GENERAL DISCUSSION

The present work is limited to five genera, namely Pteris, Comogramme, Cheilanthes, Onychium and Adiantum, all falling under the family Adiantaceae sensu Alston (1939). The preceding pages in the thesis have largely dealt with the cytological status and morphology of 71 taxa segregated cytotaxonornically. The data have also pointed out the various species-complexes in each genus as well as sub-complexes in a huge complex, and a discussion on the species-complexes was attempted under the respective genera.

Besides, the data provide a basis for a discussion on general aspects. These are dealt with under various headings.
1. **Cytology:**

Chromosome numbers and breeding behaviour of 71 taxa distributed to five genera have been worked out presently. The observations along with citation of voucher specimens deposited in the Panjab University Herbarium are detailed in Appendix I. Out of these only three, namely *P. cratica* var. *nristata*, *P. cratica* var. *albolineata*, and *P. multifida* have been worked out from cultivated material, the rest having been collected personally in wild state in Darjeeling and Sikkim Himalayas. Incidentally these results have been included by Prof. Mehra (1961b) in the compilation of chromosome numbers in Himalayan ferns and prior to this date (1961) only 7 taxa (met with in the Himalayas) were known with a similar cytological status (marked + in App. I), but not from the Himalayas. Even to this date this list remains as the first cytological report for a very large number of taxa.

Besides the cytotaxonomic aspect and discussion on species-complexes, the information gathered from the present data provides collectively a basis for further discussion on these pteridaceous members which represent 85 per cent of the taxa met within the Himalayan Adiantaceae (sensu Alston). The cytological composition of the E. Himalayan pteridaceous members are summarized in Table XXVIII, which besides other

* Except *Adiantum edgeworthii* Hk. which is sampled from Mussoorie (W. Himalayas).
aspects reveals an overall preponderance of diploids.

2. **Cytology and systems of classification**

Ever since Manton's (1950) pioneering work on the cytology of British ferns, chromosomal evidence has been taken to be one of the good evidences to discuss the systematic position of a debatable taxon. Even in recent systems of fern classification, Alston (1956), Pichi-Sermolli (1958) and Mehra (1961b) have largely been guided by the chromosomal evidence. Presently investigated five genera belong to Copeland's Pteridaceae, but in the six best known recent systems (cf. Table XXIX) opinions differ as regards grouping of genera into families or tribes. The extent of disagreement in various treatments is a measure of the importance attached to various morphological criteria deducing the phylogeny of a genus.

Cytologically all the 71 taxa investigated are homogenous, being based largely either on 29 or 30, except Cheilanthes tanifolia which possesses an aberrant number n=2n=56 (or n=56, Manton and Sledge, 1954). These results are consistent with earlier reports and likewise point to a sharp discontinuity in the basic numbers from the genera placed above Pteris in Copeland's Pteridaceae, a fact very explicitly pointed out earlier by Manton (1958). Copeland's Pteridaceae requires splitting and this has been done on a cytological basis by Alston (1956, 1959) who included all the genera
from Pteris onwards (x=29, 30) into the family Adiantaceae. The cytological data as such neither support the segregation of various genera or groups of genera from Alston's assemblage into distinct families, nor conflict with a segregation maintained by various workers on morphology. As already pointed out by Verma and Kurita (1961) in addition to the chromosomal evidence, more stress should be laid on comparative morphology. The present cytotaxonomic observations are incompetent to deal with this aspect.

However, chromosomal evidence has often been useful in the generic delimitation of ferns and in only one case of Cheilanthes tenifolia an aberrant number (x=28) is reported. Incidentally this species has been placed in the genus Cheilosoria Trev. as well. It is desirable to investigate the entire element of Cheilosoria in Cheilanthes before any conclusions are advanced.

3. **Cytological evolution of Himalayan 'Pteridaceae':**

The significance of both the incidence of polyploidy, apogamy and grade of polyploidy in ferns have been the subject of interest ever since Manton's (1950) attempt to correlate such data on British ferns with those of Madeira. Manton (1953) later extended the enquiry to tropical ferns of Ceylon and her data based on percentage of polyploidy, grade of polyploidy, percentage hybridity and comparison of genera common to different regions, convincingly advocated a
faster evolutionary rate in the tropics. Recently Mehra (1961a) arrived at similar conclusions with special reference to Himalayan ferns, comparing the ferns from the Western part with those of the Eastern part. He could also advance an additional explanation for greater evolutionary potential in the tropics. Exactly similar conclusions are stated by Abraham, Ninan and Mathew (1962) with respect to S. Indian ferns. It is hence improper to deal with this aspect in general once again based only on a part of the data on Himalayan ferns.

Amongst the five genera included in this thesis, cytological reports in Coniogramma and Onychium are largely confined to the Himalayas. Out of the nine taxa in Himalayan Cheilanthes, 8 belong to sect. Aluritopteris and out of these only one, C. farinosa, is so far reported from elsewhere, thus leaving a larger proportion of taxa being only known from the Himalayas. These three genera are incidentally small and more than 50 per cent of their element is known. Pteris and Adiantum are the only two widespread genera included here and are sufficiently known cytologically too. For example 30 per cent of the species in Pteris are known prior to this work and from as many as 47 regions (cf. T. Walker, 1962), although for many regions only one or two species are reported (statistically unimportant). Most of the general aspects like polyploidy, apogamy, species-complexity etc. have recently been touched upon by T. Walker (1962) especially in relation to
Pteris and it does not seem reasonable to duplicate a similar discussion.

However, a critical comparison of the situation in five genera of Himalayan Pteridaceae (investigated presently) with their members from other regions is likely to be helpful in revealing the cytological evolutionary status of Himalayan 'Pteridaceae', or in pointing out any peculiarities in the Himalayan region. It should be pointed out that the present work includes 85 per cent of the Himalayan Adiantaceae (sensu Alston) and also records largest number of taxa for any genus reported from any single region. This fact claims certain amount of reliability on the nature of comparisons to follow.

The cytological situation in the five genera from various regions representing the tropical (Ceylon, Trop. Africa, S. India, Malaya and Java), sub-tropical (Madeira, Himalayas), and temperate latitudes (Japan, Australia and New Zealand) is summarized in Table XXX. A perusal of this Table reveals significant facts. Onychium and Coniogramma are largely known from Himalayas and nearly 50 per cent or more of them are sexual diploids. Cheilanthes, a genus of tropical and warm temperate lands has nearly all the Himalayan forms diploid while triploids and tetraploids are met with in tropical latitudes.

Pteris has nearly 50 per cent sexual diploids in the Himalayas and apparently nearly the same situation is met with in Ceylon and tropical Africa. But in S. India and Malaya
sexual diploids are far less (17% S. India, 20% Malaya) and so far are not known in Java. It should be added that the three tetraploids in the Himalayas are also known similarly from tropics and in one case (P. vittata) a diploid relative or ancestral type is discovered in the Himalayas while its hexaploid cytotype is known from S. India. The highest level of ploidy attained in the tropics is octoploid, being known in P. asteria Pr. from Brazil. The comparison is subtle but it certainly points to preponderance of diploids in the Himalayan Pteris. It becomes more clear when Himalayas are compared to Japan and New Zealand in temperate latitudes, which not only show far less percentage of diploids but also octoploids are known in New Zealand and Australia. This observation as such contrasts with the general conclusion of faster evolutionary rate in the tropics. The genus Adiantum presents nearly the same situation as Pteris. The preponderance of diploids in the Himalayas is also clear from the total percentage figures for various regions (cf. Table XXX).

Two important facts have emerged from the comparative data discussed above.

1) There is a preponderance of diploids in the Himalayas and nearly 57 per cent of the pteroids under consideration are diploid sexual, which figure is much higher from either tropical or temperate latitudes.

2) Wherever data are known (in Pteris and Adiantum), the temperate latitudes of Japan and New Zealand compare very well with tropical latitudes and thus create an
intriguing situation.

There is no denial from the conclusion 'of faster evolutionary rate in the tropics' arrived at by Manton (1950, 1953), Mehra (1961a) and Abraham, Ninan and Mathew (1962) in consideration to large fern floras. But the two points brought out above require an explanation. In the first instance I should add that the data from regions other than the Himalayas are not enough for any final conclusion to be suggested here. All the same, tentative suggestions (mutually not exclusive) are advanced which may form the basis of future investigations.

a) Cytologically speaking, Himalayas are of relatively recent origin and possibly it is because of this that more diploids are discovered. Furthermore, in many cases of polyploids (incl. apogamous forms) their diploid relatives are present alongside pointing towards the recent origin of polyploids. Furthermore, it is clear from some previous works (cf. Abraham, Ninan and Mathew, 1962) that the regions which are geologically very old and have longest escaped great geological upheavals generally show higher levels of polyploidy as well as greater number of polyploids, the latter are often unassociated with their diploid ancestors. This is supported by the presence of a decaploid Adiantum in Madeira (a sub-tropical island with an uninterrupted vegetation cover since tertiary times when it emerged from the sea, cf. Manton, 1950); and octoploid Pteria in Australia and Brazil, as well as a hexaploid apogamous Adiantum in Australia.
b) Possibly the geological history of the Himalayas and other physical factors are to be understood fully in relation to Manton's (1950) analysis that "under stable conditions, the natural spread of species is probably accompanied by some, though perhaps infrequent, polyploidy as new species come into contact with old ones and hybridize with them. In relatively undisturbed flora the incidence of polyploidy might, therefore, be expected to be low".

Possibly similar factors shall have to be accounted for the contrasting situation in Japan and New Zealand. The situation in these regions may be explicable more or less on similar terms as done by Manton (1950) for British ferns in relation to tropical flora, i.e. the increased percentage of polyploidy in Britain was local and an incidental effect of glaciation, mostly because of violent climatic disturbances caused by succession of glacial and interglacial periods.

c) Particularly for the Himalayas, the altitudinal distribution of taxa seems an important point. In the Himalayan range, above 1,500 m. alt. the climate is more or less akin to warm temperate latitudes, becoming cold temperate higher above. It is more seasonal than tropical because the ferns normally grow during the monsoons only. A perusal of the data with this delimitation (cf. Table XXXI) reveals that it is largely above 1,500 m. alt. that comparatively more sexual
diploids are recovered. It is the climatic factor which seems important rather than simply subtropical latitudes of the Himalayan range. A similar explanation was advanced earlier too in case of Athyrium (cf. Mehra and Verma, 1957a). Incidentally, the consideration of the altitudinal factor supports the concept of faster evolutionary rate in the tropics.

Summing up, the comparisons reveal a larger percentage of diploids in the Himalayas as compared to either tropical or temperate latitudes. A composite of three factors, i.e.
i) relatively recent birth of the Himalayas, ii) comparatively floristically stable conditions, and iii) more or less temperate climate above 1,500 m. alt. (and perhaps more) may be responsible for the preponderance of diploids in the Himalayan Pteridoids.

4. *Species-complexes*:

Two forms of species-complex are revealed in the present study. The first kind concerns the occurrence of cytotypes (chromosomal races) in a taxon, the cytotypes being apparently (more or less) morphologically similar. In most cases a complex exhibits chromosomal races coupled with polymorphicity. The second type corresponds to polymorphic taxa with similar cytological status. So far 18 species-complexes are discovered, mostly within the Himalayas. Those are tabulated below under the various categories, reports of cytotypes from elsewhere (by other workers) are marked *.
1. Pteris vittata 2x ( W. Him. ), 4x ( common ),
   6x ( S. India*).
2. P. aretica 2xa ( Him. ), 3xa ( Turkey*, Japan*),
   4xa ( S. Rhodesia*, Ascension Isl.*, Uganda*).
3. P. quadriaurita complex in general
4. P. 'himalayense' ( quadriaurita sub-complex ) 2xa and
   3xa
5. P. 'blumeana' and P. 'sikkimense' ( quadriaurita sub-
   complex ) former 2xa, latter 3xa
6. P. 'aspericaulis' ( 2xa ), P. 'rigida' ( 2x ),
   P. subindivisa ( 2x ), quadriaurita sub-complex
7. P. biaurita ( incl. P. nemoralis ) 2xa ( Ceylon*, Assam*),
   3xa ( Himalaya and Ceylon* )
8. Coniogramma fraxinea 2x ( typical ), 4x ( var. denticulo-
   serrata ), 3x ( x var. denticulo-serrata ),
   all from eastern Himalayas
9. C. intermedia 2x ( 3 taxa- var. glabra, B and var. 
   villosa- Himalayas ), 4x ( Japan- var. glabra ),
   3x ( Him. perhaps C. indica )
10. Cheilanthes farinosus 2x ( n=29, Him., n=30 Trop. Africa*
    and Ceylon*), 4x ( Ceylon* and S. India* ), 3x (Trop.
    Africa* )
11. C. tenuifolia 2xa ( Him. ), 4x ( Ceylon* and S. India* )
12. Onychium japonicum ( Himalayas ) 2x, 4x ( var. lucidum ),
    6x ( perhaps O. indi ? )
13. *Q. contiguum* (Himalayas) 2x, 2xa and 3xa (var. 'major')

14. *Adiantum caudatum* (s.l.) 2x (*A. incisum*-Him.),
   4x (*A. incisum*- Trop. Africa*), 2xa (*A. caudatum* -
   Him.), 3xa (*A. caudatum*-Him. and Ceylon*),
   4x (Malaya-)var. *A. malayanum* chatk. 1960,
   4x (*A. edgeworthii*, Him.)

15. *A. luminatum* (Himalayas) 2x (*A. teestae*), 2x, 4x,
   3xa (wide distribution, 3 taxa) (2x, 4x and 3xa also in S. India*).

II category:

16. *P. tongluense* (quadriaurita sub-complex) 2 taxa,
   forms a and b*, both diploid

17. *P. longipes* (quadriaurita- sub-complex) 2 taxa
   (*P. longipes, P. mahrae*+), both diploid

18. *Adiantum pedatum*, two taxa (*A. pedatum, A. lachenense*),
   both diploid.

A perusal of the above categorization of the various
species-complexes shows that they are represented in all the
genera investigated, whether large or small, widely distributed
or restricted primarily to Himalayan region. Obviously more
or less similar type of evolutionary mechanisms are operative
in each genus. Furthermore, in each case morphological criteria
have been of immense help in maintaining the identity of each
cytotaxon, but the type of characters employed varies in each
+Species nov.
case. These two aspects, viz. i) the role of morphological characters and ii) evolutionary mechanisms are taken up below.

5. Role of morphological characters:

The chromosomal evidence no doubt initiates a deeper taxonomic probe in a species-complex, but a polymorphic species requires a thorough understanding prior to cytological undertaking. The five genera have presented their own problems, the taxonomy of each genus requiring a particular set of characters, often distinct from others. The genus *Pteris* could be segregated arbitrarily on vein pattern, architecture of fronds and nature of spores into four groups, and while dealing with the huge polymorphic species-complex of *P. quadriserrata*, a number of criteria were employed (for details see p. out of which the criterion of scales was most distinctive (cf. Table X, Figs. 63A-P), although other criteria were not unimportant. *Coniopteris* is different and besides pinnation, the characters of pinnae or pinnales count more than anything else. These may be sessile or petiolate, entire or serrated, nature of serrations, nature of veins and hydathodes, nature of base and apex of pinnae, and so on. *Cheilanthes* (especially sect. *Aleuritopteris*) is largely governed by scales, their type and extent of occurrence, architecture of frond, nature of farina, and above all nature of spores and indusial margin. *Onychium* is the smallest of all the genera treated here and yet
the most difficult. Morphological characters that have gained prominence in taxonomy are the extent of pinnation, colour of stipe and indusia, nature of ripe sori, nature of infertile spores of fertile segments and nature of spores. In this genus alone stelar anatomy has been of immense help and has remarkably maintained the morphological grouping (cf. Tables XXII and XXIV). All these characters have collectively clarified taxonomy and evolutionary relationships of polyploids in *Onychium*.

*Adiantum* is a large genus and a system based on morphology was proposed by Hooker and Baker (1874) (cf. Table XXXII) which reveals applicability of diverse characters. Himalayan forms belong only to three of the seven groups and the difficulty has been only with the group *Radicantes*, which includes *A. caudatum* and *A. lunulatum* complexes. In these cases nature of pinnae, nature of veins, nature of pubescence (if so) help to a large extent in sorting out various taxa.

From the present work, it is clear that there is no regular set of criteria to clarify taxonomic complexities. Each particular genus has to be taken on its own merits and taxonomic identity could be maintained on a complex of characters rather than on a single character. However, rhizome posture (and also stelar anatomy), nature and extent of scales, and nature of spores are among the characters which are common to all and which must be taken into account.
6. **Evolutionary mechanisms**:

The nature of the species-complexes considered in the foregoing section itself explains the various types of evolutionary mechanisms operative in the E. Himalayan Pteroids, irrespective of the size and distribution of the genus. Nearly four methods—gene mutation or other chromosomal alterations, hybridization, apogamy (apomixis) and polyploidy—which are very well known in Angiosperms (cf. Stebbins, 1950) are equally applicable to the present five genera.

**Gene mutation**: The Sino-Himalayan region is one of the centres of speciation for many genera especially Coniopteryx and Onychium, and also perhaps Pteris and Cheilanthes. The overall preponderance of sexual diploids in the Himalayas (57%) stands testimony of their having evolved by genetic and chromosomal change, unaccompanied by multiplication of whole sets of chromosomes or by apogamy. The presently segregated taxa in the classical Coniopteryx fraxinea complex is one good example though several instances are available in Cheilanthes (especially C. farinosa s.l.) and Pteris (P. quadriaurita s.l.). In only one case of P. 'longissima' sub-complex, two morphological forms, $\lambda$ and $\rho$ seem to be in a preliminary stage of evolution, where genetic isolation has not been complete. A natural hybrid between the two very often yields viable spores.
Hybridization: The role of hybridization can scarcely be doubted since over 41 per cent of the taxa examined are either apogamous or polyploid (mostly alloplloid) in nature, to which a hybrid origin can be imputed safely. However, only in Coniopterygium two sterile hybrids, both triploid, are discovered out of the 67 taxa from E. Himalayas. One of them C. x fraxinea var. denticulo-serrata is rare and shows 3x univalents at meiosis; while the other C. x intermedia (= C. indica?) is extensive in N. Sikkim and reveals x pairs + x univalents at meiosis. These two cases reveal the extent of hybridization.

Hybridization is presumably extensive but the significantly lesser number of sterile diploids or polyploids discovered presently suggests that intensive search is still desirable to explore all types of ecological niches and sites of various taxa in the area.

Polyploidy: The phenomenon of polyploidy is widespread in ferns but it seems to be less significant in E. Himalayan Pteroids (10.5%). Pteris has only three tetraploids out of 26 and these very tetraploids are widespread so that the weightage of their occurrence in Himalayas is minimized. Coniopterygium is largely diploid with only one tetraploid out of nine. Chelanthea has no polyploid. Onychium, although small, is the only active genus discovered and out of 5 sexual taxa, two are polyploid. One of them is tetraploid and the other hexaploid, the highest level recorded presently. A single
tetraploid occurs in Adiantum out of 14 taxa. This comparative data point out convincingly a lesser role of polyploidy in the evolution of E. Himalayan Pteroids. Onychium alone is seemingly more active.

A comparison with previous data is only possible in Pteris because it is widespread, and also the Sino-Himalayan region is possibly one of its centres of speciation. Furthermore, Pteris is the only genus which has been extensively sampled over a very wide geographical range and excluding the E. Himalayan data, 33 per cent of the previously known species are sexual polyploids (55% incl. apogamous ones), by far a large majority being tetraploid (cf. T. Walker, 1962).

Eastern Himalayan element of Pteris is fully investigated and shows only 10.5 per cent polyploids (27% incl. apogamous ones), which figures are significantly lower. Obviously, in the Himalayan region the evolution has not progressed significantly through polyploidy.

Apogamy: Many unrelated genera are now known to possess taxa which are either sexual or obligately apogamous. Amongst the five genera, it is prevalent in Pteris (c. 30%) and Adiantum (40%), recorded in Onychium (29%) and Cheilanthes; but it is completely absent in Coniogramme, although two apparently sterile triploid hybrids are discovered. At least one of the hybrids is extensive and shows x pairs + x univalent associations. Production of diplospores through irregular
meiosis are recorded and it is possible that they reproduce apogamously, but it needs confirmation. From the statistical data, it seems that in at least three genera, apogamy has a significant hand in 'speciation'. Apogamous species are by no means strict evolutionary dead ends (cf. T. Talker, 1962).

It should be pointed out here that out of 71 taxa included in the thesis, 21 have been discovered to be apogamous, of which only three were known earlier to be so (cf. Table XXXIII).

Furthermore, it seems some genera are predisposed to apogamy and *Pteris* appears to be one such genus. In the *P. quadriaurita* complex (excl. *P. semipinnata*, cf. Table II) it is significant to note the absence of tetraploids and natural sterile hybrids. The only evidence of hybridity in this complex are the apogamous taxa (6 out of 16).

The data are probably suggestive that hybrids in *Pteris* tend to behave apogamously. The reliability of the data from Himalayas and the conclusion based on it becomes apparent when it is stated that excluding the present report, apogamy is 34 per cent in *Pteris*; a figure closer to Himalayas (30%).

7. **Problem of genetic constitution of apogamous ferns**

The normal 16-celled sporangia in apogamous ferns are considered to be of paramount importance in deducing the cytogenetic make up, since probably such sporangia depict the unaltered chromosomal associations. A reliance on their analysis
by many workers implies that uniformity of results is to be expected in a species. On this assumption recently a wholesale symbolization in genetic terms have been made by Mehra (1961a) of all the apogamous ferns for which analyses of the 16-celled sporangia are known.

The present study includes only two apogamous cases, namely the triploid *Pteris crtica* var. *albolineata* and tetraploid *P. cristata* var. *cristata*, whose 16-celled sporangia have been investigated and were also known previously. Incidentally the present results are at variance from the earlier reports by Manton (1950) for the tetraploids in general and the triploid var. *albolineata* in particular.

Presently, the average associations in the triploid var. *albolineata* are 27.8₁ + 21.8₁ + 5.2₁₁₁, while quadrivalents are altogether lacking (cf. Table VII). The total number of chromosomes involved into associations roughly correspond to x pairs + x univalents. The tetraploid var. *cristata* shows on an average 35.5₁ + 36.2₁₁ + 2.7₁₁₁ and total absence of quadrivalents (cf. Table VI). These figures do not in any way compare with Manton's (1950) analysis for tetraploids, especially *Pteris crtica* from Uganda and triploid var. *albolineata* (cf. Table XXXIV). Evidently, a question arises as to what extent reliance can be placed on the nature of associations in the 16-celled sporangia since discordant results are likely to lead to contrasting conclusions (cf. Table XXXV).

*Pteris crtica* is a very widely distributed species,
a successful horticultural fern and above all largely diploid apogamous in constitution. Variation is bound to occur in a species of such a wide range, a fact supported by the existence of a large number of morphovariants (including forms sikkimensis Verma) in a limited area of the Himalayas. However, here in apogamous ferns the variation is more of an opportunistic type rather than of any fundamental evolutionary significance. Furthermore, it would be plausible to assume that the apogamous taxon in P. cretica arose in a particular area, which in course of time successfully spread over other areas and probably effective colonization of new habitats was helped by apogamy. During this period normal mutational processes (as well as chromosomal aberrations) continued since apogamy is simply a highly specialized asexual reproduction which does not take into account the ability of chromosomal pairing but maintains the somatic constancy of number by 'endoduplicational meiosis' (cf. Håkansson and Levan, 1957). Hence there is every possibility that by selection and isolation preceded by genic mutation in apogamous ferns, new entities may arise in a single step provided the mutations are not lethal. What is more important in apogamous ferns is that the individual members do not share a common gene pool and obviously the smallest integrated unit above the individual is the clone or the biotype and the smallest well defined taxonomic unit may be a huge polymorphic complex, which is really the case in P. cretica. The variation is 'inherent' and gene mutations or chromosomal
aberrations including translocations that do not affect the adaptability of the organism to its environments shall multiply without disturbance or segregation, producing all types of morphovariants, which may even possess their own ecological preferences and thus aid in wide distribution. Such chromosomal alterations can accumulate with time and present totally an erroneous picture in their 16-celled sporangia as compared to the original situation.

If the thesis for the existence of variation due to non-injurious gene or chromosomal mutations is accepted in apogamous ferns, it is not difficult to presume that some of these changes would affect the original pairing behaviour of the taxon. For instance, translocations would produce multivalents at meiosis. In apogamous ferns these effects would only be apparent in the 16-celled sporangia (normal in a sexual species), but what they really represent is the state of affairs in an individual or at the most a biotype (clone) but never for the entire 'species'. Statistical analysis of chromosomal associations in the 16-celled sporangia is, hence, expected to vary particularly in widely distributed polymorphic apogamous species.

In conclusion it may thus be stated that while analysing the phylogeny of a particular apogamous taxon, especially a polymorphic widely ranging one, chromosomal data in their 16-celled sporangia need be given only due importance and in polyploids it should be assisted by morphological
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comparisons with the related taxa. Nevertheless, 16-celled sporangia still retain their importance, especially for the recent apogamous species, and their analysis is the only source of some information in others. One has, therefore, to be rather cautious while making any conclusions about the descent of an apogamous taxon or its genomic constitution based entirely on the pairing phenomenon.

8. Concluding remarks:

An account of cytotaxonomic investigations on 67 taxa of E. Himalayan Pteroids with respect to five genera (Pteris, Coniostrongale, Cheilanthes, Onychium and Adiantum) is nearly completed and the first thing it points out is the immediate need of a revised Himalayan fern flora which area has been shown to be intrinsically important. The present work, apart from revealing the cytological composition of pteridaceous flora has brought out many new taxa and species-complexes. It has pointed out peculiarities about the Himalayan region and has indicated the necessity of a more intensive and experimental study involving individual genera.