

THE GENUS ARTHROPTERIS J. SM. IN MALESIA

R. E. HOLTUM

Royal Botanic Gardens, Kew

Arthropteris is a small genus of the Old World tropics (and southwards to New Zealand) the affinity of which is not clear. It shares with *Oleandra* and *Elaphoglossum* the character of outgrowths from the rhizome (phyllopodia) to which the stipes of fronds are jointed, and also has peltate rhizome-scales comparable with those of both genera. One group of species closely resembles *Nephrolepis* in shape and articulation of pinnae and in form and position of sori, another group has the frond-form and soral form of *Thelypteris*, and a third has sterile fronds so like those of *Teratophyllum* that they might be mistaken for that genus; the slender dorsiventral rhizome in all species is comparable with that of *Teratophyllum*, though the anatomy is different in detail. A remarkable feature, absent in all the other genera already mentioned, is the presence in *Arthropteris* of short multi-septate hairs essentially like those of *Ctenitis* and *Tectaria*; similar hairs occur in *Davallodes* (not in *Davallia*) and thus give a possible link with the *Davallia* group of genera (which all have dorsiventral rhizomes with articulated stipes, and peltate scales). The peculiar monotypic genus *Psammisorus* C. Chr. (Madagascar) shows features in common with *Arthropteris* and the Davallioid ferns. As regards spores, those of *Nephrolepis*, *Oleandra*, and *Davallodes* lack perispore, but a perispore is present in *Arthropteris*, *Ctenitis*, *Teratophyllum*, and *Elaphoglossum*.

The original species of *Arthropteris* was the exindusiate *A. tenella* (*Polypodium tenellum* Forst.) and the genus was described by John Smith in J. D. Hooker's Flora of New Zealand; Smith stated that there were also indusiate species which should be included in the genus. W. J. Hooker, however, did not recognize *Arthropteris*, and subsequently placed *A. tenella* in *Polypodium*, *A. orientalis* in *Nephrodium*, and *A. palisotii* in *Nephrolepis*. John Smith knew a large number of ferns as living plants under his care at Kew (a century ago he estimated that he had had a thousand species in cultivation, though doubtless not all at one time) and in distinguishing genera he took into consideration characters, noted from the living plants, which Hooker was not prepared to accept as significant for the purpose. I agree with Smith in accepting *Arthropteris* as a natural genus, and believe that its peculiar combination of characters may give significant hints as to inter-relationships among various groups of ferns, but it is not yet clear to me how such inter-relationships may best be formally expressed in a scheme of classification. *Arthropteris* is usually placed near *Nephrolepis*, but I do not think *Nephrolepis* is its nearest relative.

ARTHROPTERIS

J. Sm. in Hook. f., Fl. Nov. Zeland. 2 (1854) 43, pl. 82.

Rhizome slender, long-creeping and climbing, bearing projecting phyllopodia to which fronds are jointed; scales peltate; vascular structure dorsiventral. *Stipe* and rachis more or less densely covered with short multiseptate hairs. *Fronde*s simply pinnate, pinnae jointed to rachis, apex of frond a pinnatifid lamina continuous with rachis or pinna-like and jointed at its base; *pinnae* almost entire to deeply lobed, base more or less asymmetric

and often auricled on acroscopic side, veins once or more forked, basal acroscopic one usually pinnate in the auricle, others more or less pinnate where frond is deeply lobed. *Sori* at the ends of acroscopic branches of veins, indusiate or not; indusium, if present, reniform; spores with folded perispore.

Distribution: tropical Africa, Arabia, islands of Indian Ocean, Ceylon, southern Burma to Ryukyu Is, Malesia to Fiji, eastern Australia, New Zealand, Juan Fernandez.

KEY TO MALESIAN SPECIES

1. Phyllopodia 1—3 mm long, stipe to *c.* 10 mm; pinnae never lobed as much as half-way to costa; veins once forked; apex of frond a lobed lamina or a pinna jointed at its base; pinnae readily disarticulating from rachis.
 2. Sori nearer to edge than to costa, indusiate with entire indusium; pinnae on adult plants 3 cm or more long, 8 mm wide.
 3. Apex of frond a pinna jointed to rachis or (more rarely) a few-lobed triangular lamina continuous with rachis; fertile pinnae narrowed to apex, edges distinctly sinuous 1. *A. palisotii*
 3. Apex of frond a ± elongate narrowly triangular lamina lobed near its base only; fertile pinnae with slightly sinuous edges and broadly rounded apex. 2. *A. caudata*
 2. Sori about half-way between edge and costa, indusiate or not; pinnae of adult plants rarely over 2 cm × 5—6 mm; apex of frond always a deeply lobed triangular lamina.
 4. Sori exindusiate; upper surfaces glabrous 3. *A. repens*
 4. Sori indusiate, indusia hairy on edges; upper surfaces ± hairy 4. *A. beckleri*
1. Phyllopodia and stipe much longer; pinnae of adult plants lobed at least half-way to costa; veins often forked more than once; apex of frond a triangular deeply lobed lamina not jointed to rachis; pinnae imperfectly jointed to rachis.
 5. Pinnae lobed about half-way to costa; hairs on rachis and pinnae uniformly short
 5. *A. articulata*
 5. Pinnae lobed almost to costa; hairs 1 mm long on rachis and pinnae, also very abundant shorter hairs
 6. *A. wollastonii*

1. *Arthropteris palisotii* (Desv.) Alston, Bol. Soc. Broter. ser. 2, 30 (1956) 6; Tindale, Contr. N.S.W. Nat. Herb. Fl. Ser. 208—211 (1961) 11. — *Aspidium palisotii* Desv., Ges. Naturf. Berl. Mag. 5 (1811) 320. — *Aspidium ramosum* Beauv., Fl. Oware 2 (1821) 54, t. 91. — *Aspidium subpectinatum* Bl., Enum. Pl. Jav. (1828) 145. — *Aspidium sublobatum* Schum. in Kongel. Dansk Vid. Selsk. Naturvid. & Math. Afl. 4 (1829) 235. — *Nephrolepis ramosa* (Beauv.) Moore, Ind. Fil. (1858) 104; Bedd., Handb. Ferns Br. Ind. (1883) 284. — *Nephrolepis obliterated sensu* Hook., Spec. Fil. 4 (1862) 154 (*excl. syn. Nephrodium obliterated* R. Br.); Bedd., Ferns Br. Ind. (1864) t. 251. — *Arthropteris obliterated sensu* C. Chr., Ind. Fil. (1905) 62, *excl. syn. R. Br.*; v. A. v. R., Handb. (1908) 155; Suppl. (1917) 133; Backer & Posth., Varenfl. Java (1939) 88. — *A. glabra* Copel. in Perkins, Fragm. Fl. Philip. (1905) 178; Copel., Polypod. Philip. (1905) 46; v. A. v. R., Handb. (1908) 155; Copel., Fern Fl. Philip. (1960) 190. — *A. oblanceolata* v. A. v. R., Bull. Jard. Bot. Btzg II, 20 (1915) 6; v. A. v. R., Handb. Suppl. (1917) 134.

Rhizome-scales very dark, appressed, to 1 mm long, base round, apex acuminate; phyllopodia 1—3 mm long, stipe 7—10 mm. *Frond* to 45 cm long; rachis densely hairy beneath, hairs *c.* ¼ mm, upper surface similarly or less hairy; pinnae to *c.* 40 pairs below few-lobed triangular apex or terminal pinna, lower pinnae gradually reduced, lowest much deflexed; *middle pinnae* at right angles to rachis, sessile, to *c.* 3.2 cm long, 8—9 mm wide above auricled base, basisopic base very narrowly cuneate, acroscopic truncate and auricled, edges where sterile entire, where fertile regularly undulate, apex ± narrowed, rounded to bluntly pointed; veins oblique, forked, basisopic branch running almost to edge in one of the waves, pinnate in auricle; costa rather sparsely hairy on lower

surface with a few hairs on veins, more densely hairy on upper surface. Sori nearer to edge than to costa, indusiate; indusia entire, reniform.

Distribution: West & East trop. Africa, Mascarene Is., Ceylon, southern Burma to Ryukyu Is., Malesia to Queensland and Fiji.

SUMATRA. *Hancock* 85, Barisan Range (K); *Bünnemeijer* 9044, G. Koerintji 1500 m (L); *Lörzing* 5831, Bandarbaroe, 850 m (L); *Lörzing* 15169, Sibajak, 1300 m (L).

MALAY PENINSULA. *Molesworth Allen* 4649, Cameron Highlands Rd, 600 m (K).

JAVA. *Zollinger* 2219, 2812 (L); *Ernst* 987, Gedeh (K); *Koorders* 20740, Besoeeki; *Mousset* 1002, Tengger Mts, 1300 m; *Mousset* 123, same loc.; *Rosenst. Fil. Jav. Or. Exsic.* 33, Tengger Mts, 700 m (*Mousset*); *Posthumus* 582, Zuidergebergte, 600 m; *Backer & Posthumus* 659, Djember, 600 m; *Danser* 5782, Tjibodas; *Palmer & Bryant* 1262, 1059, Tjibodas; *Posthumus* 1805, Mt Dorowati, 1550 m.

BALI. *Posthumus* 3716, nr Gilgit, 1400 m.

TANIMBAR Is. *Buwalda* 4711, 4203; *Pleyte* 173.

CERAM. *De Vriese & Teysmann* 235.

BURU. *Toxopeus* 294, 348.

SOELA Is. Obi, *Saanan* 1 (type of *A. oblanceolata*, L).

SUMBAWA. *Kostermans* 18333, 700—800 m; 18737, 500—700 m.

PHILIPPINES. *Merrill* 740, Palawan (type of *A. glabra* Copel.); *Merill* 1307, Palawan; *Edaño* PNH 16628, Luzon; *Ramos & Edaño* BS 34053, Luzon; *Sulit & Conklin* PNH 17260, 32929, Mindoro; *Macgregor* BS 32517, Panay.

NEW GUINEA. West: *Versteeg* 1023. — Papua: *Brass* 8034, Lower Fly River; *Cheesman* 72, Shurava, 900 m; 139, Mafulu, 1500 m; *Carr* 11770, Kanosia. — Northeast: *Womersley* NGF 11845, Morobe Distr., 100 m; *Brass* 32388, Eastern Highlds, 1370 m; *Schlechter* 17884, Kani-geb.; *Womersley & Millar* NGF 8540, Western Highlds, 900 m; *Rosenst. Fil. Novog. exsic.* 98 (*Bamler*).

As pointed out by Carruthers (in Seem., Fl. Vit. 361, 1873), *Nephrodium oblitteratum* R. Br. is quite distinct from *Aspidium ramosum* Beauv., and Hooker's description under *Nephrolepis oblitterata* applies wholly to the latter. This statement was overlooked by Christensen. The identification of *A. ramosum* with the still older species *A. palisotii* is due to Alston.

2. *Arthropteris caudata* Rosenst., Fed. Rep. 8 (1910) 163.

Rhizome scales dark, with close glandular marginal papillae; phyllopodium and stipe very short; *frond* to 40 cm long, pinnate with apical lamina 7—10 cm long the lower part only of which is sometimes lobed; *pinnae* 30 or more pairs, middle ones to $2\frac{1}{2} \times 1$ cm, basicopic base narrowly cuneate, acroscopic base truncate, hardly auricled, edges entire or where fertile very slightly sinuous, veins once forked (apart from basal acroscopic vein). Sori near edge, indusiate, indusium entire.

Distribution: Eastern New Guinea.

E. NEW GUINEA. *Rosenst., Fil. Novog. exsic.* 92, Sattelberg, 900 m (*Bamler*); *Carr* 13070, Boridi, 1500 m.

This is very near *A. palisotii*, but *Bamler's* specimen is distinct enough. *Carr's* is similar in shape and size of pinnae but the apex of the frond has a smaller lamina; the rhizome-scales are not well preserved.

3. *Arthropteris repens* (Brack.) C. Chr., Bishop Mus. Bull. no 177 (1943) 48. — *Nephrolepis repens* Brack., U.S. Expl. Exp. 16 (1854) 209 — *Arthropteris oblitterata sensu* Copel., Bishop Mus. Bull no 59 (1929) 84, p.p.

Phyllopodia 1—2 mm long, scales about as in *A. palisotii*; stipe 5—7 mm long, glabrous apart from very small appressed round scales; *rachis* hairy on lower surface, hairs $\frac{1}{2}$ mm long, spreading, glabrous on upper surface. *Frond* to 35 cm long, 4—5 cm wide; *pinnae* to c. 35 pairs, lower few pairs reduced and lowest deflexed, upper ones more gradually

reduced and merging into lobes of triangular apical lamina $1\frac{1}{2}$ —2 cm long; *middle pinnae* spreading, 2—2.4 cm \times 5—6 mm, basiscopic base very narrowly cuneate, acroscopic truncate and distinctly auricled; edges almost entire in sterile pinnae, regularly sinuous in fertile; apex rounded to bluntly pointed, costa beneath rather sparsely hairy, hairs as rachis, pinnae otherwise glabrous; veins as in *A. palisotii*. *Sori* about midway between costa and edge, at end of acroscopic vein-branch, exindusiate.

Distribution: N. Borneo, New Guinea; Samoa, Fiji.

N. BORNEO. *Clemens 27303, 29568*, Mt Kinabalu, 1500 m.

NEW GUINEA. Northeast: *Blackwood 194*, Morobe Distr., 1500 m. — Papua: *Cheesman 75, 76*, Shurava, 900 m; *Crutwell 1187*, Milne Bay Distr., 1050 m.

Brackenridge described his species as having an entire indusium, but I cannot detect any such on specimens from Fiji and Samoa, and Christensen also found specimens to be exindusiate. An indusiate specimen from Fiji, labelled *A. repens*, seems to me to be intermediate between *A. repens* and *A. palisotii*. As Christensen remarked, this species is very near *A. beckleri*.

4. *Arthropteris beckleri* (Hook.) Mett, Novara Reis. Bot. 1 (1870) 213; Tindale, Contr. N.S.W. Nat. Herb. Fl. Ser. 208—211 (1961) 10. — *Polypodium beckleri* Hook., Spec. Fil. 4 (1862) 224. — *Arthropteris obliterated sensu* Copel., Fern Fl. Philip. (1960) 190 (*p.p.?*).

In general aspect similar to *A. repens* differing as follows: hairs on both surfaces of rachis lax, more than $\frac{1}{2}$ mm long; middle pinnae *c.* 15 \times 4 mm, apex rounded; costae and veins beneath hairy as rachis, also scattered hairs present on upper surface; sori indusiate, indusia small, edges and surface bearing slender hairs nearly $\frac{1}{2}$ mm long consisting of 3—4 cells.

Distribution: N.E. Australia, Philippines.

PHILIPPINES. *R. S. Williams 2445*, Mt Apo, Mindanao; *Elmer 10677*, Mindanao (sterile); *Copeland PPE 83*, Luzon, 600 m; *Elmer 7971, 16323*, Luzon; *Cuming 101*, Luzon.

The Kew specimen of *Cuming 101* has old sori which have lost their indusia, but I believe it represents this species; it was distributed under the unpublished name *Nephrolepis trichomanoides* J. Sm. Philippine specimens differ from Australian ones in having only marginal hairs on indusia, and in less abundant marginal glands on rhizome-scales.

5. *Arthropteris articulata* (Brack.) C. Chr., Ind. Fil. Suppl. III (1934) 26. — *Lastrea articulata* Brack., U.S. Expl. Exp. 16 (1854) 191, t. 26, f. 1; Copel., Bishop Mus. Bull. no 93 (1929) 85. — *Nephrodium webbianum* Hook., Spec. Fil. 4 (1862) 85. — *Nephrodium albo-punctatum* Desv. var. *fijianum* Hook., Spec. Fil. 4 (1862) 85. — *Polypodium harpophyllum* (non Kze) Christ, Ann. Jard. Bot. Botz 15 (1898) 150, pl. XVI, 22a, b. — *Arthropteris kingii* Copel., Philip. J. Sci. Bot. 6 (1911) 80; v. A. v. R., Handb. Suppl. (1917) 133; Copel., Philip. J. Sci. 73 (1940) 356. — *Arthropteris dolichopoda* v. A. v. R., Nova Guinea 14 (1924) 5. — *A. webbiana* (Hook.) Alston, J. Bot. 77 (1939) 288.

Rhizome-scales c. 2 \times 1 mm, not closely appressed; *phyllopodia* and stipe about equal, together 3—10 cm; *phyllopodia*, stipe, and rachis bearing throughout close short septate hairs. *Fronde*s to 35 cm long, apical lamina triangular, deeply many-lobed and grading into upper pinnae; *middle pinnae* 2—3 $\frac{1}{2}$ cm \times 5—8 mm, lobed half-way to costa (on smaller fronds rather less than half-way), base asymmetric with auricle on acroscopic side; veins more or less pinnately branched in larger lobes; hairs like those of rachis

scattered on costa and veins of both surfaces, also on lamina especially near edges of upper surface. *Sori* 1—3 to a lobe, indusiate, indusium with glandular edge.

Distribution: N. Celebes, Moluccas, New Guinea, Fiji.

MOLUCCAS: *Curtis s.n.* (K). Halmahera: *Pleyte 273*, 300 m; *292*, 600 m. — Amboina: *Herb. Webb*, probably coll. *Labillardière* (type of *N. webbianum*, K). — Ceram: *Rutten 2050*, W. Tana, 100 m. — Morotai: *Lam 3502*, 80 m. — Aru Is.: *Buwalda 5163*, P. Kobroor, limestone forest.

NEW GUINEA. West: *Lam 934, 1172*, Mamberamo R., 80—90 m; *Lam 1283*, Doorman R., 200 m; *Docters v. Leeuwen 9850, 10063, 10068*, Rouffaer R., 175 m; *Pulle 279*, v. d. Sande R.; *Pulle 1241*, Lorentz R., 40 m; *Brass 13755*, Idenburg R., 60 m; *Brass 13052*, Idenburg R., 850 m; v. *Royen & Sleumer 7839*, Vogelkop Penin., Isjin valley, 700 m. — Papua: *Brass 23469*, Mt Dayman, 500 m; *Brass 7059*, Palmer R., 100 m. *Gray & Floyd NGF 8078*, Gulf Div.; *Carr 12290*, Koitaki, 450 m; *Cheesman 118*, Kokoda, 360 m. — Northeast: *Schlechter 16327*, near Kelel, 250 m; *Schlechter 18133*, Finisterre Mts; *Ledermann 8161*, Sepik-gebiet; *Brass 29443* Gurakor, Morobe Dist., 640 m.

This species has been united by some authors with *A. orientalis* (syn. *Nephrodium albo-punctatum*) of Africa, Arabia, and Madagascar, but the latter is distinct in the following characters: bases of pinnae subequal; large circular white calcareous scales present at apices of veins on upper surface; rhizome-scales almost circular, rather large and overlapping, thin and brown with dark centre.

The type of *N. webbianum* is small, and the pinnae lobed hardly half-way to costa, but is certainly conspecific with large specimens from New Guinea. Fiji specimens on the whole are larger than those from New Guinea and dry a paler colour; as regards colour, specimens from New Guinea are variable, and some approximate to the Fiji condition. Differences in colour of dried specimens may be due in part to method of drying.

6. *Arthropteris wollastonii* (Ridl.) Holttum, *comb. nov.* — *Polypodium wollastonii* Ridl., *Trans. Linn. Soc. II Bot.* 9 (1916) 262. — *Arthropteris orientalis* [non (Gmelin) C. Chr.] Copel., *Fern Fl. Philip.* (1960) 190.

Rhizome-scales to 2×1 mm, with rounded apex, rather thin; *phyllopodium* $4\frac{1}{2}$ —10 cm, stipe 3—4 cm; *frond* 30 cm long; free pinnae 12—15 pairs below a long, deeply lobed, triangular apical lamina; *rachis* densely covered with spreading, blunt, very short, 2—3-celled hairs (hardly $\frac{1}{8}$ mm long), with scattered lax multiseptate hairs 1 mm long. *Largest pinnae* 6.5×1.2 cm, acuminate, lobed almost to costa, lobes very oblique, entire, bluntly pointed, c. $2\frac{1}{2}$ mm wide, basiscopic basal lobe half length of acroscopic and more oblique to costa; veins pinnate in all but distal smaller lobes, hydathodes at ends of veins not conspicuous; both surfaces of costae and veins bearing scattered long hairs as rachis, also spherical glandular hairs, glandular hairs also on both surfaces between veins. *Sori* 1—3 to a lobe, at ends of veins, indusiate; indusium as in *A. articulata*.

Distribution: New Guinea, Mindanao.

NEW GUINEA. West: *C. B. Kloss s.n.*, Feb. 1913, Mt Carstensz, Camp III, 870 m (type, K); *Pulle 344*, van der Sande R. (L). — D'Entrecasteaux Is: *Brass 27167*, Fergusson Isl., 800 m.

MINDANAO: *Copeland PPE 155*, Zamboanga, San Ramon, 500 m.