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PROBLEMS INVOLVED IN THE PROPER IDENTIFICATION OF FERNS

J. GHATAK
Systematic Botanist, Central Office, Botanical Survey of India, Calcutta

ABSTRACT

The paper illustrates how the meiotic counts of six species of wild ferns namely, *Hicriopteris glauca* Copel. showing n=56, *Pteris vittata* L. *sensu* Holttum (1954) showing n=58 (Figs. 4 & 4a), *Pteris biaurita* L. *sensu lato* showing n=3n=87 (Figs. 2, 2a, 3 & 3a), *Blechnum orientale* L. *sensu lato* showing n=2n=34, *Cyclosorus dentatus* Forsk. *sensu lato* showing n=36 (Figs. 1 & 1a) and *Polystichum aculeatum* (L.) Roth *sensu lato* showing n=82, prove useful in their identifications and in finding out their modes of reproduction i.e. sexual or apogamous. These observations also confirm in general the previous findings by few other workers on the materials from Darjeeling, Ceylon and West Africa. So far as the investigator is aware, this is the first report on the signs of apogamy on the diploid level in *B. orientale* L., on the triploid level in *P. biaurita* L. and on the availability of a new diploid cytotype provisionally placed under *C. dentatus* Forsk. among ferns collected from Shillong and some adjacent areas on the Khasi hills.

INTRODUCTION

In ferns, the application of cytology to solve taxonomic complexities in a family (e.g. Pteridaceae of Copeland, 1947), genera (e.g. *Pteris* and *Idiopteris*, T. Walker, 1957) and numerous groups of aggregate species (e.g. *Adiantum caudatum* complex, Ghatak, 1959) has been firmly established first by Manton (1950 onwards). The absence of easily recognizable identifying characters with the presence of complexities due to very high polyploidy, frequent natural hybridization and gene mutations make the ferns taxonomically a very complex group. There are technical difficulties too. Even in many of the type specimens, taxonomic characters are not well represented. Fragments of ill-preserved fronds practically devoid of rhizomes, spores and indusia, let alone minute details of colour, hairs, scales, etc. are common in different herbaria of the world. Moreover, different workers described the same species under different names, as a result numerous synonyms are present in literature.

There are about 300 genera including some 10000 species of ferns distributed all over the world. The search for a suitable character-complex for their identification, like the floral morphology of higher plants is still in progress. Consequently, three important systems of classification of Polypodiaceae *sensu lato* were published within a space of seven years (Ching, 1940; Holttum, 1946; Copeland, 1947). As a result, not to speak of numerous specific and generic ambiguities, even in the case of some families complete agreement is yet to be achieved. This is important because at any time a group of key characters may become unreliable due to its variability in natural populations. In that case additional characters which are less adaptive and relatively constant like the cytological characters and minute details about the ferns growing in nature, must be sought. There are, however, a few cytotaxonomists working directly on tropical ferns. About nine out of every ten genera are confined to the tropics and the rate of their evolution is highest here (Manton, 1958; Mehra, 1961).

In January 1960 a short trip was taken to Shillong and its neighbourhood and the primary purpose was to collect materials for cytotaxonomic study of the available fertile fern-specimens growing wild in nature. The search for the probable ancestral types of especially two groups of aggregate species, namely, *Cyclosorus parasiticus* complex and *Adiantum caudatum* complex, was also envisaged. The collecting of specimens started in the woodlands ($\pm$1200 m.), the Elephant Falls ($\pm$1500 m.) and Shillong Peak ($\pm$1800 m.) at Shillong, turned out to be very fruitful at the lower altitudes (600-900 m.) of Umsaw, Nongkharai, Noonmati and the Margaret Falls (59.5-65 km. on the Shillong-Gauhati Road) and ended on the hill tops of the Kamakshya ($\pm$1050 m.) in the outskirts of Gauhati.

Shillong (lat. 25° 34′ N., long. 91° 56′ E.), the capital of Assam, situated amongst the Khasia hills, enjoys a damp, moist and moderate climate almost throughout the year. As is well-known, this type of climate is congenial for the growth of ferns. Even within a week of the severe winter, about 30 different genera comprising some 50 different species were collected. This list would very easily extend to more than a hundred if the collection was done during the favourable months of the year.

The soil of the hills is composed of a metamorphic complex, but that of the plains has been formed by the alluvial materials of the river Brahmaputra and its tributaries. This variation in edaphic conditions accompanied by the overhead canopy of the evergreens at higher altitudes and the Sal-forests at lower altitudes together with other favourable ecological factors, has not only provided an ideal home for the luxuriant undergrowth and multiplication of numerous genera of ferns (whose up-to-date reliable record is yet to be published), but also promoted colonization by different species and their hybrids, which appear to be mostly apogamous. In this area, earthquakes and torrential rains are opening up new areas of virgin soil every year on the hill-slopes for fresh habitation of some critical species which would not otherwise grow on older soils.

OBSERVATIONS

It is rewarding to note in the field that several distant genera were sharing in general the same ecological habitat, whereas a few species of the same genus, sometimes belonging to the same group of aggregate species, were favouring markedly different ecological niches. A species each of the genera, *Sphenomeris, Selaginella, Aleuritopteris, Polystichum, Blechnum, Pteris, Cyclosorus* and *Gleichenia s.l.* (the order of distribution being roughly from below upwards), were growing on the same shady corner. These rocky slopes had a superficial deposition of moderately moist, blackish brown and fairly loose soil and faced mostly the west or the north. On the opposite side of the road, generally facing the east and inhabiting the steeper freshly opened areas of bright red faces, was a species of *Lycopodium* alone. On the other hand, to cite a few representatives of the different species included under the same genus but growing under different ecological situations, were the species of *Cyclosorus* and *Pteris.*

Cyclosorus is an almost exclusively tropical genus of ferns comprising some 300 species (Copeland, 1947), many of which are species-complexes. These exhibit great taxonomic difficulties, because the inter-relationship between the components of a species-complex can only be deduced by experimental methods. As a result numerous species now included under the genus *Cyclosorus* had previously been placed under *Abacopteris, Aspidium, Dryopteris, Nephrodium, Polypodium, Thelypteris*, etc. The pioneer workers to establish the taxonomical differences of *Cyclosorus* from its allies were Link (1833), Farewell (1931) and Christensen (1932). The matter was further pursued by Ching (1938), Copeland (1947) and Holttum (1954) who progressed much with the taxonomy of the species included under the genus. But still the position of the genus under two of the modern classifications varies. Copeland placed it under the huge family Aspidiaceae, while Holttum in accordance with Ching placed it under the small and relatively primitive family Thelypteridaceae.

Manton (1950, 1953, 1954) first cytologically demarcated *Cyclosorus* with n=36 from *Dryopteris* showing n=41. Recent cytotaxonomic studies employing modern cytological techniques for the synthesis and analysis of fern-hybrids between taxonomically recognised species collected from different parts of the world, have brought to light that the number of species included under *Cyclosorus parasiticus* complex (one of the most widely spread and difficult complexes of the genus), are fewer than those previously recognised by taxonomists (Ghatak, 1959). Several diploids had contributed in the ancestry of the complex. Only one diploid species, namely *C. contiguus*, out of at least five postulated diploid ancestors of the complex was known so far (Panigrahi & Manton, 1958 ; Ghatak, 1959). During the trip it seems another has been found. The sporangial fixing done in the field from this plant has yielded many clear meiotic counts of n=36.(Figs. 1 & 1a). This specimen might prove to be a link in the ancestry of *C. dentatus* (this includes also *C. subpubescens sensu* Holttum).

The new diploid provisionally identified pending breeding tests as *C. dentatus* was collected from Umsaw, situated on the 58 km. of the Gauhati-Shillong Road at an altitude of about 750 m. In striking contrast to the other members of the complex studied so far, it was growing hidden under thickets. The very shortly creeping rhizomes of this rare, primitive and delicate diploid were sheltered between the huge boulders which guarded the water-edge of a small, quietly flowing rivulet. The fronds almost touched the surface of shady water. Only 5-7 fronds produced by each of this diploid plant were shorter in size, glossier and lighter green in colour with deciduous indusia. The tetraploid form of *C. dentatus*, the member with world-wide distribution, is a more hardy, tolerant and stouter plant bearing larger, thicker, darker green and more numerous fronds. Moreover, the indusia in the tetraploid are persistent in contrast to their deciduous nature in the diploid. Both these cytotypes, the diploid and the tetraploid, however, are similar in respect of the dominant and diagnostic specific characters of *C. dentatus* (e.g. several pairs of the lower pinnae very strongly reduced to mere wings ; general shape, dentation and number of the anastomosing veins in the pinnae ; shortly creeping rhizome, etc.).

Pteris is another very widely distributed tropical genus including some 280 species (Copeland, 1947), many of which are species-complexes (T. Walker, 1956, 1958). Among the three species of *Pteris* collected, *Pteris biaurita* from Umsaw and *Pteris vittata* from the Kamakshya hill of Gauhati have given good meiotic plates. *Pteris biaurita* was found to be an apogamous triploid with n=87, because of the presence of both the 8-celled and the 4-celled sporangia (Manton, 1950). The cells from the 4-celled sporangia showed very clearly the presence of 174 bivalents (Figs. 2 & 2a). But the count from the cells of the 8-celled sporangia was 87 bivalents (Figs. 3 & 3a). As regards *Pteris vittata* which showed n=58 (Figs. 4 & 4a), it might be mentioned that the specimens examined from the plains of West Bengal are also sexual tetraploids. The basic chromosome number of 29 for the genus *Pteris* is thus in conformity with the previous intensive observations of Manton & Sledge (1954) and of T. Walker (1956) for their specimens from Ceylon and West tropical Africa. Dr. Walker (1959) has further reported an apogamous diploid count of n=58 for *P. biaurita s.l.* from Ghana. The name *Pteris vittata* has been used here provisionally in preference to *Pteris longifolia* L., because the latter name, according to Holttum (1954), should be confined to the tropical American specimens which possess among other differences articulate and deciduous pinnae, whereas the Asiatic specimens of *Pteris vittata* exhibit persistent nature of the pinnae. Christensen (1906), however, had reduced *P. vittata* to a synonym of *P. longifolia* L. Only breeding tests can, therefore, give a decisive answer to this ambiguity.

The extensive population of *Blechnum orientale* contains an apogamous diploid showing n = 34, in the cells from the 8-celled sporangia and n = 68 for those from the 4-celled sporangia. This confirms the previous diploid counts by Mehra and Bir (1958) for their specimens collected from Darjeeling, but this is the first report of apogamy on the diploid level of the genus *Blechnum*.

Several fixings of *Polystichum aculeatum* from Umsaw, showed a clear tetraploid meiotic count of n = 82, which agrees with that by Manton (1953) for the specimens which she had collected from Ceylon.

At least two species with probably several varieties, now to be included under two different genera of Gleicheniaceae were very common among the highland ferns. The specimen which yielded a clear meiotic count could be identified either as *Gleichenia longissima* Bl. if we follow Holttum (1954) or as *Hicriopteris glauca* according to Copeland (1947). The presence of 56 clear bivalents in the spore mother cells, clearly supports Copeland's treatment of the group. Manton (1954) first reported n = 39 and n = 78 for materials from Malaya and Ceylon. Later Mehra and Singh (1956) found another new number of n = 56 for their materials from Darjeeling, a result supporting Copeland. The present finding of n = 56 for the specimens from Shillong, is thus in agreement with that of Mehra and Singh.

A similar controversy between the two generic names, *Cyathea* Sm. (Copeland, 1947; Holttum, 1954) and *Alsophila* R. Br. (Beddome, 1883; Biswas, 1943) for the specimen of the tree-fern collected near Umsaw remains to be solved, pending reliable chromosome counts.

CONCLUSION

From the above findings on several ferns of the Khasi hills, it is evident that accurate chromosome counts and other minute details of morphology in addition to the ecological characteristics of the specimens collected are necessary for the proper identification of ferns. Thus cytology is a wholesome corrective to pure taxonomy or herbarium botany of ferns, providing conclusive information for the delimitation of many genera and families. Moreover, for the correct demarcation of the specific boundaries specially of the groups of the aggregate species, the different cytotypes of a species-complex must be collected throughout the world; bred together in all probable combinations; morphology, cytology and genetic relationship of the parents and their hybrids must be carefully worked out and then only can one be positive about the naming of a fern.

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Explanation as for Plate.

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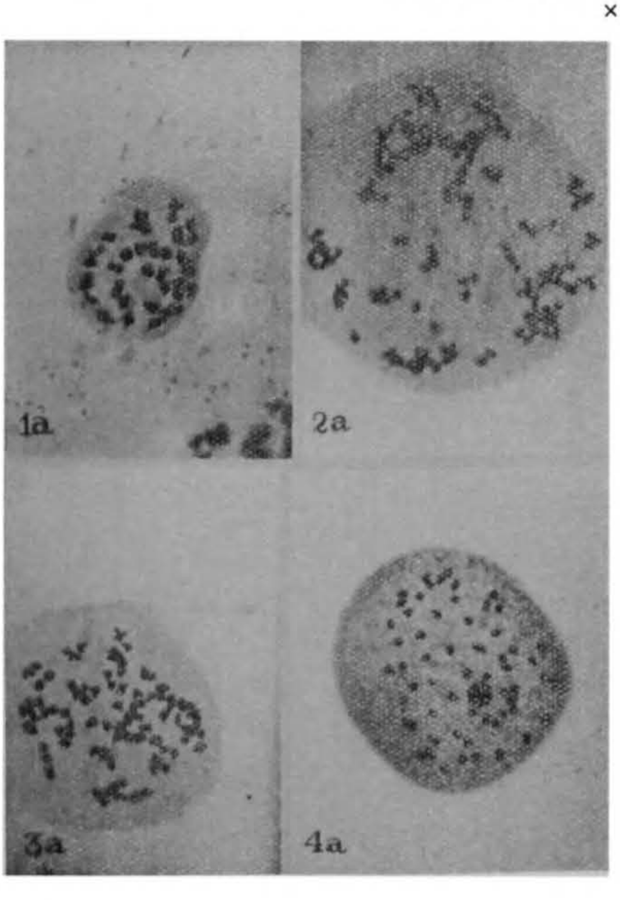

EXPLANATION OF FIGURES

PLATE

The photo-micrographs are from permanent acetocarmine preparations at a magnification of three hundred and seventy four diameters.

Figs. 1 & 1a. Meiosis in a spore mother cell of *Cyclosorus dentatus* Forsk. *s.l.* from Umsaw, with 36 bivalents showing n=36.

Figs. 2 & 2a. Meiosis in a spore mother cell from the 4-celled sporangia of *Pteris biaurita* L. *s.l.* from Umsaw, with 174 bivalents showing the doubling of the chromosomes.

Figs. 3 & 3a. Meiosis in a spore mother cell from the 8-celled sporangia of the same plant as fig. 2, with 87 bivalents showing n=3n=87.

Figs. 4 & 4a. Meiosis in a spore mother cell of *Pteris vittata* L. *s.l.* from the Kamakshya hill, with 58 bivalents showing n=58.