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EDITED BY

B. SAHNI



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THE INDIAN BOTANICAL SOCIETY

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THE JOURNAL OF THE INDIAN BOTANICAL SOCIETY.

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OF THE



Indian Botanical Society

EDITED BY
P. F. FYSON, MA., F.L.S.

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No. 2.

A SHORT STUDY ON THE CONFIGURATION AND THE FORMATION OF SEXUAL ORGANS IN *MARCHANTIA PALMATA*, IN RELATION TO CERTAIN EXTERNAL FACTORS.

BY H. CHAUDHURI,

Panjab University, Lahore.

When growing different species of *Marchantia* in the laboratory the author observed during the spring of 1924 that *Marchantia palmata* grown on blotting papers and placed near the window, had always the lobes elongated and pointed towards the source of light (fig. 2). The same *Marchantia* when grown in covered vessels (as when growing inside petri dishes) with similar one-sided illumination produced no such marked elongation but simply the tips of the lobes turned almost vertical.

A fresh set of plants were grown for 20 days and similar results were obtained, *viz.*, those in the open vessels had elongated lobes pointing towards the window and in the covered vessels no such marked elongation took place but simply the tips of the lobes turned almost vertical.

The effect of completely sealing the vessels was next tried. For this the plants were grown on blotting papers moistened with Knop's solution in large petri dishes and the edges were sealed with melted paraffin. The petri dishes were now placed near the window. Control plants similarly sealed were placed in diffuse light. The lobes of the plants placed near the window after some days began to elongate and in about a fortnight's time the elongated plants grew vertically upwards (figs. 3 & 4). The tips now appeared to be indifferent to the source of the light. The rhizoids also instead of growing vertically downwards grew diageotropically and were almost

perfectly parallel to each other (fig. 4). In the control vessels which were placed in diffuse light, the plants had their lobes pointed vertically without any apparent elongation of the lobes. It seemed therefore that when the plants assumed a vertical position, it was a question of something else than mere illumination.

The effect of carbon dioxide and moisture in producing the configuration was next investigated. The joint and independent effects of these factors were studied. For this, the plants grown in small glass troughs were placed in glass chambers provided with an inlet and an outlet tube. The outlet tubes were connected to the suction pump worked by means of a water tap and through the inlet tubes, ordinary air, dry air, moist air, air free from carbon dioxide, moist air free from carbon dioxide, dry air containing 5% of carbon dioxide and moist air containing a similar amount of carbon dioxide were drawn in. The experiments were performed near the window and continued for over four weeks. Quite striking results were obtained, which may be summarised as follows:—

- A. Ordinary air: lobes elongated and pointed towards the source of light.
- B. Dry air: no marked result, growth stunted.
- C. Moist air: lobes markedly elongated and pointed towards the source of the light.
- D. Dry air free from CO_2 : no further growth; plants dried up before the conclusion of the experiment.
- E. Moist air free from CO_2 : no further growth; plants survived the period of experiments.
- F. Dry air containing 5% CO_2 : quicker movement; lobes pointing vertically, but no elongation of the lobes, and rather stunted.
- G. Moist air with 5% CO_2 : quicker movement, lobes pointing vertically, elongation of the lobes took place, the plants growing vigorously.

In B, D and F, when dry atmospheres were maintained, it was never perfectly dry, as the blotting papers and sods on which the plants were growing had to be kept moist to prevent the plants drying up. However the experiments have clearly shown the action of carbon dioxide and a little moisture on the configuration of these plants. It has been also seen that the time period for these orientations could easily be reduced by putting in a few germinating seeds inside the closed vessels. In a closed atmosphere of 10% CO_2 (to start with) the plants grew very well and the lobes elongated and grew vertically when placed near the window and grew vertically without elongating when placed in diffuse light.

When the plants were growing vertically, if ordinary air was let in the lobes pointed towards the source of the light (fig. 5). This took place in 4 to 8 hours. If now the vessel was closed, the tips of the lobes grew vertically again (fig. 6). It was apparent that the carbon dioxide of the atmosphere was the most important factor in producing this configuration. In another series of closed vessels the plants were grown in atmospheres containing 2% 5%, 8%, and 10% CO_2 without any apparent bad effects for four weeks and it was found that the period in which the plants assumed vertical positions was systematically reduced. Thus the usual period of three weeks was reduced to less than two weeks with an atmosphere containing 10% carbon dioxide to start with. With 15% or more of carbon dioxide the plants were poisoned and failed to grow.

In this connection interesting observations were made regarding the formation of gemma cups and sexual organs.

In many of the preceding experiments plants were grown from gemmae obtained from the cups on moist blotting papers. When the plants had grown to a diameter of 4-5 mm., these were used for experiments; or similar sized plants growing in nature were obtained. It was observed that from these plants gemma cups were only formed when they were grown in open vessels with a continuous supply of fresh air. In the closed vessels though no gemmae cups were formed, the tips of the vertical plants produced sexual organs long before the plants in the open had produced any. Also it was noticed that the sexual organs consisted mainly of archegoniophores. Hence it may be concluded that the increase in carbon dioxide not only produced abnormal configuration in *Marchantia palmata*, but also prevented the formation of gemmae and favoured the production of sexual organs consisting mainly of archegoniophores.

Summary.

The effect of certain external factors on the configuration and the formation of sexual organs in *Marchantia* have been studied.

It has been observed that plants grown in open vessels with one-sided illumination had lobes elongated and pointed towards the source of the light. In closed vessels no marked elongation was produced but the lobes turned almost vertically upwards. In sealed vessels the lobes grew up quite vertically and produced abundant rhizoids diageotropically.

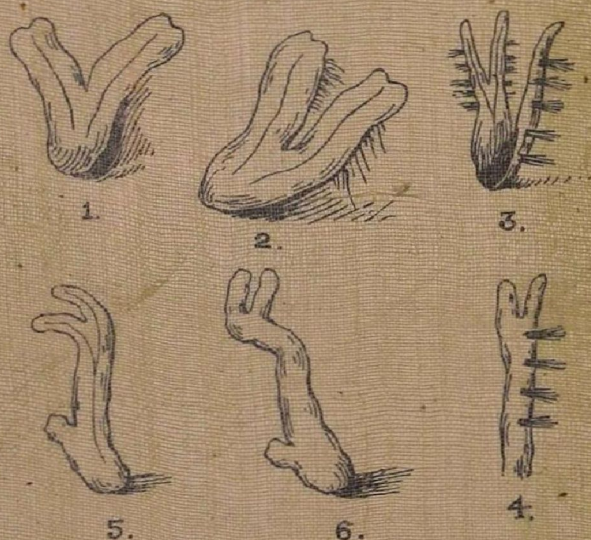
When fresh air was let into the sealed vessels, the lobes again pointed towards the source of light which the vessels being again sealed grew vertically upwards.

This orientation has been found to be due to an increase in CO_2 and was facilitated in humid atmospheres. Similar growths have been induced in plants grown in closed vessels through which a current of air containing a large amount of CO_2 was passed.

It has also been observed that plants grown under such artificial conditions failed to produce gemmae but bore sexual organs consisting mainly of archegoniophores long before the control plants left outside had produced any.

LAHORE,

25th January, 1927.



Marchantia palmata.

Explanation of the Figs. 1—6.

1. *Marchantia palmata* grown in diffuse light.
2. Grown near the window; the lobes are pointing towards the source of light, the rhizoids are pointing downwards.
- 3, 4. Plants grown in sealed vessels. In 4 the clusters of rhizoids are seen growing diageotropically.
5. A plant grown in a closed vessel into which after some time fresh air was let in. As a result of letting in fresh air, the tips are pointing towards the source of light.
6. Same plant, after the vessel had been sealed again. The tips grew up vertically again.

THE FLORA OF THE INDUS DELTA.

BY

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AND

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PART II.

(Continued from p. 47, Vol. VI, No. 1)

Apocynaceae.

NERIUM, Linn.

Nerium odorum Soland. in Hort. Kew. ed. 1, I (1789), 297.

Loc.:—Gharo, Mirpur Sakro (D44!).

Distribution:—Afghanistan, Baluchistan, India, China and Japan.

VINCA, Linn.

**Vinca rosea* Linn. Syst. ed. X, 944. Loc.:—Gholam.

Asclepiadaceae.

PERIPLOCA, Linn.

Periploca aphylla Dene. in Jacq. Voy. Bot. (1844), 109, t. 116.

Loc.:—Tatta (D337!, D539!).

Distribution: Egypt, Arabia, Persia, Afghanistan, Baluchistan, Sind, Punjab, Rajputana.

Periploca sp. This is a new species to be described elsewhere

Loc.:—Gholam, on limestone hill.

CALOTROPIS, R. Br.

Calotropis procera R. Br. in Ait. Hort. Kew ed. 2, II (1811), 78.

Loc.:—Mirpur Sakro.

Distribution:—Tropical Africa, Persia, India, Ava.

OXYSTELMA, R. Br.

Oxystelma esculentum R. Br. in Mem. Wern. Soc. I (1811), 40.

Loc.:—Mirpur Sakro (D59!, D63!, D64!); Gholam, limestone hill (D60!), Bughar river (D58!).

Distribution:—Indo-Malaya.

PENTATROPIS, *R. Br.*

Pentatropis cynanchoides *R. Br. in Salt Voy. Abbyss.* (1814), *Append.* 64. Loc.:—Gharo. (D47!, D50!, D51!), Mirpur Sakro (D49!, D52!, D61!, D62!), Kullian Kote Lake (D48!), Tatta (D17!).

Distribution:—Tropical Africa, Arabia, Baluchistan, Afghanistan, India.

DAEMIA, *R. Br.*

Daemia extensa *R. Br. in Mem. Wern. Soc.* I (1811), 50. Loc.:—Gholam (D57!), limestone hill (D56!, D568!), Tatta (D54!, D55!), Tatta Tombs (D53!).

Distribution:—Afghanistan, India, Ceylon.

SARCOSTEMMA, *R. Br.*

Sarcostemma Stocksii *Hook. f. Fl. B. I.* IV (1883), 27. Loc.:—Gholam, limestone hill (D523!).

Distribution:—Apparently endemic in the Bombay Presidency.

LEPTADENIA, *R. Br.*

Leptadenia Spartium *Wight Contrib.* (1834), 48. Loc.:—Mirpur Sakro (D46!), Bughar river (D45!), also at Gharo.

Distribution:—Egypt, Arabia, Baluchistan, India.

ASCLEPIAS, *Linn.*

**Asclepias curasavica* *Linn. Sp. Pl.* (1753), 215. Loc.:—Gholam, in a garden (D569!).

Gentianaceae.

ENICOSTEMMA, *Bl.*

Enicostemma littorale *Bl. Bijdr.* (1826), 848. Loc.:—Gharo (D361!), Mirpur Sakro (D102!, D103!), Tatta Tombs (D204!).

Distribution:—Tropics of the Old World; W. Indies.

Boraginaceae.

CORDIA, *Linn.*

Cordia Myxa *Linn. Sp. Pl.* (1753), 190. Loc.:—Mirpur Sakro, Tatta, associating with *Acacia arabica*.

Distribution:—Throughout India, wild and cultivated; Egypt, Ceylon, CochinChina and tropical Australia, often planted.

Cordia Rothii *Roem. and Schult. Syst.* IV (1819), 798. Loc.:—Bohara (D69!), Kullian Kote Lake (D 531!), also at Mirpur Sakro.

Distribution:—Abyssinia, Arabia, India, Ceylon.

HELIOTROPIMUM, *Linn.*

Heliotropium ophioglossum *Stocks ex. Aitch. Pb. and Sind Pl.* (1869), 94. Loc.:—Gholam, limestone hill (D94!), Tatta (D84!, D85!, D101!).

Distribution:—Tropical Africa, Baluchistan.

Heliotropium calcareum Stocks in Kew Journ. Bot. IV (1852), 174. Loc.:—Gholam, limestone hill (D100 !).

Distribution:—Baluchistan, Sind, Rajputana.

Heliotropium ovalifolium Forsk. Fl. Aegypt. Arab. (1775), 38. Loc.:—Tatta (D123 !).

Distribution:—Tropical Africa, India, Burma, Australia.

Heliotropium undulatum Vahl. Symb. I, 13. *H. tuberosum*, Boiss. Loc.:—Gharo (D96 !, D97 !, D98 !, D99 !, D562 !); Gholam limestone hill (D95 !); Tatta (D91 !, D92 !, D93 !).

Distribution:—Persia.

Heliotropium paniculatum E. Br. Prodr. (1810), 494. Loc.:—Gharo (D90 !), Mirpur Sakro (D86 !, D87 !, D88 !, D89 !), Gholam limestone hill (D122 !); Kullian Kote Lake (D121 !).

Distribution:—Indo-Malaya, Australia.

Heliotropium rariflorum Stocks in Kew Journ. Bot. IV (1852), 174. Loc.:—Tatta (ex Cooke).

Distribution:—Nubia, Socotra, Afghanistan, Baluchistan, India.

TRICHODESMA, E. Br.

Trichodesma indicum, E. Br. Prodr. (1810), 496, var. *amplexicaule*, Th. Cooke, Fl. Bombay II (1904), 215. Loc.:—Gholam limestone hill (D82 !, D83 !); Tatta, gravel (D81 !).

Distribution:—Punjab, Central India, Konkan, Mysore, Malabar.

Convolvulaceae.

CRESSA, Linn.

Cressa cretica Linn. Sp. Pl. (1755), 223. Loc.:—Gharo (D294 !), Gholam (D293 !, D295 !), Kullian Kote Lake (D296 !), also at Mirpur Sakro.

Distribution:—All warm countries.

CONVOLVULUS, Linn.

Convolvulus scindicus Stocks in Kew Journ. Bot. IV (1852), 173. Loc.:—Gharo (D297 !, D307 !).

Distribution:—Baluchistan.

Convolvulus Rottlerianus Choisy Convolv. Orient in Mem. Soc. Phys. Genev. VI (1834), 477, var. *tenella*, C. B. Clarke. Loc.:—Gharo (D301 !, D302 !, D313 !), Mirpur Sakro (D311 !), Gholam limestone hill (D304 !, D310 !, D314 !), Tatta (D303 !), Tatta Tombs (D298 !, D299 !, D300 !).

Distribution:—Afghanistan, Baluchistan, India.

Convolvulus microphyllus Sieb. ex Spreng. Syst. I (1825), 611. Loc.:—Gharo (D318 !, D319 !, D320 !, D322 !), Tatta Tombs (D315 !, D316 !).

Distribution:—Nubia, and from Egypt to India.

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Convolvulus rhyniospermus Hochst. ex Choisy in DC. Prodr. IX (1845), 405. Loc.:—Tatta Tombs (D312 !, D323 !).

Distribution:—Kordofan, Sind, Rajputana.

Convolvulus arvensis Linn. Sp. Pl. (1753), 153. Loc.:—Bohara (D324 !).

Distribution:—Cosmopolitan.

Convolvulus sp. A new species to be described elsewhere. Loc.: Gharo.

MERREMIA, Bennst.

Merremia chryseides Hallier f. in Engl. Bot. Jahrb. XVI (1893), 552. Loc.:—Bughar river (D326 !).

Distribution:—Tropical Africa, India, Ceylon, Malaya, China, Australia.

Merremia aegyptia Linn. Sp. Pl. (1753), 162. Loc.:—Gholam (D305 !, D306 !).

Distribution:—Tropics generally, often cultivated.

IPOMOEA, Linn.

Ipomoea eriocarpa R. Br. Prodr. (1810), 484. Loc.: Gholam (D325 !).

Distribution:—Tropics of the Old World, Afghanistan.

Ipomoea aquatica Forsk. Fl. Aegypt.-Arab. (1775), 44. Loc. Tatta (D327 !), Keti (D317 !).

Distribution:—Tropical Africa, Asia, Australia.

Ipomoea biloba Forsk. Fl. Aegypt.-Arab. (1775), 44. Loc.: Mirpur Sakro (D292 !), also at Gharo.

Distribution:—Sea-shores of both hemispheres throughout the tropics.

**Ipomoea batatas* Poir. Encyc. Meth. VI (1804), 14. Loc.: Gholam (D321 !).

Distribution:—Tropical America.

RIVEA, Choisy.

Rivea hypocrateriformis Choisy Convolv. Orient. in Mem. Soc. Phys. Genev. VI (1834), 408. Loc.: Ghōlam, limestone hill (D309 !), Tatta (D308 !).

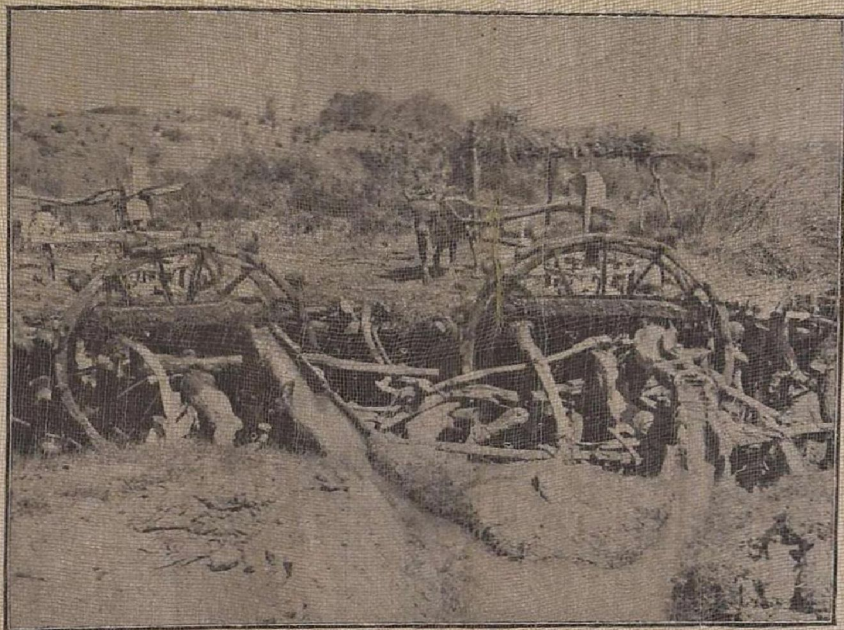
Distribution:—India.

Solanaceae.

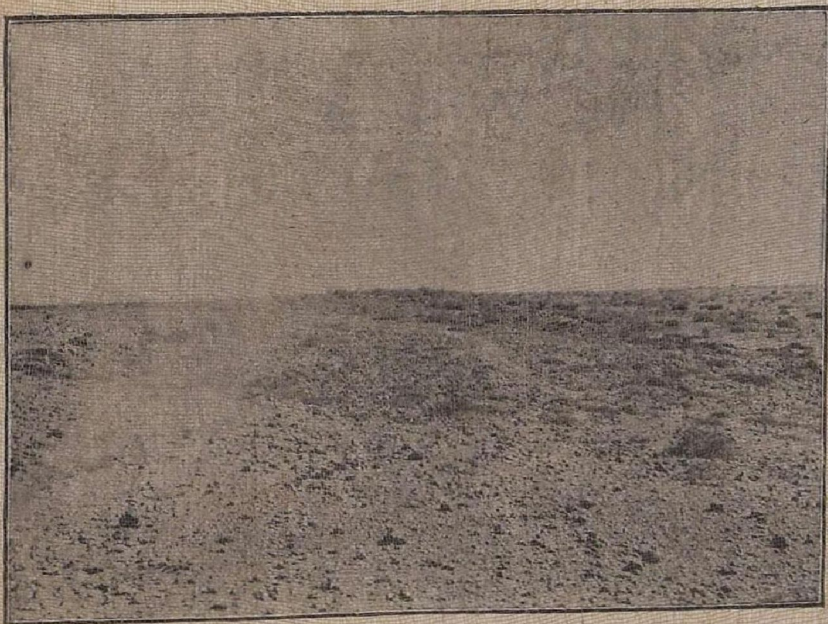
SOLANUM, Linn.

Solanum nigrum Linn. Sp. Pl. (1753), 106. Loc.: Bughar river. (D70 !, D71 !).

Distribution:—Cosmopolitan in the temperate and tropical regions of the world.



No. 9. Lifting water from the Bughar canal near Gholam.—Vegetation: Grasses and Sedges.



No. 10. Limestone rock and gravel on hill near Gholam, showing chiefly *Capparis decidua* Pax and *Commiphora Mukul* Engl.

Solanum xanthocarpum Schrad. and Wendl. *Sert.* I (1795), 8, t. 2. Loc.:—Gharo (D72 !), Mirpur Sakro (D68 !), bank of Bughar river (D79 ! D80 !), Chunar (D573 !).

Distribution :—Indo-Malaya, Australia, Polynesia.

Solanum albicaule Kotschy ex Dunal in DC. *Prodr.* XIII, Pt. II. (1852), 204. Loc.:—Gharo (D72 !, D77 !), Kullian Kote Lake (D575 !).

Distribution :—Tropical Africa, Arabia, Sind.

**Solanum Melongena* Linn. *Sp. Pl.* (1753), 186. Loc.:—Bohara (D66 !), Bughar river (D78 !), also at Gholam.

Distribution :—Native country uncertain.

PHYSALIS, Linn.

Physalis minima Linn. *Sp. Pl.* (1753), 183. Loc.:—Tatta (D67 !), Chunar (D65 !).

Distribution :—Tropical Africa, India, Ceylon, Australia.

WITHANIA, Pauq.

Withania somnifera Dunal in DC. *Prodr.* XIII, Pt. I (1852), 453. Loc.:—Gharo (D75 !, D76 !, D574 !).

Distribution :—Mediterranean region, Cape of Good Hope, India, Ceylon.

LYCIUM, Linn.

Lycium barbarum Linn. *Sp. Pl.* (1753), 192. Loc.:—Gharo (D205 !), also between Gharo and Mirpur Sakro.

Distribution :—Persia, Afghanistan, Baluchistan, India.

DATURA, Linn.

Datura fastuosa Linn. *Syst. Nat. ed.* 10 (1759), 932. Loc.:—Bohara.

Distribution :—Throughout the tropics of both hemispheres.

LYCOPERSICUM, Mill.

**Lycopersicum esculentum* Mill. *Gard. Dict. ed.* 8 (1768) n. 2. Loc.:—Mirpur Sakro.

CAPSIUM, Linn.

**Capsicum annuum* Linn. *var.* Loc.:—Gholam.

Scrophulariaceae.

LINARIA, Juss.

Linaria ramosissima Wall. *Pl. As. Rar.* II (1831), 43, t. 153. Loc.:—Gharo (D215 !, D219 !, D221 !, D222 !), Tatta Tombs (D228 !).

Distribution :—Throughout India, usually in rocky or stony places; Afghanistan, Ava, Burma.

SCHWEINFURTHIA, A. Braun.

Schweinfurthia sphaerocarpa A. Braun in *Monatsb. Akad. Wiss. Berl.* (1866), 875. Loc.:—Tatta Tombs (D220!, D223!, D224!, D225!, D226!, D227!).

Distribution:—Afghanistan, Baluchistan, Sind, Rajputana.

LIMNOPHILA, R. Br.

Limnophila gratioloides R. Br. *Prodr.* (1810), 442. Loc.:—Gholam (D229!).

Distribution:—Tropical Africa, Baluchistan, India, Ceylon, Malayan Archipelago, China, Australia.

BONNAYA, Link and Otto.

Bonnaya veronicaefolia Spreng. *Syst. Veg.* I (1825), 41. Loc.:—Tatta (D218!).

Distribution:—Throughout India, Ceylon, Java, Siam, China, Philippine Islands.

PEPLIDIUM, Delile.

Peplidium humituum Delile. *Descrip. de l'Egypte* (1812), 148, t. 4. Loc.:—Tatta (D577!), Koti (567!).

Distribution:—Egypt, Kurdistan, India, Ceylon, Australia.

LINDENBERGIA, Lehm.

Lindenbergia abyssinica Hochst. ex Benth. in *DC. Prodr.* X (1846), 377. Loc.:—Tatta (D217!).

Distribution:—Abyssinia, Somali Country, Arabia.

Lindenbergia urticaefolia Link and Otto *Ic. Pl. Rar. Hort. Berol.* (1828), t. 48. Loc.:—Gharo (D566!), Tatta (D216!).

Distribution:—Afghanistan, India.

Orobanchaceae.

CISTANCHE, Hoffm. and Link.

Cistanche tubulosa Wight. *Id. t.* 1420 bis (1850). Loc.:—Gharo (on *Salvadora*), (D203!).

Distribution:—Arabia to Central Asia, India.

Bignoniaceae.

TECOMELLA, Seem.

Tecomella undulata Seem. in *Ann. and Mag. Nat. Hist. ser. 3, X* (1862), 30. Loc.:—Kullan Kote Lake (D532!), Tatta (D538!), Koti.

Distribution:—Arabia, Baluchistan, India.

Pedaliaceae.

SESAMUM, Linn.

**Sesamum indicum* Linn. *Sp. Pl.* (1753), 634. Loc.:—Mirpur Sakro.

Distribution:—Tropical Africa, cultivated throughout India.

Acanthaceae.

THUNBERGIA, *Linn. f.*

**Thunbergia fragrans* *Roxb. Cor. Pl. I* (1795), 47, t. 67. Loc.:—Mirpur Sakro, Tatta.

Distribution.:—Throughout India in elevated districts; Ceylon, Malaya, Philippines, N. Australia.

BLEPHARIS, *Juss.*

Blepharis sindica *T. Anders. in Journ. Linn. Soc. IX* (1867), 500. Loc.:—Gharo (D234 !), Tatta Tombs (D235 !), Kullian Kote Lake (D233 !).

Distribution.:—Sind, Punjab, Rajputana, Gujerat.

RUELLIA, *Linn.*

Ruellia patula *Jacq. Misc. Bot. II* (1781), 358. Loc.:—Gharo (D252 !), Gholam, limestone hill (D242 !), Kullian Kote Lake (D240 !, D241 !, D243 !), Tatta (D239 !).

Distribution.:—From tropical Africa to India.

Ruellia prostrata *Poir. Encyc. Meth. VI* (1804), 349, var. *dejecta* *C. B. Clarke, in Hook. f. Fl. B. I. IV* (1884), 412. Loc.: Gholam (D244 !).

Distribution.:—East Africa, Ceylon and throughout India.

BARLERIA, *Linn.*

Barleria Prionitis *Linn. Sp. Pl.* (1753), 636. Loc.:—Gharo (D237 !), Kullian Kote Lake (D236 !).

Distribution.:—Tropical and S. Africa, tropical Asia; India, Ceylon.

Barleria acanthoides *Vahl Symb. I* (1790), 47. Loc.:—Gharo (D230 !), Tatta (D231 !, D232 !).

Distribution.:—Egypt, Nubia, Abyssinia, Baluchistan, India.

Barleria Hochstetteri *Nees in DC. Prodr. XI* (1847), 231. Loc.:—Gholam, limestone hill (D251 !).

Distribution.:—Nubia, Abyssinia, Arabia, Baluchistan, Sind, Rajputana.

JUSTICIA, *Linn.*

Justicia heterocarpa *T. Anders. in Journ. Linn. Soc. VII* (1864), 41. Loc.:—Kullian Kote Lake (D245 !, D246 !, D247 !, D248 !).

Distribution.: Tropical Africa, India (Punjab).

Verbenaceae.

LIPPIA, *Linn.*

Lippia nodiflora *Michaux Fl. Bor. Amer. II* (1803), 15. Loc.:—Mirpur Sakro (D212 !, D214 !), Bughar river (D206 !, D211 !, D213 !).

Distribution.:—Most tropical and subtropical regions.

CLERODENDRON, *Linn.*

Clerodendron Phlomidis *Linn. f. Supp.* (1781), 292. Loc.:—Mirpur Sakro, Kullan Kote Lake (D586 !).

Distribution :—India, Ceylon.

AVICENNIA, *Linn.*

Avicennia officinalis *Linn. Sp. Pl.* (1753), 110. Vern. Name : *Timar, Tiwar.* Loc.:—Along the coast.

Distribution :—India, Ceylon, Malaya, shores of the Indian and Pacific oceans.

Labiatae.

OCIMUM, *Linn.*

Ocimum sanctum *Linn. Mant.* I (1767), 85. Loc.:—Mirpur Sakro (D206 !).

Distribution :—Arabia, W. Asia, India, Malay Archipelago, Australia.

Ocimum canum *Sims in Bot. Mag.* (1824), t. 2452. Loc.:—Tatta Tombs (D210 !).

Distribution :—Tropics of the Old World.

* *Ocimum basilicum* *Linn. Sp. Pl.* (1753), 597, var. *thrysiflorum*, *Wight Ic. t.* 368. Loc.:—Mirpur Sakro (D238 !).

LEUCAS, *R. Br.*

Leucas urticaefolia *R. Br. Prodr.* (1810), 504. Loc.:—Kullan Kote Lake (D519 !), Tatta (D209 !), Tatta Tombs (D207 !, D208 !).

Distribution :—Abyssinia, Arabia, Baluchistan, India.

SALVIA, *Linn.*

Salvia aegyptiaca *Linn. Sp. Pl.* (1753), 23. Loc.:—Gharo (D563 !), Tatta (D564 !).

Distribution :—Mediterranean, W. Asia, Afghanistan, India.

Nyctaginaceae.

BOERHAAVIA, *Linn.*

Boerhaavia diffusa *Linn. Sp. Pl.* (1753), 3. Loc.:—Mirpur Sakro (D124 !).

Distribution :—Tropical and subtropical Africa, Asia and America.

Boerhaavia vericillata *Poir. Encyc. Meth.* V (1804), 56. Loc.:—Mirpur Sakro (D125 !, D126 !, D127 !).

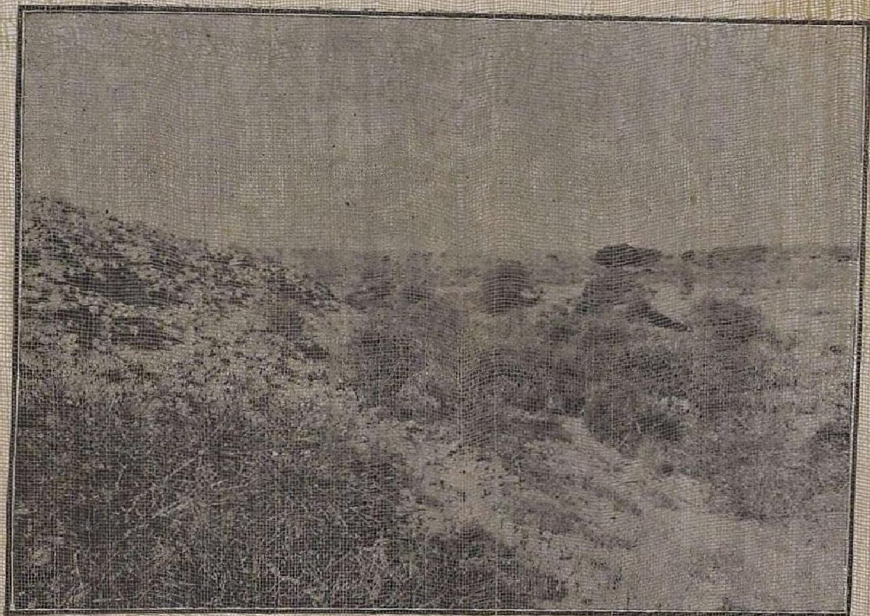
Distribution :—From tropical Africa to W. India and the Punjab.

Amarantaceae.

CELOSIA, *Linn.*

Celosia argentea *Linn. Sp. Pl.* (1753), 205. Loc.:—Mirpur Sakro.

Distribution :—Throughout the tropics.



No. 11. Nala on limestone hills near Gholam. In foreground : *Periploca*, *Capparis*, *Grewia*. In background : *Salvadora*.



No. 12. Gravel and limestone—rock between Gholam and Tatta, almost pure formation of *Euphorbia nivulia* Ham.

DIGERA, Forsk.

Digera arvensis Forsk. *Fl. Aegypt.—Arab.* (1775), 65. Loc.:—Mirpur Sakro.

Distribution :—N. Africa, Arabia, Afghanistan, Baluchistan, India, Ceylon.

AMARANTUS, Linn.

Amarantus viridis Linn. *Sp. Pl.* (1763), 1405. Loc.:—Mirpur Sakro (D153 !), Gholam, in a garden (D142 bis !), Bughar river (D149 !, D151 !).

Distribution :—All tropical countries.

Amarantus polygamus Linn. *Amoen. Acad.* IV (1759), 294. Loc.:—Gharo (D 148 !, D 150 !), Mirpur Sakro (D 152 !); Gholam, in fields (D141 !), in a garden (D144 !, D145 !); Kullian Kote Lake (D146 !), Bughar river (D147 !).

Distribution :—Most hot countries.

AERUA, Forsk.

Aerua tomentosa Forsk. *Pl. Aegypt.—Arab.* CXXII and 170 (= *Aerua javanica* Wight). Loc.:—Gharo (D136 !), Mirpur Sakro (D134 !), Tatta (D135 !).

Distribution :—Cape Verd Islands, E. and W. tropical Africa, North Africa, Arabia, India, Ceylon (not Java).

Aerua pseudo-tomentosa Blatt. and Hall. in *Journ. Bom. Nat. Hist. Soc.* XXVI (1919), 817. Loc.:—Gharo (D138 !), Gholam, limestone hill (D139 !), Mirpur Sakro (D140 !), Bohara (D137 !).

Distribution :—Jodhpur and Jaisalmer States.

ACHYRANTHES, Linn.

Achyranthes aspera Linn. *Sp. Pl.* (1753), 204. Loc.:—Gharo. Distribution :—In the tropics generally.

NOTHOSAERUA, Wight.

Nothosaerua brachiata Wight *lc.* VI (1853), 1. Loc.:—Tatta (D130 !).

Distribution :—From tropical Africa to India and Ceylon.

PUPALIA, Juss.

Pupalia lappacea Moq. in *DC. Prodr.* XIII (1849), 331. Loc.:—Gholam, limestone hill (D554 !).

Distribution :—Tropics of the Old World.

ALTERNANTHERA, Forsk.

Alternanthera triandra Lam. *Encycl. Meth.* I (1783), 95. Loc.:—Mirpur Sakro, in fields (D128 !, D132 !, D133 !), Bughar river (D131 !).

Distribution :—All warm countries.

Alternanthera nodiflora Br. Prodr. 417. Loc.:—Tatta (D129!).

Distribution:—Africa, tropical Asia, Japan, Australia, Polynesia.

Chenopodiaceae.

CHENOPODIUM, Linn.

Chenopodium murale Linn. Sp. Pl. (1753), 219. Loc.:—Mirpur Sakro (D199!, D559!), Bohara (D196!, D198!), Bughar river (D197!).

Distribution:—Ubiquitous.

ATRIPLEX, Linn.

Atriplex Stocksii Boiss. Diagn. ser. 2, no. 4 (1859), 73. Loc.:—Banks of Indus.

Distribution:—W. Peninsula.

ARTHROCNEUM, Moq.

Arthrocnemum indicum Moq. *Chenopod. Enum.* (1840), 113. Loc.:—Mouth of Indus (D187!, D188!, D189!, D190!).

Distribution:—Tropical Africa, India (W. Peninsula, Bengal), Ceylon.

SUAEDA, Forsk.

Suaeda fruticosa Forsk. *Fl. Aegypt.—Arab.* (1775), 70. Loc.:—Gharo (D155!, D178!, D558!), Mirpur Sakro (D154!, D160!, D172!, 179!), Gholam, limestone hill (D174!, D185!) Tatta (D183!), mouth of the Indus (D200!, D201!, 202!).

Distribution:—Africa, India, America.

Suaeda nudiflora Moq. in *Ann. Sc. Nat.* XXIII (1831), 316. Loc.:—Mirpur Sakro, common in bushes (D161!), D162!). Bohara (D186!), Gholam, limestone hill (D156!, D157!, D184!), Tatta (D163!, D164!), mouth of Indus (D158!, D165!, D166!, D167!).

Distribution:—India (Orissa on the sea-coast, W. Peninsula), Ceylon.

Suaeda monoica Forsk. *Fl. Aegypt.—Arab.* (1775), 70. Loc.:—Mirpur Sakro (D169!, D173!), Bohara (D168!, D170!, D171!), Kullian Kote Lake (D180!).

Distribution:—Tropical Africa, Arabia, India (W. Peninsula), Ceylon.

HALOXYLON, Bunge.

Haloxylon recurvum Bunge ex Boiss. *Fl. Or.* IV (1879), 949. Loc.:—Gharo (D175!, D176!, D177!), Kullian Kote Lake (181!), Tatta Tomba (D182!).

Distribution:—Afghanistan, India, Yunnan.

SALSOLA, *Linn.*

Salsola foetida *Del. Fl. Aegypt. Illustr.* (1812), 310. Loc.:—Gholam, limestone hill (D194 !), Bohara (192 !, D193 !), Kullian Kote Lake (D195 !), Tatta Tombs (D191 !).

Distribution :—N. Africa, Arabia, Persia, Baluchistan, India.

Polygonaceae.

POLYGONUM, *Linn.*

Polygonum plebejum *R. Br. Prodr.* (1810), 420. Loc.:—Gharo (D565 !).

Distribution :—Throughout tropical India.

Aristolochiaceae.

ARISTOLOCHIA, *Linn.*

Aristolochia bracteata *Retz. Obs. Bot. fasc. V* (1789), 29. Loc.:—Gharo (D437 !, D440 !), Tatta (D438 !, D439 !).

Distribution :—Tropical Africa, Arabia, India, Ceylon.

Euphorbiaceae.

EUPHORBIA, *Linn.*

Euphorbia Nivulia *in Trans. Linn. Soc. XIV* (1825), 286. Loc.:—Tatta.

Distribution :—S. E. Punjab, Rajputana, Sind, Gujarat, Bihar, Orissa.

Euphorbia hypericifolia *Linn. Sp. Pl.* (1753), 454. Loc.:—Mirpur Sakro (D403 !, D404 !, D405 !, D407 !, D408 !, D409, D410 !, D416 !, D417 !), Bohara (D406 !, D415 !), Gholam, in a garden (D413 !, D414 !), Bughar river (D418 !).

Distribution :—Almost throughout the tropics.

Euphorbia hirta *Linn. Sp. Pl.* (1753), 454. Loc.:—Bughar river (D433 !).

Distribution :—Most tropical and subtropical countries.

Euphorbia pilulifera *Linn. Sp. Pl.* (1753), 454. Loc.:—Gharo.

Distribution :—Throughout the hotter parts of India, Ceylon and most tropical and subtropical countries.

Euphorbia granulata *Forsk. Fl. Aegypt.—Arab.* (1775), 94. Loc.:—Kullian Kote Lake, on a rock (D401 !), Tatta (D402 !).

Distribution :—Canary Isles, Egypt, Arabia, Afghanistan, India.

Euphorbia Clarkeana *Hook. f. Fl. Brit. Ind. V* (1887), 253. Loc.:—Gharo (D422 !), Mirpur Sakro (D420 !, D576 !), Kullian Kote Lake (D421 !), Tatta (D423 !, D427 !).

Distribution :—India.

Euphorbia jodhpurensis Blatt. and Hall. in Journ. Bom. Nat. Hist. Soc. XXVI (1920), 969. Loc.:—Gharo (D428 !), Mirpur Sakro (D424 !, D425 !, D426).

Distribution :—Jodhpur.

**Euphorbia Tirucalli* Linn. Sp. Pl. (1753), 452. Loc.:—Gharo.

**Euphorbia heterophylla* Linn. Sp. Pl. (1753), 453. Loc.:—Gholam.

ANDRACHNE, Linn.

Andrachne aspera Spreng. Syst. Veg. III (1826), 884. Loc.:—Tatta.

Distribution :—Tropical Africa, Arabia, Persia.

Andrachne sp. nov. To be described elsewhere. Loc.:—Tatta, on limestone rock near lake (D752 !, D723 !, D754 !).

PHYLLANTHUS, Linn.

Phyllanthus reticulatus Poir. Encyc. Method. V (1804), 298. Loc.:—Bohara (D431 !), Bugar river (D429 !, D430 !), on the Indus.

Distribution :—Tropical Africa and India, Ceylon, Malay Islands, China.

Phyllanthus Niruri Linn. Sp. Pl. (1753), 981. Loc.:—Gharo (D419 !), Mirpur Sakro (D395 !, D397), Bohara (D400 !), Gholam (D394 !, D396 !), Gholam, on gravel (D412 !), Kullian Kote Lake (D398 !), Tatta (D399 !).

Distribution :—Tropics generally, except Australia.

**Phyllanthus distichus* Muell. Arg. in DC. Prodr. XV, part 2 (1866), 413. Loc.:—Ketī (D432 !).

RICINUS, Linn.

**Ricinus communis* Linn. Sp. Pl. 1007. Loc.:—Gholam, in a garden (D434 !), also at Mirpur Sakro.

Distribution :—Tropics generally, probably indigenous in Africa; cultivated throughout India.

Moraceae.

MORUS, Linn.

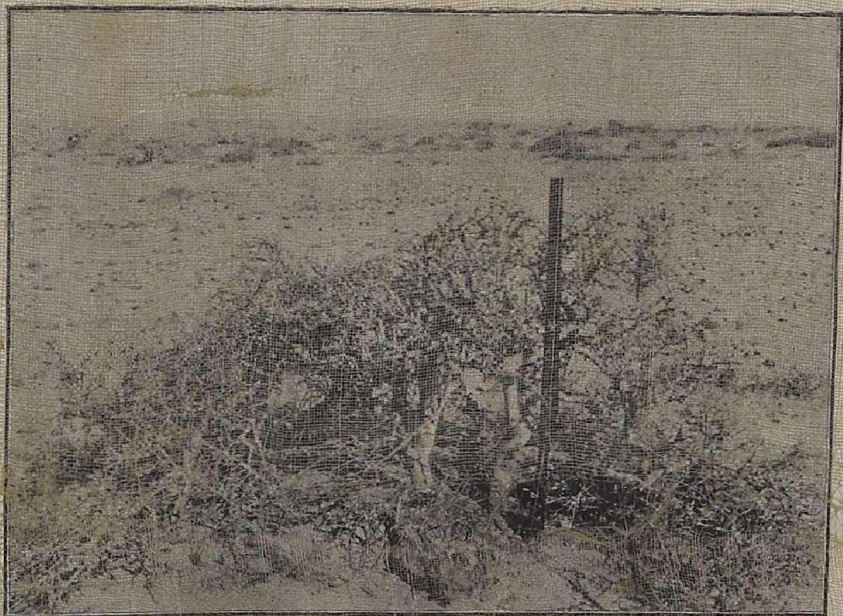
**Morus indica* Linn. Loc.:—Mirpur Sakro (D436 !).

Urticaceae.

FICUS, Linn.

**Ficus bengalensis* Linn. Hort. Cliff. (1737), 471, No. 4. Loc.:—Mirpur Sakro (D436 !).

Distribution :—Wild in the subhimalayan forests and on the lower slopes of the hill ranges of Southern India.



No. 13. Almost flat hill-top near Gholam. Old specimen of *Commiphora Mukul* Engl. The same in background mixed with *Euphorbia nivulia* Ham.



No. 14. A clump of arborescent *Euphorbia nivulia* Ham. in the neighbourhood of Gholam.

**Ficus religiosa* Linn. *Sp. Pl.* (1753), 1059. Loc.:—Bohara (D435 !).

Distribution :—Subhimalayan forests in Bengal and Central India.

Ficus glomerata Roxb. *Cor. Pl.* II (1798), 13, t. 123. Loc.:—Mirpur Sakro.

Distribution :—Throughout India, Ceylon.

Casuarinaceae.

CASUARINA, Forst.

**Casuarina equisetifolia* Forst. *Char. Gen.* (1776), 104, t. 52. Loc.:—Tatta.

Distribution :—India, Malay Archipelago, Australia.

Salicaceae.

POPULUS, Linn.

Populus euphratica Oliv. *Voy. Atlas*, III, 449, *tt.* 45, 46. Loc.:—Chunar (D587 !, D588 !, D589 !, D590 !, D591 !).

Distribution :—Egypt and Syria eastwards to Afghanistan, Baluchistan and Tibet; India (Punjab).

Gnetaceae.

EPHEDRA, Linn.

Ephedra foliata Boiss. *Fl. Orient.* V (1881), 716. Loc.:—Gharo (D533 !, D534 !, D535 !), Tatta (D524 !, D525 !, D526 !, D527 !, D528 !, D529 !, D540 !), Tatta Tombs (D536 !).

Distribution :—Syria to Afghanistan, Punjab, Rajputana.

Hydrocharitaceae.

VALLISNERIA, Linn.

Vallisneria spiralis Linn. *Sp. Pl.* (1753), 1015. Loc.:—Tatta, lake (D520 !).

Distribution :—Warm regions of the Old and New World.

Scitamineaceae.

MUSA, Linn.

**Musa sapientum* Linn. *Syst. ed.* 10 (1759), 1303. Loc.:—Mirpur Sakro, Gholam, Tatta.

Amaryllidaceae.

CRINUM, Linn.

Crinum salaticum Linn. *Sp. Pl.* (1753), 292. Loc.:—Mirpur Sakro.

Distribution :—Wild on the Chittagong coast and the Sundribuns.

Liliaceae.

ASPARAGUS, Linn.

Asparagus gharoensis sp. nov. Blatter.

Nearly related to *Asparagus dumosus* Baker, but differs by the cladodes not being channeled, by larger leaves and cladodes, by the greater number of flowers forming a cluster, by the lanceolate perianth segments, by longer pedicels and by recurved stigmas.

A shrub, about 180 cm. high, diffuse, the stem and older branches woody, ashy-grey, stiff, the younger flexuose, grass-green, conspicuously striate, striae scabrous. Leaves scale-like, deltoid-ovate, acute or ovate-acuminate, 6 mm. long and more, with a spur about 2 mm. long at the base, standing out from the branch. Cladodes up to 35 mm. long, in clusters of 3-8, stout, linear, triquetrous, (not channeled). Flowers axillary, up to 12 in a cluster; pedicels 3-5 mm. long, filiform. Perianth 4-5 mm. long, segments lanceolate (not oblanceolate) with a strong midrib. Stamens 6, adnate to the base of perianth-segments; filaments free. Ovary slightly trigonous on top and depressed. Style 1-2 mm. long; stigmas 3, recurved. Berry 3 mm. in diameter. Seed 1 by abortion; testa black, shining.

Loc.:—Gharo in the Indus Delta on sandy and clayey soil, associated with *Lentadenia spartium* (Blatter 699! type, 700-708! co-types), Tatta, associating with *Euphorbia nivulia* (Blatter 709-713!); Gholam, on limestone hill (Blatter 714!).

Flowers and Fruits: October, 1922.

Asparagus dumosus Baker in Journ. Linn. Soc. XIV (1874), 608. Loc.:—Gholam, on limestone hill.

Distribution:—Sind.

Asparagus deltae sp. nov. Blatter.

Differs from all other Indian species by the absence of leaves. A tall diffuse shrub, up to 2½ m. high. Stem and branches woody, terete, grey; branchlets rigid, straight, almost at right angles to the axis, flexuose towards the tips, striate, pale green, not scabrous. Leaves none. Cladodes usually solitary, sometimes 2-6-nate, especially on the older branches, up to 3.5 cm. long, 2-3 mm. broad, flat, linear, straight, mucronate, midrib prominent beneath. Flowers yellow, pendulous in dense simple or compound, lateral and terminal racemes up to 12 cm. long if simple, up to 20 cm. if compound; rhachis terete with 1 small cladode at the base of each flower, decreasing in size upwards. Pedicels solitary, 1-1½ mm. long, comparatively stout, curved downwards. Bracts minute. Perianth petaloid, campanulate, 6-partite. Stamens on the bases of the segments. Ovary 3-gonous. Style very short; stigmas 3, recurved. Fruit an

almost globose berry, 2-3 mm. diam. Seeds 2 or 1 or even 3 in each cell, dark brown. Loc.:—Gholam in Indus Delta, on limestone hill (Blatter 715! type. 716! 717! co-types); Tatta (Blatter 718-720!). Rare. Flowers and Fruits: Oct. 1922.

Commelinaceae.

COMMELINA, Linn.

Commelina albescens Hassk. in Schaeinf. Beitr. Fl. Aethiop. (1867), 210. Loc.:—Kullan Kote Lake (D522!), Tatta Tombs (D521!).

Distribution:—Tropical Africa, Arabia, Baluchistan, Sind, Rajputana.

Palmae.

COCOS, Linn.

Cocos nucifera Linn. Sp. Pl. (1753), 1188. Loc.:—Keti.

Distribution:—All tropical shores.

PHOENIX, Linn.

* *Phoenix dactylifera* Linn. Sp. Pl. 1188. Loc.:—Gharo, Mirpur Sakro, Keti.

Pandanaceae.

PANDANUS, Linn. f.

Pandanus tectoribus Soland. ex Parkinson, Journ. Voy. H.M.S. Endeavour (1773), 46. Loc.:—Keti Bunder.

Distribution:—Sea-coast of India and Burma, Andamans.

Typhaceae.

TYPHA, Linn.

Typha angustata Bory & Chaub. Exp. Sci. Moree, Bot. I (1832), 338. Loc.:—Between Mirpur Sakro and Bohara.

Distribution:—N. Africa, N. Asia, and more or less throughout India.

Typha elephantina Roxb. Fl. Ind. III (1832), 566. Loc.:—On Indus, plentiful.

Distribution:—Algiers, N. W. India to Assam and southwards.

Lemnaceae.

LEMNA, Linn.

Lemna sp. Loc.:—Near Bohara.

Alismaceae.

SAGITTARIA, Linn.

Sagittaria sagittifolia Linn. Sp. Pl. (1753), 993. Loc.:—Bughar on the Indus.

Distribution:—Europe, Asia, N. America.

Naiadaceae.*ZANICHELLIA, Linn.**Zanichellia palustris* Linn. *Sp. Pl.* (1753), 969. Loc.:—Tatta, lake (D765!).

Distribution:—Most temperate and subtropical regions.

*APONOGETON, Linn. f.**Aponogeton monostachyon* Linn. *f. Suppl.* (1781), 214. Loc.:—Mirpur Sakro.

Distribution:—Throughout India, Ceylon, tropical Asia, Australia.

*NAIAS, Linn.**Naias* sp. Loc.:—Tatta, lake (D766!).*Naias* sp. Loc.:—Tatta, lake (D767!).**Cyperaceae.**

(Named by PROF. B. N. VAKIL).

*CYPERUS, Linn.**Cyperus stoloniferus* Retz. *Obs.* IV, 10. Loc.:—Tatta Tombs (D710!).

Distribution:—Mauritius, India, China, Malaya, Australia.

Cyperus alopecuroides Rottb. *Descrip. et Icon.* (1773), 38, t. 8, fig. 2. Loc.:—Kullan Kote Lake (D711!), lake near Tatta (D712!).

Distribution:—Africa, India, Ceylon, tropical Australia.

Cyperus Haspan Linn. *Sp. Pl.* (1753), 45. Loc.:—Mirpur Sakro (D713!, D714!), Gholam (D715!, D716!, D717!).

Distribution:—Tropical Africa, throughout India, common in rice-fields; Ceylon, Malaya, Indo-China, tropical Australia.

Cyperus arenarius Retz. *Obs. fasc.* IV (1786), 9. Loc.:—Gharo (D718!).

Distribution:—Arabia, Persia, India (sea-coast from Sind to Ceylon and Orissa, Punjab), Ceylon.

Cyperus tegetum Roxb. *Fl. Ind.* I (1832), 208. Loc.:—Keti (D719!).

Distribution:—Tropical Africa, cultivated in Mauritius; India, Ceylon.

Cyperus rotundus Linn. *Sp. Pl.* (1753), 45. Loc.:—Mirpur Sakro (D720 to D726!), Bohara (D727!), Gholam (D728!), in a garden (D729!); Kullan Kote Lake (D730!), Tatta (D731!, D732!), Bughar on the Indus (D733!, D734!), Chunar (D735!).

Distribution:—Most hot countries.

*FIMBRISTYLIS, Vahl.**Fimbristylis dichotoma* Vahl. *Enum.* II (1806), 287. Loc.:—Mirpur Sakro (D736!).

Distribution:—Warm regions of the Old World.



No. 15. A vast plain of various species of *Chenopodiaceae*. To the right: *Tamarix articulata* Vahl.



No. 16. Neighbourhood of Gholam. In background a belt of *Acacia arabica* Willd., in front of this a belt of *Tamarix TroupiiHole*, partly hidden by a growth of *Grewias*.

Fimbristylis ferruginea Vahl, *Enum.* II (1806), 291. Loc.:—Tatta (D737 !, D738 !).

Distribution:—Indo-Malaya, Australia, Polynesia.

ELEOCHARIS, R. Br.

Eleocharis atropurpurea Kunth, *Enum.* II (1837), 151. Loc.:—Tatta (D739 !).

Distribution:—Tropics generally.

SCIRPUS, Linn.

Scirpus quinquefarius Ham. in Wall, *Cat.* (1828), 3465. Loc.:—Gholam (D740 !), in a field (D741 !), Tatta (D742 !, D743 !), Bughar on the Indus (D744 !).

Distribution:—Africa, Afghanistan, Baluchistan, India.

Scirpus maritimus Linn. *Sp. Pl.* (1753), 51. Loc.:—Mirpur Sakro (D745 !, D746 !, D746 !, D747 !), Tatta (D748 !, D749 !), in a lake (D750 !), Bughar on the Indus (D751 !).

Distribution:—Cosmopolitan.

Gramineae.

COIX, Linn.

Coix Lachryma-Jobi Linn. *Sp. Pl. ed.* I, 972. Loc.:—Gharo (D682 !), Mirpur Sakro (D681 !, D683 !), on the Indus (D680 !).

Distribution:—Throughout the hotter and damper parts of India, wild or cultivated; Ceylon, tropical Asia, cultivated in Africa and America.

HEMARTHRIA, R. Br.

Hemarthria compressa R. Br. *Prodr.* 207. Loc.:—Mirpur Sakro (D662 !), Bughar on the Indus (D661 !).

Distribution:—Throughout the hotter parts of India, generally in wet places; Ceylon, most warm climates.

SACCHARUM, Linn.

Saccharum spontaneum Linn. *Mant.* II, 188. Vern. Name: *Kanh grass*. Loc.:—Mirpur Sakro (D697 !).

Distribution:—Africa, Syria, Arabia, Afghanistan, India, Burma, Ceylon, China, Java, Philippines, New Guinea, Australia.

**Saccharum officinarum* Linn. *Sp. Pl.* (1753), 54. Loc.:—Mirpur Sakro, Tatta and many other places in the northern part of the Delta.

Saccharum Griffithii Munro ex Ait. in *Journ Linn. Soc.* XIX (1882), 191. Loc.:—Tatta (D699 !).

Distribution:—Afghanistan, Baluchistan, Punjab, Sind.

Saccharum Ravennae Linn. *Syst. ed.* XIII, 1888. Loc.:—Mirpur Sakro (D694 !), on the Indus (D695 !), Indus Delta (D696 !).

Distribution:—Mediterranean countries to Turkestan and N. W. India.

SORGHUM, Linn.

- * *Sorghum vulgare Pers. Syn.* I (1805), 101. Loc.:—Gholam.
Distribution:—Tropical and subtropical regions.

DICHANTHIUM, Willem.

- Dichanthium annulatum Stapf Fl. Trop. Afr.* IX, 178. Loc.:—Kullan Kote Lake (D667!), Tatta Tombs (D668!).
Distribution:—Tropical Africa, India, China, Australia, Pacific Islands.

CYMBOPOGON, Spreng.

- Cymbopogon Jwarancusa Schult. Mant.* II, 458. Loc.:—Gharo (D669!), D670!), Gholam (D671!).
Distribution:—N. W. India, W. India, Deccan, westward to N. Africa.

DIGITARIA, Rich.

- Digitaria sanguinalis Scop. Fl. Carn. ed.* 2, I (1772), 52. Vern. Name:—*Taro, modhan.* Loc.:—Gholam, in a garden (D687!), Bughar on the Indus (D686!).
Distribution:—All warm countries.

- Digitaria pennata Chiov. in Result. Scient. Miss. Stefanini-Paoli.* I, 188. Loc.:—Kullan Kote Lake (D684!), Tatta (D685!).

- Distribution:—Tropical Africa, Arabia, Baluchistan, Sind, Rajputana, Gujerat.

ERIOCHLOA, H.B.K.

- Eriochloa ramosa O. Kuntze Rev. Gen. Pl.* II, 775. Loc.:—Kullan Kote Lake (D692!), Tatta (D693!), Bughar on the Indus (D691!).

- Distribution:—India, Ceylon, most hot countries.

PASPALUM, Linn.

- Paspalum scrobiculatum Linn. var. Commersonii Stapf Fl. Trop. Afr.* IX, 573. Loc.:—Bohara (D689!).

- Distribution:—Tropics of the Old World.

PASPALIDIUM, Stapf.

- Paspalidium geminatum Stapf Fl. Trop. Afr.* IX, 583. Loc.:—Tatta (D611!, D612!).

- Distribution:—Tropical America and Africa, Arabia, Afghanistan, India, Ceylon.

UROCHLOA, Beauv.

- Urochloa setigera Stapf Fl. Trop. Afr.* IX, 598. *Panicum setigerum*, Retz. Obs. fasc. 5 (1789), 17. Loc.:—Gharo. (D610!), Mirpur Sakro (D609!).

- Distribution:—India (Bengal, W. Peninsula), Ceylon.

ECHINOCHLOA, Beauv.

Echinochloa colona Link Hort. Berol II, 209. Loc.:—Mirpur Sakro (D618!), D620!; Gholam (D619!), Bughar (D617!), Chahar (D616!, D621!).

Distribution:—Most warm countries.

Echinochloa Crus-Galli P. Beauv. Agrost. 161. Loc.:—Gholam (D613!), Ketī (D614!).

Distribution:—Common throughout the greater part of India and Malaya and as a weed throughout the warm temperate countries of the northern hemisphere, tropics of Africa and the New World.

Echinochloa stagnina P. Beauv. Agrost. 161. Loc.:—Gholam (D615!).

Distribution:—More or less throughout India; Ceylon. most warm countries.

PANICUM, Linn.

Panicum antidotale Retz. Obs. fasc. 4 (1786), 17. Loc.:—Gharo (D606!, D607!, D608!).

Distribution:—Tropical Africa, Afghanistan, India, Ceylon, Australia.

SETARIA, Beauv.

Setaria verticillata Beauv. Agrost. (1812), 51. Loc.:—Mirpur Sakro (D642!); Gholam, in a garden (D641!), Bughar on the Indus (D640!).

Distribution:—Temperate and tropical regions.

PENNISETUM, Pers.

* *Pennisetum typhoideum* Rich. in Pers. Syn. I (1805), 72. Loc.:—Mirpur Sakro (D637!), Gholam (D638!).

Distribution:—Probably a native of Africa, widely cultivated in India.

Pennisetum cenchroides Rich. in Pers. Syn. I (1805), 72. Loc.:—Kullan Kote Lake (D630!, D631!, D633!), Tatta (D632!, D635!), Tatta Tombs (D634!), Indus Delta (D636!).

Distribution:—Tropical Africa, Mediterranean, India.

CENCHRUS, Linn.

Cenchrus biflorus Roxb. Fl. Ind. I (1832), 233. Loc.:—Mirpur Sakro (D627!), Tatta (D628!).

Distribution:—Africa, Arabia, Baluchistan, India.

Cenchrus catharticus Del. Cat. Hort. Monsp. (1838). Loc.:—Gharo (D629!).

Distribution:—Tropical Africa, Arabia, India.

PHRAGMITES, Trin.

Phragmites karka Trin. ex Steud. Nom. ed. 2, part 2 (1841), 324.

Loc.:—Kullan Kote Lake (D654 !), Ketī (D652 !, D653 !).

Distribution:—Africa, tropical Asia, India, Afghanistan, Japan, Australia.

SPOROBOLUS, Br.

Sporobolus arabicus Boiss. Diagn. ser. I, fasc. 13 (1853), 47.

Loc.:—Gharo (D673 !, D676 !), Mirpur Sakro (D672 !, D677 !, D678 !), Tatta (D674 !), Tatta Tombs (D675 !).

Distribution:—Arabia, Baluchistan, India (Punjab).

HELEOCHLOA, Host.

Heleocholea dura Boiss. Fl. Orient. V (1881), 477. Loc.:—Gholam, limestone hill (D688 !).

Distribution:—Arabia.

ARISTIDA, Linn.

Aristida Adscensionis Linn. Sp. Pl. (1753), 82. Loc.:—Kullan Kote Lake (D625 !), Tatta Tombs (D626 !).

Distribution:—Most warm countries.

Aristida funiculata Trin. and Rupr. in Mem. Acad. Petersb. ser. 6, VII (1849), 159. Loc.:—Gharo (D622 !), Gholam (D624 !), Tatta Tombs (D623 !).

Distribution:—Tropical Africa, Arabia, Baluchistan, India.

TRAGUS, Haller.

Tragus racemosus Scop. Introd. (1777), 73. Loc.:—Tatta Tombs (D679 !).

Distribution:—More or less throughout the dry plains of India; Ceylon, all warm countries, S. Europe.

DESMOSTACHYA, Stapf.

Desmostachya cynosuroides Stapf (ex. Haines Bot. Bihar and Orissa (1924), 962). Loc.:—Gharo (D645 !, D648 !), Mirpur Sakro (D644 !, D646 !, D647 !), Gholam, in fields (D643 !).

Distribution:—Nubia, Egypt, Syria, throughout India in hot and dry places.

ERAGROSTIS, Beauv.

Eragrostis ciliaris Link Hort. Reg. Berol. I (1827), 192.—var. *brachystachya* Boiss. Fl. Orient. V (1881), 582. Loc.:—Tatta (D649 !).

Distribution:—Tropical Africa, Arabia, India.

Eragrostis interrupta, Beauv. Agrost. (1812), 71 (not of Roem. and Schult. nor of Trin.) var. *Koenigii*, Stapf, in Hook. f. Fl. B. I., VII (1896), 316. Loc.:—Bughar on the Indus (D650 !).

Distribution:—Tropical Africa and Asia, India, Ceylon.

Eragrostis amabilis Wight and Arn. ex Nees in Hook. and Arn. Bot. Beech. Voy. (1841), 251. (not of Linn.) Loc.:—Mirpur Sakro (D651!).

Distribution:—India, Ceylon, tropical Asia.

DIPLACHNE, Beauv.

Diplachne fusca Beauv. Agrost. (1812), 163. Loc.:—Kullan Kote Lake (D639!).

Distribution:—Egypt, India, Ceylon, tropical Africa, Asia and Australia.

CYNODON, Pers.

Cynodon dactylon Pers. Syn. I (1805), 85. Loc.:—Bughar (D690!).

Distribution:—All warm countries.

CHLORIS, Sw.

Chloris villosa Pers. Syn. I (1805), 87. Loc.:—Gharo (D655!).

Distribution:—From the Canaries to India.

Chloris barbata Sw. Fl. Ind. Occ. I (1797), 200. Loc.:—Mirpur Sakro (D656!), Tatta (D657!).

Distribution:—Throughout the plains of India; Ceylon, tropics generally.

ELEUSINE, Gaertn.

Eleusine flagellifera Nees, in Linnaea XVI (1842), 220. Loc.:—Gharo (D605!).

Distribution:—North Africa to India and Afghanistan.

Eleusine aegyptiaca Desf. Fl. Atlant. I (1798), 85. Loc.:—Gholam, in a garden (D599!), Tatta (D600!), Indus Delta (D601!).

Distribution:—Warm regions of the Old World, introduced into the New.

Eleusine aristata Ehrenb. ex Boiss. Fl. Orient. V (1881), 557. Loc.:—Gharo (D604!), Mirpur Sakro (D603!), Indus Delta (D602!).

Distribution:—Nubia, Arabia, Afghanistan, India.

* *Eleusine coracana* Gaertn. Fruct. I (1788), 8, t. 1.

Vern. Name: Nanguli. Loc.:—Indus Delta.

ORYZA, Linn.

Oryza coarctata Roxb. Fl. Ind. II (1832), 206. Loc.:—Covering huge sandbanks to the exclusion of everything else in many places along the Indus; Ketī (D666!), below Ketī (D665!).

Distribution:—India (Sundribuns, W. Peninsula).

* *Oryza sativa* Linn. Sp. Pl. (1753), 333. Loc.:—Between Gharo and Mirpur Sakro, Mirpur Sakro (D664!), Bughar on the Indus (D963!).

AELUROPUS, Trin.

Aeluropus villosus Trin. ex L. Mey. Verz. Pflanz. Gunc. (1831).

18. Loc.:—Gharo (D659 !, D660 !), Mirpur Sakro (D658 !), everywhere in the Delta near salt marshes.

Distribution:—Mediterranean and Caspian regions, Arabia, Persia, Afghanistan, Ceylon, India (Punjab, W. Peninsula, in salt ground).

HORDEUM, Linn.

* *Hordeum vulgare* Linn. Sp. Pl. (1753), 84. Loc.:—Mirpur Sakro.

Marsiliaceae.

Marsilia quadrifolia Linn. Loc.:—Mirpur Sakro (D760 !).

Equisetaceae.

Equisetum debile Roxb. Loc.:—On Bughar Canal near Mirpur Sakro (D761 !).

Characeae.

Chara sp. Loc.:—Mirpur Sakro (D762 !).

Additamentum.

We forgot to mention the following species on p. 35 of this volume:

Cossypium Bakeri Watt in Kew Bull (1926), 210. Loc.: Near Gharo (C. N. Baker).

"It is undoubtedly a wild species and was found in the Sind desert 5 miles from the nearest field and 50 miles from cotton cultivation. Moreover, it does not look as if it could have been cultivated. At all events there is no trace of its influence in any known Indian hybrid". Watt l. c.

(To be continued)

THE SUB-AERIAL BLUE-GREEN ALGAE OF RANGOON.

BY

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During the wet months of the year blue-green algae are met with in nearly all kinds of exposed places in Rangoon, while in the dry months only a few forms are found in a fresh vegetative state in places more or less constantly moist. For the greater part the blue-green algae of Rangoon are sub-aerial, while a few forms, such as *Clathrocystis aeruginosa*, *Anabaena spiroides* var. *contracta*, *Anabaena oblonga*, *Anabaena circinalis* var. *crassa*, *Spirulina major*, *Spirulina gigantea*, *Lyngbya aestuarii* var. *constricta* and *Lyngbya perelegans*, are aquatic.

Rangoon is situated in latitude 17° N. and longitude 96° E. at a height of 18 feet above the sea-level. The hot months, namely March, April, May, June and October, have a mean maximum temperature of 82° F.; the highest temperature may reach as much as 106° F. The cold months, namely, November, December, January and February have a mean minimum temperature of 76.3° F.; the thermometer may sometimes fall below 56° F. The rain-fall is confined chiefly to the months of May, June, July, August, September and October and the average total yearly rain-fall is about 99 inches.

In Rangoon, the sub-aerial blue-green algae have various habitats. They are found on a damp soil, on barks of trees, on roofs and walls of buildings, on wooden palings and on sides of drains. A systematic account of some of the species mentioned below has already been published in the Journal of the Burma Research Society (Ghose 1926) and of the rest of them will be published shortly in the next number of the same periodical, so in this paper I shall deal with the sub-aerial blue-green algae of Rangoon chiefly from an ecological point of view.

/ Chroococcaceae.

Chroococcus indicus Zell. was found growing on the bark of *Moringa pterygosperma* intermingled with a species of *Cylindrocystis* and *Scytonema mirabile*, the latter forming a felt-like layer on the tree. The species was first described by Zeller in 1873 (Zeller 1873, p. 176) as occurring in a forest stagnant pond near Promé.

Gloeocapsa conglomerata Kutz. forms thin dark olive-green gelatinous patches on damp soil during the early rainy months. As it gets drier the stratum becomes brownish, hardens a little and then disappears. No spores were seen to be formed but the walls of the cell become hard and brown, and probably in this state the alga perennates. It was also found growing on the bark of some trees, intermingled with a species of *Lejeunea*. This alga was also recorded from Lahore by the writer (Ghose 1923, p. 336) as occurring on moist ground after a little rain or watering.

Aphanocapsa biformis A.Br. is found on damp sandy soil, producing a thin gelatinous olive-green layer on it. The dry stratum takes up a darker colour and is able to revive on getting moisture. No spores were seen. This alga has also been recorded from Lahore (Ghose 1923, p. 336), occurring on moist ground or banks of drains. In Europe it is found on moist walls of hot-houses (Lemmermann 1910, p. 60; De Toni 1907, p. 68).

Oscillatoriaceae.

Oscillatoria tenuis Agardh is the predominant species of *Oscillatoria* in Rangoon and occurs in stagnant ponds, on damp soil and in dirty drains, in fact on any exposed muddy place which is constantly wet. In Lahore also the species predominates and is found in similar habitats (Ghose 1923, p. 338).

Phormidium subfuscum (Agardh) Kutz. and *Phormidium Bohneri* Schmidle are sometimes met with growing on damp soil, or the former occasionally in standing water. On damp soil they are generally found together, but they can be easily distinguished because *Ph. subfuscum* is much broader than *Ph. Bohneri* and also as *Ph. subfuscum* has a conical calyptra at the apex of its filaments, while *Ph. Bohneri* has a rounded apex without a calyptra. *Ph. subfuscum* is found in Europe in water, on stones or posts etc., while *Ph. Bohneri* has been recorded only from Africa, besides Burma, growing on damp soil (Lemmermann 1910, pp. 126 and 131).

Phormidium ambiguum Gom. occurs on soil where water has stood for some time. It is often met with on the sides of unmetalled or muddy roads, where rain-water collects in shallow depressions. The sheaths can hardly be seen when the plants are young, but as the water slowly dries, the filaments develop thin mucilaginous colourless sheaths which become diffuent and thus form a thin blue-green stratum, which, however, becomes yellowish-green on further desiccation. In Europe this alga is found attached to water-plants in standing water, which may be warm or saltish (Lemmermann, 1910, p. 127).

Lyngbya aerugineo-coerulea (Kütz.) Gom. is an interesting form as it is the commonest species of *Lyngbya* in Rangoon and grows in various habitats. It occurs on very wet soil such as grassy lawns a few days after a heavy shower of rain. It also forms sometimes conspicuous bluish-green expanded strata on barks of many palms, generally near the base. In Europe it is found attached to decaying leaves in stagnant and flowing water (Lemmermann 1910, p. 141). In Bengal it occurs on barks of trees such as *Terminalia Catappa*, *Swietenia mahagoni* and *Enterolobium saman* (Brühl and Biswas 1923, p. 10).

Lyngbya truncicola Ghose, var. *burmense* Ghose, forms very conspicuous bluish-green expanded strata on the barks of many trees such as *Plumeria alba*, *Caryota sobolifera*, *Moringa pterygosperma* and *Artocarpus integrifolia*. The colour of the thallus becomes reddish when dry and gives a conspicuous appearance to the bark. The type species was first described by the writer and recorded from Lahore, where it was found growing on the bark of *Acacia modesta* (Ghose 1923, p. 339). The Burmese variety differs from the type form in the colour of the mature stratum and in having cells comparatively longer as compared with the breadth than those of the latter.

Symploca cartilaginea (Mont.) Gom. is occasionally met with growing on damp soil which is more or less protected from direct sunlight. The stratum is covered with dark blue-green sub-erect spine-like bundles, which consist of filaments arranged in a parallel manner.

Schizothrix arenaria (Berk.) Gom. is found growing on sandy places where rain-water has stood for a short time or where it has frequently been flowing for some time. In such places species of *Mougeotia* and *Zygnema* often grow and mixed up with these *Schizothrix arenaria* is occasionally found and becomes more prominent as other algae get older and begin to conjugate.

Microcoleus delicatulus W. et G. S. West, var. *attenuata* var. nov., forms a very thin bluish-green layer on damp soil, generally on the outer side of hanging wooden orchid-boxes. It is usually associated with other Blue-green algae. The threads are unbranched and spread over the surface in various directions, crossing each other here and there so that a coarse felt-like stratum is produced. The new variety differs from the type in having broader threads and in having spine-like apices to the filaments.

Nostocaceae.

Nostoc muscorum Kütz. forms large expanded firm gelatinous strata on exposed damp soil during the rains. In the beginning the thallus is small and rounded, but it slowly expands and fuses with

other thalli later on. In this way very large conspicuous mucilaginous sheets are produced, the surface of which is more or less folded. The colour is at first bright blue-green, but later changes to dull olive or dark-brown. It has been recorded from Lahore as occurring on moist ground, generally intermingled with species of *Gloeocapsa* (Ghose 1923, p. 340). In Europe it occurs on damp soil amongst mosses etc. (Lemmermann 1910, p. 168).

Nostoc sphaerium Vauch. forms much smaller strata. The thallus is very small and globose at first but later on becomes irregularly lobed and dark olive-green or yellowish-brown in colour. It generally grows on the outside of wooden flower-boxes and sometimes occurs on barks of trees. It forms spores which are oval in shape and have a smooth brown outer wall.

Cylindrospermum muscicola Kutz. occurs on damp soil and wet walls forming bright bluish-green patches which become blackish-brown as the spores ripen. It seems to be a very short-lived alga; the filaments are very delicate and begin to form spores very soon.

Scytonemataceae.

Scytonema myochrous (Dillw.) Agardh is found on damp walls forming a brownish-green, velvety continuous layer. The sheath is very well marked and is lamellose with divergent layers. It is, however, not so common in Rangoon as some of the other species of *Scytonema*. In Europe also it occurs on damp soil or moist walls (Lemmermann 1910, p. 214).

Scytonema javanicum (Kutz.) Bornet forms cushions, 2-4 mm. high on damp soil, intermingled with moss and a species of *Selaginella*. It has also been recorded from Victoria Gardens, Bombay, by Hansgirg (*Prodromus* 11, p. 34). In Europe it is sometimes found in hot-houses on damp soil or moist wooden structures (Lemmermann 1910, p. 209).

Scytonema zellerianum Brühl et Biswas forms an extensive felt-like dark brown stratum on damp soil, generally amongst Liverworts. The species was erected by Brühl and Biswas in 1923 to include some species of *Scytonema* described by Zeller, three of which were from Burma (Brühl and Biswas 1923, p. 16). After a careful examination of more copious material all these forms proved to be various phases of the same species. *Scytonema zellerianum* also occurs on mud walls in the Sibpur Botanical Gardens, Calcutta, and is occasionally found on barks of trees there (Brühl and Biswas 1923, p. 16).

THE SUB-AERIAL BLUE-GREEN ALGAE OF RANGOON. 83

Scytonema mirabile (Dillw.) Bornet was found on the barks of *Moringa pterygosperma* and *Plumeria alba*. It forms a felt-like, spongy, dark brown or dark bluish-green stratum on the tree. The sheaths are lamellose but the slight divergence of the layers does not become evident till late in the rainy season or early in the dry weather. It is also found on exposed slopes of hard ground forming a beautiful bluish-green layer on it. It is interesting to note that while this species is the commonest alga in Barkuda Island, growing on rocks, gravel and sandy path-ways (Biswas 1925, p. 360) it seems to have taken on more prominently an epiphytic habit in Rangoon. In the Sibpur Botanical Gardens it has been recorded to occur both on moist ground and on the bark of *Terminalia Catappa* (Brühl and Biswas 1923, p. 15). In Europe it occurs on damp rocks and water mosses (Lemmermann 1910, p. 212).

Rivulariaceae.

Calothrix thermalis (Schwabe) Hansgirg forms a felt-like slightly slippery thin crust on the cement walls of *pucca* drains, intermingled with some other species of blue-green algae. The species seems to be confined to rather warm places. In Europe it has been recorded from the warmer of Bohemia, Austria, Hungary and Italy, in Africa from Algeria (De Toni, 1907, p. 626), and in America from Wyoming, at the crater of Excelsior Geyser, where the temperature ranges between 49-54.5°C; at the Fountain Hotel Geyser Basin it was found to be very common in colder portions of overflows at the temperature of 34°C (Tilden 1910, p. 268).

Conclusion.

In studying the Blue-green Algae of Rangoon one is struck with the comparative paucity of purely aquatic forms and also the absence of spores in a large majority of the sub-aerial species. Broadly speaking, perennation during dry months, with a few exceptions, is brought about by either the filaments remaining dormant inside a thickened and coloured sheath or sometimes by their just drying up and reviving again on getting moisture. Another interesting fact is that many European forms which live in water are found in sub-aerial habitats in Rangoon. A possible explanation of this fact may be that as sub-aerial habitats in Europe are exposed to snow and frost, the algae are comparatively safer in water. While sheaths may form a good protection against desiccation and too intense light, they may not be as effective against too much cold.

In conclusion, I have much pleasure in acknowledging financial help towards the purchase of literature required for the preparation of this paper, given by the University of Rangoon and the Biological Department of the University College, Rangoon. To Mr. V.Y. Kolhatkar, B. Sc., of the Geography Department of University College, I am indebted for supplying me with the geographic data of Rangoon.

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SOME PECULIAR FEATURES OF THE SUB-AERIAL ZYGNEMALES OF RANGOON.

By M. R. HANDA, M.Sc.,
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The members of the Zygnemales are, as a rule, characterised by the absence of any organs for attachment. They are generally found freely floating in the stagnant water of ponds and ditches or in slow-running freshwater streams. Further, the Zygnemales are said to consist of *unbranched* filaments of cylindrical cells placed end to end. Various authors, such as West (1893), Delf (1913) and Iyengar (1923) have recorded the presence of hapteral outgrowths on species of *Spirogyra*, *Mougeotia* and *Zygnema* as organs for attachment. The presence of such outgrowths also came under the observation of the writer so far as *Mougeotia* and *Zygnema* were concerned. In addition to these hapteral protuberances, these plants presented what appeared to be quite interesting and anomalous features.

The material was found growing on sandy soil just by the side of the road near the New Race Course, Tamwe, Rangoon. The two plants, species of *Mougeotia* and *Zygnema* were found invariably mixed up together. It was in the middle of September, 1926, a part of the year marked by heavy rains, that the first collection of this material was made.

The examination of the first collection revealed the presence of rhizoidal outgrowths in profuse abundance, both in species of *Mougeotia* and of *Zygnema*. The filaments were purely vegetative. Later collections, repeated from time to time and specially continued over a span of two months after the cessation of the rains, showed the same hapteral structures and the same sterile filaments. Though the plot has been kept under constant observation, these two plants have not as yet been found in a fertile condition in this particular spot, whereas the species of *Spirogyra* examined at exactly the same time of the season, though not from the same locality as the above, showed conjugation and fully ripe zygospores. It is curious that this should be the behaviour of the species of *Mougeotia* and *Zygnema*. Attention will presently be drawn to the probable significance of the persistently sterile condition of these two plants and to the interesting conclusion to be drawn from it.

These outgrowths have not been found up to the present in the species of *Spirogyra*. Nevertheless one or two features were observed in the species of *Spirogyra*, which will be noted below.

Mougeotia sp.

Cells 9.6-11 μ thick and 2 to 4½ times as long. Short knob-like outgrowths are given off from the sides of the cells (fig. 1). There is no cell which gives off more than one rhizoidal knob, and no rhizoidal knob has been seen in a branched condition. Very often two cells put out these rhizoidal outgrowths which lie side by side and almost touch each other (fig. 1). The interesting point to be noted in this connection is seen in the strong tendency of the chloroplast of the cell to migrate into the outgrowth. Two kinds of such outgrowths are met with. In the one kind there are no cross-walls in the outgrowths, and hence they may be regarded as simple ones, while in the other kind the outgrowth becomes two-celled by the appearance of a cross-wall and is also better developed than the former. That these outgrowths are rhizoidal in nature is indicated by the presence of soil particles round them. In the case of an attached species of *Spirogyra* described and figured by Delf (1913), the outgrowth bearing a bunch of outspread haptophores is nothing but patently rhizoidal in function. She has also figured the extension of chromatophores into the rhizoids of *Spirogyra adnata* (?), but she has not drawn attention to any probable significance connected therewith. But I venture to think that in addition to their rhizoidal function these outgrowths in species of *Mougeotia* and *Zygnema* have also something to do in connection with formation of 'resting buds' to carry plants safe through adverse circumstances. This reminds one of the case of *Botrydium*, a coenocytic alga, which has at its disposal a richly branched system of rhizoids which fix it firmly to the substratum, but on the inception of drought the contents of the vesicular bladder retreat into the branched rhizoids where they break up into a number of pieces forming the so-called aplanospores. This is a method on the part of the latter plant to bridge over unfavourable periods. Similarly the occurrence of a large number of rhizoidal outgrowths in the species of *Mougeotia* with a strong tendency of chloroplasts to enter these outgrowths, if interpreted according to the above tentative suggestion may be looked upon as so many would-be 'resting buds' for perennation as well as multiplication. This tendency may be regarded as an offset against the absence of conjugation. In other words, outgrowth formation may be provisionally held to be a substitute for zygote-formation.

There is still another interesting point about the species of *Mougeotia* which deserves special mention. Iyengar (1923) has described and figured rhizoids in *Zygnema* sp. which are sometimes cut off by a cross-wall into separate cells containing the chloroplasts.

his author, too, has not attempted to give any probable biological significance of the strange behaviour of the chloroplasts. In the species of *Mougeotia* under consideration the majority of outgrowths are simple, without any transverse partitions, but there are also a few which are two-celled, being cut off by a cross-wall (fig. 2), and are also better developed. Such two-celled outgrowths may better be regarded as short branches of the filaments and not as mere rhizoids. If the existence of these short branches in the species of *Mougeotia* and *Zygnema* under discussion were to be at all general, it would throw some doubt on their systematic position.

Zygnema sp.

Cells 18 μ thick. Length 1-2 times the breadth of the cell.

All that has been said about the above species of *Mougeotia* applies to *Zygnema* sp. also. There are the same club-shaped rhizoidal outgrowths with a similar behaviour of the chloroplasts (fig. 3) and the same two-celled branches (fig. 4).

The probability that the outgrowths with the strange behaviour of their chloroplasts may be looked upon as future 'resting buds' finds an indirect but fair confirmation by the observation of an important fact in another species of *Zygnema*. This species was collected in the last week of August 1926 from a spot just behind the Chemistry Department of the University College. The rains were pretty thick and the plants were growing as usual on sandy soil. In these filaments a large number of zygotes were seen, but curiously these filaments were conspicuous by the absence of any rhizoidal outgrowths on them.

The presence of such 'resting buds' in a living condition after the other parts of the plant are dead remains, however, to be seen. The point requires further observation and experimental investigation.

Spirogyra sp.

Cells 105 μ thick and 112-114 μ long.

As already mentioned, no rhizoidal outgrowths have been seen in the species of *Spirogyra* observed, but there are one or two interesting points in it which are noteworthy. The first point is the presence of two spores in a single cell (fig. 5). Such a state of affairs, however, is not general. One of the spores is always bigger than the other. The bigger spore is 57 μ thick and 66 μ long, and the smaller one is 47 μ thick and 60 μ long, whereas the spore occurring singly in a cell is 69-83 μ thick and 96-110 μ long. The cells of the opposite filament were empty. It

is reasonable to suppose that though the gamete migrated to the opposite cell, yet there was no fusion of the gametes but both of them developed parthenogenetically.

The second interesting point is the presence of a spore in each of the cells facing each other (fig. 6). This may also be explained by assuming that parthenogenetic development of the gametes has taken place, that is, that the spores are parthenospores.

Summary

The two sub-aerial algae belonging to the Zygnemales—*Mougeotia* sp. and *Zygnema* sp.—produce a large number of rhizoidal outgrowths, which may be with or without a cross-wall. In the former, two-celled, condition, they may be taken as short branches of the filament. That these outgrowths are rhizoidal in function is shown by the fact that soil-particles adhere to them. A remarkable behaviour, however, is exhibited by the chloroplasts of the cells producing these outgrowths; the chloroplasts unmistakably show a tendency to insinuate themselves into the outgrowths. Furthermore, the above species have not as yet been seen in a state of conjugation.

This leads one to conclude that these outgrowths in the species of *Mougeotia* and *Zygnema*, in addition to their rhizoidal function, have something to do with vegetative reproduction. The view appears to be strengthened by the entire absence of any outgrowths in another sub-aerial species of *Zygnema* growing in another spot but which produced unmistakable young zygospores. It is therefore reasonable to suppose that these outgrowths are future 'resting buds', developed to replace the sexual method of reproduction. However, this provisional suggestion needs further investigation.

The anomalous features presented by the species of *Spirogyra* examined are, in the first place, the presence of two parthenospores in a single cell, and in the second place the presence of a parthenospore in each of the opposing cells.

The writer takes this opportunity of expressing his indebtedness to Dr. S. L. Ghose for his valuable help and guidance in connection with this work.

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FIG. 1

55 u



FIG. 2

55 u

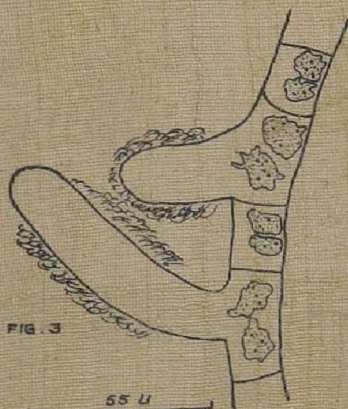


FIG. 3

55 u



FIG. 4

55 u

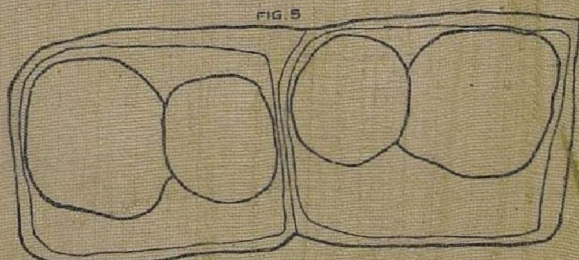


FIG. 5

55 u



FIG. 6

360 u

Explanation of Figs. 1—6

- Fig. 1. *Mougeotia* sp. Adjacent cells, with simple rhizoidal outgrowths, with extension of chloroplasts into the latter.
 Fig. 2. *Mougeotia* sp. Simple and two-celled rhizoidal outgrowths.
 Fig. 3. *Zygnema* sp. Club-shaped simple rhizoids.
 Fig. 4. *Zygnema* sp. Two-celled rhizoidal branch.
 Fig. 5. *Spirogyra* sp. Two parthenospores in each cell.
 Fig. 6. *Spirogyra* sp. A parthenospore in each of the opposing cells.

PRESIDENTIAL ADDRESS.

*Delivered before the Annual Meeting of the Indian Botanical Society
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Difficulties of Botanical Research in India.

BY PROF. S. L. AJREKAR.

Dr. Dudgeon, our first President, in his presidential address to the joint meeting of the Botany Section of the Indian Science Congress and the Indian Botanical Society at Madras in 1922, spoke of "the Botanical Opportunity in India". In this very suggestive address he took stock of botanical work done in India up to that date and pointed out that there was an immense field of opportunity waiting to be worked by us. He made it quite clear that, if progress in botanical research in India was small, it at least was not due to lack of material or problems for investigation. Yet it remains a fact that the output of botanical research from India is insignificant, comparatively speaking, and I thought it would not be inappropriate, in the address which I have the honour to give you, to consider the causes of this our failure to do justice to the "ample botanical opportunity" spoken of by Dr. Dudgeon. I have, therefore, chosen for my subject "The difficulties of botanical research in India" with a view to try and find out if we, as members of the Indian Botanical Society, can do anything to remove any of them.

It is not easy to classify the difficulties of botanical research, though, for convenience of treatment it is necessary to do so. They are often interdependent and form vicious circles from which no way out seems possible. We may, however, distinguish between difficulties which are common to all research in experimental sciences and to all countries and others which are peculiar to botanical research in India.

It is not necessary to do more than to allude to difficulties which are common to all research in all countries. They are due to a lack of appreciation on the part of the public of the cultural value of scientific studies, which are believed consciously or sub-consciously to be inferior in this respect to literary studies. This belief acts as a great handicap to scientific education, for, if anything has to be dropped out from the programme of education in a school or college

for want of funds, those in authority usually feel no compunction in dropping out science, which is still regarded as an item, if not of luxury, at least not of necessity in the educational equipment of the individual. This is partly the cause and partly the effect of the state of things in which the administrative affairs of a country and its educational institutions are mostly in the hands of literary men who have at best only an imperfect appreciation of the value of scientific studies and the requirements of scientific research. Science thus comes to be tolerated rather than encouraged. This is really a serious difficulty in the way of scientific research in all countries. Eminent men of science have raised their voice in Europe and America against this state of things. The campaign started by Huxley in England to obtain for science its proper place in the scheme of education of the country has been carried on with much ability and admirable persistence up to the present day and not without some success. As one of the most recent efforts in this campaign may be mentioned the publication "Science and the Nation" edited by Professor Seward of the Cambridge University.

The real awakening, however, was not brought about until the Great War proved to the world the value of science both in war and peace, and it may now be hoped that the balance between literary and scientific studies will be righted before long. Even India may hope to profit by this change of attitude towards science brought about by recent events.

It may be observed generally that all the difficulties of research alluded to above exist in our country on a much larger scale than in any other civilized country. There is one difficulty, however, of research in general which can be regarded as peculiar to India. It is due to the belief propagated by interested persons and accepted by their dupes that Indians lack the capacity for original research work. I take this opportunity of declaring that such a belief is unjust to Indians and that given the chances Indians are capable of producing as good work in any branch of science as the members of any other nation in the world. I am not here referring to work by geniuses like Darwin, Pasteur, Edison, Marconi or Ramanujan. It is admitted, I believe, universally, that genius of this type is not confined to any country or to any stratum of society. What is not readily or generally admitted is that an appropriate system of education and adequate provision of opportunities for work will make it possible for any ordinary person to fit himself or herself for service in the army of Science in her war with Ignorance. Hence the slogan that Indians are inherently incapable of independent research work and that they can at best be fitted to work as assistants in research. The policy

underlying the organization of research departments in India affords an illustration of the evil effects of such a notion. For a long time, an Indian, no matter what his efficiency was, could not aspire to any position of responsibility in these departments. It is pleasing to note that even in such an unsatisfactory state of organisation Indian workers are coming into prominence in increasing numbers and it may be hoped that the authorities responsible for giving effect to the policy of Indianisation in research departments will take note of this fact and will not allow themselves to be misled by interested doubts about Indian capacity for research, such as have appeared, for instance, from time to time in the evidence before the Royal Commission on Agriculture. A due recognition of Indian capacity will go a great way in removing one of the greatest obstacles to the progress of research in India.

The difficulties of botanical research as distinct from research in other sciences may next be briefly considered. These arise from the circumstance that until very recently, the study of Botany meant to laymen little more than the collection, description and classification of plants and it seemed to have little or no bearing on practical life. As a matter of fact systematic and descriptive botany held the sway in botanical studies until about the middle of the last century and the appeal they could make to the general public was very feeble, especially in contrast to that of Chemistry and Physics. Again when compared to these last named sciences, Botany appears to be far from being in the condition to be called an exact science. The subject matter of Botany is too variable and too complicated to lend itself to be brought under laws of universal applicability. Many even doubt that Botany can progress ever beyond the stage of being an observational science. Thanks, however, to the recent advances in Physiological Botany, in Mendelian studies and in the various branches of applied Botany like Plant Pathology and Plant-breeding, this doubt is slowly, but I believe surely, disappearing and it may be hoped that Botany will appeal to a larger section of the students of science and of the public in the future.

Coming now to the difficulties of botanical research in India in particular, we shall find that these arise from

- (1) Defective training in schools and colleges;
- (2) Absence of the research atmosphere and of facilities for research work in most of the Indian Universities;
- (3) Want of suitable careers for persons trained for research work.

In saying this, I am afraid I shall be accused of pompously stating what is merely a trite platitude. For, in all discussions on

scientific education anywhere in the world the same difficulties have been alluded to in some shape or other. I do feel, however, that although the difficulties I am now going to discuss are the same in kind all the world over, the great difference in the magnitude in which they occur in India justifies one in regarding them as peculiar to India.

Defective Training in Schools and Colleges.

It is notorious that our school curricula are weak on the side of science and most of our students go up to the University without any training in science worth the name. Many actually come face to face with the science of Botany first when they enter the science classes at a college. Such attempts at the introduction of Nature Study in schools as have been made in recent years have yet to bear fruit and it remains a fact that students of Botany in Indian Universities have little previous knowledge of plant life and less training in observation. The standard of attainment in the science of Botany with such student material must necessarily be low and it is actually lower than the syllabuses suggest, when we take into account really assimilated knowledge as distinct from that presented to the examiner. Matters are made worse by the use of a foreign language as a medium of instruction which encourages cramming and necessitates a disproportionately greater effort to achieve the same object than if instruction could be imparted in the mother tongue of students. Briefly, the Indian student, when he takes his degree, has acquired actually much less knowledge than graduates of foreign universities and that with much greater effort and loss of energy. He has, consequently, little or no enthusiasm for further study. Our system of education is not, therefore, calculated to produce enthusiasts for the science of Botany and this must act as a great handicap to the progress of botanical research in India.

The remedy seems to lie in seriously attempting to improve our system of education, particularly on the science side in our schools by providing suitable courses in Nature Study and qualified teachers who will teach them. It will also be necessary to make an organised effort at removing the one great difficulty in the way of imparting science lessons through the medium of the vernaculars, namely, the absence of a suitable terminology. This, I suggest, is one of the directions in which some of our members will be able to help in promoting the study of Botany in the first instance and indirectly, later on, botanical research. Writing of original text-books in the vernaculars which would supplant the present foreign text books on Nature Study or their unsatisfactory translations or adaptations at

present in vogue would considerably improve science teaching in schools and I hope some of our members will come forward to do this kind of work. In doing it they will be materially assisting in removing one important class of difficulties of botanical research in India.

Absence of the Research Atmosphere and of Facilities for Research in the Universities.

The second class of difficulties, namely, those due to the absence of a research atmosphere and of facilities for research may now be considered. In the first place, the number of institutions which undertake botanical teaching in the various universities is very small and of this small number a very insignificant proportion have any research workers or facilities for research work in them. Indeed, most of our Universities are merely examining bodies. A few of them have advanced in recent years to become teaching bodies, but with perhaps the exception of the College of Science of the Calcutta University, none of the Indian Universities have so far made any special attempt to foster original research by the appointment of research professors as distinct from ordinary teaching professors. The result is that most of the science teaching in India has a flavour of staleness about it and is without life, which can be only put in by teachers who are actively engaged in the creation as opposed to the mere retailing of knowledge. This state of things is the heritage left to us by the early British administrators who, in organising the educational institutions in India, aimed at nothing higher than producing candidates for service in the subordinate ranks and persons who would be just good enough to act as interpreters between the rulers and the ruled. Even University education has not escaped the evil influence of this low ideal. Hence one misses in India the atmosphere of research, which, to my mind, is the most important point of difference between Indian and European Universities. I have no doubt that ordinary teaching which prepares students for examinations is as well done in India as anywhere in Europe, but one feels, though one can hardly describe, a difference that is due to the presence of numerous, active research workers in foreign universities. It is encouraging to find that things are improving in this respect and we already find that some of our universities, especially the newer ones, are becoming research centres. The Botany Departments of Lahore, Lucknow, Allahabad, Benares and Calcutta are inspiring examples to others and show how much can be done by individual members of our Society to provide the research atmosphere.

But the provision of a research atmosphere through the efforts of individuals, although most important, cannot take us very far. Research in experimental sciences, unlike that in Mathematics and Philosophy, has to depend on external equipment and here we are at a very great disadvantage in India. We have very few libraries worth the name and the equipment of our laboratories has not been made, in most cases, with due appreciation of the requirements of research. Those responsible for the management of university funds generally fight shy of science subjects because the equipment for these is much more costly than for non-science subjects. A persistent and systematic propaganda in favour of science subjects needs, therefore, to be carried on by those of our members who have any hand in the management of university affairs or any influence with the charitably inclined rich, if we are to remove our present regrettable absence of facilities for research.

Want of Suitable Careers for Research Workers.

Even greater than the two classes of difficulties discussed above seem to me those due to the want of suitable careers for research workers. The improvement of education in schools and colleges, the creation of a research atmosphere and the equipment of laboratories and libraries will stop short of their complete usefulness if no careers are available for students who have qualified themselves for research. Botany perhaps suffers more from want of suitable careers than any other science. The only career a botanist could follow until very recently was that of a teacher and apart from the poor prospects in the teaching profession the number of teaching posts has always been small. The present state of development of the industries of this country does not provide much room for employment of expert botanists. The chief industry of India, Agriculture, should indeed give a large scope for botanists, but as a matter of fact the scale on which agricultural departments have been organised in India is entirely inadequate to the size of the country. Moreover, Indians have had, in most cases, to remain content with subordinate and lowly paid posts in these and other research departments. How can students be attracted to Botany in these circumstances and how can one expect them to stick to it after they have left the university?

It is all very well to say that the true research worker will work for work's sake and not for hire. This really applies to the born research genius which is rare and to which ordinary rules do not apply and which, therefore, cannot be taken as a guide in directing the course of action of ordinary human beings. Because a Booker T. Washington

was born a slave, and was brought up without any education till late in life and after many struggles and trials rose to be the founder and successful director of a model educational institute for Negroes, we should not think of prescribing this eminent Negro's hardships for ordinary individuals. We must provide them liberty, education and other opportunities to make the most of their natural parts. Similarly, we must take due note of the condition that an ordinary man must live before he can do any research. It is not merely enough to train him in research methods, which is the most that even the best of our universities do at present by providing fellowships or research scholarships. At the expiry of these fellowships or scholarships the holder is generally stranded unless he happens to be one of the lucky ones to get a teaching post, which, however, in many cases, does not carry an attractive pay. No wonder then, if, in these circumstances, the best of our students avoid Botany. The students that come for Botany at the B. Sc. in the Bombay University, for example, are mostly those who have failed to get admission to the medical colleges because of their poor performance at the Intermediate-science examination. How can one expect such students to take to botanical research and to do well in it?

The want of suitable careers, then, is a real difficulty of botanical research in India and every attempt should be made by those of us in a position to do so to provide careers for botanical workers. The re-organisation of agricultural research which is included in the terms of reference of the Royal Commission on Agriculture now sitting and we may hope the situation will be improved considerably as a result of its recommendations. Even the present imperfect and inadequate organisation has shown how the provision of research careers increases the pace of research. The bulk of the papers read before the Botany section of the Indian Science Congress has proceeded from members of Agricultural Departments.

A comparison of the output of work in the field of Botany by members of the agricultural departments in India with that of those in purely educational institutions also brings home to one the great advantage of making research the main, if not the whole time duty of the botanical worker. I am not one of those who put research and teaching in strong opposition to each other. I believe that every teacher who wishes to do his work well must do some research himself, if not in any technical branch of his subject, at least in some didactic aspects of it. These latter have been pointed out very usefully by Ganong in his very suggestive book, "The Teaching Botanist" and I recommend a perusal of this book to all who have not already come across it. Yet I feel that much progress in research will not be made if research is undertaken, as at present, in most cases, as a

hobby to occupy one's leisure hours. The example of some of the American Universities like the Johns Hopkins University, and I am proud to be able to add, that of the University College of Science of Calcutta must be followed by our Universities and research departments, with research professors and adequate staff and equipment must be opened in large numbers, if our universities are to be places where new knowledge is created. As a first step in this direction may be suggested the foundation of long period, post-graduate scholarships, which would enable the holder to keep himself above want and to engage himself in research and qualify himself for a higher and more permanent situation. Most of the present scholarships and fellowships are not tenable for more than two years, which are barely sufficient to train a student in research methods and to enable him to produce a passable thesis for the M.Sc. After that there is a long gap of unemployment which is enough in most cases, to kill all enthusiasm for research. The lengthening of the period of such scholarships and provision for renewal at the end of the period in cases of exceptional merit would go a great way in stimulating research. That it would not be very difficult to move our universities in this direction is indicated by the successful appeals by some of our members to their respective universities for funds to assist our Journal. The times seem to be favourable and those of our members who are favourably placed to make this kind of effort to remove the difficulties of research may kindly take a note of this suggestion.

A suggestion to those in the control of the Botanical Survey of India may also be made by our Society with a view both to increase its usefulness and to provide careers for botanical workers. A part of the funds at the disposal of the survey can usefully be spent on the establishment of a few research posts for each Province, the holders being required to work out particular groups of plants in their locality. This could be easily done, I think, by diverting some of the grant which at present has to be spent on the travelling allowance of the officers of the Survey owing to their headquarters being far away from the actual place of work. As a matter of fact the work of the Botanical Survey, so far as some Provinces are concerned, seems to be at a standstill, owing presumably to the small number of workers and the great distances to travel. My suggestion would, if carried out, make it possible to increase the staff of the Survey considerably, without a corresponding increase of expenditure on the Survey as a whole and would greatly stimulate botanical research.

Apart, however, from what we can do to get our Universities and Government authorities to promote botanical research, I think it is our duty as members of the Indian Botanical Society to carry on a

propaganda in favour of botanical research among the public, especially that section of it which is in a position to endow research. It may be helpful in this connection if such of our members as are in a position to do so prefer for their subjects of research such as make a direct appeal to public interest and sympathy by their bearing on practical life. In saying this I may appear to draw a distinction between pure and applied research and to prefer the latter to the former. In the sense that the end of the one kind of research is to solve a definite, well understood problem while in the case of the other the worker does not know what his research may lead to, the distinction is a real one. Applied research tries to solve a particular problem, pure research aims at the discovery of universal laws. But there is really no difference in the methods of the two kinds of research and, other things being equal, I would prefer the practical problem, for I agree with F. E. Clements that "learning that is not applied to life in terms of service, efficiency, comfort or enjoyment" is to be "regarded as spurious".

I have discussed so far what I consider as serious difficulties of botanical research in India. I think they account to a great extent for our poor achievement in the field of botanical research. I have also tried to suggest some steps to be taken to remove these difficulties either by individual or organised efforts. But I should be doing a distinct disservice to our Society, if by laying all the stress on external difficulties I leave our members in the attitude of injured innocents, who have done all they could and have only to blame circumstances if they have been unable to do more. I should suggest, therefore, that we should ask ourselves if we are sure that we are making the most of our individual opportunities; if we are not too readily persuading ourselves that we cannot do research, placed as we are; that our teaching interferes seriously with our research or that we have no facilities or funds for research work. What an amount of work a person really interested in a subject can do was recently brought home to me in a very forcible manner by the case of H. Sydow, Editor of the well-known Mycological Journal, *Annales Mycologiques*, and an authority on systematic mycology. It will be a surprise to you as it was to me to learn what he told me in reply to a request to be allowed to work in his laboratory during a visit which I intended to make to Europe. He wrote to me:—

"Now you make the proposal to work with me for some months in systematic Mycology. Unhappily, this will not be possible, for you must know that I am no member of a scientific institute or museum but a banker, a head clerk of one of our leading banks (Dresdner Bank). Therefore I have to work during the whole day in

the office and I can only devote a few hours to Mycology in the evening or during night."

Let us realise then that it is the man and not the equipment that is the chief factor in the production of work. Let us turn the search-light inwards when we find ourselves in a mood to blame our surroundings. The more searchingly we can introspect and the more we try to remove the deficiencies discovered by the introspection, the more easily shall we be able to advance the cause of botanical research inspite of all the difficulties mentioned.

Thanking you for the opportunity you have given me of speaking to you, I conclude my address.



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1. J. W. Bews, M.A. D.Sc., Plant forms and their evolution in South Africa. *Longmans, London*. 1925. 12/6.
2. D. H. Campbell An outline of Plant Geography. *Macmillan, London*. 1926. 17/-.
3. August Hayek Allgemeine Pflanzen-Geographie. *Gebrüder Borntraeger, Berlin*. 1926. 20 Mk. 70Pfg.

The study of Plant Ecology, although one of the most recent developments of Botany, is already yielding results which are more than justifying the increasing attention that is being devoted to it by botanists. The three books which form the subject of this review are recent additions to the subject.

(1) Professor Bews' book is one of those notable contributions, which bring in fresh points of view and establish new lines of study and research. It is an outcome of years of patient study and observation devoted to the South African flora by the author. It deals not only with the composition and origin of the flora of South Africa, but the matter has been handled in such a manner as to make the book a valuable contribution to the general subject of Plant Distribution. After its perusal, indeed, the reader feels convinced of the vast importance of the study of Plant Geography,—“that grand subject, that almost keystone of the laws of creation” as Darwin called it—which, although studied by some of the greatest botanists of the world, is very often not assessed at its proper value.

The book is full of thought-provoking ideas, and it would appear that the author has imbibed, in no small measure, the stimulating effect of the environment of South Africa, to which he pays a tribute in his work. The author also speaks of South Africa as “a land of botanical opportunity” and a place which offers ideal conditions for the study of Botany. And in view of the volume of literature that he has produced, and the many new conceptions that he has introduced, this tribute would appear to be well paid.

In this study, Professor Bews has introduced a novel conception of the development of vegetation, on the basis of its growth forms. This concept was first put forth by Bailey and Sinnott, but its fuller treatment and amplification was left to be accomplished by Prof. Bews. A mass of evidence, from various sources, has been adduced to show that such a concept is quite compatible with the phylogenetic views on Angiosperms, held by modern botanists, on the basis of their floral characters—a line of thought which the author is further elaborating in a series of papers in the current numbers of the *New Phytologist*.

In the scheme of classification proposed, the woody forms are held to be more primitive than the herbaceous types, and the remaining habits *viz.*,

climbing, epiphytic, parasitic, herbaceous and aquatic are considered to be derivatives, in the differentiation of which not so much the climate, as the organic environment, competition for space etc., have played the chief part.

On the evidence of the old geological nature of the South African sub-continent, and the flora which it maintains, Prof. Bews holds that tropical forest vegetation is a primitive phase, which has remained unchanged for an enormous interval of time, and from this primitive phase more open types such as grassland, scrub, semi-desert and desert with their characteristic flora, and even the plants of the temperate regions, have become differentiated. Support is given to this view by citing evidence obtained from the distribution of South African flora of the moist tropical forests, the banks of streams and seashore, and the swamps, all of which are believed to represent primitive habitats, and in which conditions have remained constant since the Cretaceous period, enabling them to maintain a primitive flora.

As for the flora of South Africa itself, it is divided into two elements—the tropical-subtropical and the temperate. The first is traced to the tropics north of South Africa, which the author regards as “the vast reservoir of plant life”, the general southward migration having taken place along the eastern coast belt, owing to the presence of a dry area in the centre and the west, which acts as a barrier. The temperate flora is believed to be composite, having received contributions both from the north and the south, and this represents a compromise between two opposing views, one of which attempts to derive it from the northern regions and the other from the southern.

In advancing his views, the author is happily free from that dogmatism, which unfortunately often accompanies the exposition of a pet theory. Professor Bews clearly recognises his limitations in the preface. He says “Some of the theories may require modification, but if the plant migrations into South Africa and the whole general ecological history of the vegetation have been as described, the bearing of it all on the study of the phylogeny of Angiosperms is clearly full of great promise.”

In view of the many interesting ideas which have been introduced for the first time, the book deserves to be widely read by all who are interested in the study of ecological problems.

(2) The second book is introduced to the reader as a work on the general subject of Plant Geography, as well as a book of reference for botanists. It has grown out of the observations and data which had been accumulating for a period of 30 years, during which the author had been making excursions into different parts of the world, and which were latterly devoted particularly to the study of problems of plant distribution.

The book is divided into 9 chapters, the first one being introductory and devoted to the discussion of such general questions as the Geological Record Succession of Plants in geological time, the First Land Plants, Existing Factors in Distribution and lastly, Man and the Plant World. All these, however, receive very meagre treatment and considering their importance, the short space of 21 pages would appear to be inadequate.

The remainder of the book, consisting of 370 pages, is devoted to the consideration of the climatic zones, in the classification of which the author does not appear to follow any well-recognised lines. The world is divided into such zones as Arctic, Sub-arctic, North Temperate, Palaetropic, Neotropic and South Temperate, but there is no further attempt at climatic subdivision.

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The North Temperate Zone and the Palaeotropics receive the greatest amount of attention, although the treatment, specially of India, is very insufficient.

The general get up of the book is excellent, and the text is illustrated by numerous beautiful photographs. It is, however, disappointing to find that no attempt is made to discuss the origin and relationships of the flora, the different regions, nor are they correlated to the different environmental conditions. The book thus becomes a mere inventory of the different plants to be found in the various parts of the world, and thereby loses its usefulness as a book on Plant Geography. Another unsatisfactory feature is the entire absence of maps, which would appear to be indispensable in a work of this kind.

(3.) The German book is a concise and useful summary of the available literature on the subject. It begins with a concise statement of the aims and objects of the study. The rest of the book is divided into three sections. The first of these treats of Ecological Plant Geography, the second of the Historical Development, and the third of Floristic Plant Geography.

The Ecological part is presented under (i) Autecology and (ii) Synecology. The first gives an account of the factors of the habitat and their influence on the plant, as well as an account of the vegetation forms, with an attempt to classify them on the physiological and ecological bases. This is finally brought to a close by reproducing Raunkiaer's system of Life Forms.

Under Synecology are treated questions dealing with the various Plant Societies, and succession, and the important formations of land and water, and finally the vegetation province of the earth.

The developmental part deals with questions of the origin and expansion of species, the dispersal and wandering of plants, endemism, island floras and other questions in relation to the geological history of the earth.

The floristic part is concerned with the geographical distribution of the important families and some genera, and ends with a survey of the whole vegetable kingdom.

To the text, finally, is appended a useful list of literature, in which, however, there are some serious omissions. Some of these relate to recent work which could not be included and for which the author expresses his regret. But the absence of any mention of Dr. Willis's work, in a book which claims to deal with the general subject of Plant Geography, is unaccountable, specially as it was published some years ago. Another drawback of the book is the paucity of illustrations. In the whole book, whose text covers 343 pages, there are only 5 figures, there being no photographs. There are, however, two very useful maps accompanying the book.

The book is very well got up, and written in a readable manner. On account of its conciseness and the excellent presentation of the subject, it forms a very good and useful text-book, and if an English translation of the work appears, it is sure to benefit a larger number of readers.

N. K. T.

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