

LEMNACEAE DUCKWEED FAMILY

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Small aquatic plants floating free on or in the water, reduced to small leaf-like or spherical fronds, rootless or with 1-21 roots (without root hairs). --FRONDS single or two to many cohering together at base, 0.05-1.5 cm long (without stalk) and 0.03-1 cm wide, thin or thick; turions present in some species (turion: a compact frond reduced in size and structure, filled with starch grains, formed under unfavorable conditions, lies dormant in the ground). FLOWERS (in many species rare) 1-2 per frond, mostly perfect; sepals and petals none; stamens 1 or 2; ovary 1, bottle-shaped, tapering into the short style, the stigma funnel-shaped. FRUITS with dry pericarp, 1-5 seeded. --4 genera, 34 spp.; worldwide distribution, except arctic and antarctic zones. Landolt, E. 1986. Veröff. Geobot. Inst. ETH, Stiftung Rübél, Zürich 71: 1-566.

Proper identification of Lemnaceae requires a microscope. Frond shape and papillae are best seen in living material or fronds conserved in 70% alcohol. Colors can only be seen in living or carefully dried specimens. Fall is the best time to detect anthocyanin coloring and turions. In order to see nerves and air spaces well the fronds must be made transparent (*e.g.*, boiled in 70% alcohol and immersed in 14% NaOCl) and stained with Alum Carmine.

1. Roots (0-)1-21 per frond; fronds with 1-21 nerves, the daughter fronds and flowers originating from 2 lateral pouches at the base of frond; flowers surrounded by a small, utricular, membranous scale (prophyllum), with 2, 4-locular stamens; seeds longitudinally ribbed.
2. Roots (1-)2-21 per frond; fronds with (3-)5-21 nerves, surrounded at the base by a small scale (prophyllum) covering the point of attachment of the roots; pigment cells present (visible in dead fronds as brown dots) *Spirodela*
- 2' Roots 1 per frond; fronds with 1-5(-7) nerves, without a scale at the base; pigment cells absent (but red pigmentation present in some species) *Lemna*
- 1' Roots absent; fronds without nerves, the daughter fronds originating from a single terminal pouch or cavity at base of the frond, the flower originating in a cavity of the upper frond surface; flowers without a scale, with 1, 2-locular stamen; seeds nearly smooth *Wolffia*

Lemna L. Duckweed

FRONDS floating on or below the surface of the water, lanceolate to ovate, with entire or denticulate margins, flat or gibbous, with air spaces in tissue, with two triangular lateral reproductive pouches at the base from which daughter fronds and flowers originate, without a scale at the base; nerves 1-5(-7); root 1; anthocyanins sometimes present; pigment cells absent. FLOWERS 1(-2) per frond, surrounded by a scale; stamens 2, 4-locular. SEEDS 1-5, longitudinally ribbed. --13 spp.; worldwide (except arctic and antarctic zones). (Greek name of a water plant).

1. Fronds submerged (except when flowering or fruiting), 2-3.5 times as long as wide, with a green stalk 2-20 mm long; margins distally denticulate *L. trisulca*
- 1' Fronds floating on the water's surface, 1-2 (-3) times as long as wide, with a very small white stipe, that often decays (no green stalk present); margins entire.
 2. Fronds with 3-5(-7) nerves.
 3. Root sheath not winged; root tip mostly rounded; roots often longer than 3 cm; fronds often with reddish tinge or spots of anthocyanins.

- 4. Plants forming small, olive to brown, rootless turions which sink to the ground *L. turionifera*
- 4' Plants without turions.
 - 5. Largest air spaces normally more than 0.3 mm in diameter; fronds often gibbous, the red coloring of the lower surface beginning at the margin (not from the attachment point of the root); nerves (3-)4-5(-7) (the lateral nerves originating independently from the node); ovary 1-7-ovulate *L. gibba*
 - 5' Largest air spaces normally less than 0.3 mm in diameter; fronds rarely gibbous, the red coloring of the lower surface beginning from the attachment point of the root; nerves 3 (rarely 4-5 but then the outer nerves originating from the lower part of the inner ones); ovary 1-ovulate.
 - 6. Fronds often reddish colored on the lower surface (more intensely so than on the upper surface); greatest distance between the lateral nerves near or above the middle; seed with 30-60 ribs *L. turionifera*
 - 6' Fronds not reddish on the lower surface(or at least much less so than on the upper surface); greatest distance between the lateral nerves usually near or below the middle; seed with 10-16 ribs *L. minor*
- 3' Root sheath winged at the base; root tip usually sharply pointed; roots never longer than 3 cm; fronds without reddish color *L. aequinoctialis*
- 2' Fronds with 1 nerve.
 - 7. Nerve mostly prominent, longer than the extension of the air spaces, or running through at least 3/4 of the distance between the attaching point of the root and the tip *L. valdiviana*
 - 7' Nerve sometimes indistinct, very rarely longer than the extension of the air spaces, not longer than 2/3 of the distance between the attaching point of the root and the tip *L. minuta*

Lemna aequinoctialis Welwitsch (from equatorial region). --FRONDS floating on the surface of the water, single or 2 to a few cohering in small groups, ovate, 1-6 mm long, 1-3 times as long as wide, flat, without a green stalk but with a very small white stipe that often decays; margins entire; nerves 3, the greatest distance between the laterals near the middle; papillae near the apex and above the attachment point of the root mostly very distinct; anthocyanin absent; air spaces much smaller than 0.3 mm; root up to 3 cm long; sheath winged at the base, the tip normally sharply pointed; no distinct turions present. FLOWERS frequent, 1-ovulate, the small utricular scale open on one side. FRUIT 0.5-0.8 mm long, not winged. SEEDS with 8-26 distinct ribs. $2n = 20, 40, 42, 50, 60, 70, 80, 84$. [*L. paucicostata* Hegelm., *L. perpusilla* auct. non Torrey]. --Mesotrophic (with moderate amounts of nutrients) to eutrophic (with high amounts of nutrients), quiet waters: Cochise, Graham, Navajo, Pima, Santa Cruz cos.; below 1200 m (4000 ft); May-Oct; worldwide, mostly tropical and subtropical zones. *Lemna perpusilla* Torrey, a closely related species, has seeds with 35-70 indistinct ribs and is endemic to the eastern and central states of the U.S. (southwards to Dallas Co., TX).

Lemna gibba L. (swelling). --FRONDS floating on the surface of the water, single or 2 to a few cohering in small groups, obovate, 1-8 mm long, 1-1.5 times as long as wide, often gibbous, without a green stalk but with a very small white stipe that often decays; margins entire; nerves (3-)4-5(-7), the greatest distance between the laterals near or above the middle; distinct papillae absent; upper surface occasionally with distinct red spots; lower surface sometimes red colored, the red coloring beginning from the margins; largest air spaces wider than 0.3 mm; root up to 15 cm long, the sheath unwinged, the tips mostly rounded; no distinct turions present. FLOWERS frequent, 1-7-ovulate, the small utricular scale with a narrow opening at the top. FRUIT 0.6-1.0 mm long, laterally winged. SEEDS with 8-16 distinct ribs. $2n = 40, 42, 44, 50, 60, 64, 70, 80, 84$. --Eutrophic, quiet waters: Apache, Cochise, Graham, La Paz, Maricopa, Mohave, Pima, Pinal, Santa Cruz, Yavapai cos.; below 1800 m (6000 ft); Mar-Sep; worldwide (except Australia), restricted to oceanic temperate and subtropical zones.

Lemna minor L. (lesser). --FRONDS floating on water's surface, single or 2 to a few cohering in small groups, ovate, 1-8 mm long, 1.3-2 times as long as wide, flat, without a green stalk but with a very small white stipe that often decays; margins entire; nerves 3-5 (the outer ones originating from the lower part of the inner ones), the greatest distance between the laterals near or below the middle; papillae not always distinct (the one near the apex usually larger); upper surface occasionally diffusely reddish; lower surface very seldom slightly reddish (much less than the upper one); largest air spaces up to 0.3 mm wide; root up to 15 cm long, the sheath unwinged, the tip mostly rounded; no distinct turions present. FLOWERS rare, 1-ovulate, the small utricular scale with a narrow opening at the top. FRUIT laterally winged. SEEDS with 8-15 distinct ribs. $2n = 20, 30, 40, 42, 50, 63, 126$. --Mesotrophic to eutrophic, quiet waters: Coconino Co., Lindberg Springs, (B. Blumer 1975, ARIZ); ca. 2100 m (7000 ft); Jun-Aug; worldwide (except S. Amer.), temperate zones.

Lemna minuta H.B.K. (tiny). --FRONDS floating on the water's surface, single or 2 to a few cohering in small groups, obovate, 0.8-4.0 mm long, 1-2 times as long as wide, flat to thickish (but not gibbous), without a green stalk but with a very small white stipe that often decays; margins entire; nerve 1, sometimes indistinct, very rarely longer than the extension of the air spaces, not longer than 2/3 of the distance between the attaching point of the root and the apex; papillae small, present or not on midline; anthocyanin absent; air spaces much smaller than 0.3 mm; root up to 1.5 cm long, the sheath unwinged, the tip rounded or somewhat pointed; turions absent. FLOWERS rather rare, 1-ovulate, the small utricular scale open on one side. FRUIT 0.6-1.0 mm long, not winged. SEEDS with 12-15 ribs. $2n = 36, 40, 42$. [*L. minima* Phil., *L. minuscula* Herter]. --Mesotrophic to slightly eutrophic, quiet waters: Apache, Cochise, Coconino, Greenlee, La Paz, Maricopa, Pima, Santa Cruz, Yavapai, Yuma cos.; below 2100 m (7000 ft); May-Sep; Amer., but introduced onto most other continents, not present in zones with very cold winters.

Lemna trisulca L. (with three furrows). --FRONDS submerged, 3-50 cohering and very often forming branched chains, narrowly ovate, 3-15 mm long (without stalk), 2-3.5 times as long as wide, flat and thin, narrowed at the base into a 2-20 mm long green stalk; margins distally denticulate; nerves (1-)3, the laterals only in the lower part of the frond; papillae absent; anthocyanin often present; air spaces smaller than 0.3 mm; root up to 2.5 cm long (sometimes not developed), the sheath unwinged, the tip pointed; turions absent. FLOWERS rare (the flowering fronds floating on the water's surface), 1-ovulate, the small utricular scale with a narrow opening at the top. FRUIT 0.6-0.9 mm long, laterally winged towards the top. SEEDS with 12 to 18 distinct ribs. $2n = 20, 40, 42, 44, 60, 63, 80$. --Mesotrophic, quiet waters rich in calcium: Apache Co.; 2100-2700 m (7000-9000 ft); May-Aug; worldwide (except S. Amer.), restricted to cool temperate zones.

Lemna turionifera Landolt (turion bearing). --FRONDS floating on the water's surface, single or 2 to a few cohering in small groups, obovate, 1-4 mm long, 1-1.5 times as long as wide, flat, scarcely gibbous, without a green stalk but with a very small white stipe that often decays; margins entire; nerves 3, the greatest distance between the laterals near or above the middle; papillae distinct on midline, the apical papilla not larger than the others); upper surface (especially near the apex) sometimes with red spots; lower surface often red colored, the red coloring beginning at attachment point of the root; largest air spaces up to 0.3 mm long; root up to 15 cm long, the sheath unwinged, the tip mostly rounded; turions sometimes present, small, rootless, olive to brown. FLOWERS occasional, 1-ovulate, the small utricular scale with a narrow opening at the top. FRUIT 0.5-0.6 mm long, not winged. SEEDS with 30-60 indistinct ribs. $2n = 40, 42, 50, 80$. --Mesotrophic to eutrophic, quiet waters: Apache, Coconino, Mohave, Navajo, Pinal, Yavapai cos.; 1500-2700 m (5000-9000 ft); Jun-Aug; Northern Hemisphere (temperate zones).

Lemna valdiviana Phil. (of Valdivia). --FRONDS floating on the water's surface or (rarely) submerged, single or mostly a few cohering in groups, ovate to obovate, 1-5mm long, 1.3-3 times as long as wide, flat and thin, without a green stalk but with a very small white stipe that often decays; margins entire; nerve 1, mostly prominent, longer than the extension of the air spaces or running through at least 3/4 of the distance

between the attaching point of the root and the apex; papillae small, present or absent along the midline; anthocyanin absent; air spaces much smaller than 0.3 mm; root up to 1.5 cm long, the sheath unwinged, the tip rounded to somewhat pointed; no distinct turions present. FLOWERS very rare, 1-ovulate, the small utricular scale open on one side. FRUIT 1.0-1.35 mm long, not winged. SEEDS with 15-29 ribs. $2n = 40, 42$. --Mesotrophic, quiet waters: Apache, Pima cos.; below 1800 m (6000 ft); May-Jul; Amer., zones with mild winters.

Spirodela Schleiden Duck-meal

FRONDS floating on the water's surface (only turions sink to the ground), 2 to a few cohering, each obovate to circular, flat or sometimes gibbous, surrounded at the base by a small bifid scale covering the point of attachment of the roots, with two triangular lateral reproductive pouches at the base from which daughter fronds and flowers originate; margins entire; air spaces present; nerves (3-)5-21; roots (1-)2-21; anthocyanins (especially on the lower surface) and pigment cells present (visible in dead fronds as brown dots). FLOWERS 1(-2) per frond, surrounded by a small utricular scale, the stamens 2, 4-locular. SEEDS 1-3, longitudinally ribbed. --3 spp.; world-wide distribution except arctic and antarctic zones. (Greek: *Speira* = winding + *delos* = distinct).

1. Fronds 1-1.5 times as long as wide, with 7-21 nerves and 7-21 roots of which 1 or 2 perforate the scale *S. polyrrhiza*
- 1' Fronds 1.5-2 times as long as wide, with (3-)5-7 nerves and (1-)2-7(-12) roots of which all perforate the scale *S. punctata*

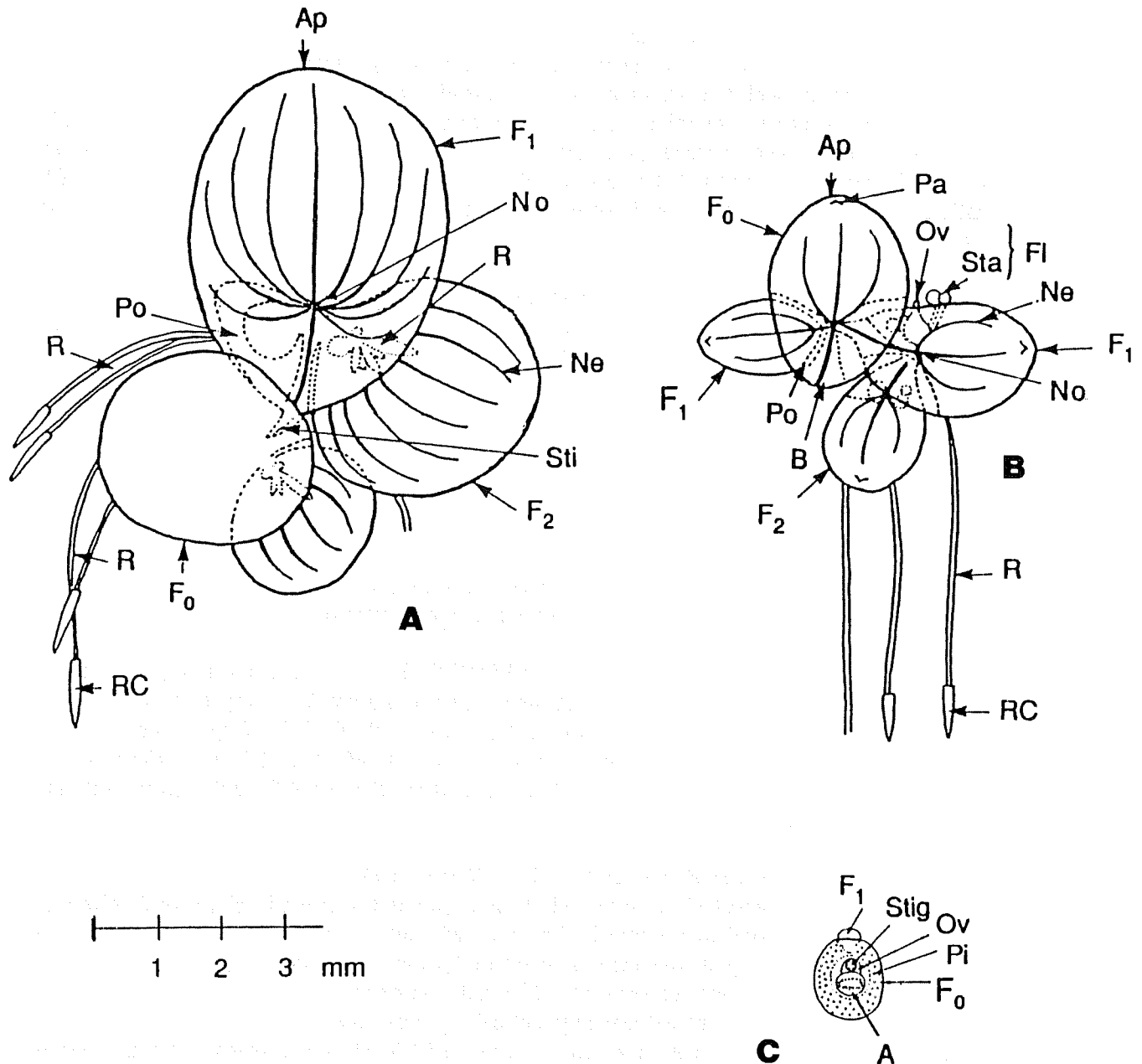
Spirodela polyrrhiza (L.) Schleiden (many roots). --FRONDS obovate to circular, rounded or pointed at the apex, 1.5-10 mm long, 1-1.5 times as long as wide, flat or rarely gibbous, sometimes with a red spot in the center of the upper surface; nerves 7-16(-21); roots 7-21, up to 3 cm long; turions sometimes present, small, circular to reniform, brownish to olive, rootless. FLOWERS very rare, 1-2-ovulate. FRUIT 1.0-1.5 mm long, laterally winged to the top. SEEDS with 12-20 distinct ribs. $2n = 30, 32, 38, 40, 50, 80$. [*Lemna polyrrhiza* L.] --Rather eutrophic, quiet waters: Apache, Cochise, Mohave, Navajo cos.; below 2450 m (8000 ft); Jun-Sep; worldwide (except arctic and antarctic zones and most of S. Amer.).

Spirodela punctata (G. Meyer) Thompson (dotted). --FRONDS obovate, 1.5-8 mm long, 1.5-2 times as long as wide, flat or gibbous, without red spot on the upper surface; nerves 3-7; roots (1-)2-7(-12), to 7 cm long; no distinct turions present. FLOWERS rare, 1-2-ovulate. FRUIT 0.8-1.0 mm long, laterally winged towards the top. SEEDS with 10-15 distinct ribs. $2n = 40, 46, 50$. [*S. oligorrhiza* (Kurz) Hegelm.]. --Rather eutrophic, quiet waters: Coconino Co.; ca. 2100 m (ca. 7000 ft); Jul-Sep; world-wide (except zones with severe frosts).

***Wolffia Horkel ex Schleiden Water-meal**

FRONDS floating on or just below water's surface (only turions sink to the ground), single or 2 cohering, spherical, ovoid or boat-shaped, less than 1.6 mm in diameter, without air spaces in tissue, with a single terminal reproductive pouch or cavity at the base of the frond from which daughter fronds originate, sometimes with a cavity on the upper frond surface from which a flower originates, without nerves and roots, without a scale; anthocyanins absent but sometimes pigment cells present (visible in dead fronds as brown dots); turions sometimes present, small, spherical, light green. FLOWER 1 per frond, without a small utricular scale; stamen 1, 2-locular. SEED 1, nearly smooth. --8 spp.; worldwide distribution except sub-arctic, arctic and antarctic zones. (For Johann Friedrich Wolff, German physician). 4 spp. in N. Amer., none of which is known in Arizona. Possibly the small fronds have been overlooked or may yet be introduced: *W. borealis* (Engelm.) Landolt. --FRONDS boat-shaped, 0.7-1.5 mm long, 1.3-2 times as long as wide, with apex bent upwards, bright green on the surface; pigment cells present. N. Amer.: s Can. to CA, n UT, KS, TN. *W. brasiliensis* Weddell. --FRONDS boat-shaped, 0.5-1.6 mm long, 1-1.5 times as long as wide, with a prominent papilla on midline, bright green on the surface; pigment cells present.

Amer.: nearest to AZ in OK, TX, and Tamps. Mex. *W. columbiana* Karsten. --FRONDS nearly spherical, 0.5-1.4 mm long, 1-1.5 times as long as wide, without distinct papillae, pale and transparently green on the surface; pigment cells absent. Amer.: nearest to AZ in CA, CO, OK, TX, and Sin. and Tamps. Mex. *W. globosa* (Roxburgh) den Hartog and van der Plas. --FRONDS ellipsoid, 0.4-0.8 mm long, 1.3-2 times as long as wide, without distinct papillae, pale and transparently green on the surface; pigment cells absent. Asia, Afr., CA, FL.



Lemnaceae Fig. 1. Groups of fronds of A, *Spirodela polyrrhiza*, B, *Lemna aequinoctialis*, C, *Wolffia brasiliensis* (from Hegelmaier). A (anther); Ap (apex); B (base); Fo (mother frond); F1 (daughter frond of the first generation); F2 (daughter frond of the second generation); Fl (flower); Ne (nerve); No (node); Ov (ovary); Pa (papilla); Pi (pigment cells); Po (pouch); R (root); RC (root cap); Sta (stamen); Stig (stigma).