled spikelets 6.3–9.1mm; pedicels 2.5–3.5mm.

Bhutan: S — Samchi (Samchi) and Sankosh (7km W of Phipsoo) districts; N — Upper Mo Chu district (Gasa); **Terai** (Jalpaiguri Duars); **Darjeeling** (Labdah, Rishap, Mongpu, Badamtam); **Sikkim** (Phodong to Kabi). Beside streams; secondary scrub at margin of subtropical forest, 200–2130m. March–December.

The Sikkim specimens are larger in all their parts than the others and one is interesting as both florets in the spikelets of the 'male' infls. are bisexual.

Used for fodder. The utricles are made into necklaces by children (T. Gyaltzen, pers. comm.). The var. *ma-yuen* (for which Watt (1904) recorded the ?Bengali name *bir-gaunli* from Darjeeling) was at least formerly cultivated as a grain crop in Sikkim (Hooker specimens from 610–1220m); it also appears to have been a major food grain in some parts of Bhutan (W. Roder, pers. comm.).

2. *C. aquatica* Roxb.; *C. gigantea* König ex Roxb. var. *aquatica* Watt

Differs from *C. lachryma-jobi* as follows: upper leaf surface densely covered in short, tubercle-based hairs, the tubercles large, persistent; leaves narrower

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(0.8–1.7mm wide); culms sometimes decumbent at base and rooting from nodes; utricles sometimes minutely hairy at apex; female glumes narrower (lower 3.4–4.2mm wide, upper 2.1–2.6mm wide); internodes of male racemes longer (c.3.5mm); male spikelets nearly all in 3s (sometimes with a basal pair).

Bhutan: C — Punakha (1km N of Punakha Dzong), Tongsa (near Langtel, Khosela to Kunga Rapten) and Mongar (Lingitsi) districts; **Sikkim** (Lower Burtuk Basti). In streams and marshes, 900–1830m. May–November.

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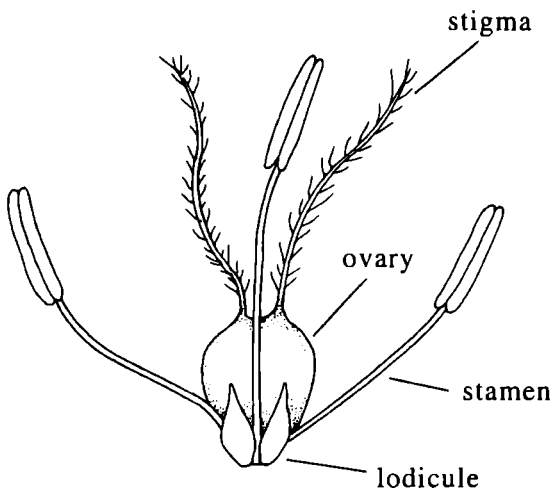
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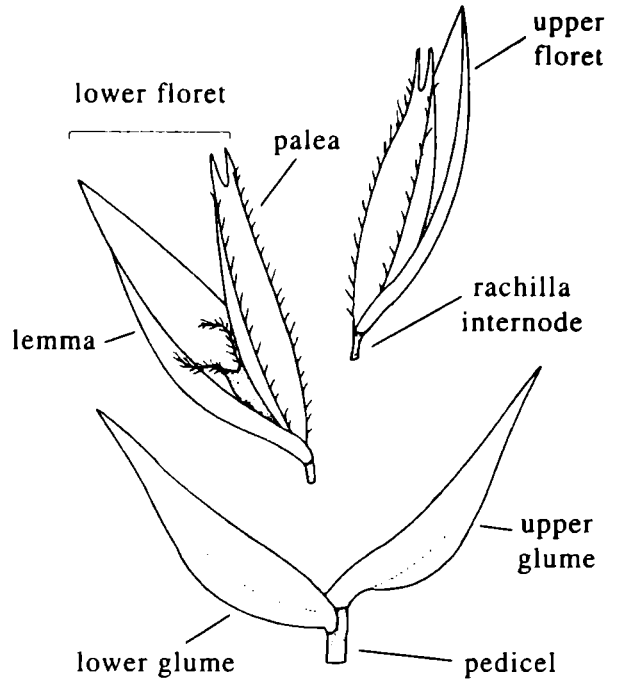
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GLOSSARY



GRASS FLOWER



GRASS SPIKELET WITH 2 FLORETS –
EXPLODED VIEW

anthesis: the time of floral maturity. N.B. the shape of the spikelets and of the whole infl. often looks very different at this short-lived stage compared with before or after

antorse: forward-pointing (e.g. of scabridities on bristles)

apomixis: where seed is set without fertilisation (i.e. the fusion of male and female gametes)

auricle: ear-like structures usually at the base or apex of an organ, e.g. at the base of a leaf blade, or at the apex of a leaf sheath on either side of the ligule

awn: a bristle-like structure often developed on lemmas, less often on glumes; the position is variable: sometimes apical, sometimes inserted on the back (dorsal), often geniculate, with 1 (or 2) angles

bifid: of an apex, sharply and deeply 2-lobed

callus: the base of a floret, sometimes sharp

chartaceous: texture like paper

chasmogamous: a floret that opens, with the stamens exerted, so that outbreeding can occur

GLOSSARY

cilia: stiff hairs, usually on margins

clavate: club-shaped (of hairs or raceme internodes)

cleistogamous: a floret which does not open; the stamens remain enclosed, so that self-pollination (inbreeding) only is possible; the anthers are often reduced

column: the lower part of an awn, below the articulation

conduplicate: folded lengthwise about midrib

connate: fused (e.g. of leaf sheath margins)

coriaceous: texture like leather

crisped: crinkled or curled, applied to leaf margins or hairs

crustaceous: texture hardened, brittle, as in the upper floret of Paniceae

culm: the stem of a grass

cuneate: wedge-shaped

denticulate: minutely toothed

diffuse: a growth habit in bamboos, where the culms are widely separated

digitate: of infls., the partial infls. (commonly racemes) radiate from a common point at the culm apex, like the fingers of a hand

disarticulation: the breaking up of a spikelet or raceme

epaleate: of a floret lacking a palea

erose: irregularly toothed (e.g. of a ligule apex)

extravaginal: literally 'outside a sheath'; of branching, where a vegetative shoot arises at the base of a sheath, but pierces through and develops outside it, usually at a wide angle, giving rise to an open habit

fascicle: a cluster of vegetative or infl. branches arising from a common point

filiform: thread-like, very narrow

fimbriate: fringed (e.g. a ligule apex with numerous, dense, short hairs)

flexuous: wavy (of infls. and awns)

floret: the basic unit of a spikelet (see diagram p. 847), in fully developed form consisting of a lemma and palea enclosing an ovary, stamens and lodicules

geniculate: knee-like (angled), applied to awns and culms

glume: the lower, sterile pair of bracts at the base of a spikelet (occasionally one not developed)

grain: the single-seeded, indehiscent fruit of a grass, technically known as a caryopsis

granular: surface with grainy texture

gregarious flowering: where a species flowers at regular, but widely separated intervals, throughout its range, the periodicity characteristic of the species

herbaceous: green, with the texture of a thin leaf

hispid: with short, rough hairs

homogamous pairs: the basal spikelets of certain Andropogonoid grasses (*Themeda*, *Heteropogon*), the lower pairs are similar to each other, usually unisexual and different from the upper spikelets within a raceme

hyaline: thin, translucent

intercarinal: between the keels, applied to the veins on the flat back of the lower glume in *Cymbopogon*

interrupted: of a dense infl. when the partial infls. are slightly separated

intravaginal: literally 'inside a sheath'; of branching, where a vegetative shoot arises at the base of a sheath and grows up inside it, appressed to the culm, giving rise to a densely clumped habit

involucre: a structure surrounding the base of a spikelet or spikelet group, e.g. the ring of bristles in *Setaria*

iterauctant: of flowering in bamboos, when buds are present at the base of a spikelets and capable of development, leading to a dense cluster of spikelets

keel: a thickened rib, like the keel of a boat

lemma: the lower bract of a floret

leptomorph: in bamboos, a slender rhizome that branches monopodially

ligule: a structure dividing the sheath apex, from the base of the leaf blade, commonly a membranous flap, sometimes a line of cilia

lodicule: a minute scale at the base of the ovary, perhaps a reduced perianth segment, usually 2 or 3 (more in some bamboos)

monoecious: having male and female florets in separate infls. or partial infls.

GLOSSARY

on a plant; rare in grasses and in Bhutan only found in *Zea*, *Coix* and *Polytoca*

monopodial: where the apex of an axis grows continuously, the branches developing from lateral buds

mucro: a stout apical projection (mucronate)

node: the point of attachment of the leaf (i.e. the base of the sheath) to the culm, often swollen

pachymorph: in bamboos, a thick rhizome that branches sympodially

palea: the upper bract of a floret, often 2-keeled (when present a floret is described as paleate)

panicle: a branched infl., the spikelets inserted on branches (which may be again branched in which case described as decomposed)

papillose: surface with rounded, nipple-like, swellings (papillae)

paraclade: in bamboos, an infl. branch

pectinate: like the teeth of a comb

pedicel: in grasses, the stalk of a spikelet

penicillate: tuft of hairs like a paint brush (e.g. the rachilla rudiment in some *Calamagrostis*)

pericarp: the outer layer of the grain, sometimes (as in *Sporobolus*) becoming free, in *Melocanna* fleshy

petiole: leaf stalk – true petioles are not found in grasses, but the narrowed base of a leaf blade can mimic them (as in *Spodiopogon lacei*)

pilose: with long, soft hairs

pit: a deep depression, as on the lower glume of *Hackelochloa* or *Bothriochloa* (pitted)

plano-convex: with one surface flat, the other convex (so D-shaped in cross-section)

plicate: folded like a fan (e.g. the leaf blades of *Setaria palmifolia*)

plumose: feathery, of an infl. with long silky hairs on one or more parts of the spikelet or rachilla

pluricaespitose: a growth habit in bamboos, where the culms form clumps connected by long rhizomes

- polyploid:** having more than two sets of chromosomes
- prophyll:** a bract-like structure (commonly 2-keeled) at the base of an infl. branch
- protogynous:** the female phase maturing before the male
- pulvinus:** a small swelling, e.g. in the axils of some bamboo infls. which increases the angle of branching
- punctate:** surface with a pattern of raised or sunken dots
- raceme:** an 'unbranched' infl., with the spikelets inserted directly on the infl. axis (if pedicels very short then 'spike-like')
- rachilla:** the axis of a spikelet. If more than one floret then composed of several internodes. Sometimes continued as a terminal rudiment/extension, not bearing a floret; sometimes, in spikelets with a single floret, e.g. some *Calamagrostis*, represented only by a rudiment
- rachis:** the axis of an infl. or partial infl. (raceme) usually used in the case of flattened ones of spike-like infls.
- reticulate:** net-like (e.g. the pattern sometimes formed by veins)
- retorse:** backward-pointing (e.g. of scabridities on a bristle)
- rhizome:** a creeping, underground stem, usually with scars or remnants of scales
- rugose:** with transverse ridges
- scabrid:** rough, with sharp, siliceous protrusions, often applied to veins or leaf surfaces
- scar:** the broken tissue where the callus breaks from its point of attachment (the shape is of diagnostic importance in *Stipa*)
- sclerenchyma:** strengthening tissue next to the veins in a leaf, composed of thick-walled cells (of diagnostic importance in *Festuca*)
- secund:** spikelets arranged on only one side of a rachis
- semelauctant:** of flowering in bamboos, when a spikelet lacks basal buds, or has vestigial buds that are incapable of further development
- seta(e):** bristle(s). In bamboos those at the sheath apex are called oral setae
- sinus:** a gap, such as the space between the two terminal lobes of a bifid lemma
- spathe:** a bladeless sheath, subtending the infl. branches in *Cymbopogon*, *Themeda* and *Apluda*

GLOSSARY

- spatheole:** a small spathe subtending a raceme or raceme pair
- spikelet:** the basic unit of the grass infl., when fully developed represented by a pair of glumes and one or more florets (see diagram, p. 847)
- stipe:** a narrowed, stalk-like base, e.g. in the upper floret of *Coelachne* (stipitate)
- stolon:** an above-ground, creeping stem
- strigose:** with rigid (bristle-like), appressed hairs
- subulate:** needle-like (of an apex)
- sympodial:** where the apex of a main axis stops growing and growth is continued from a subterminal, lateral bud
- tardily:** slowly, of the way in which spikelets or raceme axes break up (disarticulate)
- tessellated:** chequered, of leaf blades where cross-veins are well developed, e.g. in some bamboos
- triad:** in Andropogoneae a group of three spikelets, one sessile and two pedicelled
- trigonous:** three-angled
- triquetrous:** sharply three-angled
- tubercle:** a wart-like swelling (e.g. the base of certain hairs in Paniceae and Andropogoneae)
- turgid:** swollen
- undulate:** wave-like, as in the leaf blade of *Oplismenus*
- unicaespitose:** a growth habit in bamboos, where the culms form a single clump
- utricle:** a swollen, bladder-like structure (in *Coix*, a modified leaf base enclosing the female infl.)
- verrucose:** warted, in *Digitaria* applied to hairs with irregular thickenings (these visible only at high magnifications)
- vestigial:** rudimentary, not fully developed
- villous:** with long, shaggy hairs
- viviparous:** where a floret develops vegetatively into a small plantlet; characteristic of certain species (e.g. *Poa mustangensis*), but occurring as a rare monstrosity in others

APPENDIX 1

Introduced grass species tested for fodder in Bhutan; adapted from Roder *et al.* (1998)

Name (Temperate/Subtropical)	Year	Test level	Naturalised (+)/Modern name
<i>Agropyron desertorum</i> (T)	1980	3	
<i>A. elongatum</i> (T)	1980	3	(= <i>Elymus elongatus</i>)
<i>A. inerme</i>	1980	3	
<i>A. intermedium</i> (T)	1980	3	(= <i>E. hispidus</i>)
<i>A. smithii</i>	1980	3	
<i>A. trachycaulum</i> (T)	1980	3	(= <i>E. trachycaulus</i>)
<i>Agrostis alba</i> (T)	1987	3	(? = <i>A. stolonifera</i>)
<i>A. tenuis</i> (T)	1980	2	(= <i>A. capillaris</i>)
<i>Alopecurus pratensis</i> (T)	1990	2	+
<i>A. arundinaceus</i> (T)	1988	2	
<i>Andropogon gayanus</i> (S)	1996	2	
<i>A. gerardi</i> (S)	1996	3	
<i>Arrhenatherum elatius</i> (T)	1975	3	
<i>Avena sativa</i> (T)	?	1	
<i>Bothriochloa caucasica</i> (S)	1988	3	
<i>B. insculpta</i> (S)	1996	3	
<i>B. ischaemum</i> (S)	1988	3	(+) also native
<i>B. pertusa</i> (S)	1996	3	
<i>Brachiaria brizantha</i> (S)	1996	2	+ (= <i>Urochloa brizantha</i>)
<i>B. decumbens</i> (S)	pre 1982	1	(= <i>U. brizantha</i>)
<i>B. humidicola</i> (S)	1996	3	+ (= <i>U. dictyoneura</i>)
<i>B. ruziziensis</i> (S)	1988	1	
<i>Bromus catharticus</i> (T)	1980	2	+
<i>B. erectus</i> (T)	1988	3	
<i>B. inermis</i> (T)	1980	2	
<i>Cenchrus ciliaris</i> (S)	pre 1982	3	
<i>Chloris gayana</i> (S)	pre 1982	3	+
<i>Cynosurus cristatus</i> (T)	1980	3	
<i>Dactylis glomerata</i> (T)	1974	1	+
<i>Digitaria milanjiana</i> (S)	1988	3	
<i>D. natalensis</i> (S)	1996	3	
<i>D. setivalva</i> (S)	1996	3	(= <i>D. eriantha</i>)
<i>D. smutsii</i> (S)	1988	3	(= <i>D. eriantha</i>)
<i>Echinochloa utilis</i> (S)	1988	3	
<i>Elymus junceus</i> (T)	1980	3	(? = <i>Psathyrostachys juncea</i>)
<i>E. dahuricus</i> (T)	1988	3	+ also native

APPENDIX 1

<i>E. sibiricus</i> (T)	1988	3	
<i>Festuca arundinacea</i> (T)	1978	1	+
<i>F. ovina</i> (T)	1989	3	
<i>F. pratensis</i> (T)	1974	2	
<i>F. rubra</i> (T)	1975	2	
<i>Holcus lanatus</i> (T)	1981	3	+
<i>Lolium multiflorum</i> (T)	1974	1	+
<i>L. perenne</i> (T)	1974	2	+
<i>L. multiflorum</i> × <i>perenne</i> (T)	1979	3	+
<i>Melinis minutiflora</i> (S)	pre 1982	1	+
<i>Panicum antidotale</i> (S)	pre 1982	3	
<i>P. coloratum</i> (S)	1996	3	
<i>P. maximum</i> (S)	pre 1982	2	+
<i>P. virgatum</i> (S)	1988	3	
<i>Paspalum atratum</i> (S)	1996	2	
<i>P. dilatatum</i> (S)	pre 1982	3	+
<i>P. guenoarum</i> (S)	1996	3	
<i>P. notatum</i> (S)	1981	3	+
<i>Pennisetum clandestinum</i> (S/T)	pre 1975	1	+
<i>Phalaris arundinacea</i> (T)	1989	3	
<i>P. tuberosa</i> (T)	1979	3	(= <i>P. aquatica</i>)
<i>Phleum pratense</i> (T)	1974	3	
<i>Poa compressa</i> (T)	1989	3	
<i>P. pratensis</i> (T)	1975	2	+
<i>Secale cereale</i> (T)	1974	2	
<i>S. montanum</i> (T)	1980	3	
<i>Setaria incrassata</i> (S)	1988	3	
<i>S. sphacelata</i> (S)	pre 1982	2	+
<i>Sorghastrum nutans</i> (S)	1988	3	
<i>Sorghum bicolor</i> (S)	1988	3	
<i>S. sudanense</i> (S)	1988	3	(= <i>S. × drummondii</i>) derivative +
<i>Trisetum flavescens</i> (T)	1979	3	
<i>Urochloa mosambicensis</i> (S)	1996	3	
<i>U. oligotricha</i> (S)	1996	3	

The names are as given in the source: many are now superseded and where possible the correct name has been given in brackets.

S = subtropical

T = temperate

1 = in 'extension' i.e. widely cultivated.

2 = tried 'on farm' i.e. small-scale farm trials throughout Bhutan, particularly in Paro, Thimphu, Bumthang, Mongar and Pemagatsel districts.

3 = tried only in observation nurseries at Bhur (Gaylegphug), Pemagatsel (Deothang), Paro (Thimphu), Bajo (Punakha), Tintibi (Tongsa), Jakar (Bumthang) and Lingmethang (Mongar).

Sources of seed for these introductions have included: Swiss Federal Research Station, Reckenholz, Switzerland; D.S.I.R. Grasslands Division, Palmerston North, New Zealand; C.S.I.R.O. Division of Plant Industry, Canberra, Australia and U.S.D.A. Soil Conservation Centre, East Beltsville, Maryland, U.S.A. for temperate species. C.S.I.R.O., Australian Tropical Forages Genetic Resource Centre, Australia and I.L.R.I., Addis Ababa, Ethiopia for subtropical ones (W. Roder, pers. comm.).

Some of these species (marked +) have already become established in pastures or as escapes in natural habitats, in either case appearing as native. Most of the species commonly encountered 'in the wild' are those that have been widely distributed, but several that have only been tried in observation nurseries or in limited trials on farms have also escaped.

APPENDIX 2

DISTRIBUTION OF SPECIES WITHIN AND OUTWITH AREA COVERED BY THE *FLORA*

* introduced or cultivated

Bhutan (B), Terai (T), Darjeeling (D), Sikkim (S) and Chumbi (C).

Numbers refer to the Phytogeographical areas listed in the Introduction (see pp. 472–473)

<i>Acroceras zizanioides</i>	B	7
<i>Agrostis brachiata</i>	B	4A
* <i>Agrostis capillaris</i>	B, D	
<i>Agrostis hookeriana</i>	B, S	5A
<i>Agrostis inaequiglumis</i>	B, S	5A
<i>Agrostis micrantha</i>	B, D, S	4A
<i>Agrostis nervosa</i>	B, D, S	5
<i>Agrostis petelotii</i>	B	4A
<i>Agrostis pilosula</i>	B, D, S	5
* <i>Agrostis stolonifera</i>	B	
<i>Agrostis triaristata</i>	B, D, S	5A
<i>Agrostis ushae</i>	S	5C
* <i>Agrostis vinealis</i>	D	
<i>Agrostis zenkeri</i>	B, S	4A
<i>Alopecurus aequalis</i>	B	1
* <i>Alopecurus pratensis</i>	B	
* <i>Ampelocalamus patellaris</i>	D, S	
<i>Anthoxanthum flexuosum</i>	B, S	5A
<i>Anthoxanthum hookeri</i>	B, S, C	5A
* <i>Anthoxanthum odoratum</i>	D	
<i>Anthoxanthum sikkimense</i>	S	5A
<i>Apluda mutica</i>	B, T, D, S	6
<i>Apocopis paleaceus</i>	B, T	5
<i>Aristida adscensionis</i>	B	7
<i>Arthraxon hispidus</i>	B, D, S	7
<i>Arthraxon lancifolius</i>	B, D, S	6
<i>Arthraxon microphyllus</i>	B, S	5A
<i>Arthraxon prionodes</i>	B	7
<i>Arthraxon quartinianus</i>	B	6
<i>Arundinaria racemosa</i>	B, S	5A

<i>Arundinella bengalensis</i>	B, T, D	6
<i>Arundinella dagana</i>	B	5B
<i>Arundinella decempedalis</i>	T	5D
<i>Arundinella hookeri</i>	B, D, S, C	4A
<i>Arundinella nepalensis</i>	B, D, S	6
<i>Arundinella setosa</i>	B	6
<i>Arundo donax</i>	B, S	1
<i>Avena fatua</i>	B, S, C	1
* <i>Avena sativa</i>	B	
* <i>Axonopus affinis</i>	B	
* <i>Axonopus compressus</i>	B, S	
* <i>Bambusa alamii</i>	B	
* <i>Bambusa balcooa</i>	B	
<i>Bambusa clavata</i>	B	5B
* <i>Bambusa multiplex</i>	B	
* <i>Bambusa nutans</i> subsp. <i>cupulata</i>	B, D, S	
* <i>Bambusa tulda</i>	B	
<i>Borinda grossa</i>	B	5A
<i>Bothriochloa bladonii</i>	B, S	6
<i>Bothriochloa ischaemum</i>	B	1
<i>Brachypodium sylvaticum</i>	B, D, S	1
<i>Briza media</i>	B, S, C	1
* <i>Bromus catharticus</i>	B, D	
<i>Bromus himalaicus</i> var. <i>himalaicus</i> var. <i>grandis</i>	B, D, S, C B, S	5
* <i>Bromus hordeaceus</i>	B	
* <i>Bromus pectinatus</i>	B	
* <i>Bromus racemosus</i>	B	
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<i>Bromus tectorum</i>	B, C	1
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<i>Calamagrostis debilis</i>	S	5C
<i>Calamagrostis elatior</i>	B	5A
<i>Calamagrostis emodensis</i>	B, S	4
<i>Calamagrostis filiformis</i>	B, S	5A
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<i>Calamagrostis tibetica</i>	S	3
<i>Calamagrostis treutleri</i>	B, S, D	4A
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<i>Chrysopogon serrulatus</i>	B	5
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<i>Cymbopogon microtheca</i>	D, S	5A
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* <i>Cymbopogon nardus</i>	D	
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Dz: Dzongkha

Sha: Shachop

K: Kengkha

N: Nepali name

L: Lepcha name in Sikkim

E: English name

B: name in Bhutan – language not recorded

S: name in Sikkim – language not recorded

I: Indian name – language not recorded

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