

## SALVINIACEAE

槐叶萍科 huai ye ping ke

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Plants aquatic, forming floating mats; roots present (*Azolla*) or lacking (*Salvinia*); stems horizontal, protostelic, vegetative reproduction rapid due to fragmentation. Fronds with exposed upper surface covered with water-repellent papillae, fronds in whorls of 3: two fronds floating, green, lamina orbicular to oblong, small (8–25 mm), third one submersed, finely dissected and rootlike (*Salvinia*), or fronds alternate, distichous, minute (ca. 1 mm), 2-lobed: one lobe floating, with a cavity near base containing blue-green algae (*Anabaena*), other lobe submersed, only 1 cell thick (*Azolla*). Sporangia contained within sporocarps, these inserted on submersed frond and externally uniform (*Salvinia*) or in pairs with a globose microsporocarp and a smaller ovoid megasporocarp (*Azolla*); spores of two kinds (plants heterosporous), microspores globose, trilete, megaspores large, spore germination endosporic.

Two genera and ca. 17 species: tropical to temperate regions worldwide; two genera and four species (one introduced) in China.

Lin Youxing. 2000. Salviniaceae and Azollaceae. In: Lin Youxing, ed., *Fl. Reipubl. Popularis Sin.* 6(2): 340–345.

- 1a. Fronds in whorls of 3, two floating, green, 8–25 mm, with midrib, third one finely dissected, submersed, rootlike; true root absent; sporocarps in clusters or chains of 6 or more, externally all similar ..... 1. *Salvinia*  
1b. Fronds alternate, usually overlapping, ca. 1 mm, divided with a floating upper lobe and submersed lower lobe; root present; sporocarps in pairs, each usually with a small megasporocarp and a larger microsporophyte ..... 2. *Azolla*

### 1. SALVINIA Séguier, *Fl. Veron.* 3: 52. 1754.

槐叶萍属 huai ye ping shu

Plants floating, small. Stems horizontal, slender, covered with dark brown articulate hairs. Fronds in whorls of 3, sessile or very shortly stipitate; two fronds floating on water surface, green, entire, herbaceous, densely covered with papillae on upper surface, costae slightly distinct; veins obliquely spreading; third frond submersed and finely dissected, densely hairy, and rootlike. Sporocarps clustered at stipe bases of submersed fronds, or in 2 rows along midrib of submersed frond; microsporocarp large, thin-walled, and containing many microsporangia on a branched receptacle, each microsporangium containing 64 microspores; megasporangia vase-shaped, each one only containing 1 megaspore, trilete, perispore absent; microspores ?covered, trilete, mark usually retuse, triangular, perispore absent, exospore thinner, smooth.  $x = 9$ .

About ten species: worldwide, mostly in American and African tropics; two species in China.

- 1a. Frond papillae dome-shaped, each ending in a tuft of free multicellular hairs; sporocarps clustered at base of submersed frond ..... 1. *S. natans*  
1b. Frond papillae cylindrical, each ending in a group of (2–)4 multicellular hairs joined at their tips; sporocarps in long straight chains of up to 55 ..... 2. *S. molesta*

#### 1. *Salvinia natans* (Linnaeus) Allioni, *Fl. Pedem.* 2: 289. 1785.

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*Marsilea natans* Linnaeus, *Sp. Pl.* 2: 1099. 1753.

Floating fronds sessile or with stipe to ca. 1 mm; lamina *Robinia*-shaped, 0.8–1.4 × 0.5–0.8 cm, base rounded or subcordate, margin entire, apex obtuse; lateral veins 15–20 on each side of costa, each one with 5–8 low dome-shaped papillae, each with a terminal bunch of ca. 4 white setae; lamina deep green on upper surface, densely brown villous on lower surface; submersed fronds finely dissected into linear segments, covered with hairs, and acting as roots. Sporocarps 4–8, clustered at bases of submersed fronds, with sparse bunches of hairs; microsporocarps yellowish, megasporocarps brownish.

Floating on rice fields, ponds, ditches. Throughout most of China, widely distributed along the Chang Jiang [India, Thailand, Vietnam; Africa, Asia, Europe].

The whole plant is used medicinally; it is boiled and eaten for “consumptive disease” and eczema and externally used for inflammatory diseases affecting the skin.

The name *Salvinia natans* has been misapplied to plants in North America (*S. minima* Baker).

#### 2. *Salvinia molesta* D. S. Mitchell, *Brit. Fern Gaz.* 10: 251–252. 1972.

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Floating fronds: lamina oblong to obovate or orbicular, ca. 2.5 × 2.4–3 cm, base rounded or cordate, apex emarginate, flat

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or often infolded along costa, surface abaxially with sparse pale multicellular hairs, adaxially densely papillate, papillae cylindrical, ca. 1.5(–2) mm, terminated by (2–)4 setae incurved and joined at their tips; submersed frond to 12 cm. Sporocarps in long chains of up to 55, ca. 1 mm in diam., microsporangia up to 53, megasporangia 2(or 3), more densely hairy; most sporangia empty, spores if present deformed.

Still water, often forming very dense mats. Taiwan [throughout Old World tropics].

*Salvinia molesta* has been reported as occasionally escaping from cultivation in Taiwan. It is a very aggressive weed of hybrid origin that has been declared a noxious weed and banned from cultivation in many countries. Biological control using a weevil has been successful in some areas (R. C. Moran, Fiddlehead Forum 19: 26–28. 1992).

## 2. AZOLLA Lamarck, Encycl. 1: 343. 1783.

满江红属 man jiang hong shu

*Rhizosperma* Meyen.

Plants usually very small, floating. Stems prostrate or erect, very short and slender, easily broken, green, branching pinnate or falsely dichotomous, normally decumbent and floating on water surface, up to 5 cm above water surface when in shallow water or in crowded situations. Fronds sessile, alternate, in 2 rows along upper side of stem, usually overlapping, divided into dorsal (floating) lobe and ventral (submersed) lobe; dorsal lobe oblong or ovate, slightly concave abaxially at middle, densely papillose adaxially, fleshy, with a cavity near base containing blue-green algae (*Anabaena*), green, yellow, or red; ventral lobe shell-like, membranous, tightly imbricate, transparent, colorless, or reddish and slightly thickened near base, sometimes resembling ventral lobe when stem is erect and emergent from water. Sporocarp usually in pairs [or 4 together], at base of lateral branches; megasporocarp located under microsporocarp, oblong or ovoid, containing 1 megasporangium producing 1 functional megaspore; megaspore topped with conic structure (indusium) covering 3–9 colorless spongelike floats and an *Anabaena* colony; microsporocarps globose or peach-shaped, large, 4–6 × size of megasporocarp, umbonate at apex, wall thin and transparent, containing many microsporangia, each microsporangium containing 32 or 64 microspores, embedded in 5–8 colorless massulae, covered with various attachments according to species.  $x = 22$ .

About seven species: tropical to temperate regions worldwide; two species (one introduced) in China.

The color of the lamina can change from green to yellow or red dependent on environmental conditions (e.g., high temperature, lack of nutrients, salinity). The blue-green algae fix atmospheric nitrogen.

- 1a. Megasporangia with 9 floats on exospore, massulae with few simple or irregularly branched silklike hairs; lateral branches as many as fronds ..... 1. *A. pinnata*  
 1b. Megasporangia with 3 floats on exospore, massulae with several anchorlike hairs; lateral branches fewer than fronds ..... 2. *A. filiculoides*

1. *Azolla pinnata* R. Brown subsp. *asiatica* R. M. K. Saunders & K. Fowler, Bot. J. Linn. Soc. 109: 349. 1992.

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*Azolla imbricata* (Roxburgh) Nakai; *A. imbricata* var. *prolifera* Y. X. Lin; *A. imbricata* var. *sempervirens* Y. X. Lin; *A. pinnata* var. *imbricata* (Roxburgh) Bonaparte; *Salvinia imbricata* Roxburgh.

Plants ovate or triangular in outline. Stems slender and creeping, lateral branches axillary, falsely dichotomous, with downward-growing fibrous roots. Fronds as small as sesame seeds, alternate, sessile, imbricate in 2 rows, trapezoidal blade parted into dorsal and ventral lobe; floating dorsal lobes green, or usually becoming purplish after autumn, oblong or ovate, cormous, colorless at margin, densely papillose; submersed ventral lobes ± purplish red, or colorless and transparent, shell-like. Sporocarps in pairs; megasporocarp small, narrowly ovate, apex beaked; megasporangium with 9 floats in 2 rows around it, upper 3 floats larger, lower 6 floats smaller; microsporocarps large, globose or peach-shaped, apex with a short beak, microsporangia long stalked, each containing 64 microspores; microspores individually embedded in 5–8 massulae, massulae with silklike hairs on surfaces.

Floating on ponds, paddy fields, irrigation ditches, widely distributed in the Chang Jiang valley. Anhui, Fujian, Guangdong, Guangxi, Guizhou, Hebei, Henan, Hubei, Hunan, Jiangsu, Jiangxi, Liaoning, Shandong, Shanxi, Sichuan, Taiwan, Yunnan, Zhejiang [Bangladesh, India, Indonesia, Japan, Korea, Malaysia, Myanmar, Pakistan, Philippines, Sri Lanka, C Thailand, Vietnam].

This species has been long cultivated as a fertilizer (upon decomposition) in rice paddies of SE China.

The whole plant is used as green manure and forage; it is used medicinally to induce perspiration, promote diuresis, and to treat a variety of other conditions.

Saunders and Fowler (Bot. J. Linn. Soc. 109: 329–357. 1992) recognized three subspecies within *Azolla pinnata*: *A. pinnata* subsp. *pinnata*, restricted to E and N Australia; *A. pinnata* subsp. *asiatica*; and *A. pinnata* subsp. *africana* (Desvaux) R. M. K. Saunders & K. Fowler, restricted to Africa and Madagascar. *Azolla pinnata* subsp. *asiatica* is separated by the laxer fronds with short, wide submersed lobes (L:B ratio ± 1.2) and the megaspore surface with long prostrate or erect processes. The other subspecies have overlapping fronds with narrower submersed lobes (L:B ratio ± 1.7) and the megaspore surface with generally short tubercles.

*Azolla pinnata* subsp. *asiatica* has been divided into three varieties, but these were not accepted by Saunders and Fowler. Their morphological characters and geographic distribution are presented below.

*Azolla imbricata* var. *imbricata*: Dorsal lobes of fronds turning from green to reddish from autumn to winter or during hot summertime; plants usually sterile or producing few sporocarps and reproducing vegetatively. Widely distributed in Chang Jiang valley, also in Taiwan [Japan, Korea].

*Azolla imbricata* var. *prolifera* Y. X. Lin (Acta Phytotax. Sin. 18: 454. 1980; 多果满江红 *duo guo man jiang hong*): Plants producing many sporocarps during autumn and dying in winter, reproducing by spores in following year. Henan, Shandong.

*Azolla imbricata* var. *sempervirens* Y. X. Lin (Acta Phytotax. Sin. 18: 454. 1980; 常绿满江红 *chang lu man jiang hong*): Dorsal lobes of fronds evergreen; ventral lobes colorless and transparent, not purplish red. Fujian, Guangdong, Guangxi, Zhejiang [Vietnam].

**2. *Azolla filiculoides*** Lamarck, Encycl. 1: 343. 1783.

细叶满江红 *xi ye man jiang hong*

*Azolla japonica* Franchet & Savatier; *A. pinnata* R. Brown var. *japonica* (Franchet & Savatier) Franchet & Savatier.

Plants more robust than *Azolla imbricata*. Lateral branches axillary, numbers of lateral branches less than fronds of stem; when in shallow water or wet places or plants in crowded situations, stems becoming erect and dorsal lobes changing to ventral ones. Sporangium with 3 floats on exospore; massulae of microsporangium covered with anchorlike hairs.

Cultivated and escaped, rice fields, ponds, ditches. Widely distributed in the Chang Jiang valley, also in S China, including Taiwan [Japan; NE Asia, Europe, North and South America, Pacific islands].

The whole plant of *Azolla filiculoides* is used as green manure and forage.