THE FLORA OF PAKISTAN: SOME GENERAL AND ANALYTICAL REMARKS

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ABSTRACT. A brief account of the history of plant collecting and early botanical literature of Pakistan precedes general information about the current Flora of Pakistan project and its progress. More than 106 parts have now been published since the first appeared in 1970. Some remarks on the topography of the country, a guide to regional plant-lists, a numerical analysis of the flora and data on endemism are also given.

Pakistan in many respects is a land of contrasts. Lying between 23°–37° N and 61°–81° E with a total area of 804,152 sq. km (310,403 sq. miles), it varies altitudinally from sea level to 8611 m (K2, the second highest peak in the world) and, in temperature, ranges from well below zero in the mountains to c. 52°C (125°F at Sibi) in the plains. The mean annual rainfall fluctuates between c. 50 mm (1·95 in. at Nok Kundi) and 2032 mm (80·00 in. in parts of Kashmir).

Geologically, Pakistan is of recent origin. The mountains in the western and northern areas were uplifted during the Middle Miocene and at that time the present-day plains were still sea. The plains later came into existence as a result of gradual accumulation of silt brought down by the rivers during and since the Upper Tertiary period. During the middle and upper Pleistocene, repeated glaciations seem to have taken place in the mountains. Four major ice periods are reported. During the first and second glaciation, the permanent snow line was around 1828 m and during the third and fourth glaciation periods it was at c. 2133 m and 2590 m respectively. Today the permanent snow-line on the side of the Himalayas facing Pakistan varies from 4267 m to 5790 m (Wadia 1961).

Though detailed information on the soils of Pakistan is not available, reconnaissance soil surveys carried out in various parts of the country indicate that they belong to the following main groups: Alluvial, Chernozem, Serozem and Red Desert (Rafique 1960). Generally sandy loams are present on the plains but on the hills the soil is shallow and stony. The soils are mostly rich in calcium carbonate and poor in organic matter. The alluvial soils in the uplands consist of old deposits called *Bhangar* while the new alluvium of the flood plains is known as *Khadar*. The former (Bhangar) consists mostly of loam, derived from Pleistocene silts deposited by glacio-fluvial and aeolian agencies, and the latter (Khadar) consists of sand and silt. In the deserts of Thar, Thal and Cholistan the soil is largely aeolian in nature. Limestone concretions known as *Kankar* are found in drier places. According to Champion et al. (1965), the soils of Pakistan can be classified in the following sub-groups: i, Alluvial soil, exemplified by the Indus alluvial plain, often low in nitrogen and phosphorus; ii, Coastal sand, present along the coast of the Arabian Sea; iii, Saline and alkali soils, mainly developed in the drier parts of the country especially in canal irrigated areas; iv, Arid and

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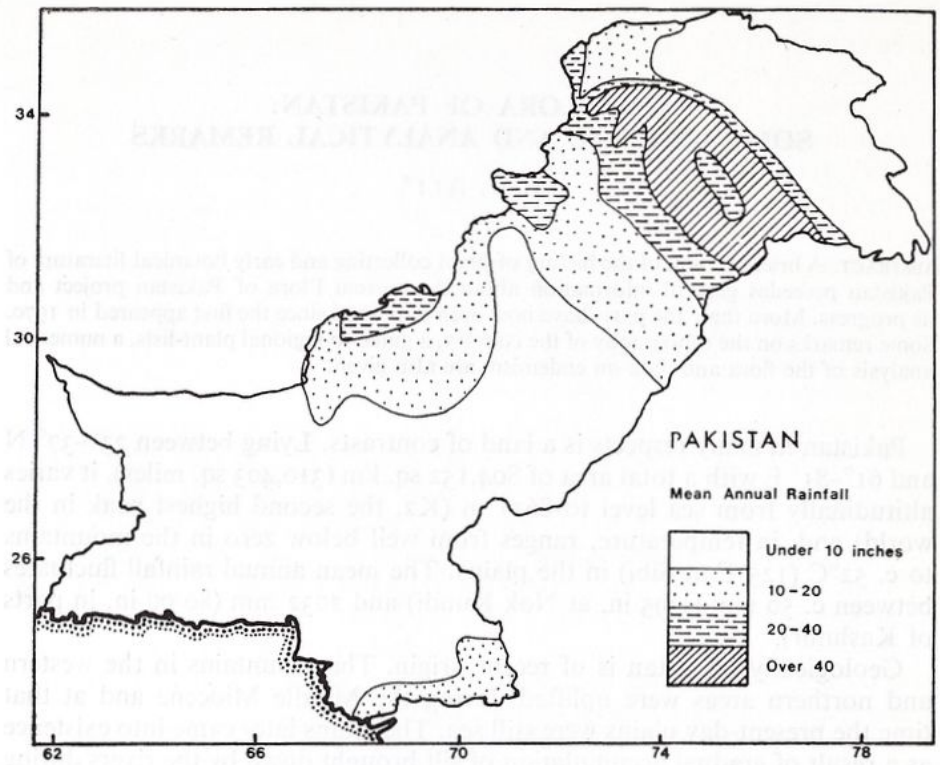

FIG. 1. Rainfall map of Pakistan (after K. S. Ahmad, 1969). See fig. 2, p. 431.

desert soils, typical of much of the plains of Pakistan; v, Montane soil, found in the Himalayas and ± immature; vi, Skeletal soil, mainly in the high lands of drier regions of the Himalayas.

Fig. 1 shows the yearly rainfall pattern in the country. In general, there are two rainy seasons, the winter rains from mid-December to March and summer monsoon rains from mid-June to September. In, however, the southern part of the plains it usually rains during the summer monsoon months only. In moist mountainous regions (Kashmir, Murree, Hazara, Swat and Dir) it rains during both seasons, but the summer rains are dominant. In arid mountain tracts (Quetta, Waziristan, Khyber, Chitral, Gilgit and the upper parts of Dir, Swat, Kaghan and Kishenganga) the precipitation is mostly during the winter and spring months. There is snowfall in the mountains during winter months at higher elevations but at lower elevations and occasionally in the northern plains the nights are frosty (K. S. Ahmad 1969).

PLANT EXPLORATION IN PAKISTAN

It is beyond the scope of the present article to give an account of the history of plant exploration in Pakistan, for which reference may be made to Santapau (1958), Burkill (1965) and R. R. Stewart (1967c, 1972). Nevertheless, we must pay brief homage to some of the pioneers, and more recent workers, who have left a trail for botanists of future generations to follow.

Unlike South India where information about the plants of the region was given as early as 1565 with the publication of *Os Coloquios* by Garcia da Orta, and subsequently widened by the monumental *Hortus Indicus Malabaricus* (1678–1703) by Heinrich van Rheede tot Draakenstein, the first person to have introduced the plants of our region to the western world was William Moorcroft, who collected in Ladakh and Kashmir from 1820–1822. Victor Jacquemont, the brilliant French botanist was the first to have collected in the Punjab and Kashmir between 1828–1832. Because of his untimely death, his work was written up by J. Cambessèdes & F. Decaisne in *Voyage dans l'-Inde . . . . pendant les années 1828–1832* (1835–1844). J. F. Royle, who was curator at Saharanpur, sent collectors into Kashmir between 1829 and 1832. His *Illustrations of the Botany etc. of Himalayan Mountains and the Flora of Kashmir* (1833–1840) is an outstanding piece of work. H. Falconer (1808–1865) who collected in Hazara, Baltistan, Ladakh and Kashmir from 1836–1838, was the first botanical traveller in many out-of-the-way places in the inner Himalayas. N. Vicary was the first to collect in Sind, in 1838, and he also collected in the Salt Range, Punjab and the frontier regions. William Griffith (1810–1845), who collected from Shikarpur, Sind through the Bolan Pass into Afghanistan and returned via the Khyber Pass, was the first collector in Baluchistan and Khyber Pass area (from 1838–1840). D. Ritchie (1809–1866) was another early collector in Sind and W Punjab. J. E. Stocks, who travelled in Sind and Baluchistan in 1848 and 1850 made collections of c. 400 species in Sind and c. 1500 species in Baluchistan. These are the chief foundations of our knowledge of plants of these areas. Judging by the number of specimens collected by subsequent collectors, out of a list of 397 persons prepared by R. R. Stewart (1972) the following names stand out as beacons of light in this rather dimly lit corridor: J. E. T. Aitchison (1836–1898), E. Blatter (1877–1934), I. H. Burkill (1870–1965), C. B. Clarke (1842–1906), J. R. Drummond (1851–1921), J. F. Duthie (1845–1922) and his collector Inayat Khan, W. N. Koelz (b. 1895), F. Ludlow (1885–1972) and his associate G. Sherriff (1898–1967), J. L. Stewart (1832?–1873), R. R. Stewart (b. 1890) and T. Thomson (1817–1878).

During the recent past, some outside groups have been active in our country, such as the Flora Iranica group lead by K. H. Rechinger (b. 1906), the Japanese group lead by S. Kitamura (b. 1906) and such British collectors as J. Lamond, J. D. A. Stainton and S. A. Bowes-Lyon. Amongst the Pakistani botanists, Sultan Ahmad, N. A. Qizilbash, A. H. Khan and E. Nasir are amongst the first to have collected plants. Later on, some young enthusiasts joined the band. It is not possible to list all of them, but Amin Siddiqi, A. R. Beg, S. M. A. Kazmi, S. M. H. Jafri, S. I. Ali, Y. Nasir, M. Qaiser, Sultanul Abedin and Nazir Chaudhri are amongst the more active workers. However, despite their activities, there are still some areas of our country not yet explored. R. R. Stewart (1967c) has pointed out that the largest such area is the region between the Kurram valley and the Khyber Pass and the mountainous area from the Khyber Pass to Dir. Judging by the new taxa which keep turning up, there is tremendous scope for plant collectors in various other parts of our country as well.

The most important historical collections from our country are present either in India (Calcutta, Dehra Dun and Bombay) or in various European herbaria; Kew, British Museum (Natural History) and Edinburgh being the

more important. Except for some odd duplicates, no historical collections are in Pakistan. The conditions for writing a *Flora of Pakistan* by a team of workers based in Pakistan could thus scarcely be said to be encouraging.

During the first decade, after the establishment of the state of Pakistan, the need for a National Herbarium was realised by the authorities concerned and ultimately through the courtesy of the British Council, it was possible to obtain the services of Mr B. L. Burtt, Edinburgh, to advise the Government of Pakistan on this important issue. Mr Burtt visited Pakistan in early 1958 and had extensive meetings with the relevant botanists and government officials and visited all the herbaria in our country. He recommended the establishment of a National Herbarium as soon as possible. He suggested that the collections at Gordon College, Rawalpindi, should be used as the nucleus of the proposed National Herbarium. Unfortunately his recommendations were filed away and never implemented. Since then proposals for a National Herbarium have been aired from time to time. So much so that more than one herbarium has claimed to be national in character.

When the Flora project was started by E. Nasir & S. I. Ali in the late 1960s the best available herbarium was that of Gordon College, Rawalpindi, with about 60,000 specimens. The credit for this rich heritage goes to the genius and love of Dr R. R. Stewart. This herbarium has presently been incorporated in the National Herbarium (Stewart Collection), Agricultural Research Council, Islamabad. Other important herbaria are present in Karachi (KUH); Lahore (LAH); Peshawar (ICP, PES, PPFI, PUP) and Islamabad (SL).

Résumé of Taxonomic Literature

As mentioned above, the works of Royle and Jacquemont are the earliest publications which introduced the plants of our country to other parts of the world. In 1855, Hooker & Thomson published the first volume of *Flora Indica* but this work was discontinued and replaced by the more comprehensive *Flora of British India* (1872–1897). The areas covered by this Flora did not include the regions of Baluchistan and N.W.F. Province. These two provinces, however, were covered by Boissier's monumental *Flora Orientalis* (1867–1884). Reference may be made to R. R. Stewart (1956) and Kazmi (1970) for fairly comprehensive lists of publications of a taxonomic nature in our area. A selection of the more important contributions, arranged province-wise in alphabetical sequence, is presented in Table 1. The region involved in each case is also indicated (see also fig. 2).

TABLE 1

Regional Floras, Lists of Plants etc.
The full title and reference is given in the bibliography.

1. BALUCHISTAN

Anon (1907)—Zhob district
Anon (1907)—Loralai district
Blatter *et al.* (1921)—Baluchistan
Burkill (1909)—Baluchistan
Hughes-Buller (1907)—Quetta-Peshin
Lace & Hemsley (1891)—Baluchistan
Rechinger, f. (1963–)— ,,
Stocks (1852)— ,,

FIG. 2. Map of Pakistan showing some of the districts and areas referred to in this paper. Land over 2400 m is stippled.

ii. N.W.F. PROVINCE

Aitchison (1881–82)—Kurram valley
Beg & Khan (1974)—Malakand Div.
Blatter & Fernandez (1933–35)—Waziristan
Duthie (1896)—Chitral
Kerstan (1937)—Chirtal
Kitamura (1964)—Swat, Gilgit
Lowndes (1942)—Waziristan
Pampanini (1916)—Karakorum
,, (1930)—Karakorum
Quraishi & Khan (1965–67)—Peshawar Distr. & Khyber Agency
,, ,, ,, (1971) — ,, ,,
Rechinger, f. (1963–)—N.W.F. Province
Stewart, J. L. (1863–64)—Peshawar valley
,, ,, (1867a)—Hazara, Kaghan
Stewart, R. R. (1967a)—Swat
,, ,, (1967b)—Kurram valley
Wendelbo (1952)—Tirich Mir

iii. PUNJAB

Ahmad, I. (1964)—Salt Range
Ahmad, S. (1954)—Lahore Distr.
Aitchison (1869)—Punjab and Sind
,, (1871)—Hushiarpur Distr.
,, (1888)—Jhelum
Bamber (1908–13)—Punjab
Chaudhry (1969)—Lyallpur
Ireland (1934)—Punjab
Jafri (1965)—Lahore Distr.
Kashyap (1936)— ,, ,,
Parker (1956)—Punjab
Sabnis (1940)—Punjab Plains
Stewart, J. L. (1867b)—Salt Range
,, ,, (1869b)—Punjab
Stewart, R. R. (1952)—Rawalpindi Distr.
,, ,, (1961a)— ,, ,,

iv. SIND

Aitchison (1869)—Sind and Punjab
,, (1902)—Jerruck Div.
Blatter *et al.* (1927–29)—Indus Delta
Blatter & Hallberg (1918–21)—Indian Desert
Chaudhri & Chuttar (1966)—Thar Desert
Cooke (1904–1908)—Sind
Griffith (1946)—Thar Desert
Hasanain & Rahman (1957)—Sind
Jafri (1966)—Karachi
Sabnis (1923–24)—Sind
Stocks (1848a)— ,,
,, (1855)— ,,
Talbot (1909–11)— ,,

v. KASHMIR

Blatter (1928)—Kashmir
Coventry (1923)— ,,
Dolk (1929)—Karakorum
Duthie (1893)—Kashmir
,, (1894a,b)— ,,
Fuller (1913)—Jammu and Kashmir
Haeckel & Troll (1938)—Hindukush
Lambert (1933)—Kashmir and Jammu
Meebold (1909)—Kashmir
Noel (1903)— ,,
Pampanini (1915)—Karakorum
Pampanini (1916)—Karakorum
,, (1930)— ,,
Pearson (1938)—Kashmir
Rao (1960)— ,,
,, (1961)— ,,
Stewart J. L. (1869a)—Ladakh
Stewart, R. R. (1916–17)—,,
,, ,, (1961b)—Deosai plains
Terra (1933)—Karakorum, Zanskar
Troll (1939)—Nanga Parbat
Wright (1931)—Kashmir

Flora of West Pakistan Project

Proposals for writing a Flora of West Pakistan were submitted in 1966–67 through the Agricultural Research Council to the United States Department of Agriculture, under Public Law 480. These projects were separately awarded to Gordon College, Rawalpindi under the supervision of Prof. E. Nasir and to the Department of Botany, University of Karachi, under the supervision of Dr S. I. Ali, with the understanding that the two groups work in close collaboration with each other.

As stated earlier, the facilities available in Pakistan are far from ideal. Nevertheless, our task would have been impossible without *An Annotated Catalogue of the Vascular Plants of West Pakistan and Kashmir* by R. R. Stewart (1972). We had free access to it in manuscript form from early days in the Flora project and it has been the basis of all our humble efforts.

It is pertinent to add here that in 1963, Prof. K. H. Rechinger, Vienna, launched the monumental *Flora Iranica*. In addition to N Iraq, Iran and Afghanistan it covers the provinces of Baluchistan and the N.W.F. Province of Pakistan. Since the first issue of the Flora appeared, 138 families of the Flora have now been published. Prof. Rechinger and his colleagues have always been very co-operative in giving us free access to material, particularly from parts of our country and extending us every possible type of help from time to time.

Our aim in producing a Flora is to provide a work which can be used for proper identification of all our plant-wealth so that its exploitation could be taken up on a scientific and systematic basis. Although it is not necessary to elaborate on the format adopted in the Flora, it is not out of place to state that, of necessity, we had to adopt the morphological species concept. Only c. 4% of our vascular plants have been investigated cytologically. (Ali, unpublished data). Information about breeding systems and crossing behaviour is almost non-existent, though inferences can certainly be made by studying the variation patterns. Members of only one family have hitherto

been subjected to chemotaxonomic studies (Qaiser 1976). Thus it is obvious that improvements in the existing classification will certainly have to be made when more information is available. Nevertheless, gross morphological features will always have to be used, at least in part for delimiting the taxa. Subspecies, wherever a correlation between morphological features and geographical distribution could be demonstrated, are recognized. Varietal ranks are accorded on relatively minor morphological differences without any geographical significance.

The editors have frequently visited European herbaria in the course of editing manuscripts. In addition we have tried to send draft copies of manuscripts to various institutions and experts all over the world. Many authorities and friends have responded to our requests and pointed out short-comings and offered suggestions for improvements. It is a matter of pleasure to express our gratitude to them. Over the years, one such group, stationed at the Edinburgh Herbarium, comprising of Mr B. L. Burtt, Mr I. Hedge and Miss J. Lamond, has almost become a part of our own team. Almost all our manuscripts have been read and, from time to time, improved by them.

The account of the first family was published in 1970. Seven years later, at the time of writing this article, accounts of 106 families, involving 507 genera and 1608 species spread over 1873 printed pages and accompanied by 375 plates, depicting 449 genera and 1019 species, have been published. In all, twenty-five taxonomists and eleven artists have contributed. Including Pteridophytes, the accounts of 92 families involving 819 genera and 3469 species have yet to be completed.

It is difficult to forecast a completion date for the Flora—there are too many imponderables—but at current rates of progress about another ten years may be needed.

TABLE 2

List of authors and illustrators who have contributed to the *Flora of West Pakistan* up to 1977.

AUTHORS:	P. Abdullah (Rawalpindi)	S. M. H. Jafri (Karachi)
	Sultanul Abedin (Karachi)	S M. A. Kazmi (Peshawar)
	S. I. Ali (Karachi)	S. A. Khan (Peshawar)
	Zaffar Ali (Rawalpindi)	S. K. Khanzada (Peshawar)
	K. Aziz (Karachi)	Edward Murray (Levittown, U S A)
	Perveen Aziz (Lahore)	E. Nasir (Rawalpindi)
	A. R. Beg (Peshawar)	Y. Nasir (Rawalpindi)
	M. H. Bokhari (Shiraz, Iran)	M. Qaiser (Karachi)
	Mohammad Iqbal Dar (Rawalpindi)	Saida Qaiser (Karachi)
	E. J. Ecker (Tarbela)	N. K. B. Robson (London)
	A. Ghafoor (Karachi)	Mohammad Amin Siddiqi (Rawalpindi)
	Shahina Ghazanfar (Rawalpindi)	
	F. Grohmann (St Georgen, Austria)	C. C. Townsend (Kew)
ILLUSTRATORS:	M. Saleem	Patricia Abdulla
	S. Azmat Ali	Azad
	Shaukat Sultana	Shakira Khatoon
	Asad Raza Zaidi	P. Halliday (Kew)
	Fauzia Bano	M. Rafiquddin
	V. Goaman (London)	

Numerical Analysis of the Flora of Pakistan

The present analysis is based on the accounts of published families (Nasir & Ali, 1970–1976) and the data available in R. R. Stewart (1972). As the accounts of almost half of the families have still to be published, it can only be said to be tentative. However, the basic results of the final analysis are not likely to be appreciably different.

The native flowering plants are represented by 186 families, 1283 genera and about 4938 species*; of these the Gymnosperms are represented by 4 families, 7 genera and 21 species and the Angiosperms by 182 families, 1276 genera and 4917 species. Thirteen families (i.e. 7%) are represented by more than 100 species. Compositae, with 604 species, is the biggest family, Gramineae and Papilionaceae come next with 523 and 382 species respectively. It may be noted that Gramineae is represented by a larger number of genera (165) than Compositae (110). Only 7 families (i.e. 4%) are represented by more than 50 and less than 100 species. Forty-four families (24%) are represented by 10–50 species and 121 families (i.e. 65%) have 9 or fewer species.

Only 1 genus, *Astragalus* is represented by more than 100 species (c. 134 species). Only 5 genera, *Taraxacum*, *Carex*, *Polygonum*, *Euphorbia* and *Nepeta* (?), may be represented by more than 50 species in Pakistan. Eighteen genera are represented by 25–50 species and 64 genera have 11–24 species; the rest of the 1195 genera (i.e. 93%) are represented by 1–10 species. Of these, 624 genera are represented by only 1 species, including 92 monotypic genera. The Pteridophytes are represented by 12 families, 43 genera and 139 species; Pteridaceae is by far the biggest family with 25 genera and 95 species.

Endemism

The flora of Pakistan does not include a single endemic family and, to date, only 3 genera, *Douepia* Cambess. (Cruciferae), *Stewartiella* E. Nasir (Umbelliferae) and *Decalepidanthus* Riedl (Boraginaceae), are known to be endemic to Pakistan. All are monotypic. *Douepia* is present in Waziristan, Bannu, Jhelum, Sakesar, Naushera and Khewra; *Stewartiella* is known from Maslakh, c. 30 miles from Quetta; and *Decalepidanthus* is reported from Nathiagali, Hazara and Murree hills.

With our present knowledge, there are 203 endemic species (i.e. 6% of the total flora) belonging to 149 genera and 41 families. The highest number of endemics (i.e. 57 species) is in the Papilionaceae. Other significant families in descending order are Umbelliferae (33 species), Compositae (21 species), Brassicaceae (20 species), Boraginaceae (18 species), Scrophulariaceae (17 species), Gramineae (15 species), Cyperaceae and Rosaceae (11 species each). The remaining families have less than 10 endemic species per family.

Astragalus has the highest number of endemic species, i.e. 37 or 12% of the total number of endemics. *Bupleurum* and *Carex* have 10 and 8 endemics respectively; *Berberis* and *Euphrasia* have 7 each; *Potentilla*, *Oxytropis* and *Tamarix* have 6 and *Corydalis*, *Abutilon* and *Heliotropium* have 5 endemic species. Seven genera have 4 endemic species each; 10 have 3; 22 have 2 and 99 genera have 1 endemic species.

* The corresponding totals when naturalized or cultivated taxa are included are: 205 families; 1557 genera and c. 5691 species.

TABLE 3

Geographical distribution of species endemic to Pakistan

A. Western and northern mountainous regions—over c. 1200 m.

Kashmir	66	Swat	7
Chitral	39	Waziristan	5
N Baluchistan	31	Hazara	4
Gilgit	12	Peshawar	3
Kurram	10	Dir	1
Distributed in more than one region	93		

B. Southern regions

Sind	11	Punjab (Campbellpore, Jhelum)	2
S Baluchistan	6	Sind, Baluchistan, Punjab plains	12

A geographical analysis of those species which are endemic to Pakistan is presented in Table 3. About 90% of the total number of endemic species are confined to the western and northern mountainous regions (c. 1200 m or more) and only 10% of the total number of endemics are known from the southern region of Pakistan. Kashmir, with 66 species (22%) has the highest number of endemics. Chitral, with 39 species (13%) and N Baluchistan with 31 species (10%) are the other two major areas.

With the present state of our knowledge, it is not possible to differentiate between paleo-endemics and neo-endemics. Further, the available information on those families not yet revised for *Flora of Pakistan* may give a false picture of endemism. On the other hand, it is quite possible that newly described taxa may prove to be more widely distributed when better information is available about the floras of adjoining countries.

The Introduced flora of Pakistan

Under this heading, the naturalized plants and those commonly cultivated in Pakistan are mentioned. In recent times, however, new plant introductions are continually being made and it has not been possible to keep track of all such activities, particularly with respect to garden annuals.

The families with most introduced plants in Pakistan are Papilionaceae, Compositae, Malvaceae, Caesalpiniaceae and Gramineae. They are represented by 48, 38, 34, 33 and 29 species respectively.

The introduced flora is represented by 653 species in 373 genera and 47 families and thus comprises c. 12% of the total number of species reported from Pakistan. Maheshwari (1962) estimated that in India c. 40% of the flowering plants were alien and naturalized although it is not unlikely that this total may have to be revised when a more objective assessment is possible.

Acknowledgments

The author is grateful to Dr M. Qaiser, Mr M. Nazimuddin and Mr Kamal A. Malik for their help in processing the data. The financial assistance received from the United States Dept of Agriculture under P. L. 480 is thankfully acknowledged.

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