A SUMMARY OF INDIAN CHEILANTHOID FERNS AND THE DISCOVERY OF *NEGRIPTERIS* (PTERIDACEAE), AN AFRO-ARABIAN FERN GENUS NEW TO INDIA

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ABSTRACT

A summary of Indian cheilanthoid ferns treated under nine genera includes three new names, *Notholaena dipinnata* Fras.-Jenk., *Cheilanthes bhutanica* Fras.-Jenk. & Wangdi and *Cheilanthes tibetica* Fras.-Jenk. & Wangdi, and five new combinations, *Cheilanthes nitidula* Hook. subsp. *henryi* (Christ) Fras.-Jenk., *Aleuritopteris bicolor* (Roxb.) Fras.-Jenk. & Dulawat, *Aleuritopteris subdimorpha* (C.B.Clarke & Baker) Fras.-Jenk. and *Notholaena muelleri* (Hook.) Fras.-Jenk. *Negripteris scioana* (Chiov.) Pic.Serm. (*Pteridaceae*), a close relative of both *Aleuritopteris* and *Chrysochosma*, was discovered by the second author in semi-arid conditions in the Kumbhalgarh and Sitamata Reserves of the Aravalli Hills in central Rajasthan, N.W. India, the first record for the Indian sub-continent. It was known previously only from N.E. Africa, Socotra and S. Arabia and is an Afro-Arabian species which, as now found, extends eastwards into the hills of the semi-arid region of W. India.

INTRODUCTION

The cheilanthoid ferns of India have at various times been placed in the families *Sinopteridaceae*, *Negripteridaceae*, *Cheilanthaceae* and *Hemionitidaceae*, but are now generally accepted as belonging to subfamily *Cheilanthoideae*, within *Pteridaceae*, with the other four families, among others, in its synonymy. The common term cheilanthoid is a vague and undefined one, though it should be recognisable to most fern-workers. The most obviously "cheilanthoid" ferns of India belong to nine genera, though various other genera are also allied or within Subfam. *Cheilanthoideae*, but are not dealt with here (see, for example, Tryon, Tryon & Kramer 1990). These nine genera with their Indian subcontinental species are as follows:

1. *Notholaena* R.Br., includes *Cosentinia* Tod., *Paraceterach* Copel. and *Paragymnopteris* K.H.Shing, perhaps also *Chrysochosma* (J.Sm.) Kümmerle. This genus has long been accepted internationally as typified by *N. marantae* (L.) Desv., following Christensen (1905) and subsequently the carefully reasoned work of Pichi Sermolli (1981, 1989). An apparent lectotypification by Smith (1875) merely used the word "type" in the sense of "typical species", or even "representative species" and in several other cases Smith cited species not included by the original author of a genus, or even cited more than one species after the word "type". His misuse of the word

"type" is therefore not acceptable as effective lectotypification. Christensen's proper lectotypification was also followed world-wide, including in N. America (Tryon 1956, 1964 *et al.*), but Tryon & Tryon (1980) subsequently reversed it in favour of his own local regional misapplication of the name *Notholaena* to the N. and C. American segregate-genus, *Chrysochosma* (J.Sm.) Kümmerle, on the basis that Smith's "lectotypification" was earlier, though that was then rejected by the International Committee for Nomenclature (Pichi Sermolli 1981), which Tryon did not mention again. He thus ignored the bulk of literature across four other continents of the Old World, which created considerable nomenclatural confusion, and was subsequently supported locally in the USA by Yatskievych & Smith (2003). The conservation of *Notholaena* with a conserved type, *N. marantae*, is therefore advisable to restore the *status quo ante* without any room for doubt and allow current Old World authors to continue using *Notholaena* in its usual sense. Neither the Australian genus *Paraceterach*, nor Shing's genus, *Paragymnopteris*, are accepted as replacing *Notholanea* for the eight well marked Old World species. *Notholaena*, in its traditional and present sense, and *Chrysochosma* are very close, critical genera, very difficult to define separately, and maintained largely on molecular grounds of unknown and possibly minor taxonomic significance. Their separability at a rank as high as genus is somewhat doubtful, despite being accepted in the USA, but if maintained, Pichi Sermolli (1989) has already made the great majority of necessary combinations for the New World species within *Chrysochosma*. *Notholaena* species are frequently exindusiate (without a pseudoindusium) and usually markedly hairy/scaly on the surfaces and axes; they often have the sori spreading down the veins from the margin, as a derivative from the marginal condition in many other cheilanthoid ferns. The five Indian subcontinental species are:

N. himalaica Fras.-Jenk. (1997) (syn.: *Gymnopteris vestita* (Hook.) Underw., shown to have been misplaced in that genus by Mickel (1974)). Simply pinnate, with slightly elongated-ovate, densely silky-hairy pinnae. Widespread throughout the W. and E. Indo-Himalayan region, except for the far west Himalaya; Tibet; and S.W. China.

N. borealisinensis (Kitag.) Fras.-Jenk. (1997) (probable syn.: *Gymnopteris bipinnata* var. *auriculata* (Franch.) Ching). China; newly reported from the Indian subcontinent in Bhutan (Thimphu, Taba, *CRFJ* 31573, 11 Oct. 2005, TAIF). Simply pinnate; distinguishable from *N. himalaica* by its smaller, cordate-based pinnae, narrowing slightly more to their apices and thus hastate-sagitate in shape.

Notholaena dipinnata Fras.-Jenk., ***nom. nov.*** for *Gymnopteris bipinnata* Christ, Not. Syst. (Lecomte) 1: 55 (1909), *non N. bipinnata* Liebm. The lower pinnae are again pinnate and the upper ones lobed. The relationship between this species and *N. borealisinensis* is unclear as some intermediate plants appear to connect them together, though not in the Indian subcontinent. They were therefore treated as two varieties by Ching, but it is not considered likely here that the two extremes could merely represent variation within a single species. The intermediates require further study. This species has not been found in India, as the record by Fraser-Jenkins (2008), from Arunachal Pradesh (Lohit. *B. Krishna* 48966, ASSAM) was in error for a scrumpled specimen of *N. borealisinensis*, but it is mentioned here to explain its separation from the previous species and because it occurs very near to the border in S.W. China.

N. marantae (L.) Desv. Sometimes stated to consist of three subspecies in Europe and Macaronesia, subsp. *marantae*, subsp. *subcordata* (Cav.) Benl & Poelt and subsp. *cupripaleacea* (Benl) Rivas Mart. *et al*., but these merely represent minor variation

within the species and are not considered here to be appropriately ranked as subspecies, or needing recognition. Cape Verdes; Morocco; Algeria; Ethiopia; Macaronesia; across S. Europe; the Caucasus and Turkey; Cyprus; Lebanon; Syria; Iran; Yemen; from the west to east Indo-Himalaya; Tibet; and S.W. China. *N. marantae* is diploid sexual, with $n = 29$, including from Uttarakhand, and a report by Khullar, Sharma & Verma (1988) of $n = 58$, from Jamunotri, Uttarakhand, is considered to have been in error (Fraser-Jenkins 1997: 184).

N. lanuginosa (Desf.) Desv. *ex* Poir. (syn.: *N. vellaea* (Aiton) Desv., non R.Br.; *Cosentinia vellaea* (Aiton) Tod.). Pichi Sermolli (1985) treated this species as a separate genus, *Cosentinia*, which he revived from earlier Italian literature, on the basis of its more trilete spores, but this has seldom been accepted. Morocco; Tunisia; Libya; Macaronesia; across S. Europe; Turkey; Cyprus; Lebanon; Syria; Israel; Yemen; Sudan; Iran; Afghanistan; Pakistan; N.W. India (Himachal Pradesh). A typical Mediterranean European element in the W. Himalaya. There are two subspecies, the tetraploid subsp. *lanuginosa*, which occurs throughout the range, excluding Pakistan and India, and the very closely similar, and cryptic diploid subsp. *bivalens* Reichst. (Badré & Reichstein 1983), apparently confined to Macaronesia, Spain and the Indian subcontinent.

A further species is the Chinese *N. sargentii* (Christ) Fras.-Jenk. (1997). Two additional Australian species, ***Notholaena muelleri*** (Hook.) Fras.-Jenk., ***comb. nov***., basionym: *Gymnogramma muelleri* Hook., *Sp. Fil*. 5: 143, *t*. 295 (1864), and *N. reynoldsii* F.Muell., were formerly placed in the genus *Paraceterach*, which was treated as endemic to Australia, but *N. marantae* and four other species were placed within *Paraceterach* by Tryon (1986) in order to accommodate his misapplication of *Notholaena*.

2. *Cheilanthes* Sw., which includes *Cheilosoria* Trevis. and *Mildella* Trevis., normally consists of efarinose species in Asia, with generally narrow stipe-scales and small segments. The 11 species present in the Indian subcontinent are:

C. pteridioides (Reichard) C.Chr. subsp. *acrosticha* (Balb.) O.Bolòs (syn.: *C. acrosticha* (Balb.) Tod.,). W. Himalaya westwards to Mediterranean S.W. Asia and Europe, N. Africa and the Cape Verdes Islands. Subsp. *pteridioides* (syn.: *C. fragrans* (L.f.) Webb & Berth., *non* Sw; *C. maderensis* R.Lowe; *Negripteris quezelii* Tardieu) occurs from Mediterranean S.W. Asia, west across Mediterranean Europe to Macaronesia and across N. Africa, but is not present in the Indian subcontinent or near to it. The two subspecies are different cytotypes with a close reticulate relationship and are very similar to each other, differing only in the length of the indusium. They have thus been much confused in earlier literature, usually under the name *C. fragrans*, which is illegitimate. Following the rejection by Committee of Nardi & Reichstein's (1986) proposal to reject *Polypodium pteridioides* Reichard, in order to preserve their nomenclature, the nomenclature of this critical complex is now stable at either the specific or subspecific rank.

C. persica (Bory) Mett. *ex* Kuhn (syn.: *C. szovitzii* Fisch & C.A.Mey.). Far N.W. Himalaya, ?Himachal Pradesh, W. Asia, E. Mediterranean Europe and N. Africa. The lamina bears many long, pale hairs beneath.

C. tibetica Fras.-Jenk. & Wangdi, ***nom. nov.***, for *Pellaea straminea* Ching, *Bull. Fan Mem. Inst. Biol.*, *Bot.*, 2: 203, *t.* 17 (1931), *non Cheilanthes straminea* Brause [= *Woodsia indusiosa* Christ] (syn.: *Mildella straminea* (Ching) C.C.Hall & Lellinger). S. and S.E. Tibet (type) and Bhutan. Newly reported here from the Indian subcontinent in

W. Bhutan (Chele La Pass, Ha District, *T. Wangdi*, *CRFJ* no. 31625, 12 Oct. 2005, THIM, TAIF, det. CRFJ). Specimens from S. Tibet by the N. Sikkim border and from Lhasa in Herb. Lloyd Botanic Garden, Darjeeling (!). Lamina pale-green, with long rather unlobed pinnules, a pale-brown stipe and rachis and hair-tipped, linear red-brown scales up the stipe; fronds deltate-lanceolate, bipinnate; indusia both short and long, arising at the curled over laminar edge rather than shortly within it as in other species formerly placed in *Mildella*.

C. nitidula Hook. subsp. *nitidula* (syn.: *Pellaea nitidula* (Hook.) Baker; *Mildella nitidula* (Hook.) C.C.Hall & Lellinger), from the W. Himalaya only, reaching eastwards to W. Nepal.

C. nitidula* subsp. *henryi (Christ) Fras.-Jenk., ***comb. nov.***, basionym: *Pellaea henryi* Christ, *Bull. Herb. Boissier* 7: 7 (1890) (syn.: *Mildella henryi* (Christ) C.C. Hall & Lellinger). N.E. India (Arunachal Pradesh), Bhutan (Thimphu, Taba, *CRFJ* 31496, 8 Oct. 2005, THIM, TAIF), S.E. Tibet, S. China (Yunnan (type), Szechuan, Kweichow, Kwangtung, Fukien), Taiwan, Vietnam. Reported from Namdapha, Arunachal Pradesh, by Singh & Panigrahi (2005) *sub Aleuritopteris albomarginata* (C.B.Clarke) Ching in error. Their drawing shows *A. albomarginata* from some other source, that being a higher altitude species they could not have found in the lower reaches of Namdapha they visited. However their photograph is of *C. nitidula* subsp. *henryi*, whose presence at Namdapha has been verified by CRFJ, from specimens previously cited by Chauhan (1996), but misreported by them as the Afro-Arabian *C. farinosa* (Forssk.) Kaulf. Very close to subsp. *nitidula* and differing only in the rachis hairs being denser and more prominent and sometimes extending further around the sides of the rachis and the smaller fronds with slightly less lobed pinna and pinna-lobes. This subspecies is a vicariant of subsp. *nitidula* and replaces it in the eastern part of its range. Previous records and collections of *C. nitidula* from further east referred to the present subspecies, which merges into it morphologically. The interesting bicentric range of this species is a well known distribution-pattern for species that prefer a somewhat drier climate and thus occur scattered behind the Himalayan line in the otherwise wetter parts of the central and east Himalaya.

C. opposita Kaulf. (syn.: *C. mysurensis* Wall. *ex* Hook., *C. fragrans* Sw.). Sri Lanka, S. India (N. to Orissa), S. China (Yunnan, Hainan, Kwangtung, Fukien), Taiwan, Myanmar and the Philippines. This beautiful species with narrow, upright and finely dissect, bright green leaves has been nomenclaturally confused until recently (see Fraser-Jenkins 1997), though its nomenclature was clarified by Alston (1936) and in detail by Fuchs (1961). Its range has sometimes been given as throughout China and other areas in error for the closely related, but less dissect *C. chusana* Hook.

C. tenuifolia (Burm.f.) Sw. Sri Lanka, through most of the Indian subcontinent except the N.W., China, Taiwan, S.E. Asia, Australia, New Guinea and Oceania. Although reported as diploid apomict by Verma (1961) it is now known that this species is tetraploid sexual in India and Sri Lanka, but like apomictic species produces only 32 spores per sporangium, as do several other sexually reproducing *Cheilanthes* species.

C. hancockii Baker. Newly reported from the Indian subcontinent, from Taba, Thimphu, Bhutan, *CRFJ* 31497, 8 Oct. 2005, THIM, TAIF; previous records from the E. Indo-Himalaya were in error for *Aleuritopteris bicolor*. S.W. China. ?N. Thailand (*C. delicatula* Tagawa & K.Iwats., which may otherwise be distinct).

C. belangeri (Bory) C.Chr. (syn.: *C. varians* Hook.). N.E. India, from Nepal eastwards; Bangladesh; Myanmar; S.E. China; Thailand; and S.E. Asia to the Philippines.

Reported from S. India by Beddome (1864) in error for *C. thwaitesii* (below), which he included within his concept of this species.
C. trichophylla Baker (syn.: *Pellaea trichophylla* (Baker) Ching; *Cheilanthes undulata* C.Hope & C.H.Wright). S.W. China. Reported tentatively by *S.C. Verma* in Mehra & Bir (1964), from the Kyangnosla pass, below Chhangu [Tsomgo] Lake, E. Sikkim (Verma, pers. comm. to CRFJ, 2004), but the specimen lost and unverified, though perhaps correctly recorded due to its distinct appearance, as recalled by Verma and illustrated in a drawing in his unpublished Ph.D. thesis of 1962 at Panjab University, Chandigarh. Distinctive zig-zag rachides and the axes and deeply tripinnatifid lamina densely covered in short yellowish-brown hairs.
C. bhutanica Fras.-Jenk. & Wangdi, ***nom. nov.***, for *Pellaea yunnanensis* Ching, *Act. Phytotax. Sinica* 20(2): 235 (1982), *non Cheilanthes yunnanensis* Brause [= *Aleuritopteris subvillosa* (Hook.) Ching]. China (Yunnan (type), Szechuan), Bhutan. Newly discovered from the Indian subcontinent by CRFJ as a common species of rocks and walls around Thimphu and elsewhere in W. Bhutan (Serbithang, *CRFJ* 31487, 8 Oct. 2005, with *T. Wangdi*; Taba, *CRFJ* 31570, 11 Oct. 2005; Paro, *CRFJ* 31596, 12 Oct. 2005, with *R. Pradhan* & *T. Wangdi*; Chuzzom, *CRFJ* 31676, 15 Oct. 2005, with *T. Wangdi*, THIM, TAIF). A small plant similar to a coarser-segmented and slightly less dissect *C. nitidula* with more deltate fronds and no hairs above the axes; sori and indusia continuous around the edges.
C. thwaitesii Mett. *ex* Kuhn (syn.: *Cheilanthes laxa* T.Moore *ex* Bedd., *nom. superfl.* for *C. thwaitesii*; *Cheilanthes keralensis* N.C. Nair & S.R. Ghosh, *Aleuritopteris thwaitesii* (Mett. *ex* Kuhn) Saiki). Sri Lanka (type) and South India; a Hindu-Lankan endemic. Type from Sri Lanka. This often overlooked species is important in illustrating that the presence or absence of farina is not confined to *Aleuritopteris*, but also occurs in some true *Cheilanthes* species.

3. *Aleuritopteris* Fée, formerly treated by most authors as *Cheilanthes* subgen. *Aleuritopteris* (Fée) W.C.Shieh, and all the species, except *A. stenochlamys* Ching *ex* S.K.Wu, have names in *Cheilanthes*. But it was recognised generically by Ching in Ching & Wu (1981, 1983) and subsequent Chinese workers and Saiki (1984). It appears likely that it constitutes a distinct, if probably heterogeneous entity, which being easily recognisable is practicably and usefully recognisable as a genus. The species are usually well-marked and readily distinguishable by their stipe-scales (bicolorous or concolorous) and their distribution up the axes, though most were at one time referred to the African and Arabian species, *A. farinosa* (Forssk.) Kaulf., which does not occur in Asia. The genus includes *Sinopteris* C.Chr. & Ching and *Leptolepidium* Ching & S.K.Wu (in the sense of its type species and also in the sense of Ching & Wu, which was based on a misapplication of the name *Cheilanthes dalhousiae* Hook.). It also has two sections, the first being the less dissect, more palmate species related to *A. argentea* (below) and the rest being the more pinnate species along the pattern of *A. farinosa*. Morphologically *Aleuritopteris* is slightly difficult to define in a way that distinguishes it from some species of *Doryopteris*, which are rather close to the *A. argentea* group, but are perhaps more likely to be related to the imparipinnate genus, *Pellaea*. Most species have rather wide segments and a strong white or yellow farina, with wide stipe-scales. Due to considerable lack of clarity and confusion, the cytology and reported aneuploid base-numbers for various species need to be carefully reinvestigated with accurate identification and preservation of voucher-specimens. The 18 species present

in the Indian subcontinent have mostly been detailed by Fraser-Jenkins (1992, 1993 and 1997) and are:

A. argentea (S.G.Gmel.) Fée (syn.: *A. flava* (Ching & S.K.Wu) S.R.Ghosh, *non* Saiki, *nec sensu* Ghosh [= *A. subargentea*]). Far N.E. India, a single collection of *J.D. Hooker & T. Thomson*'s from the Khasi Hills, Meghalaya (K!), might be correctly localised, but it has never been collected since in this generally well known area and is normally a higher-altitude, and usually higher latitude species. A similar case occurs with their collection at Kew of *Lycopodium annotinum* L. subsp. *alpestre* (Hartm.) Å. Löve & D. Löve, said to be from Khasia, but almost certainly from N. Sikkim. However *A. argentea* (S.G.Gmel.) Fée, which otherwise occurs in W., S.W., C., N. and E. China; Tibet; Taiwan; Korea; Japan; and Siberia, has now been discovered in Bhutan (Taba, near Thimphu, *CRFJ* 31500, 8 Oct. 2005, THIM, TAIF), and was previously collected from N. Lohit, at the Tibetan border in or on the border of Arunachal Pradesh (*F. Kingdon-Ward*, BM!). A further species, close to *A. argentea*, but without white farina and with small, narrow, less lobed segments has also turned up in N.E. Arunachal Pradesh (Changlang, Namdapha, Shirung to Hunung, c. 1100 m., *B.K. Shukla* 88207, 7 Feb. 1986, ASSAM, det. CRFJ). It appears to belong to the efarinose Chinese species, *A. shensiensis* Ching, though further comparative study may be required.

A. subargentea Ching *ex* S.K.Wu. Similar to *A. argentea* but slightly more dissect and the frond slightly more pinnately arranged, less palmate. Newly discovered in the Indian subcontinent (Marpha to Tukuche, Mustang, N.C. Nepal, *CRFJ* 30509, 27 June 2004, with *G. Tamang*, TAIF); Songgong, Sikkim, 1,400ft, *Ribu & Rhomoo Lepcha*, for *G.H. Cave* 7634, 4 Oct. 1923 (Herb. Lloyd Botanic Garden, Darjeeling!, det. CRFJ). Tibet; S.W. China.

A. tamburii (Hook.) Ching. N.C. Nepal; N. Sikkim; Meghalaya; Tibet and S.W. China. A very distinctive, large species of the *A. argentea* group, with wide, coarse lobes and bright white farina.

A. subvillosa (Hook.) Ching (syn.: *A. tenella* (Ching & S.K.Wu) Saiki). W. to E. Indo-Himalaya; Tibet; S.W. China. Efarinose, but closely related to the farinose *A. caesia* (Christ) Ching and *A. kuhnii* (Milde) Ching, from Tibet and S.W. or C. to N.E. China; Japan (the latter reported from India in error for *A. dalhousiae* by Dixit (1984)).

A. duthiei (Baker) Ching. W. Indo-Himalaya (very rare); N.W. Nepal; Bhutan. Efarinose, related to *A. leptolepis* (Fras.-Jenk.) Fras.-Jenk., but with a wider-triangular and more dissect lamina; both have wide, pale stipe-scales.

A. leptolepis (Fras.-Jenk.) Fras.-Jenk. (2008) (misapplied name: *A. dalhousieae* (Hook.) Ching, *nom. utrique rejic*.). The totally efarinose, higher-altitude species long known as *A. dalhousieae* ["*dalhousiae*"] in error due to Hooker's confusing the efarinose Summer (monsoon) fronds of *A. albomarginata* (below) with this species. W. to E. Indo-Himalaya; Myanmar; Tibet; S.W. China. Misreported sub "*C. dalhousiae*" *sensu auct. Ind*. by Dixit (1996) from Orissa, in error for *A. bicolor* with the powder washed off by alcohol during herbarium-poisoning.

A. rufa (D.Don) Ching. Common from the W. to E. Indo-Himalaya; also in S.W. China; Myanmar; Thailand. The fronds are lanceolate, narrowing slightly to the base, and the axes are densely covered with narrow, hair-like, fibrillose scales.

A. dubia (C.Hope) Ching (syn.: *A. subrufa* (Baker) Ching; *C. leveillei* Christ; *A. humatoides* Saiki; *C. wusukungii* Miyamoto & Ohba). Intermediate between the last and next species and sharing the same phytochemistry of its white flavonoid powder (Fraser-Jenkins & Wollenweber in prep.). W. to E. Indo-Himalaya; N. Western Ghats;

Myanmar; Tibet; S.W. and S. China; Taiwan; Thailand; the Philippines. Confused in China and reported as the next species.

A. albomarginata (C.B.Clarke) Panigrahi (syn.: *A. dalhousieae* (Hook.) Ching, *nom. utrique rejic*., *non sensu auct. Ind*.). Widespread at somewhat higher altitudes from the far W. to N.E. Himalaya; Orissa; N. Western Ghats; Tibet; S.W. China; Taiwan; Thailand; Vietnam. The fronds are deltate and instead of hair-like scales have bicolorous scales extending up the stipe, rachis and costae. The Summer (monsoon) fronds are taller and more developed and almost or quite without farina, unlike the smaller, basal Winter fronds.

A. chrysophylla (Hook.) Ching (syn.: *A. humatifolia* X.C.Zhang & L.Shi; *A. flavopygmaea* S.R.Ghosh). The only species with bright sulphur-yellow farina beneath in the Indian subcontinent. The W. Indo-Himalaya (Simla); C. Nepal to N.E. India; Myanmar; Tibet; S.W. China; Thailand.

A. formosana (Hayata) Tagawa (syn.: *C. brevifrons* (Khullar) Khullar). One of the most widespread species, frequently reported from China under the name *A. anceps* in error. W. Africa (Guinea); far W. to the E. Indo-Himalaya; Rajasthan (*C.S. Dulawat*, det. CRFJ); Uttar Pradesh; Bihar (Parasnath); Orissa; N.W. Ghats; Arunachal Pradesh; Tibet; S.W. and S. China; Taiwan; Myanmar; Thailand; the Philippines. It is fairly close to *A. anceps*, but has a narrower and usually smaller frond, which is characteristically bullulate-wrinkled above, and the slightly narrower, bicolorous stipe-scales extend up the rachis as well, but not (except rarely an odd one) onto the costae. The rachis usually bears scattered glands.

A. anceps (Blanf.) Panigrahi (syn.: *A. pseudofarinosa* Ching & S.K.Wu; *A. interrupta* Saiki; ?*A. javanensis* Saiki, *non C. javanensis* (Willd.) T.Moore). Widespread at lower altitudes in India *etc*., far W. to N.E. Himalaya; Rajasthan; N.W. Ghats; C. India; S. India; Sri Lanka; Tibet; S.W. China (rare); Taiwan; Myanmar; Thailand; ?Java; ?Timor. The lamina is deltate-lanceolate, but not as triangular and wide-based as in *C. bicolor* (below), and has a brighter white farina; the slightly wide, bicolorous stipe-scales do not normally extend above the top of the stipe.

A. dealbata Fée (syn.: *C. dealbata* D.Don, non Pursh; *A. doniana* S.K.Wu *ex* Ching, *nom. superfl*.; *C. doniana* Fras.-Jenk. & Khullar; *A. sikkimensis* S.R.Ghosh). E. part of the W. Himalaya (Uttarakhand); Nepal to N.E. India; Tibet; S.W. China; Myanmar; ??Thailand. This species is closely related to *C. anceps*, but has a longer, often very large frond and wider, less lobed segments, with narrower indusia, and a very bright white farina. The stipe-scales, though vaguely bicolorous, do not have such an obvious dark central stripe and tend to have a yellower basal region and slightly darker apical region. It was illustrated from Nagarjun, Kathmandu, Nepal, on the front dust-jacket by Fraser-Jenkins (1997).

A. bullosa (Kunze) Ching (syn.: ?*A. indica* Fée; *A. flaccida* (Bedd.) B.K.Nayar & S.Kaur; *C. flaccida* (Bedd.) Mehra & Bir, *non sensu* Mehra & Bir [= *A. bicolor*]). Sri Lanka and S. India. A very large species with long fronds, a bullulate upper surface, well lobed pinnules, thick stipes and concolorous red stipe-base scales.

A small-sized, more creamy-yellowish powdered segregate of *A. dealbata* from S. India (especially the Shevaroy Hills) is *A. wollenweberi* Fras.-Jenk. (2008), superficially similar to the Chinese, Taiwan and Japanese *A. krameri* (Franch. & Sav.) Ching.

A. stenochlamys Ching *ex* S.K.Wu. E. part of the W. Himalaya (Uttarakhand); Nepal; Bhutan; Manipur; Tibet, S.W. China. This rare, high-altitude taxon is closely related to *A. grisea* and is perhaps of slightly doubtful status, requiring further study, though

possibly a good species. Fraser-Jenkins previously confused its type and used the name *C. stenochlamys* for it in error.

A. grisea (Blanf.) Panigrahi, *non sensu* Panigrahi (syn.: *A. platychlamys* Ching; *C. platychlamys* (Ching) Fras.-Jenk.). A high-altitude Himalayan species with concolorous red stipe-scales; widely misrecorded from C. or S. India and Orissa by Panigrahi (1965) and Dixit (1996) in error for *A. formosana* among other species. Far W. to E. Indo-Himalaya; Tibet, S.W. China; Taiwan.

A. bicolor (Roxb.) Fras.-Jenk., ***comb. nov***., basionym: *Pteris bicolor* Roxb. in Griff., *Calcutta J. Nat. Hist*. 4: 507 (1844) (syn.: *Cheilanthes farinosa* var. *tenera* C.B.Clarke & Baker; *C. bicolor* (Roxb.) Griff. *ex* Fras.-Jenk.; *A. bicolor* (Roxb.) Punetha & Kholia, *comb. inval*., *sin. basionym*; *A. kathmanduensis* Ching & S.K.Wu; misapplied name: *Cheilanthes farinosa sensu auct. Ind. plur*., Blanf. *et al.*, *non* (Forssk.) Kaulf.). A very common and widespread, rather low-altitude species in India. W. Africa (Nigeria, Jos); far W. to N.E. Indo-Himalaya; Rajasthan; Bihar (Parasnath); C. India; Orissa; S. India; Bangladesh; Myanmar; ?Thailand; Laos. A similar taxon, but more delicate and with russet, concolorous stipe-base scales (like those of *A. subdimorpha*) occurs in Sumatra. There is some apparent transition, or some intermediate taxon, between the otherwise highly distinct *A. bicolor* and *A. anceps* (and also somewhat towards *A. subdimorpha*) in S.E. Bangladesh (Chittagong Hills), S. India, Myanmar, S.E. China and ?New Guinea (Papua). But it is not yet clear why this should appear to be so.

A. subdimorpha (C.B.Clarke & Baker) Fras.-Jenk., ***comb. nov.***, basionym.: *Cheilanthes farinosa* (Forssk.) Kaulf. var. *subdimorpha* C.B.Clarke & Baker, *J. Linn. Soc*., *Lond*. 24: 411 (1888) (syn.: *Cheilanthes subdimorpha* (C.B.Clarke & Baker) Hieron.; *A. longipes* Ching & S.K.Wu, *nom. inval*., *sin. typ*. (which is not *A. bicolor*, as tentatively thought by Fraser-Jenkins 1997, in the absence of the type); *C. longipes* (Ching & S.K.Wu) Dixit & Bal Krishna, *comb. inval*.; *A. pentagona* Saiki; *A. pseudoargentea* S.K.Wu). From C. Nepal eastwards to N.E. India; Arunachal Pradesh; Manipur; abundant in Meghalaya; ?Bangladesh; Myanmar; Thailand; S.W. to S.E. China; Vietnam. This rather little known species is generally similar to *C. bicolor*, but has a longer, thicker stipe, shorter and more coarsely lobed lamina and concolorous, russet stipe-scales.

4. *Negripteris* Pic.Serm. is closely similar to *Aleuritopteris* but differs in having only rather few (1-4) sporangia per sporangium (also shown by some *Aleuritopteris*), which are rather deeply embedded in the laminar powder ("subsessile") and an apparently primitive, large sporangium, without a definite stomium area and a very broad annulus with all its walls thickened (indurated), including the outer one, appearing like a solid, dark cap to the sporangium. During dehiscence, the sporangium splits laterally and the whole annulus or top half of the sporangium falls off to release the spores. This may be a retained adaptive feature connected with a very dry climate, allowing protection of the developing sporangia against desiccation. However, on the strength of this hypothetically being supposed to be a very primitive characteristic Pichi Sermolli not only raised a new genus, but even a new family for the single specimen he had seen (which was undoubtedly and obviously mistaken), despite pointing out its evident similarity to *Aleuritopteris*. In all its other features it is not separable from *Aleuritopteris* in its concolorous, lanceolate, pale-reddish stipe-scales, frond-shape, white farina beneath and shallow, interrupted pseudo-indusia formed by the leaf-margin. Weatherby (1948) pointed out tendencies within what is now *Chrysochosma*

from N. America, towards a similar annulus and embedded sporangium, and pointed out the likeness of *N. scioana* to some "*Notholaena*" species (*i.e*. *Chrysochosma* spp.). While not in any way invalidating the genera *Aleuritopteris* and *Notholaena*, it must be said that a few species in either genus can hardly be distinguished morphologically from the other genus. The likelihood is therefore that *Negripteris* is either an *Aleuritopteris* or a *Chrysochosma*, or may perhaps be nearer to an ancient ancestor of both. However it is maintained here as a somewhat dubious genus, resting on its peculiar sporangia, pending further study. *A. rosulata* (C.Chr.) Ching (syn.: *A. pygmaea* Ching), from Tibet and S.W. China, has similar scales and lamina (with the lobes rather broadly joined at their bases and fusing at the apex as in *Negripteris*) and appears to be very close to it, but without the characteristic sporangia. A rare S.W. Chinese species, *A. sichouensis* Ching & S.K.Wu, is again similar and by definition only would most probably be placed in *Chrysochosma*.

N. scioana (Chiov.) Pic.Serm. (syn.: *Mohria scioana* Chiov.; *Negripteris tricholepifera* Pic.Serm.). An Afro-Arabian species, formerly known from N.E. Africa and South Arabia only; Ethiopia, Sudan, Somalia, Socotra (also seen there by the first author in 1967), N. Kenya, Yemen, Saudi Arabia. To this must now be added a remarkable discovery of it from W. India in the semi-arid hills of Rajasthan. Last year, Dr. C.S. Dulawat (the second author) sent the first author material of his Rajasthan *Aleuritopteris* for identification and most surprisingly there was some fine, unidentified material of typical *Negripteris scioana* (Chiov.) Pic.Serm. among them that he had collected from the Kumbhalgarh and Sitamata Sanctuaries, Aravalli Hills and Chittorgarh, Rajasthan. This discovery is of considerable phytogeographical interest as it was otherwise only known to be in N.E. Africa and S. Arabia and fits in with a small handful of other Afro-Arabian connections in Western India, mainly in Rajasthan. The photograph purported to be *Cheilanthes albomarginata* C.B.Clarke *sensu lato* published by Chaudhary & Khichi (2007) is actually of the tip of the frond of *Negripteris* from Sitamata. Specimens collected are:

1. Rajasthan, Sitamata Wild Life Sanctuary, Ambaretti, crevices of rocks, 500-800 m. *C.S. Dulawat* CSD/SM/05-147, 14 Oct. 2005, Herb. Botany Dept., M.L.S. University, Udaipur.

2. Rajasthan, Sitamata Wild Life Sanctuary, Ambaretti, crevices of rocks and bank of *nalah* [stream], c. 500-800m. *C.S. Dulawat* CSD/SM/06-197, 5 Oct. 2006, Herb. Botany Dept., M.L.S. University, Udaipur.

3. Rajasthan, Khumbhalgarh Wild Life Sanctuary, Ranakpur Ghat, crevices of rocks, 550-800 m. *C.S. Dulawat & B.L. Chaudhary* CSD/SM/05-183, 23 Oct. 2005, BSD.

5. *Doryopteris* J.Sm. Characterised by the long, uninterrupted sori and often palmate fronds, but though widely and usefully accepted, is difficult to define exclusively, especially in relation to the *Aleuritopteris argentea* group, which also contains some efarinose species. Two species occur in the Indian subcontinent:

D. concolor (Langsd. & Fisch.) Kuhn (syn.: *Doryopteris geraniifolia* (Raddi) Klotzsch). S. and C. America; Africa; Sri Lanka; S. India (N. to Orissa); S. China; throughout S.E. Asia; Australia; Oceania. *D. kirkii* (Hook.) Alston from Africa has occasionally been reported from India in error for *D. concolor*, but is anyway a somewhat doubtful taxon. The taxonomic position of this fern has long been in some doubt as it is very similar to an efarinose member of the *Aleuritopteris argentea* group

and has often been placed in *Cheilanthes*. Pending further study, including molecular DNA work, it is maintained here in *Doryopteris*, where it appears most likely to belong and has more usually been placed.

D. ludens (Wall. *ex* Hook.) J.Sm. A distinctive species with tall black stipes and black midribs and the horizontal frond varying from cordate to considerably and deeply palmate-pinnately lobed into long, narrow segments, the lowest lobe basiscopically lobed again and the fertile fronds taller and more narrowly lobed than the sterile. It occurs in Orissa (Dixit 1996) and from N.E. India eastwards; Assam; Manipur; Nagaland; Tripura; Mizoram; Bangladesh; Myanmar; S.W. and S. China; Thailand; and S.E. Asia. Hope (1901) reported it from Chitral, N.W. Pakistan, in error on the basis of a specimen given to him by General Gatacre, ostensibly collected during the Chitral Relief Military Expedition, at Kaffir Rock on the road S. of Ziarat, along with *Lygodium microphyllum* (Link) R.Br. The specimens of both species, along with drawings and a sketch-map provided by Gatacre are in DD (!) and are correct. But anyone who knows the Pakistan fern-flora (Fraser-Jenkins 1992, 1993) and who has been there, where Kaffir Rock still exists beside the main road into Chitral from the Lowarai Pass, would know that neither species could possibly occur there or anywhere within thousands of miles. The specimens were almost certainly collected during Gatacre's duty in Myanmar shortly previous to the Chitral expedition and seem most likely to have been more in the way of a "military prank", than due to confusion. It is surprising that such an experienced expert as Hope could possibly have swallowed it!

6. *Pellaea* Link, *nom. cons*. Although various species, including those subsequently placed in *Mildella* by Hall & Lellinger (1967) and now in *Cheilanthes*, have been put into *Pellaea* in the past because of their glabrous, efarinose segments with long sori, the genus is now confined to those species with imparipinnate fronds, the apical segment being similar to a lateral one. The species may be glabrous or hirsute. Ghosh (1985) claimed to have "done" the taxonomy of Indian *Pellaea* and listed 3 species, but the 5 species occurring in India are as follows:

P. falcata (R.Br.) Fée (syn.: *P. seticaulis* (Hook.) S.R.Ghosh). This species has simple, unlobed, elongated, nearly glabrous pinnae with a only few hair-like scales beneath, and a hairy and scaly stipe and rachis, similar in both Australasia and S. India. It is absent from Malaysia (given by Ghosh), Hooker's type-locality of "Penang" being in error for Lady Dalhousie's collection from Sri Lanka (from where it was reported by Sledge 1982), which was omitted by Ghosh (1985).

P. longipilosa Bonap. (syn.: *P. malabarica* B.K.Nayar & Geev.). Similar to *P. falcata*, but with narrow, tripartite lower and mid pinnae. Africa; S. India; confined to a few localities in Kerala. Though redescribed as if a new, endemic species, Fraser-Jenkins has reidentified it as being the African species, *P. longipilosa*, which is thus one of a rather small group of tropical African elements in S. India.

P. boivinii Hook. A rather small, bipinnate species with from 2 to 3 pairs of elongated ovate, articulated-stalked pinnules on the lower pinnae and all the axes densely covered in very short, dark, blackish-brown hairs. S. and E. Africa; Madagascar; Mascarenes; Sri Lanka (Sledge 1982, omitted by Ghosh 1985); and S. India. Another tropical African element in S. India.

P. viridis (Forssk.) Prantl. Another bipinnate species, with slightly larger, thinner and non-articulate-stalked, often biauriculate-based segments and glabrous axes. Adventive in S. India and Sri Lanka (Sledge 1982). Also naturalised in Australia and Oceania. S.

and E. Africa; Madagascar; and Yemen (type).
P. calomelanos (Sw.) Link *non Pityrogramma calomelanos* (L.) Link. (syn.: *P. hastata* (Thunb.) Prantl, *non* (L.) Thunb.). A rare and very seldom-collected species occurring in a few scattered localities in very dry rocky areas. The stalked leaf-segments are cordate-hastate and without scales, borne on glossy black costae. Africa; Pakistan (Swat; Hazara); Himachal Pradesh; Uttarakhand; W. Nepal; S.W. China. An Afro-Arabian element reaching the W. Himalaya.

7. *Pityrogramma* Link. The "silver ferns" and "gold ferns" of cultivation where they often spread by self-sporing. They are exindusiate and the sori spread along the veins and cover the whole surface beneath the segments. Four New World species are adventive in the Indian subcontinent:
P. calomelanos (L.) Link. The farina beneath the leaf, which is usually rather thin and weak, is white. S. and C. America. Adventive throughout the world in warmer climates and so abundant in even remote places throughout nearly all of the Indian subcontinent that it is sometimes difficult to remember that it is in fact an alien species not recorded before the later 19th Century.
P. austroamericana Domin (syn.: *Pityrogramma calomelanos* var. *austroamericana* (Domin) Farw.; *P. calomelanos* (L.) Kaulf. var. *aureoflava* (Hook.) Weath. *ex* F.M.Bailey; misapplied name: *P. chrysophylla* (Sw.) Link). The farina beneath the leaf is sulphur yellow. S. and C. America. A common adventive in Sri Lanka and S. India. In addition to the bright yellow powder, which is often lost in old specimens by treatment with alcohol (containing pesticides), it also has a shorter lamina with rather shorter and often less lobed segments. For some reason it has not reached N. India to date. It was first recognised as a separate species by Domin (1928, 1929) and detailed further in his later publications. The genus was monographed by Tryon (1962), and information was thence extracted by Panigrahi (1975) and from the determinations at Kew.
P. dealbata (C.Presl) R.Tryon. White farina, a small, thin lamina with well lobed and toothed segments. C. America. Adventive in Sri Lanka, but probably not well established.
P. sulphurea (Sw.) Maxon. Pale lemon-yellow, rarely white farina and the frond narrowed towards the base, with the ultimate segments cuneate-based and fanned out or flabellate at their strongly toothed apices. C. America. Adventive in Samoa and Sri Lanka, but probably not well established in the latter.

8. *Parahemionitis* Panigrahi. Following Mickel's (1974) establishing that the Indian species is not a true *Hemionitis*, and Tryon, Tryon & Kramer's (1990) clear statement that "*H. arifolia*" is not readily included in any genus, Panigrahi (1993) took it upon himself to utilise that information and make several attempts to interject a new generic name of his own for it (see Fraser-Jenkins 1997: 187-188), finally succeeding in validating one. *Parahemionitis* is therefore accepted here as the name for the genus and its single species-complex.
P. cordifolia (Roxb.) Fras.-Jenk. (misapplied name: *Hemionitis arifolia* (Burm.f.) T.Moore). Distinctive cordate-rounded leaves. N.E. India (Bihar; Assam; Manipur; Nagaland; Tripura; Mizoram); Sri Lanka; S. India; Bangladesh; Myanmar; S. China; Vietnam; Malesia; Philippines. The widespread Indian triploid cytotype may often be proliferous with small plantlets developing in the axil of the leaf during the wet season,

but dropping off during the dry season. A Chinese diploid, which is more delicate, is never proliferous (Huang, Manickam & Chiou 2007).

9. *Hemionitis* L. (syn.: *Gymnopteris* Bernh.; *Gymnogramme* Desv.). The detailed work carried out by Mickel and his colleagues (Mickel 1974, 1988, Gianassi & Mickel 1979, Ranker 1989) on this genus has been usefully summarised in Pichi Sermolli & Bizzarri's (2005: 66-68) final *magnum opus*. One species in the Indian subcontinent: *H. tomentosa* (Lam.) Raddi (syn.: *Gymnopteris tomentosa* (Lam.) Underw.) S. America. Adventive and very common in Sri Lanka.

CONCLUSION

The discovery of the African *Negripteris* in India is not only of considerable phytogeographical interest, but also suggests that further collection and study by Indian pteridologists with a specialist knowledge, able to recognise all the species they see, may reveal a number of other species hitherto overlooked in the subcontinent. The discovery of *Notholaena borealisinensis*, *Cheilanthes hancockii*, *C. bhutanica*, *C. tibetica* and *Aleuritopteris subargentea*, all previously unknown in the Indian subcontinent are further examples.

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