

## LEMNACEAE

浮萍科 fu ping ke

Li Heng (李恒 Li Hen)<sup>1</sup>; Elias Landolt<sup>2</sup>

Herbs, mostly perennial, minute, aquatic, floating or submersed, reduced to small green bodies called fronds corresponding partly to leaf and partly to stem. Roots absent or 1–21, filiform, arising from lower surface of frond; root hairs absent. Fronds 1 to many coherent together, orbicular or oblong to lanceolate and flat or convex (gibbous) on lower surface, or globose to ovoid, 0.4–15 mm, with or without veins; daughter fronds successively formed from 1 basal cavity or 2 basal pouches detaching or remaining attached for many weeks, bases of pouches sometimes surrounded by a small, membranous scale (prophyll) covering bases of roots. Node (point of origin of veins, roots, and daughter fronds) situated ca. 1/3 from base toward apex. Turions (in some species) formed under unfavorable conditions, frondlike but smaller, compact, sinking to bottom. Flowers (interpreted as inflorescences by some authors) rarely seen in most species, 1(or 2), emerging from one of pouches or from a cavity near median line on upper surface, sometimes surrounded by a small, utricular, membranous scale (corresponding to a spathe in the Araceae); perianth absent; stamens 1 or 2; pollen grains ulcerate, exine spinulose; ovary 1, bottle-shaped, 1–7-ovuled, tapering into short style; stigma funnel-shaped. Fruit indehiscent, opening by bursting.

Five genera and 38 species: worldwide in aquatic ecosystems; four genera and eight (possibly nine) species in China.

In the opinion of the present authors, it is too early to decide if the Lemnaceae should be included within the Araceae. While this placement has been supported by some phylogenetic studies, only a few species of Lemnaceae have been investigated so far. Before the whole spectrum of variability of molecular characteristics of the Lemnaceae is known, it would be unwise to change the status. The Lemnaceae are a well-characterized entity of taxa, whereas the Araceae are a heterogeneous group. It is very difficult to find common characters in the Lemnaceae and Araceae. The flowering organ is not at all decisive. It is not even certain if the flowering organ of the Lemnaceae is a flower or a reduced inflorescence. It is also very difficult to find special common characters between Lemnaceae and the genera that are placed nearest to them according to phylogenetic studies.

Different species of Lemnaceae are often found sympatric at the same habitats; sometimes they are associated with various kinds of aquatic ferns and vascular plants. They usually grow gregariously and with rapid reproduction (up to doubling within 24 hours). The fronds of all species are commonly utilized as high-quality feed for domestic animals, fish, and fowl.

Li Hen. 1979. Lemnaceae. In: Wu Cheng yih & Li Hen, eds., Fl. Reipubl. Popularis Sin. 13(2): 206–211.

- 1a. Fronds rootless, without veins, each frond with 1 basal cavity reproducing daughter fronds; flower emerging from a cavity near median line of upper surface, not surrounded by scale; stamen 1, 2-locular; seed 1, subsmooth ..... 4. *Wolffia*
- 1b. Fronds with 1–21 roots, with 1–21 veins, each frond with 2 lateral pouches at base reproducing daughter fronds and (rarely in most species) 1 flower; flower surrounded by small, utricular, membranous scale; stamens 2, 4-locular; seeds 1–5, longitudinally ribbed.
  - 2a. Fronds with 1 root and 1–5(–7) veins, without a scale at base ..... 3. *Lemna*
  - 2b. Fronds with 2–21 roots and (3–)5–21 veins, surrounded at base by a small membranous scale covering point of attachment of roots.
    - 3a. Fronds 1–1.5 × as long as wide, with 7–16(–21) veins, with (5–)7–21 roots, flat, rarely slightly gibbous; 1(or 2) roots perforate covering scale ..... 1. *Spirodela*
    - 3b. Fronds 1.5–3 × as long as wide, with (3–)5–7 veins, with (1 or)2–7(–12) roots, flat or gibbous; all roots perforate covering scale ..... 2. *Landoltia*

### 1. SPIRODELA Schleiden, Linnaea 13: 391. 1839.

紫萍属 zi ping shu

Fronds free floating, 1–10 individuals coherent together, shiny green on upper surface, usually red on lower surface, outline usually asymmetric, flat on upper surface, rarely slightly gibbous on lower surface; 2 lateral pouches for reproducing daughter fronds and flowers present at base, bases of pouches surrounded by a small membranous scale covering bases of roots; veins 7–16(–21), splitting from node toward apex, sometimes visible on upper surface. Pigment cells present (visible in dried fronds as brown dots). Roots (5–)7–21, surrounded by a tubular sheath at base, enclosed by a rounded to pointed cap at apex. Daughter fronds connected to mother frond by a thin white stipe. Flower surrounded by a small, utricular, membranous scale with a narrow opening at apex; stamens 2, 4-locular. Seeds 1–3, ribbed longitudinally.

Two species: one species worldwide, the other restricted to Central and South America; one species in China.

**1. *Spirodela polyrhiza*** (Linnaeus) Schleiden, Linnaea 13: 392. 1839.

紫萍 zi ping

*Lemna polyrhiza* Linnaeus, Sp. Pl. 2: 970. 1753.

Fronds obovate to orbicular, 3–10 mm, 1–1.5 × as long as wide, flat, rarely gibbous, sometimes with indistinct papillae on

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upper surface along veins. Roots (5–)7–21, 1(or 2) perforating scale, 0.5–3 cm. Turions sometimes present, without roots, brownish to olive, orbicular to reniform, 1–2 mm. Ovary with 1 or 2 ovules. Fruit laterally winged toward apex. Seed with 12–20 ribs. Fl. (very rare) Jun–Sep.  $2n = 30, 32, 38, 40^*, 50, 80$ .

Ponds, lakesides, rice fields, pools, ditches; not seen in regions with cool summers; sea level to 2900 m. Anhui, Fujian, Guangdong, Guangxi, Guizhou, Hebei, Heilongjiang, Henan, Hubei, Hunan,

Jiangsu, Jiangxi, Jilin, Liaoning, Qinghai, Shaanxi, Shandong, Shanxi, Sichuan, Taiwan, Yunnan, Zhejiang [worldwide].

A variety, *Spirodela polyrhiza* var. *masonii* Daubs was proposed for the ecotype, which has gibbous fronds. This variety, however, occurs only rarely throughout the whole distribution range, so the use of this name is not systematically necessary.

*Spirodela polyrhiza* is used as a Chinese medicinal herb for diuretic effect, for reducing swelling, and for reducing perspiration.

## 2. LANDOLTIA Les & D. J. Crawford, Novon 9: 532. 1999.

兰氏萍属 lan shi ping shu

Fronds free floating, 1–10 coherent together, shiny green on upper surface, often red on lower surface, outline usually asymmetric, flat or gibbous; 2 basal lateral pouches for reproducing daughter fronds and flowers present, bases of pouches surrounded by small membranous scale covering bases of roots; veins (3–)5–7, splitting from node toward apex, often visible on upper surface. Pigment cells present (visible in dried fronds as brown dots). Roots (1 or)2–7(–12), surrounded by a tubular sheath at base, enclosed by a rounded or pointed cap at apex. Daughter fronds connected to mother frond by thin white stipe. Flower surrounded by a small, utricular, membranous scale with a slit on one side (rarely on two sides); stamens 2, 4-locular. Seeds 1(or 2), ribbed longitudinally.

One species: possibly native to SE Asia and Australia, now invaded to Nearctic, Afrotropical, and Neotropical regions.

**1. *Landoltia punctata*** (G. Meyer) Les & D. J. Crawford, Novon 9: 532. 1999.

兰氏萍 lan shi ping

*Lemna punctata* G. Meyer, Prim. Fl. Esseq. 262. 1818; *L. oligorrhiza* Kurz; *Spirodela oligorrhiza* (Kurz) Hegelmaier; *S. punctata* (G. Meyer) C. H. Thompson; *S. sichuanensis* M. G. Liu & K. M. Xie.

Fronds obovate to elliptic, 1.5–8 mm, 1.5–3 × as long as wide, flat or gibbous, usually with papillae on upper surface along midvein. Roots (1 or)2–7(–12), all perforating scale, 0.5–7 cm. Turions not seen. Ovary with 1 or 2 ovules. Fruit laterally

winged toward apex. Seed with 10–15 distinct ribs. Fl. (rare) Jun–Sep.  $2n = 40^*, 46, 50$ .

Ponds, lakesides, pools, ditches; in regions with mild winters and not very hot summers; sea level to 2400 m. Fujian, Henan, Hubei, Sichuan, Taiwan, Xizang, Yunnan, Zhejiang [India, Indonesia, Japan, Malaysia, Philippines, Thailand, Vietnam; Africa, Australia, North and South America, Pacific islands].

*Spirodela sichuanensis* was thought to be distinct from *Landoltia punctata* (as *S. punctata*) by its utricular scale surrounding the flower having two lateral slits instead of one as in *L. punctata*. However, two slits can be occasionally observed from various geographical races of *L. punctata*. Due to the rarity of flowering, the frequency of this character is hard to estimate. In general, all the vegetative characters of *S. sichuanensis* are included in the range of morphological variation of *L. punctata*.

## 3. LEMNA Linnaeus, Sp. Pl. 2: 970. 1753.

浮萍属 fu ping shu

Fronds free floating on water surface or submersed, 1 to many individual fronds coherent together, green on upper surface, sometimes red on lower surface, symmetric or asymmetric in shape, flat or sometimes gibbous on lower surface; 2 lateral pouches reproducing daughter fronds and flower present at base, bases of pouches not surrounded by a scale; veins 1–5(–7), splitting from node toward apex. Pigment cells absent. Root 1, sometimes dropped off or lacking (*Lemna trisulca*), surrounded by a short tubular sheath at base and enclosed by a cap at apex. Daughter fronds connected to mother frond by a thin white stipe or a green stalk (*L. trisulca*). Flower surrounded by small, utricular, membranous scale; stamens 2, 4-locular. Seeds 1–5, longitudinally ribbed.

Thirteen species: nearly cosmopolitan; five (possibly six) species in China.

- 1a. Fronds submersed (except when flowering or fruiting), often forming branched chains, at base narrowed into green stalk, margin denticulate distally ..... 1. *L. trisulca*
- 1b. Fronds floating upon water surface, solitary or forming small groups, rounded at base, without green stalk, margin entire.
- 2a. Frond with 1 vein ..... *L. minuta*
- 2b. Frond with 3–5 veins.
- 3a. Root sheath winged at base; root shorter than 3 cm; fronds without reddish color ..... 5. *L. aequinoctialis*
- 3b. Root sheath not winged at base; root 0.5–15(–19) cm; fronds sometimes reddish, deep red, or with reddish spots on lower or upper surface.
- 4a. Plants often with small, olive-brown, rootless turions, which sink to bottom ..... 2. *L. turionifera*
- 4b. Plants without distinct turions.

- 5a. Fronds with mostly distinct papillae on midline of upper surface; greatest distance between lateral veins near or distal to middle ..... 2. *L. turionifera*  
 5b. Fronds with distinct papillae only above node and apex; greatest distance between lateral veins near or proximal to middle.  
 6a. Fronds often reddish or red on lower surface (more intensely so than on upper), flat or slightly gibbous ..... 3. *L. japonica*  
 6b. Fronds always green on lower surface, sometimes reddish on upper surface, flat ..... 4. *L. minor*

**1. *Lemna trisulca*** Linnaeus, Sp. Pl. 2: 970. 1753.

品藻 pin zao

Fronds (except when flowering or fruiting) submersed, 3–50 coherent in one group and often forming branched chains, attenuate at base into green connecting stalk 2–20 mm, green and subhyaline, sometimes purplish, narrowly ovate to elliptic, 3–15 mm (without stalk), 2–3.5 × as long as wide, flat, without papillae on upper surface, margin denticulate distally; veins 3, rarely 1, central vein approximating apex, lateral veins ca. 1/2 of frond length. Root 0.5–2.5 cm, often lacking, sheath not winged, apex mostly pointed. Turions absent. Flowering and fruiting fronds free floating on water surface, 1–5 coherent, 3–5 mm. Ovary with 1 ovule; utricular scale with narrow opening at apex. Fruit laterally winged toward apex. Seed with 12–18 distinct ribs. Fl. (rare) May–Sep.  $2n = 20, 40, 42, 60, 63, 80$ .

Lakesides, spring pools, ponds; in regions with cool temperate climate; sea level to 3000 m. Anhui, Hebei, Heilongjiang, Hubei, Jiangsu, Nei Mongol, Shaanxi, Shanxi, Sichuan, Taiwan, Xinjiang, Yunnan, Zhejiang [worldwide except South America].

**2. *Lemna turionifera*** Landolt, Aquatic Bot. 1: 355. 1975.

鳞根萍 lin gen ping

Fronds free floating on water surface, 1–8 coherent in one small group, without green stalk at base (but with a thin white stipe connecting fronds), shiny green, sometimes with reddish spots on upper surface, red on lower surface (always deeper red on lower surface than on upper), obovate, 1.5–4 mm, 1–1.5 × as long as wide, flat, with distinct papillae on midline of upper surface, margin entire, base rounded; veins 3, nearly reaching apex, greatest distance between lateral veins near or distal to middle, lateral veins outcurved medially. Root 0.5–1.5 cm, sheath not winged, apex rounded (to pointed). Turions often present, rootless, olive-brown, 0.5–1.5 mm. Ovary with 1 ovule; utricular scale with narrow opening at apex. Fruit not winged toward apex. Seed with 30–60 indistinct ribs. Fl. (rare) Jun–Sep.  $2n = 40, 42, 50, 80$ .

Lakesides, spring pools, ponds, slow-flowing streams; in regions with continental cool-temperate climate; sea level to 3000 m. Anhui, Hebei, Heilongjiang, Nei Mongol [N Japan, Korea, Mongolia, Russia; C and SW Asia, North America; introduced in Europe].

**3. *Lemna japonica*** Landolt, Veröff. Geobot. Inst. E.T.H. Stiftung Rübél Zürich 70: 23. 1980.

日本浮萍 ri ben fu ping

*Lemna leiboensis* M. G. Liu & C. H. You.

Fronds free floating on water surface, 1–8 coherent in one group, without green stalk at base (but with a thin white stipe connecting fronds), shiny green, sometimes reddish or red

on lower surface (always deeper red on lower surface than on upper), obovate to elliptic, 2–6(–7) mm, 1.3–1.8 × as long as wide, flat or slightly gibbous on lower surface, with mostly distinct papillae on upper surface near apex and above node and indistinct ones along midline, margin entire, base rounded; veins 3(–5), nearly reaching apex, greatest distance between lateral veins near or proximal to middle, lateral veins outcurved medially. Root 0.5–1.5(–1.8) cm, sheath not winged, apex rounded (to pointed). Turions absent. Ovary with 1 ovule; utricular scale with narrow opening at apex. Fruit not known. Fl. (very rare) Jul–Oct.  $2n = 40^*, 50, 63$ .

Lakesides, pools, ponds, ditches; in regions with moderately temperate to warm-temperate climate; sea level to 2900 m. Hebei, Heilongjiang, Henan, Hubei, Jiangsu, Nei Mongol, Shaanxi, Shandong, Shanxi, S Sichuan, Yunnan, Zhejiang [Japan, Korea].

*Lemna japonica* may have originated from hybridization between *L. minor* and *L. turionifera*.

*Lemna leiboensis*, described from S Sichuan, most likely is conspecific with *L. japonica*. It can only be distinguished by its larger fronds, conspicuous veins, and pointed root caps. However, these characters are shared by *L. japonica* as well.

**4. *Lemna minor*** Linnaeus, Sp. Pl. 2: 970. 1753.

浮萍 fu ping

Fronds free floating on water surface, 1–8 coherent in one small group, without green stalk at base (but with a thin white stipe connecting fronds), shiny green, sometimes reddish on upper surface, scarcely reddish on lower surface (always deeper red on upper surface than on lower), obovate to elliptic, 2–6(–10) mm, 1.3–2 × as long as wide, flat, with mostly distinct papillae on upper surface near apex and above node, margin entire, base rounded; veins 3(–5), nearly reaching apex, greatest distance between lateral veins near or proximal to middle. Root 0.5–1.5 cm, sheath not winged, apex mostly rounded. Turions absent. Ovary with 1 ovule; utricular scale with narrow opening at apex. Fruit winged laterally toward apex. Seed with 10–16 distinct ribs. Fl. (rare) May–Sep.  $2n = 20, 40, 42, 50, 63, 126$ .

Lakesides, pools, ponds, ditches, slow-flowing streams; in regions with suboceanic cool- to moderately temperate climate; (sea level to) 2000–3000 m. W Xizang [Afghanistan, N India, Kazakhstan, Nepal, N Pakistan, W Russia, Turkmenistan; Africa, SW Asia, Europe, North America; introduced in Australia, Japan, and Pacific islands (New Zealand)].

**5. *Lemna aequinoctialis*** Welwitsch, Apont. 578. 1859.

稀脉浮萍 xi mai fu ping

*Lemna paucicostata* Hegelmaier; *L. perpusilla* Torrey var. *trinervis* Austin; *L. trinervis* (Austin) Small.

Fronds free floating on water surface, 1–8 coherent in one small group, without green stalk at base (but with a thin white stipe connecting fronds), shiny bright green, without reddish color, obovate to lanceolate, 1.5–4(–6.5) mm, 1–3 × as long as wide, flat, with distinct papillae on upper surface near apex and above node, margin entire, base rounded; veins 3, nearly reaching apex, lateral veins outcurved at middle. Root 0.5–3 cm, sheath winged toward base, apex pointed. Turions absent. Ovary with 1 ovule; utricular scale with slit on one side. Fruit not winged. Seed with 8–24 distinct longitudinal ribs. Fl. (frequent) all seasons.  $2n = 20, 40^*, 42, 50^*, 60, 70, 80, 84$ .

Lakesides, pools, ponds, rice fields, ditches; in regions with warm-temperate to tropical climate; sea level to 2800 m. Anhui, Fujian, Guangdong, Guizhou, Hebei, Henan, Hubei, Jiangsu, Jiangxi, Liaoning, Qinghai, Shaanxi, Shandong, Shanxi, Taiwan, Yunnan, Zhejiang [world-wide].

The plants with large thin fronds and conspicuous veins and without distinct papillae are often called *Lemna trinervis*. These characters, however, can be observed easily in most geographical races of *L. aequinoctialis*.

In FRPS (13(2): 210. 1979), the name *Lemna perpusilla* Torrey was misapplied to this species.

#### Species possibly occurring in China

***Lemna minuta*** Kunth in Humboldt et al., Nov. Gen. Sp. 1, ed. 4<sup>o</sup>: 372. 1816.

单脉萍 dan mai ping

*Lemna minima* Philippi; *L. minuscula* Herter.

Fronds free floating on water surface, 1–8 coherent in one small group, without green stalk at base (but with a thin white stipe connecting fronds), bright green, without reddish color, obovate, 0.8–4 mm, 1–2 × as long as wide, flat to thickish (but not gibbous on lower surface), with or without indistinct papil-

lae on midline of upper surface, margin entire, base rounded; vein 1, not longer than 2/3 of distance between node and apex. Root 0.2–1.5 cm, sheath not winged, apex rounded to pointed. Turions absent. Ovary with 1 ovule; utricular scale with slit on one side. Fruit not winged. Seed with 12–15 distinct ribs. Fl. (very rare) May–Sep.  $2n = 36, 40, 42$ .

Lakesides, spring pools, ponds, ditches; in regions with suboceanic moderately temperate to warm-temperate climate; sea level to 3000 m [data from general distribution]. Not formally documented in China but expected from further investigation [native to America; introduced elsewhere].

#### 4. **WOLFFIA** Horkel ex Schleiden, Beitr. Bot. 1: 233. 1844, nom. cons., not *Wolffia* Schreber (1791).

无根萍属 wu gen ping shu

Fronds free floating on or beneath water surface, 1 or 2 coherent together, green on upper surface, green to transparent on lower surface, never reddish, symmetric, globose, ovoid, or boat-shaped, with 1 basal cavity reproducing daughter fronds, cavity not surrounded by a scale at base; veins absent. Pigment cells (in our species) absent in vegetative cells. Roots absent. Daughter fronds connected to mother frond by a very short stipe (not visible). Flower emerging from a cavity near median line of upper surface, not surrounded by a scale; ovary with 1 ovule; stamen 1, 2-locular. Seed 1, subsmooth.

Eleven species: nearly cosmopolitan; one species in China.

**1. *Wolffia globosa*** (Roxburgh) Hartog & Plas, Blumea 18: 367. 1970.

无根萍 wu gen ping

*Lemna globosa* Roxburgh, Fl. Ind., ed. 1832, 3: 565. 1832.

Fronds free floating on or just below water surface, green on upper surface, transparent green on lower surface, ovoid, 0.4–0.8 mm, 1.3–2 × as long as wide, 1–1.5 × as deep as wide, rounded or slightly pointed at apex; papillae absent. Turions

sometimes present, whitish green, globose, 0.2–0.8 mm. Fl. (very rare) Jun–Sep.  $2n = 16, 23, 30, 40^*, 46, 50, 60$ .

Lakesides, pools, ponds, ditches; in regions with warm-temperate to tropical climate; sea level to 1300 m. Fujian, Guangdong, Hainan, Henan, Hubei, Jiangsu, Jilin, Sichuan, Taiwan, Yunnan, Zhejiang [Bangladesh, Cambodia, India, Indonesia, Japan, Laos, Malaysia, Myanmar, Nepal, Pakistan, Philippines, Singapore, Sri Lanka, Thailand, Vietnam; introduced in North and South America].

In FRPS (13(2): 211. 1979), the name *Wolffia arrhiza* (Linnaeus) Horkel ex Wimmer was misapplied to this species.