

PTERIDACEAE

Pteridaceae Rchb., Handb. Nat. Pfl.-Syst. (1837) 138.

SUBFAMILY PARKERIOIDEAE

(H.P. Nooteboom et al., Leiden, The Netherlands)

Parkerioideae (J.Sm.) R.M.Tryon, Amer. Fern J. 76 (1987) 184; R.M.Tryon in Kubitzky, Fam. Gen. Vasc. Pl. 1: Pteridophytes and Gymnosperms (1990) 232. — *Parkeriaceae* Hook. & Grev., Icon. Filic. (1828) t. 97 — *Ceratopterideae* J.Sm., Hist. Fil. (1875) 170. — Type: *Parkeria pterioides* Hook.

Acrostichaceae Mett. ex A.B.Frank in Leunis, Syn. Pflanzenk. ed. 2, 3 (1874) 1453, 1454, nom. rejic. — Type: *Acrostichum* L.

Plants terrestrial in moist places, aquatic or semi-aquatic. *Rhizome* stout, creeping, ascending or erect, scaly; vascular system a dictyostele, with medullary strands. *Fronde* dimorphous, or monomorphous but distal pinnae fertile only. *Sterile fronds* simple to tripinnate, the venation reticulate or anastomosing with no free included veins. *Fertile fronds* more deeply dissected, glabrous on both surfaces. *Sporangia* globose, solitary, scattered along the veins, large with very short stalks or sori acrostichoid, sporangia covering the abaxial surface of pinnae except on costae and/or very near the costae and the margin.

Two genera, pantropical distribution.

Note — Smith et al., A classification of extant ferns, Taxon 55 (2006) 715 place *Acrostichum* and *Ceratopteris* in Parkerioideae.

KEY TO THE GENERA

- 1a. Aquatic or semi-aquatic plants. Rhizome short, erect, bearing a rosette of leaves. Fronds dimorphous; sporangia globose, solitary **1. Ceratopteris**
- b. Erect terrestrial or subaquatic plants. Rhizome woody, short, stout, erect; the lamina simply pinnate, often the terminal pinnae fertile; sporangia acrostichoid **2. Acrostichum**

1. CERATOPTERIS

Ceratopteris Brongn., Bull. Sci. Soc. Philom. Paris (1821) 186; Lloyd, Brittonia 26 (1974) 139; Backer & Posth., Varenfl. Jav. (1939) 251. — Type: *Ceratopteris thalictroides* Brongn.

Aquatic or semi-aquatic plants. *Rhizome* short, erect, bearing a rosette of leaves; vascular system a dictyostele, seen in section as a ring of many meristeles, with medullary strands. Scales on rhizome apex and young fronds, thin, translucent with dark lateral cell-walls, entire, broadly ovate, more or less cordate on either side of the narrow attachment at the base. *Stipes* green, fleshy, with many longitudinal air-channels, rounded and ribbed on the abaxial side, flattened and smooth on the adaxial side; vascular system of 4 to many small peripheral bundles, one to each rib and several on the adaxial side



Fig. 1. *Ceratopteris thalictroides* (L.) Brongn. a. Sterile frond, natural size; b. fertile frond; c. part of lacinia of fertile frond, dorsal view, enlarged; d. idem, ventral view; e. idem, involucre opened; f. idem, strongly enlarged; g. capsule (sporangium) with obsolete annulus; h. part of capsule membrane with annulus, much enlarged; i. dehiscent capsule; j. spores; k. idem, much enlarged; l. integument of spore with m. oily material. — All from Hook. & Grev., *Icon. Filic.* (1828) t. 97.

also, with several smaller medullary strands. *Fronde*s dimorphous. *Sterile fronds* simple to tripinnate, the venation reticulate with no free included veins. *Fertile fronds* more deeply dissected, with narrow lobes, their edges reflexed to meet and completely cover the lower surface; veins longitudinal, arising by branching at the base of the lobes. *Sporangia* globose, solitary, scattered along the veins, large with very short stalks, the annulus broad, irregular, of many slightly indurated cells. *Spores* pale, translucent, tetrahedral, with raised superficial lines forming a fine network of irregular long meshes.

Note — According to Holttum (1954) only one species, according to Lloyd (1974) 4 species. In Malesia only one species:

1. *Ceratopteris thalictroides* (L.) Brongn.

Ceratopteris thalictroides (L.) Brongn., Bull. Sci. Soc. Philom. Paris (1821) 186; Backer & Posth., Varenfl. Jav. (1939) 251; Holttum, Revis. Fl. Malaya 2 (1954) 578. — *Acrostichum thalictroides* L., [Fl. Zeyl. (1747) 179, nr. 377, t. 4] Sp. Pl. 2 (1753) 1070. — Type: *Hermann Herbarium* 3: 42 specimen 377 (holo BM), Ceylon.

Sterile fronds narrowly ovate to ovate to deltoid or cordate (2–)6.5–59 by 1.3–20 cm; stipes (0.2–)2–31 by 0.7–8 mm at their broadest point near the base; blade pinnate to frequently bipinnate with deeply incised pinnules to tripinnate; pinnae lobed or incised, elliptic to narrowly ovate to deltoid 1–12.5 cm long; lowermost pinnae inserted mostly alternately on the stipe; bud initials frequent in pinnule sinuses, mostly dormant on living fronds. Fertile fronds erect, narrowly ovate to ovate to deltoid or cordate, longer than sterile fronds, (1.8–)9–117 by (0.6–)2.4–48 cm; stipes (0.8–4)–46 cm by 1–11 mm at their broadest point; blades tripinnate to quandripinnate below, bipinnate above with narrowly ovate to deltoid to ovate pinnae, the lowermost 2–36 cm long and mostly inserted alternately on the stipe; terminal segments linear to deltoid, rounded, acute to attenuate at tips with margins inrolled to enclose 1–3 rows of mature sporangia; sporangia with (13–)20–71 indurated annulus cells; spores 32 per sporangium, 96–124 μ m in distal diameter. — **Fig. 1.**

Distribution — Tropics of Asia and the Pacific, in Africa in Tanzania, and in the New World.

Habitat — Aquatic habitats, ponds, streamsides, taro patches, rice paddies swamps; altitude 0–800(–1300) m.

2. ACROSTICHUM

(Agung Sedayu, Indonesia; P.H. Hovenkamp, Leiden, The Netherlands;
emend. H.P. Nootboom, Leiden, The Netherlands)

CHROMOSOMES

Several reports on the cytology of *A. aureum* as Marcon et al. (2003), Love et al. (1977) showed that $n = 30$, $2n = 60$. Polyploidy with $2n = 120$ is reported by Kawakami (1980, 1982; Roux 1993), and aneuploidy with $2n = 119$ reported by Nakato (1996).

References: Kawakami, S.M., Karyomorphological studies on Japanese Pteridaceae II – *Pteris*, *Acrostichum*, *Cheilanthes*, *Onychium*. Bull. Aichi Univ. Educ. (Nat. Sci.) 29 (1980) 129–150. — Kawakami, S.M., Karyomorphological studies on Japanese Pteridaceae IV – Discussion. Bull. Aichi Univ. Educ. (Nat. Sci.) 31 (1982) 175–186. — Love, A., D. Love & R.E.G. Pichi Sermolli, Cytonomical atlas of pteridophyta (1977). Cramer, Vaduz. — Marcon A.B., I.C.L. Barros & M. Guerra, A karyotype comparison between two closely related species of *Acrostichum*. Amer. Fern J. 93, 3 (2003) 116–125. — Nakato, N., Notes on chromosome of Japanese pteridophytes (4). J. Jap. Bot. 71 (1996) 163–167. — Roux, J.P., *Elaphoglossum* Schott ex J. Smith (Lomariopsidaceae: Pteridophyta) in the Tristan da Cunha, Gough and Marion Island groups. Bot. J. Linn. Soc. 112 (1993) 203–222.

ECOLOGY

Mostly in coastal areas, especially mangrove. Sometimes classified as true mangrove (Chapman 1976; Maxwell 2002), or as associated mangrove. Most investigators like Troll (1933), Croft (1985), Tomlinson (1986), Kramer & McCarthy (1998), stated that *A. aureum* survives better inland, where *A. speciosum* is generally absent. On the contrary, Backer & Posthumus (1939) stated that *A. speciosum* can reach the altitude of about 900 m, meaning very much inland location, especially at mineral hot springs. Some specimens previously identified as *A. speciosum* also come from a quite high altitude locality. Therefore, it is hard to differentiate *A. aureum* and *A. speciosum* by saline-freshwater preference.

Some inland specimens collected far from the coastline, completely in freshwater, reflect the ability of *A. aureum* to tolerate the absence of salinity. Even cultivation in freshwater as in Kebun Raya Bogor is successful, reflecting that this species is totally able to live in freshwater. Some specimens were also being collected from inland in mineral springs, which may act as a substitute source of mineral and salt.

The world record for altitude was by *Kairo & Streimann NGF30938* from 1158 m (3800 ft) at Wau, Morobe, New Guinea. Occurrence of *A. aureum* from high altitude also recorded from some specimens as *Bünnemeyer 8168* (Kerinci, Jambi, 850 m), *Madulid PPI 18625* (Apulit, Palawan, 650 m), *Bakhuizen v.d. Brink 6042* (Rawa Tjimandala, East Bogor, 500 m) and *Rappart 217* (Air Poetih, Bengkulu, 450 m). One record by Collenette (1991) recorded the occurrence of *A. aureum* at 100 km inland in Saudi Arabia at the altitude of 823 m (2700 ft).

References: Backer, C.A. & O. Posthumus, Varenflora voor Java (1939) 181, 182. Lands Plantentuin, Buitenzorg. — Chapman, V.J., Mangrove vegetation (1976). Cramer, Vaduz. — Collenette I.S., *Acrostichum aureum*: an inland record from Saudi Arabia. Fern Gaz. 14, 2 (1991) 57–58. — Croft, J.R., Fern and fern allies, in G.J. Leach & P.L. Osborne, Freshwater plants of Papua New Guinea (1985) 62–65. The University of Papua New Guinea Press, Port Moresby. — Kramer, K.U. & P.M. McCarthy, Pteridaceae. Fl. Australia 48 (1998) 241–242. — Maxwell, G.S., The mangrove fern; associate or true mangrove? Mem. Hong Kong Nat. His. Soc. 25 (2002) 117–121. — Tomlinson, P.B., The botany of mangroves (1986). Cambridge University Press, New York. — Troll, W., Über *Acrostichum aureum* L., *Acrostichum speciosum* Willd. und neotene formen des letzteren. Flora 128 (1933) 301–328.

FOSSIL RECORD

The fertile frond, sporangia and spores of *A. aureum* were recorded by Sen & Banerjee (1995) from Holocene peat near Calcutta, India. The macrofossils are recorded from

Early Paleocene of Maghalaya, India by Kar (1992). The oldest record of the genus *Acrostichum* was recorded by Bonde & Kumaran (2001) from Late Cretaceous, also in India.

References: Bonde, S.D. & K.P.N. Kumaran, The oldest macrofossil record of the mangrove fern *Acrostichum* L. from the Late Cretaceous Deccan intertrappean beds of India. *Cretaceous Research* 23 (2001) 149–152. — Kar, R.K., Occurrence of *Acrostichum* spores from the Langpar Formation, Early Paleocene of Meghalaya, India. *Geophytology* 21 (1992) 33–35. — Sen, P.K. & M. Banerjee, Study of mega plant remains from Holocene sediments of Bengal basin, India for biostratigraphic zonation and environmental analysis, in Pant, D.D. (ed.), *Global environment and diversification of plants through geological time: Birmal Sahni Centenary Volume* (1995) 395–407. South Asian publishers, Allahabad.

ETHNOBOTANY

Heyne (1927) noted that the soft young frond of *A. aureum* is eaten as vegetable in Timor, North Sulawesi and Kangean. In Indochina (Annam) the mature hard pinnae are used as thatched roofing, more expensive than ordinary straw thatch roof. In Bangladesh, the stem (stipe and rhachis) are used for construction of mud walls and fencing (Rahman 2000).

References: Heyne, K., *De nuttige planten van Nederlandsh Indie*. 2nd ed. (1927). Ruygrok & Co., Batavia. — Rahman, L.M., *The Sundarban, a unique wilderness of the world*. USDA Forest Service Proceedings RMRS 15, 2 (2000) 143–147.

ACROSTICHUM

Acrostichum L., *Sp. Pl.* 2 (1753) 1067; Backer & Posth., *Varenfl. Jav.* (1939) 181; Holttum, *Revis. Fl. Malaya* 2 (1954) 578.

Erect terrestrial or subaquatic ferns of medium to large size, mostly in brackish, sometimes in freshwater, swamps and marshes. *Rhizome* woody, short, stout, erect, dictyostelic with medullary strands, bearing broad thick scales attached by a broad base, often with aerenchymatous strut-roots. *Fronde*s long stipitate, the stipes adaxially grooved, with a single U-shaped vascular strand, the lamina simply pinnate, the pinnae alternate, stalked, large, lanceolate or narrow-oblong, entire, thick-coriaceous, the apical pinnae similar to the lateral, a few reduced glandular pinnae that function in young fronds represented by short residual spines on the stipe, costa prominent, no main veins evident, venation oblique, closely anastomosing to form many series of irregular but \pm uniform, narrow areoles, without included free veinlets. *Sporangia* acrostichoid, densely covering all or the apical half of the abaxial surface of the apical few pinnae, the fertile portions slightly contracted; exindusiate, paraphyses numerous, apically clavate or variously lobed (? = abortive sporangia), annulus longitudinal, interrupted, of 20–22 thickened cells. *Spores* trilete, pale, minutely tuberculate.

Distribution — A pantropical genus with two species known from most humid tropical areas of the world, especially those with mangrove formations. One species in Malesia:

1. *Acrostichum aureum* L.

- Acrostichum aureum* L., Sp. Pl. 2 (1753) 1069; Backer & Posth., Varenfl. Jav. (1939) 181; Holttum, Revis. Fl. Malaya 2 (1954) 578. — *Chrysodium vulgare* Fée, Mém. Foug., 2. Hist. Acrostich. (1845) 99. — Lectotype: *Plumier*, Descr. Pl. Amér. (1693) 7. Martinique: Front Royal, without data (lectotypified by Lellinger, Proc. Biol. Soc. Wash. 98 (1985) 366).
- Acrostichum inaequale* Willd., Sp. Pl., ed. 4, 5 (1810) 117. — *Acrostichum aureum* L. var. *inaequale* (Willd.) T. Moore, Index Fil. 3 (1857) 5. — *Chrysodium inaequale* Fée, Mém. Foug., 2. Hist. Acrostich. (1845) 99. — Type: *Willdenow* 'India orientali' (holo B, Herb. Willdenow n.v., IDC microfiche), India orientali.
- Acrostichum speciosum* Willd., Sp. Pl., ed. 4, 5 (1810) 117; Backer & Posth., Varenfl. Jav. (1939) 182. — *Acrostichum aureum* L. var. *speciosum* (Willd.) T. Moore, Index Fil. 3 (1857) 5. — *Chrysodium speciosum* Fée, Mém. Foug., 2. Hist. Acrostich. (1845) 99. — Type: *Willdenow* 'India orientali' (holo B, Herb. Willdenow n.v., IDC microfiche), India orientali.
- Acrostichum fraxinifolium* R.Br., Prodr. Fl. Nov. Holland (1810) 145. — *Chrysodium fraxinifolium* Fée, Mém. Foug., 2. Hist. Acrostich. (1845) 101. — Type: *R.Br. s.n.* (BM?, n.v.), tropical Australia.
- Acrostichum obliquum* Blume, Enum. Pl. Javae (1828) 101. — *Chrysodium vulgare* Fée var. *minus* Fée, Mém. Foug., 2. Hist. Acrostich. (1845) 99. — *Acrostichum aureum* L. var. *minus* T. Moore, Index Fil. 3 (1857) 5. — Type: *Korthals s.n.* L0050893, L0050894 (L), Java, Provincia Bantam circa Pandeglang.
- Chrysodium urvillei* Fée, Mém. Foug., 2. Hist. Acrostich. (1845) 100. — *Acrostichum urvillei* C. Presl, Epimel. Bot. (1849) 181. — *Acrostichum aureum* L. var. *urvillei* T. Moore, Index Fil. 3 (1857) 5. — Type: *d'Urville* (P?, n.v.), Tahiti.

Terrestrial or subaquatic fern, growing in clumps, sometimes gregariously occupying an area. *Rhizome* short or long, erect, or shortly prostrate, then erect at the bud/frond base, 6 cm or more diam., up to 30 cm height or taller, covered with scales of various sizes and aerenchymatous strut-roots. Broader scales ovate-oblong, 6–30 by 3–12 mm; apex acute to obtuse, usually abraded; margin always abraded, possibly entire at the early stage; basifixed; mid-cells thick dark brown-black arranged in broad array, the thickest in the centre; marginal cells clathrate light brown-golden, arranged in wide or thin array, sometimes much abraded, so that the scales look as if they only consist of thick black cells. Narrower scales linear to needle shaped, 1.9–17 by 0.5–2 mm, apex acute, margin apparently entire, but always abraded; basifixed; apparently both kinds of scales derived from same origin. The abrasion of the marginal-clathrate cells on a young scale, while the thickened middle cells are few, will result in a linear form of scale. This can be observed on young scales around the stipe with only few thick middle cells, with ovate, not linear form. The very young scales are even throughout with clathrate cells without any thickened middle cells. *Stipe* 21–125 cm long and 0.2–2.6 cm diam.; rudimentary pinnae 1–14, alternate, the lowest 1–23 cm from caudex, usually dark, blackish coloured; hairs (trichomes) fine colourless to light golden coloured, abundant on the base of small sized stipes, and much reduced in number toward frond apex; but absent on big sized stipes. *Fronde* pinnate, 36–over 300 cm long, pinnae 3–29, alternate, imparipinnate, stalked, large, lanceolate or narrow-oblong, entire, thick-coriaceous, the apical pinnae similar to the lateral, a few reduced glandular pinnae that function in young fronds represented by short residual spines on the stipe; basal pinnae ± the largest, gradually reducing in size toward apex, pinnae only sterile, only fertile, or sterile pinnae on basal portion of lamina and fertile pinnae on the apical portion. *Lateral sterile pinnae* linear, ensiform, subulate, narrowly ovate 6–64 by 1.1–9 cm, base acute-

obtuse-oblique, apex acute, acuminate (with or without short or long drip tip), obtuse, acuminate, emarginated, to truncate (with or without mucro), margin entire; midrib glabrous; stalk 0.2–1.5 cm long, glabrous; terminal pinna sometimes pinnatifid without stalk, sometimes decurrent; areoles 5–21 from midrib to margin, arranged at 50–60° toward midrib, and widening up to 90° on broad pinnae, the first areole adjacent to the midrib linear, 2–9 by 0.1–0.7 mm, the second and third more or less broader, 0.5–5 by 0.3–1.5 mm, the areoles in the middle between midrib and margin linear, 1.4–6.1 by 0.3–1.3 mm, the marginal areoles smallest, 0.4–1.75 by 0.2–1 mm; abaxial and adaxial surface of pinnae glabrous. *Fertile pinnae* linear, lanceolate, subulate to long ovate, 6–46 by 1–6.5 cm, base acute, obtuse, or oblique, apex acute-acuminate-obtuse, with or without mucro, margin entire; stalk 0.3–1 cm long, or without stalk when terminal and pinnatifid, glabrous, or few with trichomes; abaxial side of lamina covered entirely or partly by acrostichoid sori, except the midrib, small part of the lamina base and the mucro. Partly fertile pinnae usually present in between the completely sterile and completely fertile ones, similar or different in shape from the fertile and sterile pinnae, when different, the sterile base usually broader than the narrower-tapering fertile apical



Fig. 2. *Acrostichum aureum* L. Part of leaf with sterile and fertile pinnae. EcoLibrary: *Acrostichum aureum*, entire: 20p@discoverlife.org.

portion; the border between sterile and fertile follows the areole line, usually narrowing down forming an isthmus. *Paraphyses* between the sporangia with elongated translucent golden-light brown fragile or sometimes dark red stout stalk (Maluku and New Guinea specimens) 0.25–0.35 mm long, apically clavate or variously lobed (? = abortive sporangia). *Sporangia* short stalked, annulus lined by 16–25 indurated cells. *Spores* trilete, 37.5–62.5 by 45–65 μm diam., according to Devi (Spores of Indian ferns 1977) 50 by 65 μm and Tryon & Lugardon (Spores of the pteridophyta surface, wall structure, and diversity based on electron microscope study 1991) 42–70 μm , finely scabrate, observation using LM always shows bubbles of spore contents, probably oil. — **Fig. 2.**

Distribution — Pantropical and subtropical (Japan, South Africa).

Conservation status — Being a very common plant in coastal areas *A. aureum* throughout the world or in Malesia is not threatened; except locally in Florida (Florida Fish & Wildlife Conservation Commission 1997), where this fern is listed as an endangered species.

Notes — 1. Small sizes, pinna apex shape and other characters formerly attributed to *A. speciosum* vary within the whole geographical distribution area.

2. The shape of pinna apex is apparently in accordance with frond development, the younger frond seems to have an acute apex, which in time becomes obtuse. The old individuals then bear pinnae which are more or less emarginate. Numbers of specimens with big size (big frond) are combined with acute/acuminate pinna apex, which meant that those may be big (and mature) individuals, but not old enough to show the obtuse-emarginate apex. Therefore, logically the opposite combination, small frond (body) size – meaning plant in young stage – with obtuse-emarginate apex is rarely (never?) observed. The *A. aureum* pinna shape types tend to occur in specimens with big size, and *A. speciosum* types on the specimens with smaller sizes. But overlaps occur in many cases.

3. Troll (Bot. Mitt. Tropen 1929: 19) tried to describe the shape of *paraphyses* of the two species and said that the *A. aureum* has paraphyses with protrusions, *A. speciosum* not. In the specimens previously identified as *A. aureum*, both shapes of paraphyses occur in a single sterile pinna. When the paraphyses without protrusions are abundant, the other form is sometimes difficult to observe, and the other way round. But, both shapes are definitely occurring in one specimen.

4. *Trichomes on stipe*. The minute, 1–3 (mostly 1) celled trichomes (hairs) were found on many specimens, but never reported before. The hairs can be found from the base of stipe up to petiolules, but the latter position is rarely observable. As the frond grows bigger, all the hairs tend to fall off; therefore the bigger specimens are always glabrous. For this reason the hairs are only found in specimens that formerly were regarded as belonging to *A. speciosum*. From SEM images of the stipe surface it is clear that the hairs would have been present in all individuals, gradually falling off (leaving hair scars), and eventually they have completely disappeared from the frond.