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A BRIEF COMPARISON OF MODERN PTERIDOPHYTE CLASSIFICATIONS (FAMILIES AND GENERA IN INDIA)

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ABSTRACT

Since the 1970s a number of modern classifications have been put forward, beginning with those where families and genera were split into as many small units as could be recognised, based on morphology and traditional Linnaean taxonomy. Subsequent workers began to rationalise families and genera into larger, more recognisable and fundamental units, containing smaller subgenera and sections within them, and the beginnings of a more general consensus were achieved by the turn of the present Century. More recently the advent of molecular-cladistic studies have largely upheld the larger units that had come into use, but a number of surprising findings and unexpected controversies have come up. It is suggested here that further time and understanding, combined with changes in methodology from both traditional taxonomists and moleculologists are required before all these changes should become widely accepted and that cladistic constrictions be removed from moleculology. Revision of the older-style, more splitting system and the level of ranks still in use in China is strongly recommended. A family and generic list of Indian subcontinental pteridophytes is given in taxonomic order. Corrections to Fraser-Jenkins (2008b) have resulted in the new generic name *Pichisermollodes* and 11 combinations within it; validation of the hybrid, *Athyrium* x *langtangense* Fras.-Jenk..; and *Selliguea triphylla* (Jacq.) Fras.-Jenk., non Christ, is replaced by *Polypodium triphyllum* Jacq.

Key Words : Cladistics Classification, Colysis, Family, Genus, Moleculology, Pichisermollodes, Pteridophyte, Rank.

INTRODUCTION

The earlier systems of classification of Pteridophytes, up until 1970, were summarised in detail by the late Professor Rodolfo E.G. Pichi Sermolli (1973), whose remarkable work on Families, Genera and classification has never been surpassed in its careful study and detail. Although he continued to refine and add further details to fern classification later on, his main classificatory work culminated in his "*Tentamen Pteridophytorum genera in taxonomicum ordinem redigendi*" (Pichi Sermolli 1977), a detailed and reasoned placement of the genera and families of Pteridophytes, with most useful discussion of their relationships. However it was very much a work of its time, when every recognisable group of species would often become raised to generic level and many small, closely related and ill-defined families were raised that were often not fundamentally different from each other. In the 1960s and 1970s much taxonomic study was being done by a number of well known pteridologists world-wide on what had until then been rather obscure small groups or genera, and as a result of the interest in recognising them they were often brought to attention at the generic level. Monographic work on the Thelypteridaceae, Hymenophyllaceae, Polypodiaceae and genera of other families was coming to the forefront

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concerning Asia and many small genera were being treated. Retrospectively it can be seen that Pichi Sermolli's scheme was in many respects an ode to taxonomic "splitting" and the fragmentation of more recognisable and fundamental genera into small groups of species. In keeping with most work at the time, it was largely a classification based too much on differences instead of on a necessary balance between differences and similarities, keeping in mind the significance of the degree of differences observed. However in general it was the best reasoned classification ever produced and far from decrying it as has sometimes been the case by a few authors subsequently, it remains of great significance because the discussion he made at all points allows it to be modified and related to more recent work, by "unsplitting".

Pichi Sermolli (1953, 1958, 1970, 1981, 1982, 1986, 1993) also listed and discussed all published Pteridophyte families and genera, and with his great knowledge of nomenclature and his careful application of the ICBN to historical literature, was thereby able to produce a guide-line that enabled future workers to deal with the major modern phase of revision of the classifications of the 1970s.

About the same time Crabbe, Jermy & Mickel (1975) produced a detailed generic list in taxonomic order which was similarly split the families into minor genera and Nayar (1970) had produced an evolutionary scheme for families, though of necessity less soundly based and with the recognition of a few highly anomalous new genera.

Throughout all this time, and continuing from his ground-breaking work alongside Christensen in the 1930s, the late Professor Ren-Chang Ching was working actively in Beijing on Chinese Pteridophytes, the richest region after S.E. Asia, and was able to make many very successful monographic studies of complex genera in China, often understanding relationships that others had been unable to fathom out, particularly in the Polypodiaceae etc. A considerable number of the genera and families recognised by Pichi Sermolli had been raised by Ching. Following an earlier attempt (Ching 1940), Ching's (1978) classification of Chinese Pteridophytes, *The Chinese fern families and genera. Systematic arrangement and historical origin*, was published almost simultaneously with Pichi Sermolli's and combined with the discussions in his monographic publications was also of great importance and value, especially given his detailed knowledge of species and groups almost unknown outside China.

For the next nearly 15 years these two systems, both based on detailed discussion of their groups built up over previous decades, but both characterised by the recognition of many "micro-genera" or families and based on a high degree of "splitting", held sway over international pteridological opinion, virtually unchallenged. Yet both, and in particular Ching's scheme, contained a number of controversial genera (and families) that many other pteridologists would not recognise.

Bir (1983) listed and summarised the schemes of most of those working on Pteridophyte classification at the time, and mentioned various different points of view, but

did not himself come to any conclusions or put forward any scheme of classification.

RATIONALISING GENERA AND FAMILIES

One of the signs of trouble with the mini-genera and families of the 1970s was that quite often no-one could recognise them. Many families in Pteridophytes were quite unusable, in comparison with those of Flowering Plants, and as circumscribed did not allow people to look at a fern and guess what family it belonged to. They could hardly be used in Floras because the reader could not find where to look for a species or genus if they were separated under the mass of close and unrecognisable families, and instead it was more useful to simply list the genera alphabetically and more-or-less ignore families. It is true that fern-families, even today, are perhaps not always as easy to recognise as in Flowering Plants as there are a number of exceptions due to soral migration along veins, exindusiate species etc., but as the families were so split up in the 1970s the families then were totally impracticable almost to the point of meaninglessness. The editor of one as yet unpublished W. Asian Flora, for which the accounts of Pteridophyta were mostly written some 20 years ago, reacting to the situation that pertained following Pichi Sermolli and Ching, decided to abandon modern fern-families altogether and place them all under Polypodiaceae, apparently not understanding how they had been rationalised in recent years.

It was similarly difficult when it came to genera. While nearly everyone with a modicum of knowledge could recognise the major generic group ("polypodioid, thelypteroid, cheilanthoid, athyrioid" etc.), there were a number of split and closely affiliated, almost unrecognisable "genera" where, if they were candid about it, nearly all specialists would identify or recognise the species first and then know or look up which genus that species was in! The area *par excellence* where this was the case was in the thelypteroid genera of Holttum (1971, 1982 etc.). Unlike what one less knowledgeable author in India said in adverse and misguided criticism of Holttum's excellent and detailed work on Thelypteridaceae it was indeed most thoroughly and painstakingly based on genuine natural groups of species. With care these groups can be recognised even when the species is unknown. But what was inappropriate under today's views was that the "genera" were so close morphologically, based on micro-characters such as hairs on the sporangium etc. It was a classic case of taxonomy according to the differences, while not giving enough weight to the evident close similarities. Holttum himself stated that in his opinion the only logical alternative to recognising them as genera would be to recognise a single genus, *Thelypteris*, which seems the most appropriate treatment to the present author, given their common features. In N. America (Smith & Cranfill 2002), and increasingly elsewhere as a result, Holttum's genera (that concern India) have been grouped into 5 remodelled genera, *Thelypteris* (free veins [in India]), *Cyclosorus* (anastomosing veins [in India]), *Phegopteris*, *Pseudophegopteris* and *Macrothelypteris*. But it seems that this was very much a half-way house that should better have gone further. The present author recognises a single genus,

Thelypteris, but has not lost sight of Holttum's properly extrapolated groups within it, as subgenera and sections. It is important for a major rank like a genus to have a useful, practicality and to be readily recognisable, yet the sections etc. within it can still be properly recognised, but at the lower rank, not affecting the binomial nomenclature we are all obliged to use. Ask a pteridologist to define (or even recognise) a *Metathelypteris* and they will usually be stumped, but ask them to do the same for a *Thelypteris*, in the present sense, and it will be relatively easy. Hymenophyllaceous "genera" and several of Ching's Polypodiaceous ones are other examples of the inappropriateness and problem created by treating relatively more minor species-groups as genera. Of course one could say it would be easier, then, to let us call them all one genus per family, but that would be to ignore the evident and readily recognisable differences between the modern genera!

Following the seminal work of Manton (1950) there was a large build-up of cytological data concerning genera, begun by Manton & Sledge (1954). As a result Alston (1956) and Mehra (1961) were the first workers to attempt to make a cytological scheme of generic and family classification. This was attempted by Lovis (1977) on a wider and more detailed scale, and much subsequent work has been added to it since then, including further understanding of the variability and significance of morphological features, group-by-group. Kato (1983) thus produced a more conservative classification reducing the number of families and genera. A new approach therefore began to emerge where families and genera were rationalised into more major and recognisable units. Small genera believed to be systematically related, were sunk into more major ones to become more recognisable and meaningful. Kramer & Green's (1990) and their co-authors' great work on the classification of Pteridophytes in Kubitski's, *The Families and Genera of Vascular Plants*, definitively introduced "the big sink" and was a work of considerable courage, based on very thorough and experienced international collaborative work from many leading authorities. Once names are in existence at generic etc. rank, everyone generally likes to use them in their new publications, to keep up with research-developments and increase the number of taxa. But it requires a more thorough knowledge on a wider scale to sink genera as they did. Thus from Pichi Sermolli's 443 genera, they reduced it to 223, more fundamental genera and if all Ching's genera are also added to Pichi Sermolli's there used to be a total of 469 erstwhile genera. Pichi Sermolli's 64 families (plus Ching's extra 14 families) were reduced to 38 families. The resulting genera and families are not merely thrown-together chimaeras of unrelated groups, but genuinely show their systematic relationships through their common morphology.

On the whole the Kramer & Green system generally began to be widely accepted and at last introduced an unprecedented degree of agreement and uniformity in classifications world-wide. Unfortunately though, some areas of the world have taken a long time to bring it to notice due to isolation combined with lack of funding for acquiring modern literature, thus leaving somewhat of a gap in the development of understanding of families and genera.

It must be admitted that the Indian subcontinent is one such area and in addition, when the word does spread, there is a tendency for authors here to prefer utilising extra names and newly split taxa in their publications as a means of producing something different from others with greater numbers of taxa being reported than previously - for non-scientific reasons which are well known here. Nevertheless there are signs that many more authors are now becoming more aware of modern classification and of problems concerning excess erstwhile families, genera and also species, with their associated "New Species Syndrome" problem (see Fraser-Jenkins 1997, 2008a, 2008b).

A list of families and genera in alphabetical order, as accepted in the herbarium at Kew (where, however, the families are in taxonomic order) was prepared by Brummitt (1992), with input on the pteridophytes from R.J. Johns and B.S. Parris, but without discussion, which would have been impossible on such a large scale. The family system (36 families) was similar to Kramer & Green's system, from which there was presumably much important input in the herbarium, but it also recognised a few minor families, Actiniopteridaceae, Parkeriaceae, Platyzomataceae and Stromatopteridaceae, which had been placed as synonyms by Kramer & Green. However the genera (316) were clearly too numerous and were far less satisfactorily dealt with, including many from Ching and others which had not been revised effectively at Kew, or had been based on Holttum's previous more splitting treatments. Many genera that had been successfully placed in Pteridaceae by Kramer & Green were maintained in Adiantaceae by Brummitt, while recognising other genera as within Pteridaceae. Although Adiantaceae and Pteridaceae are very close, as reflected in Kramer & Green's sinking it within Pteridaceae, Brummit's placing so many genera in Adiantaceae was hardly advisable and if maintained at all it would be better confined to *Adiantum*, with its indusial veinlets.

Hennipman (1996) also produced a classification based on an apparent consensus, but thereby included *Blechnaceae* and *Woodsiaceae* within *Thelypteridaceae*, and *Dicksoniaceae* within *Cyatheaceae* along with other anomalies such as sinking Grammitidaceae into the related Polypodiaceae, in a system which has not been adopted by others.

THE ADVENT OF MOLECULOGY

In the present decade or so an increasing and surprisingly rapid series of moleculological-cladistic publications on pteridophytes, largely centred on a few N. American or Japanese teams and recently some Chinese ones, have put forward various generic revisions and these are immediately accepted by their authors and others as being the absolute, and correct, technically verified changes to taxonomy (see particularly Wolf, Soltis & Soltis 1994, Gastony & Rollo 1995, Murakami 1995, Hasebe et al. 1995, Conant et al. 1996, Crane 1997, Murakami et al. 1999, Yatabe et al. 1999, Sano et al. 2000, Thomson 2000, Nakazato & Gastony 2001, Schneider et al. 2002, 2004a, b, Pryer et al. 1995, 2001a, b, 2004, Hennequin et al. 2003, Cranfill & Kato 2003, Des Marais et al. 2003,

Hauk et al. 2003, Little & Barrington 2003, Ranker et al. 2004, Geiger & Ranker 2005, Tsutsumi & Kato 2005, Zhang et al. 2005, Ebihara et al. 2006, Korall et al. 2006, Schuettpelz & Pryer 2007, Kirkpatrick 2007, Zhang et al. 2007, Kato & Tsutsumi 2008, Tsutsumi, Zhang & Kato 2008, Murdock 2008, Krier et al. 2008, Der et al. 2009). Most of them state that their cladistic trees constitute the new classification of the ferns they have sampled as if there were no alternatives. After a wide-reaching study of chloroplast moleculology, Smith et al. (2006) put forward a new classification of pteridophytes, which has been taken up as constituting the properly based revision of pteridophyte families superceding all previous schemes and is held by a number of Botanists to be the definitive work for present and future classification.

There is indeed a general congruence between Smith's classification and Kramer & Green's taxonomic classification, though for reasons which are not always clear, but there are several minor and one or two major points of difference. However automatically accepting such a scheme and the other generic findings from related papers as correct taxonomically is fraught with problems. It might be more appropriate to see it as a possible alternative which needs fundamental new study, probably not yet entirely possible with present-day methodology, before it can be tested further as to its accuracy. Some of the more surprising findings might indeed indicate places where traditional morphological study could not readily supply answers so far, but it seems to the present author that the moleculological results still need verification by some other methods.

One of the greatest drawbacks of such studies is that it is all placed in an unnecessary straightjacket of cladistic hypothesis - that taxa must be monophyletic, or clades. In a wider taxonomic context it is actually not necessary at all that taxa have to be monophyletic and both the almost universally common state of paraphyly (see Brummitt 1996, 1997, 2001, 2006, Rieseberg & Brouillet 1994) and, in the present author's opinion, apparent molecular polphyly are perfectly acceptable states, which are not as artificial as cladistic moleculologists believe them to be. In fact, along with many other taxonomists who have serious doubts about cladistic hypotheses, the present author is actually of the opinion that the whole of cladistic theory is not only a gross and obvious blunder of the "flat earth" type, but that it is also now propagated against common sense and all the odds as a kind of compulsory neo-mythology - a cladistic delusion! Strict cladistic-moleculo adherence actually obstructs perfectly proper and meaningful morpho-taxonomic considerations from being balanced up with the molecular results prior to coming to a wider-based conclusion. "Genera" which are indistinguishable except by some very minor and insignificant character are surely best understood as not being genera at all, but some minor group within a more recognisable genus.

Furthermore the significance of the molecular basis itself may be suspected of not being properly and fully understood at the present juncture. This applies particularly to sequences which are connected only with physiology and biochemistry, as opposed to

structural and morphological aspects. The whole picture would undoubtedly become clearer and more refined if we could actually know which genes did what in the plants and could concentrate a new type of study more on those involved with fundamental structural changes in the origins of new groups. At present there is no guarantee that gene-sequences coding for physiological processes cannot actually arise independently on more than one occasion. Moleculologists simply do not know and cannot know for the present what sequences are relevant to what structures and merely matching sequences between plants may not necessarily indicate absolute relationships. In some ways the speed with which these studies are produced is slightly unfortunate as many appear to need further consideration and investigation - perhaps with methods yet to come. But it appears to some new authors to be easier than gradually gaining taxonomic insight and experience over a long time and is often the only viewpoint many workers are able to have.

Some inadequacies are exemplified in one recent paper (Little & Barrington 2003) which concluded that African *Polystichum* forms an "African Clade" despite the fact that the genus in Africa contains at least three major and separate sections, which all have very close relations within India. Many of the papers have also been quite unable, given the methodology of working on the chloroplasts, where the genetic material is inherited only from the female ancestral species, to allow for the mixed origins of allopolyploid species. Yet they continue to include them undifferentiated in their cladology without troubling to look up what is often long known or suspected about their allopolyploid origin.

Another aspect that requires overhauling prior to attempting to draw conclusions concerns the rate of molecular change through evolution. *Sphenodon*, the ancient and primitive Tuatara Lizard of New Zealand, was recently found to have a surprisingly high rate of genetic change in its DNA, but we are not therefore obliged to place it in a different genus from its structurally similar ancestors. Differential rates of evolutionary DNA change in different groups at different times, some faster, some slower, must introduce an error-factor that becomes greater as one covers a greater time-period such as while looking at genera and families as opposed to close-knit recently evolved species-complexes (where molecular studies are much more obviously successful and prove reliable in elucidating the systematics of such groups). Genetic change does not necessarily go hand-in-hand with the morphological changes that can constitute different genera and families and may indeed be widely disconsolant.

Because taxonomic capability, intuition and experience are not actually necessary to produce molecular-cladistic trees and then translate them directly into "taxonomic classifications", it has become the situation in parts of Asia that the workers do not themselves have a proper taxonomic background sufficient to allow a wider-based interpretation of results. They do not understand the groups they are dealing with properly and often cannot even identify the species properly, but any molecular similarities are immediately interpreted as being the major evolutionary factors of significance. The present

author believes there is actually a very long way to go before anyone can interpret such results accurately.

At present the Kramer & Green scheme is given more weight here and felt to be more reliable than much of the molecular scheme, though with a number of modifications. But rather than abandoning it, the molecular scheme should also remain in mind, if not always at the forefront, and while still being able to be superceded by morphological considerations.

Some of the "genera" recognised molecularly that the present author finds far too similar morphologically to be worthy of generic separation are placed as follows: *Ptisana* belongs to *Marattia*; *Bierhorstia* (and *Sphenomeris*) belong to *Odontosoria*; *Paraceterach* and *Paragymnopteris* belong to *Notholaena* (for both typification reasons and the morphological closeness of N. American and Old World plants); *Haplopteris* belongs to *Vittaria*; *Pentarhizidium* belongs to *Matteuccia* (and not to *Onoclea*); *Wibelia* and *Humata* belong to *Davallia*. Others may be seen in the list of genera below.

THE CHINESE SYSTEM

Due to its position adjacent to India and its being a much richer part of the same Sino-Himalayan plus SE Asian fern-flora, the situation that pertains in mainland China is of particular importance to pteridologists in the Indian region. However since the Pteridophytes of the *Flora Reipublicae Popularis Sinicae* (1959- 2004) were published under Ching's system of 1978 it remains the official policy to stick to that system and not make changes to it. This means that in contrast to other regions, where important fundamental change has occurred as time and research-based understandings went on and advances were made, the mainland Chinese system, which is effectively compulsory, has remained in the same state as during the era of Pichi Sermolli and Ching some 30 years ago. The retention of excess families and genera - and it has to be said that Ching was responsible for many more of them than any other modern worker - has resulted in a system where most ranks are actually utilised one step too low in comparison to the rest of the world. What might be subfamilies elsewhere are often families in mainland China, and subgenera and sections are frequently treated at the rank of genera. The work done elsewhere for the last 20 years or more, even by the outstandingly careful and thorough Japanese botanists, for example, on generic revision and monographing is often simply ignored, even when some of the Chingian genera (e.g. the "athyrioid" i.e. Woodsiaceous "genera" *Allantodia*, *Callipteris*, *Diplaziopsis*, *Pseudocystopteris* and *Kuniwatsukia*) have lost support as a result of preliminary molecular studies (such as Wang et al. 2003), as long advocated by the present author (Fraser-Jenkins 1997, 2001 *ined.*, 2008b). One outstanding example concerns the good natural genus *Deparia*, found to be acceptable moleculologically, but split in China into *Lunathyrium*, *Athyriopsis* and *Dryoathyrium*. There are many other such examples in many complex genera.

In addition it became abundantly clear in the 1980s, when contact between Western

and Chinese pteridologists began again, that Ching and subsequently his followers, who often took up many of his unpublished herbarium-names, had named a massive excess of erroneous new species, based on minor growth and developmental variation, but alongside many genuine new species, as would be expected. A few of the authors of the Chinese *Flora* managed to investigate and sink an important initial swathe of these names in certain genera (but not in others such as the now almost intractable genera, *Cyrtomium* and *Arachniodes*). But that work still has to continue a great deal further and in addition proper taxonomic balance will have to be maintained in order to understand and interpret the new results from moleculology in a meaningful and appropriate way. The challenges facing mainland Chinese pteridology are thus far greater at present than in other parts of the world, the first step required being a large-scale modernisation of the old splitting system of classification instead of the obligation to maintain it more-or-less rigidly (with only occasional minor revisions allowed here and there from moleculology). A recent paper (Lu & Yang 2005) setting out to "revise" Taiwanese pteridophytes according to the mainland Chinese system was a quite ironic and unnecessary, complete reversal of what actually needs to be done, as was abundantly clear to most pteridologists in Taiwan when it was published.

Fortunately taxonomic research is able to continue actively in mainland China, despite its near demise and starvation of funds in most other countries and there is thus considerable hope that a new approach may come in there before long, which need not even depend on molecular work, providing some rather fundamental decisions and much rethought can take place. In the meantime it continues to be necessary for workers elsewhere to "translate" the nomenclature of the Chingian system into a more international context in order to be able to assimilate the many continuing and valuable Chinese pteridological publications that are frequently so relevant floristically to Indian pteridology. The first indications that this might be about to happen is given in a paper by Liu et al. (2008) who published their acceptance and support of Smith et als. (2006) classification for families. However it is therefore somewhat surprising to find a new paper by Qi et al. (2009), involving some of the same authors, continuing to utilise Ching's system, perhaps as an indication that the necessary change may come rather slowly and may not at first turn out to be as far-reaching as is required, especially for genera. It is also perhaps rather disappointing merely to see the moleculological cladological classification being adopted wholesale rather than being modified here and there by some non-cladistic, taxonomic and morphological considerations, where appropriate.

TABLE OF FAMILY AND GENERIC NAMES SUGGESTED FOR INDIAN SUBCONTINENTAL PTERIDOPHYTES

In the following table the author has set out a scheme largely based on Kramer & Green (1990), with certain modifications including from Smith et al. (2006) and some other modifications of his own, recognising 34 families and 135 genera. In general some of the more surprising changes put forward by Smith and other N. American molecular workers

are treated as tentative alternatives that may or may not prove to be correct in time - they are alluded to at the end for Indian workers to bear in mind and make their own decisions on utilising their experience and knowledge of the genera concerned. The geographical area covered is: further east Afghanistan, Pakistan, India, Andaman & Nicobar Islands, Nepal, Sikkim, Bhutan, Bangladesh and Sri Lanka. The author is currently working on updating pteridophyte lists for Myanmar and Tibet. Adventive species are excluded, except for the two very widely established species of *Pityrogramma*. Hybrids are excluded as of no floristic importance. The number of species per genus is given in brackets, with an upper number for species of uncertain status.

Lycopodiaceae

Huperzia (17)
Lycopodiella (2)
Lycopodium (8 - 9)

Isoetaceae

Isoetes (2 - 3)

Selaginellaceae

Selaginella (48 - 53)

Equisetaceae

Equisetum (4)

Psilotaceae

Psilotum (2)

Ophioglossaceae

Botrychium (6) - includes splinter genera.
Helminthostachys (1)
Ophioglossum (9 - 11) - includes splinter genera.

Marattiaceae

Angiopteris (2 - 3) - Some specimens with cordate segment-bases collected by the author and others from Arunachal Pradesh may perhaps represent a third species present in India.
Christensenia (1)
Marattia (1) - includes the molecular splinter genera, *Ptisana* etc. of Murdock (2008).

Osmundaceae

Osmunda (6) - *O. regalis* L. is absent from India, though included by Fraser-Jenkins (2008b) in error.

Plagiogyriaceae

Plagiogyria (4)

Schizaeaceae

Schizaea (2)

Lygodiaceae

Lygodium (7)

Marsileaceae

Marsilea (3 - 4)

Gleicheniaceae

Dicranopteris (5)

Gleichenia (2) - Subgen. *Diplopterygium* applies to the Indian Subcontinental species and would also be acceptable to treat at generic rank, if preferred, on account of its distinctive unlobed segments with lines of several sori in the segments.

Dipteridaceae

Dipteris (1)

Polypodiaceae

Arthromeris (9 - 10) - *A. tomentosa* W.M.Chu is a good species, present in Bhutan and Arunachal Pradesh, mistakenly not recognised by Fraser-Jenkins (2008b).

Belvisia (3)

Colysis (2) - its type species belongs to the earlier genus, *Leptochilus* (which is why *Leptochilus* cannot be sunk into the later *Colysis*). But it is conceivable that the pseudo-pinnate species (*C. elliptica* (Thunb.) Ching, *C. pothifolia* (D.Don) C.Presl and relatives, but not *L. insignis* (Blume) Fras.-Jenk. or *L. pteropus* (Blume) Fras.-Jenk.) might be taken to constitute a minor genus separated from both.

Drynaria (6 - 7) - including *Aglaomorpha*.

Goniophlebium (3) - species with fully separate pinnae.

Lemmaphyllum (3)

Lepisorus (14 - 17) - including *Paragramma*, *Drymotaenium* (in contrast to Smith et al. 2006) and *Platygyria* and hence requiring conservation.

Leptochilus (11-12) - including *Colysis* (type C. *hemionitidea* C.Presl), *Paraleptochilus* and *Dendroglossa*. Further consideration is required as to the circumscription of *Leptochilus* with its type species, *L. axillaris* (Cav.) Kaulf., in relation to some pseudopinnate species formerly placed in *Colysis*. If they are all congeneric, *Leptochilus* would include all the species formerly placed in *Colysis*, not only its type and other simply pinnate species.

Loxogramme (5)

Microgramma (1)

Microsorum (6)

Neocheiropteris (2) - including *Neolepisorus*.

Pichisermollodes (10)

Phymatosorus (4 - 5)

Platycerium (1)

Pleopeltis (1)

Polypodiodes (8) - species with mostly or all joined pinnae.

Pyrrosia (21) - including *Drymoglossum*.

Selliguea (8) - including *Christiopteris*, in contrast to Smith et al (2006) and *Crypsinus* and *Phymatopteris*.

Thylacopteris (1)

Tricholepidium (3) - may require further study in relation to the type-species of *Leptochilus*.

Grammitidaceae - it is not accepted here to include this family within Polypodiaceae.

Calymmodon (1)

Chrysogrammitis (1)

Ctenopterella (3)

Dasygrammitis (1)

Micropolypodium (1)

Oreogrammitis (8)

Prosaptia (5)

Radiogrammitis (1)

Scleroglossum (2)

Tomophyllum (4)

Hymenophyllaceae

Hymenophyllum (12 - 13)

Trichomanes (31-36) - treated here as one genus consistent with the treatment of *Hymenophyllum* and in contrast to Smith et al. (2006).

Dicksoniaceae - including Cibotiaceae.

Cibotium (1)

Cyatheaceae

Cyathea (14 - 16) - some authors have separated *Alsophila*, *Gymnosphaera* and *Sphaeropteris* from *Cyathea*, but Holttum's arguments versus Tryon in favour of their status as subgenera are preferred here and Smith et al. (2006) are not followed in separating them.

Dennstaedtiaceae

Dennstaedtia (3) - including *Emodiopteris*.

Histiopteris (1)

Hypolepis (2)

Microlepia (14)

Monachosorum (1) - included here, as by Fraser-Jenkins (2008), on the basis of its obviously similar morphology, and apparently also supported by Smith et al. (2006).

Pteridium (2)

Lindsaeaceae - included by Kramer & Green within Dennstaedtiaceae, but separated here as being morphologically distinct, which is apparently supported by Smith et al. (2006).

Lindsaea (23 - 28) - several species reported from the Andaman and Nicobar Islands

require confirmation.

Odontosoria (1 - 2) - including *Bierhorstia*, in contrast to Barcelona (2000). *O. tenuifolia* (Lam.) J.Sm. might alternatively be treated as a cytological subspecies of *O. chinensis* (L.) J.Sm.

Tapeinidium (1)

Pteridaceae - requires conservation against Parkeriaceae.

Acrostichum (2)

Actiniopteris (2)

Aleuritopteris (20) - including *Negripteris*, *Sinopteris* and *Leptolepidium*.

Anogramma (2)

Ceratopteris (2) - definitely included in Pteridaceae despite some molecular findings of dubious significance.

Cerosora (1)

Cheilanthes (10 - 11) - including *Mildella*, despite its recognition by Smith et al. (2006), and *Cheilosoria*.

Coniogramme (6 - 7)

Cosentinia (1) - A.R. Smith (pers. comm.) has pointed out that molecular work (Nakazato & Gastony 2001) combined with its spore-morphology suggests that *Cosentinia* may be a separate genus from *Notholaena*, where it was placed by Fraser-Jenkins (2008b) and Fraser-Jenkins & Dulawat (2009), and it is thus rather tentatively separated here.

Cryptogramma (2)

Doryopteris (2)

Notholaena (5) - including *Paraceterach*, *Paragymnopteris* (and probably also *Chrysochosma* from the New World).

Onychium (6)

Parahemionitis (1)

Pellaea (4) - the molecular separation of various minor species-groups from *Pellaea* is not accepted here at the generic rank.

[Pityrogramma (2) - adventive]

Pteris (52 - 53)

Syngramme (1)

Taenitis (1)

Adiantaceae - this family may also be included within Pteridaceae if preferred.

Adiantum (15, excluding several adventive species).

Vittariaceae - definitely excluded from Pteridaceae, in contrast to its inclusion by Smith et al. (2006).

Antrophyum (6)

Monogramme (1)

Vittaria (11) - including *Haplopteris*.

Aspleniaceae

Asplenium (76 - 81) - definitely including *Hymenasplenium*, also *Thamnopteris*.

Thelypteridaceae

Thelypteris (85 - 90) - includes all splinter genera.

Woodsiaceae - including Onocleaceae, in contrast to Smith et al. (2006).

Acystopteris (1)

Athyrium (50) - including *Pseudocystopteris* and *Kuniwatsukia*.

Cornopteris (4)

Cystopteris (3 - 5, depending on which rank is preferred for the *C. fragilis* (L.) Bernh. aggregate)

Deparia (9 - 10) - including *Lunathyrium*, *Athyriopsis* and *Dryoathyrium*.

Diplazium (40 - 41) - including *Callipteris*, *Diplaziopsis* and *Allantodia*.

Gymnocarpium (3) - including *Currania*.

Hypodematium (1) - this genus has recently been suggested to belong to an ill-defined group close to *Didymochlaena* and *Arachniodes* (both Polystichoid ferns) in Dryopteridaceae on molecular grounds, but is maintained in Woodsiaceae here until further evidence is available, though its position is rather unclear from its morphology.

Matteuccia (2) - the recent placement of *M. orientalis* (Hook.) Trevis. and *M. intermedia* C.Chr. within *Onoclea* and also within a separate genus, *Pentarhizidium* (on molecular grounds), is not accepted here.

Woodsia (8)

Dryopteridaceae - definitely including Subfam. Tectarioideae (s.l.), including *Ctenitis*, in contrast to Smith et al. (2006).

Acrorumohra (1)

Arachniodes (10) - including *Lithostegia*.

Ctenitis (4)

Cyrtomium (5)

Didymochlaena (1) - definitely included here as belonging to Subfam. Polystichoideae, in contrast to Hasebe et al. (1995).

Dryopsis (7)

Dryopteris (61) - including *D. haselttii* (Blume) Ching, not an *Arachniodes* or *Acrorumohra*.

Heterogonium (1)

Lastreopsis (2)

Nothoperanema (2) - maintained as separate from *Dryopteris* in contrast to Geiger & Ranker (2005) and Smith et al. (2006).

Peranema (3) - including *Diacalpe* and *Acrophorus*, in contrast to Smith et al.

(2006).

Phanerophlebiopsis (1) - this genus could be included within *Cyrtomium* or *Polystichum* if preferred.

Pleocnemia (2)

Polystichum (46 - 51) - including *Sorolepidium*.

Pteridrys (3)

Tectaria (25 - 26) - including *Quercifilix*.

Oleandraceae - definitely including Nephrolepidaceae, which was separated by Kramer & Green and was tentatively placed by Smith et al. in Lomariopsidaceae.

Arthropteris (1) - placed here and not in "Tectariaceae" as suggested by Hasebe et al. (1995) and Smith et al. (2006).

Nephrolepis (6)

Oleandra (4)

Lomariopsidaceae - including *Bolbitis* and Elaphoglossaceae, both placed by Smith et al. (2006) in Dryopteridaceae.

Bolbitis (17) - including *Egonolfia*.

Elaphoglossum (9)

Lomagramma (1)

Teratophyllum (1)

Davalliaceae - Nooteboom's (2008) sinking all the genera into *Davallia* is strongly rejected here, but not all of Tsutsumi, Zhang & Kato's (2008) generic placements are accepted.

Araiostegia (4) - this genus is definitely maintained here despite Tsutsumi et al. placing it within *Davallia*.

Araiostegiella (2)

Davallia (10) - including *Humata*, *Wibelia* and *Pachypleura*.

Davallodes (2)

Gymnogrammitis (1) - Schneider et al. (2002) transferred this genus to near *Selliguea* in the Polypodiaceae, but while this is accepted as a possibility here, there is too little morphological or other evidence to remove doubt arising from its entirely different morphology and it is tentatively maintained here within Davalliaceae until more is known from other types of study.

Leucostegia (1) - Schneider et al (2004c) concluded that this genus is related to *Hypodematium* in Dryopteridaceae; but this is not accepted here, pending further research of a different type.

Blechnaceae

Blechnum (4 - 5)

Brainea (1) - this genus could well be included within *Blechnum* as it hardly differs in features of generic significance, but is tentatively maintained here for

convenience.

Doodia (1)

Stenochlaena (1)

Woodwardia (1)

Azollaceae - maintained here as separate from *Salviniaceae* in contrast to Smith et al. (2006) due to its very distinctive morphology.

Azolla (1, plus 1 widespread adventive species)

Salviniaceae - Smith et al. (2006) associated *Marsilea*, *Salvinia* and *Azolla* in one order, but it is conceivable that their molecular relationship might not be a systematic one and it is not followed here.

Salvinia (2, plus 1 widespread adventive species)

CORRECTIONS TO '*TAXONOMIC REVISION OF 300 INDIAN SPECIES*'

Mrs. Katherine Challis, Editor of IPNI (database at *www.ipni.org*) has most kindly pointed out to the present author that due to various factors not noticed by him, a few changes are unfortunately necessary to the nomenclature adopted in the author's revision of Indian ferns and Census-List (Fraser-Jenkins 2008b). These are added here in order to avoid incorrect nomenclature from becoming widely used. Note that the correct abbreviation for the present author's name should be Fras.-Jenk., not Fraser-Jenk., as mistakenly listed by Brummitt & Powell (1992) and unfortunately thence by Pichi Sermolli (1996).

1. ***Pichisermollia*** Fras.-Jenk. is a later homonym of *Pichisermollia* H.C.Monteiro, a genus of family Palmae, which was overlooked. The new name for this fern genus is therefore ***Pichisermollodes*** Fras.-Jenk. & Challis, ***nom. nov.*** for *Pichisermollia* Fras.-Jenk., *Tax. Rev. Three Hundred Ind. Subcont. Pterid.*: 48-49 (2008), *non* H.C.Monteiro. The following combinations are made :

Pichisermollodes ebenipes (Hook.) Fras.-Jenk., ***comb. nov***., basionym: *Polypodium ebenipes* Hook., *Sp. Fil.* **5**: 88 (1863).

Pichisermollodes subebenipes (Ching) Fras.-Jenk., ***comb. nov.***, basionym: *Phymatopsis subebenipes* Ching, *Act. Phytotax. Sinica* **9**(2): 193 (1964).

Pichisermollodes malacodon (Hook.) Fras.-Jenk., ***comb. nov.***, basionym: *Polypodium malacodon* Hook., *Sp. Fil.* **5**: 87 (1863).

Pichisermollodes nigrovenia (Christ) Fras.-Jenk., ***comb. nov.***, basionym: *Polypodium shensiense* Christ var. *nigrovenia* Christ, Bull. Acad. Int. Géogr. Bot. Le Mans **15**: 106 (1906).

Pichisermollodes veitchii (Baker) Fras.-Jenk., ***comb. nov.***, basionym: *Polypodium veitchii* Baker, *Gard. Chron.*, n.s. **14**: 494 (1880).

Pichisermollodes erythrocarpa (Mett. *ex* Kuhn) Fras.-Jenk., ***comb. nov.***, basionym: *Polypodium erythrocarpon* Mett. ex Kuhn, *Linnaea* **36**: 135 (1869).

Pichisermollodes crenatopinnata (C.B.Clarke) Fras.-Jenk., ***comb. nov.***, basionym:

Polypodium crenatopinnatum C.B.Clarke, *J. Linn. Soc.*, Bot. **25**: 99, *t.* 42 (1889).

Pichisermollodes quasidivaricata (Hayata) Fras.-Jenk., ***comb. nov.***, basionym: *Polypodium quasidivaricatum* Hayata, *Mater. Flor. Formos.*: 446 (1911).

Pichisermollodes connexa (Ching) Fras.-Jenk., ***comb. nov.***, basionym: *Phymatodes connexa* Ching, *Bull. Fan Mem. Inst. Biol.*, n.s. **1**: 306 (1949).

Pichisermollodes stewartii (Bedd.) Fras.-Jenk., ***comb. nov.***, basionym: *Pleopeltis stewartii* Bedd., *Ferns Brit. India*: *t.* 204 (1867).

Pichisermollodes tibetana (Ching & S.K.Wu) Fras.-Jenk., ***comb. nov.***, basionym: *Phymatopsis tibetana* Ching & S.K.Wu, *Flora Xizangica* **1**: 325 (1983).

Pichisermollodes albopes (C.Chr. & Ching) Fras.-Jenk., ***comb. nov.***, basionym: *Polypodium albopes* C.Chr. & Ching, Bull. Dept. Sunyatsen Univ. **6**: 15 (1933).

2. ***Selliguea triphylla*** (Jacq.) Fras.-Jenk. (2008: 45), from S. Africa, is a later homonym of *S. triphylla* Christ. Jacquin's accurate and carefully drawn plate is an obvious and exact match for the S. African species (as found by Kunze 1847, and see Nooteboom 1998), and is entirely dissimilar to any of the species from Java or Sri Lanka, where it was said to have come from, which was undoubtedly in error. The S. African species has been misplaced in *Microsorum* and slightly less so in *Marginaria* (which is a synonym of *Pleopeltis*), but Roux (1999) has shown that it belongs to the genus *Polypodium* (in a slightly wide sense) and is not at all a *Selliguea*, as the present author had thought superficially, nor can it be combined with *Pleopeltis* on morphological grounds (in contrast to Schneider et al. 2004b). It should therefore to be known as *Polypodium triphyllum* Jacq. (syn.: *P. ensiforme* Thunb., as used by Roux 1999, who placed it generically). But further study to find its closest relatives within *Polypodium* would be desirable as they might eventually suggest a relationship to *Microphlebodium* or some other group, rather than to *Polypodium* in a strict European sense. Roux (pers. comm. Aug. 2009) suggests that it may be related to S. American polypodioid species.

3. Due to a typing error in the author's script the herbarium for the holotype of *Athyrium* x *langtangense* Fras.-Jenk. (2008: 222) was inadvertently omitted, rendering the name invalid. It is therefore validated here with the type at the Botanical Museum, Helsinki, H:

Athyrium* x *langtangense Fras.-Jenk., *hybr. nov.* (*A. anisopterum* Christ x *A. micropterum* Fras.-Jenk.). *Planta hybrida, morphologia intermedia inter A. anisopterum et A. micropterum, sua parentes praesumptivi. Lobi pinnarum maiores quam in A. micropterum, sed apices loborum acuti et dentati. Sporae abortivae.* Holotype, here designated: C. Nepal, Rasuwa District: Domen to Bompu, S. side of Langtang river, between Syabrubensi and bridge below Lama Hotel, lower Langtang valley, in forest, 1600-2200 m., *C.R. Fraser-Jenkins* 29242 (F.N. 5217), 21 Aug. 2001 (H).

4. Concerning the combination, ***Colysis decurrens*** (Blume) Panigrahi, a synonym of *Leptochilus decurrens* Blume, it appears that Panigrahi's publication was effective (correction to Fraser-Jenkins 2008: 63) as the Symposium catalogue concerned was sent to Kew and other places. The same combination was also made later by Manickam & Irudayaraj in 1997, while the combination *Colysis decurrens* (Wall. *ex* Hook. & Grev.) Nakaike, a synonym of *C.* [or *L.*] *elliptica* (Thunb.) Ching, was also later than Panigrahi's as it was published in 1992, cited incorrectly as 1991 in *Index Filicum* Suppl. **7** due to a confusion with Panigrahi's page reference and date. Although most Indian subcontinental species of *Leptochilus* have at some stage been combined in *Colysis*, partly through misunderstanding that *Leptochilus* cannot be so synonymised, the actual situation is that most or all *Colysis* species belong to *Leptochilus*.

5. *Lygodium andamanicum* R.D.Dixit, Bhadari & Mukhopadhyay is a normal specimen of *L. salicifolium* C. Presl, with dimensions given incorrectly.

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