

FLORESTIC STUDIES ON THE LOWER GANGA PLAIN OF THE STATE OF WEST BENGAL : PRESENT STATUS AND FUTURE STRATEGIES

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INTRODUCTION

The state of West Bengal can be divided into two natural geographical divisions : the Himalayan and the Plain Divisions. Of these, the latter is a part of the vast land of the Lower Ganga Plain of the old province of Bengal. It extends from the district of West Dinajpur in the north to the Sunderbans in the south (Randhawa, Mitra & Mehta, 1964). The area of the West Bengal Plain Division encompasses the following 4 botanical divisions of Prain (1903a) : (1) *West Bengal proper*, lying between the river Bhagirathi-Hooghly and the Chotanagpur Plateau, (2) a part of the *North Bengal*, adjacent to the river Ganga, (3) the strip of land of the *Central Bengal*, lying east of the Bhagirathi and (4) the western part of *Sunderbans*. The flora of the tract as it stands at present, is the result of the intense bio-edaphic influences but it is significant owing to its varied contents. Floristic study on this area received a great impetus in Bengal from the establishment of the Botanic Garden at Calcutta about 200 years ago. Some distinguished botanists and plant geographers like Roxburgh, Buchanan-Hamilton, Hooker, Kurz, Clarke, Prain and others studied its floristic composition and contributed much to our knowledge of this region (Prain, 1903a, 1905 ; Burkill, 1965). In his provisional list or census of the plants of Bengal, Prain (1903a), however, observed : 'The time for the preparation of a complete

flora of the Lower Provinces has not yet come ; much special work is still called for in many of the more outlying districts'. It is, therefore, interesting to record facts of the progress of taxonomic researches on the area with a view to preparing a regional flora of West Bengal. The bibliography on the flora and vegetation of Bengal (Basak, 1973) presented exhaustive references to such studies and the readers are referred to that work for details. Only a few selected ones and some additions are cited in the present paper for the sake of brevity. Monographs, revisions and Indian floras, which record plants of West Bengal as well, usually are not discussed in the present resume.

RELIEF FEATURES, GEOLOGY AND RIVERS

The Ganga after rounding the Rajmahal hills, bends southwards in West Bengal and near Dhulian in Murshidabad district, the water bifurcates. One branch passes into Bangladesh and the other flowing through West Bengal under the names of Bhagirathi and Hooghly enters the Bay of Bengal at the southern tip of the Sagar Island. The plain, 40-80 km wide around the Bhagirathi, is an alluvium trough, the variable depth of which perhaps no where exceeds 400 m (Chatterjee, 1965). According to Hooker (1854) and Theobald (1881), the present West Bengal Plain was originally an estuary, which was filled up by the drainage from the young folded mountains in the north, in the later part

of Tertiary period. But the lack of discovery of marine formations has led to a weakening of the theory. Oldham (1893) suggested that the Indo-Gangetic trough of which the Bengal Plain is a part, has been created by the sinking of the crusts under their own weights of alluvial deposits. Later on, the origin of the trough was variously explained by compression, depression or tension (also see Ahmad, 1958). The whole of this alluvial and detrital plain except the south western part, has thus a common structural history (Spate, 1957). The low land, lying west of the Bhagirathi, though not a part of the delta proper, is equally flat (Chatterjee, *l.c.*). The Lower Ganga Plain in West Bengal is composed of (a) the northern parodelta of the Ganga and the *Barind* tract in West Dinajpur and Malda districts, (b) the western margin, consisting of the largely lateritic piedmont plain along the Peninsular block in western districts (the *Rarh* area) and the Contai Coastal Plain with old beach ridges and (c) the vast alluvial flat plain of the Ganga delta proper, subdivided further into *Meribund* area of Nadia, Murshidabad, Howrah and Hooghly districts, *mature delta* of the northern half of 24-Parganas and Howrah and the active section of *south Sunderbans* and *new islands*.

The geological formation in western districts of Birbhum, Purulia, Bankura, Burdwan and west Midnapur are Archean Gneiss and other metamorphic rocks, the Gondwana system, laterite and alluvium. The laterite interspersed with associated rocks of sands and gravels forms the characteristic feature of this region. The Goghat thana of Hooghly district also consists of low laterite fringe and laterite debris. All other districts of the West Bengal Plain are covered with old and recent alluvium of considerable depth (Randhawa, Mitra & Mehta, 1964). The altitude of the tract is at the sea level or even low at depressions, while towards

the west it varies between 30 and 700 m above the mean sea level. From 50 m contour line, the surface of the Bengal basin rises and the landscape changes with the appearance of older alluvium and laterite soil in the *Rarh* area.

All rivers west of the Bhagirathi flow west to east, indicating that the country west of the Bhagirathi increases in elevation as one goes farther west. To the east of the Bhagirathi, all rivers flow north to south with a south easterly slant, except the Jalangi and Churni in Nadia which turn westwards into the Bhagirathi. The western area is flanked by the coalesced fans of seasonal flashy streams of the Ajay, Damodar, Rupnarayana, Mayurakshi, Kangsabati etc., which fall to a dead delta zone along the Hooghly bank. The low land of Midnapur is only partly deltaic with a coastal plain around Contai in the south. The physiography of the changing rivers, like Ganga, Damodar and others, explains how the present surface of the Southern plain has been built up (Sen, 1968). The remnants of old river beds, commonly called *jhils* or *bils*, form long stretches of marshes and small lakes in many parts, particularly towards the east. The Hooghly-Ganga delta has web of distributaries near its sea-ward face and the shallow tidal depressions near Calcutta contain salt water.

SOIL

The main soil groups of the West Bengal Plain are (1) laterite, (2) older and newer alluvium and (3) deltaic alluvium (Champion & Seth, 1968). The soils of the West Bengal plain presents diverse soil conditions (Chakravarti & Chakravarti, 1957). The soil for the most part belongs to the Ganga alluvium, while laterite and red soils are found in the western sector. Alluvial and colluvial soils, brought down by the

Vindhayan group of rivers originating from the Rajmahal hills and the Chotanagpur Plateau, occur in the western districts. The Ganga family of soils are found in the districts of Murshidabad, Malda, Nadia 24 Parganas, Burdwan, Hooghly and Howrah. The coastal soils of tidal origin are met with in the southern 24 Parganas, Sunderbans, Midnapur coast and Howrah.

CLIMATE

The entire plain of West Bengal comes within the range of hot west wind from the upper Ganga Valley in summer. It thus enjoys a typical tropical monsoon climate with rather high temperature and oppressive humidity. Climatologically, the area belongs to the 'Southern Zone' called the 'Gangetic West Bengal Rainfall Sub-division' of the Indian subcontinent.

VEGETATION AND FOREST BELTS

The past vegetational history in the Lower Ganga Plain is quite interesting (Chaudhuri, Mallik & Sen, 1962). The anatomical studies on the wood excavated from the submerged forests below Calcutta revealed that most of the tree trunks resemble those of the mangroves which have since migrated further southward, to flourish in Sunderbans (Ghosh, 1941 & Ghosh & Negi, 1958). The pollen flora from the estuarine river mud samples and fresh water tank sediments showed the presence of some of the Sunderban elements (Das, 1961).

However, the pollen flora of the peat horizons around Calcutta does not contain any trace of mangrove vegetation. The flora which the peat reveals, is quite different from the swamp vegetation and suggests that the Calcutta peat has not originated *in situ*. The peat flora has been probably brought down by rivers from different localities and deposited in the area. The occurrence of *Suaeda*

maritima (L.) Dum., a halophytic plant, in different levels of the peat layer is noteworthy. It seems that stumps of *Heritiera fomes* Buch.-Ham. or of other mangroves, which are found occurring *in situ* in the soil immediately below the peat layer, have contributed a little or nothing at all towards the formation of Calcutta peat. The theory of the drift origin of Calcutta peat is a fascinating field of study (Ghosh, 1964).

In the western sector, the Upper Series of the Gondwana system in the Raniganj coalfields is marked by the prevalence of ferns, cycads and conifers, while the Lower Series of Gondwana contains *Equisetaceous* plants, *Glossopteris* and *Cordaites* stems (Randhawa, Mitra & Mehta, *l.c.*).

Apart from the vegetation of the remote past, the entire tract of West Bengal Plain had heavily wooded areas even at the end of the 19th century. The forests were particularly conspicuous in West Dinajpur and Malda districts, in the greater part of the south western districts along the Chotanagpur Plateau and in the Sunderbans. In addition, there were depressions and extensive marshes near the confluence of rivers, around the fringe of which were fairly dense forest stands. Such formations were the area between the Mahananda and Kalindi and between the Tangan and Punarbhava in Malda, the *Hijal* and *Kalantar* bils in Murshidabad, the marshes between the Damodar and Hooghly in Hooghly district, between the Damodar and Saraswati in Howrah, the marshes between the Kalighai and Rupnarayana in Midnapore and the vast expanse of salty marshes south east of Calcutta down towards the sea. The history of last hundred years however, has been the story of steady denudation of forests and rapid reclamations of marshy tracts for cultivation. The percentage of forest area to geographical area in the plain is about 11% and it varies from 3% in Birbhum

to about 20% in Bankura and 31% in Sunderbans (Anon., 1966).

The geographical conditions of plant life in the West Bengal Plain are more diverse than those of any other area of similar size in India. The flora of this region falls into the two subprovinces *Bengal proper* and *Sunderbans* as described by Hooker (1904) under his 4th botanical province of the Gangetic Plain. The forests of this region may be divided into (a) laterite forest (b) alluvial forest and (c) mangrove and tidal forests. The composition of forests in West Bengal has not followed any established pattern of classification into different forest types (Anon., 1966). But according to Champion and Seth (*l.c.*), the forests may be grouped as follows : (1) Littoral and swamp forests (2) Northern tropical dry deciduous Peninsular sal forests (3) Tropical seasonal swamp forest and (4) Dry deciduous scrub.

1. *Littoral and swamp forests* : Of the large area covering tidal forests in the delta region of the Ganga and Brahmaputra, only the poorer part lying west of the Raimangal river now belongs to West Bengal (Prain, 1905). It has been indicated that the invasion of salt water is detrimental to the growth of the trees and as such, forests in the eastern Sunderbans grow faster than those in the western half, because of differences in salt deposition. The following two forest types were described by Banerjee (1966) : (1) Salt water *Heritiera* type and (2) Low mangrove type. These are usually associated with mangroves of *char* and water areas. Champion and Seth (*l.c.*) recognized the undermentioned types in the West Bengal Plain Division : (1) Littoral forests on sandy beaches and dunes along the sea face (Type : 4A/L1), (2) Mangrove scrub or salt water forest (Type : 4B/TS1), (3) Mangrove forest (Type : 4B/TS2), (4) Salt water mixed forest of *Heritiera* (Type : 4B/TS3), (5) Brakish water mixed

forest (Type : 4B/TS4) and (6) Palm swamp (Type : 4B/E1). The typical representatives of the mangrove forests are species of *Rhizophora*, *Ceriops*, *Xylocarpus*, *Bruguiera*, *Sonneratia*, *Amoora*, *Aegiceras*, *Avicennia*, *Excoecaria*, *Heritiera* and *Nipa*. The salt water mixed forest of *Heritiera*, rarely about 20 m high, is fairly dense and occupies a large area. The upper story of it is comprised mainly of *Heritiera fomes* Buch.-Ham., *Excoecaria agallocha* L., *Ceriops decandra* (Griff.) Ding Hou, *Xylocarpus gangeticum* (Prain) Parkin. The typical evergreen mangrove of moderate height are represented by *Kandelia candal* (L.) Druce, *Avicennia alba* Blume, *Ceriops tagal* (Perr.) C. B. Rob., *Xylocarpus gangeticum*, *Excoecaria agallocha* and others. The mangrove scrub or the salt water forest is of very low height and occupies an extensive area in the western Sunderbans. The Brakish water mixed forest is poorly represented owing to the encroachment of salt water. The two palms of gregarious habit are the stemless tufted palm, *Nipa fruticans* Wurm., with about 9 m long leaves and *Phoenix paludosa* Roxb. on drier localities of the palm swamp. The grasses of western Sunderbans include *Myriostachya wightiana* (Nees ex Steud.) Hook. f., *Zoysia matrella* (L.) Merr., *Paspalum distichum* L., *Porteresia coarctata* (Roxb.) Tateoka and others.

The process of formation of land (*char*) in Sunderbans is continuing still by desiltation of the tides coming inland as also of the rivers flowing into the Bay of Bengal. A newly formed island is first colonised by *Leersia hexandra* Sw., *Porteresia coarctata* (Roxb.) Tateoka and *Sesuvium portulacastrum* (L.) L., which are later followed by tree species like *Avicennia alba* Blume, *A. marina* (Forsk.) Vierh., *A. officinalis* L., *Sonneratia apetala* Buch.-Ham. and *Aegiceras corniculatum* (L.) Blanco. After the stabilisation of the soil by the regular deposition of silt, the next species to come are

Ceriops decandra, *Excoecaria agallocha* and with a sprinkling of *Bruguiera gymnorrhiza*, *Heritiera fomes* and *Xylocarpus gangeticum* (Banerjee, l. c.).

Of the species recorded from the western Sunderbans, Prain (1905) considered that about 85 species are either confined to the Sunderbans or only extend a little way north from Sunderbans into Ganga delta and about 100 species extend from the northern tract into the Sunderbans.

2. *Northern tropical dry deciduous Peninsular sal forest*: This type of forest occurs as the dry sal forest of low rainfall laterite zone (about 1000 mm or less) in West Midnapur, Purulia, Bankura, Burdwan and Birbhum districts (Type: 5B/C1c). In the reserve sal forests of *Shorea robusta* Gaertn. f., the usual associates are *Adina cordifolia* (Roxb.) Hook. f. ex Brandis, *Boswellia serrata* Roxb., *Buchanania lanzan* Spreng., *Butea monosperma* (Lamk.) Taub., *Cochlospermum religiosum* (L.) Alston, *Dalbergia latifolia* Roxb., *Diospyros melanoxylon* Roxb., *Garuga pinnata* Roxb., *Gmelina arborea* Roxb., *Lagerstroemia parviflora* Roxb., *Mallotus philippensis* (Lamk.) Muell.-Arg., *Madhuca longifolia* var. *latifolia* (Roxb.) Chemlir, *Semecarpus anacardium* L. f., *Schleichera oleosa* (Lour.) Oken, *Terminalia alata* Heyne ex Roth, *T. arjuna* (Roxb. ex DC.) Cot. & Asn., *T. bellirica* (Gaertn.) Roxb., *T. chebula* Retz. and others.

The undergrowth of forests and their outskirts, usually include *Bridelia squamosa* Gaertn., *Combretum roxburghii* Spreng., *Cleistanthus collinus* Hook. f., *Flacourtia indica* (Burm. f.) Merr., *Holarrhena antidysenterica* (L.) Wall. ex G. Don, *Indigofera cassioides* Rottl. ex DC., *Ochna obtusata* var. *pumila* (Buch.-Ham. ex DC.) Kanis, *Olex scandens* Roxb., *Phoenix acaulis* Roxb. ex Buch.-Ham., *Woodfordia fruticosa* (L.) Kurz, *Xeromphis spinosa* (Thunb.) Keay and *Ziziphus* spp.

Some grasses notable in the dry region are *Aristida setacea* Retz., *Desmostachya bipinnata* (L.) Stapf, *Eulaliopsis binnata* (Retz.) C. E. Hubb., *Hackelochloa granularis* (L.) O. Kuntze, *Heteropogon contortus* (L.) Beauv., *Psuedoraphis spinescens* (R. Br.) Vickery, *Setaria tomentosa* (Roxb.) Kunth. and *Eragrostis* spp.

Owing to the porous eroded soil, dry climate and low rainfall, the forests are poor. They are open and park like with scrubby undergrowths, and reduced to the secondary dry deciduous forests, particularly in the dry western sector and also in Malda and West Dinajpur districts.

3. *Tropical seasonal swamp forest*: As stated earlier, the Lower Ganga Valley has many marshy areas some of which are former river beds. The extensive swampy tracts that must once have been present at the head of the Ganga delta have now been mostly cleared and reclaimed. The curious forest type of fresh water *Barringtonia* swamp (Type: 4D/SS2) form almost pure crop in water logged *bil* areas in Murshidabad, Malda and Midnapur districts. The characteristic feature of the swamp forests is that they often remain submerged under the flood water for about 2-3 months and regenerate thereafter.

4. *Dry deciduous scrub*: It originates from the dry deciduous sal forest due to the cumulative effect of the bio-edaphic influences (Type: 5D/S1). Thorny thickets composed of low forest species of *Holarrhena*, *Cleistanthus*, *Carissa*, *Combretum*, *Flacourtia* and *Xeromphis* are frequent.

Apart from the main forest types as described above, the vegetation in other parts stands on diluvial soil. Older alluvium of meadow type occurs on west of the Bhagirathi. There is nothing that could possibly be termed as genuine forest in the district of Hooghly, Howrah, Nadia, Murshidabad, Malda and West Dinajpur. Trees, characteristic of village

and suburban shrubberies sometimes present certain compact formations in scattered patches. *Phoenix sylvestris* Roxb., *Borassus flabellifer* L. and *Cocos nucifera* L. also grow abundantly and are characteristic to the landscape. Shrubby and herbaceous vegetations in the flat rice plain are typical of the Ganga Plain. Moreover, this entire tract consists of land laid down by the Ganga and its distributaries and thus, all the plants growing there must be immigrants from elsewhere. Quite a number of alien species which were introduced deliberately, are now established as wild plants in the area. Several Indian plants have also spread into this transitional zone from the adjacent regions by ocean currents, rivers, winds or by living beings and now constitute the wild flora of the area (Prain, 1905). The vegetation of the cultivated fields is anthropogenic and has no direct bearing on the vegetation as a whole, as it is composed of weeds of disturbed nature.

TAXONOMIC STUDIES

A. Exploratory Stage : The botanical activity in Bengal actually started between the years 1784 and 1787 with the foundation of the Asiatic Society of Bengal and of the Botanic Garden at Calcutta by William Jones and Robert Kyd respectively. The Botanic Garden of Calcutta played a distinct role in the introduction, naturalization and development of Tea, Jute, Cinchona, Teak and Mahogany cultivation in India, particularly in Bengal. It helped the local people to come closer to an understanding of the sources of their own existence and awaken their interest in plant life. The earlier botanical work on economic plants of Bengal were published by J. Fleming, W. Jones, Roxburgh, Buchanan, Hamilton and others (Santapau, 1958) and were centred around the Calcutta Botanic Garden. The garden at Calcutta thus played an important role both for utility and pleasure.

The first man to do any great amount of botany on the Lower Ganga Plain was W. Roxburgh. He collected plants, wrote descriptions and corresponded about the plants of this area. It is evident from the letters written by Buchanan-Hamilton that the manuscript copies of Roxburgh's *Flora Indica* was available for use as early as 1798, by at least some of the friends of Roxburgh (Prain, 1905). This was perhaps the first attempt to provide the description of plants of the plains around Calcutta and Madras. The famous *Hortus Bengalensis*, which catalogued about 3500 species in cultivation in the Botanic Garden of Calcutta, was published by Roxburgh in 1814. Roxburgh did not travel much from Calcutta, but he had his staff for collections. He prepared about 2533 coloured illustrations of Indian Plants, many of which were obviously collected from Bengal (Prain, 1903a & Basak, 1973). The *Flora Indica* of Roxburgh was later edited in part by Carey and Wallich (1820 & 1824) in 2 volumes with some 'added crowds of species' by Wallich. Carey at the request of Roxburgh's friends, published in 1832 in 3 volumes Roxburgh's manuscript of the *Flora Indica* as he left it and took no notice of Wallich's additions.

Two other contemporary botanists are W. Carey and Buchanan-Hamilton who actively helped Roxburgh to collect plants from the Central Bengal and Sunderbans (Prain, 1903a). Carey had a significant role in the history of the botanical and horticultural researches in Bengal (cf. Basak, 1973). The *Hortus Suburbanus Calcuttensis* by Voigt (1845) presented the list of plants grown in the Calcutta Garden and in the Carey's Garden at Serampore upto the year 1841. It included besides the list drawn up by Masters for his abandoned *Calcutta Flora* (1839-40). On his way to the north West India, French Botanist Jacquemont travelled through the plains of Chandernagore, Hooghly, Burdwan and

Raniganj in West Bengal and made some observations (Jacquemont, 1841). Most of his collections are now on deposit in Paris (Stacton, 1954).

The Calcutta herbarium (CAL) is closely linked with the advancement of Taxonomic researches on plants of Bengal. It was started by Roxburgh near about the year 1800. It also houses many valuable collections and/or type specimens of Buchanan-Hamilton, Wallich, Hooker, Thomson, Griffith, McClelland, Clarke, Heinig, Prain and others from the Botanic Garden at Calcutta and from different parts of West Bengal. Griffith realized the need for a working herbarium for identification of local plants and organised 'A general herbarium as well as an extensive series of local ones, so valuable as illustrating botanical geography and vegetable statistics of each part of British India' (Mukerjee, 1959).

Gradually the botanical phase of pharmacology came to the forefront in the study of medicinal plant resources in Bengal. Griffith developed a garden illustrating the useful plants of lower Bengal and labelled medicinal plants in *Bengali* for medical students (Burkill, l. c.).

J. D. Hooker came to India in 1848 and travelled through the West Bengal Plain and widely collected in Sunderbans (Hooker, 1854). Anderson (1862) utilized the information of Voigt (1845) regarding the indigenous species around Calcutta and described them under 86 families comprising of 327 genera and 738 species. The collections of Campbell and V. Ball from Manbhum in Purulia district deserve special attention (Ball, 1869). Kurz collected plants from the Lower Bengal and with sufficient materials at hand wanted to prepare the flora of Bengal, when he was asked to switch over to Burma (Burkill, l. c.). Clarke was interested chiefly in the weed flora of the rice fields and was the first botanist to present a comprehensive account of

Sunderbans after Heinig (Clarke, 1871, 1874, 1896 & 1898).

B. Consolidation Period : The exploratory stage gradually entered into the floristic stage and resulted in the publication of several floras. Consequent upon the publication of the *Flora of British India* (Ed. by J. D. Hooker, 1872-1897), Prain (1903a) published *Bengal Plants* in which with admirable precision he described each taxon and listed the species under the 11 botanical divisions recognised by him. Moreover, he referred to Watt's dictionary (1889-1896) for plants of economic importance. The introductory chapter of *Bengal Plants* brings out the essential features and phytogeographical relationships of the flora of the specified area. Prain described the Plain, lying east of the Bhagirathi along with the land immediately South-West of it, as a typical representative of the alluvial deltaic rice plain abounding in water plants and remarked, 'Of this tract, as of Sunderbans, we possess a knowledge that is probably, practically complete. Little or nothing has been left by Roxburgh and Carey for the succeeding generations to add'. He, however, admitted that except the collections of Kurz, Ball and some references by Roxburgh to Midnapur jungles, the collections from his botanical division of West Bengal were inadequate. He further observed that the non-alluvial tract in the west, presents many elements of Bihar and Chotanagpur and a few species of Punjab, Rajasthan and Bundelkhand from the west and a few others from the Coremondal and Circars in the south.

Following the publication of *Bengal Plants*, Prain consolidated his studies on the flora of the Lower Ganga Plain. He successively published the *Flora of Sundribuns* (1903b) and the *Vegetation of the districts of Hughli-Howrah and 24-Pergunnahs* (1905). He recorded 120 families of Phanerogams including 670 genera and 1316 species from the

districts of Hooghly, Howrah and 24-Parganas including western Sunderbans. Of these, he considered about 900 species as native in a qualified sense. He analyzed in details the various naturalized species introduced and/or migrated from other countries or from contiguous areas into the alluvial plain of West Bengal. Consequent to Prain's contributions, a well arranged and annotated local herbarium of Bengal plants became an asset to the Calcutta herbarium. It now became possible to put a referable name with accuracy on about any specimen submitted for identification from Bengal. Thereafter, the taxonomic researches in the Lower Bengal gradually became neglected in the two decades between the World Wars I and II.

A noticeable change occurred in the field of systematic botany in Bengal after the independence. Taxonomists in different universities, colleges, research institutions and other branches of public service, became interested in the flora of Bengal and published their observations and enumerations (Basak, 1973). These also included numerous casual publications of limited scope and several incomplete check lists of species occurring in small areas. Often the descriptions of such works are somewhat meagre and no proper distinguishing characters were specified. Several interesting notes on the distribution of certain species in the area from the other parts of India and from foreign countries were also published by different authors.

The illustrated studies on the trees of Calcutta (Benthall, 1946) and on the grasses of 24-Parganas and weed flora of 24-Parganas (Majumdar, 1956 & 1962) filled the long standing gap in the botanical literature on the flora of the Lower Bengal since Prain. Some other notable contributions were by Mitra (1952, 1958), dealing with the family Commelinaceae and the Monocotyledonous plants of Bengal and neighbouring regions. The species of

Corchorus growing mainly in Bengal, were described by Chakrabarty (1951). The members of the family Poaceae and Cyperaceae from the Lower Ganga Plain were enumerated by Guha Bakshi *et al.* (1976 & 1977) and Sur and Das (1976). Jain *et al.* (1975) also enumerated grasses of this region in their study on grasses of Bihar, Orissa and West Bengal. An account of grasses of Indian Botanic Garden, Calcutta was given by Banerjee and Pal (1977).

With the revival of the Botanical Survey of India in 1954 having Calcutta as its headquarters and with the ample facilities for research now available in various organizations, a fresh impetus to floristic studies on the plants of different districts of West Bengal is apparent during the recent years. These works, such as on Howrah district by Bennet in 1968, on Nadia district by Das in 1968, on Bankura district by Sanyal in 1970, on the flora of Calcutta Botanic Garden by Vappuluri Sharma in 1970, on Hooghly district by Sen in 1972, on Tollygaunge and adjoining areas by Mitra in 1973, on Murshidabad district by Guha Bakshi in 1974 and on Purulia district by Malick in 1977 have already been completed and expected to be published in the near future. More or less a complete set of representative collections by Basak from Birbhum district is also available in the Calcutta herbarium. In connection with his work on the floristic survey of Midnapur district, Majhi collected plants for the Calcutta herbarium between the years 1975 and 1977. Mukherjee also collected plants from the Hooghly estuary and the vicinity during his ecological study on the area. Some plants from the northern half of 24-Parganas were collected by Mallick.

Very little attention has been paid so far to the vascular cryptogams of this zone. Majumdar (1930 & 1933) made some preliminary observations on the fern flora of

Calcutta and Ghatak (1963) described a new species of the *Adiantum caudatum* complex from Calcutta.

According to Chatterjee (1939, 1962), the Lower Ganga Plain belongs to the Indo-Gangetic Floristic Region and is relatively poor in endemic forms. However, it is interesting to note that several new taxa have been described from the area during the past few years. These are : *Phyllanthus mukerjeeanus* by Mitra & Bennet (1966) from Howrah, a new variety of *Cardanthera uliginosa* Buch.-Ham. by Guha (1967) from Birbhum, a new variety of *Peristrophe bicalyculata* (Retz.) Nees by Bennet (1969) from Howrah and *Cuscuta sharmanum* by Mukerjee & Bhattacharyya (1970) from Burdwan and Midnapur districts. The holotype of *Adiantum indicum* Ghatak (1963) was also collected from Calcutta.

Apart from the extensive studies on Sunderbans (cf. Prain, 1903b & Basak, 1973), few geographical and ecological studies have been carried out on the vegetation of this region. Chanda (1977) reproduced the earlier observations on the area (cf. Anon, 1959). The present conditions of forest belts in different districts and various facets of forestry in West Bengal were considered in several symposia and publications (Anon., 1959 & 1966). The problem of afforestation of *hil* areas in Malda district was discussed by Biswas (1960). In a series of studies, Rao and his associates (Rao *et al.*, 1965, 1970, 1972 & 1974) noted their observations on the coastal vegetation of West Bengal. Guha Bakshi *et al.* (1976) enumerated some halophytic plants of Sunderbans. An interesting account of the *flora advena* of Bengal was presented by Brühl (1908). He moreover, gave a chronological classification of the immigrant plants in Bengal. A considerable number of species of American origin, are now naturalized in West Bengal. The recent reports on the alien

weeds indicate that year by year some species are gradually being added to the flora of the adjoining districts of Calcutta. Such exotics, like *Parthenium hysterophorus* L. (Mandal *et al.*, in ed.) and others, may become harmful to agriculture and cause health hazards in their later stages of naturalization. The vegetation of salt lakes area near Calcutta attracted many botanists since 1845 (Biswas, 1927). Korlahalli (1967) reported from the Salt lakes locality several new records of the members of the family Cyperaceae for India and eastern India as well. Das Gupta (1973) enlisted 97 species under 41 families from the salt lake area and reported present ecological conditions.

Agharkar (1923) stressed on a thorough biological study of aquatic plant pests of Bengal and other parts of India. Biswas and Calder (1936) and Subramanyam (1962) noted the distribution of aquatic and marsh plants in Bengal. Calder (1937) and Biswas (1943) described the distribution and characteristic of the different floristic elements in the vegetation of the Lower Ganga Plain. A critical assessment of the plant types and of the ecological features of the aquatic vegetation of the Lower Damodar Valley of West Bengal was made by Kachroo (1956 & 1959). The grasses of Murshidabad, Nadia and 24 Parganas were described by Chaudhuri (1959) and later he discussed certain aspects of ecology of grasses and grassland types in West Bengal (Chaudhuri, 1965). Basak (1975) showed the pattern of distribution of carnivorous plants in different districts of West Bengal and reported several noteworthy records. The recent *West Bengal District Gazetteers* on West Dinajpur (1965), Bankura (1968), Howrah (1972) and Hooghly (1972) also contain brief sketches of the vegetation of respective areas. The chapter on the 'flora' in the District Gazetteer, Birbhum (Basak, 1975, communicated by the Botanical Survey of

India) deals with the vegetation, forest belts and economic plants of the district and alongwith analyzes the phytogeographical relationship of the present flora. It reveals that a large number of rare plants got introduced in the district from the adjoining areas, most of which form new records for the state of West Bengal. While certain species like *Acampe praemorsa* (Roxb.) Blatter & McCann, *Desmodium benthamii* Ohashi, *Drosera indica* L., *Jatropha heynei* Balak., *Mitrasacme pygmaea* R. Br. var. *malaccensis* (Wight) Hara, *Oldenlandia umbellata* L., *Rotala verticillaris* L., *Rhynchospora longisetis* R. Br., *Pseudarthria viscida* (L.) Wt. & Arn. *Sphaeromorphaea russeliana* DC., and *Utricularia minutissima* Vahl extend to Birbhum district from the Central and Peninsular India, some Himalayan species like *Hypericum japonicum* Thunb. ex Murr. *Atylosia volubilis* (Blanco) Gamble and *Synnema uliginosum* (L. f.) O. Kuntze succeeded in spreading in Birbhum through North Bengal and Bihar. The occurrence of *Ophioglossum nudicaule* L. f. var. *macrorrhizum* (Kze) Clausen in Birbhum district is also noteworthy (Basak, 1973, 1975 & in ed.). The vegetation of this part of West Bengal is of semi-arid nature and is similar to that of Rajmahal hills in eastern Bihar (Panigrahi, 1966).

Mukerjee (1938) in his study on the ecology of the plains with reference to the regional balance of Man concluded that the eroded soil and the combined effect of all activities of man have gradually depressed the natural vegetational stands to the open grassland and grazing areas with remnants of trees scattered here and there (cf. Geddes, 1927-28). He further concluded that on the Indo-Ganga Plain, the vegetation is now rather delicately balanced against man at about the grassland or the thorn scrub stage which will remain practically stationary as no relaxation of pressure is possible in the

methods of exploitation. The West Bengal Plain with its enormous urban concentration, especially on the Hooghly side and with influx of refugees from East Bengal, is an over populated and food deficient area. The indiscriminate utilization of land surface for cultivation and grazing and the exploitation of forests for fuel and timber, particularly over the past 30 years, have greatly affected the problem of preservation of soil and forest. The reckless and random collection of medicinal and other useful plants which form articles of trade, has already reduced the frequency of several important species (cf. Jain & Tarafdar, 1970). The land use statistics of West Bengal (Anon., 1966) indicates the trend of changes in the land use pattern, so far as agriculture and forests are concerned. Intensification of agriculture and proper protection and cultivation of economic plants in selected regions seem to be the only remedy under the present conditions (Mukherjea, 1956; Ketkar, 1976 & Ghosh *et al.*, 1977).

PRESENT TREND OF TAXONOMIC RESEARCH AND CONCLUSION

It has been estimated that about 750 genera and 1450 species under 150 families of Phanerogams are now available in the Lower Ganga Plain Division of West Bengal. The utility of Prain's contributions in the study of all these plants in West Bengal is immense. But in view of recent changes in the taxonomic categories and owing to the realignment of political boundaries, the state of West Bengal presently requires an up-to-date flora. It was Culshaw (1950), who first contemplated for the preparation of a flora of West Bengal. It is hoped that the recent works on various districts of West Bengal when published, will be valuable additions to our knowledge. The need for the publication of district floras in an integrated manner from the horticultu-

ral, botanical and genetic respects was also stressed by the committee for survey, conservation and utilization of resources of the Indian Science Congress (Sethna, 1977).

It is now evident that the period of exploration has practically come to an end, at least for the natural geographical region of the Lower Ganga Plain in West Bengal. The present goal of floristics is to prepare accurate keys and descriptions for plants of this region and to provide explanations for the development and distribution of the flora and to suggest the strategies for their survival. These facts will ultimately form the basis for monographic works and other aspects of vegetational history.

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