

THE PTERIDOPHYTA OF TAIWAN-4 THE AQUATIC FERNS OF TAIWAN

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Most of the aquatic ferns of Taiwan are of very wide distribution and are therefore well known. Most of them belong to small families which are very different from each other and from all other fern families. There are a few aquatic ferns which are common along ditches and water courses, such as: *Diplazium esculentum* and *Goniopteris prolifera*, and some that grow on rocks at or near the waters edge of mountain streams, such as: *Microsorium pteropus*, which belong to large families. The other species in these genera to which they belong are not aquatic, therefore such ferns will be treated later.

Parkeriaceae Hooker

Hooker (1825:147) created a new genus *Parkeria* and this family (Parkeriaceae) because he thought that the sporangial wall of these ferns had no annulus. Later it was found that the annulus of these ferns is quite variable (Thompson, 1918: 363-397) and that on the same frond are sometimes found sporangia with a well developed annulus and others with no annulus at all. In 1926 Maxon (1926:379) suggested the name Ceratopteridaceae for this family as the genus name *Parkeria* was no longer in use.

This family only has the one genus and all species are aquatic. Some usually grow floating on quiet waters, others grow in shallow water rooting in the mud as marsh plants, some are grown in aquaria as submersed plants. All are usually tropical or subtropical plants but they have a range from nearly 30°N to 30°S. Vegetative reproduction is rapid, buds are borne on the margin of the leaves and from these are developed large numbers of plants.

Ceratopteris Brongn.

水蕨屬 Shui Chüeh Shu = Water Fern

Stems erect, very short, and apparently absent but plants growing in deep shade show distinct internodes⁽²⁾; fibrous roots are borne from near the base of the stipes; fronds are dimorphous, the first leaves are all sterile, these are either deeply lobed or pinnate or tripinnatifid (depending on the species), in some species transitional fronds are formed, these look somewhat like fertile fronds but do not usually bear sporangia, finally fertile fronds are formed, these are taller and finely dissected, no sterile leaves are borne after the fertile leaves appear; the fronds

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(2) See Chiang's figures 1-3. (Chiang and Chiang 1962: 36)

are glabrous; scales on base of stipe are thin and pale brown; venation is anastomosing, aerolae are without included veinlets; tissues are succulent.

Sporangia are borne in a single line along the marginal veins and not in distinct sori; they have short stalks, are nearly globose; usually have a well developed annulus but may have no annulus at all; when an annulus is formed dehiscence is transverse. Lip cells sometimes well developed.

A false indusium is formed by the modified reflexed leaf margin which nearly meets at the midrib. The marginal cells of the indusia are thin, translucent, and do not contain chloroplasts. Spores are large, tetrahedral and are strongly ribbed. Gametophytes are elongate at first becoming cordate. Copeland, 1947: 83; Holttum, 1954: 577-579; Smith 1955: 357-360; Bower, F. O. 1963: 70-72.

Smith's (1955: 357-360) description of this genus was based on *C. pteridoides*, Holttum's description of this genus was based on *C. thalictroides* (Holttum, 1954: 577-579). Hooker (1868: 184) combined the characters of two species in one description and thus confused the situation.

Key to species

1. Marsh plants, rooting in mud; stipes long, slender; sterile fronds bipinnatifid to tripinnatifid.....1. *C. thalictroides*
1. Floating plants, stipes very short, fleshy, widest at base of leaf; sterile fronds simple, deeply 3-lobed.....2. *C. pteridoides*
1. *C. thalictroides* (L.) Brongn.

Fig. 1

Brongniart, 1821: 186; Benedict, 1909: 467-469 pl; Tagawa 1963: 66, pl 20, fig 121.

Acrostichum thalictroides Linnaeus 1753: 1070.

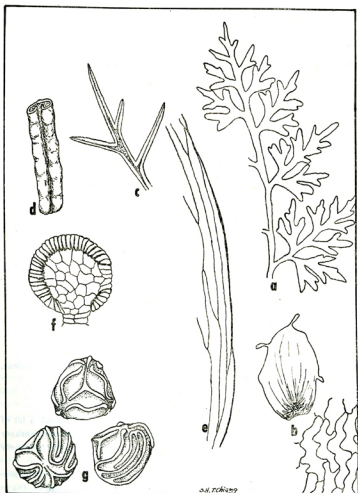
Ceratopteris siliquosa (L.) Copeland, 1935: 107; Wagner and Grether 1948b: 39.

C. Guadichaudii Brongniart, 1821: 187; Wagner and Grether 1948a: 77-78.

Fronds dimorphic, sterile fronds narrowly oblong in outline, bipinnatifid to tripinnatifid, stipe slender, about as long as blade, pinnae usually alternate, rarely opposite, ultimate segments usually 2 to 3 mm wide, rarely wider; fronds vary a lot in size, usually ranging from 10 to 35 cm tall; fertile fronds usually much taller; sporangia globose, annulus well developed; lip cells usually not well developed; stalk short; spore number reported as 32; Nishida and Kurita (1963: 369-372) found the chromosome number of Japanese specimens to be $n=78$, Manton (1954) reported Malayan specimens to have a number of $n=76-78$, and Ninann (1956) reported Indian plants to have a number of $N=77$.

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

- a. Portion of sterile frond ($\times 1$).
- b. Scale from stipe ($\times 12$), and enlarged cells ($\times 120$).
- c. Underside of fertile pinna ($\times 3$). d. ($\times 8$).
- e. Marginal cells of false indusium ($\times 120$).
- f. Sporangium ($\times 50$). g. Spores ($\times 200$).



Distribution⁽¹⁾:

Asia: Ceylon, India, Nepal, Malaya, Vietnam, Indonesia, Philippines, Hainan, South China, Japan, Ryukyu, Taiwan.

Pacific Islands: Guam, Palau, Yap, Admiralty Islands, New Guinea, Australia.

Africa: Madagascar, Seychelles Islands.

West Indies Central America, South America, Southern U.S. (Texas).

Taiwan: known from nearly every county. Common along ditches, marshy places and edges of paddy fields.

C. Gaudichaudii from Guam is probably only a small form of *C. thalictroides*. I know of no other distinction between these two taxa except size. Specimens collected for me by Wilson (DeVol 5293) are very similar to those collected by Grether and Wagner (Grether 4326) these are all very small plants but Nelson 203 and Stone 4900 are much larger and appear to be exactly like *C. thalictroides*. Stone's specimens were collected from very near the same locality as Wilson and Grether collected the smaller ones.

2. *C. pteridoides* (Hook.) Hieron.

Hieronymous, 1905: 561; Benedict, 1909: 470, DeVol 1957: 67-72 fig. (Note: the name under the figure should have been *C. pteridoides*.)

Parkeria pteridoides Hooker 1825: 147; Hooker and Greville, 1831 (1): pl. 97.

Plants usually floating on quiet waters, but grow better when rooted; first leaves to be borne are simple, sterile, and usually deeply 3-lobed; then transitional leaves are borne which are deeply pinnatifid, finally the much dissected fertile leaves are borne; stipe is short, fleshy, often somewhat swollen, widest at base of frond and tapers downwards.

Distribution:⁽²⁾

North America: U.S.A. (Florida)

West Indies: Cuba.

Central America: Guatemala, El Salvador, Panama

South America: Columbia, Venezuela, British Guiana, Surinam, French Guiana, Brazil, Paraguay, Argentina.

Asia: Pakistan (Bengal), Vietnam, China: Kiangsu, Shantung.

Taiwan: Cultivated at Taipei Zoo.

One day when visiting the Aquarium at the Taipei Zoo I found a lot of these plants in the Aquaria. I tried to find out from the caretakers and manager where they came from but got no satisfactory reply. They said it grew commonly in Taiwan but I have never found any.

While attending the 11th Pacific Science Congress in Tokyo, I took the opportunity to check through the *Ceratopteris* collection at the Herbarium of Tokyo

(1) Based on herbarium specimens examined.

(2) Based on herbarium specimens examined.

University and found a specimen of *C. Pteridoides* collected by Makoto Togashi in Tsining (濟寧) Shantung along the Grand Canal (2383). This is the most northern station for this fern in Asia. Togashi happened to be in the building at the time and was able to give me a good many details concerning its collection.

Marsileaceae

Bower 1963, 2: 176-192; Eames, 1936: 197-224; Holttum, 1954: 618-620; Steward, 1958: 26.

Small aquatic ferns, rooting in mud; rhizome creeping, with an amphiphloic siphonostele, and the cortex with many large air chambers; leaves linear or with 2 or 4 leaflets, circinate; sporocarps borne on the stipes or in the axil of stipe and rhizome; within the sporocarps is a gelatinous ribbon to which are attached two rows of sori; each sorus has a delicate indusium; the central region of the sorus consists of a row of megasporangia, on either side of which is a row of microsporangia; gametophytes develop inside the spores. 3 genera, only one on Taiwan.

Marsilea Linn.

蘋屬 P'in Shu-Apple

Leaves with 4 leaflets, venation dichotomous, distal veins uniting to form narrow areolae; sporocarps borne on the stipe or in axils of stipe and rhizome, having very hard and usually hairy coats; where the stalk is fused to the sporocarps is a line called the raphe, when the sporocarp is borne at the top of stalk there is no raphe; two small projections called "teeth" are usually present, the lower tooth is at the end of the stalk, and is usually blunt, the upper tooth is more slender and often sharp-pointed.

1. *M. crenata* Presl

Fig. 2

Presl, Rel. Haenk. 1: 84 t. 12, f. 13. 1825. Holttum, 1954: 619.

Plants usually growing in paddy fields or along the edges of ponds and ditches, being submersed and with the leaflets floating on the water for much of the year, then growing on the drained rice fields or along dry ditches during the winter months; the plants growing in the water being without sporocarps and quite different from those growing in dry fields.

Aquatic form: Plants growing in deep water have their leaflets floating on the water and succulent stipes, up to 30 cm long; those in shallow water have erect stipes 8-10 cm long; leaves far apart, internodes 6 to 9 cm long; leaflets large, measuring 2 cm from base to center of leaflet.

Winter plants growing on drained fields are much smaller, internodes are very short often only 1 mm or so long, but may be 4 cm long; stipes 2-8 cm long; leaflets 5-10 mm long from base to center.

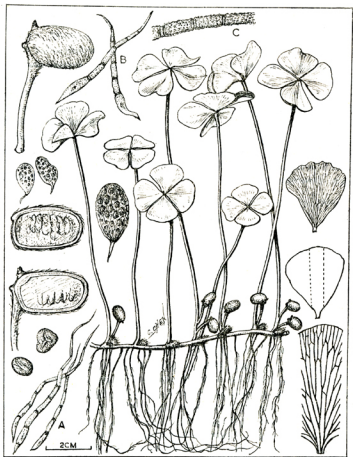


Fig. 2. *Marsilea crenata* Presl

Note the different places the sporocarps may be attached to stipe or rhizome. A. Rhizome hairs, much magnified. B. Hairs from sporocarps much magnified. C. Sporocarp hair highly magnified.

Leaflets with entire or slightly crenate distal margin; venation dichotomous, somewhat reticulate, areolae very narrow, distal veinlets united.

Sporocarps usually borne singly at or near base of stipe, rarely with 2 sporocarps on a stipe, these borne on separate stalks; the stalks 3-12 mm long; sporocarps oval, dark brown, covered with pale colored fugacious hairs; upper tooth acute; lower tooth very short, blunt.

Distribution: Malaya, Indonesia, Philippines, Hongkong, Taiwan.

Taiwan: Known from every county. Common in paddy fields and along ditches.

So far as is known we only have one species in Taiwan. *M. quadrifolia* Linn. (Masamune, 1936: 31; 1954:4) has often been reported from Taiwan but we have seen no specimens of it. One difference between *M. crenata* and *M. quadrifolia* is that sporocarps of *M. quadrifolia* are borne on the stipe, a short distance above the base (about 5-6 mm from the base) and there are often two sporocarps borne on a single forked stalk, while in *M. crenata* the sporocarps are borne singly in the axils of stipe and rhizome, or near base of stipe. *M. quadrifolia* is common in Central China, Steward, 1958: 26, DeVol, 1945: 43. Bower's illustration of *M. quadrifolia* is excellent. (Bower 2: 177 fig. 459).

Azollaceae

A family with only the one genus *Azolla*.

Azolla Lam.

滿江紅屬 Man Chiang Hung Shu=Whole River Red

Small floating ferns, with very short horizontal stems and closely imbricating leaves; roots borne singly or in groups; plants usually triangular in outline.

Leaves consist of an upper aerial lobe and a lower submersed lobed, upper lobe with papillae covering the surface, and a cavity on its lower side which opens to the outside; within this cavity are filaments of the Blue-green algae; *Anabaena azollae*.⁽¹⁾ The ventral lobe is only one cell thick and is without chloroplasts. Plants are usually green until late fall when a lot of anthocyanin develops, especially in temperate areas.

Sporocarps are usually in pairs, being borne near the base of the ventral lobe. A sporocarp either contains a single megasporangium or many microsporangia. Sporocarp walls are thin. Microsporangia are globose, megasporocarps are smaller and ovoid.

Within the microsporangium are many long stalked microsporangia. Each microsporangium contains several massulae. Within each massula are imbedded microspores. Some massulae are nearly globular and have long trichomes (glochidia) with barbs on their ends, other massulae have a dorsal and ventral side with a few straight, pointed trichomes borne on the ventral side.

(1) See Shen's picture of a section of a leaf (1960: pl. III fig. 5)

Within the megasporocarp is a large basal megasporangium which contains a single megaspore. Above the megasporangium there often is a collar, then one or two tiers of floats with an apical flagellated funnel-like zone. The number of floats, presence or absence of a collar, type of markings on the megasporangium are of taxonomic value.

1. *A. pinnata* R. Br.

Plates 1-5 Taiwan 7:1-8.

Brown, 1810:167; Baker 1886:100; 1888:231; Holttum, 1954:622; Shen, 1960:1-8, pl. 1-5; Shen, 1961; 151-155 pl. 10.

A. pinnata R. Br. var. *africana* (Desv.) Baker in Chevalier, Expl. Bot. Afr. Occid. Francaise 1: 788. 1920; H. Ito, 1939: 71.

A. africana Desvaux. 1827: 178.

A. imbricata (Roxb.) Nakai 1925:185; Ching, 1933:346; Ghristensen 1934:45; DeVoi 1945:44. Steward, 1958:62; Tagawa 1963:172 pl. 72, fig. 398.

A. japonica Fr. et Sav. sensu Masamune 1936:31.

Plants more or less triangular in shape about 1 cm wide, much branched, vegetative reproduction rapid by the breaking up of the plants; leaves minute, imbricating, trapezoidal; upper lobe green, succulent, covered with papillae, lower lobe colorless, thin; microsporocarps globose, microsporangia long stalked, microspores imbedded in massulae; the massulae with a dorsal and ventral side, long pointed trichomes borne on the ventral side; megasporocarps ovoid, acute at tip, with a warty basal megasporangium and two tiers of floats (9 floats in all; 3 above, 6 below); and a terminal flagellate crown.

Distribution: Africa, Asia, Australia, Islands of Pacific.

Taiwan: Known from every county. Common, floating on paddy fields and irrigation ditches.

Notes:

Shen's excellent detailed drawings in *Taiwania* and in the American Fern Journal referred to above make it unnecessary us to give any further illustrations here.

A. pinnata R. Br. has a very wide distribution but plants I have examined from Africa and many parts of Asia all show the same structures.

Anthocyanin develops in the leaves during the colder months. Taiwan plants do not usually become as red and those in Central China.

Sporocarps are seldom seen on Taiwan plants. They are abundant on plants in Central China during the late fall and early winter.

A. japonica Fr. et. Sav. has often been listed from Taiwan, but this is a case of confusing it with this species. *A. japonica* has never been collected from Taiwan, it is not only a much larger plant, but the contents of the megasporocarp and type of massula are very different.

Salviniaceae

A family with only the one genus *Salvinia*. *Azolla* has often been placed in this family but is very different, the following chart contrasts some of their characters.

Salvinia (Michx.) Adans.

槐葉萍屬 Huai Yeh Ping Shu = Locust-leaf Duck-weed

Small floating plants without roots; with a slender, branching, horizontal stem, which break easily thus reproducing vegetatively very rapidly; leaves of two types: floating leaves are green, usually oval or oblong in shape, have a midrib, covered with papillae on upper surface, in most species the papillae bear a tuft of hairs; undersurface covered with long straight, multicellular hairs, floating leaves occur in pairs; the submersed leaves are finely dissected and root-like.

Sporocarps are borne in a cluster on a branch of the root-like leaf; sporocarps are globular or ovoid, all appear alike, and are covered with long multicellular hairs; some contain microsporangia and others megasporangia; these are borne on the much branched receptacles. (Eames 1936:232 fig. 147)

S. natans (L.) Allioni, 1785. Flora pedemont 2: 289.

Baker 1886:97; Hegi, 1906:47 fig; Herzog, 1935:268-272; Masamune, 1936:31; Makino, 1940:912 fig; DeVol 1945:43; Ohwi, 1957:163; Tagawa, 1963:171, pl. 72 fig. 397;

Marsilea natans Linnaeus 1753:1099

Characters *Azolla* and *Salvinia* contrasted

	<i>Azolla</i>	<i>Salvinia</i>
Roots	with roots	without roots
Leaf shape	trapezoidal	oval or elliptical
Midrib	absent	present
Papillae of leaves	without hairs on top of papillae	with hairs on papillae
Leaf arrangement	imbricating	floating leaves in pairs
Leaf structure	with an upper floating lobe & a lower submersed lobe	with a pair of green floating leaves and a much dissected root-like submersed leaf.
Symbiosis	containing <i>Anabaena</i> within cavity of leaf and in sporocarps	without symbiotic <i>Anabaena</i>
Sporocarps	in pairs	in clusters
Microsporocarps	spherical, not scaly, contain stalked microsporangia	spherical, covered with multicellular hairs, containing branched receptacle bearing microsporangia
Megasporocarp	ovoid	spherical
Contents of Megasporocarp	one basal megasporangium containing 1 megaspore; with floats above sporangia.	containing a much branched receptacle bearing many megasporangia.

Plants up to 10 or 15 cm long; leaves oval-oblong 10 to 15 mm long, papillate on upper surface, with 4 free hairs on tip of papillae; with long multicellular hairs on lower surface; sporocarps globose, covered with brown multicellular hairs; fruiting in late fall and winter,

Distribution: Europe, Asia, Africa, North America.

Taiwan: Known from every county.

Floating on paddy fields, ponds and ditches.

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