Joseph Dalton Hooker

BOTANIST, EXPLORER, AND ADMINISTRATOR

by

W. B. Turrill O.B.E. F.R.S.

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Preface

Joseph Dalton Hooker was a botanist and by far the greater part of his scientific activities and publications were directly concerned with plants, but he was exceedingly versatile and had a long life with diverse experiences. In this biography a chronological arrangement is generally used, broken occasionally by chapters dealing with restricted subjects, for a history of even one branch of science demands some classification or it becomes confused. In preparing this account of Sir Joseph Hooker and his work the author has been fortunate in having access to ample written material concerning his subject. He also had the honour of being introduced to Sir Joseph Hooker on his last visit to Kew, over half a century ago, when he was actually examining specimens of *Impatiens* (Balsam) in the Herbarium. He was with Lady Hooker and was seated at a table on the ground floor of what is now Wing B. While this fleeting personal acquaintance gives no qualification for writing this book, it has enabled more than an historical figure or a mere name to be kept constantly in mind.

The author wishes to record his sincere thanks to Dr G. Taylor, Director of the Royal Botanic Gardens, Kew, for permission to consult and use the many original manuscripts in the Library and Registry at Kew. Copies of almost all the published works of Hooker and his predecessors, contemporaries, and successors, in those branches of botany on which he specialized, and botanical periodicals, were available in the unique botanic library at Kew. Gratitude is also due to many past and present members of the Kew staff who have been con-

sulted on a variety of topics in connection with this book.

Special mention must be made of Leonard Huxley's *Life and Letters of Sir Joseph Dalton Hooker O.M., G.C.S.I.*, based on material collected and arranged by Lady Hooker, which has been frequently consulted during the writing of this book.

Help has been freely and generously given by all the author's colleagues. To Sir Gavin de Beer the author is indebted for advice, assistance, and encouragement, and here records his gratitude.

W. B. T.

Kew
November 1961

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G. de B.

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Chapter 1

Botanical and Family Background

Joseph Dalton Hooker was born of a botanical father and brought up in a botanical environment. This environment was most particularly due to the influence of his father, William Jackson Hooker. The relationship between the 'two Hookers', their resemblances and differences, and the sum total of their contribution to botany, in many ways form a unit subject. The paternal background must certainly be emphasized in considering the life-work of the son. In preparing the following brief account of W. J. Hooker the excellent biography by his son[1] has been used.

The Hooker family were for many generations natives of Exeter, whence Joseph and Lydia Hooker migrated to Norwich, where W. J. Hooker, the younger of two sons, was born on 6 July 1785. Early in life he was interested in entomology and ornithology, and the first available evidence of his taking up botany was his discovery in Britain in 1805 of the curious moss *Buxbaumia aphylla*, though correspondence with the botanist Dawson Turner showed that by the time of his majority he had widely studied both the flowering and cryptogamic[2] plants of Norfolk. In 1806 he was elected a Fellow of the Linnean Society and in the same year visited London and was introduced to Sir Joseph Banks, at that time acting Director

[1] *Ann. Bot.*, vol. 16 (1902)

[2] For explanations of this and other technical terms see the glossary on pp. 216-18.

at Kew Gardens. He was bitten by a viper in 1807, and, thinking he had been pricked by a thorn, took little notice until he collapsed. Fortunately he was found by friends and recovered after a tedious illness. He botanized widely in the Scottish Highlands and in 1809 visited Iceland. Though his collections made in Iceland were destroyed by fire on board ship he prepared and published his *Journal of a Tour in Iceland* (two editions, 1811 and 1813). He became a partner in a brewery firm at Halesworth, but his botanical interests continued to increase and became centred round bryophytes and algae. During the years 1814 and 1815 he visited Devon and Cornwall, France, Italy, and Switzerland, meeting such famous botanists as Antoine-Laurent de Jussieu, Desfontaines, Lamarck, Bory de St Vincent, and de Candolle. The *British Jungermanniae*, an account of the liverworts of this country, was finished in 1816. Joseph Hooker described this as 'the most beautiful of all my father's works, in point of the drawing, analyses, and engraving of the plates'. The work had taken ten years to prepare.

On 12 June 1815 he married Maria Sarah, eldest daughter of Dawson Turner. Their elder son, William Dawson Hooker, was born in 1816. He died in Jamaica in 1840. Joseph Dalton was born in 1817.

W. J. Hooker's interests were now markedly in botany, and the brewery business was proving unsatisfactory. He wrote to Sir Joseph Banks requesting that he 'might be informed should he hear of any opportunity of applying his botanical knowledge to the improvement of his income'. The result was that early in February 1820 Hooker was appointed by the Crown to the Chair of Botany in Glasgow. In the first quarter of the nineteenth century botany, in the universities, was regarded as a study 'ancillary to that of Materia Medica, and as a means of enabling the practitioners to recognize the plants used in

medicine when there might be no druggist to appeal to'. Since for medical degrees or licences a candidate had to attend a course of lectures delivered in a botanic garden registered for the purpose, and the plants in such were invariably arranged according to the Linnaean system, this system had to be taught. W. J. Hooker was a first-class botanical artist and both his blackboard sketches and folio coloured drawings were greatly admired. He was a most hard-working and conscientious teacher and had great success as a lecturer. In height he was over six feet and had a commanding presence, flexible features, good voice, eloquent delivery, and urbane manners. His lectures were attended by gentlemen from the city, and even by officers from the barracks three miles distant.

He purchased a cottage with an acre of ground near Kilmun on the Holy Loch, and there indulged his fondness for gardening. Botanical excursions with students were an important part of his teaching courses. His son records that

> he was a vigorous pedestrian, covering sixty miles a day with ease. When taking the week's end rest at Helensburgh, during his summer course of lectures, he habitually on Sunday walked to Glasgow, twenty-two miles, to be in time for his eight o'clock Monday morning class.

However, teaching, gardening, developing the Glasgow Botanic Garden, and botanical excursions were only part of the activities of this remarkable man. All the time he was building up a rich herbarium and botanical library and extending his researches, which resulted in numerous publications. In addition to his *Flora Scotica* (1821) he published a new edition of Curtis's *Flora Londinensis* (1817-28), four editions of the *British Flora* (1830, 1831, 1832, 1838—later editions were 1842, 1850, 1855, 1860, the last three in collaboration with A. W. Arnott), and

other works and papers, and commenced, edited, and contributed largely to several periodicals. Towards the end of his period in Glasgow, Sir William Hooker (he was knighted in 1836), undertook a study of ferns and in 1838 began the publication of Hooker and Bauer's *Genera Filicum*. Truly there were giants for work in those days.

The foundation of the Royal Botanic Gardens, Kew, is conveniently dated as 1759, when the Princess Augusta of Saxe-Gotha, Dowager Princess of Wales, with the help of the Earl of Bute, established a botanic garden with William Aiton as superintendent. The botanic garden and considerable adjacent areas were the private property of the royal family, and during the reign of George III the scientific value of Kew was greatly increased by the activities of Sir Joseph Banks, who succeeded the Earl of Bute as Advisory Director. George III and Banks both died in 1820 and the scientific importance of Kew declined. In January 1838 the Treasury appointed a committee 'to inquire into the management &c. of the Royal Gardens'. The committee consisted of Dr John Lindley, a renowned botanist, Mr (later Sir) Joseph Paxton, and Mr Wilson, gardener to the Earl of Surrey. The resulting report described the state of the collections then at Kew, the greenhouses, and so on. It was extremely critical and was itself criticized by John Smith, then a foreman at Kew, in his records (*Records of the Royal Botanic Gardens*, 1880); more important, the report clearly made out the need for a well-managed, well-equipped botanic garden in this country. It was presented to Parliament, after some delay, on 12 May 1840. The result was that the control of Kew was transferred from the Lord Steward to the Commissioners of Woods and Forests, that is, from the Crown to the Government.

Sir William Hooker was appointed Director of the Royal Botanic Gardens, Kew, in March 1841, and took up

his duties in this new position on 1 April 1841. Thus began the long connection of the Hookers with Kew. When Sir William became Director the garden area in his charge was only about 15 acres, divided up by brick walls, most of which he speedily had pulled down. The size of the gardens was greatly increased in less than five years to over 250 acres, and at one time the Old Deer Park, now separate, was under the care of the Director but let out to a tenant for grazing. The gardens and greenhouses were opened to the public on week-day afternoons.

It would be difficult to overestimate the importance of what Sir William Hooker did for Kew. The lay-out was planned with a landscape gardener, W. A. Nesfield, and many of the avenues, vistas, and main paths that resulted still remain. New greenhouses were built, the Palm House and the Temperate House were erected, and the lake was dug. On the scientific side, museums of economic botany were established and the Herbarium and Library were commenced in 1853. Collectors were sent out to many parts of the world and new collections of living plants and preserved specimens flowed into Kew at an ever increasing rate. The Director prepared a *Guide Book* to the Gardens and brought out twenty-one successive editions. All the administrative duties to which he gave the fullest personal attention, did not prevent Sir William from continuing and extending his editorial and research work. The *Journal of Botany* (one volume, 1841-2), the *London Journal of Botany* (seven volumes, 1842-8), the *Journal of Botany and Kew Garden Miscellany* (nine volumes, 1849-57), the *Botanical Magazine*, and *Icones Plantarum* were edited and largely contributed to by him. In particular he extended his researches on ferns. His *Genera Filicum* was published in 1842, and his *Species Filicum* between 1846 and 1864 in five volumes. He died on

12 August 1865 when he was six weeks past his eightieth birthday and was buried in the churchyard of St Anne's, Kew Green.

The influence of the father on the life-work of his son was evidently very great. It would appear that Joseph Dalton Hooker owed much to inheritance from his father, especially his physical stamina, his long active life, his capacity for hard work, and his artistic ability. His love of botany resulted from the interaction of natural aptitude and environment. The example and experience of Sir William Hooker were given full effect since the relationship that existed between him and his sons was always excellent. It is obvious from Joseph Hooker's letters and from his biography of his father that there was very full mutual understanding, affection, and respect between him and his father. There was constant consultation on projects and Sir William's advice was frequently sought by his son. Somewhat strangely they rarely collaborated as authors. An exception is the paper 'The botany of the Niger Expedition; notes on Madeira plants', by W. J. Hooker and J. D. Hooker, in Hooker's *London Journal of Botany*, vol. 6 (1847). Moreover Sir William prepared for publication various letters and records of his son connected with the latter's Antarctic and Indian travels, and, of special note, edited *The Rhododendrons of Sikkim-Himalaya* (1849-51).

Joseph Hooker apparently did not enjoy teaching, lecturing, or public speaking as much as his father did. Sir William was probably a greater organizer and administrator than his son, and his achievements as such at Glasgow and Kew were outstanding. While allowing for differences in circumstances and times it is perhaps not unfair to say that Sir William Hooker made the Royal Botanic Gardens as we find them today and Joseph Hooker made its modern botanical reputation by his own

scientific contributions and by collaboration with, above all, George Bentham.

From 1841 to 1885 Kew was directed by the Hookers, father and son, in unbroken continuity. Joseph Hooker's early collections came to Kew and were, in the main, worked out at Kew while his father was Director. He was Assistant Director under his father for ten years and succeeded his father, who died while still Director. There is every evidence that the general lines of management laid down by the elder Hooker for Kew were continued without abrupt change by his son. Both were great botanists and great administrators, but the son, as judged by his published works, contributed more as a man of science, while the credit for making the modern Kew Gardens should go mainly to his father. Certainly the more one studies the history of Kew from 1841 to 1865, the greater becomes one's admiration for Sir William Hooker and the deeper one's appreciation of what he did. The son was a very great man who was fortunate in his inheritance.

In order to understand Joseph Hooker's position as a British Man of Science, and in order to appreciate the changes that took place when he became the 'leading botanist of his age', it is essential to know something of the state of botany before his contributions were made.

Botany is the scientific study of plants, a subdivision of the scientific study of living organisms. It is not easy to find and state criteria for separating all organisms usually accepted as plants from all organisms usually accepted as animals, allowing no exceptions. This is largely due to the manifoldness and intricacies of evolution and may be partly due to our ignorance. Some unicellular and colonial organisms are described as plants by botanists and as animals by zoologists, as for example members of the *Volvox* group. About certain groups of organisms, such

as bacteria and fungi, one can only say that if there are to be only two major groups, plants and animals, the evidence is by and large in favour of classifying them with plants rather than with animals. There are however quite valid reasons for suggesting that bacteria and fungi are major groups that should be considered apart from both plants and animals. The presence of the green colouring matters known collectively as chlorophyll, and the manufacture of carbohydrate foods from water and carbon dioxide, are distinctive characters of true plants, and the relatively few completely colourless plant parasites and saprophytes are fairly to be considered as degenerate in the sense of having lost the chlorophyll apparatus of their ancestors.

The subdivisions one accepts within botany are largely a matter of scientific convenience. Hence there have arisen a considerable number of branches of botany with their special aims, methods, and terminology. There are plant taxonomy, palaeobotany, plant genetics, plant ecology, phytogeography, and so on. With increasing knowledge the number of subdivisions is multiplied and specialization increases, and it is now impossible for any one botanist to keep adequately in touch with advances in all branches of botany. This is partly because specialized research often necessitates a considerable knowledge of subjects outside the realm of botany; many plant physiologists are at least as much biochemists or biophysicists as they are botanists; plant genetics involves concepts derived from animal genetics and also necessitates the use of special methods of statistics; ecology and phytogeography link on to many branches of science within and beyond biology; even taxonomy is becoming more and more synthetic. All this is unavoidable and indeed is to be welcomed, but it has its dangers. Paradoxically specialization may lead to incorporation of methods and outlooks from other subjects and thus broaden the basis

of research, but at the same time lead to a narrowing of outlook. There must be attempts from time to time to 'see the wood' as well as its component trees. It is valuable to see how Joseph Dalton Hooker maintained a balance between specialization and breadth of outlook.

The first botanists were applied botanists in that they dealt with plants as sources of food and for their healing properties. In addition to elementary scientific knowledge regarding plant life, superstitions and religious rites developed around certain plants. The earliest extant account of plants that can be claimed as a scientific treatise is that of Theophrastus (370-285 B.C.). A long gap brings us to Dioscorides (dates uncertain but probably between 30 B.C. and A.D. 98) and Pliny (A.D. 23-79). The Dark and Middle Ages saw little advance in man's knowledge of plants, though it is probable that in some monasteries more was known than has yet been appreciated by historians. With the Renaissance began the period of the herbalists, who named and described plants mainly for their 'virtues', which were in part recognized by the 'doctrine of signatures', that is, that some outward sign of form or colour indicated properties of medicinal or other value. Their 'herbals' became more and more botanical in that descriptions and illustrations improved and accurate observations increased at the expense of superstitions. Andrea Cesalpino (1519-1603) has been called the first plant taxonomist and he was followed by Jean Bauhin (1541-1631), Gaspard Bauhin (1560-1624), and others. With botanists like Ray (1628-1705) and Tournefort (1656-1706) a high standard was reached in the analysis of floras, and more and more was being learnt regarding the structure and function of plants and plant organs. The invention of the microscope resulted, among other things, in the development of plant anatomy.

Plant taxonomy was given a modern guise in regard to

nomenclature by Linnaeus (1707-78); for seed-bearing plants names of genera are validated from 1735 and of species from 1753, when Linnaeus's *Genera Plantarum* and *Species Plantarum* respectively were published. Genera and species were recognized in biological classification before the time of Linnaeus, but there is no doubt that the regular designation of species, with a generic name followed by a specific epithet, had and has a great advantage for many purposes over any other proposed system. It is not perfect, because genera and species are not fixed and uniform entities, and for certain purposes special classifications and designations are desirable. Moreover it does tend to encourage a belief in 'species' as almost sacrosanct units linked with the very ancient belief in the sacredness of names. Linnaeus himself stressed the importance of his 'sexual' system of plant classification, and with more justification than is sometimes allowed. It is certainly artificial in the sense that it emphasizes the numerical relationships of stamens and carpels, and by ignoring other valuable characters for classification many plants that are now accepted as closely related were placed far apart. It is worth recording that all flowering plants that have been discovered since the time of Linnaeus could be accommodated in his system without any major alteration to it and that Linnaeus himself recognized that it could probably be replaced by a 'natural' system. The difficulties of defining 'artificial' and 'natural' in regard to plant classification will be discussed later when Joseph Hooker's contributions to taxonomy are considered. The influence of Linnaeus on botany, and above all on taxonomy, was great and long-lasting—indeed it still continues.

Following Linnaeus there was a great development in the describing and naming of plants from many parts of the world, and his hints for a 'natural' classification led to

the devising of various systems which culminated (for our present purpose) in that of Bentham and Hooker. We have to recall that before the publication of Darwin's *Origin of Species* in 1859 there was a general tacit belief in the fixity of species within limits, though Lamarck (1744–1829) was an evolutionist. We shall see in a later chapter that the position was in several ways a peculiar one and that the change from belief in 'fixity of species created once and for all' to 'evolution' was not so abrupt as is often stated.

Other branches of botany developed more slowly. When Joseph Hooker was training and commencing research as a botanist in the first half of the nineteenth century, taxonomy based on morphology was the greater part of botany. The world was in process of being opened up to botanical exploration and in this Hooker himself played an important role. Plants new to botanists were being discovered at a great rate and were being classified as new species, new genera, and even new families. On the whole the standard of description, often with adequate illustration by drawings and paintings, improved and large herbaria accumulated. While Joseph Hooker was primarily a taxonomist and phytogeographer throughout his long life, he had a very broad outlook on and extensive knowledge of other branches of botany. He was interested in the cryptogams and indeed the first and second of his published papers dealt with mosses. A glance through the list of his published works prepared by S. A. Skan (*Kew Bull.* (1912), 18–34) shows that outside the taxonomy and phytogeography of seed-bearing plants he did research on fossil botany, bryophytes, lichens, algae, marine animals, economic botany, luminous plants, plant morphology, longevity of seeds, and even glaciers. In addition his responsibilities as Director of the Royal Botanic Gardens, Kew, for twenty years (1865–85),

as President of the British Association for the Advancement of Science (1868), as President of the Royal Society (1873-8), and official associations with or membership of a very large number of other learned societies and institutions meant that as well as his research work and many publications he acquired a vast knowledge of the scientific organizations of his time. He had an enormous capacity for work.

Chapter 2

The Antarctic Voyage

Joseph Hooker and his elder brother William went to Glasgow High School, where the education was mainly in the classics, mathematics, logic, English literature, and moral philosophy. He was extremely industrious and a plodder while William was described as quick, clever, and brilliant but with a strain of instability. It is recorded that at thirteen 'Joseph is becoming a zealous botanist', and at fifteen 'Joseph is contented and happy at home, and studying Orchideae most zealously'. At fifteen Joseph entered Glasgow University and attended lectures in Greek, Latin, mathematics, and moral philosophy. His spare time was devoted to botany and entomology and collecting in the Highlands and parts of England. Later, in preparation for a medical degree, he studied surgery, chemistry, materia medica, attended anatomical demonstrations, and occasionally the dissecting-room. In 1838 he went on a botanizing trip to Ireland and somewhat later in the same year attended the British Association meeting at Newcastle. He was 'much surprised to hear that ladies were precluded from attending this section of Botany and Zoology on account of the nature of some of the papers belonging to the latter division'.

At the age of twenty-one Joseph Hooker had a very wide knowledge of botany and was finishing his medical course, and the question of his immediate future career

arose. His father's position and reputation and active interest played a prominent part in settling this. Sir William knew James Clark Ross, the distinguished Arctic explorer, and was informed of Ross's expectation of leading a government expedition to the southern seas. Joseph Hooker met Ross and eventually it was agreed that he would 'be taken into the Navy as soon as he had completed his curriculum. . . . Then he would be employed until the Antarctic Expedition was determined upon.' He graduated in medicine early in 1839 and was appointed Assistant Surgeon and Naturalist to the *Erebus*.

The two exploring ships, *Erebus* (378 tons) and *Terror* (340 tons), were under the command of Captain James Clark Ross, who had shared in seven Polar expeditions. Each ship had a crew of sixty-four men and was strengthened to withstand the pressure and shocks of the ice. They were of course sailing-ships and Hooker wrote that they possessed every superiority except that of sailing qualities for manoeuvring amongst ice. The expedition was definitely organized as a scientific one with a Government agreement to fit it out at a cost of £100,000, the purchasing power of a pound sterling being very much higher then than it is now. One of its main objects was to determine the position of the South Magnetic Pole, concerning which there were some doubts. Ross had his general instructions but these left him considerable latitude, and indeed his plans in the extreme south were wisely changed.

The expedition left England during September 1839 and returned on 7 September 1843. Its accomplished activities can conveniently be divided into three parts: (1) the journey to Tasmania, lasting nearly eleven months, with stops at various oceanic islands and the Cape of Good Hope, and the journey from Tasmania to Victoria Land and the Great Ice Barrier; (2) a three months' stay in Tasmania with a visit to Sydney, a stay

of three months in New Zealand, a trip to the Falkland Islands east of Cape Horn, and another visit to the Barrier; (3) a stay of six months in the Falklands, broken by a seven weeks' excursion to Hermite Island off Tierra del Fuego and west of Cape Horn, visits to Louis Philippe Land and the South Shetlands and to the Cape of Good Hope, and the return home via St Helena, Ascension, and Rio. The homeward journey occupied four months.

The scientific equipment for botanical and zoological purposes was very meagre. Hooker records:

> Except some drying paper for plants, I had not a single instrument or book supplied to me as a naturalist—all were given to me by my father. I had, however, the use of Ross's library, and you may hardly credit it, but it is a fact, that not a single glass bottle was supplied for collecting purposes, empty pickle bottles were all we had, and rum as preservative from the ship's stores.

It is true that *Erebus* and *Terror* explored within the true Antarctic, and indeed Ross discovered the great volcano named Mt Erebus, 13,200 feet high in latitude 77½° S., and twice forced his way beyond the 78th parallel. Nevertheless the 'Antarctic' exploration, from the botanical point of view and so far as Hooker's main interests and subsequent publications were concerned, was well north of the Antarctic Circle. General details of the whole voyage are given in Sir James Clark Ross's *A Voyage of Discovery and Research in the Southern and Antarctic Regions* (two volumes, London, 1847). This is an interesting and readable work and there are some botanical contributions by Hooker in it that were not entirely included in his independently published researches. These appeared in three large publications under the general title *The Botany of the Antarctic Voyage of H. M. discovery ships* Erebus *and* Terror *in the years 1839-43, under the command of Captain Sir James Clark Ross*: I. *Flora Antarctica* (London, 1844-7)

parts 1 and 2. II. *Flora Novae-Zelandiae*, part 1, Flowering Plants (London, 1853-5); part 2 (London, 1855). III. *Flora Tasmaniae*, vol. 1, Dicotyledones (London, 1855-60); vol. 2, Monocotyledones and Acotyledones (London, 1860). There was a pre-publication advertisement, with some details, in Hooker's *London Journal of Botany*, vol. 3 (1844), 274-8. It may be of interest to note that the original two parts of the *Flora Antarctica* were offered in May 1961 (by Bernard Quaritch Ltd.) for £265 ($742.00). In the same catalogue it was announced that a reprint of *The Botany of the Antarctic Voyage of H.M.S.* Erebus *and* Terror, *1839-43* was to be published shortly, price after publication £83 ($232.40), the three sections being in six volumes comprising *Flora Antarctica*, *Flora Novae-Zelandiae*, and *Flora Tasmaniae*, with plates.

This great work finally established the botanical reputation of Joseph Hooker as a taxonomist and plant-geographer. The voyage lasted nearly four years, and for Hooker it was divided into periods of extremely active collecting and observation on land with long intervals at sea, under cramped conditions, in between. No doubt these latter periods enabled him to work on his specimens and to think over the very numerous problems that they and his experiences raised. While a great deal of preliminary work was done in the field and on board ship, detailed comparisons could only be made on his return and were mainly carried out at Kew, where determinations were settled and interpretations given.

A very interesting summary of the Antarctic voyage from the botanical point of view was prepared by Sir William Hooker from 'the information given by my son, Dr J. D. Hooker' and published in the *London Journal of Botany*, vol. 2 (1843). This account gives some facts not repeated elsewhere and has been used in preparing this outline account of the voyage.

The vessels *Erebus* and *Terror* left the Medway in late September 1839 and proceeded to Madeira, where some collecting was done. There were very brief stays at Teneriffe and Cape Verde Islands and the vessels passed St Paul's Rocks. One boat went ashore but Hooker was not on it; he commented that a seaweed inhabited the marine edge, but it did not appear that any plant, not even a lichen, could be seen on the rocks themselves. Steering westwards, the small solitary island of Trinidad, latitude 20° S., was reached but only a fern and one or two species of *Cyperus* were obtained. St Helena was reached on 1 February 1840. Man's destruction of nearly all the indigenous vegetation is commented upon but a 'tolerable' collection of native plants was made from several places. On the way to the Cape of Good Hope great masses of floating seaweed were encountered, associated with numerous parasites and marine animals. Hooker never suffered from seasickness but said, 'once my foot has touched *terra firma*, there is a sort of magic connected with it, that makes me grievously loth to quit it for sea again'.

After a short stay at the Cape the voyage was continued to Kerguelen's Island, or the Island of Desolation. The difficulties of landing from a sailing-ship on the shores of such an island are vividly described and can be visualized from accounts of the fearful surf, continually roaring and lashing against a mile of precipices, or of the wind spending its terriffic fury, rendering all the anchors and cables barely sufficient for securing the ship, and sometimes forbidding, for many days, any communication with the shore. As regards the vegetation particular emphasis was laid on the 'cabbage' of Kerguelen, with its thick round roots, 1-2 inches in diameter, and large cabbage-like heads of a white heart surrounded by green leaves, sometimes 18 inches across. The heart ate like coarse tough mustard and cress; the root tasted like horse-radish

and the seeds like those of cress. The green leaves were much relished by the sailors. Hooker says they tasted to him like very stale cabbage, with a most disagreeable essential oil which resides in cavities in the parenchyma of the leaves. The oil gives a curious anti-heartburn property to the vegetable. The 'cabbage', *Pringlea antiscorbutica*, was later described in detail by Hooker (see p. 27). It is endemic on Kerguelen and a few other associated islands, and on Kerguelen it grows near the sea in great abundance and extends to the top of the hills, 1,500 feet high.

Other strange species were noted. A considerable number of species of liverworts and mosses occur and lichens formed a particularly large component part of the vegetation, especially considering that there were no trees on which they could grow. Seaweeds were in enormous profusion. The expedition remained two and a half months at Kerguelen and about 130 'plants' (presumably 'species') were collected, the majority being cryptogams. Hooker was on Kerguelen in the winter and his rambles were generally solitary, 'through the wildest country I ever beheld', with the hills always covered with frozen snow. Coal and fossil wood abounded, the latter lying in immense trunks, bedded in the solid basaltic rock.

The vessels left Kerguelen Island on 30 July and met dreadful weather (one poor fellow of the crew being swept overboard) before reaching Tasmania (Van Diemen's Island), where nearly three months were spent. On 12 November 1840 *Erebus* and *Terror* left Tasmania for the south. One of the main purposes of the expedition, to ascertain the precise bearing of the South Magnetic Pole, was fully accomplished. As Sir William Hooker remarks, 'Our bold voyagers penetrated as far as 78° S. latitude, 7 degress farther than Capt. Cook was able to reach, and nearly 4 degrees beyond the no less enterprising Weddell'.

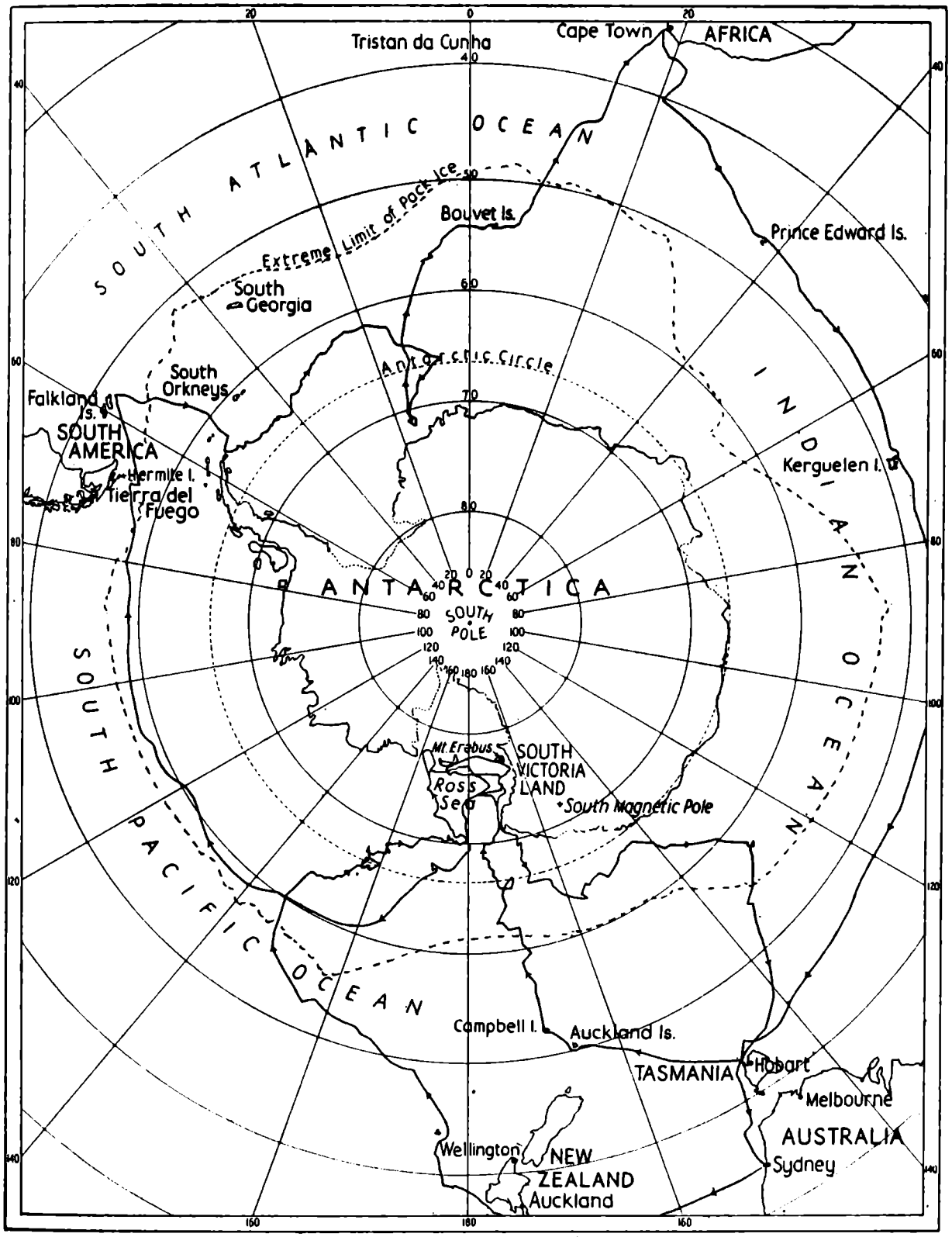


Fig. 1 Map to illustrate Hooker's travels in the Southern Hemisphere, the black line with arrows showing the route taken by *Erebus* and *Terror* under the command of Captain James Clark Ross.

They discovered and ran along a vast extent of new continent, covered with everlasting snow yet presenting to the view mountains of vast magnitude, from 9,000 to 12,000 feet in elevation, and one of them an active volcano! On the way to the Antarctic proper the ships called at Lord Auckland's Islands (20 Nov.-12 Dec.) and Campbell's Island (14–17 Dec.). These were thoroughly investigated botanically especially the former. On 28 January, in latitude 76° 57′, longitude 169° 25′, the active volcano named Mt Erebus was first described—'a spectacle the most stupendous and imposing that can be imagined', 13,200[1] feet above the level of the sea. The ships coasted along the Victoria Barrier east from Mt Erebus, but no passage to the south was found and they returned to Tasmania. After a short stay for needful refreshment and repairs, *Erebus* and *Terror* sailed for Sydney and thence for the North Island of New Zealand. Botanizing in New Zealand was mainly in the area of the Bay of Islands.

The second voyage to the extreme south was commenced in November 1841 and the vessels became entangled in pack-ice of immense extent, between latitudes 62° and 68°, from 18 December 1841 till 2 February 1842. Though they reached a little farther south than in the previous year they were again brought up against the same impenetrable Victoria Barrier. They turned northwards, rounded Cape Horn, and on 6 April 1842 reached Berkeley Sound in the Falkland Islands—the first clear land they had seen for 138 days. Storms badly damaged both vessels. Regarding one of the storms Joseph Hooker says:

> I have neither time nor inclination to dwell on the events of that dreadful night, which it even now makes me shudder to think of; but, some day, if it please God, through whose

[1] As measured in 1958.

Plate 1 Joseph Hooker, portrait painted by Richmond in 1855.

Plate 2 Photograph of Joseph Hooker, from the Kew Collection of Portraits, exact date unknown but probably the early 1850s

Plate 3 Photograph of Sir Joseph and Lady Hooker, taken at Kew in the Royal Botanic Gardens on Sir Joseph's 90th birthday, 30 June 1907.

merciful interposition we were saved, I will give you an account when sitting over the fireside.

The two vessels came to anchor in Berkeley Sound on 5 April 1842, at the commencement of winter, and were soon hauled ashore for repairs. There was a long stay in the Falklands and an enumeration is given of the plants collected during the winter months. On 6 September 1842 the ships paid a visit to Hermite Island, west of Cape Horn, returning to the Falklands on 13 November.

Sir William Hooker's account of the Antarctic voyage refers to a third cruise to the dreary South Polar regions and to the return of the expedition to the Cape of Good Hope on 4 April 1843. An appendix gives some details of this last cruise to the south. The expedition left Berkeley Sound on 17 December 1842 and was soon in Antarctic waters with pack-ice, icebergs, and so on, finally re-crossing the Antarctic Circle on 11 March 1843. On their return northwards attempts were made, without success, to find Vouvet's Island (54° 10′ S.). Details of the voyage home are not given by Sir William Hooker. The ships reached Woolwich in early September 1843 and were paid off on the 23rd, though Hooker, as a junior officer, only reached home on 9 October.

The more important taxonomic results published in the three divisions of the *Antarctic Voyage* may now be briefly considered.

Flora Antarctica 1 (1844–5) includes an account of the botany of Lord Auckland's group and Campbell's Island. While the Lord Auckland's group had been previously visited by French and American 'Discovery' ships only very few plants from the islands had been recorded, and their flora, as well as that of Campbell's Island, was practically unknown until Hooker's very thorough investigation. He described 63 species and 6 genera new to

science; 5 of the latter were later (in the *Flora of New Zealand*) reduced by him to earlier described genera.

When approached from the sea the Auckland group is seen to be covered with wood, shrubs, and pasture-land; the mountains do not exceed 1,500 feet and are mostly covered with long grass. *Metrosideros umbellata* (Myrtaceae) forms the greater part of the wood near the sea, mixed with an arborescent *Dracophyllum* (Epacridaceae), *Coprosma* spp. (Rubiaceae), *Veronica* spp. (*Hebe* spp.), and *Panax simplex* (Araliaceae), under which are many ferns. A shrubby belt succeeds the wooded region on the hill slopes, and towards the summits of the hills the most striking plants are found 'vying in brightness of colour with the Arctic Flora, and unrivalled in beauty by those on any other Antarctic country'. The exceedingly fine coloured plates by Fitch enable one to appreciate Hooker's enthusiasm. Special mention should be made of the umbellifers *Anisotome latifolia* (*Ligusticum latifolium*) and *A. antipoda* (*L. antipodum*); the composites *Pleurophyllum speciosum*, *P. criniferum*, and *Celmisia vernicosa*; the gentians *Gentiana concinna* and *G. carina*; a forget-me-not, *Myosotis capitata*; a shrubby speedwell, *Veronica* (or *Hebe*) *benthamii*; and a liliaceous plant, *Chrysobactron rossii* (now usually placed in *Bulbinella*). A considerable number of less conspicuous plants are also described and many of them figured. The very careful and full Latin descriptions and the extensive and critical taxonomic notes in English in the text are extremely good. The thoroughness and accuracy of Hooker's researches, both in the field and in the working out of his collections, is evidenced by the very few additions made by subsequent explorers and workers (see for example Cheeseman, 1909[1]).

[1] Full details of references in brackets are given in the Bibliography on p. 218.

A few words must be said about the very fine illustrations in this and subsequent volumes of the *Antarctic Voyage* published by Hooker. The illustrations are mostly separately imprinted as 'Fitch del. et lith.'. This is Walter Hood Fitch (1817-92), the famous botanical artist, 'discovered' by Sir William Hooker, who did so much for botanical taxonomy for several decades (see *Journ. Bot.*, vol. 30, (1892), 100-2; *Gard. Chron.*, ser. 3, vol. 11 (1892), 120; *Kew Bull.*, (1915), 277-84). For the volumes of the *Antarctic Voyage* Fitch recopied and modified many of Joseph Hooker's original drawings and paintings made in the field or on board the *Erebus*. Many, if not all, of these drawings and paintings are at Kew—the dissections often attached to the type specimens in the Herbarium and the coloured paintings preserved in the Collection of Drawings. Thus, as one example, the type material of *Veronica benthamii* (*Hebe benthamii*) is represented in the Kew Herbarium by three sheets of specimens collected by Hooker, and to one of these are attached two separate pieces of paper with drawings of dissections of the reproductive parts in pencil; also in the Collection of Drawings there is a water-colour of the plant by Hooker. It is obvious on comparison that the painting and the dissections are the basis of Fitch's 'del. et lith.' plates of the species. Other species have been checked at random with similar results. This is not to discredit Fitch but to add to our knowledge of the actual achievement of Joseph Hooker.

Some additional information is given in the botanical contributions by Joseph Hooker to Sir James Clark Ross's *A Voyage of Discovery and Research in the Southern and Antarctic Regions* regarding the islands just considered, particularly details of the vegetation of Campbell's Island. The island is 120 miles south of Lord Auckland's group and is of much smaller extent. It has steep precipices

and ravines, suited to the growth of lichens, mosses, and grasses. There is a belt of brushwood and very stunted trees. Most of the species of Lord Auckland's group were found here, but 34 were not found and at least 20 additional ones were collected.

As is to be expected from the high southern latitude, a large proportion of taxa, in both the Lord Auckland group and Campbell's Island, is cryptogamic. Joseph Hooker like his father was a good cryptogamic taxonomist, though he gradually came to devote his studies almost entirely to flowering plants. In the *Flora Antarctica* he obtained the help of specialists in working out the Algae, Fungi, Lichens, and Bryophyta, though his name appears as joint author with another for all the groups. Preliminary papers were published in Hooker's *London Journal of Botany*, vol. 3 (1844) as follows: with Dr Thomas Taylor for Hepaticae Antarcticae; with W. Wilson for Musci Antarctici; and with Dr Thomas Taylor for Lichenes Antarctici.

The Lord Auckland group and Campbell's Island are included in the area covered in *The Subantarctic Islands of New Zealand*, an account of the *Hinemoa* expedition, 1907, edited by C. Chilton (1909). There are several articles referring to the earlier and basic researches of Joseph Hooker.

The second part of the *Flora Antarctica* deals with the plants of all the areas in the Southern Hemisphere in which Hooker botanized on the Antarctic voyage, except those dealt with in volume 1 and Tasmania, Australia, and New Zealand. Most of the plants recorded were collected in the Falkland Islands, the south of South America (Fuegia, Hermite Island, and Strait of Magalhaens), and Kerguelen Island. While in many ways this part is similar in format, arrangement, and style of contents to the first, there is one somewhat important difference. A considerable

number of species collected by other botanists than Hooker himself are included. Thus plants collected by Charles Darwin are quoted and described, especially those from South America. The specimens were presumably in the W. J. Hooker Herbarium (now part of the Kew Herbarium). There is an interesting introduction in which comments are made upon general features of the vegetation and flora of the various parts of the area. Hooker did not have a wide personal experience of Fuegia or Patagonia, and the much later researches of Skottsberg and others have added greatly to the botanical information now available concerning this peculiar region (see summaries by Turrill in *Kew Bulletin*, (1919 and 1958) and *Proceedings of the Royal Society*, (1960)). Hooker notes the southern beeches as distinguishing botanical features of the country. These trees (rarely shrubs) were placed in the genus *Fagus* by Hooker but are now generally separated generically from the northern beeches as the genus *Nothofagus*, distinguished from *Fagus* by their smaller, more closely set, leaves and the male and female flowers being either solitary or in threes. In *Fagus*, as now usually delimited, the male flowers are in many-flowered heads. Most of the species of *Nothofagus* are evergreen. Hooker as noted above spent a long time in the Falkland Islands and the collections which he had available were pretty well a complete representation of the plant life. The absence of trees is explained thus:

> The most evident causes for the absence of trees in the Falkland Islands are the dislocation or removal of that group from the main land; their comparatively plane surface, everywhere exposed to the violence of the westerly gales, and more especially to the rapid evaporation and sudden changes in temperature and in other meteorological phenomena.

He also comments upon the poverty of the flora.

A few of the other more interesting plants dealt with in the second part of the *Flora Antarctica* may be mentioned. *Caltha dioneaefolia*, from Fuegia and Hermite Island, is a kingcup or marsh marigold with strange leaves which in appearance recall those of the Venus's flytrap (*Dionaea muscipula*). This species of *Caltha* is one of the most striking of the section *Psychrophila* endemic to South America. The section is characterized by the development of the auricles of the leaf blades to form upturned or erect appendages and in *C. dioneaefolia* the two appendages arise from the base of the blade and are wing-like structures covering the two halves of the blade, and their margins, like those of the deeply bilobed blade, are bordered with teeth. A. W. Hill (1918) revised this section of *Caltha* and in his paper may be found other references to Hooker's remarkable species.

Hooker's record of the sea pea, *Lathyrus maritimus*, from Cape Tres Montes, collected by Charles Darwin, is an unexpected example of discontinuous range. The species is restricted to the Northern Hemisphere except for its occurrence in southern Chile. A full descriptive account is given of the mistletoes, *Myzodendron* spp., parasitic on the southern beeches (*Nothofagus* spp.), with a series of fine plates imprinted 'J. D. Hooker del.'. A number of ragworts (*Senecio* spp.) are described and three are figured, including *S. falklandica*. The unusual-looking composite *Nassauvia serpens* D'Urv. is well illustrated. Hooker remarks that it is almost confined to the 'Streams of stones', which are those curious tracts of land covered with loose blocks of quartz, abounding in some parts of the Falkland Islands. The strange *Lyallia kerguelensis* from Kerguelen is described and figured and placed provisionally in the Portulacaceae though later it was referred to the Caryophyllaceae. There is an excellent account of the southern beeches and of the famous tussock

grass under the name *Dactylis caespitosa* (now usually named *Poa flabellata*). In working out the numerous cryptogams, many of which are illustrated by coloured plates (J. D. H. del.), Hooker had the assistance of various specialists.

The lonely island of Kerguelen was discovered by Captain Yves Josephe de Kerguelen-Tremerac on 13 February 1773 and was investigated in greater detail by Captain Cook in 1776, and through his surgeon-naturalist, Anderson, the first account of the flora reached Europe. Hooker however was the first to investigate the flora properly, when Sir James Ross spent sixty-eight days there. In the *Flora Antarctica* Hooker described most of the peculiar flowering plants and some of the cryptogams known from the island, but another and in some respects fuller account was published later by him, based especially on Moseley's collection ('Observations on the botany of Kerguelen Island', *Phil. Trans. Roy. Soc.*, vol. 168, (1879)). 21 species of flowering plants are recorded by Hooker from Kerguelen. The American affinity of much of the flora is shown by the following analysis as given by Hooker:

(*a*) 1 endemic genus (*Pringlea*), with no near ally known.
(*b*) 1 endemic genus allied to an Andean one (*Lyallia*, Caryophyllaceae).
(*c*) 6 species allied to American congeners.
(*d*) 5 species common to Fuegia but not found elsewhere.
(*e*) 6 species common to America and also to New Zealand and the islands south of it.
(*f*) 2 species found elsewhere but not in Fuegia.

The name *Pringlea antiscorbutica* is here applied to the Kerguelen cabbage. The generic name was adopted from

a manuscript name given by Anderson to specimens in the Banks Herbarium, and the specific name given by Robert Brown in the same herbarium. A long account is given by Hooker of the plant and the coloured double plate is of fruiting specimens. This most peculiar crucifer was first discovered during Captain Cook's third voyage, with Anderson as surgeon-naturalist. It was given the generic name of *Pringlea* in honour of Sir John Pringle (1707-82), President of the Royal Society, 1772-8, who was interested in and discussed (in discourses delivered at the Royal Society, published in 1783) Captain Cook's account of the means by which he kept his crews free from scurvy.

Pringlea is not strictly endemic to Kerguelen for it is recorded from Marion, Crozets, and Heard Islands (see Moseley, 1874 and 1877, Oliver, 1877, and Kidder, 1876).

It is of interest to refer to an account of the vitamin C content of the Kerguelen cabbage (Hatt, 1949) where the results of the analysis of material collected on Heard Island are summarized as follows:

> It is seen that the most edible portion of the cabbage, the heart leaves, are rich in ascorbic acid, the amounts present exceeding that found in most cabbages and being in the same order as that present in broccoli leaves and flower and in parsley. Eaten raw, the heart leaves would be a valuable anti-scorbutic. However, it is not an exceptional source of ascorbic acid such as the rose hip and the green walnut, which contain exceedingly large amounts.

A concise summary of work on the flora and vegetation of Kerguelen since Hooker's time is given by Turrill (1953), and an additional account is that of A. Chastain (1958).

The *Flora Novae-Zelandiae* occupied two quarto parts, the first with the important Introductory Essay and the systematic account of the flowering plants by Hooker, the second dealing with the cryptogams, all of which

except the ferns were worked out by various specialists. There are excellent plates imprinted 'Fitch del. et lith.', but these are not, as in the *Flora Antarctica*, coloured. Hooker, on the Antarctic voyage, did only a limited amount of field work in New Zealand, and the bulk of this flora is based on collections by Colenso, Sinclair, and Lyall (as acknowledged in the dedication of part 1), and by other botanists, above all by Banks and Solander during Captain Cook's first voyage in 1769. This great flora is the first of a number which have kept our taxonomic knowledge of the vascular plants of New Zealand up to date. Of plants described and figured in it and worthy of special mention are *Clematis colensoi*, *Ranunculus insignis*, *Donatia novae-zelandiae* (Saxifragaceae), *Panax colensoi* (Araliaceae), *Celmisia holosericea* (Compositae), *Olea montana*, and *Phyllocladus alpinus* (Coniferae).

The third division of the *Botany of the Antarctic Voyage* was published in two volumes as the *Flora Tasmaniae*. The first of these volumes deals with the 'Dicotyledones' and the second with the 'Monocotyledones and Acotyledones'. Hooker himself dealt with the seed-bearing plants and the vascular cryptogams, and various specialists with the remaining cryptogamic groups. Both volumes are illustrated by fine coloured plates, mostly imprinted 'Fitch del. et lith.'. From sampling it appears that some are based at least in part on Hooker's originals, while others were drawn by Fitch from dried specimens and then coloured. As in the *Flora Novae Zelandiae* there is an Introductory Essay of the greatest interest. As a selection of the plants described and figured one may name: *Hibbertia ericaefolia* (Dilleniaceae), *Drosera gracilis*, *Myriophyllum pedunculatum*, *Eucalyptus giganteus*, species of *Hydrocotyle*, *Pernettya tasmanica* (Ericaceae), species of *Mitrasacme* (Loganiaceae) and *Prostanthera* (Labiatae), and conifers (*Diselma*, *Pherosphera*, *Microcachrys*, and

Dacrydium), and a considerable number of orchids and cryptogams. As with the *Flora Novae-Zelandiae*, the *Flora Tasmaniae* was the first published flora of the country. More recent floras are those of Rodway (1903) and Curtis (1956).

Turning now to some of the wider and more general problems raised by the botanical results of the Antarctic voyage, we find these considered especially and at length in the Introductory Essays to the *Flora Novae-Zelandiae* (published on 6 December 1853) and the *Flora Tasmaniae* (published between 28 January and 6 February 1860). These problems are mainly either phytogeographical or are concerned with the nature and origin of species, though it is sometimes difficult to classify them as clearly one or the other. Indeed the impression is left on the reader that Hooker was interested in 'species problems' especially from phytogeographical standpoints, and eventually became a Darwinian evolutionist largely because of phytogeographical evidence. It may be recalled here that Darwin in the *Origin of Species* (6th ed.) devotes two chapters (XII and XIII) to Geographical Distribution (of animals and plants), but Hooker's approach was in various ways different from that of Darwin though the latter quotes or refers to Hooker a dozen times in the chapters mentioned.

Several matters concerning the ranges of plant taxa in the Southern Hemisphere were discussed by Hooker. In this half of the world the principal land masses and islands are separated by wide areas of sea and their floras are thus isolated from one another by barriers to ready and easy dispersal. This isolation is reflected in the high degree of endemism, that is, of the large number of taxa occurring naturally only in a given restricted geographical area. Thus for the flora of New Zealand Hooker gave 26 genera and 507 species as endemic, or more than two-

thirds of the whole of the known seed-bearing flora. The remaining third of the New Zealand flora he divided into five groups for illustrating the relations of the plants to those of other countries:

(*a*) 193 species, or nearly one-fourth of the whole, are Australian.
(*b*) 89 species, or nearly one-eighth of the whole, are South American.
(*c*) 77 species, or nearly one-tenth of the whole, are common to both the above.
(*d*) 60 species, or nearly one-twelfth of the whole, are European.
(*e*) 50 species, or nearly one-sixteenth of the whole, are common to Antarctic islands, Fuegia, etc.

Moreover a close relationship to plants in other countries can be traced (on the basis of morphological resemblances) in most of the endemic genera and species, though there are some eight or nine genera that are exceptionally isolated taxonomically. One has to remember that Hooker during the Antarctic voyage sampled personally southern South America, Antarctica and Subantarctica, Australia (especially Tasmania), New Zealand, and South Africa, and on his return worked in detail at the floras of all except the last. The important taxonomic resemblances between the floras of South America, the Subantarctic islands, New Zealand, and Australia were fully appreciated by Hooker and have been amply confirmed by more recent researches. The flora of South Africa also shows some taxonomic resemblances with the other southern floras, but these are less marked than those between the South American and Australasian floras. While it is of course important not to lose sight of the considerable differences between all the floras mentioned, an attempt has to be made to account for the resemblances.

There is no doubt that wide stretches of water are barriers to the easy dispersal of the vast majority of terrestrial seed plants. It is the extent, not the depth of the seas, which determines the effectiveness of the barrier. The permanence of the ocean or sea in geological time has also to be taken into account in studying the history of floras. Briefly one may say that there are two main groups of hypotheses purporting to explain resemblances between now discontinuous floras: long-distance transport of disseminules and previous land connections. The latter may have been provided either by 'land bridges' or by continental drift. Hooker considered the possibility of transport of disseminules between Antarctic (i.e. southern) continents and islands over wide expanses of ocean, and in general rejected its feasibility as an explanation of the known facts of range and distribution. He speculated

> on the possibility of the plants of the Southern Ocean being the remains of a flora that had once spread over a larger and more continuous tract of land than now exists in that ocean; and that the peculiar Antarctic genera and species may be the vestiges of a flora characterized by the predominance of plants which are now scattered throughout the southern islands.

Continuous land communication by itself however was, according to Hooker, not essential to account for the interchange of plants, for an intermediate land, peopled with some or all of the plants common to both, may have existed between New Zealand and Chile when neither of these countries was as yet above water. There must also have been changes in climate to account for the Antarctic plants on the lofty mountains.

Hooker was at this time on the whole in favour of land bridges, as opposed to long-distance dispersal by transport of disseminules. Darwin favoured transoceanic transport especially by winds and birds. We may note that while these two hypotheses, with various modifications, are

still often opposed one to the other by botanists working on phytogeographical problems they are not necessarily and invariably mutually exclusive throughout the history of any flora. Hooker knew the essentials of the problems involved, but since his time there have been new lines of research and the introduction of new possible explanations. Nevertheless the problems he raised and to which he gave or suggested tentative solutions are still not all fully answered to everyone's satisfaction.

The phytogeographer is dependent to a high degree on the geologist and palaeometeorologist when he attempts explanations of present-day ranges, or, conversely, he can criticize their conclusions on biological grounds. Even if the taxonomy be highly reliable and the field exploration reasonably complete and up to date for existing floras, the time factor must be of great importance in determining the history of a flora apart from the evolution of taxa within the present-day areas of the floras concerned. In the past hundred years there have been considerable additions to our knowledge of southern floras and of facts which must be taken into account in attempting to elucidate their origin and history. Fossil floras of various geological ages in many parts of the region have been investigated. A start has been made on studying pollen grains in peaty or other deposits within the area. The ecology of the plant life has been investigated and comparisons are becoming possible on a sound basis of plant communities growing in widely separated areas, additional to the comparisons of floristic lists of genera and species on which Hooker so largely depended.

There is one other matter of considerable importance which would undoubtedly have been discussed by Hooker (and by Darwin) had it been to the fore a century ago. This is the possibility of continental drift as explaining resemblances between now widely separated floras.

Continental drift postulates the continents, including the Antarctic continent, as formerly one continuous land mass. Separation occurred or commenced, according to Wegener, in the late Mesozoic and early Cainozoic era. There have been suggested modifications of the original scheme and it is important to remember that Wegener (and Köppen) linked up continental drift with very considerable wandering of the Poles. There has been opposition to the various schemes of continental drift and Polar wanderings from geologists, geophysicists, and biologists. Researches on rock magnetism, now in vogue on the physico-geological side, may settle definitely whether the continents once formed a single continuous land area, and if they can say when (in geological time) the continents first separated, the relative speed and directions of their movements, and the times and movements (relative to continental drifting) of Polar movements, many biologists would be grateful. At present there are so many hypotheses concerning these matters that a phytogeographer can surely find one to support any generally reasonable explanation he cares to suggest regarding the relationships of now widely separated floras. Certainly some form of continental drift would help to explain a number of peculiarities of range, but acceptance of the full Wegener scheme leaves some unexplained and raises additional problems.

For the Darwinian point of view of the effectiveness of long-distance transport there has been some recent supporting evidence, even within the region covered by Hooker's *Botany of the Antarctic Voyage*. For instance the results of the very full investigation of the botany of Macquarie Island by Taylor (1954) support the trans-oceanic-transport hypothesis. Nevertheless much more direct evidence of transport by wind, birds, or other natural agencies (i.e. agencies independent of man) across wide expanses of ocean is needed. That disseminules,

particularly fruits and seeds, are dispersed by ocean currents over long distances is proved for a limited number of species, but there are relatively few that can be so dispersed as to reach a land area in a viable condition and where the environment is suitable for their establishment. The direct evidence for transoceanic dispersal by wind or birds is much less, though there is considerable indirect (circumstantial) evidence favouring its occurrence.

Any conclusions on the subject of the historical relationships of the floras covered by Hooker in the *Antarctic Voyage* must obviously be tentative. It seems most likely that some closer land links occurred in the Mesozoic and early Cainozoic eras than there are now between the southern lands, particularly of South America and Australasia. Perhaps via an enlarged Antarctic continent or by land bridges (more or less complete but not necessarily all contemporaneous) between South America and the Antarctic continent, and between this and Australia and New Zealand, or it may be that continental drift will be supported by sufficient evidence that botanists can accept it with confidence as a solution for the resemblances and differences between the floras of southern lands.

Of course there are many other problems in explaining plant ranges besides those involved in separation by extents of sea or ocean. There are many 'queer' ranges of plants within present-day continental areas. The area covered by Hooker in the *Botany of the Antarctic Voyage*, however, was so largely an area of ocean with widely separated lands that the problem of transoceanic connections was bound to be important in theoretical discussion of origin of floras. This is emphasized in the series of articles published in the *Proceedings of the Royal Society* (B, vol. 152, no. 949 (1960) 429-682) under the general title 'A Discussion on the Biology of the Southern Cold Temperate Zone'. The reader particularly interested in

the subject of the origin and relationships of the southern floras should certainly consult this series of papers, and by using the references at the end of every paper he could obtain a clear record of the various published opinions.

The somewhat unfortunate phrase 'bipolar plant distribution' has been applied to ranges that are composed of areas discontinuous as between the Northern and Southern Hemispheres, that is, the same taxon or closely related taxa occur in the northern temperate or cold and southern temperate or cold zones but are not recorded for the subtropical and tropical zones in between. For taxa at or about the species level as generally accepted in botany it is doubtful if one can assume an independent origin in place (polytopism) or in time (polychronism) for populations of any one taxon now geographically separated. Hooker certainly did not assume polytopism or polychronism either before or after his acceptance of evolution and natural selection. Consequently he and most other phytogeographers accept such range discontinuities as shown by 'bipolar' or 'bihemispherical'[1] ranges as due either to fragmentation of a range, or a migration range continuous at one time or over a period of time, or to dispersal jumps. Examples are *Empetrum nigrum* and *E. rubrum* (or *E. nigrum* var. *rubrum*), and *Primula farinosa* and *P. magellanica*.

A related problem is the northern or southern origin of such hierarchically higher taxa as genera or families. There are a number of families occurring naturally today only or mainly in the Southern Hemisphere. Proteaceae is a good example, and moreover one that occurs in Australia, New Zealand, South America and South Africa. A southern origin is postulated for such families

[1] Neither term is satisfactory. The taxa involved do not occur at the two Poles nor is it meant that they have ranges exactly 180° apart; nor for the most part do their ranges occupy more than a small part of the Northern and Southern Hemispheres.

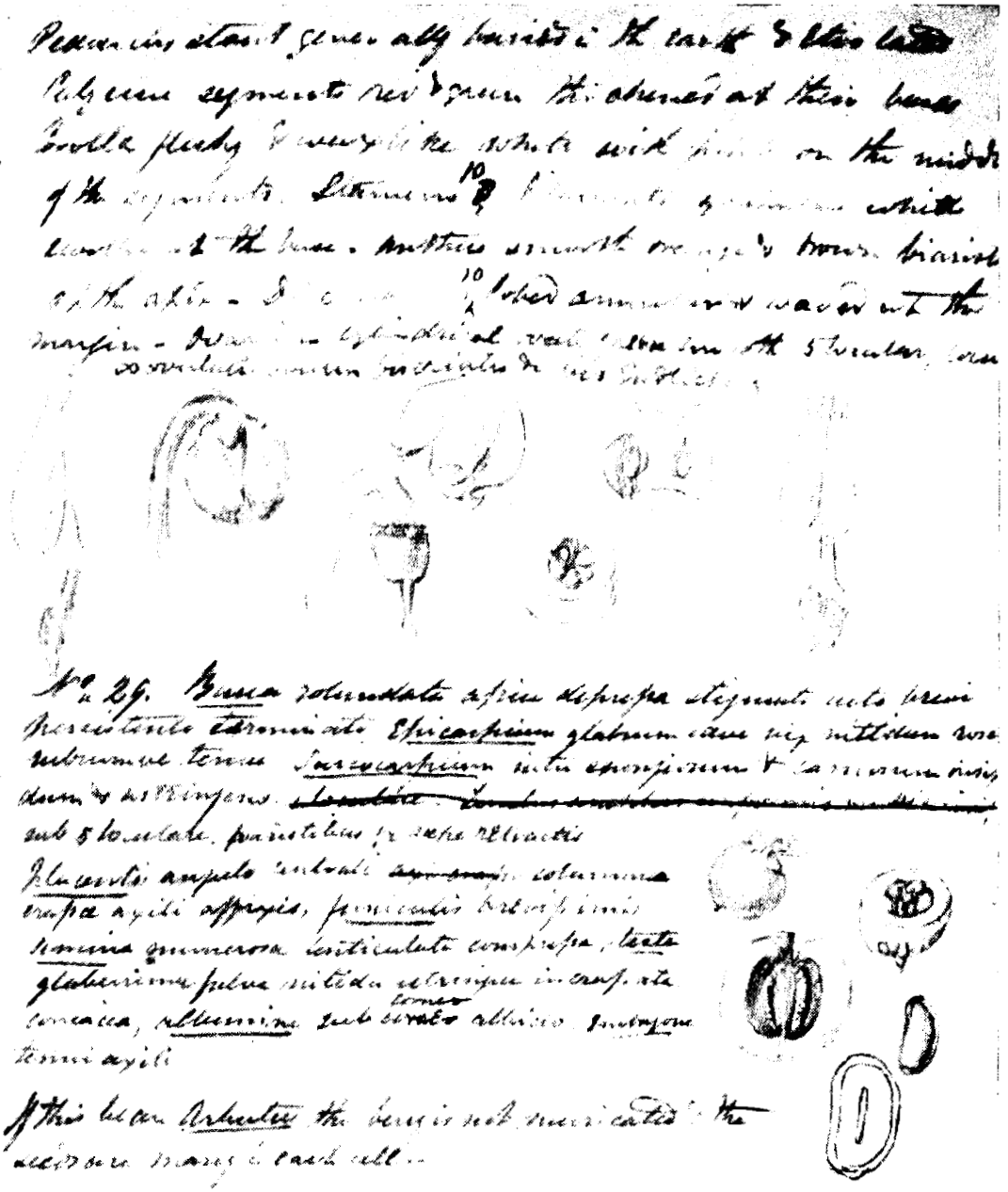
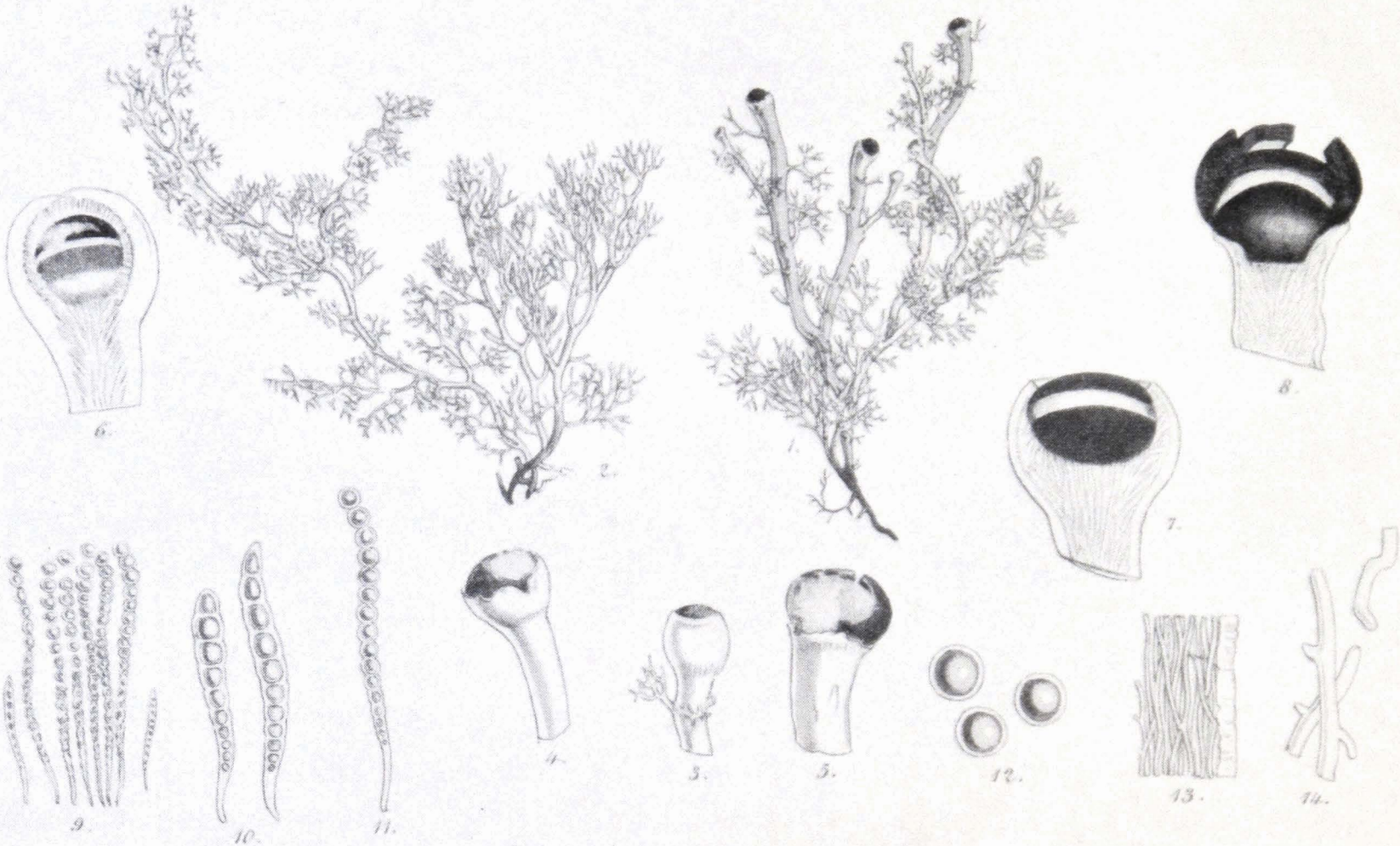
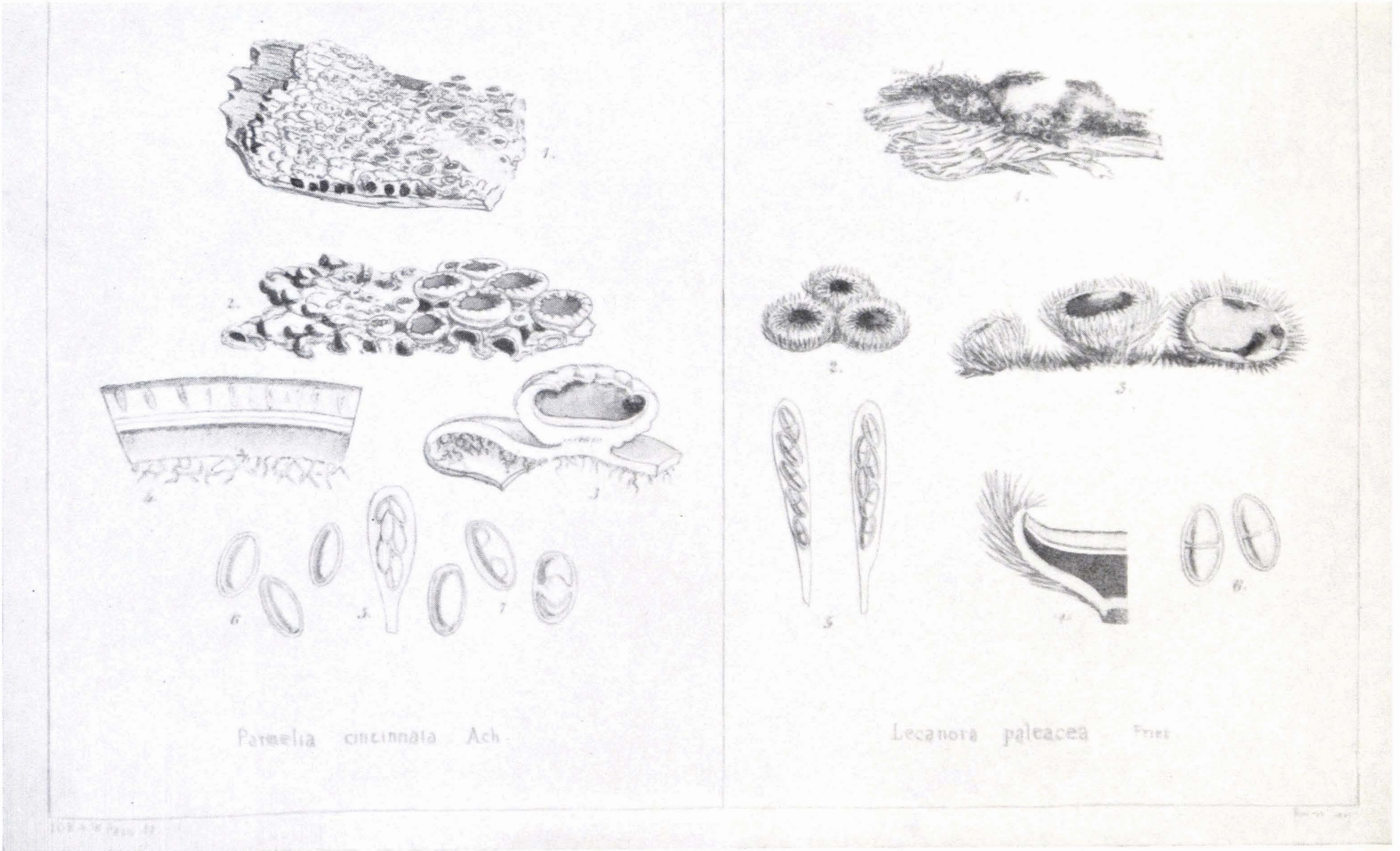


Plate 4 A page from Hooker's notebook, ' Antarctic Botany ', dealing with the flora of the Falkland Is. Much of the description of No. 29, a possible arbutus, is in Latin.



Sphærophoron . tenerum . Laur.



Plates 5 and 6 together form Plate CXCVII of Hooker's *Flora Antarctica*, Volume II. It is inscribed J. D. H. & W. Fitch del, in the lower left corner, indicating that W. Fitch ' worked up ' Hooker's original drawings. The lichens *Sphaerophoron tenerum*, *Parmelia cincinnata*, and *Lecanora paleacea* are shown.

Plate 7 (left) *Luzulata crinata* from *Flora Antarctica*, Volume II.

Plate 8 (right) *Eucalyptus urnigera* from *Flora Tasmaniae*, Volume I, Plate XXVI.

by some botanists (e.g. Camp, 1947). Others (e.g. Thiselton Dyer, 1878, 1909) have argued for a northern origin and a southern migration. The facts available at present are too few to settle the question. A similar problem is met with in attempting to elucidate the history of some genera. One can only say that recent palaeobotanical evidence favours a former wider range extending into the Northern Hemisphere for *Nothofagus* and for Proteaceae (see Sein, 1961).

It must be emphasized here that though the flora of New Zealand is not large in the number of genera and species composing it when compared with the floras of many other warm-to-temperate areas of approximately the same size, recent researches confirm in general terms Hooker's conclusions that it is remarkable for taxonomic peculiarities as shown by its high degree of endemism at the species level. Cockayne (1928) gives the total number of vascular plants 'together with such varieties as are of equal rank to many admitted species' as 1,843 and the endemics as 1,451, i.e. 78·6 per cent of the vascular flora. A second peculiarity is the high degree of variability shown by many of the genera and species. Cockayne and Allan (see Allan in Huxley, 1940, and references there) have shown that some, possibly much, of this is due to hybridization as in *Hebe* (or *Veronica* section *Hebe*), *Leptospermum*, *Rubus*, *Senecio*, *Celmisia*, *Coriaria*, and so on. By hybridization is here meant interspecific or even intergeneric hybridization. Whether hybridization is more rife in the New Zealand flora than in other floras of approximately the same size is uncertain because of the lack of research on most comparable floras. There is a wide area of research open to students in the field study of plant hybrids—even in our own British flora. Hooker apparently did not place much importance on hybridization as a cause of variability or as having much influence on species problems.

In the latter part of the Introductory Essay on the *Flora Tasmaniae* Hooker summarizes facts concerning the flora of Australia, so far as it was then known. The uniqueness of the native Australian flora is shown by its containing more genera and species peculiar to its own area, and fewer plants belonging to other parts of the world, than any other country of equal extent. Upwards of seven-eighths of its species (as recognized by Hooker) are entirely confined to Australia. Many of the plants have a peculiar habit or physiognomy or are even grotesque in appearance and many have peculiar or peculiarly developed organs or other unusual structures. On the other hand the relative proportions of the major groups of seed-bearing plants are much the same as in floras in other parts of the world. Hooker said there were only two natural orders (families) completely restricted in range to Australia (one of these was later sunk in a larger family) but there are a number of families that are very abundant in Australia and rare elsewhere. He terms these 'Australian' and examples are Epacridaceae, Goodeniaceae, Stylidiaceae, and Casuarinaceae. In spite of its many peculiarities

> The Australian flora . . . neither breaks down nor improves the Natural System of plants as a whole, though it throws great light on its parts; the Australian genera fall into their places in that system well enough, though that system was developed before Australia was known botanically, and was chiefly founded upon a study of the vegetation of its antipodes.

Hooker estimates that the number of species of flowering plants in the Australian flora will be found eventually to be from 9,000 to 10,000. The number of genera of Australian flowering plants exceeds 1,300 and a genus has on an average about 6 species. *Acacia* has over 200 species and every one of the following genera over 100: *Eucalyptus*, *Melaleuca*, *Leucopogon*, *Stylidium*, *Grevillea*, and *Hakea*. The extreme peculiarity of the flora of south-

western Australia is emphasized by comparing the floras of the southwestern and southeastern portions. 'There are about 180 genera, out of about 600, in southwestern Australia that are either not found at all in south-eastern, or that are represented there by a very few species only, and these 180 genera include nearly 1,100 species.' There are also a number of generally diffused Australian genera that are absent from the southwest, but the massing of most of the peculiar features of the Australian flora in the west, unmixed there with Polynesian, Antarctic, or New Zealand genera, is an argument for regarding western Australia as the centrum of Australian vegetation, whence a migration proceeded eastward.

The Australian flora as a whole is more allied to the Indian than to any other but differs from it so organically that it is impossible to look upon one as derived from the other, though both may have had a common parentage. The western Australian flora is singularly uniform in character for it is purely Australian without admixture of any other element, and may be considered to be the earliest of the floras now found in Australia which then sent colonists to the eastern quarter, where they became mixed with Indian, Polynesian, etc. colonists. Hooker held that this view was more likely than that the western area was populated floristically by one section only of the inhabitants of the eastern quarter. A purely speculative way of viewing the whole question is that the antecedents of the peculiar Australian flora may have inhabited an area to the westward of the present Australian continent and that the curious analogies which the latter presents with the South African flora, and which are so much more conspicuous in the southwest quarter, may be connected with such a prior state of things.

The flora of Tasmania itself is identical in all its main features with that of Victoria and especially with that of

the mountainous parts of the latter state (in Hooker's time, 'colony'). Out of 1,063 species only 280 have not been found on the Australian continent. There is a remarkable rise in the number of European 'forms' in Tasmania, and the New Zealand flora is another which enters proportionally much more largely into the Tasmanian than into the Australian, nearly 200 of the genera and 170 of the species of Tasmania being common to New Zealand. There is also a larger proportion of 'Antarctic' plants. The high mountain flora of Tasmania has many features of interest. Considering species which are most prevalent at or confined to altitudes above 3,000 feet: 30 are probably altered 'forms' of lowland plants; 120 are of Australian genera (10 of these are probably varieties); about 10 are of New Zealand genera; 55 are of European genera (17 of them probably varieties); and 25 are Antarctic 'forms'.

Comparisons between the floras of Australia and New Zealand reveal some interesting facts. New Zealand has representatives of many Australian genera but some of the latter's most extensive and widely distributed are wholly absent, as for example are: *Eucalyptus*, *Acacia*, *Stylidium*, *Casuarina*, *Callitris*, *Banksia*, *Grevillea*, and *Hakea*. Yet the resemblances between the floras are many. Most of the families are the same. Of the 282 genera of seed-bearing plants in New Zealand 240 are also Australian, and 60 of them are almost or entirely confined to the two countries. The greatest amount of generic affinity exists in the three largest families in each area: Compositae, Orchidaceae, and Gramineae. Of species, 216, or one-fourth of the New Zealand seed-bearing plants, are natives also of Australia, and of these, 115 are confined to these two countries but only 26 belong to genera endemic to them. The absence of *Eucalyptus*, *Acacia*, etc. from New Zealand can scarcely be explained 'except by going back

to epochs when the prevalent botanical as well as geographical features of each [area] were widely different from what they are now'.

Hooker's use of certain terms (e.g. 'Antarctic', 'Alpine', 'Scandinavian') in a peculiar phytogeographical sense can be criticized. However he gives the following reasons for his use of the term 'Antarctic' and the matter is of sufficient importance to quote him at some length on this:

> From the geographical position of Australia, no less than from the altitude of its southern mountains, it is well placed for the maintenance of those types of vegetation which I have denominated Antarctic. These, it must be remembered, are so called not because they really inhabit the country of that name beyond the Polar circle, but because in a botanical point of view, no less than in position relative to the south temperate Flora, they represent the Arctic Flora. They might indeed almost be called alpine plants, for many which are found at the level of the sea in the so-called Antarctic islands, also ascend the mountains of more genial latitudes. An alpine vegetation, however, in the tropics especially, is supposed to commence only where the forest is replaced by low brushwood; whereas, owing to the uniformity and humidity of the high southern latitudes, an arboreous vegetation there encroaches upon the limits of perpetual ice. In the latitude of Cape Horn, on the mountains of Fuegia, of the Middle Island of New Zealand, and of Australia, the belt of country occupied by low and chiefly herbaceous plants, that intervenes between the arboreous vegetation and the extinction of phanerogamic life, is a very narrow one indeed compared with what analogous regions the Alps, Andes, Himalaya, or Arctic latitudes present.

To some of the phytogeographical problems that intrigued Hooker we return in a later chapter, where we consider his more mature views. Burbidge (1960) gives a very recent account, with a long bibliography, of the phytogeography of Australia, and Allan (1961) has written a new *Flora of New Zealand*.

The *Botany of the Antarctic Voyage* is an important work in its contributions to plant taxonomy and to phytogeography. As we have noted it has also another claim to study in that its appearance covered a specially critical period in biology, and its contents, particularly the Introductory Essays, throw much light on the state of knowledge and feeling at the time of the publication of Darwin's *Origin of Species*. This matter is dealt with here as a separate chapter, but in order to keep as far as possible a chronological order in dealing with Joseph Hooker's activities while at the same time bringing relevant subject-matter together, two chapters are interposed before that on Hooker and Darwinism. The considerable delay in the completion of publication of the *Botany of the Antarctic Voyage* and the chronological interpolation of the Indian expedition make it difficult to avoid confusion of subject-matter and chronology whilst at the same time clearly tracing developmental and causal sequences in the biography of so energetic and versatile a personality as Joseph Hooker.

Chapter 3

Joseph Hooker as a Palaeobotanist

After his return to England in the autumn of 1843 Joseph Hooker worked at Kew on his *Flora Antarctica* and other subjects, mainly using his father's herbarium and library. For a time he lived on 'pay' from the Admiralty, granted apparently for working out the botanical results of the *Erebus* and *Terror* voyage. However it became necessary for him to find other remunerative employment. In 1845 he undertook to give a course of lectures on botany at Edinburgh, apparently with the aim of succeeding to the professorship of botany on the death of Professor Robert Graham, who was dangerously ill. At first he did not at all enjoy lecturing but later found that it became 'perfectly easy and natural', although in a letter to Harvey he pokes fun at lecturing and at the matter of his own lectures, which he now terms as 'extempore preaching'. He did not like canvassing for the professorship, which was a dual post, the Crown appointing to the less valuable Regius Professorship and the Town to the valuable College Professorship. The election became largely a matter of politics and local interests and John Hutton Balfour was elected to the Edinburgh chair on the death of Graham.

Hooker returned to Kew and during the 1845-6 winter continued work on the *Botany of the Antarctic Voyage* and the *Niger Flora* (published in 1849). In February 1846 he accepted a post under Sir Henry de la Beche, head of

the Geological Survey. The Geological Survey was at that time under the same Government department, Woods and Forests, as Kew. The appointment was made for working out the British flora, extant and fossil, in relation to geology. Much of the work could be done at Kew and would not prevent Hooker from continuing the Antarctic researches with the associated allowances from the Admiralty.

His first task was to prepare a catalogue of the known British fossil plants, as a basis for arranging those in the Geological Survey Museum and corresponding for more. In May and June he went to south Wales to examine the coal-bearing strata for fossil plants *in situ*, and in August and September 1846 he visited the Bristol coalfield for a similar purpose. He frankly stated that he liked the work and his interest in fossil plants grew, though he evidently considered his work on them as subordinate to his studies on existing floras. He remarked in a letter to George Bentham on the impossibility of relating all but the ferns of the coal strata to any existing 'Natural Order'. He studied underground the conditions of the preservation of fossil plants and their association so as to know which of the various broken pieces belonged to the same genus or species. He noted that 'the majority of the genera of some of the tribes of coal plants are merely names applied to individual parts, sometimes of the same plant; thus Calamites are all stems, Lepidodendron all branches, Lepidostrobus all cones'.

The winter and early spring of 1846-7 were partly occupied with arranging the collection of fossil plants he had made and in preparing three papers on plants from the Coal Measures. Two of these papers dealt with the structure of *Stigmaria* and *Lepidostrobus* and the third drew a general comparison between the plants of the Coal Measures and those of the present day. The prepara-

tion of these papers involved personal superintendence of slicing and polishing coal-balls and the drawing of woodcuts. The papers were published in the *Memoirs of the Geological Survey* for 1848.

Actually Hooker's interest in palaeobotany dates from before his official connection with the Geological Survey. He published his first paper on fossil plants in 1842 under the title 'On the examination of some fossil wood from Macquarie Plain, Tasmania' in the Tasmanian *Journal of Natural Science*, vol. 1, p. 24. More than sixty years later the material was reinvestigated by E. A. N. Arber and named by him *Cupressinoxylon hookeri*. His continued interest in the geology and palaeobotany of coal is shown by his comments on the coal basin of the Damuda valley, which he visited in 1848 from Calcutta and refers to in his *Himalayan Journals* (see chapter 4). This coal crops out at the surface but the shafts worked are sunk through thick beds of alluvium. The age of the coalfields was then quite unknown though upwards of thirty species of fossil plants had been procured from them and the majority of these referred to 'the inferior oolite of England, from the prevalence of species of *Zamia*, *Glossopteris*, and *Taeniopteris*'. There was also *Vertebraria*, a very remarkable Indian fossil. The reference of Hooker's visit to these Indian coal beds is made here because his criticisms of the state of fossil botany at this period are very just. He says:

> the outlines of the fronds of ferns and their nervation are frail characters if employed alone for the determination of existing genera, and much more so of fossil fragments. Moreover, recent ferns are so widely distributed, that an inspection of the majority affords little clue to the region or locality they come from. In fact, finding similar fossil plants at places widely different in latitude, and hence in climate, is, in the present state of our knowledge, rather an argument against than for their having existed contemporaneously.

A similar argument applies to the Cycadaceae. There have been tremendous advances in palaeobotany since the time when Hooker was writing his *Himalayan Journals*. In particular we may recall that many of the fossils then regarded as those of true ferns have been shown to represent fernlike seed plants, the Cycadofilices or Pteridospermae. We have to confess however that the origin and developmental history of the flowering plants cannot yet be established on palaeobotanical evidence.

The following passage from the *Himalayan Journals* is worth quoting as showing Hooker's justifiable caution in the use to be made of published determinations of fossil plants:

> Specific identity of their contained fossils may be considered as fair evidence of the contemporaneous origin of beds, but amongst the many collections of fossil plants that I have examined, there is hardly a specimen, belonging to any epoch, sufficiently perfect to warrant the assumption that the species to which it belonged can again be recognized. The botanical evidences which geologists too often accept as proofs of specific identity are such as no botanist would attach any importance to in the investigation of existing plants. The faintest traces assumed to be of vegetable origin are habitually made into genera and species by naturalists ignorant of the structure, affinities and distribution of living plants, and of such materials the bulk of the so-called systems of fossil plants is composed.

The coal-bearing beds in the Damuda (or Damodar) valley are now placed in the Gondwana system of the Permo-Carboniferous, Lower Division, as the Damuda series. This series forms the chief coal-bearing set of beds in India and is the most important member of the Gondwana system. The total thickness of the series sometimes reaches 10,000 feet and consists of sandstone, shales, clay-ironstones, and coal seams and contains many fossil plants (see Reed, 1949). Relatively little research appears to have been done in recent years by modern methods on the

fossil flora of the Gondwana system, though its importance taxonomically and phytogeographically must be very considerable. This is especially true of the rich deposits in the Damuda valley. Here it must suffice to note that the principal genera are now regarded as probably belonging, at least in part, to the Pteridospermae or to the Caytoniales. A critical review of the evidence (see Walton and Wilson, 1932) shows that some at any rate of the numerous forms of *Glossopteris* were attached to species of *Vertebraria*. Recently it has been pointed out by Hamshaw Thomas that there is similarity between the fronds of *Glossopteris* and leaflets of *Sagenopteris*, the latter is probably the leaf of one of the Caytoniales. *Taeniopteris* is a 'form genus' of leaves which were possibly borne on the Pteridosperm stems known as Medullosae.

A number of other contributions to fossil botany by Joseph Hooker may be referred to here. An investigation of *Trigonocarpus*, a fossil seed (in *Proc. Roy. Soc.*, vol. 7 (1854) and *Ann. Mag. Nat. Hist.*, vol. 14 (1854)), led to suggesting that it had affinities with Coniferae, especially with *Salisburia*. *Salisburia* is a synonym of *Ginkgo* (the maidenhair tree), which was in 1854 and till considerably later included in the Coniferae. *Trigonocarpus* is now known to be a genus of pteridosperm (*sensu lato*) seeds, which according to Seward were borne on *Alethopteris* fronds, which are the foliage of a *Medullosa*. Such is an example of the complexity of nomenclature of fossil plants, due largely to the need for giving names to separate parts as these were found and described. A full and careful account of one of the species of *Trigonocarpus* seeds is given by Salisbury (1914). Hooker's 'Notes on the Fossil Plants from Reading' and 'On a New Species of *Volkmannia* (*V. morisii*)' appeared in the *Journal of the Geological Society*, vol. 10 (1854), and 'On some minute Seed-vessels from the Bovey Tracey Coal' in the *Quarterly*

Journal of the Geological Society, vol. 11 (1855). At a later date there appeared 'Ueber die von Dr Lyall in Grönland entdeckten fossilen Pflanzen' (*Vierteljahrsschrift der Naturforsch. Gesellsch. Zürich* (1862)). Finally in the *Annals of Botany*, vol. 3 (1889), there was published a paper on *Pachytheca*. This name was applied by Hooker to seedlike bodies in the form of thick-walled hollow spheres and he concluded that they would probably have to be referred to an alga but that at present 'no certain conclusion as to its real nature of affinities is possible'. The material was handed over for further examination to Barber (1889, 1891). *Pachytheca* has been referred to various classes of plants and even to the animal kingdom by some writers. The bodies are spherical, usually about 0·5 cm. in diameter, and found in Old Red Sandstone and Silurian rocks.

A general appreciation of Hooker's contributions to the study of fossil botany, with a special list of seventeen references to publications of his researches in the subject or indication of his interest in the subject, was given by D. H. Scott in *Proc. Linn. Soc. Lond.*, 124th Session (1912), who devoted most of his retiring presidential address to Hooker and his connection with fossil botany. This was of course peculiarly appropriate at the time for it was only a few months after Hooker's death. One paragraph of Scott's address is worth quoting as a conclusion to this short chapter:

> Hooker's definite contributions to our knowledge of palaeobotany were valuable, though limited in extent, owing to the small part of his time that he was free to devote to such investigations. His influence as a severe but just and friendly critic was of the greatest importance, and his warnings against the many pitfalls of the subject, though they may have discouraged some, are in reality entirely wholesome, and are no less needed today than at the time they were given.

Chapter 4

Botanical Exploration in India

Joseph Hooker became engaged in July 1847 to Frances Henslow, the eldest daughter of the Rev. John Stevens Henslow (1796-1861), Professor of Botany at Cambridge. The engagement was fated to be a long one, or at least what would now be considered a long one. For some time Hooker had been eager for another botanical journey, preferably to the mountains of the tropics, either the Andes or the Himalaya. After various discussions India was selected. Sir Henry de la Beche, who wished to retain Hooker on the staff of the Geological Survey, encouraged the Indian plan, hoping to obtain for the Geological Museum any fossils he might collect while letting the living and herbarium plant material go to Kew. With a certain amount of string-pulling the Admiralty, to whom Hooker still owed allegiance, made favourable financial arrangements with regard to his pay, and a successful appeal was made to the Treasury for a grant of £400 a year for the two years to cover the expenses of botanical collecting for Kew Gardens. An expedition to Borneo, following a visit to India, was projected but fell through and another £300 was then allotted to a third year in India. Lord Auckland, then First Lord of the Admiralty, and Dr Hugh Falconer, in charge of the Calcutta Botanic Garden and a personal friend of Hooker, alike proposed that he should explore the state of Sikkim up to the snows

on the Tibetan border. The East India Company were, in 1847, a decade before the Indian Mutiny, responsible for the administration of India. Lord Dalhousie had been appointed as the new Governor-General of India and arrangements were made for Hooker to travel in the same ship, the *Sidon*, which left Portsmouth on 11 November 1847.

Fortunately we have very full published reports and descriptions of Hooker's travels in India and a mass of manuscript material at Kew. Some accounts were printed in the *Journal of the Asiatic Society of Bengal*, vols. 17 and 18 (1848-9), and in his father's *London Journal of Botany*, vol. 7 (1848) and the *Kew Journal of Botany*, vols. 1, 2, and 3 (1848-51). These are mostly and essentially extracts from his diary, though often designated 'letters'. Above all there is his *Himalayan Journals*, with the subtitle 'Notes of a Naturalist in Bengal, the Sikkim and Nepal Himalayas, the Khasia Mountains, etc.'. This was first published in 1854 in two volumes. A second edition appeared in 1855 and another (Minerva Library, London) in 1891, with a reissue in 1905. The 1891 edition, for which some revision of the text was made, has been used in preparing this chapter, with the other sources mentioned. The work was dedicated to 'Charles Darwin F.R.S., &c., by his affectionate friend J. D. Hooker, Kew, Jan. 12th, 1854'. The greater part of the *Himalayan Journals* is written in a straightforward descriptive style which may in some passages seem somewhat ponderous by modern standards. One enjoys it more at later readings than when reading it for the first time. It retains a high place among travel books in the English language and it is rather surprising that it has not been reprinted during the past half-century. It has much botanical information especially concerning the flora and vegetation of northern India that was not only

quite new at the time of publication but has not yet been superseded by modern field studies. The work not only confirms any estimate of Hooker as a most observant field botanist but also proves his great versatility. Not only did he add much to knowledge of the Indian flora but he carried out a great deal of exploration, surveying, and mapping of unknown territory and drew up first-hand careful descriptions of the modes of life of little-known peoples.

The voyage entailed calls at Lisbon, Gibraltar, and Malta on the way to Alexandria, where the old 'Overland route' started. The Suez Canal was not opened till 1869, and passengers and baggage for India and farther east had to be transported by the Nile from Alexandria to Cairo and thence by horse-drawn vehicles and camels to Suez. Hooker visited the Pyramids and narrowly avoided missing the Governor-General's party when they went from Cairo to Suez, where they embarked for India. Conditions on the *Moozuffer*, as the vessel on which they continued the voyage from Suez was called, were not so good as those on the *Sidon*, and though the captain did his best for Lord and Lady Dalhousie, Hooker records that 'the rest of us have to *pig* it out in the ship's armoury, a dirty place, next to the engine, intolerably hot and smothered with coal-dust. We lie on mattresses on the deck, and it is all we can do to turn out tidy for meals in the cabin.' In a letter written from Madras he complains of having lost nearly all his collections, particularly the one made at Aden, 'from the salt water in our wretched dormitory on board this ship'. Aden he describes as 'the ugliest, blackest, most desolate and dislocated piece of land of its size that ever I set eyes upon, and I have seen a good many ugly places'. Via Ceylon and Madras he reached Calcutta on 12 January 1848. He visited the famous Botanic Garden and made criticisms of its condition and suggestions for its improvement.

The first expedition Hooker undertook from Calcutta was with Mr Williams of the Geological Survey to the coal basin of the Damuda valley and on to Parasnath, the sacred mountain of the Jains, northwest of Calcutta. In this account of the very first part of his tours in India we note at once the wide range of his observations and how he links them on to previously known facts. Thus he saw women making gunpowder, grinding the usual ingredients on a stone, with the addition of water from the hookah. The charcoal used was made from an *Acacia*, while, he remarks, in other parts of India *Justicia adhatoda* (*Adhatoda vasica*) is employed for the purpose and at Aden the Arabs prefer *Calotropis*, probably because it is most easily procured. The grain, he noted, of all these plants is open, whereas in England closer-grained and more woody trees, especially willows, are preferred.

One cannot refrain from quoting his account of what was apparently his first elephant ride:

> The docility of these animals is an old story, but it loses so much in the telling, that their gentleness, obedience, and sagacity seemed as strange to me as if I had never heard or read of these attributes. The swinging motion, under a hot sun, is very oppressive, but compensated for by being so high above the dust. The Mahout, or driver, guides by poking his great toes under either ear, enforcing obedience with an iron goad, with which he hammers the animal's head with quite as much force as would break a cocoa-nut, or drives it through his thick skin down to the quick. A most disagreeable sight it is, to see the blood and yellow fat oozing out in the broiling sun from these great punctures! Our elephant was an excellent one, when he did not take obstinate fits, and so docile as to pick up pieces of stone when desired, and with a jerk of the trunk throw them over his head for the rider to catch, thus saving the trouble of dismounting to geologise.

Parasnath is a mountain of peculiar sanctity, being the eastern centre of Jain worship. The Jains form a sort of

Plate 9 Wallanchoon village (Wallungchung) in eastern Nepal, November, 1848.

Plate 10 Clasping roots of *Wightia*. Hooker's original sketches, shown here, were used for *Himalayan Journals*

Plate 11 A living bridge formed of the aerial roots of the India-rubber and other kinds of figs. (*above*) The original sketch by Joseph Hooker and *Plate 12* (*below*) the picture made from it by W. Fitch for *Himalayan Journals*, 1891.

transition sect between Buddhists and Hindus. The mountain was ascended, at first through woods of trees with clumps of bamboos. In a valley, ferns and a much more luxuriant vegetation, especially of members of the nettle family and wild bananas, were met with. At about 3,000 feet species of *Clematis* and *Thalictrum* (meadow-rue) and increasing numbers of grasses with bushes of the verbena and daisy families occurred. At 3,500 feet the trees all became gnarled and scattered, the dampness increased, and with this more ferns and mosses appeared. The saddle of the crest (at 4,230 feet) had a small temple, one of five or six which occupied various prominences of the ridge.

> The culminant rocks are very dry, but in the rains may possess many curious plants; a fine *Kalanchoe* was common, with the berberry, a beautiful *Indigofera*, and various other shrubs; a *Bolbophyllum* (*Bulbophyllum*) grew on the rocks, with a small *Begonia*, and some ferns. There were no birds and very few insects, a beautiful small *Pontia* being the only butterfly. The striped squirrel was very busy among the rocks; and I saw a few mice, and the traces of bears.

This ascent of Parasnath is referred to because it gave Hooker his first experience in India of altitudinal zonation of vegetation, though the elevation of the mountain was not great and the zonation of the vegetation was less marked than he expected and showed some peculiar features.

He heard and saw for the first time, in the woods near Dunwah, the wild peacock and records that its voice is not to be distinguished from that of the tame bird in England, 'a curious instance of the perpetuation of character under widely different circumstances, for the crow of the wild jungle-fowl does not rival that of the farmyard cock'. The river Soane (Son) was crossed and a rich and highly cultivated country had crops of indigo, cotton, sugar-cane,

safflower, castor-oil, poppy, and various grains. Dodders (*Cuscuta*) covered even tall trees with a golden web. Hooker proceeded up the Soane valley and comments that 'The climate of the whole neighbourhood has of late changed materially; and the fall of rain has much diminished, consequent on felling the forests; even within six years the hail-storms have been less frequent and violent. The air on the hills is highly electrical, owing, no doubt, to the dryness of the atmosphere, and to this the frequent recurrence of hail-storms may be due.' These statements are partly derived from the records of others but it may be noted that the degree and kind of influence on climate exercised by forests is still often a matter of dispute.

Leaving the Soane Hooker struck inland over a rough hilly country covered with forest in which peacocks, jungle-fowl, and pigeons were very frequent and the hooting of monkeys was constantly grating on the ear. Progress was made gradually to Mirzapore. Here he met a Lieutenant Ward, one of the suppressors of Thuggee, and was introduced to a thug, a dacoit, and a poisoner. The thug was

> a mild-looking man, who had been born and bred to the profession: he had committed many murders, saw no harm in them, and felt neither shame nor remorse. . . . He explained to me how the gang waylaying the unwary traveller, enter into conversation with him, and have him suddenly seized, when the superior throws his own linen girdle round the victim's neck and strangles him, pressing the knuckles against the spine.

The dacoit belonged to a class who robbed in gangs, but never committed murder. They were all high-class Rajputs, originally from Guzerat, who on being conquered vowed vengeance on mankind. The poisoners

> all belong to one caste, of Pasie, or dealers in toddy: they go

singly or in gangs, haunting the travellers' resting places, where they drop half a rupee weight of pounded or whole *Datura* seeds into his food, producing a twenty-four hours' intoxication, during which he is robbed, and left to recover or sink under the stupefying effects of the narcotic.

The species of thornapple referred to is no doubt *Datura metel*. Other details of the activities of these criminal types and their variants are given.

Hooker engaged a boat at Mirzapore to carry him down the river Ganges to Bhagulpore, whence he was to proceed to Sikkim. He visited Benares and noted various features of the vegetation and of the crops on his way down the Ganges. He gives in particular a long account of the cultivation of the poppy and the production of opium, mainly for the Chinese market. The date was not very long after the Opium War, which followed the destruction in 1840 of a number of British vessels carrying opium into Chinese ports and which resulted in the establishing of 'Treaty Ports' in China and the cession of Hong Kong to Britain. In 1906 the Chinese Government proposed to the British Government an arrangement by which the importation of Indian opium into China should cease within ten years.

At Bhagulpore Hooker visited the Horticultural Gardens. On 8 April he left the Bhagulpore district for Darjeeling and the Himalaya. Via Caragola Ghat, Purnea, and Titalya he reached Siligoree on the verge of the Terai, the 'low malarious belt' skirting the base of the Himalaya. The tropical vegetation is vividly described, with thick jungle choked with grasses though with few trees. Besides the brushwood much of the vegetation is made up of terrestrial orchids, ferns, and numerous climbers of the vine, convolvulus, marrow, and bignonia families. The path soon began to ascend and a giant forest replaced the stunted and bushy communities of the Terai

proper. The most important trees belonged to the genera *Duabanga* (Lythraceae or Sonneratiacea), *Terminalia* (Combretaceae), *Cedrela* (Meliaceae), and *Dordonia* (Theaceae). There were many smaller trees and shrubs and also large bamboos which 'rather crest the hills than court the deeper shade'. Torrents had cut deep gulleys down the hills and these were choked with vegetation and bridged by fallen trees whose trunks were clothed with epiphytes—orchids, ferns, club-mosses, etc. At about 1,000 feet above Punkabaree the tropical-forest vegetation was particularly rich with giant trees scaled by woody climbers (lianes) and clothed with often beautiful epiphytes. Wild bananas were conspicuous, as were also screw-pines (*Pandanus*).

> Bamboo abounds everywhere; its dense tufts of culms, 100 feet and upwards high, are as thick as a man's thigh at the base. Twenty or thirty species of ferns (including a tree-fern) were luxuriant and handsome. Foliaceous lichens and a few mosses appeared at 2000 feet. Such is the vegetation of the roads through the tropical forests of the Outer-Himalaya.

A little below 4,000 feet a change began with the appearance of scattered oaks and a yellow-fruited bramble, and at about 4,800 feet the spring vegetation clearly recalled that of England with 'the oak flowering, the birch bursting into leaf, the violet, *Chrysosplenium*, *Stellaria* and *Arum*, *Vaccinium*, wild strawberry, maple, geranium, bramble', but for another 2,000 feet tropical genera accompanied the European ones. The tree-fern (*Alsophila gigantea*) for example ascends to 7,000 feet.

Hooker arrived at Darjeeling on 16 April and passed the summer or rainy season of 1848 at or near this well-known hill station. He was chiefly and busily engaged in forming collections and in taking meteorological observations. The view from the house where he stayed he says 'is one quite unparalleled for the scenery it embraces,

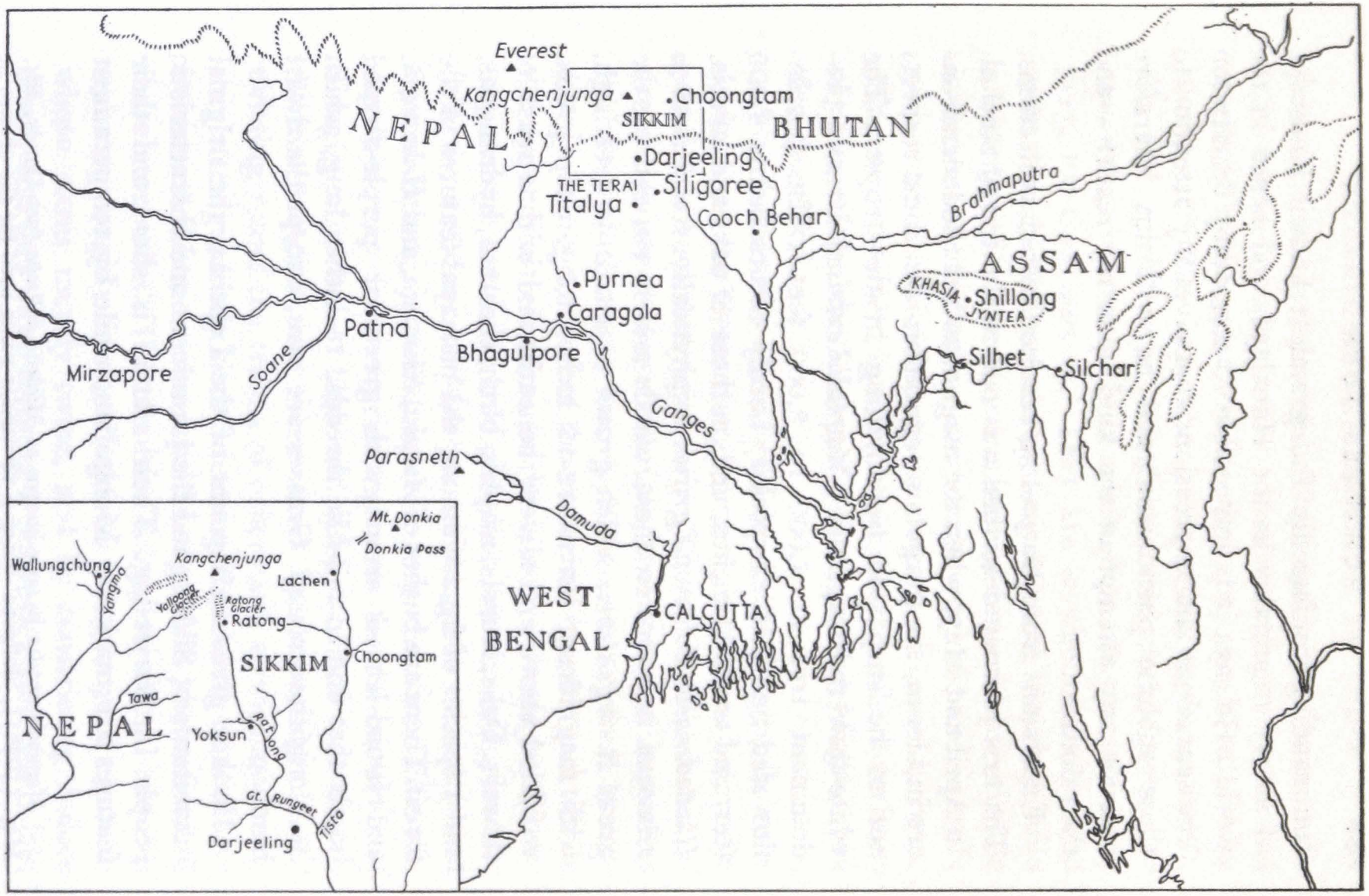


Fig. 2 Map of north-eastern India and the Kangchenjunga area (inset) where **Joseph Hooker** did much collecting.

commanding confessedly the grandest known landscape of snowy mountains in the Himalaya, and hence in the world'. He says it is impossible to convey by description 'the sensations and impressions that rivet my attention to these sublime phenomena' and he will not 'therefore obtrude any attempt of the kind upon my reader'—and then does so!

Excursions from Darjeeling resulted in rich collections. The first journey described was one to the top of Sinchul. In April and May, when the magnolias and rhododendrons are in bloom, the gorgeous vegetation is in some respects not to be surpassed by anything in the tropics. The white-flowered magnolia (*Magnolia excelsa*) forms a predominant tree at 7,000 to 8,000 feet.[1] The purple-flowered one (*M. campbellii*) hardly occurs below 8,000 feet, and on its branches, and on those of oaks and laurels, *Rhododendron dalhousiae* grows epiphytically. *Rhododendron arboreum* is scarce in these woods and is outvied by the great *R. argenteum*, which grows to a tree 40 feet high, with magnificent leaves 12-15 inches long, deep green, wrinkled above and silvery beneath, and with a mass of flowers. Oaks, laurels, maples, birch, chestnut, hydrangeas, and a species of fig are among the principal features of the forest. There are bushes of *Aucuba*, *Skimmia*, and *Helwingia*, and broad-leaved arums with green or purple-striped hoods that end in tail-like threads, 18 inches long, which lie along the ground. Grasses are rare, except the dwarf bamboo.

Hooker gives an account of the Lepchas, the original inhabitants of Sikkim and the prominent and characteristic people in Darjeeling. Their stature is short and their features are markedly Mongolian, while by temperament

[1] *Magnolia excelsa* is now known as *Michelia doltsopa* (see Dandy, *Bot. Mag.* (1943)), 'doltsopa' being a vernacular name used for the species in Nepal.

they are timid and peaceful. The Lepchas profess no religion but acknowledge the existence of good and bad spirits. To the good spirits they pay no heed. 'Why should we?' they say, 'the good spirits do us no harm; the evil spirits, who dwell in every rock, grove, or mountain, are constantly at mischief, and to them we must pray, for they hurt us.' They are excellent carriers and mountaineers and are skilled as woodmen, 'for they build a waterproof house with a thatch of banana leaves in the lower, or of bamboo in the elevated regions, and equip it with a table and bedsteads for three persons, in an hour, using no implement but their heavy knife'. Characteristics of other tribes, the Limboos, Moormis, and Magras, are also described.

A very favourite excursion from Darjeeling to the cane bridge over the Great Rungeet river, 6,000 feet below the station, is recorded very fully. The altitudinal zones of vegetation are well marked. Oak, chestnut, and magnolias are the main features from 7,000 to 10,000 feet. Immediately below 6,500 feet the tree-fern appears and this is the upper limit of palms in the Sikkim Himalaya, *Plectocomia* alone attaining this elevation and a wild plantain (that is, a species of *Musa* to which genus the cultivated banana belongs) ascending to nearly the same altitude. Another trip from Darjeeling was to the summit of Tonglo, 10,079 feet high and lying west of the station. At about 6,000 feet there were 'great scandent trees twisting round the trunks of others and strangling them: the latter gradually decay, leaving the sheath of climbers as one of the most remarkable vegetable phenomena of these mountains'. The climbers belong to several families and may roughly be classified into two groups: (1) those whose stems merely twine, and by constricting induce death, and (2) those forming a network round the trunk, by the coalescence of their lateral branches, aerial roots,

etc. To the first group belong many legumes, ivies, hydrangea, vines, and *Pothos* (Araceae); to the second, figs and *Wightia* (Scrophulariaceae). Hooker notes that

> Except for the occasional hooting of an owl, the night was profoundly still during several hours after dark—the cicadas at this season not ascending so high on the mountain. A dense mist shrouded everything, and the rain pattered on the leaves of our hut. At midnight a tree-frog ('Simook', Lepcha) broke the silence with his curious metallic clack, and others quickly joined the chorus, keeping up their strange music till morning.

At 8,000 feet the mass of the forest was formed of oaks, chestnut, magnolias, trees of the laurel family and, arborescent rhododendrons. Ticks and leeches were a great nuisance. Higher up many European genera of plants occurred. The rarity of pines is a curious feature of Tonglo. Between 2,500 feet, the upper limit of *Pinus longifolia* (*P. roxburghii*) and 10,000 feet, the lower limit of *Taxus*, there is no coniferous tree in southern Sikkim. That the excursion was not entirely pleasant is indicated by the following extract:

> We encamped amongst Rhododendrons, on a spongy soil of black vegetable matter, so oozy that it was difficult to keep the feet dry. The rain poured in torrents all the evening, and with the calm, and the wetness of the wood, prevented our enjoying a fire. Except a transient view into Nepal, a few miles west of us, nothing was to be seen, the whole mountain being wrapped in dense masses of vapour. Gusts of wind, not felt in the forest, whistled through the gnarled and naked treetops; and though the temperature was 50°, this wind produced cold to the feelings.

However there was compensation in the study of the rich vegetation and

> It is always interesting to roam with an aboriginal, and especially a mountain people, through their thinly inhabited valleys, over their grand mountains, and to dwell alone with them in their gloomy and forbidding forests, and no thinking man

can do so without learning much, however slender be the means at his command for communication.

Hooker now made arrangements for travel deep into Sikkim but the Rajah refused permission for an honourable and safe escort through his dominions; but permission was obtained from the Nepal Rajah to visit the Tibetan passes west of Kinchinjunga, and pending the result of further negotiations with the Sikkim authorities Hooker determined to avail himself of the arrangement with the Nepal Rajah, hoping to be able to return through Sikkim. The expedition lasted three months and the whole journey had to be performed on foot, everything being carried on men's backs. The party consisted of fifty-six persons. Travelling was often arduous over rough and rocky ground with frequent difficult crossings of rivers and streams. The vegetation was very often magnificent with firs and rhododendrons conspicuous. Penetrating towards the Tibetan border, many fine herds of yaks were encountered.

The yak is a very tame, domestic animal, often handsome, and a true bison in appearance; it is invaluable to these mountaineers from its strength and hardiness, accomplishing, at a slow pace, twenty miles a day, bearing either two bags of salt or rice, or four to six planks of pinewood slung in pairs along either flank. Their ears are generally pierced, and ornamented with a tuft of scarlet worsted; they have large and beautiful eyes, spreading horns, long silky black hair, and grand bushy tails: black is their prevailing colour, but red, dun, parti-coloured and white are common. In winter, the flocks graze below 8,000 feet, on account of the great quantity of snow above that height; in summer they find pasturage as high as 17,000 feet, consisting of grass and small tufted *Carices*, on which they browse with avidity.

The importance of the yak in the economy of the people is stressed. Besides being the beast of burden, its rich

milk and curd, eaten either fresh or dried, its flesh for meat, its hair for making ropes or tents, its bones and dung used for fuel, is a list indicating the needs it fills for the peoples of the Himalaya.

Hooker collected ardently in the Wallanchoon district, sending back his collection of plants, minerals, etc. to Darjeeling before continuing his journey north up the Yangma valley to its head, over moraines and snow, to over 16,000 feet altitude. Nango mountain was also ascended and there was botanizing amongst the high mountain vegetation, from forests of fir and rhododendrons to low scrub and herbaceous communities. A descent was made to the Yalloong river, and then the journey continued up the valley of the Tawa and eventually crossed the Islumbo pass over the Singalelah range into Sikkim at 11,000 feet, a few stones marking the boundary between Nepal and Sikkim. The valley of the Kulhait river, down which he descended, is one of the finest in Sikkim.

Dr Archibald Campbell, the Superintendent of Darjeeling and Political Agent to Sikkim, who had already given him a very great deal of help, met Hooker by arrangement at Bhomsong. Hooker was delighted to be with his friend but unfortunately the Sikkim authorities again made difficulties about further expeditions. The Rajah was friendly but his Dewan (or prime minister), who had great influence with the aged and infirm Rajah, was not. However an interview with the Rajah was finally obtained, and after continuing together for a time Hooker and Campbell parted and the former continued along the south flank of Kinchinjunga north to Jongri.

He botanized in the district around the mountain and was much impressed by the magnificence of the views. Thus he comments: 'The river to the southward from Mon Lepcha, including the country between the sea-like

plains of India and the loftiest mountain in the globe, is very grand, and neither wanting in variety nor in beauty.' From the deep valleys choked with tropical luxuriance to the scanty yak pasturage on the heights above, five belts of vegetation can be distinguished: (1) palm and plantain (*Musa* spp. or wild bananas); (2) oak and laurel; (3) pine; (4) rhododendron and grass; and (5) rock and snow. The vegetation along the Ratong river is especially mentioned because of the magnificent *Rhododendron argenteum*. Yoksun occupies a warm sheltered flat and many tropical genera occur there.

Descriptions are given of Sikkim lamaseries, the sects of the Lamas, and the organization and government of the monasteries. In one of the temples Hooker saw monks doing repairs and

> Some were painting the vestibule with colours brought from Lhasa, where they have been trained to the art. . . . Amongst the figures I was struck by that of an Englishman, whom, to my amusement, and the limner's great delight, I recognized as myself. I was depicted in a flowered silk coat instead of a tartan shooting jacket, my shoes were turned up at the toes, and I had on spectacles and a tartan cap, and was writing notes in a book. On one side a snake king was politely handing me fruit, and on the other a horrible demon was writhing.

The collection Hooker made during 1848 amounted to eighty loads and on his return to Darjeeling they were sent to Calcutta by coolies, carts, and water. An excursion was made to the Terai and on returning to Darjeeling preparations were put in hand for an expedition to the loftier parts of Sikkim. We may, before giving an account of this important second journey into Sikkim, conveniently interpolate some general matter concerning Mt Kinchinjunga and Himalayan rhododendrons.

Kinchinjunga or, as it is now more often spelt, Kangchenjunga, on the Nepal-Sikkim border only a little south of

Tibet, is constantly referred to by Hooker in the *Himalayan Journals* and was wrongly stated by him to be the loftiest mountain in the world. It is now accepted as the third highest and its altitude is given as 28,146 feet. German-led expeditions in 1929, 1930, and 1931 were repulsed by the terrible conditions on the mountain, in 1931 with loss of life. The mountain was photographed from the air in 1933 and was finally climbed by a British party on 25 May 1955. The mountain is regarded as sacred and in respect to the religious feelings of the Sikkimese the climbers stopped short of the summit by five feet.

The genus *Rhododendron* belongs to the heath and heather family (Ericaceae). Linnaeus in his *Species Plantarum* (1753), which is the work from which botanists date the modern nomenclature of species of seed-bearing plants and vascular cryptogams, has 5 species of *Rhododendron*, of which one (*R. chamaecistus*) is now placed in a different genus (*Rhodothamnus*). In addition he has 6 species of *Azalea*, a genus now usually united with *Rhododendron*, and one of these (*A. procumbens*) is now placed in a separate genus (as *Loiseleuria procumbens*). Thus Linnaeus in 1753 knew 9 species of *Rhododendron* in the modern sense. Now well over 1,450 have been named and described as species. Many of these will probably be reduced to synonymy in the future but one can reasonably say that 700-800 species are now known. According to the Royal Horticultural Society's *Dictionary of Gardening* (1951) and *Supplement* (1956), there are 316 species in cultivation, in addition to a very large number of garden varieties and hybrids. The natural range of the genus is mainly in the Northern Hemisphere. The greatest centre of differentiation is in Asia and particularly in west and central China, southeast Tibet, north India, north Burma, Indonesia, and perhaps New Guinea. Japan and North America especially contribute members of the azalea

section. There are few species in Europe, one in Australia, and none in South America or Africa.

There is no doubt that Hooker's botanizing in the Sikkim and Nepal Himalaya greatly added to knowledge of the genus, and by the publication of his fine work *The Rhododendrons of Sikkim-Himalaya* (London, 1849) widened the interest of horticulturists to the possibilities of rhododendrons as garden subjects. In this folio volume, edited by Sir William Hooker, there are thirty plates, of which two have figures of two species. The work is dedicated to Her Royal Highness the Princess Mary of Cambridge and a long list of subscribers is given. There is printed text to every species figured, with a Latin diagnosis and English description and usually first-hand field notes. The plates are in colour and are imprinted 'J. D. H. del. Fitch lith.'. The original partially coloured field sketches of these rhododendrons by Hooker are in the collection of drawings in the Kew Herbarium. From these and probably with some aid from Hooker's dried specimens, Fitch made the completed lithographs and prepared for their colouring as full plates. One of Hooker's species, *Rhododendron thomsoni,* is portrayed in Wedgwood, together with species of four other genera, on his commemorative tablet in St Anne's Church, Kew Green.

In addition to research in the field on the genus *Rhododendron,* Hooker's name will always be linked with the genus through his introductions into cultivation in Great Britain. The genus has grown very much in favour with gardeners. This is partly because there are a great many species with a wide range of flower size, shape, and colour, and many of them also have attractive foliage. Moreover it has been found that many of the species hybridize freely one with another and the production of many artificial hybrids and cultivars has been an easy matter. Following Hooker's introduction of Himalayan species a number of

collectors introduced many more from China and thus interest in the genus has been maintained among those who constantly crave for horticultural novelties. Now many species are being discovered in New Guinea and in recent years a large number of new ones from this island have been described and named. They will probably mostly need greenhouse protection when cultivated in the British Isles but it is evident that the genus is not yet exhausted of novelties, taxonomically or horticulturally. The large majority of rhododendrons in cultivation require an acid soil and cannot grow in soils with lime.

Returning now to Hooker in Sikkim we find he left Darjeeling for his second long journey into the northern parts of the country on 3 May 1849. The route was through eastern Sikkim up to and just over the ill-defined border with Tibet and the party of forty-two was composed mainly of young Lepchas. The route followed was essentially up the valley of the Tista and various of its tributaries. The varied and rich tropical vegetation along the lower part of the main valley is described in detail and is correlated with the hot damp climate. For several mornings on waking Hooker had constant headaches and attributed them to coming fever or to the unhealthiness of the climate, till he found they arose from the aromatic wormwood (*Artemisia indica*), on a thick couch of the cut branches of which he was accustomed to sleep and which under dry conditions produced no such effects. The plant is common in Sikkim at 2,000–6,000-feet altitude and grows to 12 feet in height. It is a favourite food of goats. He noted that snakes were shy in most parts of the Himalaya and he collected about a dozen species in Sikkim, seven of which are venomous. At Choongtam there was a profusion of beautiful insects.

From Choongtam Hooker, with a reduced number of attendants, explored the Lachen tributary through rich

and varied vegetation and also the Zemu river, which runs into the Lachen. His attempts to advance up the Zemu were however fruitless. A snow bridge by which he had hoped to cross to the opposite bank was carried away by the daily-swelling river, while the continued bad weather prevented any excursions for days together. He had however a rich botanical harvest, for, as he said, June is the most glorious month for show in the Himalaya. There were 8 or 10 species of *Rhododendron*, every bush being loaded with a great profusion of blossoms. Primulas came next in beauty and abundance. Gentians were beginning to unfold their deep azure bells, aconites to rear their tall blue spikes, and fritillaries and *Meconopsis* to burst into flower. On the black rocks the gigantic rhubarb (*Rheum nobile*) formed pale pyramidal towers a yard high of inflated reflexed bracts that conceal the flowers and, overlapping one another like tiles, protect them from the wind and rain. A whorl of broad green leaves edged with red spreads on the ground at the base of the plant, contrasting in colour with the transparent bracts, which are yellow margined with pink. He regarded this as the handsomest plant in Sikkim. The root attains a length of 4 feet and grows as thick as the arm. The dried leaves are used as a substitute for tobacco. The altitude was 12,080 feet. This was above the limit of the forest trees and the ground was covered with many kinds of small-flowered honeysuckles, a barberry, a white rose, 8 or 9 rhododendrons, species of stonecrop (*Sedum*), a white *Clematis*, a red-flowered cherry, birch, willow, juniper, many saxifrages, spikenard (*Nardostachys*), and species of other genera. He left the Zemu and continued up the Lachen, which was a furious torrent for five or six miles. Above 11,000 feet the valley expanded with more grassy vegetation appearing. Here more than 200 species were collected, nearly all belonging to north-European genera.

Sedges were in great profusion and there were 7 or 8 orchids. Insects also were of northern kinds.

Proceeding to Tungu Hooker encamped at 12,750 feet. The slope of a moraine was covered with small trees and brushwood, rhododendron, birch, honeysuckle, and mountain-ash. The magnificent yellow-flowered *Primula sikkimensis* gilded the marshes, and *Caltha*, *Trollius*, *Anemone*, *Arenaria*, *Draba*, saxifrages, potentillas, buttercups, and other high mountain plants abounded. At the foot of the moraine there was a Tibetan camp of broad black yak-haired tents, stretched out with a complicated system of ropes. In one was a buxom girl, the image of good humour, making butter and curd from yak milk. The butter is made into great squares and packed in yak-hair cloths; the curd is eaten either fresh or dried and pulverized. A small glacier was passed and precipices of blue ice and black rock towered 5,000 feet above, and a feeling of awe was produced that was almost overpowering. There were frequent avalanches of rock.

The boundary between Sikkim and Tibet was reached at the top of the Longra Lama at about 15,700 feet. Isolated patches of vegetation appeared on top of the pass, where 40 kinds of plants were gathered, most of them being of a tufted habit characteristic of an extreme climate. Some members of the pink family formed hemispherical balls on the naked soil and other plants grew in matted tufts level with the ground. At this elevation Hooker suffered from the cold and with headache and giddiness, and says that having walked about thirteen miles botanizing he was glad to ride down on his sure-footed pony reflecting 'on the events of a day, on which I had attained the object of so many years' ambition . . . and returning laden with materials for extending the knowledge of a science which had formed the pursuit of my life'. Various excursions in directions lateral to the main route were

made. At Palung, 15,867 feet, turnips are grown during the short stay of the people in summer, and this is the highest altitude of cultivation in Sikkim. The tops of the hills were relatively barren but at 17,000-feet elevation several minute 'Arctic' plants were found with *Rhododendron nivale*, the most 'Alpine' of woody plants. On the almost sterile slopes grew *Arenaria rupifraga*, forming great hemispherical balls on the ground, 8-10 inches across.

The last week of July was spent at Tungu, and Hooker then proceeded farther downstream to Choongtam to await supplies from Darjeeling. These duly arrived and he started for the north again, but farther to the east, up the Lachoong river. The valley was more open and grassy than that of the Lachen. A deviation eastwards was made to the Tunkra pass. Old moraines several miles long, choked with rhododendron shrubs, had to be crossed at 12,000 feet. There were magnificent gentians, a ragwort, *Corydalis* sp., and a new species of *Aconitum*. Higher up the main valley silver firs ascend to nearly 13,000 feet, where they are replaced by large junipers 60 feet tall. Ascending to the snow banks Hooker found the level of perpetual snow to be 15,985 feet by barometric reading. A heavy snowstorm drove him down to Yeumtong, a mile below which some hot springs burst from the bank of the river. Later he ascended to the Donkia pass to between 19,000 and 20,000 feet and reached vast masses of blue-ribboned ice, capping the ridges. One flowering plant, *Arenaria rupifraga*, attains to the summit, and a fescue grass, a small fern (*Woodsia* sp.), and a woolly composite (*Saussurea* sp.) nearly reach it. On other excursions Hooker reached from 18,000 to 19,000 feet. He also ascended the great Donkia glaciers, in the valley leading to which are four marshes or lakes, alternating with transverse moraines that have made dams across the river.

Early in October he returned to Yeumtong to meet his friend Dr Campbell and the two made their way back together to Choongtam, and then, with Campbell, Hooker paid a second visit to the Kongra Lama pass. More collecting was done, and Mt Bhomtso (18,590 feet by barometric measurement) and Mt Donkia (to upwards of 19,000 feet) were climbed. He records the great shrubby nettle (*Urtica crenulata*) as attaining 15 feet in height. It has broad glossy leaves with microscopic stinging hairs confined to the young shoots, leaves, and flower-stalks. 'I gathered many specimens without allowing any part to touch my skin; still the scentless effusion was so powerful, that mucous matter poured from my eyes and nose all the rest of the afternoon, in such abundance, that I had to hold my head over a basin for an hour.'

Campbell and Hooker paid a visit to the Rajah's residence at Tumloong in early November and made an excursion to the Chola pass. At Chumanako the two travellers were violently arrested by Sikkim Bhoteeas, whose leaders said that this was done by order of the Rajah. Campbell, against whom the whole animus was directed, was very roughly treated. It became evident that the arrest and treatment were on instructions from the Dewan and not from the Rajah. The two prisoners were taken to Tumloong and for a time were confined apart. After some weeks' detention they were brought to near Darjeeling and released, the whole captivity having lasted from 7 November to 23 December. Those responsible for the arrest, treatment, and detention of the two travellers were later punished. 'The Dewan, disgraced and turned out of office, is reduced to poverty, and is deterred from entering Tibet by the threat of being dragged to Lhasa with a rope round his neck.' The Rajah lost his Terai lands to the British and other culprits 'live disgraced in their homes'.

During January and February 1850 Hooker was chiefly occupied in arranging his collections and in transmitting them to Calcutta, whence he proceeded and arranged for a trip with Dr Thomas Thomson to the Khasi Mountains in Assam. He returned to Darjeeling on 17 April and the expedition started thence on 1 May. Much of the journey was by boat. The Khasia people are of the Indo-Chinese race and they were 'sulky intractable fellows, contrasting unpleasantly with the Lepchas' of Sikkim.

Hooker estimated that the Khasia flora is, in extent and number of fine plants, the richest in India, and probably in all Asia. More than 2,000 flowering plants were collected within ten miles of Chura (4,000 feet), their first centre, besides 150 ferns and a profusion of mosses. This great number of species was attributed to the variety of terrain and environment, from tropical swamps and hot damp jungles to rocks and bleak table-lands and finally moorlike uplands. There are fully 250 kinds of orchids in the Khasia, growing chiefly on trees and rocks, but many also on the ground in damp woods and on grassy slopes. Balsams (*Impatiens* spp.) are next in relative abundance with about 25 species, and they are of great beauty and variety in colour, form, and size of blossom. Palms, bamboos, and other grasses, and Scitamineae (in Hooker's sense the ginger and banana family) are also important. No rhododendron grows at Chura but several species occur a little farther north. There is one pine, and the yew and two podocarps also occur. Members of the daisy and pea families are far more numerous than in Sikkim.

The climate of Khasia has a very heavy rainfall. Thomson and Hooker recorded 30 inches in one day and night and during the seven months of their stay over 500 inches fell. A record by a Mr Yule for the month of August 1841 is quoted as 264 inches or 22 feet.

At the end of June Hooker and Thomson started on foot for the northern face of the hills and collected plants in more mountainous country. Other excursions followed, involving the districts of Shillong, Moflong, the Myrung valley, etc., and a return to Chura was made on 7 August. They were off again on 13 August, starting for the eastern part of the Khasi and Jyntea Mountains. Large collections were made and orchids particularly attracted attention. Although in some ways the botany of the Khasia region was less exciting than that of Sikkim, in that there were fewer new species of temperate genera, the richness of the flora enabled very large collections to be made and over 2,500 species were collected. In the latter part of the period many of the species were procured in fruit and a collection of over 300 kinds of wood was also made. Hooker left Chura on 17 November and voyaged, mainly in canoes, to Silchar, the capital of the district of Cachar, through the Jheels, the country of anastomosing rivers and marshes, with hillocks that are the haunts of wild boars, tigers, and elephants and which are covered with jungle made impenetrable by rattan canes and screw-pines (*Pandanus*). At the first range of hills a forest commences of oaks, figs, and the commonest trees of eastern Bengal. Bamboos abound and the trees are covered to 60 feet or more with a strange plant, *Cardiopteris* (Icacinaceae), like hops in appearance, with a mass of pale-green foliage and dry white glistening seed-vessels. Some botanizing was done around Silhet and then, mainly by boat, he reached Calcutta in February after various shorter excursions to Chittagong etc.

Considerable space has been devoted to Hooker's travels in India, particularly as described in his *Himalayan Journals*, for several reasons. We have in this work a first-hand account of a very important expedition. It is however not only full of valuable botanical and other in-

formation but it is the only publication by Hooker with a wide appeal outside scientific circles. He was never a 'popular' writer and did not try or pretend to be such, and the *Himalayan Journals* make the nearest approach to general literature he ever published. Even in this work it is evident that the scientific outlook, in the widest sense, is dominant. The *Journals* have an appeal not only to the botanist but also to the zoologist, ethnologist, geologist, meteorologist, and geographer. In all these fields Hooker left an enduring mark, and had he wished he could have attained the highest eminence in any of them. This one volume gives a good idea of his great versatility, width of knowledge, and powers of observation.

It has been said that his survey work in Sikkim was perhaps the most important result of his Himalayan travels, since it formed the basis of a map, published by the Indian Trigonometrical Survey with the aid of which, such is its accuracy and its detail, the operations of various campaigns and political missions were carried to a successful issue. A botanist may well question the scale of values on which such a judgment depends, but the facts increase one's admiration and respect for a great explorer.

Chapter 5

Hooker and Darwinism

It is widely conceded that the theory of evolution as based on natural selection has been the greatest single contribution to human thought by a biologist, its influence extends far outside the realm of biology in a strict sense. It is a matter of history that it was Darwin's book *The Origin of Species* which led to the general acceptance of the theory of evolution, whatever criticisms have been, and sometimes still are, made of his explanation of the process. That Alfred Russel Wallace put forward extremely similar ideas independently probably shows that natural selection would have been debated more or less intensely by biologists had Darwin not lived, but it remains extremely doubtful if evolution would have been accepted so readily and so quickly by the majority of biologists had not Darwin experienced, thought, worked, and published very much along the lines he did.

Hooker was eight years the junior of Charles Darwin (1809-82) and lived twenty-nine years after Darwin's death. The two first met in 1839 in Trafalgar Square, and by the middle 1840s were on extremely friendly terms with each other. There is no need to outline the work of Charles Darwin here and we simply remind the reader that the joint communication of Darwin and Wallace *On the Tendency of Species to form Varieties; and on the Perpetuation of Varieties and Species by Natural*

Means of Selection was presented by Lyell and Hooker to the Linnean Society of London and read on 1 July 1858, and that Darwin's classic work *The Origin of Species by means of Natural Selection* was published on 24 November 1859.

Behind these few facts is an extremely interesting situation involving Hooker. In the covering letter, signed by Charles Lyell and Jos. D. Hooker, to J. J. Bennett Esq., Secretary of the Linnean Society, it is stated that the first section (of the communication) consisted of 'extracts from a MS. work on Species, by Mr Darwin, which was sketched in 1839, and copied in 1844, when the copy was read by Dr Hooker and its contents afterwards communicated to Sir Charles Lyell'. Darwin in his *Autobiography* says, 'In June 1842 I first allowed myself the satisfaction of writing a very brief abstract of my theory in pencil in 35 pages; and this was enlarged during the summer of 1844 into one of 230 pages, which I had fairly copied out.' Later in the same covering letter the writers (Lyell and Hooker) highly approved of obtaining Wallace's consent to the publication of his essay, provided Darwin 'did not withhold from the public . . . the memoir which he had himself written on the same subject, and which, as before stated, one of us had perused in 1844, and the contents of which we had both of us been privy to for many years'. It is certain from this, and other published statements by Hooker himself confirm the fact, that for fourteen or fifteen years before 1858-9 Hooker knew Darwin was a 'transmutationist' and that the theory of natural selection was the important basis for his acceptance of evolution. Yet Hooker kept Darwin's 'secret' very faithfully. Lyell of course did so too, but Lyell was primarily a geologist while Hooker was a biologist and was constantly writing on subjects involving 'species problems'.

We shall see in some detail that Hooker was gradually forced to accept fully the theory of evolution, largely as the result of his own botanical researches and experiences, but he hesitated to commit himself for a long time because to him the cause or causes, or the mechanism, of mutability and adaptation remained unknown, obscure, or uncertain, or at least not fully appreciated. Also Hooker was essentially a pragmatist in that for much of his work, especially in the two decades from 1840 to 1860, he aimed at systematizing his facts taxonomically and phytogeographically rather than committing himself to broad generalizations.

When Darwin's *Origin of Species* appeared in 1859 Hooker read it slowly over a period of months. In a letter to Harvey, apparently written in 1860, he says, 'I was aware of Darwin's views *fourteen years* before I adopted them and I have done so *solely* and *entirely* from an independent study of plants themselves.' All this redounds to Hooker's credit but one cannot help wondering if this careful avoidance of plagiarizing Darwin's views did not restrict Hooker's own speculations. We know that the timing of Darwin's publications of 1858 and 1859 was in a sense forced upon him by his learning about Wallace's independently reached conclusions, and that Darwin's friends, at least Lyell and Hooker, had urged Darwin to publish, previous to 1858, his views on evolution and natural selection. One can debate whether Darwin's holding back from such publication for so long was entirely fair to Hooker (amongst others). On the other hand the speedy acceptance of Darwinism by so many biologists suggests that for general purposes the date of publication was 'just right'. That the biological atmosphere was becoming unfavourable to the doctrine of the fixity of species and favourable to the theory of evolution is clearly illustrated by a study of Hooker's publications between 1853 and 1860.

We have emphasized the importance of the Introductory Essays to the *Flora Novae-Zelandiae* (1853) and the *Flora Tasmaniae* (1860) particularly because of their dates of publication and the relations between Hooker and Darwin. Several other works are also of special interest in this connection. We commence with the Introductory Essay to the *Flora Novae-Zelandiae*, remembering that Darwin had not yet published even an outline of his views on evolution and natural selection but that the essence of these was known to Hooker.

That individuals of a species have all proceeded from one parent (or pair of parents) and retain their distinctive (specific) characters was the view held by Hooker in 1853. However, species vary more than is generally admitted and are much more widely distributed than is usually supposed. He puts forward a practical argument that the idea of the constancy of species as such is essential to the systematist

> to give unity to his design, and to guide him in the more or less arbitrary restriction of the species of a variable genus. . . . Except he act upon the idea that for practical purposes at any rate species are constant, he can never hope to give that precision to his characters of organs and functions which is necessary to render his descriptions useful to others.

Hooker here touches on a difficulty in taxonomy which has not yet been adequately overcome, for it is broadly true to say that nowadays taxonomists accept the theory of evolution but retain a hierarchy of taxa very similar to that in use before 1859. The new wine of evolution has been poured into the old skins designed for a much earlier vintage. Some wine has been spilt, some skins have burst, but it remains true that in botanical taxonomy this major difficulty has been largely shirked. It is assumed, with a high degree of practical success, that for the great majority of groups evolution is so slow that the taxa are essentially

static. Whether the frank recognition of elastic or plastic taxa or a greater number or variety of kinds of taxa would enable taxonomy to be expressed better in conformity with evolutionary ideas and at the same time to remain practical (in Hooker's sense) has not been fully explored.

Hooker then in 1853 accepted, for practical reasons, permanency of species. He discusses the ideas on species held by various naturalists and rejects the view that changes directly induced by the environment on bodily characters account for the evolution of species. However it is plain that he is not entirely satisfied with his own tentative conclusions, as when he says, 'I would again remind the student that the hasty adoption of any of these theories (of permanence of species) is not advisable.' When Hooker puts forward views in favour of the permanence of specific characters one cannot help noticing that the same underlying negative reason underlies many of them—the absence of any known satisfactory cause or mechanism of or for evolution.

Only one volume was published of the *Flora Indica* by J. D. Hooker and T. Thomson and this appeared in 1855. While the work is of joint authorship, with personal pronouns used in the plural throughout, the style, phraseology, and thought of those parts of the Introductory Essay that concern us here are essentially those of Hooker. Species are regarded as 'being definite creations' but 'created with a certain degree of variability'. An attempt is made to explain the facts as then known and understood by accepting that species were created as such but were much more plastic and even genetically variable than had been generally recognized.

It is difficult to determine precisely what was intended by the word 'created'. Thus it is said, 'As regards specific centres, we proceed in our investigations on the assump-

tion that all the individuals of a unisexual plant proceeded from one originally created parent, and all of a bisexual from a single pair.' In modern botanical terminology the word 'unisexual' in this last sentence means hermaphrodite or monoecious and 'bisexual' means dioecious. Some authors prefer the terms 'monoclinous' and 'diclinous'. The particular interest of the Introductory Essay of the *Flora Indica* is that in it is the nearest approach to a consideration of natural selection that the present writer has found in any of Hooker's published works prior to 1858. The position is of sufficient interest to make the following quotation (op. cit., p. 41):

> Plants, in a state of nature, are always warring with one another, contending for the monopoly of the soil—the stronger ejecting the weaker—the more vigorous overcrowding and killing the more delicate. Every modification of climate, every disturbance of the soil, every interference with the existing vegetation of an area, favours some species at the expense of others. The life of a plant is as much one of strife as that of an animal, with this difference, that the contention is not intermittent, but continuous, though unheeded by the common observer. In the common course of events, therefore, the ground occupied by a widely-distributed plant is held on a very different tenure in different places; some individuals are obliged to grow in the shade, others in the sun; and they hence flower earlier in certain places; we say of such plants that they have a power of accommodating themselves to their altered conditions, or better, that they have the power of resisting the effects of change.

Between the publication of the *Flora Novae-Zelandiae* and the *Flora Tasmaniae* there appeared A. de Candolle's *Géographie botanique raisonnée*, and Hooker published a long essay-review of this important work in the *Journal of Botany* (*Kew Journal of Botany*), vol. 8 (1856). This review showed that Hooker very thoroughly studied de Candolle's methods and theories and they undoubtedly

influenced some of his later work. In the final instalment of the essay-review there is a discussion on the nature of species. De Candolle believed 'that the majority of species were created such as they now exist', but Hooker comments, 'there is not a shadow of proof of this'. In favour of transmutation of species he notes 'the fact that species are variable', that 'this theory of transmutation accounts better for the aggregation of Species, Genera, and Natural Orders in geographical areas, and for their limitation', and that transmutation involves 'less of the marvellous at first sight' than does special creation. The whole argument so far favours acceptance of a theory of evolution, but Hooker has to add, 'unfortunately transmutation brings us no nearer the origin of species, except the doctrine of progressive development be also allowed and, as we can show, the study of plants affords much positive evidence against progressive development, and none in favour of it'.

Two groups of what in 1856 he regarded as botanical facts were against Hooker accepting 'progressive development': the evidence of the fossil record, and the high place he assigned to the Coniferae (and other gymnosperms) in structure and in taxonomic position and therefore in any postulated scheme of 'progressive development'.

The evidence of the fossil record has been largely extended and the interpretation of many of the fossil plants known to Hooker has been much modified since 1856, yet we still do not know when, where, or from what the modern kinds of flowering plants (Angiospermae) arose (see Harris, 1960). The earliest-known fossils certainly referable to the angiosperms are of Cretaceous age, and by the Middle Cretaceous period members of the group became prominent, and often dominant, in many of the investigated fossil floras. Since various families (of both dicotyledons and monocotyledons) are represented in

these Cretaceous floras it is reasonably assumed that they do not represent the beginning of the Angiospermae. This much was known to Hooker, and though he was perhaps over-impressed by the incomplete evidence of fossil angiosperms, one has to acknowledge that with the data accumulated by over a century of additional researches by palaeobotanists we cannot in 1962 clearly define general progress within the group of the angiosperms on the basis of the fossil record.

For other groups of vascular plants Hooker says that either the fossil representatives (as in Cycadaceae of the Lias and Oolite, the 'ferns' of the Oolite and Coal, and the 'Lycopodiaceae' of the Carboniferous) are as highly organized as their present-day representatives (and by and large this cannot be disputed, though his classification is now out of date), or, as in the Coniferae, knowledge is too imperfect 'to afford the smallest evidence of their relative development'. As regards the Coniferae there is a consensus of modern opinion that Hooker was wrong in the high evolutionary position he assigned to them. Indeed he appears to have had 'a bee in his bonnet' on this matter, and there is some evidence that he knew it for he describes his opinion (that conifers are highest Phaenogs.) as 'heretical' in a letter to Darwin of December 1858. The clearest statement traced of his reasons for the high position he assigned to the conifers is in a letter to Darwin (see L. Huxley, vol. 1 (1918), 460) and is as follows: 'If you take reproductive organs as test of highness or lowness, then Coniferae are top of the Vegetable Kingdom; if you take coverings of those and neglect the organs themselves, you may place them below Monocots, but in so doing you neglect the vascular system, germinative and embryological characters which are all as in Dicots, not as in Monocots.' This was presumably in 1858. Very much more is known today about the structure

and history of the Coniferae than was known to Hooker, particularly from the work of R. Florin. Hooker was certainly wrong in assigning them to a position amongst 'the very highest of Natural Orders', although he was presumably using the word 'highest' in regard to their actual structure and not in a strict evolutionary or phylogenetic sense.

It may be noted that in Bentham and Hooker's *Genera Plantarum* the gymnosperms (including the Coniferae as one family in a broader sense than is now usual) were placed between the dicotyledons and the monocotyledons. The account of the gymnosperms however was prepared by Bentham, who says in(*Journ. Linn. Soc. Bot.*, vol. 20 (1883), 307), 'Hooker was to have done the Gymnosperms, of which he had so much practical knowledge in a living state; but unfortunately he was at that time again much engaged in other duties, and I was obliged to satisfy myself with consultation on points which appeared to me doubtful.' The classification in the *Genera Plantarum* is not to be considered as based on phylogeny or on strictly phylogenetic theories, but the position assigned to the Gymnospermae does reflect Hooker's published views of their relationships as nearly as this can be expressed in a linear arrangement.

In spite of Hooker's difficulties regarding 'progressive development' he carefully puts forward arguments in favour of transmutation in discussing de Candolle's views and says:

> For our own part we confess that we see no more means of forming an opinion on the subject of the origin of species, than we do of the origin of time; whether they are all suffering transmutation or not, appears to be immaterial as regards the progress of botanical science; on the one hand we cannot treat practically of the species of plants, either systematically or physiologically, save under the assumption that most are

hereditarily permanently distinct; and on the other, we cannot study any species or organ physiologically or morphologically without being strongly impressed with the fact that variability is an ever-operating law.

There are further elaborations of the difference between the theories of special creation and 'creation of species by transmutation', and it is clear from these and from what has been said above that in 1856 evolution was much in Hooker's mind but that he felt he had to take up a half-way, compromising, or on-the-fence position. Perhaps he was deliberately waiting for Darwin to publish his work on species.

Some consideration of a most difficult matter is desirable here: what, previous to the full acceptance of evolutionary views, did Hooker understand by some of the terms he uses? In particular one may mention 'created' (or 'creation'), 'highest' ('higher', 'lower'), and 'types'. There are a few passages in Hooker's letters to Darwin (1843 to 1856) and to Asa Gray (1854 to 1858) which help to an interpretation of such words in the Hookerian sense, though at the same time they indicate something of the maze in which Hooker found himself. The full letters, or fuller extracts from them, are given by L. Huxley, vol. 1 (1918). We select various sentences before considering their implication and take letters to Darwin first, under dates:

July 1845. 'Bother variation, development and all such subjects! it is reasoning in a circle I believe after all. As a Botanist I must be content to take species as they *appear to be*, not as *they are*, and still less as they were, or ought to be.'

July 1845. 'Those who have had most species pass under their hands, as Bentham, Brown, Linnaeus, Decaisne, and Miquel, all I believe argue for the validity of *species* in nature; ... Nature may have both made and muddled species.'

Apparently before 10 April 1846. For the Galápagos Islands 'I have a class in reserve for *"apparently peculiar species, possibly the altered forms of introduced plants"*.' The plants of the Galápagos Islands are divided into four groups: ubiquitous, of nearest continent, possibly altered state, original creations. 'Such however is the difference of opinion amongst Botanists as to what should or should not be a species, that the question in any shape will be a troublesome one. . . . Generally speaking, in Botany highness and lowness are synonymous with complexity and simplicity of structure. I can hardly conceive either simplicity or complexity of one particular organ indicating the rank of a being in the scale of creation.'

June 1854. '. . . in plants I should say that a high development in the scale is indicated by special adaptations of organs to the discharge of functions, great deviations in those organs from the type upon which they are constructed. Thus Ranunculaceae are low in the scale because the floral organs are apt to run into one another and revert to the type (a leaf) on which they are constructed—because calyx and corolla are so much alike—stamens often reverting and the follicles present little deviation from a leaf folded on itself. Hence Monopetalous flowers are higher than polypetalous, inferior ovaries a higher type than superior, Dicotyledons than Monocot, Exogens than Endogens, &c., &c.' (Darwin replied to this, and the distinction he draws lies in the amount of morphological differentiation and the division of physiological labour.)

Apparently between June 1854 and 2 March 1855. 'The more I study the more vague my conception of a species grows, and I have given up caring whether they are all pups of one generic type or not—that the main forms remain so long distinct.'

9 November 1856. 'I have finished the reading of your

MS. (on Geog. Distrib.). . . . Your case is a most strong one and gives me a much higher idea of *change* than I had previously entertained; and though, as you know, never very stubborn about unalterability of specific type, I never felt so shaky about species before.'

Short extracts from two letters to Asa Gray follow:

26 January 1854. '. . . that two originally created distinct species . . . my mind is not fully, faithfully, implicitly given to species as created entities *ab origine*'.

2 January 1858. 'I wish I could see my way clearly through the maze of high and low amongst Dicotyledonous Exogens'.

It must be remembered that these letters were written to personal friends in a free-and-easy conversational manner. They were not intended for publication or for the most part to express Hooker's considered set conclusions. Rather they are 'thinking in writing', but they do add something to our understanding of the coming of evolution, of the perplexities Hooker (and no doubt other biologists) had in considering origins, and what were the meanings attached to certain terms at that time.

Hooker was not a theologian and he was not a philosopher either by inclination or training beyond matters concerned directly with the taxonomic botany and plant geography on which he was engaged. There is no evidence that religious views impeded or encouraged his acceptance of evolutionary theories, general or particular. One is again and again struck, on reading his published works and letters, with Hooker's insistence on the need for 'practical' standpoints, that is, for devices, methods, and expressions that will enable the botanist best to record the results of examining plant life as it is without reference as to how it has possibly come so to be. Here, he seems to say, is a collection of plant specimens from an area hitherto botanically unknown, or very imperfectly known.

How can we best record and express the facts of resemblances and differences and what method of so doing will best enable us to record and help us to explain the geographical ranges of the groups into which the specimens or most of them seem almost inevitably to fall?

We have to remember that in the 1850s taxonomic botany was based almost entirely on gross morphology. Hooker and his contemporaries of a century or more ago had little to help them, in making classifications, from what we should now term facts of cytology, genetics, biochemistry, palaeobotany, or even of comparative plant histology. These subjects are still very backward as aids to the phylogeny of the angiosperms but they do provide, directly or indirectly, strong evidence for evolution.

Hooker, basing his conclusions on his own extensive knowledge of plants, held at this period that as a working hypothesis it was most satisfactory to accept the view that all individuals of a species are the offspring of a single parent or pair of parents and retain their original specific characters under altered circumstances. He does not however commit himself to the theoretical dogma of the fixity of species. He emphasizes their variability and definitely repudiates any intention of wishing his views to be interpreted as an avowal of the adoption of a fixed or unalterable opinion on his part. In the *Flora Novae-Zelandiae* he proceeded on the assumption 'that species, however they originated or were created, have been handed down to us as such'. It is only by assuming 'that for practical purposes at any rate species are constant' that the systematist can 'hope to give precision to his characters of organs and functions which is necessary to render his descriptions useful to others'.

Actually this pragmatic standpoint still dominates the practice of much of botanical taxonomy and indeed of

cytogenetics, ecology, and other modern branches of botany—at least so far as the angiosperms are concerned. General acceptance of evolution as opposed to special once-and-for-always creation made little or no difference to taxonomic practice. Even the latest definitions of species and other taxa have little that would not be acceptable to Hooker and others in the 1840-58 period, once the terminology were explained. This may not be true of taxonomy in the future, since synthetic taxonomy is basically evolutionary and plant taxonomy is more and more supplementing gross morphology with data of a kind unknown to Hooker or Darwin.

Hooker then, previous to 1858, accepted species as having 'originated' or having been 'created', and from their origin or creation continuing as such generation after generation. Yet, he states, they vary 'more than is generally admitted to be the case'. Surely, it would seem to us, not a great step to take from variation within a species to variation overstepping the species boundary and thus resulting in the evolution of a new species from a pre-existing one. Again and again one notes Hooker's expressed doubts regarding the absence of any known and published satisfactory 'cause' of such evolution as would account not only for the origin or creation of a new species here and there but for the whole wealth of the plant kingdom. Yet we are forced to ask ourselves whether Hooker was tied by loyalty to Darwin in discussing these questions of fixity of species and evolution as freely as he might in his publications, or in his letters so far as these latter are available. He had read the preliminary account of natural selection nearly a decade before the publication of the Introductory Essay to the *Flora Novae-Zelandiae* in 1853. While it is true that Hooker was, in botanical taxonomy, more practical than speculative, one feels after reading and rereading the essential publications dated

from 1840 to 1860 that Hooker did not let himself go on theories or hypotheses of 'creation' and 'origin', because he knew that Darwin was working on these matters and had indeed reached definite conclusions and he wished to avoid any suspicion of plagiarism.

Hooker's published views, prior to 1859, show that he was not dogmatically orthodox and that he tended to use the word 'creation' as simply synonymous with origin or beginning, leaving the causal and other details entirely vague. Similarly 'higher' and 'lower' seem to have meant little if anything other than more or less complicated in structure and function. In some passages it appears that Hooker accepted Goethe's idea of metamorphosis in the sense of many plant parts being modifications of a type. That the parts of a flower named sepals, petals, stamens, and carpels were metamorphosed leaves is probably the best example. There was a theoretical type for a leaf and in some similar way there was a theoretical type for a species and for every species (not a nomenclatural type but a type definable in descriptive terms).

So far as we know, Hooker was in no sense a theologian but he had been brought up in a simple religious atmosphere and his father-in-law, the Rev. Professor J. S. Henslow, was a priest of the Church of England. Hooker must have known that the accounts of creation in the book of Genesis so far as plants are concerned are not very explicit, and given an allegorical interpretation of the phrase 'and the evening and the morning of the third day', could easily be interpreted to accord with evolutionary ideas. It is well to remember that evolution in the wild is, in terms of human life-spell, generally a slow process. A tree, a grass, or a fern normally produces fruit or seed 'after his kind' and the process is repeated for many generations. This is what Hooker meant when he accepted 'fixity' of species as a basis for his practice of taxonomy

and for his attempts to explain the facts of ranges of species and other taxa.

Actually natural selection acts at least as much towards fixing a species within certain limits of variation as in favouring changes in it. The evolution of a new species can only occur after the advent and with the spread of favourable mutations. Most mutations are unfavourable, often indeed they are lethal. There has to be establishment of mutants following their appearance, and this again is a process with many risks and takes time. Darwin, by considering cultivated plants and domesticated animals in evolution by artificial selection, by-passed, so to speak, the slowness of action of natural selection in evolution and also the risks of establishment of new variants. Hooker, in agreement with the early chapters of Genesis, believed in the fixity of species in so far as not to allow any importance to the direct action of the environment in bringing about changes in heredity.

There has unavoidably been some speculation in this chapter when trying to understand Hooker's position in regard to evolution previous to 1859, and a little more may be added. In reading the mass of printed and manuscript material at Kew concerning the relationships between Hooker and Sir Richard Owen there arose in the mind of the present writer a possible historical 'if' which may be of some interest. Sir Richard Owen (1804–92) was a famous anatomist, who from 1856 to 1883 was Superintendent of the Natural History Departments of the British Museum. He held to a doctrine of the Archetype and was strongly opposed to Darwin. It has been stated that 'His bitterness against any possible scientific rival and his disingenuous attitude towards Darwin and his work ended by leaving him isolated in the scientific world.'

When Kew became a Government institution in 1841 and Sir William Hooker was appointed Director, it was

placed under the Commissioners of Woods and Forests. The Kew Herbarium was founded in 1853 and very speedily developed in size and importance of the collections. This development was continuous and there is no doubt that rivalry resulted between the British Museum, where there was the very important Herbarium of the Department of Botany, and Kew. The rivalry at times became extremely personal, especially between Joseph Hooker and Owen. It may be that Owen's antagonism to Darwin and to evolution was because he could not brook any rival to his own theories, but it was very probably increased because of Hooker, who was a friend of Darwin and after 1859 an open supporter of Darwinism. It is just possible that a prime cause of Owen's open opposition to Darwin was the friendship of Darwin and Hooker, and that his hatred (not too strong a word) of Hooker was the feeling that Kew should be subordinate to the British Museum (and to Owen) and should not be allowed to develop as a scientific institution independently and with the advantage of a great botanic garden. It is often stated that Owen primed Bishop Wilberforce in his attack on Darwin at the meeting of the British Association for the Advancement of Science in Oxford on 30 June 1860, when the defence was led by T. H. Huxley and Joseph Hooker. Certainly Owen attacked Hooker, right and left, in the 'Ayrton Episode' of 1870-2. To what degree was Owen anti-Hooker because Hooker was pro-Darwin or to what degree was he anti-Darwin because Hooker was pro-Darwin, and was he mainly anti-Hooker because Hooker represented Kew, which as a scientific institution Owen considered should be abolished and the scientific collections taken over by the British Museum? What would the position have been in 1858-60 had Kew in 1841 been placed administratively under the British Museum (perhaps with a high degree of autonomy and

with the botanical collections from the Museum moved to Kew)? If this had happened is it not just possible that Owen's antagonism to Hooker and to Darwin would have been either non-existent or at least much milder and more reasonable than it was? Even the Oxford attack by Bishop Wilberforce on Darwin might not have occurred, and the often unhappy and sometimes stupid antagonism between theologians and evolutionists might have been avoided, with all-round advantages. All this is guesswork, but it has certain possible lessons for the present and the future which cannot be discussed here. That there were some faults on both sides in the Hooker-Owen controversies is certain, and there was hard hitting, but the basic causes of antagonism were not the superficial ones.

It is for zoologists to consider in detail the position of Owen in regard to evolutionary theory. On the botanical side of biology we are greatly mistaken if we think that a scientist of the calibre of Joseph Hooker was a fool not to recognize and accept evolution as an explanation of so many of his problems long before he did. It is not entirely wild to say even today that to accept a general theory of evolution by mutations with natural selection (a more or less orthodox position in 1962) requires as much faith as to accept some theory of special creation. There are still innumerable problems concerning the course of evolution, of how and when changes occurred in this and that group of plants (and, one supposes, of animals), that remain unsolved, and proposed solutions are sometimes absurd. Darwin was right, one would conclude after reviewing the history of evolutionary theories, not to publish his theory until he had accumulated masses of data in favour of it from as many sources and points of view as possible.

Before 1859 the obstacles to accepting evolutionary theory were to Joseph Hooker scientific and not theological or philosophical. The fossil evidence did not, to

him, show that there had been 'progressive development'. Species, while variable, on the whole remained constant and certainly bred to produce their like within the limits of their determinable variability. What could be the cause of evolution and how could it occur by 'natural' means?

Let us imagine ourselves in 1858, examining a large collection of orchids of numerous genera from many parts of the world. They show certain characters in common (family characters) which enable one to group them together as 'orchids', but the variations (the play around a central theme) appear innumerable and most strange, affecting every organ and every phase of behaviour. Many of the variations are extreme in size, shape, relative development of parts, colour patterns, and so on, and appear to fulfil no purpose that could not have been adequately fulfilled by something simpler. There is diversity in all directions but little or no evidence of continued progress in any one. Neither special creation nor transmutation appear satisfactorily to account for the diversity. It is however, we may say, our business as botanists to record all the kinds of orchids by descriptions, figures, and comparative accounts, using for convenience of reference a recognized system of classification into genera and species with an internationally recognized system of nomenclature. We will leave it to the philosophers to decide how and why this diversification came about and if it be a fixture, or at least we will wait till new facts are known which may enable us to come to some theoretical conclusions for ourselves. Meantime there is so much of exciting interest in all the new floras being investigated for the first time that we have our hands and minds full, and so, to creationists and evolutionists, 'A plague o' both your houses'.

There is no doubt that the desire to have clear-cut units as taxa (especially species and genera) for phytogeo-

graphical purposes was a contributing cause of Hooker's hesitation in accepting their evolutionary origin. 'Units' can be dealt with statistically and nomenclaturally in a hierarchy of classes, blurred 'fields' cannot, and the latter were to be expected if evolution had occurred and was occurring and was to be made the basis of taxonomy. We still use old schemes, and attempts to provide new ones have not so far met with general acceptance. Perhaps a recognition of the difficulties Hooker knew might give us suggestions for radical changes in taxonomic procedure.

With the publication of the joint communications of Darwin and Wallace in 1858 and that of the *Origin of Species* in 1859, Hooker was free of any possible suspicion of plagiarism with regard to the theory of natural selection. To discuss evolution or transmutation of species could not possibly come into any question of breaking confidence before 1858, because at least from the days of Lamarck its possibility was a matter of debate among biologists.

In the Introductory Essay to the *Flora Tasmaniae* (6 February 1860) Hooker essentially proclaims his acceptance of evolutionary ideas and the theory of natural selection. While however he in the main accepts the ideas of the 'two wholly independent and original thinkers, Mr Darwin and Mr Wallace', he at considerable length gives his own botanical evidence for general, if sometimes tentative, agreement with the new outlook. In the *Flora Novae-Zelandiae* (1853) Hooker was not anti-evolutionary, in the *Flora Tasmaniae* (1860) he was rationally but mildly evolutionary. That he later became more strongly a pro-Darwinian may be partly in reaction to attacks made upon his friend by Owen and others. It is not impossible that T. H. Huxley's well-known position as a protagonist of Darwin was strengthened by his enjoyment of a good fight. Hooker at any rate in 1860 gave a fairly long account of his theoretical views in 'On the General

Phenomena of Variation in the Vegetable Kingdom'. This is too long to quote in full and a brief paraphrase and condensation must suffice here. Species and their organs vary. The rate at which plants vary is always slow, and the extent or degree of variation is graduated. There are natural groups of varying (unstable) and of unvarying (stable) species. Complexity of structure is generally accompanied with a greater tendency to permanence in form: thus Acotyledons, Monocotyledons, and Dicotyledons are an ascending series in complexity and in constancy of form.

Similar remarks apply to all the higher divisions of plants—genera and orders (families). It is due to the extinction of species and genera that we are indebted for our means of resolving plants into limitable genera and orders. Cultivation hastens the processes of Nature (in rapidly inducing variation), or anticipates these processes (in producing sports, i.e. better-marked varieties, without graduated stages), or by placing the plant in unnatural conditions eventually either kills it or gives origin to a series of varieties which might otherwise have never existed. As in the wild so in cultivation some species are long hereditarily immutable and thus give rise to the doctrine that all are so normally, while others are so mutable as to induce a belief in the very opposite doctrine, which demands incessant lawless change. Nature has provided for the possibility of indefinite variation, but she regulates it as to extent and duration; she will neither allow her offspring to be weakened or exhausted by promiscuous hybridization and incessant variation, nor suffer a new combination of external conditions to destroy one of these varieties without providing the possibility of a substitute. Hybridization between genera is rare and the hybrids are almost invariably barren.

One may interpolate here a comment on Hooker's

rather frequent use of the word 'Nature' in such phrases as 'Nature has provided', 'Nature does not supply the conditions', 'the tendency of Nature', and 'Nature acts slowly'. Of course this apparent personification following the consideration of natural happenings, such as are not in any way controlled by men, is not peculiar to Hooker. It is found in many other authors both before and after his time. *Natura non facit saltum* is quoted as a canon by Darwin, who however cannot be charged with writing of 'Nature' as a person to the extent of many other scientists, even quite modern ones. Probably it is not any tendency to pantheism that is indicated by making 'Nature' responsible for so much of what scientists record or assume but simply an unfortunate carelessness of expression. 'Nature has provided' should read 'we find provision made by natural means' or more shortly 'provision in Nature'.

Hooker refers to the delimitation of species by natural selection. He briefly outlines the salient points of the theory and applies it to the facts of plant geography. He raises again the important question of progressive evolution in the plant kingdom, asking abruptly, 'What is the standard of progression?' He considers that 'the doctrine of progression, if considered in connection with the hypothesis of the origin of species being by variation, is by far the most profound of all that have ever agitated the schools of Natural History'.

At this date (1860) the view that species were immutable creations was not yet unorthodox. Hooker commented that

> we have no direct knowledge of the origin of any wild species: (though we know) that many are separated by numerous structural peculiarities from all other plants; that some of them invariably propagate their like; and that a few have retained their characters unchanged under very different conditions and through geological epochs.

There are, he argues, very few 'absolute facts' for the theory that existing species have arisen through the variation of pre-existing ones and the destruction of intermediate varieties, or for the opposite theory that demands an independent creative act for every species. All considerations have to be taken into account, the conclusions to which they lead, and their bearing upon collateral phenomena. Creation separately and independently of every species is a 'gigantic conception of power intermittently exercised in the development, out of inorganic elements, of organisms the most bulky and complex as well as the most minute and simple'. On this view the consanguinity of every new being to its pre-existing nearest ally has no scientific significance or further importance to the naturalist than that it enables him to classify. On the other hand the attributes of organic life which are involved in the study of classification, representation, and distribution receive a rational explanation under the Darwinian theory. Though this

> does not positively establish the doctrine of creation by variation, I expect that every additional fact and observation relating to species will gain great additional value from being viewed in reference to it, and that it will materially assist in developing the principles of classification and distribution.

One may sum up by saying that in 1860 Hooker accepted cautiously and critically the theory of evolution by variation and natural selection. He had never been dogmatic with regard to special creation and fixity of species but had accepted this standpoint as a useful principle for practical purposes, especially in taxonomy and phytogeography. Darwin's theory gave a rational basis for evolution but it did not fully explain all the botanical facts known to Hooker. It is scarcely true to describe Hooker as a convert overnight from the follies

of one belief to the full enlightenment of another. Apart from the fact that the essential conclusions of Darwinism were known to Hooker since 1844, though of course without all the details of evidence given in the *Origin of Species* in 1859, he was again and again unable to explain facts of 'relationship' (i.e. of morphological resemblances) and geographical distribution (range) satisfactorily on the basis of fixity of taxa. On the other hand he could not accept Lamarckian ideas of direct action of the environment as accounting for variation and adaptation and was thus left without any causal explanation for evolution. There were also other difficulties, but dogmatism—scientific, religious, philosophical, or any other kind—was not among them.

Hooker after 1859 became more and more strongly and openly a protagonist of Darwinism. As an example of this we may briefly note his address as President of the Geographical Section of the British Association for the Advancement of Science at York in 1881. He comments that before the publication of the doctrine of the origin of species by variation and natural selection, all reasoning on their distribution was in subordination to the idea that they were permanent and special creations. This left much unexplained, especially many facts of range and ecological distribution (in more modern terminology). On the Darwinian theory all the leading facts of distribution are clearly explicable'. Such include

> the multiplication of new forms; the importance of barriers in forming and separating zoological and botanical provinces; the concentration of related species in the same area; the linking together under different latitudes of the inhabitants of the plains and mountains, of the forests, marshes, and deserts, and the linking of these with the extinct beings which formerly inhabited the same areas; and the fact of different forms of life occurring in areas having nearly the same physical conditions.

We have remarked several times that Hooker's main but not sole interests in botany were in taxonomy and phytogeography. It is important to give due weight to the facts of 'relationships' or 'affinities' as known to him and to the correlations of distribution, in which he was deeply interested, if we are to understand his appreciation of 'the doctrine of the orderly evolution of species under known laws'.

Chapter 6

Work at Kew while Assistant Director

Hooker reached England from India on 25 March 1851. The value to science of his Indian travels was very great. First there were the great collections of herbarium and museum specimens and of fruits and seeds for Kew; secondly there was the mass of first-hand information he had accumulated, especially concerning the flora and vegetation of Sikkim; thirdly there was the exploratory work he did in the Himalaya and the surveying and map-making; fourthly, and not of least importance, there was the deep and lasting interest he had acquired in the flora of the Indian subcontinent and which led to the preparation of *The Flora of British India* and to valuable accounts of the plant geography of the great area covered by this.

On his return to Kew Hooker had to complete his *Botany of the Antarctic Voyage* and make domestic arrangements following his marriage to Frances Henslow in August 1851. He managed for a time to exist financially on grants for arranging his Indian collections. In May 1855 he was appointed assistant to his father, Sir William Hooker, and he and his wife moved to what is now Herbarium House, 55 The Green, Kew, next to the Main Gate, where they lived for the next ten years.

The period of Hooker's life we are now to consider was one of hard work on a variety of subjects mainly in the

Kew Herbarium, with one overseas collecting expedition of secondary importance to his Antarctic and Indian travels. No doubt a number of matters were dealt with more or less at the same time in alternating intervals. One can best deal with the more important results in the order of publication, which may or may not be the sequence in which the researches were done.

The importance of the Galápagos Islands, off the north-western coast of South America, in providing information regarding the connection of geographical isolation to evolution has been much to the fore on the zoological side from the time of Darwin to recent days. One may refer to Lack's interesting accounts of 'Darwin's Finches' (Lack, 1945, 1947). The scientific value of the islands was evident from the field work of Darwin in 1839. Hooker, although he himself had not visited the islands, published two important papers on the flora in *Transactions of the Linnean Society of London*, vol. 20 (1851). These papers are based on specimens collected in the Galápagos Islands by Charles Darwin, James Macrae, and a few other naturalists. Hooker and Darwin had already been in touch with each other over botanical matters, but Hooker's working out of Darwin's plants from the Galápagos Islands greatly increased their intimacy and the friendship that lasted till the latter's death, necessitating as it did visits by Hooker of from a week to ten days' duration to Darwin's home at Down, in Kent.

Hooker devoted much time and thought to the preparation of these papers and a brief account of his conclusions regarding the flora and vegetation may be given. He considers the flora an exceedingly poor one when compared with that of other tropical islands of similar or even less extent. One peculiarity is the paucity of monocotyledons, 'which hardly equal 1/9 of the Dicotyledons' though 'tropical islands in general possess proportionally

more Monocotyledons than do the continents'. In the Galápagos Islands there are 28 species of ferns, and of flowering plants the families with the largest number of species are Compositae (daisy family) 28, Leguminosae (pea family) 24, Euphorbiaceae (spurge family) 18, Rubiaceae (bedstraw family) 15, Solanaceae (potato family) 13, Gramineae (grass family) 12, Amaranthaceae (amaranth family) 10, Verbenaceae (vervain family) 9, Cyperaceae (sedge family) 7, and Boraginaceae (borage family) 7. There are 43 families. The families are those forming a large part of the vegetation of every tropical country, except the Amaranthaceae, which however attain a maximum development on the west coast of South America.

It is not to the prevalence of any one family or to the undue numbers in any one that the Galápagos Islands owe their extraordinary amount of novelty. This is due to the development of species of which one-half are confined to that archipelago (that is, are species endemic to the group). Moreover this endemism is not only relative to the Galápagos and the mainland of South America but to the separate islands of the group. The paucity of monocotyledons is due to the scarcity of the petaloid monocotyledons (such as members of the lily, narcissus, iris, and orchid families) and grasses. There is a relative abundance of members of the sedge family.

The daisy family (Compositae) is the most remarkable family in the Galápagos Islands as regards the number of new species and genera, and also as forming much of the wood of the islands. This family is probably the largest family of flowering plants in the world's flora in the number of genera and species into which it is usually divided, but the vast majority of its members are herbs. In the Galápagos Islands the species are very clearly defined and the endemic genera have representatives in the different islands.

Hooker divides the flora of the Galápagos Islands into 'two types': the West Indian (including Panama), to which almost all the wider-ranging plants belong, and the Mexican or more temperate American type, in which are classed the great majority of the endemic species. He discusses the possible means of transport by which the plants of the widest-ranging group could have been introduced into the islands. About 90 species are presumed to have been introduced into the Galápagos Islands by various agents. He obviously lays very considerable stress on oceanic currents as agents of fruit and seed transport to the Galápagos Islands. They are held to account for the majority of the littoral species and for some non-littoral species belonging to the pea, borage, vervain, and potato families, with seeds too large for probable transport by winds and with no devices for attaching themselves to birds etc. For other species birds are apparently the main active agents in transporting fruits and seeds. No land bird is common to the Galápagos Islands and the mainland and seabirds are the probable carriers. It must not however be overlooked that these birds plume themselves with exquisite care, and there is also little chance of a seed remaining attached to a body subjected to such violent motion and constant immersion as these birds undergo. The winds are steady southeast trades, blowing from the coast of Peru, and by which seeds of West Indian species cannot have been carried. That man has been an agent in seed transport is indicated by the fact that Charles Island, the only colonized island (in 1835, the date of Darwin's visit), contains the smallest proportion of endemic plants.

The major interest of the flora is that the several islands are tenanted for the most part by different plants. This peculiarity is not confined to those species which may have come direct from the continent but is most

marked in the ranges of the species that are Galapageian only. No more than 13 of the 128 endemic flowering plants and ferns had been found (i.e. up to 1845-6 when Hooker's papers were read to the Linnean Society) on two of the four islands whose flora was known, 2 upon three, and only 1 on all four. Numerically the difference is great but morphologically it is restricted, since the plants of one island are replaced or are represented by similar but not the same species on others. There is a similarity in all the general features combined with a difference in details. Hooker concluded that such well-marked and at the same time very narrow limits to the dispersion of nearly 130 species, probably nowhere to be met with outside the Galápagos Archipelago, is very much the accident of their birthplace. In great measure it is due to want of means of intercourse, especially atmospheric storms, between the several islands, and does not indicate any physical peculiarity or want of vigour in the species themselves. Hooker argues that the first steps towards ensuring the continuance of many species in a given area are to isolate them and to cut off the means of migration, 'exactly as in a garden the plants are protected from encroachment mechanically, and the seeds of the more volatile collected betimes, to prevent a like effect being brought about'.

James Island is the richest in species, as might be expected from its central position in the archipelago and from its containing very elevated land. Charles Island, the smallest, is also rich, while Albemarle, the largest, and Chatham Island are described as peculiarly sterile and arid. These and other conclusions are of course drawn from the collections received and from the notes supplied by the collectors, and refer only to the four islands mentioned.

Since the publication of Hooker's accounts a considerable

number of important papers dealing with the flora and vegetation of the Galápagos Islands have appeared. The archipelago is situated about 500 miles west of the coast of Ecuador and the flora is almost entirely of American affinities. The main points of phytogeographical interest more recently emphasized were in part those considered by Hooker: the influence of the environments as limiting and selecting agents and the question of the origin or origins of the flora—whether it arrived from the American mainland to colonize the virgin surface of newly formed volcanic islands, ecologically initiating a primary succession, or whether it is a survival, with subsequent modifications, of the flora of a piece of land formerly joined to Central or South America. The geological evidence appears to be in favour of the volcanic origin of the islands independent of the mainland. Some at least of the recently or fairly recently published zoological evidence is in favour of 'emergence' and not 'subsidence', as for example can be seen by the conclusions reached by Lack (1947). With one exception the botanists who have studied the flora of the Galápagos Islands, and whose publications have been read, either favour the view of Hooker that the archipelago is of oceanic origin and has been stocked, with very few exceptions, by transport of disseminules from Central and South America, or they reserve their opinion.

With islands far from a mainland we can only observe the results of happenings mostly long since completed, apart from the activities of man. An element of doubt usually remains in any deductions from the facts of present range and distribution, the more so that natural introduction, if it occurs, is at long and irregular intervals and can very rarely be observed by botanists. Unfortunately too the geological history of an area concerned is not always known or stated so clearly, and unequivocally accepted by all qualified geologists who have specialized in it, that

the botanist has a safe background for considering his own evidence for emergence and transport of flora or for subsidence and the relict nature of the flora. Hooker's work on the flora of the Galápagos Islands illustrates very clearly the pioneer work of many of his studies on the taxonomy of floras and their phytogeography.

The decade following Hooker's return from India saw the completion of his *Botany of the Antarctic Voyage* with the publication of the *Flora Novae-Zelandiae* and the *Flora Tasmaniae*. A good deal of the systematic work may have been done before he started on his Indian journey. We have already dealt with the three volumes of the *Antarctic Voyage* from several points of view and only refer to them here because of the chronology of their publication.

There was published in 1855 Volume 1 (the only volume to appear) of the *Flora Indica* by J. D. Hooker and T. Thomson. The Introductory Essay of 280 pages has been referred to (p. 79) because of its value in placing on record what were at that date 'diplomatic' rather than advanced views on the nature of 'species', with some suggestions verging on natural selection. This essay also included a rather elaborate sketch of the 'Physical Features and Vegetation of the Provinces of India'. In this account 'India' covers the whole area from Afghanistan and Tibet to Ceylon and the whole of the Malay Peninsula —from 36° N. to the Equator and from 62° to 105° E., an area of little less than two millions of square miles of land surface.

Hooker and Thomson note that there are very few natural orders (families, in the modern sense) peculiar to India. Their estimate of 12,000 to 15,000 species of seed-bearing plants for 'India' is very conservative and is partly due to the taking of a very wide delimitation for species. Hooker, frequently and frankly acknowledged that he was a 'lumper'. The tropical forests of India may be

divided into those in perennially humid districts and those in areas of contrasted seasons of summer rain and winter drought. The former are characterized by the prevalence of ferns, and, below 5,000-7,000 feet, by the immense numbers of epiphytic orchids, aroids, and members of the ginger family. There are also many palms and species of the ivy, pepper, fig, nutmeg, and other families. The number of species is far higher than in drier forests. These latter have palms, cycads, etc. only locally, but contain many leguminous trees and members of the cotton tree, *Combretum*, vervain, and many other families.

The transition from tropical to temperate flora is more rapid in ascending above the level of the plains than in advancing northwards at the same level, that is, altitudinal zones are transversely less extensive than are horizontal ones. The change in vegetation in a few thousand feet of ascent is much greater than in as many degrees of latitude as would compensate for the decrease of temperature in that ascent. In the Himalaya the truly temperate vegetation supersedes the subtropical above 4,000-6,000 feet, and the elevation at which this change takes place corresponds roughly with that at which the winter is marked by an annual fall of snow. The Arctic-Alpine flora commences above the limit of trees and hardly reaches its extreme upper limit at 18,500 feet. In the Himalaya it contains many genera characteristic of the north temperate and Polar regions but has many peculiar features. Thus there is a comparative paucity of cryptogams and the flora is especially poor in mosses of tall and luxuriant growth.

The 'geographical alliances or affinities' of the Indian flora are considered under the groupings: Australian type, Malay Archipelago type, China and Japan type, Siberian type, European type, Egyptian type, and Tropical African type. 'India' is divided by the authors into four

primary divisions: (1) Hindostan, in the widest sense of that term, including the whole Western (Madras) Peninsula, and the Gangetic plain to the base of the Himalaya; (2) the Himalaya; (3) Eastern India (India ultra Gangem), including Burma and the Malay Peninsula; (4) Afghanistan. Hindostan is further divided into eighteen provinces the Himalaya into sixteen (and Tibet into nine), and Eastern India into nine. The more one reads and considers this essay on the plant geography of India the more one appreciates the depth of knowledge and the width of experience involved in its preparation. It formed a basis for Hooker's *A Sketch of the Flora of British India* (1907) which is referred to later.

Hooker was appointed in 1854 to examine in botany the candidates for the medical service under the East India Company. He was already examiner to the Apothecaries Company. In letters to botanical friends he makes many criticisms of teaching methods, lecture courses, and botanical textbooks. He insists on the need for candidates to know perfectly the definition of terms employed. One piece of advice to teachers in reference to students of botany might serve as a text for a long discussion in modern terms. It runs:

> and in conclusion din for ever into their ears that the principal Nat. Ords., properly studied and rightly understood, are the exponents of all branches of Botany, embrace a knowledge of all, are the application of the results of all to practice, and are synonymous with 'Botany' in its highest significance.

Hooker emphasized again and again the need for students to know their plants at first hand.

About this period too Hooker was much engaged in arranging the affairs of the Linnean Society of London, especially with regard to its publications. His correspondence with scientists and non-scientists was extensive.

One has to remember that typewriters, shorthand secretaries, Dictaphones, and other modern secretarial devices were not then in existence and that every letter and every report or article for publication had to be written in longhand and often similarly duplicated. A great deal of his time was spent over matters concerning the economic botany of tropical plants such as cinchona (for quinine), rubber, etc.

We have already outlined Hooker's travels in the Southern Hemisphere and in India. He never visited the Arctic regions but had worked intensively on many of the collections made in various parts within the Arctic Circle in the first half of the nineteenth century and now at Kew. The results of his studies were summarized in an important paper under the title 'Outlines of the distribution of Arctic plants' and published in *Transactions of the Linnean Society of London*, vol. 23 (1862), and partly reprinted in an abridged form in *Admiralty Arctic Manual* (London 1875).

Apparently Hooker defined 'the Arctic' very definitely by the Arctic Circle; at least the map accompanying his paper suggests this, as does the sentence 'The arctic flora forms a circumpolar belt of 10° to 14° latitude, north of the arctic circle.' Hooker of course knew at first hand more about the 'Antarctic' flora than did any botanist living at that time. The contrast between the Arctic and the Antarctic in matters botanical is very great in correlation with the much more severe environment in the latter, and also with the proportions and arrangements of land and sea both beyond 66½° N. and 66½° S. and the areas approximating to these parallels of latitude. The flora within the Antarctic Circle is very poor, with 3 species of flowering plants now known, while within the Arctic Circle Hooker estimated the flora to consist of 762 species of phanerogams (214 monocotyledons, 548 dicotyledons

—gymnosperms being included with the dicotyledons) and 925 species of cryptogams.

He found the Arctic flora, regarded as a whole, to be decidedly Scandinavian, for 'Arctic Scandinavia, or Lapland, though a very small tract of land, contains by far the richest arctic flora, amounting to three-fourths of the whole.' Of the 762 species of seed-bearing plants 616 are Arctic European. In his view the Scandinavian flora is the flora *par excellence* of the Arctic region both in number of species and in antiquity, and he agrees with Darwin first

> that previous to the glacial epoch it was more uniformly distributed over the polar zone than it is now; secondly, that during the advent of the glacial period this Scandinavian vegetation was driven southward in every longitude, and even across the tropics into the south temperate zone; and that on the succeeding warmth of the present epoch, those species that survived both ascended the mountains of the warmer zones, and also returned northward, accompanied by aborigines of the countries they had invaded during their southern migration.

He says that 8 species (and 1 genus) of phanerogams are wholly confined to the Arctic while all the rest extend southwards, some even into the south temperate zone. He makes a very full and careful analysis of Arctic plants by groupings, tabulations, and 'observations on the species'.

The Arctic region is divided by him into five districts: Arctic Europe, Arctic Asia, Arctic West America, Arctic East America (excluding Greenland), and Arctic Greenland. These are considered separately and their botanical characters and peculiarities clearly analysed. One may mention in particular that he emphasizes the European, not American, affinities of the flora of Greenland. He remarks that he shows 'how little mutual dependence there is amongst the arctic florules. Each has profited but little through contiguity with its coter-

minous districts; though all bear the impress of being members of one northern flora.'

Hooker's paper was a bold first attempt to analyze the flora of the Arctic regions. Some of his conclusions have stood the test of more recent work but others have been very much modified by subsequent investigators. Hooker's essay is essentially floristic and not ecological and he does not discuss in detail the environmental factors limiting ranges and communities. He demarcates the southern limit of the Arctic as a botanical region by the Arctic Circle but most modern authors take the southern boundary as the tree limit, although there is not complete agreement where this is in some areas. Hooker's views were also much influenced by his bias in favour of the 'Scandinavian flora' as dominant in the flora of the Arctic. There has been a great deal of research since 1862 not only on the taxonomy of Arctic plants but also on their ecology and cytogenetics. Nevertheless there are many hypotheses that still await confirmation or refutation regarding the history of the Arctic flora, such as those involving possible Polar migrations and continental wanderings.

In the autumn of 1860, with Daniel Hanbury, Hooker spent about two months in the Nearer East, visiting Palestine and Syria. No full account of this journey was published but various papers were written connected with it. One was 'On the cedars of Lebanon, Taurus, Algeria, and India', in the *Natural History Review*, vol. 2 (1862). In this he describes the grove of *Cedrus libani* in the Kadisha valley at 6,000 feet (1,829 metres). The cedars were growing on a moraine immediately bordering a stream and nowhere else. They formed 'one group, about 400 yards in diameter, with an outstanding tree, or two, not far from the rest, and appear as a black speck in the area of the corry and its moraines, which contain no

other arboreous vegetation, nor any shrubs, but a few small barberry and rose bushes, that form no feature in the landscape'. The trees numbered about four hundred and were disposed in nine groups. They were of various sizes but no tree was of less than 18 inches girth and no young trees, bushes, or even seedlings of a second year's growth were found. From annual rings in a branch he calculated that the youngest trees averaged 100 years and the oldest 2,500 years old, 'both estimates no doubt widely far from the mark'. He doubted if cedar forests were ever extensive on the Lebanon, though there was no doubt that the grove had within the historic period 'increased and diminished in extent, owing to secular changes in climate'. The notes and exact measurements made by Hooker of the different cedar trees of the Kadisha grove were given in *Woods and Forests* for 7 May 1884. A statement was published in *Timber Trades Journal*, September 1920, that the cedar trees of the Kadisha grove were almost totally destroyed by the Turks during the 1914–18 war, the timber being used as fuel for the Palestine railway. Davis reported in 1947 that the stand was reduced to a hundred trees.

His visit to the Lebanon increased Hooker's interest in the cedars. He recognized in the genus *Cedrus* three 'well-marked forms, which are usually very distinct, but which graduate into one another'. These three 'kinds' of cedars, whatever taxonomic rank be given to them, are the Atlas or Atlantic cedar (*Cedrus atlantica*, if regarded as a species), the cedar of Lebanon (*C. libani*) extending into the Taurus range of Asia Minor, and the Himalayan cedar or deodar (*C. deodara*). The Cyprus cedar (*C. brevifolia*) is now generally accepted as a fourth 'kind'. There is no doubt that the four kinds of cedar are morphologically very closely related to one another, and occasional trees of unknown wild origin found in cultivation are

difficult to determine, but usually there are differences of vegetative and reproductive parts that are well correlated and quite sufficient for determination. The four kinds are now geographically isolated in their natural wild ranges and the evidence is that the isolation is of fairly long standing, though the comparative history of the cedars in the areas they now occupy is still a matter of some controversy.

The Lebanon cedar was first introduced into cultivation in Great Britain between 1670 and 1680, the deodar in 1831, and the Atlantic cedar in 1845. Various horticultural varieties of all three are recognized. The Cyprus cedar, from the mountains of Cyprus, is structurally close to the Lebanon cedar but is dwarfer in habit and has shorter leaves and smaller cones. It was introduced into cultivation in 1879 but is not so common in gardens as the other three.

An interesting paper by Hooker, 'On three oaks of Palestine', in the *Transactions of the Linnean Society of London*, vol. 23 (1862), is essentially taxonomic but contains references to his own field experiences. The most abundant tree throughout Syria and Palestine is the oak referred to by Hooker as *Quercus pseudo-coccifera*, which more often occurs in the form of brushwood or scrub than as a tall tree. Its destruction, and for many areas complete extermination, is such that even the roots are dug up for fuel. Hooker says, 'We saw but few very good trees, one of which is the famous oak of Mamre, called "Abraham's Oak" . . . and I saw other good ones at Anturah on the Lebanon.'

In Smith's *Dictionary of the Bible* (1863), and in a series of later editions, the account of the botany of Syria and Palestine was prepared by Hooker. This is an excellent summary of what was then known of the flora and vegetation of the area and is evidently based on his own

field investigations. Three main phytogeographical divisions are recognized: (1) Western Syria and Palestine, (2) Eastern Syria and Palestine, and (3) Middle and Upper Mountain Regions of Syria. The plant life of these divisions is described in very clear language, and the contrasts between the vegetation of the desert parts, the rocky mountains, the Jordan valley, and the vicinity of the Dead Sea are particularly vividly outlined.

When Sir William Hooker became Director of the Royal Botanic Gardens, Kew, not only were the Gardens small and in poor condition but there were no herbarium or museum collections and no libraries there. He brought with him from Glasgow to Kew his own rich collections of dried specimens and of botanical books, and these were used freely by many botanists. In 1853 Miss E. Bromfield presented to Kew the herbarium and library of her late brother Dr W. Arnold Bromfield, and these formed the first official nucleus of the Kew Herbarium and Library. George Bentham gave his valuable collections in 1854 to be added to these and in 1861 the Government purchased those of Sir William Hooker. Both the Herbarium and Library rapidly grew, and the former now contains well over 6,000,000 specimens and the latter over 55,000 bound volumes. Further details of the collections are given by Turrill (1959).

This last paragraph is to introduce George Bentham, who was born at Stoke, Plymouth on 22 September 1800. He early became interested in botany and collected many plants during continental tours. He commenced work on a British flora for beginners in 1853 and this was published in 1858. A seventh edition (revised by A. B. Rendle and following others revised by J. D. Hooker) appeared in 1924. After presenting his collections, of about 103,000 sheets representing 50,000 to 60,000 species, to Kew, Bentham settled in the village, and his great botanical

works, including the *Flora Australiensis* in seven volumes, were prepared at Kew. He died on 10 September 1884, within a fortnight of completing his eighty-fourth year. Many details of his life and botanical activities are given by B. Daydon Jackson (1906) in a biography of Bentham. He was one of Kew's best friends. It is worth mention that he kept a regular diary for over seventy years, a feat of personal recording that cannot often have been equalled or exceeded. He was a prodigious worker. He purchased a famous gold pen in 1856 with which he wrote most of his manuscripts. The story is that a fortnight before his death the points of the nib became crossed and he took this as a sign that his work was done. The pen is preserved in the Herbarium at Kew.

Students of botany in Great Britain become familiar with the names 'Bentham and Hooker' early in their studies, if they have been properly brought up. This is partly because of the *British Flora* (prepared originally by Bentham and revised by Hooker) and partly because of the system of classification of seed-bearing plants in the great work *Genera Plantarum* published under their joint names. Each of them had felt the need for a work that should bring together the mass of scattered information on the gross structure of seed-bearing plants in a systematic order down to the hierarchical level of genera. They agreed to prepare such a work and to divide its preparation on the basis of orders (families in the modern terminology of plant taxonomy) or groups of such. This was a gigantic undertaking and only a working taxonomist with experience and with knowledge of the conditions of botany a century ago can realize what was involved. The full title given to the work was *Genera Plantarum ad exemplaria imprimis in herbariis kewensibus servata definita* and it was written entirely in Latin. The Rev. Miles Joseph Berkeley (1803-89), an amateur botanist noted

especially for his researches on fungi and algae, and a classical scholar, checked the latinity of the work. The dates of appearance of the separate parts of this most important contribution to botanical taxonomy are as follows:

Volume 1 (1,040 + xv pp.)
Pars 1, 7 August 1862; Pars 2, 19 October 1865; Pars 3, September 1867
Volume 2 (1,279 + viii pp.)
Pars 1, 7-9 April 1873; Pars 2, May 1876
Volume 3 (1,258 + xi pp.)
Pars 1, 7 February 1880; Pars 2, 14 April 1883

George Bentham, it has to be remembered, was a worker of independent means with no official post. Hooker was Assistant Director and later Director of the Royal Botanic Gardens, Kew during the period of the preparation of the *Genera Plantarum*. It was therefore inevitable that the greater part of the preparation of the *Genera Plantarum* should fall to Bentham. The following summary tabulation indicates the shares of each author and is based on Bentham's published details (Bentham, 1883):

	Families	*Pages*	*Words (estimates)*
Bentham	123	2,399	1,199,500
Hooker	76	951	475,500
Jointly	1	13	6,500
Totals	200	3,363	1,681,500

Addenda, corrigenda, indexes, and a conspectus for every volume have not been included in the last two columns. These would add over 200 pages. Besides less voluminous works of many kinds during the period (1862-83) of the publication of the *Genera Plantarum*,

Bentham published and largely prepared his *Flora Australiensis* (1863-78) and Hooker a large part of his *Flora of British India* (1875-97). Hooker also had an enormous number of official and semi-official duties to carry out.

It was planned that the *Genera Plantarum* should provide good clear descriptions of all the families and genera of seed-bearing plants then known and accepted as such by the authors, quoting also all known names regarded as synonyms, often with comments. The sequence of families was, with considerable modifications, that of de Candolle.

Classifications of plants may be roughly divided into those that are frankly artificial and those that claim to be natural. The former are based on a limited number of more or less arbitrarily chosen characters, while the latter in theory take into consideration all known characters. It is usually assumed that natural classifications reflect, at least in some degree, the course of evolution and the groups (taxa) are spoken of as 'lower' or 'higher', and some such classifications claim to be phylogenetic, which presumably means that they indicate the origin of 'phyla'. It would be better perhaps to say they are supposed to be taxogenetic, indicating the origin of the taxa recognized and classified. Bentham and Hooker's classification is natural, in contrast for example with that of Linnaeus, but its authors made no extravagant claims that it was phylogenetic or was based on phylogeny. Hooker, as we have seen, was by 1862 a convert to evolutionary theory. Bentham was much slower in accepting Darwinian views, and the classification of orders (families) for the *Genera Plantarum* was settled probably before 1858. Hooker, in a letter to Dr E. N. Arber in 1907, said that he held 'to Robert Brown's view of the orders being reticulately not lineally related'. This point of view is certainly a true one

in the sense of morphological relationship, whatever may be the genetical and phylogenetical explanations, and moreover is true at other levels than that of families. It means that a single lineal sequence of taxa is impossible within the limits of a natural classification, without arbitrary (or convenient) breaks.

The *Genera Plantarum* is concerned with seed-bearing plants only. The main divisions of these are given as:

Dicotyledones Polypetalae (usually referred to as the Polypetalae)
  Series Thalamiflorae, Disciflorae, and Calyciflorae
Dicotyledones Gamopetalae (the Gamopetalae)
  Series Inferae, Heteromerae, and Bicarpellatae
Dicotyledones Monochlamydeae (divided into 8 series)
Gymnospermae
Monocotyledones (divided into 7 series)

We notice that the gymnosperms are kept distinct from both the dicotyledons and from the monocotyledons and placed between them. It is probable that this in part reflects Hooker's views, to which we have already referred, now held to be quite incorrect, that the gymnosperms, and in particular the conifers, were the highest-developed existing group of plants and were related to the dicotyledons by having secondary thickening. Those who still use the Bentham and Hooker system of classification nearly always modify it by removing the gymnosperms from the anomalous position between the dicotyledons and monocotyledons.

The group of dicotyledons termed the Monochlamydeae (or sometimes the Incompletae) is a hotchpotch of families of varied relationships morphologically and presumably genetically, but designated by having flowers with a simple perianth not separable into calyx and corolla or with no perianth. Some of the families thus

placed can now be more or less clearly associated with others in the Polypetalae on the basis of the sum total of their characters, but there remain some whose best position is still a matter of doubt and controversy. On the whole the sequence of families in the *Genera Plantarum* has much to recommend it and it is still widely used for British and other floras. Indeed one may say that some of the proposed modifications of it have little to recommend them.

Apart from the actual classification, the descriptions of families and genera are by and large the best that have been prepared on this scale. Their special features are accuracy, clarity, conciseness, regularity, and, within the limits of gross morphology, completeness. One has only carefully to compare the descriptions with those of other systematists to realize the debt taxonomists working on the seed-bearing plants owe to Bentham and Hooker. Either the descriptive matter of the *Genera Plantarum* is at once obvious or it is evident that it has been used for preparing the 'new' descriptions. It is only in the absence of illustrations, especially of black-and-white analyses, that one can find reasonable cause for a general criticism, but as the work is one intended mainly for the professional taxonomist this criticism is less important than it would be in a student's textbook for schools or colleges.

By modern standards both Bentham and Hooker were 'lumpers' rather than 'splitters', that is, they took a wide view of taxa, whether species, genera, or families. It is probable that, while the splitting into two or more of some of the genera and families as recognized in the *Genera Plantarum* is essential on the basis of modern knowledge in order best to compare taxa one with another and to express degrees of similarity and dissimilarity, many modern authors have gone to excess in separating what can only be regarded as micro-species,

micro-genera, and micro-families and regarding them as full species, genera, and families respectively, since they are distinguishable at most by criteria of doubtful taxonomic value at the level claimed.

As an example of Hooker's monographic works we may briefly notice his famous paper 'On *Welwitschia*, a new genus of the Gnetaceae' (published in *Trans. Linn. Soc.*, vol. 24 (1863), with fourteen plates). This remarkable genus of one species, which Hooker named *Welwitschia mirabilis* but which now, owing to peculiarities of modern plant nomenclature, should apparently be called *Welwitschia bainesii*, grows in Angola and South-West Africa, in dry desert country. Hooker obtained good material from Dr F. Welwitsch, the renowned botanical explorer of Angola, and from Mr Thomas Baines. It is now known that the species is not so rare as it was at one time thought to be, and its range extends from the Namib region from north of Sandfisch Bay (23½° S.) to the northern boundary of South-West Africa and is continued thence along the low coastal belt of Angola to south of Mossamedes (15½° S.). The plates published by Hooker, 'del. W. Fitch, J. D. H., and D. Oliver and W. Fitch lith.', strikingly portray the habit, morphology, and various detailed analyses of this strange plant, which is believed to grow for a century or more. The stout stem, projecting little above the level of the soil and with a two-lobed form, narrows down into a strong tap-root. At the edges of the two lobes are grooves from each of which springs a leaf. These leaves are the first and only pair, after the seed-leaves, and they go on growing at the base, wearing away at the tips and becoming torn often to the base. The stem continues to grow in thickness and shows concentric grooves on the top surface. In the outer (younger) of these grooves there arise panicles of small spikes, covered by bracts which become bright red after fertilization. The

plants are dioecious and flowers are produced annually. The male flowers have two plus two perianth leaves, six stamens which are united below and have trilocular anthers, and there is a central rudimentary gynoecium (female structure). The female flowers have the perianth parts fused into a tube and show no trace of stamens. There is one erect ovule with an integument drawn out beyond it. The seed remains enclosed in the perianth, which becomes winged.

Hooker placed the genus in the family Gnetaceae but it is now usual to put the genera *Welwitschia* and *Ephedra* into separate families of their own and separate from Gnetaceae, which is retained for the one genus *Gnetum*. However the three families are still retained in the class Gnetales, one of whose many features of special botanical interest is its possible relationship to the flowering plants proper, or angiosperms, though they are generally considered gymnosperms and are thus linked on to pines, cycads, etc. *Welwitschia* has been grown at Kew and elsewhere in this country as young plants, but it is difficult to maintain in cultivation. In South Africa it has been grown in drain-pipes in a mixture of weathered granite and leaf-mould, and it has flowered under these conditions. A more modern account of the plant, by one who knew it in the wild, is found in Pearson (1929).

In 1864 there appeared the first part of Hooker's *Handbook of the New Zealand Flora*, of octavo size with 392 + lxviii pages. This first part deals with vascular plants. The second part, dealing with the various groups of non-flowering plants other than the vascular cryptogams, was published in 1867 and contained pages 393-798. We have seen above how Hooker published the *Flora Novae-Zelandiae* in 1853-5 as the second volume of the *Botany of the Antarctic Voyage*, and this gave him a firm basis for the *Handbook*. In this the descriptions are in English and there

are references to relevant literature, ranges, and other details as well as keys to families, genera, and species. In the second part, dealing with mosses, liverworts, algae, lichens, and fungi, Hooker received help from various specialists but apparently wrote the account of the groups himself. There are no illustrations in either part.

Chapter 7

Director at Kew: Administration and Improvement

Sir William Jackson Hooker died on 12 August 1865 after four days' illness. His son, Joseph Dalton Hooker, was appointed Director of the Royal Botanic Gardens, Kew on 1 November 1865 in succession to his father. He had been Assistant Director for a decade and was therefore perfectly familiar with the work done at Kew, with the lay-out of the Gardens, and with the researches centred on the Herbarium and Library. He brought great enthusiasm to the directing and improving of the Gardens. In particular he arranged for a new range of greenhouses to be built and for a new system of heating in the twenty-five houses and three museums. His correspondence was enormous and was continually increasing with his being called upon by the Government, institutions of various kinds, and numerous individuals, to answer questions on a diversity of topics and to prepare reports on a wide range of subjects. He pithily says, in a letter to Asa Gray, 'Knowledge is power—till it becomes over-powering.' It appears advisable to consider his own botanical work and researches during the period of his directorship in a separate chapter.

On the appointment of Sir William Hooker in 1841 as the first Director of the Royal Botanic Gardens, Kew as a Government institution, its control in relation to the

British Government was placed under the Commissioners of Woods and Forests. The Government department of Woods and Forests was split up in 1850. The (Old) Deer Park was retained by Woods and Forests, but the Botanic Garden and Pleasure Grounds of Kew were transferred to the new Government department, the Board of Works and Public Buildings. The Royal Botanic Gardens, Kew (the areas eventually fully amalgamated) remained under the Board of Works until 31 March 1903, when they were transferred to the Board of Agriculture and Fisheries (now the Ministry of Agriculture, Fisheries, and Food). Thus throughout the period of Joseph Hooker's directorship he was immediately responsible to the First Commissioner of Works.

From 1870 to 1872 he was engaged in a bitter and largely personal conflict with Acton Smee Ayrton, who was First Commissioner of Works in Gladstone's Government. There is a large volume of correspondence, reports, etc. at Kew dealing with the 'Ayrton Episode'. It would appear that Ayrton was overbearing, tactless, and in some ways unscrupulous, besides giving signs of being anti-scientific and desirous of turning Kew into nothing more than a public park and recreation ground. He certainly did his best to drive Hooker to resign by a series of stupid interferences, approaching subordinates behind the Director's back, refusing explanations for his behaviour, and generally making it as difficult as possible for the Director to carry out his duties. Some of the incidents recorded are relatively trivial—pages and pages of correspondence regarding a defective water pipe in one of the houses, for example.

Finally the matter became a political one of some considerable importance, with Hooker asking to be put in communication with Gladstone's private secretary, Mr (later Sir) Algernon West. The Government admitted

the essential justice of Hooker's complaints by some attempts to release him from Ayrton's control, but desired to smooth the matter over. A full statement was drawn up over the signatures of prominent scientists, including Lyell, Darwin, Bentham, Huxley, and Tyndall amongst others, outlining the history of Kew, its debt to the Hookers, and the overbearing acts of Ayrton. This was laid before Parliament by Sir John Lubbock and the matter began to be discussed in the public press. There was further correspondence, and additional papers were presented to the House of Lords in which the Treasury plainly supported Hooker and criticized Ayrton's behaviour.

One most objectionable feature was the publication of an official report on Kew and its management which had never been submitted to the Director for comment or answer. Ayrton had caused this to be written by Sir Richard Owen. We have already referred to Owen as Superintendent of the Natural History departments of the British Museum and a strong opponent of Darwin. We suggested that while there were no doubt several explanations or causes of Owen's hostility to Darwin and to Hooker, the desire of Owen to close down Kew as a scientific institution or else to have Kew placed under his charge as an offshoot of the British Museum was probably one of them. It may well be that for a long-term policy a close association of the British Museum and Kew as regards scientific research and linkage with the Government, especially the Treasury for finance, could have produced results of great benefit all round. It was the stupid and at times cruel method of attack on Hooker that was indefensible. In the memorandum included in the report officially published was an attack on the late Sir William Hooker which properly aroused his son's anger, and he insisted in adding to the parliamentary papers a full and dignified reply.

Ayrton's attack on Hooker and Kew overreached itself. A debate took place on the matter in the House of Commons and in this debate a speech by Sir John Lubbock was effective in its studied moderation and was backed by the Treasury's official rebuke to Ayrton mentioned above. Ayrton's reply was to the effect that he had not injured Hooker, who was too low an official to have a right to raise questions of matter with a Minister of the Crown. Gladstone wound up the debate without the House expressing its opinion on what it had heard. The opposition between Ayrton and Hooker continued, though less openly and less vigorously, and indeed in the form of a truce, till Gladstone in August 1874 transferred Ayrton from the Board of Works to the resuscitated office of Judge-Advocate-General. Gladstone's Ministry resigned in 1874 and Ayrton failed after two attempts to secure re-election to Parliament.

The main lay-out of the Royal Botanic Gardens, Kew as we know them today was due to Sir William Hooker and the landscape gardener, W. A. Nesfield, whom he employed to advise on the re-planning of the old Pleasure Grounds. This of course does not mean that there have been no changes or alterations carried out by later Directors. Kew was not from its origin, and is not now, static. Various improvements were made by Joseph Hooker and it is convenient to mention here a few of those affecting the Gardens proper and the living collections.

It was particularly in the Arboretum department that he made important changes. The growing of trees for purposes of amenity, as in gardens, public parks, streets, etc. is termed arboriculture, as distinct from the growing of trees as a crop (silviculture or forestry). The aim at Kew in growing trees is at least twofold: to have as complete a collection of different kinds as possible, as

befits a botanic garden, and to beautify the Gardens for public pleasure. The whole of Kew Gardens is on the old flood plain of the river Thames and the subsoil is made up of sands and gravels with bands of clay in places. This terrain gives a surface soil that is generally well drained and light to work but one that is poor in nutrients, is acid in reaction, and quickly dries out in hot weather. In addition Kew is well within the area of Thames fogs and London smogs, and the latter can do great harm to herbaceous plants in the greenhouses and to many evergreen trees and shrubs in the open. Apart from these local difficulties for gardeners one has to remember that trees do not last for ever, and diseased or damaged specimens have to be removed as a safeguard to the public and to maintain the standard of cultivation. Moreover space has constantly to be found for new introductions. Gardeners like farmers have to plan ahead. What will the tree, planted as a small sapling, look like in such and such a position in twenty, fifty, or a hundred years' time? That is a question all arboriculturists have to consider when they plant a tree as an individual or as one of a group or avenue.

One of the satisfying features of the landscape at Kew is the variation in views. Unlike some gardens Kew is flat apart from minor depressions and elevations of artificial origin. The variation has been largely achieved by the careful planning, controlled or directed by the Hookers, of trees as clumps or in lines to form avenues or vistas. The most striking of these is the Syon Vista formed in 1851 by Sir William Hooker, but his son added a number which still remain as important landmarks.

According to the Kew Report for 1867 it was in January of that year that frost and snowstorms destroyed many of the oldest trees in the Gardens, and a long list of losses and of damaged trees and shrubs is given. This meant

considerable clearance and gave Joseph Hooker the chance of extensive re-planning and re-planting.

The Thorn or Hawthorn Avenue dates from 1868 and is composed of species of hawthorn (*Crataegus*) and of crabs and their allies (*Malus, Pyrus, Sorbus*). It is particularly beautiful in spring and again in autumn with the variety of shapes, sizes, and colours of the fruits. An important avenue is the Cedar Avenue (1871) connecting the Syon Vista with the Pagoda Vista and planted on each side with Atlas cedars (*Cedrus atlantica*). In 1874 the Holly Walk was planted on each side with varieties of holly and is probably one of the most complete collections of such in any garden open to the public. The long straight Holly Walk follows a portion of the old Love Lane, which was a right of way giving the inhabitants of Richmond an almost direct route from Richmond Green to Brentford Ferry—an important matter before the building of the first Kew Bridge in 1758-9. George III obtained powers from Parliament to close Love Lane in 1765, though according to local tradition Love Lane did not entirely disappear so far as the public was concerned until 1802. The hollies as planted by Joseph Hooker continue to flourish and the collection makes a most interesting subject for the study of variations, the more so that it is especially attractive in the winter months. The shorter Chestnut, or Sweet Chestnut, Avenue, running parallel with the western end of Syon Vista, was planted in 1880. The trees (*Castanea sativa*, in many and sometimes strange varieties) are unlike the cedars and hollies, deciduous, but they flourish on an acid well-drained soil. The small valley known as the Berberis Dell was originally a gravel pit. A proposal for its planting was considered in 1869 but more gravel was removed and it was not till 1876 that the surface was prepared and the area planted. A small pond, which had botanically interesting contents,

including the water liverwort (*Riccia fluitans*), formerly occupied a portion of the lower part but has now been filled in.

Hooker's major improvement in the Arboretum portion of the Gardens was the planning and planting of the new Pinetum. The conifers constitute the major living group of the gymnosperms. In Hooker's time the conifers were retained as one large family (or natural order), the Coniferae, not all members of which had 'cones'. Nowadays it is usual to recognize several families in place of the old Coniferae. However the term 'conifers' *sensu lato* still has its uses, and amongst the genera thus lumped together is the genus of the pines (*Pinus*), which is the largest in number of known species and probably the best-known to many people. It became usual to refer to a collection of conifers grown for arboricultural purposes as a pinetum. A Latin title Pinetum was used by J. Forbes in 'Pinetum woburnense; or a catalogue of coniferous plants, in the collection of the Duke of Bedford at Woburn Abbey. Introduction by John Russell, 6th Duke' (London, 1839), and in the Preface to this work Pinetum is used as an adopted English word contrasting with Arboretum. It was also used in a copy of a letter addressed to Dawson Turner Esq. F.R.A. and L.S. &c &c on the occasion of the death of The Late Duke of Bedford, (1840), and by P. J. Selby, *British Forest Trees* (1842).

The first Pinetum at Kew was formed at the northern end of the Gardens about 1843, but few of the original trees of this now remain. The present Pinetum was planned by Joseph Hooker and was planted in 1871-2. It contains representatives of many of the genera and species of conifers and runs along the south side and west end of the Lake and then between Cedar Vista and the Queen's Cottage grounds. There are in the collection many interesting trees, but because of the nature of the

soil and atmospheric pollution, conifers generally speaking do not flourish at Kew, and since 1924 a new 'Pinetum' has been built up at Bedgebury in Kent under the joint auspices of the Royal Botanic Gardens, Kew and the Forestry Commission. There are now about 500 species and varieties of conifers grown at Bedgebury (apart from other trees). However the Pinetum at Kew remains an important part of the Gardens and is particularly valuable to students wishing to study the gross morphological features of many of the genera of this varied and interesting group of plants. The majority of the species are evergreen, the larches, swamp cypress (*Taxodium distichum*), and *Metasequoia* being exceptional in that they are bare of foliage in the winter. Examples of less hardy conifers are grown in the Temperate House.

Hooker was responsible for a number of structural improvements to the Gardens not, or not directly, concerned with planting. One of these concerned the water supply—a most important matter in horticulture. For many years the water supply centre for the Gardens had been near the present Cumberland Gate. Here in 1761 the famous engineer, John Smeaton (1724-92), who amongst other renowned activities rebuilt the Eddystone lighthouse and constructed various bridges, erected an engine to pump water from a well to supply the Gardens. It was worked by horse power and was apparently in use till 1850, when it was superseded by a steam engine. The pumping-station was removed to near Kew Palace in 1855 and water was probably drawn direct from the Thames but proved unsatisfactory.

Between 1866 and 1868 Hooker instituted a great change in the water system. Water was taken into the Lake from the Thames, pumped into filter beds near the stables (not now used as such), and thence to a reservoir in Richmond Park. From the park the water came back

to the Gardens under a good pressure. This arrangement continued for a long time, but in the drought of 1921 the water in the Lake became brackish and plants on which it was used, especially in the greenhouses, were killed or badly damaged. The general water supply for the Gardens has now been linked to the system of the Metropolitan Water Board, and Hooker's filter beds at Kew and the pumping to Richmond Park have been discarded. The distribution of the water supply throughout the Gardens has very recently been greatly improved and extended.

A new range of greenhouses, known as the T-range from its shape (now much changed by modifications and additions), was erected in 1868-9. The range was heated and otherwise made suitable for the cultivation of tropical plants, including tropical aquatics and orchids.

During Joseph Hooker's period as Director horses supplemented man-power and stables were an important part of Kew 'behind the scenes', there are no horses and no stables in use as such at Kew now. When he became Director the stables were near the pumping-station referred to above. They were removed in 1867 to the same yard as the new pumping-station and their removal enabled a new public entrance to the Gardens to be made from the Kew Road. This, named Cumberland Gate, was opened in 1869.

A year previously an entrance had been made from the Kew Road opposite the central doors of the Temperate House. This was the original of the Victoria Gate and it was so placed because it was expected that a station on the London and South Western Railway was to be built in the vicinity. The railway scheme was altered and in 1889 the gates and pillars were removed and the Victoria Gate as it now exists was erected near the tower or 'Campanile' opposite Kew Gardens Station, served by the District and North London routes. The Isleworth Ferry Gate was

opened in 1872. It gives access to and from the banks of the Thames near the southwest end of the Gardens. A drawbridge, lowered when the Gardens are open to the public, connects the towing-path and the Gardens over the Ha-ha.

A very large number of plants can only be grown at Kew in the protection of greenhouses. On the average the temperature conditions at Kew are suitable for most species from temperate climates, but even so there are many from warm temperate areas that cannot be grown out of doors at Kew as they can, or as satisfactorily and safely as they can, in the southwest of England, and of course subtropical and tropical plants require full protection throughout the year, with few exceptions. Hence Kew has a very large extent of glass. To add to Hooker's worries there was a heavy storm of hail on the morning of 3 August 1879. The hailstones are recorded to have averaged five inches in circumference and they wrecked the glass roofs of most of the greenhouses. Nearly 40,000 panes were smashed, and the weight of the broken glass amounted to eighteen tons. Some of the tropical plants suffered from cold and exposure but a grant of £7,000 was sanctioned by Parliament for repairs, and, a great many glaziers being set to work, the houses were made whole again before winter. It was not till the Second World War, with bombing from the air, that any comparable damage was done to the glass at Kew and even then it was more spread in time and limited to certain houses (see *Kew Bull.* (1946), 1).

A feature of many gardens nowadays is a 'rock garden' in which are grown plants from mountainous districts, and some from lowlands, requiring special care and attention. Mr George Curling Joad of Oakfield, Wimbledon, bequeathed in 1881 his entire collection of 'Alpine and herbaceous plants' to Kew. Hooker had long wished for a

rock garden and in 1881 a number of gentlemen interested in this branch of horticulture had addressed a memorial to the Government praying for the formation of one worthy of the Gardens. The acceptance of Mr Joad's bequest soon afterwards brought matters to a head and a grant of £500 was made by the Government for the purpose of constructing a Rock Garden, which remains in general form and extent a main portion of the present much enlarged structure. The money available for materials and construction was limited and several kinds of stone were used, including weathered Bath oolite, water-worn limestone from Cheddar cliffs, marble, and Portland oolite, amongst others. The plants bequeathed by Mr Joad amounted to 2,630, many of them being choice and rare species. The collection has since not only been maintained but has been added to very greatly with the considerable increase in area and with renewal of the rock-work of the Rock Garden.

In the decade 1870-9 some important additions were made to the buildings for scientific research at Kew, especially by the building of a wing onto the Herbarium and Hooker naturally had a major say in these matters. It is of interest to note that two of the buildings mentioned represent what in one sense may be termed the extremes of botany, or what were the extremes at that time. The Herbarium was concerned with plant taxonomy and the Laboratory was to be devoted to plant physiology and anatomy. The history of the Herbarium and Library may be briefly outlined first since we have already recorded their beginnings and they were to a very special degree the centre of Hooker's own researches.

Classification is an essential basis for all scientific studies and its degree of usefulness depends upon the care with which observations and recordings of criteria are selected and made. There has to be uniformity of treat-

Plate 13 (above) Cedar Avenue, Kew Gardens, planted during Joseph Hooker's directorship, and *Plate 14 (below)* the Marianne North Gallery, soon after it was built. It included a studio where artists could work, using living material from the gardens.

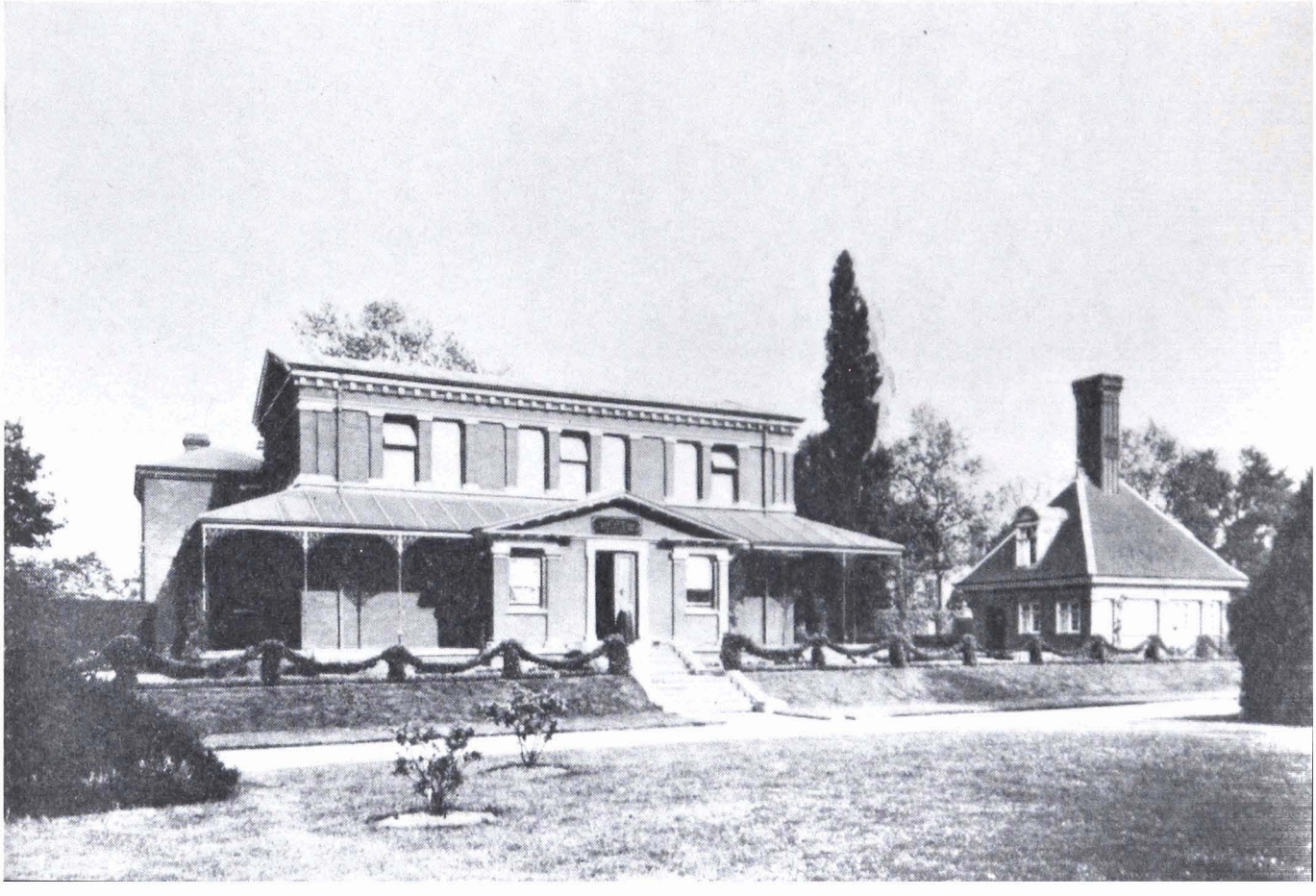


Plate 15 A photograph taken on the American expedition, showing the botanists' camp at La Veta, Colorado. Joseph Hooker is in the left of the picture, seated, with Asa Gray kneeling on the ground beside him.

ment in terminology, descriptive schemes, illustrations, etc. to the extent that accurate comparisons can be made between one individual and another and between one class and another. A grouping together of plants into classes on the basis of resemblances and differences is the essence of botanical classification. Such classes are nowadays being conveniently termed taxa, and include families, genera, species, and varieties, and biological classification resulting in the recognition of taxa is taxonomy. For purposes of comparison and revision permanent collections are essential. Botanic gardens contain living plants but cannot contain and maintain examples of all known taxa. Moreover comparisons have to be made of a wide range of individuals of one taxon and of samples of individuals at different stages of growth—vegetative, flowering, fruiting; in youth, at maturity, in old age; in spring, summer, autumn, winter.

There are various ways of preserving botanical specimens, with suitability depending on the group of plants concerned and the purposes for which the material is required. For many groups, including the flowering plants, dried specimens are largely adequate, when properly prepared and looked after by good curatorial methods, for many taxonomic purposes. One may indeed say that as complete a collection of such dried specimens as possible, forming what was once called a Hortus Siccus or dried garden, and now a herbarium, is an essential for taxonomic work. This remains true though modern research in plant taxonomy involves more than can be based solely on herbarium specimens. Since no-one who has not had training and experience in herbarium methods can appreciate what can be done with dried plant specimens, a few general remarks on this may be interpolated here, and it is appropriate to do this because, linked with his field researches, Joseph Hooker was a herbarium botanist,

although he was by no means restricted to studying dried specimens.

First, a large number of specimens, mounted on paper, can be stored in a small space. Secondly, the specimens can be arranged in covers, as a loose-leaved system so that additional sheets can be interpolated without upsetting the general arrangement. Thirdly, samples can illustrate life-history phases from seedling to fruiting and variations reflecting responses to different environmental conditions. Such samples are available at any season of the year for description or comparison. Fourthly, by treating the flowers etc. with water, especially by boiling them for a short time in water, details of structure can be distinguished on dissecting, often as clearly as if one were dealing with living specimens. A great many features of anatomy can also be determined under the compound microscope from dried material properly treated by modern methods. Fifthly, herbaria can be maintained for indefinite periods with special attention only to dryness and avoidance of insect attack. Lastly, in addition to their uses for taxonomic and phytogeographical researches, herbaria can be used for depositing voucher specimens of the taxa used in genetical, cytological, and other investigations.

At Kew the original nucleus of the Herbarium and Library block of buildings was known as Hunter's House which was purchased in 1818 by the Crown, at the suggestion of Sir Joseph Banks, with a view to utilizing it for a herbarium and library in connection with the Botanic Garden. Banks however died in 1820 and his project did not mature. From 1830 to 1851 the building was used as a residence by the Duchess of Cumberland and her husband, who became King of Hanover in 1837. He died in 1851, and in the following year the ground floor was granted to Sir William Hooker for the accommodation of his herbarium and library. In 1853 the official Herbarium

was commenced and grew rapidly by gift, exchange, and purchase. More of the old building was utilized but Joseph Hooker found it essential to arrange for additional building.

There was a considerable amount of trouble over the site, which was thought to be the private property of the Crown. Hooker, in a letter to Asa Gray dated 12 March 1876, writes:

> After a great deal of worry, lasting over nine months, the Herbarium building is in a fair way to commencing. The —— family, who had an eye to the ground and house, were bitterly opposed to it, and got over my present chief, who, after the Queen had given the site, continued throwing obstacles in the way. When Lo! by a stroke of luck, it turned out, when preparing for a legal transfer of the site, that the present Herb., House and grounds all belonged to us!—that old scamp, George IV., having sold it for £84,000 to pay his debts, in 1824!

The building completed by 1877 is the wing projecting north from the old block and now known as Wing C. Since then two other wings have been erected, in 1902 and 1931 respectively, and plans for another large building as a new library and additional herbarium accommodation have been prepared. In addition to the estimated number of sheets as 6-7 million and of books as over 55,000 volumes, there are large collections of drawings, specimens in spirit, fruits and seeds, maps, manuscripts, separates, and so on. The newer wings of the Herbarium were based on the plans of Joseph Hooker's 1877 wing, and the Herbarium and Library in this and in many other ways remain as a dynamic growing memorial to the Hookers as an integral part of the Gardens they loved and which they made in their present essentials and maintained over forty-four years.

Joseph Hooker was not a plant physiologist but he was well aware of the importance of physiology, anatomy, and

other subjects necessitating for their study a properly equipped laboratory. The Royal Commission on Scientific Instruction and the Advancement of Science, Fourth Report (1874), had stated, 'it is highly desirable that opportunities for the pursuit of investigations in Physiological Botany should be afforded at Kew to those persons who may be inclined to follow that branch of science'. Hooker persuaded his friend Thomas Jodrell Phillips Jodrell (1807-89) to build and equip at his own expense the Laboratory at the north end of the Herbaceous Ground which is known as the Jodrell Laboratory. The building was erected and equipped in 1876 and the cost to the donor is stated to have been £1,500. Enlargements and alterations were made at various dates afterwards and for nearly ninety years valuable researches in plant physiology, palaeobotany, anatomy, cytology, and other branches of botany requiring controlled laboratory experiments or the use of special microscopic techniques have been carried out there by members of the staff or visitors. Plans are now in hand for rebuilding the Laboratory in a much enlarged and modernized form. A concise history of the Jodrell Laboratory is given by Metcalfe (1942).

The entire collection of material relating to economic botany in the Indian Museum was transferred to Kew in 1880. The Museums of Economic Botany established by Sir William Hooker had to be modified to accommodate the additions. The east wing of No. 1 Museum was built in 1881, the India Office contributing £2,000 towards the cost.

Another valuable gift to Kew about this time was the fine collection of paintings, mostly of plants and vegetation, by Miss Marianne North. The oil paintings, 848 in number, were all painted by Miss North between 1872 and 1885, nearly all in countries overseas in the Northern and Southern Hemispheres, in the Old and New Worlds.

Not only did Miss North present this magnificent collection to the Royal Botanic Gardens, Kew, but she also gave the specially built gallery, and this, housing the collection, was opened to the public on 9 July 1882. Joseph Hooker wrote with appreciation in the preface to the first official guide to the North Gallery (now known as the Marianne North Gallery) that

> very many of the views here brought together represent vividly and truthfully scenes of astonishing interest and singularity, and objects that are among the wonders of the vegetable kingdom; and that these, though now accessible to travellers and familiar to readers of travels, are already disappeared or are doomed to disappear before the axe and the forest fires, the plough and the flock, of the ever advancing settler or colonist. Such scenes can never be renewed by nature, nor when once effaced can they be pictured to the mind's eye, except by means of such records as this lady has presented to us, and to posterity, which will thus have even more reason than we have to be grateful to her fortitude as a traveller, her talent and industry as an artist, and her liberality and public spirit.

The last period of Joseph Hooker's directorship of Kew involved much solid work. The general organization was continually being improved. The addition of new buildings has already been mentioned and the evidence of manuscript documents at Kew leaves no doubt that the planning and utilization of these involved much work for the Director. He did not merely give orders and then sit back till they were carried out. Details were considered personally and there was direct superintendence at all stages.

Hooker's own botanical investigations and publications while Director are described in the next chapter, but one project he initiated which was not completed till after his retirement, and by means of supplements still continues, must be referred to here. A scheme was drawn up for the preparation of the great *Index Kewensis* and work

was started under Hooker's direct supervision. It is true that the four quarto volumes of the original *Index Kewensis* were not published till 1892–5, but as its initiation dates from 1881 and owed a very great deal to Joseph Hooker some details should be given here.

It is somewhat difficult to give a precise account of its value in terms that could be appreciated by the non-specialist, including many botanists who are not 'working' taxonomists, and some preliminary considerations are essential. Plant names are accepted as valid if they accord with the International Code of Botanical Nomenclature. This code has evolved to its present condition in connection with international botanical congresses. Neither it nor any ancestor to it was in existence when the designation of plant taxa by Latin names started, or for a considerable time afterwards. Even now it is sometimes not easy to be certain of the valid name for a certain taxon, and anyhow taxonomists like anyone else sometimes make mistakes. The total result is a considerable number of redundant names in botanical literature, one taxon, say a species, may have synonyms additional to the valid name. A good many of these synonyms are, at the species level, due to different views as to the limits of genera or to advances in knowledge.

One of the guiding principles of plant nomenclature is priority of publication of a name. For this, an index to all published plant names, with the name of the author and the place of publication, is a necessity if additions to synonymy are to be avoided. For seed-bearing plants the generic names start from Linnaeus's *Genera Plantarum* (1735) and the specific names from his *Species Plantarum* (1753). For other groups of plants names start from works mostly published subsequently. Darwin had found the need for a complete index to names, and authors, of the genera and species of seed-bearing plants, with their

native countries given. Steudel's *Nomenclator* (1840) had partly fulfilled this function but was incomplete and by 1880 out of date. An interleaved copy of Steudel had been annotated at Kew, but the idea of preparing and publishing a new edition of the work, as originally proposed by Darwin, was finally abandoned. In its place a scheme drawn up by Hooker at the end of 1881 with the help of members of the Kew staff and Bentham was substituted, and was carried out in detail at Kew by B. Daydon Jackson, the Secretary of the Linnean Society.

For fourteen years the work proceeded under Hooker's supervision. In the completed work there is said to be a total of about 380,000 species names that were published between 1753 and 1885, with authors, references to place of publication, and country of origin. The specific epithets are arranged alphabetically under generic names, which are themselves in alphabetical sequence. In the original four volumes there are 2,500 pages with three columns per page. Hooker is said to have read and criticized all the proofs.

The *Index Kewensis* and its subsequent twelve supplements were published by the Clarendon Press, Oxford. The twelve supplements list a total of about 421,000 names of species under genera with references. In preparing the original *Index* a judgment was made as to the validity of the names, those accepted as valid being in roman and those considered to be synonyms in italics. This differentiation was finally dropped in Supplement 4 (1913) and in later supplements. A small number of other, mostly minor, improvements on the original scheme have been made, but in essence the usefulness of the *Index* as planned, mainly by Hooker, has so well stood the test of time that few changes have been found necessary

The *Index Kewensis* is an index and not an authority for the nomenclatural validity or botanical correctness of

application of names. Its value to working taxonomists is very great. Indeed one wonders how earlier botanists managed without it. At Kew an interleaved copy in loose-leaved bindings allows one to consult the names listed in the original and all published supplements in any one genus in the one alphabetical sequence of genera, and a card catalogue is kept up to date for the next supplement.

The cost of preparing the original work was met by funds allocated by the wish of Charles Darwin and his family (Charles Darwin died in April 1882). The exact wording of the printed official announcement on this is,

> The expense of preparing the work has been entirely defrayed by the members of the family of the late Charles Darwin. That of printing and publication has been borne by the Oxford Clarendon Press, which has no other means of recouping itself except by the sales of the work, *Kew Bull.* (1896), 29.

The compilers at the present time are official members of the Kew staff. A supplement is normally issued every five years, the last (Supplement 12) being published in 1959, covering the years 1951-5.

Chapter 8

Director at Kew: Researches and Publications

On the death of his father Joseph Hooker assumed the editorship of two important periodicals which had long been intimately although not officially associated with Kew, namely the *Botanical Magazine* and the *Icones Plantarum*. He continued the editorship of these throughout the period of his directorship and for some time after his retirement from Kew, and during that period wrote a large proportion of the text. Apart from his close connection with these two botanical serials they have much of general interest in their history and contents, and short accounts of them are therefore given.

The *Botanical Magazine* is the oldest botanical, and one of the oldest scientific, periodicals still being published. It was founded by William Curtis and the first part appeared on 1 February 1787. Curtis was born at Alton, Hampshire in 1746. His father was a tanner and a member of the Society of Friends. It is said that young William was introduced to the study of plants by an ostler, named Legg or Lagg, of an inn near his father's house. He was apprenticed to an apothecary in Pudding Lane, London, and shortly afterwards moved to Gracechurch Street to another apothecary whose business and property he afterwards inherited. He prepared and published the fine work *Flora Londinensis* but this botanical effort almost

ruined him. In contrast the *Botanical Magazine* was financially successful.

After Curtis's death the *Magazine* was edited by his friend Dr John Sims and later, till 1845, by a nephew and son-in-law, Samuel Curtis. The rights and property of the *Botanical Magazine* were acquired by Reeve Brothers (afterwards Lovell Reeve & Co.), and Sir William Hooker became editor in 1845. Since that date it has been intimately connected with Kew. After Sir William Hooker's death in 1865 Joseph Hooker became editor till 1904. For sixty years the two Hookers, father and son, edited the *Magazine* and themselves wrote much of the text. Later editors have been W. Thiselton-Dyer, D. Prain, O. Stapf, A. W. Hill, A. D. Cotton, and W. B. Turrill. In 1922 the publication of the *Botanical Magazine* was undertaken by the Royal Horticultural Society and the fellows of this great society are its owners and trustees of its traditions through the members of their Council. The paintings for the plates and the editing, as well as the preparation of most of the text, are however still carried out at Kew.

The *Botanical Magazine* consists of coloured illustrations of plants grown at Kew and in other gardens in this country, together with accompanying dissections, especially of flowers, fruits, and seeds, full taxonomic descriptions, and textual accounts of origin, habitats, cultivation, etc. Many more details are given in the text now than formerly and the standard of the illustrations and of the printed matter is very high. Over 10,000 plates with text have now been published. The aims of its editors and publishers have been, and are, to provide a permanent record of cultivated flowering plants and to help both botanists and horticulturists by increasing their knowledge of these plants as objects of interest to the scientist and the cultivator. Joseph Hooker was editorially

responsible for forty volumes of the *Botanical Magazine*.

Hooker's *Icones Plantarum* was founded by Sir William Hooker and the first volumes appeared in 1836-7. Volumes 11 to 19 inclusive were edited by Joseph Hooker and many articles by him appeared in these and later volumes. Volume 20, edited by D. Oliver 'for the Bentham Trustees' initiated the responsibility for publication by the Bentham (now Bentham-Moxon) Trustees under the authority of the Director of the Royal Botanic Gardens, Kew. Parts are issued at irregular intervals and by October 1961 3,624 plates with descriptions had been published in thirty-seven volumes (of the last volume, Part 1 only). This periodical is essentially devoted to publishing descriptions and figures of new or rare plants preserved in the Herbarium of the Royal Botanic Gardens, Kew. The descriptions are in Latin with notes in English and the figures are black-and-white reproductions of original drawings showing the habit and very full dissections of floral and other parts.

We have shown that Joseph Hooker had very wide interests within the realm of botany but that his major preoccupations were with taxonomy and plant geography. Two papers under the latter subject may now be considered. Each deals with a wide aspect and not with a restricted territory and each was given before audiences of the British Association for the Advancement of Science.

The first had the title 'Lecture on Insular Floras', delivered before the British Association at Nottingham, 27 August 1866. This was printed in the *Gardener's Chronicle and Agricultural Gazette*, (1867), and the *Journal of Botany*, vol. 5 (1867), and was reprinted separately in 1896 (L. Reeve & Co., London).

Islands always fascinate biologists who are involved in studies of the history and development of floras. They have clearly demarcated natural boundaries as distinct

from and contrasting with those formed by the whims and compromises of politicians. They are isolated from other areas to a determinable extent and have been isolated for a period of time which can sometimes be estimated with a high degree of accuracy by geologists. They occur in different parts of the world, and comparisons can be made between them and the nearest continental land or lands in any direction and between one island and another.

Hooker states that there are two kinds of relationships between the floras of oceanic islands. One is a relationship of analogy between themselves, due to physical conditions common to all—to their climate, exposure, limited area, distance from continents, etc. Thus they are rich in ferns, mosses, and some other groups of cryptogams and they possess many evergreens but comparatively few species of herbaceous plants, and fewer or no indigenous annuals. Species are few in proportion to genera, and genera in proportion to families. The mountains, however lofty, have few 'Alpine' or 'Subalpine' species and the total number of species is usually small compared with what continental areas of equal size and with similar conditions contain. The terms 'Alpine' and 'Subalpine' are ambiguous. Either they mean species or genera restricted to, or characteristic of, or with ranges centred in, the Alps of Central Europe, or refer to plants of higher altitudes whatever the range of their taxa may be. Probably Hooker here meant the latter but a doubt remains. The second relationship is one of affinity which the floras of islands display with one another or with those of certain continents. Thus Madeira, the Azores, and the Canaries contain many plants in common that are not found on any continent. Yet the flora of the Canaries is in the main a Mediterranean one, that of St Helena an African, and so on. He then deals with the floras of Madeira, the Canaries, the Azores,

Cape de Verde group, St Helena, and Ascension, all in the Atlantic, and Kerguelen's Land (or Island) in the South Indian Ocean.

The peculiarities of the floras of oceanic islands as thus illustrated are summarized as follows:

(1) None of the floras is an independent one; every one is closely allied to some one continental flora, and however distant it may be from the mother continent and however it by so much approximates to another continent, it never presents more than faint traces of the plant life of such other continent. Thus the Azores, though 1,000 miles nearer to America than Madeira, has not even so many American types as Madeira has. St Helena, though 1,000 miles nearer to South America than is any part of the African coast, contains scarcely any plants that are characteristic of America; and Kerguelen's Land, though far more distant from Tierra del Fuego than it is from Africa, Australia, or New Zealand, is almost purely Fuegian in its flora.

(2) The floras of all these islands are of a more temperate character than those of the mother continents in the same latitude; thus Madeira and the Canaries have a Mediterranean flora, though 5° and 10° respectively south of the principal parallel of the Mediterranean region; the affinities of the St Helena flora are strongly South African; and the flora of Kerguelen's Land, in latitude 48° S., is what we might expect to meet in Fuegia, were the American continent extended southward to latitude 60°.

(3) All the floras contain many and great peculiarities distinguishing them from the continental floras, and these might be classified as follows:

(*a*) Plants peculiar to the islands and showing no affinity with those of the mother continent, as the laurels etc. of Madeira, the Canaries, and the Azores, the

arborescent Compositae of St Helena, and the Kerguelen's Land cabbage.

(*b*) Genera that are different from those of the mother continent but allied more or less closely to them. Similarly there are species different from but more or less allied to those from the mother continents, and varieties occur in similar categories.

(4) As a general rule the species of the mother continent are proportionally the most abundant and cover the greatest surface on the islands. The peculiar species are rarer and the endemic genera of continental affinity are rarer still, whilst plants having no close affinity with those of the mother continent are often very common, especially in the temperate islands.

(5) Indigenous annual plants are extremely rare or absent, but recently introduced annuals are very abundant in those islands that have been frequented by man.

There were only two possible hypotheses known to Hooker to account for the stocking of an oceanic island with plants from a continent: either seeds (or disseminules of some other sort) were carried across the ocean by currents, the wind, birds, or other agencies, or the islands once formed part of a mother continent and the plants spread over intermediate land that has since disappeared. He points out that there are 'insuperable obstacles to the ready acceptance of either'. The advocates of either hypothesis agree that those plants that were common to the islands and continents were not independently created in the different localities. It is also probable that those peculiar insular plants which have no affinity with continental ones are relicts of a far more ancient vegetation than now prevails on the mother continents.

The facts regarding the floras of oceanic islands strongly support Darwin's derivative theory of species. Darwin favoured transoceanic migration and in regard to this

Hooker says, 'But though Mr Darwin's explanations cover many of the requirements of our problem, and may eventually prove to satisfy all, there are great difficulties in the way of their full acceptance.' Thus as regards transport by winds, ocean currents, etc., much that we know of the directions of these agents in the North Atlantic is in favour of their bringing American, not European, plants to the Azores, and yet we find even fewer American types in this group than in Madeira and the Canaries. St Helena and Ascension have no land birds but have an African vegetation, though nearly midway between Africa and America. Kerguelen's Land has a flora, most of the elements of which have emigrated not from the nearest land but from the most distant.

Another difficulty is presented by the extreme rarity of some of the plants common to several North Atlantic islands. Hooker's statement regarding *Bencomia caudata* (Rosaceae) in this connection requires some modification, since the plant was later found to be not so rare as it was thought to be in 1866. There are conspicuous examples of islands not having profited by migration of plants from the nearest continent. New Zealand for example has fewer Australian types than would be expected, with no eucalypts, amongst other absentees. On the other hand Hooker states that to him the great objection to the continental-extension hypothesis is that it may be said

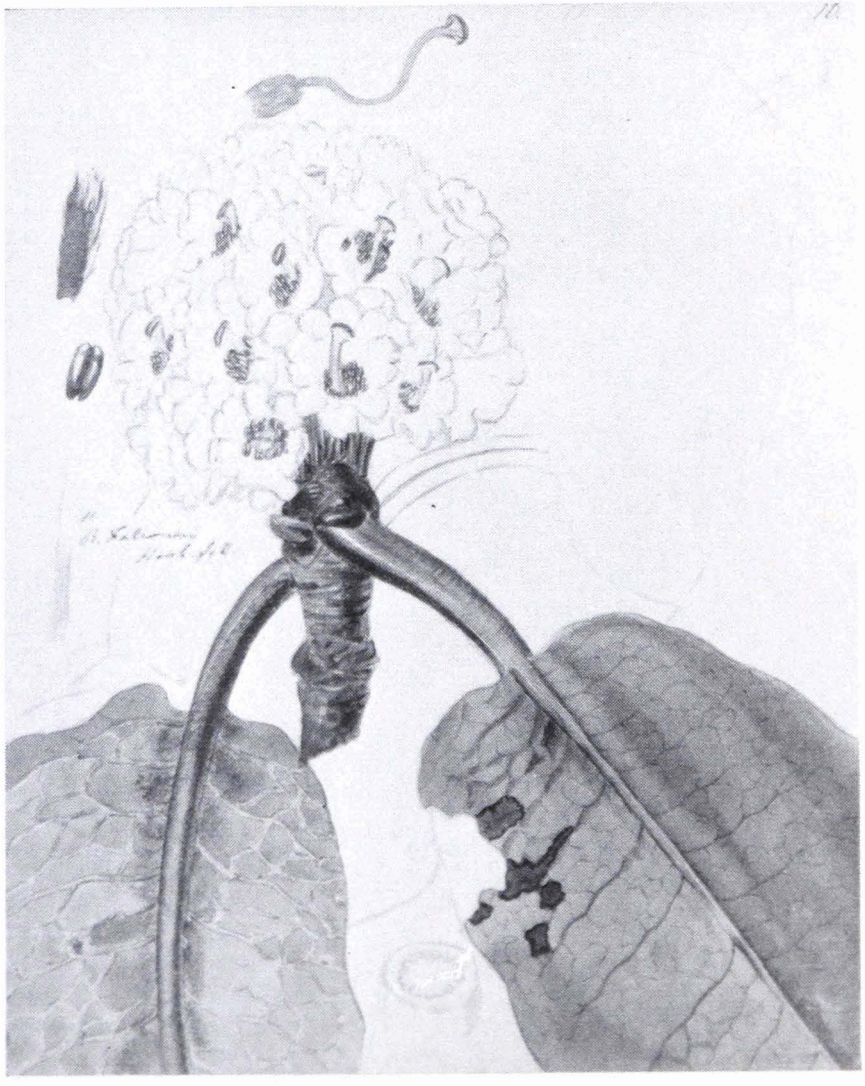
> to account for everything, but to explain nothing; it proves too much; whilst the hypothesis of trans-oceanic migration, though it leaves a multitude of facts unexplained, offers a rational solution of many of the most puzzling phenomena that oceanic islands present—phenomena which, under the hypothesis of intermediate continents, are barren facts literally of no scientific interest—are curiosities of science, no doubt, but are not scientific curiosities.

On the hypothesis of transoceanic migration and the

theory of the derivative origin of species, we can understand how the ancient types have survived on the islands, where they were not subjected to pressure from new and superior kinds as they were on the continents. We can also understand how it comes about that so many continental species and genera are represented in the islands by similar but not identical species and genera to those on the continent, and that there are different representations of genera and species on the separate islands of a group. We understand why whole tribes are absent in the islands and why the floras of these are limited and have the species few in proportion to the genera.

A second general paper on plant geography formed Hooker's presidential address to the Geographical Section of the British Association at York in 1881, with the title 'On Geographical Distribution'. In this he summarizes the progress made to date in the subject with only casual references to his own great contributions. There are however several matters in the address worth commenting upon as illustrations of Hooker's width and depth of interest in anything that had bearing on a subject so constantly in his mind. Few if any of his short papers show the extent of his reading in and around phytogeography better than this one.

He records that 'In the science of distribution, Botany took the lead.' Humboldt attributed its beginning to an idea of Tournefort, developed by Linnaeus. In 1700 the King of France sent Tournefort to explore the islands of Greece and the mountains of Armenia, and the botanist noted that in ascending mountains vegetations that represent those of successively higher latitudes are met with. This idea was greatly developed by Humboldt, though he himself did not suspect the whole bearing of the idea on the principles of geographical distribution, and that the parallelism between the flora of mountains



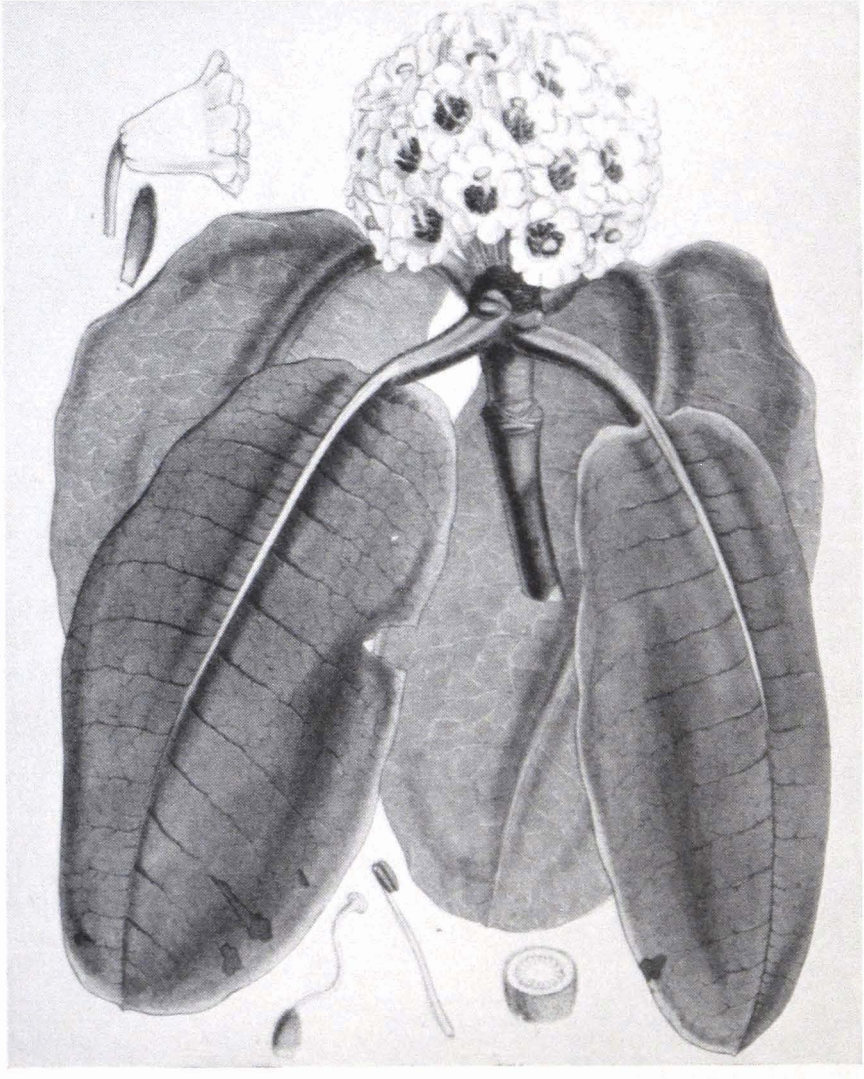


Plate 16 (*left*) J. D. Hooker's drawing of *Rhododendron falconeri* and *Plate 17* (*right*) W. Fitch's reproduction made from it in *Rhododendrons of Sikkim-Himalaya.*

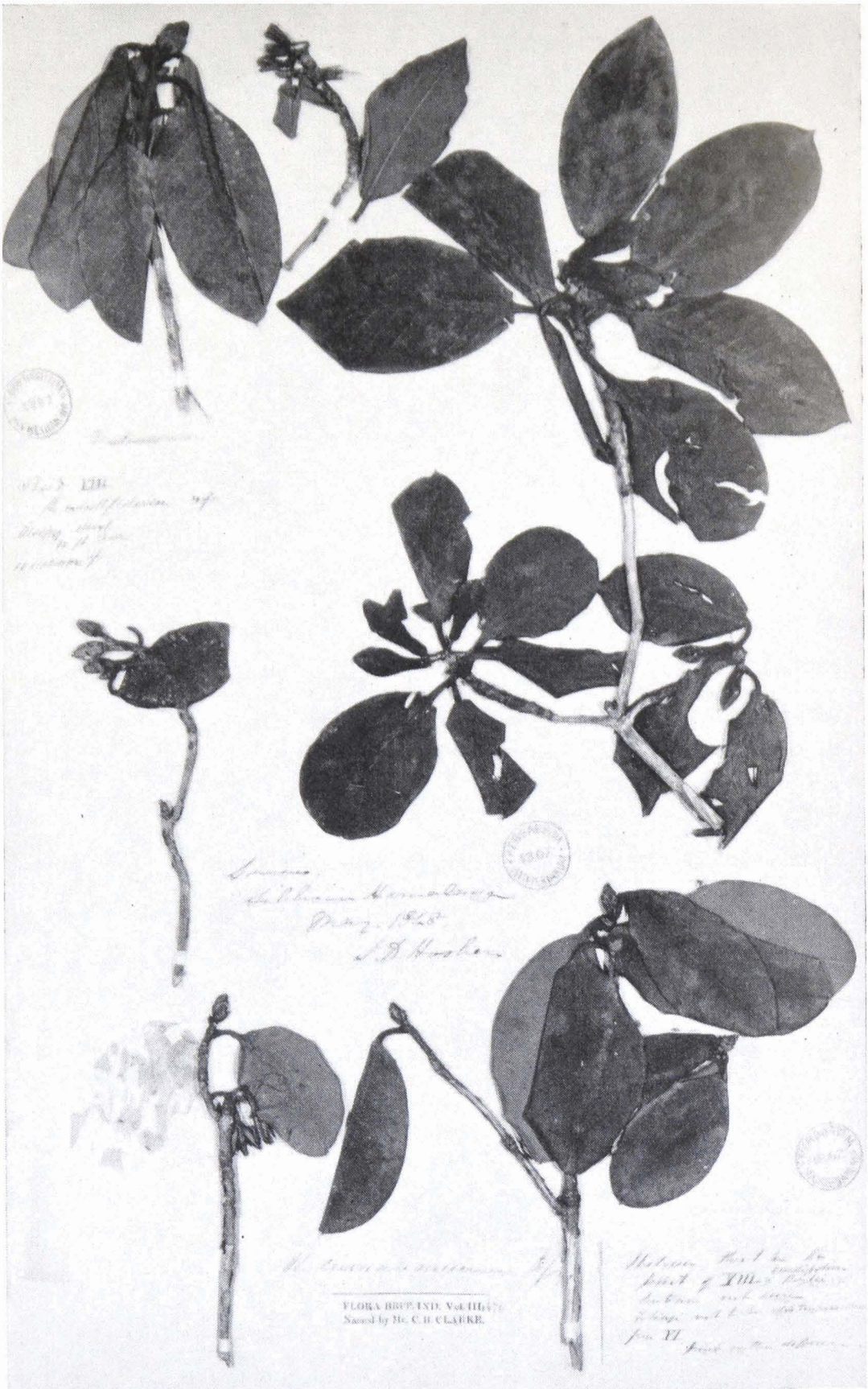


Plate 18 A recent photograph of the dried specimen of *Rhododendron roylii*, collected by Hooker in May 1848, and mounted by him on this sheet which is kept in the Herbarium at Kew.

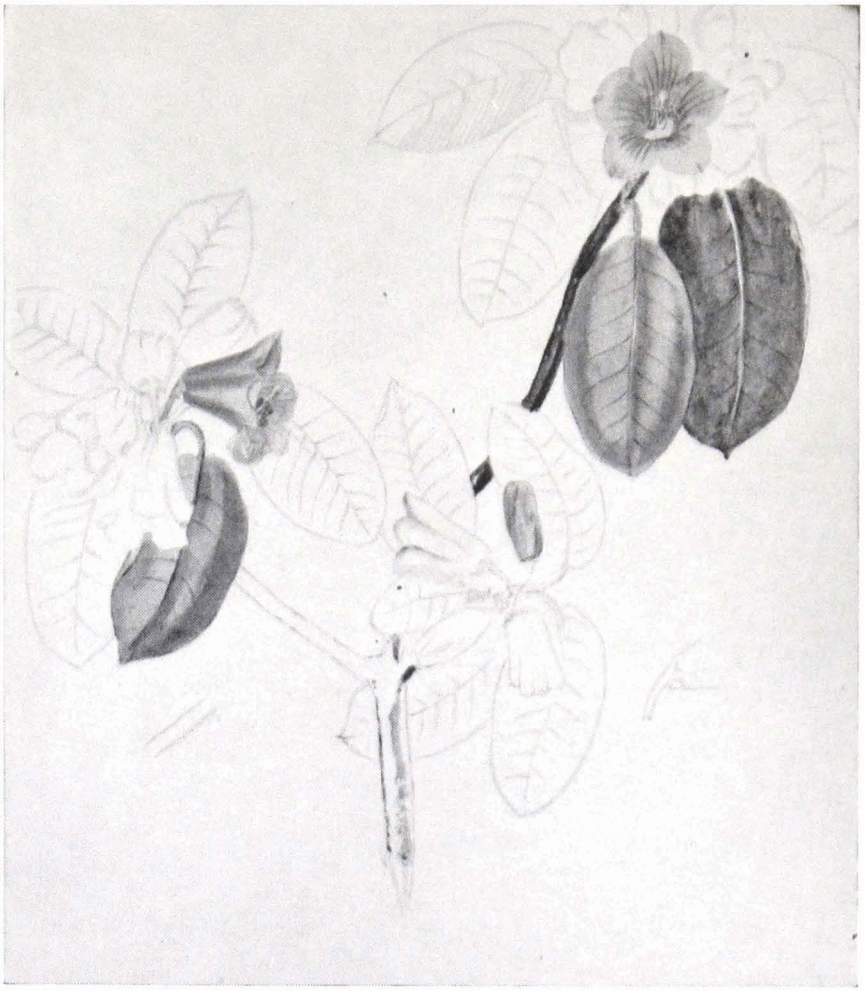


Plate 19 shows the drawing that Hooker made from the specimen at the top right of plate 18. W. Fitch used the drawing to make his engraving for *The Rhododendrons of Sikkim-Himalaya.*

Plate 20 The print from this engraving, gives the reverse of the original drawing.

Plate 21 Exterior view of the Herbarium, Kew (*c.* 1890), the part that was built during J. D. Hooker's directorship.

Plate 22 Interior view of the Herbarium, Wing C, showing the cases which hold classified sheets of dried specimens.

and of latitudes was the result of community of descent of the plants composing the floras, nor that, it was brought about by physical causes. Humboldt's contributions to the 'laws of distribution' were not limited to plants but included man and lower animals (wild and domesticated). Hooker says that 'he is indisputably the founder of this branch of geographical science'. Lyell showed that a fauna or flora may be older than the land it now inhabits and Edward Forbes dispelled 'belief in the stability of climatal conditions during the lifetime of the existing assemblages of animals and plants'. His studies of the British flora were profound and justify the claim that 'Forbes was the reformer of the science of geographical distribution'. Hooker refers with appreciation in other of his publications to Forbes's work and conclusions, and there is no doubt that he was considerably influenced by them.

Hooker points out that before the publication of the doctrine of the origin of species by variation and natural selection, all reasoning on their distribution was in subordination to the idea that they were permanent and special creations. Darwin showed that all the leading facts of distribution were clearly explicable under his theory, and as for the science of geographical distribution, 'As Humboldt was its founder, and Forbes its reformer, so we must regard Darwin as its latest and greatest lawgiver.' Reference is made to discoveries of fossil plants in the Arctic, to Asa Gray's views on the history of the North American flora, to Blytt's work on the Norwegian flora, to researches on the floras of the Southern Hemisphere, and to publications of A. de Candolle, Grisebach, and A. R. Wallace.

Joseph Hooker was President of the British Association for the Advancement of Science at its meeting at Norwich in August 1868. His presidential address dealt with

various matters regarding archaeology, anthropology, the Natural History collections of the British Museum, the use of museums, and fossil botany; with Darwin's researches on orchids, heterostyly, and climbing plants; and with the hypothesis of pangenesis. At some length he considered the progress made during the past decade in the scientific estimate of the theory of natural selection. This last is a valuable contribution and should be consulted by anyone interested in the history of Darwinism. One paragraph runs as follows:

> To search out the whence and whither of his existence, is an unquenchable instinct of the human mind; to satisfy it, man in every age, and in every country, has adopted creeds that embrace his past history and his future being, and has eagerly accepted scientific truths that support the creeds; and but for this unquenchable instinct, I for one believe that neither religion nor science would have advanced so far as they have into the hearts of any people. Science has never in this search hindered the religious aspirations of good and earnest men; nor have pulpit cautions, which are too often ill-disguised deterrents, ever turned inquiring minds from the revelation of science.

A break in the regular work of administration and of continuing researches at Kew was provided by a visit Hooker paid to Russia for six weeks, 7 May to 23 June 1869, to attend a congress. The Treasury refused to send him and he went independently, accompanied by his wife. He travelled out via Berlin and returned via Stockholm. He found the trip extremely interesting, and met many botanists and visited various botanical institutions.

Hooker's *Students' Flora of the British Isles* (504 + xx pp.) appeared in 1870. In format, contents and their arrangement, and general plan this is one of the best of British floras ever to have been published as a single volume. It deals with the seed-bearing plants and vascular cryptogams found as natives or as well-established im-

migrants in the British Isles. The descriptions of families, genera, species, subspecies, and varieties are concise, adequate for determination, and lucid. Keys to genera and to species of the larger genera are provided but there are no illustrations. In reading the descriptions and in using this flora for determination one has the impression, no doubt a correct one, that the author was describing plants he had in front of him as living or dried specimens or both, and not repeating accounts of other botanists. A second edition (539 + xx pp.) appeared in 1878 and a third (563 + xxiii pp.) in 1884.

Hooker published a number of botanical works on parts of Africa, but apart from visits to the Cape of Good Hope and St Helena on his Antarctic voyage, he had no first-hand experience of the flora and vegetation of this vast continent. However in 1871 he visited Morocco in the company of John Ball and George Maw, accompanied by a young gardener named Crump from Kew, and the tour lasted from early April to early June. The botanical features of Morocco are essentially Mediterranean, with a considerable number of North African endemics of mainly Mediterranean families and genera, and not African in the sense of the African flora south of the Sahara. A full account of their journey was published under the title *Journal of a Tour in Marocco and the Great Atlas* (London, 1878), under the names of Hooker and Ball. The general use of the pronouns 'we' and 'our' throughout the book would appear to be an acknowledgment of joint authorship (apart from the Appendices). It is however somewhat difficult to be certain of what this exactly implies. In the Preface to the work it is stated:

> Sir Joseph D. Hooker, who made careful notes throughout the journey, hoped to complete the work without delay, and actually wrote the greater part of the first two chapters; but the constant demands upon his time . . . so far interfered with the

completion of the original design as to compel him to request his fellow-traveller, Mr Ball, to undertake the completion of the work.

Apparently Ball used Hooker's journal as well as his own and Maw's diaries. Three of the Appendices, two of them phytogeographical, are by Hooker alone, and there were also published accounts by him of 'The ascent of the Great Atlas' in the *Proceedings of the Royal Geographical Society*, vol. 15 (1871) and the *Report of the British Association*, (1871). The taxonomic results as published were by Ball alone (1873).

The expedition travelled by sea to Gibraltar and thence crossed to Tangier, whence local excursions were undertaken to explore the flora. On 10 April, with a pompous interpreter and two soldiers as escort, the botanists made visits to Tetuan and to Ceuta. From Ceuta they went by boat to Algeciras and thence crossed the bay to Gibraltar and again to Tangier, where they took ship for Mogador, calling at various Moroccan ports *en route*. From Mogador the main inland excursion to southern Morocco and the Great Atlas was made in a party of thirty-seven, which included a guard of two captains and nine soldiers.

A detour to the south-southeast enabled them to examine a part of the forest of argan trees, *Argania sideroxylon* (Sapotaceae). The argan is in many respects the most remarkable plant species in Morocco and forms a conspicuous feature of the landscape in the low country near the coast. Its range covers an area of about 200 miles in length in the sublittoral zone of southwestern Morocco, where it is common between the rivers Tensift and Sous, extending for a distance of 30 or 40 miles inland, but the genus, with its one species, is unknown anywhere else in the world. The trunk always divides at a height of 8-10 feet from the ground and sends out numerous, spreading, nearly horizontal branches. Growth is slow,

the branches have stiff thick spines, and the leaves are like those of the olive in shape, but of a deeper green which is somewhat paler on the lower surface. The wood is extremely hard and the fruit, much like a large olive in appearance, is greedily devoured by goats, sheep, camels, and cows but is refused by horses and mules. The hard kernel furnishes the argan oil which is used in south Morocco in place of olive oil in cooking, imparting a flavour generally disliked by those not used to it. One may wonder if the strong flavour of argan oil camouflaged the used mineral oil that was sold for cooking purposes in Morocco in September to December 1959, with terrible results.

Crossing the hilly country between the coast and the great plain of Morocco the travellers found there was now a great change in the vegetation, owing to deficiency of water and the rapid heating of the land surface during the day and the no less rapid cooling by radiation at night. One of the wormwoods (*Artemisia herba-alba*) became especially conspicuous, in some places almost covering the surface, and there were many other plants, especially of genera belonging to the crucifer, pea, and daisy families, although much of the vegetation was dried up except for the species that can withstand the parching heat and drought. Particularly interesting were several grasses, a dwarf annual viper's bugloss (*Echium modestum*), and two knapweeds (*Centaurea* spp.).

Towards the Great Atlas the singular appearance of stunted bushes of the jujube-lotus (*Zizyphus lotus*) was very striking, and this plant formed the only woody vegetation of the area. From a short distance the plants looked as if they were covered by some white-flowered climbing plant or were laden with white fruit. This appearance however was due to the extraordinary number of two species of snail that completely covered the

branches. An oasis in a semi-desert area sustained an abundant growth of figs, olives, pomegranates, apples, plums, and apricots, with an undergrowth of grasses and herbaceous plants. The vegetation of the irrigated land, except for a few tall palms, was almost exclusively European.

The party reached the city of Marocco (now called Marrakesh) and met with some difficulties in making arrangements to extend their journey into the mountains. Anything so simple and truthful as a statement that their object was to study the vegetation and flora of the Great Atlas would be set aside as a false pretext intended to cover some sinister design. To endeavour to explain that Hooker, as Director of the Royal Botanic Gardens, Kew, was anxious to enrich his great national establishment by the introduction of new, rare, or useful plants, was not likely to be more successful. They had in some way to present themselves as persons carrying out direct orders from the Queen of England, otherwise they would have no claim to respect and would be regarded as adventurers prompted by some motive they did not care to avow. Finally it was urged that everyone would understand if they said they were collecting herbs useful in the cure of diseases and if Hooker stated that his commission was to collect and take home the plants of the country and especially those useful in medicine. The interpreter enlarged upon this text and there was little doubt that the current belief among their own followers at any rate was that the Sultana of England had heard that there was somewhere in Morocco a plant that would make her live for ever and had sent her own *hakim* to find it for her. When in the course of the journeys it was seen that their botanical pursuits entailed rather severe labour, the commentary was, 'The Sultana of England is a severe woman, and she has threatened to give them stick (the

bastinado) if they do not find the herb she wants!' One wonders if Queen Victoria would have been amused by this story.

The route up into the hills via the Ourika valley yielded many plants of botanical interest, including a fair number of species which had not hitherto been named or described. There was some trouble with the escort, including furious quarrels between the officers. The guns of the escort were securely wrapped up in complicated covers of red cloth, and the botanists thought that if there were such things as professional brigands in Morocco at that time they could have been robbed or murdered with perfect safety before one of the guns of their escort had been extracted from its case and made ready for use.

The aim was now to penetrate to the inner recesses of the Great Atlas in the district of Reraya. The slopes of the valley they traversed through the outer ranges had a dense growth of shrubs and low bushes, in great part evergreen, and had more the characteristic aspect of the Mediterranean region than anything they had seen since they had left Tangier, but there were marked differences. The oak-scrub was all formed of the evergreen oak (*Quercus lusitanica*) and there were only two species of *Cistus*. The number of bushy labiates and of umbellifers had greatly increased. Members of the pea family were conspicuous. On the ridge at 4,500 feet occurred the curious grass *Lygeum spartum*, one of the esparto grasses.

In the villages through which they passed Hooker was called upon to treat many sick people, his skill as a doctor (*hakim*) having travelled ahead of the party, and his patience was often tried by the numbers who flocked to consult him. Above Adjersiman (5,535 feet or 1,687 metres) they were reaching the inner recesses of the chain, and perceived that snow lay in abundance at a much lower level than they had supposed it would, but nowhere

in masses of any very great extent. Large collections of plants were made and as altitude increased these became more and more like those of central and northern Europe. There was further trouble with their guides and native helpers. These firmly believed that the heights of the Atlas are inhabited by *jinn*, or demons, and a storm driving the snow with blinding force was, they considered, caused by the anger of the demons at the intrusion of strangers into their sanctuary. One of the Shelluh natives carried with him a live cock under his arm and in a state of the utmost excitement proceeded to cut the animal's throat in order to appease the wrath of these supernatural foes. A return from the high ridge was made to the village of Arround (about 6,463 feet or 1,970 metres). The height of the pass above Arround, apparently the Tagherot Pass, was found to be 11,484 feet or 3,500 metres (Fig. 3).

The vegetation of the Great Atlas was found to differ very much from that of all the lofty mountain masses of southern Europe and western Asia, especially in the absence of families which in those areas are conspicuous in the high mountain zones. Thus there was no gentian, no primula or species of *Androsace*, no rhododendron, no anemone, no potentilla, and none but lowland species of saxifrage and buttercup.

The flora at first appeared poor but this was owing to so large a proportion of the plants having inconspicuous flowers. Actually, of 151 species collected in the upper part of the high valley above Arround, 31 were later described as new to science and, as far as known, peculiar to the Great Atlas chain. This gives about the same proportion of endemic species as in the flora of the Sierra Nevada of Granada, Spain, which is always regarded as a very rich botanical district. The most remarkable feature of the flora is the very large proportion, 70 out of 151, of

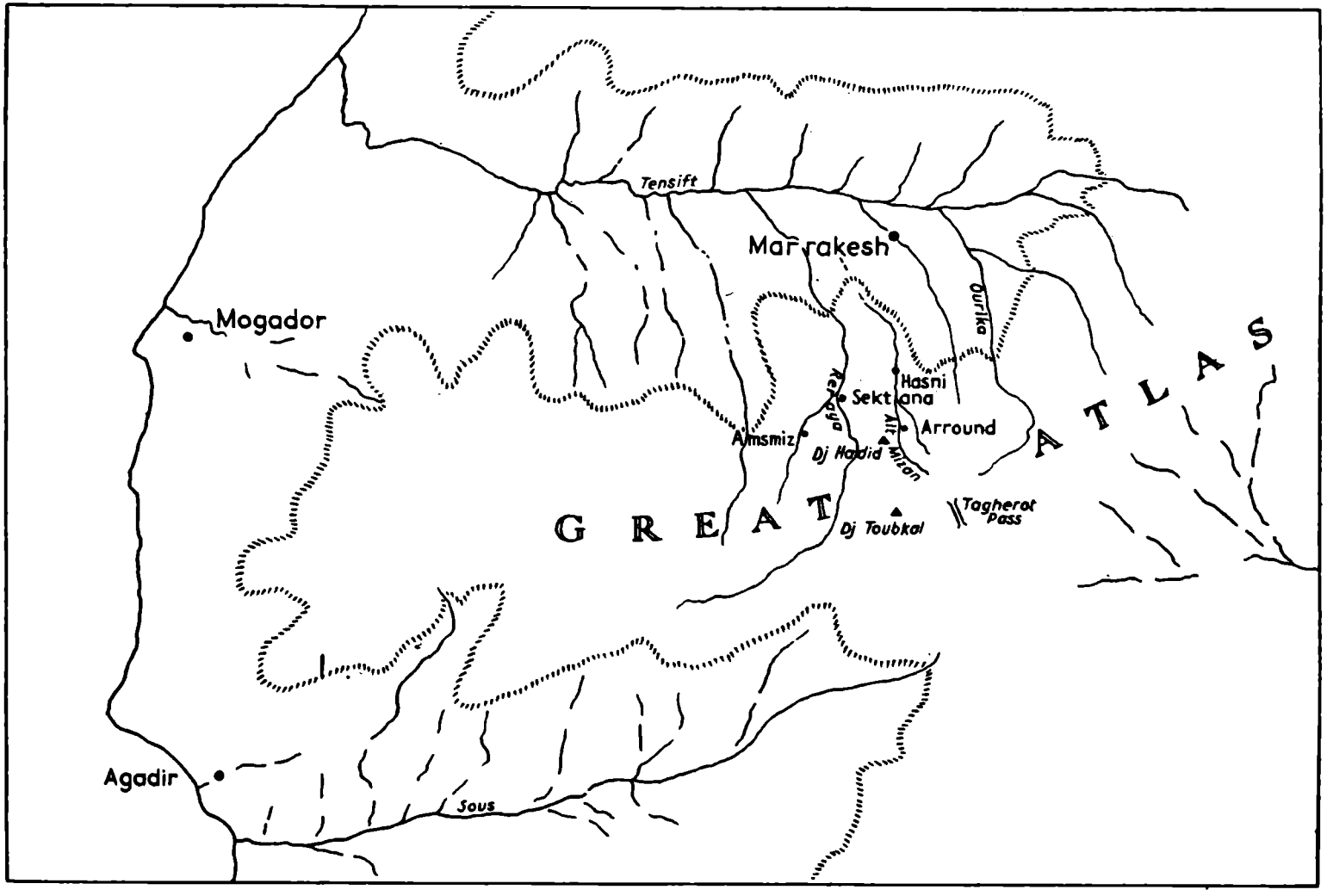


Fig. 3 On his Moroccan expedition Joseph Hooker explored in the Great Atlas Mountains; Djebel Toubkal is the highest peak. Climbing south from Amsmiz, Hooker and his party were able to see across to the Anti-Atlas range, partly shown in the lower right corner of the map.

common plants of the colder temperate region (central and northwestern Europe) here associated with species of a very different type. Ferns were deficient in number and variety, as was to be expected from the dryness of the country. About one-third of the species found in the upper zones could be described as belonging to the Mediterranean flora. The prevalence of members of the wallflower family (Cruciferae) and the pink family (Caryophyllaceae), and of species of the genera *Chrysanthemum*, *Galium* (bedstraws), and *Linaria* (toadflaxes), are prominent characters of the mountain flora of the Great Atlas.

From the highest point reached (Tagherot Pass) they descended and struck westwards from Hasni and Sektana, where Maw left the party to return to England via Mogador, on to Amsmiz. From Amsmiz a climb was again made into the higher regions, a little over 11,000 feet being reached and fine views over the Anti-Atlas obtained, while further valuable collecting was done. They then rode across the plain to Mzouda and on to Seksaoun, where on rocks in the neighbourhood many plants not hitherto seen in Morocco were collected and a nearby mountain ascended before they made their way to Milhain. Travelling west of due north over relatively bare and sterile country, no trees were passed other than a few olive trees near the houses of small hamlets. Wormwood (*Artemisia herba-alba*) and species of the fat-hen family (Chenopodiaceae) were the prevailing plants and these indicated gypsum and soluble salts in the soil. Numerous rare and local plants were growing on the rocks in a defile. Towards the Iron Mountain (Djebel Hadid) the fertility of the soil improved. A tall carrot (*Daucus maximus*) grew to a height of 4–5 feet and the flowering umbels were often more than 1 foot in diameter, and a splendid ornamental knapweed (*Centaurea* sp.), with very large heads

of deep orange florets often tinged with purple, attracted attention. Botanizing on the way they reached Mogador whence Hooker returned to England via Gibraltar, and Ball also reached home via Tangier and Gibraltar. Their large collections arrived in England in good condition somewhat later.

The *Journal of a Tour in Marocco and the Great Atlas* is an eminently readable book of travel with a strong botanical bias. Reference must be made especially to Appendix D, 'On some of the economic plants of Marocco', and Appendix E, 'On the Canarian Flora as compared with the Maroccan', both by Joseph Hooker. The former contains valuable data about gums and resins and the plants producing them in Morocco, and in particular a very useful account of the argan tree already referred to. Hooker, like many other plant geographers both before and after his time, was intrigued by the problems raised by the floras of the Atlantic islands. As regards the Canaries and Morocco, the data available in 1878 indicated that out of 1,627 species of flowering plants known to grow in Morocco 165 were endemic but only 15 were confined to that country and to the Canaries, or to it and Madeira. In addition the Canarian and Madeiran floras were known to contain many endemic species and about 9 endemic genera. Morocco has few endemic genera and of these *Argania* is the only arboreous one. In the Canaries about 1,000 species were recorded, of which 367 or more than one-third are peculiar to the archipelago, whereas out of 1,627 Moroccan species only 165 or a little over one-tenth are endemic. There are representatives of more distant floras in the Canaries, such as oriental (chiefly Arabo-Egyptian, but some extending to western India), American, and tropical and South African.

The wonderful development in the Canaries of endemic species belonging for the most part to Mediterranean

types points to the very early introduction of the parent forms of these, and the very long isolation both of the archipelago and its separate islands. Hooker applies a Darwinian explanation as follows:

> It is in accordance with generally accepted views, to assume that the endemic species of each genus have been derived from parent forms originally introduced into one or more of the islets; and that as the descendants of these species spread over the Archipelago they were exposed to different conditions in each islet, resulting in their varying, and in the segregation and conservation of different local varieties each in its own insular birth-place; a supposition which is in accordance with the fact that those endemic species are really very local, many being confined to a single islet. In Marocco the parent forms of its Flora would be exposed to no such diverse conditions, and the areas in which varieties occurred, not being isolated, would be exposed both to invasion on all sides by other plants, and to destruction by agencies that affected the whole surrounding country, as drought, floods, insects, and birds.

The dragon tree (*Dracaena draco*), and trees of tropical affinities, and the Egypto-Arabian types suggest that at a very remote period these and many other plants of warmer and damper regions flourished in northwest Africa and the adjacent islands, but were 'expelled' from the continent by altered climatic conditions though preserved in the more equable climate and more protected areas of the Atlantic islands.

There are considerable botanical differences between the eastern and western Canary Islands. Nearly all the characteristic Canarian types are absent in the eastern group, and in spite of deficiencies in knowledge of the botany of the African coast between the rivers Sous and Draha it appears that there is a closer botanical relationship between the eastern islands and the adjoining continent than there is between them and the western

portion of the Canarian Archipelago. Lyell and other competent geologists were against the possibility of the Canary Islands having been united with the African mainland but believed that the evidence was in favour of every island of the group having been formed separately by igneous eruptions, and in a sea of very great depth. It follows that the Canarian flora must have originated by transport of disseminules with subsequent *in sito* evolution.

Hooker debated whether the Canary Islands should be regarded as forming a botanical province (or region) distinct from the Mediterranean. He pointed out that the assemblage of American and oriental genera which their flora contains, together with the woody representatives of the tropical laurel family, would entitle it to be kept distinct from the Mediterranean province, or, as we should nowadays say, Mediterranean region. On the other hand fully two-thirds of the species are typical of the Mediterranean flora and the majority of the remainder are derivative species of the same origin. He was therefore disposed 'to regard it as a very distinct sub-division of the Mediterranean province, which owes its peculiarities partly to the conservation of types once common to West Europe and North Africa, but which have been eliminated in those regions, and partly to the effect of isolation and climate on the progeny of species still existing in those regions'.

Hooker's essay on the relationships between the Canarian (or Macronesian) and Moroccan floras is very clear and instructive. Moreover his conclusions are to be regarded as still surprisingly sound. Of course there has been a considerable amount of botanical exploration both of Morocco and of the Canaries and other Atlantic islands since 1878, but on the whole this has not greatly altered the figures given by Hooker and by Ball when these are considered as percentages or in contrasting relationships.

One may mention Praeger's work (1932) on the houseleeks (*Sempervivum*) and allied genera as emphasizing the endemic nature of much of the Canarian flora and the fact that many species are not only limited to the group but to individual islands in the group.

Hooker's travels in India and the large collections he made there naturally led him to maintain an interest in the flora and vegetation of the subcontinent. In collaboration with his friend T. Thomson he had prepared and published in 1855 one volume of a *Flora Indica*, a work that was never completed. The Introduction is of wide importance (see p. 79) and the descriptive matter of the few families worked out taxonomically was used later. It was not till May 1872 that Part 1 of Volume 1 of the *Flora of British India* appeared. The complete work occupies seven volumes (issued in two or more parts per volume) and the final volume was published in 1896. It is written in English and contains descriptions of families, genera, and species of all the seed-bearing plants known from India in a very wide sense of the term, including Baluchistan, Burma, Ceylon, and the Malay Peninsula. The total number of pages in the seven volumes is 5,569 and by far the greater number were written by Hooker himself. Certain families were worked out and the accounts prepared by or in collaboration with other botanists: T. Thomson, T. Anderson, M. P. Edgeworth, M. T. Masters, A. W. Bennett, J. G. Baker, C. B. Clarke, J. S. Gamble, O. Stapf, and O. Beccari. There are no illustrations but references, geographical ranges, and altitudes are given. This is still the only flora of India as a whole, even of India excluding Burma and the Malay Peninsula. It has served as a basis for many floras of Indian provinces and other subdivisions, and though now in many ways out of date is a classic to which all who work on the floras of tropical Asia have constantly to refer.

Joseph Hooker's married life had been a happy one from August 1851 till 13 November 1874, when Mrs Hooker died quite suddenly. His grief and sense of loss were very deep. There were six surviving children of the marriage, three of whom still required personal care and attention. Mrs Hooker (*née* Frances Henslow) was the daughter of a botanist and had herself a considerable knowledge of the subject. She translated into English E. Le Maout and J. Decaisne's *Traité général de botanique, descriptive et analytique* (Paris, 1868) under the title *A general System of Botany, descriptive and analytical*, and this was published in the year before she died, with some additions and rearrangements by her husband. The community of interests and very similar ideas and ideals on family and social life aided in leaving a record of twenty-three years of mutual affection and respect. Hooker's elder daughter was a great help to her father at this time and his aunt, Mrs Dawson Turner, and her daughter (afterwards Mrs Calverley Bewicke) went to live with him at Kew.

In June 1875 William Thiselton Dyer was appointed Assistant Director of Kew. This helped to relieve Hooker of some of the duties as Director, duties which had increased and had become almost overwhelming. He was a man of normally very good, almost robust, health and his long and arduous travels in the Southern Hemisphere and in India had left behind no ill effects, but about this time he suffered from ear trouble and all through 1875 he had recurrent headaches and dyspepsia, with attacks of lumbago and bronchitis. The period was a sad one for him. The death of his wife was recent and on 22 February 1875 his old friend Sir Charles Lyell died. Hooker had much to do with arranging for Lyell's burial in Westminster Abbey.

Hooker was elected a Fellow of the Royal Society in 1847 and was President from 1873 to 1878. He could not

refuse the honour and the duties it entailed—duties and responsibilities additional to those resulting from his being Director of the Royal Botanic Gardens, Kew, and commitments additional to those of his own researches—but he undertook the task with reluctance. This was partly because of the restrictions it placed on the time he could devote to his own botanical work and partly because it involved a good deal of speech-making. During the term of his presidency Hooker initiated or had much to do with a number of reforms in the affairs of the Society. The non-scientific element was restricted, the printed catalogue of all the scientific papers published by the Society was brought up to date, and a fund was established to meet the cost of publications and thus enable the very high fees of fellows to be reduced.

The administrative work as President was heavy. Council days are described by him as 'great pulls, 1-6 p.m. *continuous*—then dinner, followed by the meeting at 8½'. The matters that had to be dealt with by Hooker as President were numerous and very varied: allocation of funds and grants, advice when public funds were to be used for exploration or research or in pensions to scientists or their dependants, details as to work done in Government scientific establishments, and so on. It is true that on a number of occasions he used his position as President of the Royal Society as a lever to advance the interests of Kew, but always quite legitimately and fairly.

Leonard Huxley (1918) summarized Hooker's presidential addresses to the Royal Society as follows:

> the first, in 1874, reviewed the finances and work of the Society; the second, in 1875, dealt with various scientific expeditions initiated or directed by the Royal Society; the third, in 1876, with the Grant Fund, the Vivisection Act, the Loan Collection of Scientific Apparatus, the Meteorological Office, and the return of the Challenger; the fourth, in 1877, with Nares's Polar

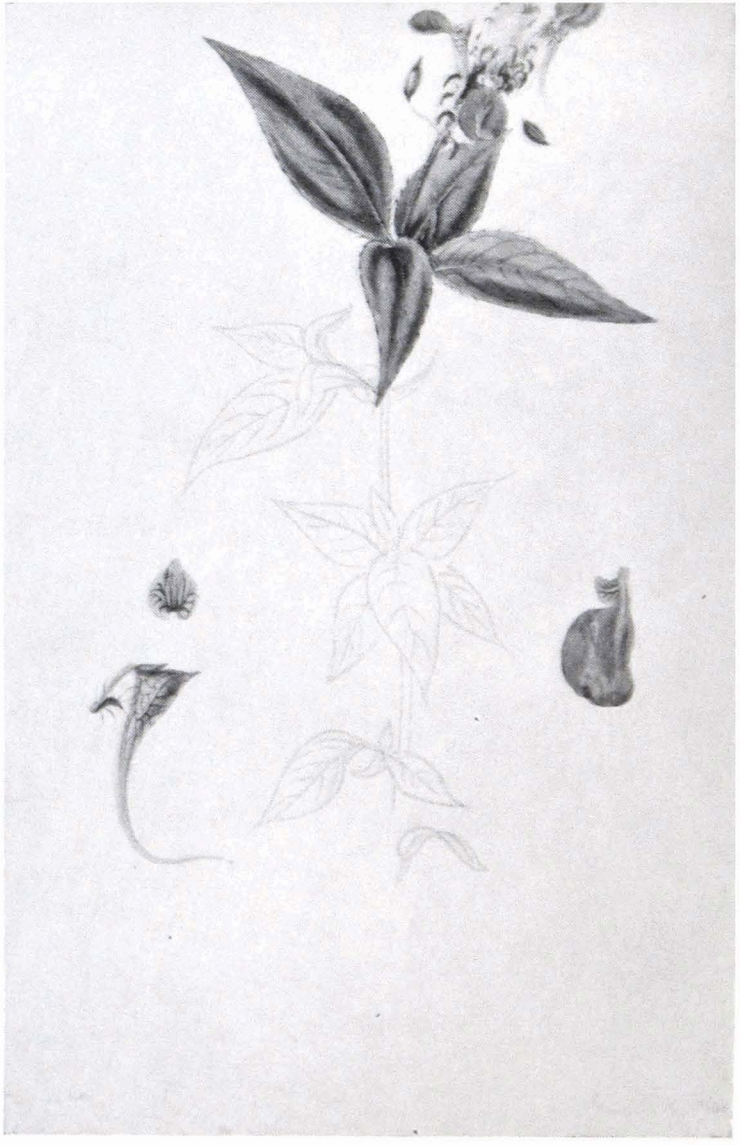


Plate 23 A dried specimen of *Impatiens bracteata* collected by Joseph Hooker in the Khasia district, and *Plate 24*, the drawing he made from it. Sir Joseph was still making dissections and drawings of these complicated species when he was ninety years of age.

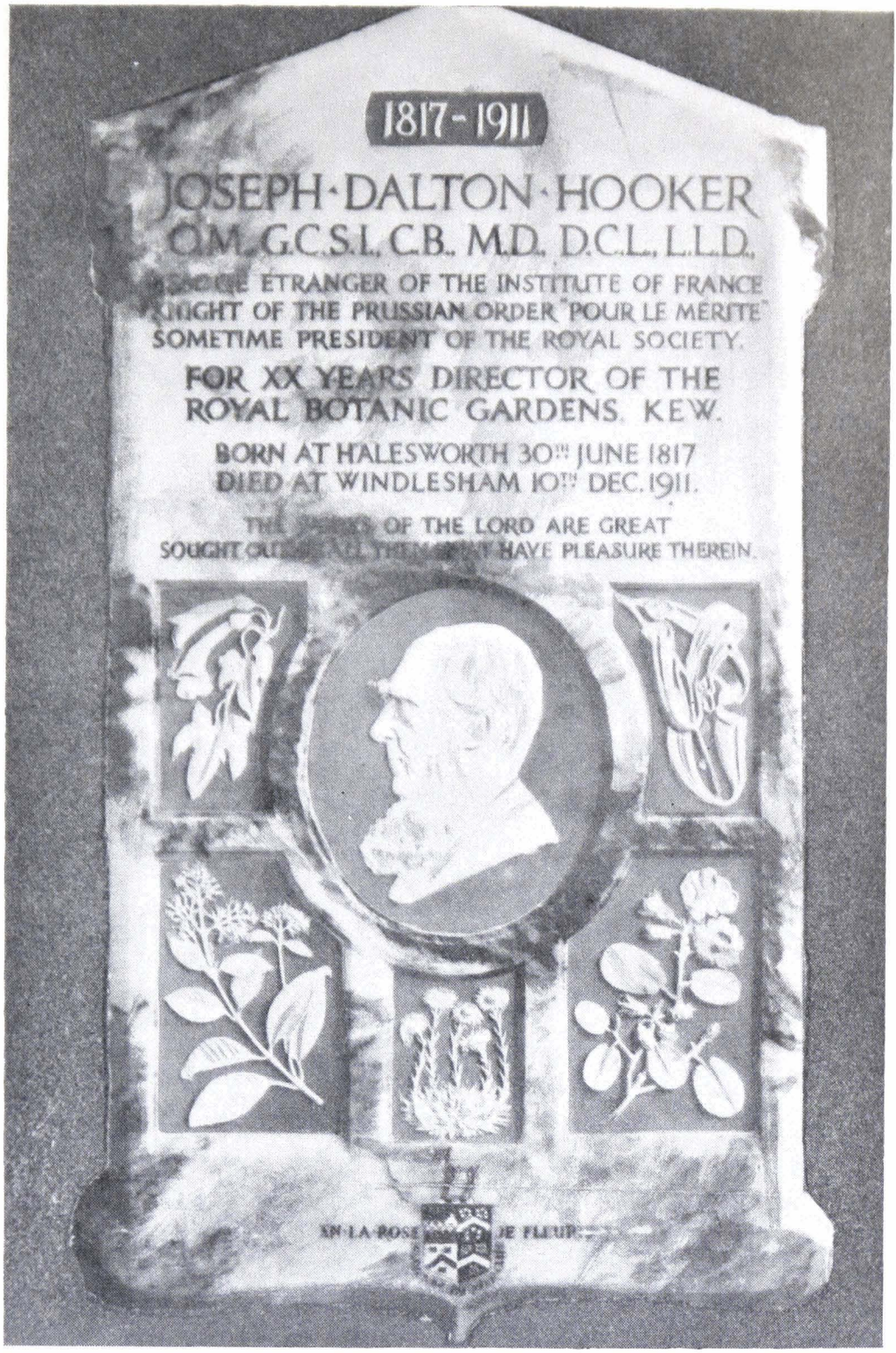


Plate 25 The memorial tablet in St. Annes Church, Kew Green.
(see p. 185)

expedition, the American Flora, and the relation between the Cretaceous and Tertiary fossils; the fifth and last, in 1878, with the reduction of fees to Fellows, recent discoveries, palaeobotany and modern development of botanical science, notably Darwin's work and the sequel to Burdon Sanderson's discovery of electromotive properties in plants, and the new world of knowledge opened by bacteriology and its bearing on the theory of spontaneous generation.

Hooker received his C.B. in 1869 and in 1877 he was knighted in the Order of the Star of India. This, he always stressed, was given him in recognition of his work for India—though in many ways it would appear to be a tardy recognition.

At the end of August 1876 he married Hyacinth, only daughter of the Rev. William Samuel Symonds, Rector of Pendock, Worcestershire, widow of Sir William Jardine. Part of the honeymoon was spent in north Wales. A son was born to them in 1877.

The last of Hooker's major botanical expeditions was to western North America in 1877. This was undertaken with his friend Asa Gray (1810-88), Professor of Natural History at Harvard, 1842-73 and successor to Agassiz as Regent of the Smithsonian Institute in 1874. The botanical problems of special interest to Gray and Hooker in the North American flora were the remarkable and close connections between the floras of the eastern United States and those of eastern continental Asia and Japan, and the line of division between the Arctic floras of America and Greenland. Independently they assigned the causes of this to the Glacial period and an earlier land connection with an Arctic continent. A difficult question was why in the great mountain chains of the western United States there appeared to be only a few botanical enclaves of plants of eastern-Asiatic affinities among plants of Mexican and more southern types.

Hooker sailed for the United States on 28 June 1877. He visited a number of cities and botanical institutions and then the party, including Major-General (Sir) Richard Strachey and his wife and Professor and Mrs Gray, moved westwards and reached La Veta, where they camped at 9,000 feet for botanical work. From Fort Garland the botanists ascended the Sierra Blanca, 14,500 feet, in the Rockies. The ascent was very fatiguing, for to reach the tree limit they had to force their way for five hours through thickets of aspen, then through forests of pine with fallen branches encumbering the ground. They slept at 13,000 feet under thick blankets. After botanizing on the heights they returned to Fort Garland, very tired and in rags, to rise at four the next morning to return to La Veta and thence to proceed beyond Colorado Springs to the neighbourhood of Pike's Peak. After botanizing there they reached Denver on the way to Salt Lake City for a botanical excursion to the Wahsatah Mountains. Then a weary journey of twenty-nine hours took them to Reno and Carson City, and thence, via Silver City and for ten days by wagon across the Sierra Nevada, they came to the Yosemite and Calaneras Groves to end up at San Francisco. Hooker was back at work in Kew in October 1877, having brought home over 1,000 species as dried specimens.

Before considering in greater detail some of the conclusions reached regarding the flora of North America and its history, we note some impressions made on Hooker in regard to matters other than botanical on this journey. A fairly long extract from a letter dated 8 August 1877 is worth quoting:

> To-day we called on Brigham Young and had a chat with him. He is about 70, stout, well dressed, and with rather a refined countenance. He reminded me more of a stout, elderly and *thoroughly respectable* butler, than anything else. In person and

conversation he is less of a Yankee than 9/10 of the gentlemen I have been introduced to. Of course he is an arrant imposter, but nothing in speech, look or manner differs from those of a quiet well-bred English gentleman. I talked a good deal with him about the climate, history and productions of his country, and found him communicative and intelligent. He gave us iced water and 'God blessed us!' when we left! His missionaries are bringing in converts from all quarters, especially Wales, Sweden and Prussia—of course from the most profoundly ignorant classes, but once arrived here, they get plenty of work, good food, comforts and domestic happiness—for a plurality of wives, which few care for and fewer can afford, is the only sin that B.Y. allows, and for that he quotes the Testament. All the school children are brought up to believe in him and in a lot of scripture history as useless and idle as that taught in our schools, and the religious teaching is altogether contemptible. The Gentile ladies hold no intercourse with their Mormonite sisters; nor is it likely they should. Educated U.S. ladies would not care to associate with the ignorant class to which the Mormonite ladies belong. In short as far as I can make out, the system of polygamy is that of making young female servants your wives. They are servants without pay who cannot run away! and a well-to-do man here with large farms, cattle, vegetables and other produce of all sorts for distant and near markets, has plenty for wives to do, if he will take the trouble to teach *and then* rule them.

Of 'the extreme finger-end of civilization', as he described Georgetown, he says the streets are better watered than at Kew, people sleep without locks to their doors, the fire-engines are well manned and in capital order, and there is no end of food. Smallpox had been raging in a neighbouring mining village and the authorities sent the bed and bedding of the sick to the capital city (of about fifty houses) to be stored there for the casual poor. No heed was paid by the authorities to a vigorous remonstrance sent by the citizens and these then set fire to the building. The alarm bells were rung but the fire-

brigade refused to turn out, and so infection was stamped out by 'lynch law'.

In a letter to Professor Daniel Oliver of Kew he gives his impressions of the manners, social life, etc. of the Americans, acknowledging that they are based on superficial observations:

> The New Englanders are most like us in language, speech, and habits, and have least of the nasal twang, which is simply obtrusive and detestable. As a rule I find the Americans too loquacious, for ever praising themselves and introducing you to *most* remarkable men. They think the curious things of their country have no parallel with us, and forget how 'Colonial' they appear to us. Their high sharp voices, and of the women especially, is the most grating feature of their life to us. In other respects they are superior to us, as in education, civility, great desire to oblige and take trouble for you,—decent cleanly manners, clean shirts and a far superior condition and manner of the official and subofficial classes attached to public conveyances and to Hotels, &c. These people are most universally well conducted, civil and obliging to all, far more so than with us. . . . The Americans are great and promiscuous eaters, and are too fond of talking of their foods. . . . Beds are remarkably clean and good but the pillows are too soft.

Many things have changed on both sides of the Atlantic since 1877 but it is interesting to have observations on the people and conditions in the U.S.A. when development westwards was still incomplete.

Several papers were published by Hooker as the result of his North American journey. In a short article in *Nature*, vol. 16 (1877), he refers especially to the section of the Rocky Mountains in Colorado and Utah and points out that it contains representatives of very distinct American floras, that are respectively characteristic of immense areas of the continent. He says:

> There are two temperate and two cold or mountain floras, viz.: (1) a prairie flora derived from the eastward; (2) a so-

called desert and saline flora derived from the west; (3) a sub-alpine; and (4) an alpine flora; the two latter of widely different origin, and in one sense proper to the Rocky Mountain ranges.

The North American flora is briefly referred to in his presidential address to the Royal Society in 1877, *Proc. Roy. Soc.*, vol. 26 (1878). It is more fully dealt with in a lecture given to the Royal Institution of Great Britain on 12 April 1878 and printed under the title 'The Distribution of the North American Flora', *Proc. Roy. Inst.*, vol. 8 (1879). The principal characters of the flora are given under a number of geographical or phytogeographical divisions and of these the following is a very brief résumé:

Polar area. The Arctic American flora is on the whole a uniform one though it is divisible into three sections: (1) from Bering Strait to the mouth of the Mackenzie river; (2) thence to Baffin Bay; (3) Greenland, which is almost exclusively European.

British North American flora. South of the Arctic flora and north of the 47th parallel this consists of a mixture of north European, north Asiatic, and American genera in very different proportions, in five meridional belts: (1) eastwards, the Canadian forest region; (2) the woodless prairie region, continued from the south; (3) the Rocky Mountain region; (4) a dry region, continued from the south; (5) the Pacific region.

United States flora, with the boundaries of the meridional belts more strictly defined. Of such belts Hooker recognized the following:

(1) The *Great Eastern Forest region*, extending over half the continent, consisting of mixed deciduous and evergreen trees, and reaching from the Atlantic to beyond the Mississippi. It is noteworthy for the number of kinds of trees and shrubs (especially deciduous ones) that are

to be found in it, even on a very limited area. Thus in a patch of native forest a few miles from St Louis, in little more than half an hour and in less than a mile's walk, Hooker saw 'forty kinds of timber trees, including eleven of oak, two of maple, two of elm, three of ash, two of walnut, six of hickory, three of willow, and one each of plane, lime, hornbeam, hop-hornbeam, laurus, diospyros, poplar, birch, mulberry, and horse-chestnut; together with about half that number of shrubs'. While many of the genera are common to Europe and Asia as well as to North America very many are confined, or almost confined, to northeastern Asia and eastern[1] America, and there is further specific identity for about 230 and very close representation in more than 350. Further there are not a few singular genera of which only two species are known, one in east Asia, the other in east America; and in some of these instances the Asiatic species ranges widely in east Asia whilst the American is extremely scarce and local in east America, suggesting that the Asiatic element in east America is one that is dying out.

Hooker says there are 38 genera (of principal trees and large shrubs) common to northern Europe, northern Asia, and North America, and these include maples, ashes, hollies, elms, planes, oaks, chestnuts, nut, hornbeam, birches, alders, willows, beeches, and poplars. 33 genera are confined to America and East Asia, including magnolias, tulip tree, negundo, wistaria, Virginia creeper, gleditschia, hydrangea, liquidambar, nyssa, tecoma, catalpa, diospyros, sassafras, benzoin, mulberry, and walnut. Only one genus, the hop-hornbeam, is confined to Europe and America, with a single species in each continent. There is, he maintains, conclusive evidence of the close botanical relationship of northeastern Asia and eastern North America. Of such a relationship there is

[1] 'Western' in the original, but this is surely a slip for 'Eastern'.

little evidence in the plant life of the Prairies and Rocky Mountains, and still less perhaps in the areas farther west.

(2) The *Prairie region* is a grassy land with many peculiar herbaceous American genera, including such American types as yucca and Cactaceae, the latter increasing in number as the Rocky Mountains are approached.

The *Rocky Mountains* have few and scattered deciduous trees and open forest of conifers in the lower parts. Higher on the mountains the coniferous forests are dense, and almost the only deciduous tree is an aspen, which forms impenetrable brakes on the slopes and in the gullies. Above the forest region are the Subalpine and Alpine regions, presenting a mixture of European, Asiatic, and American types.

(3) The *Sink region* has few deciduous trees, confined to the gullies of the mountains, and Mexican genera increase in numbers. The hoary sage-brush (*Artemisia cana*) covers immense tracts of dry soil, and saline plants occupy the more humid districts. The proportion of endemic plants. especially herbaceous ones, is very large.

(4) The *Sierra Nevada* is clothed with the most gigantic coniferous forest in the world, amongst which a very few deciduous trees are scattered, but some of these are identical with trees of the eastern forests. Mexican genera occur at all elevations and extend across the Californian valley and the coast ranges to the Pacific, mixed with northern west American genera and species.

Gray and Hooker published under their joint names a paper with the title 'The Vegetation of the Rocky Mountain Region and a Comparison with that of other parts of the World', *Bull. U.S. Geol. and Geog. Survey of Territories*, vol. 6 (1882). They divided the Rocky Mountain region into three altitudinal zones ('botanical districts' and also termed 'regions') as follows: (1) an arid and woodless zone, which occupies by far the greater part of

the area; (2) a wooded zone, in some places covering, in others only locally adorning, the mountainslopes; (3) an Alpine unwooded zone above the zone where trees exist. In some places however slopes woodless from dryness merge into tracts woodless from cold, no proper forest belt intervening. A comparison is made, group by group, of the Atlantic, Pacific, and Rocky Mountain floras.

It would appear that Hooker and Gray, in the papers mentioned and in others, were in substantial agreement in explaining the major peculiarities of the North American flora. The Glacial epoch, together with certain changes in land connections, and with peculiarities of land structure are held to account for the facts. Hooker had long contended that the flora of Greenland was 'Scandinavian', that is, north European, a view not held for the entire flora of Greenland by many modern workers. He believed that previous to the Glacial epoch a flora common to Scandinavia and Greenland was spread over the whole American Polar area. This flora was driven southwards by the increasing cold but was affected differently in different longitudes. In Greenland many species were exterminated, 'as it were driven into the sea' at the southern end of the island, where only the hardiest survived. On the return of warmer conditions the survivors migrated northwards again, and the country became populated with the hardiest species of its former flora, unmixed with American species.

In North America proper the same Scandinavian plants, when driven south on the plains of the continent multiplied and were brought into competition with American species descending from the continental mountains on to the plains, and 'assumed varietal forms'. On the return of the warmth, therefore, many Scandinavian species that had been exterminated in Greenland would travel northwards, changed or unchanged, together with American species.

In this way Hooker accounted for, as he believed, the European nature of the flora of Greenland and for its relative poverty. The explanations suggested for the more striking features in the phytogeography of North America were those of Asa Gray, although accepted by Hooker and in conformity with those he had expressed personally. It was held that in Miocene times many of the existing genera and even species of both the Japanese and North American floras coexisted in the high latitudes of America, and it was assumed that during this period the three northern continents were conjoined or so contiguous as to allow a commingling of their floras. There was a cooling of the climate through the Pliocene, culminating in the Pleistocene glaciation. The change was so gradual that plants were not exterminated but driven southwards, followed in the rear by the Arctic vegetation. As the temperature rose again when the ice retreated this flora mainly returned northwards, though some Arctic and Subarctic plants remained on the mountains of both east and west North America. This explanation still leaves the absence or rarity of eastern Asiatic types in western North America and their replacement by southern (Mexican) types to be accounted for.

Gray pointed out that the western half of the North American continent is enormously elevated as compared with the eastern and must have been well adapted for the retention of vast bodies of ice for long after the Glacial epoch. The lofty mountains were clothed with ice and the broad valley was occupied by a vast lake. On the uppermost shelves cut by the waters of this lake on the flanks of the Rocky Mountains and Sierra Nevada the skull of the musk-ox, the most Arctic of land quadrupeds, has been found. The whole region must have retained its glacial character for an incalculable period after eastern North America had been sufficiently re-warmed to allow

the return northwards of the plants driven southwards by the oncoming of the Glacial epoch. These glaciated conditions barred a similar return of the same plants in the western meridians and they must have perished on reaching southern California. Ages later, when the western ice disappeared and the climate of the valleys warmed, the Mexican and other southern plants would advance northwards till they encountered the boreal vegetation of northwestern America, with which they then commingled. There were of course some exceptions to these generalizations, and even in western North America some essentially eastern Asiatic types (or what are now such) escaped destruction.

Publication of the *Royal Botanic Gardens, Kew, Bulletin of Miscellaneous Information* was commenced in 1887 when Thiselton Dyer was Director, but in the archives at Kew there is a document signed by Joseph Hooker, dated 1 January 1885 (nine months before his retirement), in which a proposal for such a periodical is worked out. This was apparently submitted to the authorities. It was proposed by Hooker that it should mainly publish important facts and documents relating to commercial and economic subjects which 'from time to time pass through our hands at Kew'. Following the suggestion of Hooker the first few volumes dealt entirely or mainly with matters concerning economic botany, including pests and diseases of cultivated plants. More and more scientific-research papers appeared in later volumes and in 1946 the title was simplified to *Kew Bulletin*.

Chapter 9

Life after Retirement

Joseph Hooker's youngest son, Richard, was born in January 1885. Hooker definitely resolved to resign the Directorship of the Royal Botanic Gardens, Kew, early in October of the same year, and he retired at the end of November in his sixty-ninth year. He had held the post for twenty years and for ten years previously had been Assistant Director to his father. Though still hale and full of vigour he greatly desired to be relieved of official administrative duties and to be able to devote his whole time to research and to completing various botanical studies and publications, above all his work on the flora of India. There was some haggling by the Treasury over the scale of his pension. It is true that matters were somewhat complicated. He had been in the public service over a period of forty-seven years, seventeen in the Naval Service (1839-55) and thirty in the Civil Service under the Board of Works, though his name remained on the Navy List until 1870. The terms of his appointment to Kew included the stipulation that ten years' nominal time was to be added as a 'special award' for Kew in calculating his retiring pension. The main trouble was in regard to his naval pay. His claim to this was finally granted but the Treasury struck off the civil pension what was added to the naval, and it took the full year, to November 1886, before he was informed by the

Treasury that his pension would be paid on a certain scale.

Hooker anticipated his retirement by several years in that he purchased a piece of land near Sunningdale, Berkshire for building a private residence. To cover the purchase price he sold privately his superfluous books and collections. In letters he refers to the 'plot' as six acres of Bagshot sand, including a hill of 300 feet commanding a superb view, and in a country of Scotch fir and heather. 'The situation, 1½ miles from the station, from which I can reach Kew in 1-1½ hours, will be very convenient.' The house he built was called the Camp, since it was on the site of a camp formed after the battle of Culloden, 'the troops from which were such scoundrels that they could not be kept in the town'. The 'scoundrels' were employed in making the lake and waterfall at Virginia Water, the large stones for the latter being taken from the camp and its neighbourhood. The site where Hooker built his house was again used as headquarters when the volunteers were assembled in 1853, according to L. Huxley (vol. 2 (1918), 257), but 1853 appears to be a slip for 1859.

Hooker in a letter to Darwin refers to the proposed house as a 'Tusculum'. Tusculum being an ancient city of Latium. At, or more probably near, Tusculum was the favourite residence and retreat for study and literary work of Cicero. The exact site of his villa apparently remains doubtful. Other well-known and wealthy Romans had villas in the neighbourhood of Tusculum, especially towards the close of the Republic. No doubt Hooker's playful nickname for his new home-to-be is to be linked with Cicero's retreat. The building was completed and in the autumn of 1883 it was used as a winter home for his father-in-law, the Rev. W. S. Symonds, who had resigned his living at Pendock. Hooker's removal from Kew was spread over several weeks, during which he resided at Kew except for week-ends at the Camp.

He very soon settled in his new home and concentrated on his scientific work. For many years he journeyed to Kew on an average of three or four days a week to work in the Herbarium and Library. His major interest for a dozen years or so was the *Flora of British India* (1872-96; see p. 162). The last three volumes of this great work were issued after his retirement. He published the third and final edition of his *Primer of Botany* in 1886. The first edition had appeared in 1876 and there were reprintings of all three editions. Of the last edition there were nine reprintings in all and they continued up to 1909. He termed this publication 'the rashest and most profitable of all my undertakings'. He continued editing the *Botanical Magazine* and the *Icones Plantarum*. Two volumes of the *Icones Plantarum* were devoted to Indian orchids, Volume 21, Plates 2001-2100 (June 1890-January 1892) and Volume 22, Plates 2101-2200 (July 1892-April 1894). The text was by Hooker and the majority of the 200 plants figured and described were species new to science. The black-and-white figures were drawn and lithographed by Miss Matilda Smith.

A few years later, in 1895, another work on Indian orchids appeared, published in the *Annals of the Botanic Garden, Calcutta*, vol. 5, part 1. In this there are 101 plates of drawings reproduced by lithography and partly coloured, from originals by various Indian artists from the collection in the Calcutta Botanic Garden. The text of Latin and English descriptions and notes is by Joseph Hooker and many species are named and described as new. A fourth edition of his *Student's Flora* was published in 1897, and he also published work on the fossil *Pachytheca* at about this time (p. 48).

The 'Journal of the Right Hon. Sir Joseph Banks Bart., K.B., P.R.S. during Captain Cook's First Voyage in H.M.S. *Endeavour* in 1768-71 to Terra del Fuego,

Otahite, New Zealand, Australia, the Dutch East Indies, etc.' was published in 1896, edited by Joseph Hooker. The preservation of the text was, it is interesting to note, primarily due to Hooker's grandfather, Dawson Turner, and he writes in the Preface:

> It was when on a visit to my grandfather in 1833 that I first saw the original Journal in Banks' handwriting. It was then being copied, and I was employed to verify the copies of the earlier part by comparison with the original. I well remember being as a boy fascinated with the Journal, and I never ceased to hope that it might one day be published.

The work of editing was considerable. 'My son, Reginald H. Hooker, has aided me in the revision of the Journal and in the press work, and has drawn up the notices of the earlier voyagers and naturalists to whom reference is made by Banks.' Nearly half the original was omitted from the published volume. 'Owing also to the Journal being a diary written up from day to day, and in no way revised for publication, the grammar and orthography are in the original very loose, and I have therefore corrected the language to accord with modern requirements; the only exceptions being in the case of native words. . . .' There is a short *Life of Banks* from information supplied by B. Daydon Jackson, Secretary of the Linnean Society, who also contributed one of Daniel Solander. Reference may here be made in passing to *The Banks Letters*, edited by W. R. Dawson (1958) and printed by order of the Trustees of the British Museum.

When the *Flora of British India* was completed in 1897 the Colonial Office requested Hooker to undertake the completion of the *Handbook to the Ceylon Flora*, of which three volumes had been prepared and published by H. Trimen before his death. Hooker thought that this would be a relatively easy task for him but it occupied him for nearly three years. Part 3 (384 + iii pp.) appeared in

1898 and Part 4 (477 pp.) in 1900. This was of course taxonomic work undoubtedly based on his recently completed *Flora of British India.*

There was published in 1902 'A Sketch of the Life and Labours of Sir William Jackson Hooker' with portrait and bibliography, *Ann. Bot.*, vol. 16, ix-ccxxi. This is an excellent and in many ways valuable biography and the preparation of this record of his father's life gave Sir Joseph great satisfaction.

Hooker's masterly essay 'A Sketch of the Flora of British India' was written as a chapter for the descriptive volume of *The Indian Empire* in the *Imperial Gazetteer of India* (1907). An advance issue of the essay appeared in 1904 and there was an Oxford reprint or edition in 1906 or 1907. Hooker summarized what was known of the flora of a vast area. As in other of Hooker's publications the term 'British India' covers more than India proper. Not only are the modern states of India and Pakistan included but also Nepal, Bhutan, Ceylon, Burma, and the Malay Peninsula. The Kuram valley and British Baluchistan are treated in Appendices. Only the vascular plants are considered. Hooker states that the flora of this large slice of Asia 'is more varied than that of any other country of equal area in the Eastern hemisphere if not in the globe'. It is however doubtful if 'India be richer in number of genera and species than any other area of equal dimensions (in similar latitudes)' and 'it is certainly far poorer in endemic genera and species than many others'.

The 'Sketch' is no doubt based upon the earlier published Introductory Essay to the *Flora Indica* already mentioned (see p. 105) but it is more up to date and is largely a result of Hooker's own travels and his researches on the 'Indian' flora which culminated in the *Flora of British India.* He notes that the principal elements are Malayan (dominant), European-Oriental, African,

Tibetan-Siberian (nearly confined to the Himalaya), and Sino-Japanese. No natural order (i.e. family) of vascular plants is confined to 'India' and the endemic genera are few and mostly local and restricted to few species. 'It may hence be affirmed that in a large sense there is no Indian Flora proper.' There are few assemblages of species of peculiar or conspicuous plants giving a character to the landscape, except the rhododendron belt in the high eastern Himalaya. Indigenous palms are comparatively few. Bamboos are important, sometimes as clumps growing in the open, sometimes in association, forming all but impenetrable jungles. The taller kinds monopolize large areas in the hot lower regions and the smaller clothe the mountain slopes up to 10,000 feet in the Himalaya. Tree-ferns frequent the deepest forests of the eastern Himalaya, Burma, Malabar, the Malay Peninsula, and Ceylon.

Hooker estimated the number of species of seed-bearing plants in 'India' as approaching 17,000, distributed in 176 natural orders (families), and the vascular cryptogams at 600 species. The 10 dominant families are given in numerical sequence with those with the largest number of species first, as Orchidaceae (orchids), Leguminosae (pea family), Gramineae (grasses), Rubiaceae (bedstraw family), Euphorbiaceae (spurge family), Acanthaceae (acanthus family), Compositae (daisy family), Cyperaceae (sedge family), Labiatae (sage family), and Urticaceae (nettle family). Of palms there are more than 220 recorded species, of bamboos 120, of conifers 22, and of cycads 5. There are 10 genera with 100 species or more and of these 4 are orchids, headed by the genus *Dendrobium* with 200; the others are *Impatiens* (balsams), *Eugenia* (clove genus), *Pedicularis* (louseworts), *Strobilanthes* (a genus of the acanthus family), *Ficus* (figs), *Bulbophyllum* (an orchid genus), *Eria* (an orchid genus), *Habenaria* (an orchid genus), and *Carex* (sedges).

British India is considered by Hooker as primarily divisible into three botanical areas or regions: a Himalayan, an eastern, and a Western. The two latter are roughly limited by a line drawn meridionally from the Himalaya to the Bay of Bengal. The Himalayan area has a rich tropical, temperate, and 'Alpine' flora, with forests of conifers, many oaks, and a profusion of orchids; the Eastern has no 'Alpine' flora, a very restricted temperate one, few conifers, many oaks and palms, and a great preponderance of orchids; the Western has only one (very local) conifer, no oaks, few palms, and comparatively few orchids. The Himalayan flora abounds in European genera, the Eastern in Chinese and Malayan, the Western in European, Oriental, and African.

These three botanical areas or regions are divisible, according to Hooker, into nine botanical provinces, 'for the determination of which', he writes, 'I have, after long deliberation, resorted to the number of species of the ten largest Natural Orders in each Province as the leading exponent of their botanical differences'. The floras of these nine provinces are described in some detail and the provinces are named as follows: Eastern Himalayan, Western Himalayan, Indus Plain, Gangetic Plain, Malabar, Deccan, Ceylon, Burmese, and Malayan Peninsula.

Hooker's general review of the flora of India has not yet been superseded so far as modern India and Pakistan are concerned, but it is unsatisfactory for some of the other areas, particularly Burma and the Malay Peninsula. A long list of references to recent books and papers dealing with the botany of the whole area of 'British India' as understood by Hooker is given by Turrill (1953). Here we need only draw attention to a paper by Chatterjee (1939) in which 'India' (excluding Ceylon and the Malay Peninsula) is divided botanically into ten main divisions: Deccan, Malabar, Indus Plain, Gangetic Plain, Assam,

Eastern Himalaya, Central Himalaya, Western Himalaya, Upper Burma, and Lower Burma. Chatterjee was mainly interested in problems of endemism and deals with the dicotyledons whose genera he gives as 1,831 and species as 11,124. Of the species 4,274 (38·5 per cent) are endemic. The majority of the endemic species appear to be new (young) ones produced from stocks capable of change, and not having had opportunity or time for migration, are restricted to more or less narrow ranges.

An up-to-date flora of the Indian subcontinent is desirable. Since 1897 various local floras dealing with parts of the vast area have been published, and a good deal of collecting been done, especially in the Himalaya, but taxonomic ideas have changed and have led to improvements in taxonomic practice coupled with considerable changes in the rules (or code) of botanical nomenclature. Concomitant with the preparation of a flora there should be accumulated the data for a phytogeographical account of the area, although the final publication of this should be after the completion of the taxonomic flora. Whatever terminology be used for phytochoria (the phytogeographical subdivisions of an area), mere political divisions, if they cannot be ignored, must not be given undue preference or allowed to interfere with the areas and boundaries determined solely on the flora and vegetation. Hooker's work will always be the classic basis for such publications for 'India', but he would have been the first to welcome new attempts to summarize recent advances in knowledge and in methods and to graft the results on to his pioneer investigations.

It is very fitting that Hooker's last publication dealing with plant geography should deal with India. His travels in the Sikkim Himalaya and in the eastern part of the subcontinent were, as we have seen, of the greatest botanical importance and the *Himalayan Journals* is a book of wide

interest. The general accounts of the flora and vegetation of the great area reviewed under the term 'British India' require revision but they still have to be consulted by phytogeographers.

It was particularly in his work on the flora and vegetation of India that Hooker realized the need for taxonomic investigation of the balsams. The great genus *Impatiens* was placed in the family Geraniaceae, tribe Balsamineae, as worked out by Bentham in Bentham and Hooker's *Genera Plantarum* ((1862), vol. 1, p. 277). There it is credited with having up to 135 species occurring in Europe, Africa, Asia, and North America, most in tropical and montane Asia. It is now usual to place the genus in a distinct family, the Balsaminaceae, together with another genus, *Hydrocera*, but keeping the family within the order Geraniales. That Hooker himself favoured such a change is indicated in some of his latest papers (see for example *Kew Bull.* (1911), 209-11). In 1904-6 he published 'An Epitome of the British Indian species of *Impatiens*' in *Records of the Botanical Survey of India*, vol. 4, and this was followed by about fifteen other papers on the genus, largely dealing in one way or another with collections made in India. Six of these papers appeared in 1911, the year of his death. He was working on balsams till very shortly before the end. Up to October 1961 just over 900 species of *Impatiens*, excluding synonyms, have been named and described. Of these Joseph Hooker named 303 as new species.

His deep interest in the balsams and the care and intensity with which he studied them in the last years of his life are well indicated in a letter to D. Oliver dated 22 January 1908. The relevant paragraphs are:

> I have been at work ever since I retired on *Impatiens*, and have monographed all the Indian and Malayan species—well on to 200—and am now at China proper, from whence I have

140 species, of which not a dozen are natives of India! I do not know which is the more difficult task—to remove and dissect a flower, or to classify the species, or to describe their variable and grotesque organs for many points in which there is no technical terminology. Many single flowers of these curious species especially took 2 and even 3 hours to lay out the parts for drawing and description—and after all is done I doubt whether what I see, draw, and describe will fit in with the living flower! As it is I defy the acutest botanist to tell me from the best dried specimens whether there are 2 or 4 lateral sepals, whether the anthers are acute or didymous, or—even approximately—the true form of a single floral envelope. To get at these you must remove and moisten the flowers and spread out every organ flat *under* water. This done, I secure them all on slips of gummed paper as evidence of the fidelity? of my sketches that go with the analyses into the Herbarium; no reagent has helped me.

I have the loan of the Paris Chinese Balsams, 70 species, two-thirds different from the 80-90 species of the Herb. Kew. I find the bracts (as to situation) a prime character. Indeed, you may divide the genus into two groups, one with the lower pedicel of the raceme bracteate at the base, as in most, or ebracteate, as in *Noli-me-tangere*—the latter are few in India but abound in China. Of course the 1-flowered species puzzle you, but that is a detail!

After the bracts I think the anthers come next, but these are so small and so crushed in dried flowers that the getting at their form is often a long affair. Lastly, the sectional character of one region won't do for another; which is no wonder when you consider that of some 64 species of India W. of the Bay of Bengal not 5 are found in Burma and countries E. of the Bay, and only 2 or 3 in China.

I will bore you no further—my head is as twisted as a balsam flower and as upside down.

Of particular interest is Volume 30, Part 3 of the *Icones Plantarum*, published in December 1911. Plates 2951-2975 give descriptions and accounts of Asiatic species of *Impatiens*, many of them new species. The main figures

are by Miss Matilda Smith but the analyses are by Hooker. To dissect, draw, and describe in detail the complicated flowers of such a genus when well over ninety years of age is a very remarkable achievement.

Hooker's physical strength began to fail in August 1911. His mental powers still remained strong and clear and he continued to be keenly interested in current topics and the latest contributions to science. He died peacefully in his sleep on 10 December. The honour of burial in the Abbey was offered by the Dean of Westminster, where his bodily remains would lie besides those of his friends Lyell and Darwin. His own wish was however granted, to be buried in the family grave in the churchyard of St Anne's at Kew, beside his father and in close proximity to the institution to which they devoted so much time and energy and which they loved as being largely their own creation. He was buried on 17 December.

In St Anne's Church is a tablet to his memory, bearing his portrait medallion from a model by Mr Frank Bouchier, reproduced in Wedgwood ware and with the inscription:

1817-1911
Joseph Dalton Hooker
O.M., G.C.S.I., C.B., M.D., D.C.L., LL.D.
Associé Étranger of the Institute of France, Knight of the Prussian Order 'Pour le Mérite', sometime President of the Royal Society.
For XX years Director of the Royal Botanic Gardens, Kew.
Born at Halesworth, 30th June 1817.
Died at Windlesham, 10th Dec. 1911.
'The works of the Lord are great, sought out of all them that have pleasure therein.'

The Kew artist, Miss Matilda Smith (1854–1927) designed the five plates portrayed in Wedgwood on the

tablet. These were chosen to represent some of Hooker's chief interests and the plants depicted are *Aristolochia manii* (Africa), *Nepenthes albomarginata* (Malay Peninsula), *Cinchona calisaya* (America), *Rhododendron thomsonii* (Asia), and *Celmisia vernicosa* (New Zealand). Miss Matilda Smith was a connection of the Hookers, her father having been a cousin of Sir William Hooker. She followed Walter Fitch as the Kew artist and did many illustrations for Sir Joseph, who trained her in the work, especially for the *Botanical Magazine* and *Icones Plantarum*.

In Westminster Abbey there is a profile medallion in marble of Sir Joseph, also by Mr Bouchier. This is in high relief, slightly over life-size, set within an oblong frame. It shows him in old age and is very lifelike except that it suggests a greater fullness of beard than he normally wore. It is in the north aisle of the nave in close association with the Darwin memorial.

Chapter 10

The Personality of Joseph Dalton Hooker

It is extremely difficult to describe with accuracy the innate qualities of any man, above all when this can only be done from his published and accomplished works and letters and from the impressions of those who lived and worked with him or otherwise knew him. The following attempt is based on the sifting of such material with much thought given to the whole subject. There are some certain facts mainly those of a material nature, some probabilities, and some opinions and conjectures which will be mentioned, distinguished, and considered as objectively as possible.

Certain of Hooker's physical characteristics are of importance as forming the material basis of his activities. He lived to be ninety-four and there are in existence a number of portraits and photographs of him at different ages. The photographs are of course accurate within the limits of what they show, but some of the early portraits appear to be somewhat idealized if not rather imaginative and even fanciful. William Taylor's sketch (1849), of which there are several copies in existence with variations, of *The Botanist in Sikkim* should not be taken too seriously. It shows Hooker seated against a background of mountains and trees, with native collectors and servants, some kneeling, some showing him inflorescences of rhododendrons,

and some collecting, while two are apparently on guard. Hooker is peculiarly dressed in a kind of turban hat with what may be a dressing-gown over a smart suit. His face is clean-shaven and calmly serious. In the portrait collection in the Kew Herbarium there is a print, from a sketch by William Tayler (1849), of Hooker at the age of thirty-two. This shows Hooker wearing glasses and with a serious expression on his face. The hair is rather long and sharply parted on the left. The eyebrows are well developed and there are short whiskers around the sides and on the lower part of the chin, a style of treatment of facial hair growth he maintained through the later years of his life except that the whiskers and eyebrows became more bushy. The portrait by George Richmond dated 1855 shows a youthful, thoughtful, and even dreamy face, somewhat on the sad side, clean-shaven but with full, long, hair on the head and sides (Pl. 1). By 1870, as shown by the photograph of the group (including Joseph Hooker and Asa Gray) encamped in the Sierra Sangre de Cristo of Colorado (Pl. 15), he had grown long side-whiskers, and, judging by the sketch dated 1870, he still had a good head of hair then. A sketch of Hooker in his study at Sunningdale, 1886, a few months after his retirement from Kew, shows him with the same surrounding whiskers but with the hair on the head becoming thinner above the forehead. The portrait at the Linnean Society (by Sir Hubert von Herkomer, 1889) and the photograph taken at the Darwin Centenary (1909) shows the same features but with increasing baldness. It is unfortunate that a number of the photographs of Hooker in the Kew collection are not annotated with the dates at which they were taken.

He was above average height though not so tall as his father, who was over 6 feet in height. His son-in-law, W. T. Thiselton-Dyer, gives his height as 5 feet 11

inches and describes his figure as spare and wiry. From his length of life and from his very considerable and diversified activities one would conclude that he had a basically strong constitution. Sir William Hooker's family consisted of two sons and three daughters and there was definite susceptibility to tuberculosis in the family. The eldest child, William (1816-40), shortly after his early marriage was threatened with the disease and was sent to Jamaica, where he died of yellow fever. One daughter, Mary Farriet (1825-41), died of consumption and another, Elizabeth (1820-98), recovered from it. The eldest daughter, Maria (1819-89), apparently was resistant and helped her mother to nurse her sisters. It is recorded that Joseph as an infant was 'croaky Joe', with a tendency to cough and croupy hoarseness. Members of the family thus seem to have been subject to two inborn tendencies, one a susceptibility to tuberculosis and the other considerable longevity, and if the former was overcome in early life the latter was allowed full expression. This is not to say that Hooker never suffered from any illness or disability. He had what is described as 'a nervous irritability of the heart which from his school-days brought on palpitation when he stood up to construe in class'. It is possible that some of the later heart trouble was related to a sharp attack of rheumatic fever, caused, it is stated, by lying on the damp grass at lunch when overheated in Madeira near the beginning of the Antarctic voyage. In later life the delivery of an address could occasion physical nausea and severe nervous reaction. He complained of 'the frequency and pain of my palpitations' and consulted doctors on the matter both before and after his Antarctic voyage. In 1848 he wrote from India in a letter to Darwin:

> With regard to my health, it is exactly the same: I am still troubled at times with those bothering pains on the left side and palpitations, aching in the axilla and occasionally down the arm.

The motions of the heart are on these occasions very irregular, but I have no ringing in the ears, shortness of breath, or any symptoms that alarmed me. Hot or cold days make no difference, and indeed I had a long cessation of all pains for three weeks after my arrival, that I thought the hot weather had cured me. Whatever it is I am *none the worse* of being here, otherwise I never had better health, am thinking of getting fat, and hardly know what a headache is.

He was short-sighted and this was the reason for wearing glasses, but otherwise his eyesight was excellent throughout life. In the latter part of his life he suffered from eczema, which hindered his walking or standing for periods to examine botanical specimens. He had a severe attack of influenza in 1900 and suffered from bronchitis apparently in the same year. His hearing was somewhat impaired in his later years. He never suffered from continuous or even very prolonged periods of ill health, in this contrasting with his friend Darwin after his return from the *Beagle* expedition. He was fortunate in being a good traveller, in that he never suffered from seasickness and became very quickly acclimatized to the quite considerable altitudes he reached in the Himalaya. That he botanized, explored, and surveyed for long periods in Sikkim and that his exertions on his travels, especially in India, were considerable is surely proof of his great stamina and that his heart trouble was not physically serious though there was some irregularity in heart action. At eighty-three he yielded to his doctor's orders not to travel alone.

The love of family life and deep family affections within the closeness of family ties were Hookerian characteristics. We noted in our first chapter the close connections between Sir William Hooker and his son, and there is ample evidence of the affection Joseph felt for his mother, brother, and sisters. Letters he wrote on the Antarctic

voyage refer to his dreaming of telling of what he had seen to his father, mother, and brother, 'while grandpapa and my sisters will look back upon me as "the monkey that has seen the world" '. His grief over the deaths of his brother William and of his sister Mary Harriette was deep and sincere. He described his family circle as 'the seven persons I really love'. It is true that for two long periods of about four and nearly three and a half years respectively he was on his distant travels in the south and in India and that he married soon after his return from the east. Nevertheless the family ties remained till broken by death and were always looked back upon with wistful happiness.

Hooker's two marriages were happy ones. By his first wife he had six children who survived her death (four sons and two daughters), the first child being born in January 1853. By his second wife he had two sons, the second of whom was born in January 1885 when he was in his sixty-eighth year, the year in which he retired from the Directorship of Kew. He was happy and behaved well in all domestic arrangements as son, husband, and father.

Love of children was a strong feature in his make-up. The sudden death of his small daughter Minnie on 28 September 1863, at the age of six, was a great blow to him, as is feelingly revealed in letters to Darwin. In one dated 1 October 1863 he wrote:

> I have just buried my darling little girl and read your kind note. I tried hard to make no difference between her and the other children, but she was my very own, the flower of my flock in every one's eyes, the companion of my walks, the first of my children who has shown any love for music and flowers, and the sweetest tempered, affectionate little thing that ever I knew. It will be long before I cease to hear her voice in my ears, or feel her little hand stealing into mine; by the fireside and in the Garden, wherever I go she is there.

He was a great botanist, a great traveller, a great worker, but he was very human. In another letter, written a little later, he says:

I am very well, but it will be a long time before I get over this craving for my child, or the bitterness of that last night. To nurse grief I hold is a deadly sin, but I shall never cease to wish my child back in my arms, as long as I live.

One of the nursery games he used to play with his son Joseph Symonds, the elder son of his second marriage, was to be a lion, his beard representing a shaggy mane, and their pet names for each other were Old Lion and Little Lion (later, Cub). Professor F. W. Oliver, who spent much of his early life at Kew when his father, Professor Daniel Oliver was Keeper of the Herbarium and Library (1863-90) and lived at 55 The Green, Kew (Herbarium House), says that in his childhood Hooker was a familiar figure in the Gardens, going his daily round between eleven and one o'clock. He always had a cheery word for the children and took an interest in their pursuits.

I remember one day his challenging me to swarm up one of the wire stays of the great flagstaff, and, when my feet dangled over his head, his peremptory request that I should descend. I don't know whether Hooker was what would be called 'a children's man', but we were all immensely devoted to him; perhaps because he kept our individualities distinct and identified himself with our interests. In his own house on the occasion of children's parties, and my recollection of the Christmas parties with 'tree' and magic lantern-slides is vivid, Hooker, although he didn't hang about, always came in to welcome us on arrival, and to say good-bye. I have also seen him emerge as a roaring lion from under the drawing-room table, and a very good lion, too!

Sir Julian Huxley told the present writer that he was

taken as a very small boy by his grandfather, Thomas Henry Huxley, to meet Sir Joseph. He was somewhat awed but always remembered the demonstration of Sir Joseph's great entertainment for children. This was to pull down to their full length his very long eyebrows, cross them, and place their ends under tension between his lips, and then by opening his mouth to allow the hairy coils to spring back suddenly to their normal position.

Hooker's letters to his son Joseph Symonds from his schooldays onwards have been preserved as *The Lion Letters* and are referred to, with extracts, by L. Huxley ((1918), vol. 2, p. 367 seq.), and according to him they are full of affection and would keep complete touch between home and school, while guiding the boy's mental growth. The dog and the pony are not forgotten in the letters and natural history is much to the fore, it being expected that the boy would become a botanist. Drawing is strongly encouraged as a means of acquiring accuracy. The father obviously tried to visualize the boy's life at school and to understand where encouragement could best be given. He is pleased with school successes and sympathizes from his old experiences with school misfortunes.

It was a disappointment to Hooker that none of his children became a botanist. The boys did well in the Civil Service, medicine, engineering, statistics, soldiering, and colonial administration, but did not have permanent interest in any branch of biology as a pure science. A partial exception was his daughter Harriet, who married W. T. Thiselton Dyer in 1877, two years after his appointment as Assistant Director at Kew. She had considerable artistic ability and contributed illustrations to the *Botanical Magazine* when W. Fitch gave up this work and before Miss Matilda Smith became the regular artist, especially for Volume 104 (1878) and Volume 105 (1879).

Hooker had no interest in competitive sports. He was, like his father, fond of walking and in one of the Lion letters to his son he wrote, 'I hope you will inherit my powers of walking. When I was a youth of 20 I thought nothing of 30 miles and have done 60 in a day. My brother (who died in Jamaica) once did 80!' He was extremely fond of music, especially the older English and Scottish airs, good sacred music, and some operatic music. He complained that he never had much taste for Latin and Greek or any of the dead languages and regretted that he had not read more history. He had a fairly good knowledge of French and a working knowledge of German, though he found the latter laborious, and there is a story that when Darwin began German he boasted of the fact (as he used to tell) to Hooker, who replied, 'Ah, my dear fellow, that's nothing; I've begun it many times.'

A love of poetry was 'a sad deficiency'; Crabbe's poems however were his favourites. Writing to his son in one of the Lion letters in 1891 he says, 'I have often found it a great pleasure when alone with nothing to do, or when I cannot sleep at night, to recite to myself the poetry which I learnt when I was a boy. I dare say you do not know what sleepless nights are, but your turn will come.' He did a great deal of miscellaneous general reading, outside the wide range of his scientific interests. Novels, histories, biographies are frequently referred to in his correspondence, and meant 'a great relief between spells of work'. In the Hooker-Darwin correspondence there are frequent references to novels. Thus in April 1865, having received from Darwin the serial numbers of Wilkie Collins's novel, Hooker replies, 'I have nearly finished "Can You Forgive Her", and have made up my mind that I cannot at all do so, and don't care whether she minds or no.' Or again:

We have read Uncle Silas, isn't it creepy? and crawly too. One should have a brandy bottle and sal volatile to get through it safely alone. How splendidly the interest is kept up. Then I took the 'Mill on the Floss' and am ravished with it; what a clever person the authoress is, I like it even better than 'Adam Bede'. How evidently the authoress belongs to the class of life of her heroines, with whom first love is an animal passion with nothing to elevate it. How splendid are her analyses of the mixed motives of human action in the young, but not in the old, and yet how vividly she represents the acts and conversations of the old.

In 1897 he writes, 'I have been going through a long course of Boswell's Johnson, and of Boswelliana.' Many other references to his interest in general literature could be given.

In the latter part of his life Hooker had great pleasure in collecting Wedgwood ware, especially plaques and medallions, and as early as 1863 wrote, 'I do assure you without joking, Wedgwoods are an unspeakable relief to me. I look over them every Sunday morning, and poke into all the little second-hand shops I pass in London, seeking medallions.' Through Darwin, who was related to the Wedgwoods,[1] he made the acquaintance of the Wedgwoods of Etruria and visited them there. By 1894 in his Wedgwood collection he possessed complete breakfast and dessert services in the rare water-lily pattern, and at the request of William Erasmus Darwin he spent some time and trouble in attempting to trace the origin of the design. He sold some of his Wedgwood collection in 1895, apparently to W. E. Darwin, but some was returned to him. That same year he visited his friend Godfrey Wedgwood in Staffordshire and went over

[1] Robert Waring Darwin married (18 April 1796) Susannah, the eldest child of his father's friend, Josiah Wedgwood of Etruria, and Charles Robert Darwin was their son. Also Charles Darwin married his cousin Emma Wedgwood and was thus closely and directly and also by marriage related to the Wedgwood family.

Etruria and saw all the processes of making the ware, and attended the opening of the exhibition of old Wedgwood ware at the Wedgwood Institute at Burslem. His comments (in a letter to Ayerst Hooker, 30 June 1895) on what he considered the great merit of Wedgwood ware, the 'Adaptation to Purpose', are worth quoting:

> Wedgwood ware plates always had a sunk border for salt and mustard; whereas in ordinary plates, these condiments shoot into the gravy. And a better example can be drawn from the modern earthenware teapot; in lifting this, the first thing is that you scald your knuckles against the body of the pot; secondly, the lid shoots off—example, you scald the finger of your other hand, by pressing on it; thirdly, the tea shoots out and spurts out and splashes over the teacup; fourthly, the spout dribbles when you set the pot down. Now in a Wedgwood teapot, first there is room in the handle so as not to scald your knuckles; secondly, the lid won't fall off till the pot is held actually vertically; thirdly, the handle is so placed, that by a turn of the wrist, the tea leaves the spout gently, and without your having to lift your elbow at all; fourthly, there is no after dribble from the spout. I have tested these points in scores of the Wedgwood pots, and the same care *in adapting to purpose* is displayed in every pot, jug, or plate, or other article that he made. You may pile plate upon plate of old Wedgwood from floor to ceiling, and the whole forms a rigid column; and you never can spin one of his plates in another.

This quotation is not given here as an advertisement for Wedgwood ware or even to laud it but to illustrate Hooker's appreciation of utilitarian craftsmanship and his powers of observation in matters somewhat remote from botany.

As an artist he had very considerable abilities, as shown by many of the originals of his drawings and paintings preserved at Kew. As reproduced in his various works, the *Botany of the Antarctic Voyage*, the *Rhododendrons of Sikkim-Himalaya*, the *Himalayan Journals*, etc., his

originals were much worked up by W. Fitch; many of the plant plates were in fact entirely redrawn by Fitch using Hooker's sketches, notes, and specimens. Even some of the originals of landscapes and non-botanical subjects appear to have been 'worked over' or 'touched up' by Fitch. Nevertheless in choice of subjects, in their basic treatment for illustrations as well as in actual depiction, there is much artistic merit. As a botanical artist he perhaps was not the equal of his father but he was exceedingly good in dissecting and in drawing his analyses. He frankly loved dissecting and there are uncounted numbers of his drawings of flower analyses on, or stuck on, herbarium sheets at Kew. The first plant he ever dissected is recorded to have been a moss.

Hooker was not renowned for oratory. This was partly due to the nervous symptoms from which he suffered at times when he had to speak to an audience and partly because he had no desire to appeal to a wide public in any way. Although he had very decided, often extremely sound, and in some respects advanced, views on education, and especially on botanical education, he was not a good teacher in the ordinary academic sense. He was a good trainer for individuals with innate abilities but apparently could not, and did not desire to, popularize his subjects. Throughout his life he retained something of the Scottish intonation acquired in his youth. He is said to have been an excellent chairman, as he was for many years to the Scientific Committee of the Royal Horticultural Society.

He was only mildly interested in party politics. In one letter to Asa Gray he describes himself as a Whig (if anything) while another political description was 'a philosophic Conservative, a strong Unionist, but not a Tory'. Clearly to define what this means would require at least a long consideration of the politics of the Victorian era. He was not a party man but had a deep friendship for

example with the Rev. J. D. La Touche, a Shropshire clergyman, who coached three of Hooker's sons, and who was a Radical.

The household of Sir William Hooker had a definite religious atmosphere and there is no doubt that his son was in the earlier part of his life deeply, quietly, and consistently religious. This is shown in several letters written from the Southern Hemisphere, as for example in reference to the death of his brother William he writes, 'little as wordly affairs have to do with the state above, I can never divest myself of the idea, that one, though a small share of the pleasures that attend the good, is the meeting of those whom our God and duty have sanctioned our loving'. It is probable that effects of his early religious upbringing lasted throughout life in that he retained certain fundamental religious beliefs, and so far as the available evidence indicates, could at no time be considered an atheist or a general religious agnostic. On the other hand he was very modern in his objections to some dogmas. Thus in a letter to the Rev. J. D. La Touche he writes (24 December 1893):

> How many medical men do you suppose believe in the doctrine of the Incarnation? A medical man's faith in a doctrine that contradicts his daily experience of obstetric practice, must be strong indeed; a thousand times stronger than that of non-medicos.
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> It has often struck me that had the biological sciences preceded or run abreast with the mathematical and classics, we should long ago have had a religion of pure reason, such as Huxley has sketched at the end of one of his essays—I forget which. As it is, biological science is hardly a century old, and just see what havoc it is making in doctrinal religion.

He had a critical dislike of theological dogmatism and of sacerdotalism and never took part in religious controversies of a denominational kind, but he gave support to

liberalizing movements in the Church of England. Probably his religious standpoint, especially in the latter part of his life, is best described as sincere, internal, and not superficial, in many ways unorthodox or not fully orthodox by Anglican or any other denominational standards, and perhaps rather vaguely formulated even to himself. One reason for this was that he was not practised in metaphysical philosophy or indeed interested in it. It is worth recalling that to listen to good sacred music (e.g. some of Handel's) was one of his great pleasures. He had considerable interest in the history, philosophies, and religions of Asia, particularly of Buddhism and its resemblances to and differences from Christianity. He discussed the matter with the Rev. J. D. La Touche. Thus:

> I cannot understand the Church ignoring the teaching of the Buddhists, and overlooking the startling fact, that it has taken over all the Buddhist worship, vestments, appointments, litany, orders of priesthood, nunneries and convents, &c., &c. *en bloc*. . . . Did the Christians absorb all of Buddhism but Buddha and his miracles, or did the Buddhists turn Christians *en bloc*, retaining their ceremonial? and when did it happen?

He discusses the published legend of the 'Buddhist Life of Jesus' and described it as 'a Lame story', though he thinks Jesus may have come into contact with Buddhist pilgrims or monks and from them derived certain teachings of Buddhist doctrines, proverbs and parables, rules of life, duty, and so on. He recognized the whole matter as highly speculative but obviously enjoyed (in the 1890s) considering it. He also considered T. H. Huxley's essay on the 'Evolution of Religion' to be 'most remarkable' and as giving 'an astonishing idea of his grasp of mind, powerful reasoning, and admirable style. Certainly no one, theologian or other, has brought the subject before the ordinary reader in anything like the persuasive manner and rhetorical power he displays.'

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He discusses the published legend of the 'Buddhist Life of Jesus' and described it as 'a Lame story', though he thinks Jesus may have come into contact with Buddhist pilgrims or monks and from them derived certain teachings of Buddhist doctrines, proverbs and parables, rules of life, duty, and so on. He recognized the whole matter as highly speculative but obviously enjoyed (in the 1890s) considering it. He also considered T. H. Huxley's essay on the 'Evolution of Religion' to be 'most remarkable' and as giving 'an astonishing idea of his grasp of mind, powerful reasoning, and admirable style. Certainly no one, theologian or other, has brought the subject before the ordinary reader in anything like the persuasive manner and rhetorical power he displays.'

Hooker was not greatly inclined to the study of philosophy in the sense in which this is usually understood. There is no evidence that he read and pondered the works of Berkeley, Hume, Kant, and the various other standard philosophers. He was eminently practical in his outlook on the majority of matters and was a consistent optimist, holding that the balance of life is always on the side of enjoyment. He was extremely cautious in reaching conclusions and even disliked wide generalizations. His greatest enjoyment, even in his botany, was in tackling a concrete problem or in bringing concrete examples into relationship with wider problems.

His love of actual dissecting and careful describing is another aspect of this preference for the actually visible rather than for philosophical interpretation. This does not mean that he did not search for causal relationships and within limits for generalizations, both within the realm of botany and in other subjects. It is however apparent that he was less interested in the general and the abstract (in the sense of separated from matter) than he was in the thing or the limited problem before him. With some truth it may be said that there are two exceptions of major importance to this statement: his interest in and writings on phytogeographical matters and those on 'species questions'. On the former he was a master in his day, on the latter he was a John the Baptist to and later a protagonist of Darwin. He was always cautious and unwilling to commit himself irrevocably to any generalization until he had had time fully to consider and weigh all the evidence, and, more important, to test it by considering how his own wide experience fitted with or contradicted the hypothesis or theory formulated as a generalization. He had great stores of knowledge, a good memory, fine critical powers, and good judgment.

His experiences were unusually varied: as a traveller,

explorer, and field worker in many parts of the world and in two major expeditions; as a working scientist in more than one branch of botany for considerable periods; as a horticulturist dealing with living plants in very large numbers of many systematic and ecological kinds; and as an administrator on the one hand with a large staff and a great institution to administer and on the other a continual contact with persons high up in Government. Because of his critical powers, his liking for the concrete, and his very wide experience and knowledge, his advice was much sought and greatly valued. It is perhaps not unjust to suggest that if Joseph Hooker had been more philosophically inclined and trained, and if he could have been relieved of the enormous burden of administration during the middle years of his life, he might have advanced biology on the theoretical side to an extent comparable to the contribution of Darwin. It has indeed been suggested that he knew more about species than did Darwin.

In temperament Hooker is said to have been nervous and highly strung and he has been described as sometimes hasty. He was always extremely critical of what he regarded as bad craftsmanship. He possessed great powers of physical endurance and could work continuously for long periods and with a small amount of sleep. He said himself that he worked sixteen hours a day and had never done less. One has of course to know the content of the word 'worked' before being able fully to appreciate the significance of the statement. He was very versatile and was sometimes designated 'the versatile Hooker' from his broad sympathies with so many domains of knowledge, there is some truth in applying the phrase 'Versatility is the relaxation of genius' to Hooker (see *The Gardeners' Chronicle*, 3rd ser., vol. 50 (1911).

Naturally, from his position as Director of the Royal Botanic Gardens, Kew, from his extensive travels, and

from his reputation in science, Hooker had a very large number of acquaintances and correspondents. There is a huge Hookerian correspondence at Kew, a considerable proportion being in the handwriting of Sir Joseph. Of his personal friends special mention must be made of Charles Darwin, Charles Lyell, Thomas Henry Huxley, and the Rev. J. D. La Touche, and, among botanists, of George Bentham and Asa Gray.

Darwin was his closest friend for many years, apart from members of his own family. Their intimacy is evident from the numerous letters of each to the other of which many have been published. They found one another's company extremely congenial and stimulating. Darwin used Hooker as a source of botanical information and as a critic of theory and interpretation—and Hooker liked being so used. In the field of broader scientific discussions Hooker found relief from the burden of administration and change from the continuity of taxonomic descriptions. The greater part of the interchange was by correspondence and by Hooker's visits to Darwin at Down. Hooker's book *Himalayan Journals* is dedicated to Charles Darwin 'by his affectionate friend', from Kew, 12 January 1854. Regular correspondence commenced after Hooker's return from the Antarctic voyage, and his working out of Darwin's botanical collections from the Galápagos Islands made an intimate link between them. Very soon their letters became more and more informal, with such endings as 'Ever yours affectionately'. That the friendship extended beyond matters of scientific interest is shown again and again in the published letters.

One aspect of Hooker's correspondence with Darwin and with some other of his friends (as Asa Gray) is the sense of playful humour which constantly appears. There was a considerable amount of leg-pulling and at times some witty and pithy expressions and sentences. The fun

was mostly very good-natured and even outbursts against a third person were not always meant to be taken literally. Quite often they served as a safety-valve when frustration was acutely felt but could not be shown directly to officials in power. A very typical paragraph of playful writing is in a letter to Darwin (6 January 1863), as follows:

> It is rather jolly, this writing about matters non-scientific—let's give up science when you have done the three vols., and take to gossip. I quite agree with you, that a holiday is an unendurable bore, but depend on it, that is because we have no vices to indulge in, and if you will only join me in some good vice, such as talking about and writing about what will do no good to our neighbours and some harm to ourselves—we shall get on capitally, and scratch away.

All this is not to mean that there was invariably complete agreement on every subject between the friends. Darwin asked for and received full criticisms on matters botanical or on views that had reference to botany. Outside scientific matters also there were some differences of opinion. The American Civil War led to some divergence of outlook between Hooker and Asa Grey and he told Darwin, 'You and I have always differed a good deal about America.'

There was of course exchange of publications between Darwin and Hooker and the latter loaned books to his friend in his retreat at Down. There was also the frequent gift of seeds and plants from Kew to Darwin. It must not be forgotten that after the publication of *The Origin of Species* (1859) and other works up to *The Expression of the Emotions in Man and Animals* (1872), Darwin devoted more and more of his time to observations on and experiments with plants. Earlier he had worked on climbing plants and on pollination problems in orchids. Later he extensively studied insectivorous plants, the forms of flowers, cross- and self-fertilization (pollination) of plants, and, with the assistance of his son Francis Darwin,

the power of movement in plants. In working at all such problems, he received and constantly acknowledged help and materials from Hooker. Thus in the Introduction to *The Power of Movement in Plants* (1880) it is written:

> we must have the pleasure of returning our sincere thanks to Sir Joseph Hooker and to Mr W. Thiselton Dyer for their great kindness, in not only sending us plants from Kew, but in procuring others from several sources when they were required for our observations; also, for naming many species, and giving us information on various points.

Hooker's interest in the problems engaging Darwin's attention continued till the latter's death. He carried out at Kew a considerable number of experiments with insectivorous (carnivorous) plants to supplement Darwin's researches at Down.

Hooker's friendship with Sir Charles Lyell (1797-1875) was less intimate than that with Darwin, although writing to the latter (24 February 1875) he says:

> I feel Lyell's loss most keenly, he was father and brother to me; and except yourself, no one took that lively, generous, hearty, deep, and warm interest in my welfare that he did. I cannot tell you how lonely I begin to feel, how desolate, and how heavily the days, and worse still, the nights, hang on my mind and body. . . . Assuredly the sum of happiness derived from having known and loved Lyell is greatly in excess of the pain felt at his loss: the gap he filled has to be compared with the chink his mere absence for the rest of life opens.

Hooker arranged for the burial of his friend in Westminster Abbey. He had known him for some forty years and took with him on the Antarctic voyage the fifth edition of his great work *The Principles of Geology*.

With Asa Gray he held a long correspondence and met him on his visits to England. It was however Hooker's visit to North America in 1877 and their joint expedition to the western mountains, with later collaboration, that

brought them close together. Hooker had a very high opinion of Asa Gray as a botanist and their feelings were those of mutual respect and friendship rather than deep affection. Gray was an early supporter of Darwin and the theory of natural selection in spite of some early criticisms and hesitation.

Thomas Henry Huxley (1825-95) was essentially a zoologist, though he published a paper on gentians (Huxley, 1887). He was eight years junior to Hooker. The friendship lasted over forty years and strengthened with time. They had a good deal in common: early training in medicine, experience in exploring-ships within the discipline of the Navy, similar urges to unravel problems of living organisms, early acceptance and support of Darwinism, and so on. Each in his turn was President of the Royal Society and their names stand next to each other in the list of Copley and Darwin medallists. Differences were however marked. Not only was Hooker a botanist and Huxley a zoologist but the latter was, unlike the former, an excellent speaker and lecturer and a first-class teacher.

Some light is thrown on Hooker's character and abilities when his relationships with his staff at Kew are examined. He inherited a going concern from his father, under whom he had served for ten years, and was extremely conscientious in his duties at Kew. It is evident from the published Annual Reports, from manuscript documents in the archives at Kew, and from published experiences of those who were under him or in close contact with him, that he kept his finger on the pulse of all activities at Kew and very definitely directed them. There are references to daily tours round the Gardens—meaning of course other engagements permitting. He took a great deal of trouble in choosing men for the various posts under him. One has to remember that in Hooker's days there were few or no

detailed regulations for appointments at Kew or for conditions of service. Details of salaries and increments (if any) were often or usually settled for individuals, and not, as so largely now, by argument and agreement between the 'official side' and the 'staff side' for a whole class. The settlement was usually made either immediately by the Director or by application to the Treasury by the Director. The records show that Hooker frequently applied for improvement in the conditions of work and in wages or salaries of members of his staff. Frequently he worked hard for them. On the other hand he expected 'a full day's work' and would personally reprimand when he considered it necessary. There are few or no memoranda of staff discontent during the period of his Directorship of Kew, and the evidence, positive and negative, is that Hooker knew how to handle men. A similar conclusion is reached on a careful reading of the journals of his travels in the Himalaya and Morocco.

The list of degrees and honours given to Joseph Dalton Hooker is a very long and impressive one. L. Huxley ((1918), vol. 2, pp. 509-17) lists 203 'degrees, appointments, societies and honours', from his Glasgow M.D. of 1839 to the Darwin-Wallace Medal of the Linnean Society of 1908. Here there may be mentioned: Fellowship of the Linnean Society, 1842; Fellowship of the Royal Society, 1847; Royal Medal (R.S.), 1854; D.C.L. Oxford, 1866; LL.D. Cambridge, 1866; Companion of the Most Honourable Order of the Bath, 1869; President of the Royal Society, 1873; LL.D. Glasgow, 1873; knighthood of the Royal Swedish Order of the Polar Star (Riddar Nordstjerne Orden), 1873; Knight Commander of the Most Exalted Order of the Star of India, 1878; Copley Medal (R.S.), 1887; Darwin Medal (R.S.), 1892; Victoria Medal of Honour (R.H.S.), 1897; Knight Grand Commander of the Most Exalted Order of the Star of

India, 1897; and Order of Merit, 1907. On the occasion of the bicentenary of the birth of Linnaeus in 1907 the Swedish Academy of Sciences awarded him the one specially struck Linnean medal as 'the most illustrious living exponent of botanical science'. After his death he was chosen by the Japanese as 'one of the twenty-nine Heroes of the World that Modern Time has produced' (see *Proceedings of the American Academy of Science*, vol. 62 (1928), 266).

Sir Joseph Dalton Hooker left estate of the gross value of £36,861, of which £32,390 was net personalty. The testator left £100 each to the Linnean Society of London and the Scientific Relief Fund of the Royal Society of London. His extensive library of botanical books, scientific voyages, and works on other branches of science were advertised to be sold by Messrs Sotheby, Wilkinson, & Hodge at 13 Wellington Street, Strand on 17 May 1912, but no account of the actual sale and the amount realized by it has been traced.

Chapter 11

Joseph Hooker's Position in the History of Botany

This attempt to outline the life and work of Joseph Dalton Hooker has involved consideration of his parentage and upbringing, of his travels and botanical explorations, of his research work, of his administration of the Royal Botanic Gardens, Kew, and of his innate abilities and character. A long life of ninety-four years, a varied life with the central theme his love for botany, and a happy life without interruptions by world wars was his lot. In this final chapter we wish to reflect on his achievements as a botanist in relation to the growth of our knowledge of plants through much of the nineteenth century into the twentieth, and to ask if his influence is still felt and how far it has been beneficial. It is difficult to displace oneself in time and to think and feel as one who lived and worked long ago. Yet to criticize only from a modern standpoint the positions reached decades earlier may result in false conclusions.

Botany, the scientific study of anything to do with plants, is an enormous subject and it was impossible even in Hooker's time for anyone to be a specialist in every branch. Botany is dynamic not static and its growth has involved a steady accumulation of facts and modification of theories, and also spurts due to specially important discoveries (e.g. of the pteridosperms, of Mendelism, or

of natural selection). In other words the evolution of botany has been gradually continuous and mutational with occasional large mutations. Hooker's own contributions to the advance of botany were in four main fields: collecting and exploring, taxonomy, plant geography, and administration. As an administrator at Kew he carried on where his father had left off, and the developments for which he was responsible were considerable but not dramatic and were such as might be expected from an able administrator holding the position of Director for twenty years. His researches in botany are summarized under the headings of taxonomy and phytogeography.

His work as a taxonomist consistently aimed at a uniform standard of generic and specific definition and adequate description, with a keen appreciation of 'affinity' based on considerable morphological insight. His most important taxonomic contributions were in the realm of the seed-bearing plants but in the earlier part of his life he did a considerable amount of work on some of the cryptogamic groups, especially on mosses. He made one broad generalization, that species were variable—often very variable—and he reached this conclusion from his own experiences and before the publication of the theory of natural selection, and indeed independently of evolutionary views. He recognized that, distinct from fluctuating variations due to immediate reactions to environmental differences, the variations of particular taxonomic importance were, as we should now call them, genetic. It is true that the variations within a 'species' were often to Hooker more numerous and morphologically more marked than they are to us, because he was more of a lumper than are most taxonomists today. On the other hand much larger collections and more intensive study by improved methods confirm that a great amount of variation of a mutational nature within a sexually reproducing

species, however narrowly defined, is the rule. It is indeed very much greater than is indicated in most descriptive floras. This occurrence of genetic variations is essential to the theory of natural selection, and for plants Hooker knew it occurred and summarized his findings in the axiom 'That species vary much more than is generally admitted to be the case', as early as 1853, and returns to the theme again and again in his writings.

Hooker of course was not the first to recognize variants within a species. Linnaeus accepted such for a considerable number of species, freqeuntly designating them by Greek letters. Nor was he able to investigate in detail what is meant by intraspecific variation. It is only within recent years that attempts have been made to do this, and methods, terminology, collection of data, and correlation of results still have far to go before widely valid generalizations can be made. Maybe 'variation' is different in kind and degree in different groups of plants or it may mean something different to different investigators. What Hooker did was to call attention to its widespread occurrence in plants notably in his Introductory Essay to the *Flora Novae-Zelandiae*. Some aspects of intraspecific variation have since been intensively studied in the New Zealand flora and the results confirm and greatly extend Hooker's conclusions.

To descriptive taxonomy Hooker contributed a very great deal in preparing and publishing, often with excellent illustrations, accounts of species and genera new to science. He also did much to increase and maintain a high standard of clarity, uniformity, and conciseness in descriptions. Excellent examples of these virtues are the generic descriptions in the *Genera Plantarum*, though their planning and execution were shared with Bentham. The vexed question of lumping and splitting may be illustrated by genera from the Rosaceae. Nowadays there is a

general tendency to split the larger genera as accepted by Hooker. Thus from *Spiraea* proper are separated at least *Aruncus* and *Filipendula*. *Pyrus* is often much divided, as into *Pyrus* sensu stricto, *Malus*, *Sorbus*, *Mespilus*, *Chaemomeles*, and *Cydonia*. On the other hand, and somewhat strangely in contrast, *Prunus* is still often (not always) retained in the broad sense in which it was accepted by Hooker, to include *Prunus* sensu stricto, *Amygdalus*, *Armeniaca*, *Cerasus*, *Laurocerasus*, etc. There is no doubt that as far as possible Hooker liked to have clear-cut well-defined differences between what he accepted as different genera or species. He would certainly have been adverse to any tendency to over-splitting at any level. This matter is still debatable and probably will not be settled until some basis of classification more nearly consistent with evolutionary ideas than the Linnaean has been devised, tested, and accepted.

It is impossible to separate the parts played by Bentham and Hooker in the general scheme of the *Genera Plantarum*. We have already seen that Bentham did more than Hooker in the actual describing of families and genera and arranging the latter, but so far as we know equal responsibility rests on Hooker for the choice of basic principles and for the sequence of families. The great advance made in the taxonomy of the seed-bearing plants by the *Genera Plantarum* was in the care taken to prepare the descriptions of genera and families (orders) on a uniform basis from the actual examination of specimens. The descriptions are models of accuracy and their originality raised the whole work to a peak of excellency of its own which has never been exceeded by subsequent work of a truly comparable nature. It is doubtful if even a most careful and critical analysis would enable a valid distinction to be drawn between the descriptions of Bentham and those of Hooker in this great work. It is fitting that the

honour of producing it should be shared in alphabetical order without other distinction.

The great contributions of Hooker to Indian botany must be emphasized. These, apart from later research on *Impatiens*, culminated in the *Flora of British India* and in *A Sketch of the Flora of British India*.

It may be asked why, having accepted the general theory of evolution and the Darwinian account of natural selection, with some reservations, Hooker did not attempt to work out a classification of plants on evolutionary principles. To this question one can only suggest answers, any or all of which may have had some influence with him. First, there was his clear principle that classification was essentially a practical matter: that it was to enable botanists to determine the plants they had before them for any purpose. Secondly, this object seemed to him best achieved by placing, as far as possible, near together in one group or in closely associated groups, plants with a maximum number of common characters whose taxonomic value was determined by experience. He accepted from the French taxonomists (de Candolle and de Jussieu in particular) the idea of a 'natural' as distinct from an 'artificial' classification such as that of Linnaeus. Nevertheless this connotation of 'natural' was not based on acceptance of evolutionary ideas, though the possible and more or less unconscious influence of Lamarck would be worth investigating. Before 1859 Hooker and his contemporaries probably intended by 'affinity', 'relationship', and other words which later on came to indicate genetic and phylogenetic connections no more than to state facts of resemblances and differences. Thirdly, we have to recall Hooker's natural caution in theoretical matters. He did not like speculation beyond a firm basis of fact. It may well be that he was sometimes too cautious and that he would have made more valuable additions to theoretical

taxonomy had he 'let himself go' more than he did. Fourthly, he knew that the course of evolution in plants is complicated and is, so far as we can at present ascertain, not simply linear, dendroid, or penicillate, but is frequently to be best termed reticulate, but the reticulation is itself not uniform in nature or cause. Fifthly, Hooker knew, better than many botanists, that to determine a reliable phylogeny a reasonably complete fossil record was essential, and this was not available for plants. Sixthly, he may well have considered that a 'natural' classification in the Candollean sense was essentially phylogenetic and there was no need to look into the matter further. In theory acceptance of evolution surely means that phylogenies can be traced, given the evidence. Many botanists think that with the exception of a very few major plant groups and a few minor assemblages, reliable evidence is not yet available. Hence, it is argued, most proposed phylogenies are extremely doubtful approximations to what happened in the course of evolution. Every phylogenist is sceptical about every scheme but his own. It can however be said that a phylogenetic scheme, when properly explained with its evidence clearly stated, is useful in that it summarizes the application of some known facts and suggests lines for future investigation.

Modern developments in botany are throwing some light on problems of evolution and heredity in ways not known to Hooker. How far any of them, or a synthesis of them, may lead to improvements in taxonomy and to a sound phylogeny of plants, and how far such phylogeny can be made the basis for a practical taxonomy, remains to be seen. It is absurd to blame Hooker because he did not know all about chromosomes, DNA, growth hormones, or other subjects the jargon of which is now familiar to plant taxonomists and to schoolboys. What Hooker did in his day for taxonomy was to continue its

growth along sound lines, greatly to advance knowledge of hitherto unknown or little-known floras, and to prepare the way for intensive studies in the form of modern monographs or local floras. The clarity of his descriptive accounts, as in his *Student's Flora of the British Isles*, must have done much to increase interest in knowledge of plants.

With his training, outlook, and experience as a taxonomist, Hooker had certain advantages as a plant geographer. He knew what is now sometimes forgotten, that taxonomy must be the basis for the study of plant ranges and distribution. The units dealt with (taxa) must be defined consistently before their ranges or habitats can be mapped or tabulated. Again as a taxonomist Hooker knew the importance of giving due weight to all taxa as evidence for any conclusions reached. There is always a danger of missing the truth by subjective bias if the ranges of a few species (or genera or even families) are picked out for special consideration or their ranges emphasized in support of this or that hypothesis, unless at the same time an analysis of the sum-total flora, as known, is provided. Hooker presented all evidence, positive and negative, fairly and lucidly to the limits of data and knowledge then available, when reaching conclusions on a phytogeographical problem. It may be regretted that Hooker did not publish a concise working scheme for plant geographers, summarizing aims, methods, and the setting-out of results. He employed very simple statistical methods which at least have the advantage of not requiring a knowledge of advanced mathematics to follow and he did not go beyond the data then known. We have to remember that his studies in plant geography were for the most part pioneer studies, in that they were concerned with areas whose plant taxonomy was very imperfectly known before he himself did the essential taxonomic in-

vestigations. For all the areas: New Zealand, Tasmania, Subantarctic islands, Galápagos Islands, the Himalaya, Morocco, and so on, an enormous amount of research on the flora and vegetation has been carried out since Hooker's time, but with Hooker's work as the foundation.

Glossary

ALGAE. A group of unicellular and multicellular plants mostly aquatic, the marine forms being known as seaweeds. The plant body is not differentiated into stem, leaves and roots, they lack vascular tissue and have simply organized reproductive organs and contain chlorophyll or other photosynthetic pigments.

ANDROECIUM. The male reproductive organs of the flower, the stamens.

ANGIOSPERMS. See CLASSIFICATION.

BRYOPHYTES. The mosses and liverworts, small mainly terrestrial plants with some cellular differentiation but no organized vascular tissue. They show two alternating generations and after sexual reproduction a spore-bearing plant develops parasitically on the chlorophyll-containing plant.

CALYX. The outermost whorl of the flower made up of parts known as sepals which protect the other floral parts in the bud.

CAYTONIALES. An advanced Pteridosperm bearing fruit bodies which are intermediate between those of Gymnosperms and Angiosperms.

CLASSIFICATION. Plants may be divided into two main groups:
I Cryptogams; plants reproducing by spores, not by seeds, and without flowers as usually defined; the group includes algae, bryophytes, vascular cryptogams, (bacteria and fungi).
II Phanerogams; plants reproducing by flowers and seeds.
A Gymnosperms, with naked ovules and seeds, including pines, larches, cedars, cycads.
B. Angiosperms, with ovules enclosed in an ovary and seeds enclosed in a fruit. The ordinary 'flowering plants', dicotyledons and monocotyledons.
There are possible alternatives for a modern synthetic classification.

COROLLA. The petals of the flower within the calyx which are often brightly coloured.

COTYLEDON. Seed leaf.

DIOECIOUS. Having male and female flowers on separate plants.

DISCONTINUOUS RANGE. The natural occurrence of an organism in localities that are widely separated from each other.

CRYPTOGAM. See CLASSIFICATION

ECOLOGY. The study of plants (and animals) in relation to their surroundings.

ENDEMIC. Term applied to a taxon if it is restricted in its natural range to a stated area. (Different from the medical use of the adjective, meaning that a disease or causative organism, is continuously occurring in a particular area.)

EPIPHYTIC. Term applied to a plant growing non-parasitically on an aerial part of another plant.

GENUS. A taxonomic group, genetically isolated from others, containing closely related forms (species etc.) which have certain characters in common.

GYMNOSPERM. See CLASSIFICATION

GYNOECIUM. The ovary, the female reproductive organs of the flower made up of one or several units known as pistils which contain ovules.

INTERGENERIC HYBRIDIZATION. The production of a new plant by the pollination of a plant of one genus by that of another.

MUTATION. The natural occurrence of a heritable variation in an organism due to a permanent change in the structure of the chromosomes.

OVULE. The reproductive structure of seed plants containing the egg-cell enclosed within the ovary which after fertilization and subsequent development becomes the seed.

PALEOBOTANY. Fossil botany.

PARENCHYMA. A tissue of thin-walled cells forming a packing tissue between the supporting and vascular tissues.

PERIANTH. A term used for the outer parts of the flower, the calyx and corolla whether these can be distinguished from each other or not.

PHANEROGAMS. See CLASSIFICATION.

PHYTOGEOGRAPHY. The science of geographical plant distribution.

PTERIDOSPERMS. Fossil plants which have fern-like foliage but which bear seed-like reproductive structures and are known as seed ferns.

SPECIES. A taxonomic category made up of closely allied inter-

breeding individuals which are isolated genetically from other such groups and show constant differences from them.

TAXON. Any classificatory group of organisms, such as species, genera.

VASCULAR CRYPTOGAMS. Club mosses, horsetails, ferns and some other groups.

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