

1. NAJAS Linnaeus, Sp. Pl. 2: 1015. 1753.

茨藻属 *ci zao shu*

Herbs, annual, small, submerged in fresh or brackish water. Stem slender, fragile, much branched, rooting at base and lower-most nodes. Leaves subopposite or pseudowhorled, sessile, linear, small, 1-veined, sheathing at base, margin spinulose-toothed; sheaths variously shaped, often auriculate. Plants monoecious or dioecious; flowers minute, unisexual, solitary or few in leaf axil. Male flowers spatulate or rarely not spatulate; perianth (often named “involucre” or “envelope”) 2-lipped, membranous, closely applied to anther; stamen 1, anther subsessile, 1–4-theous, dehiscent at apex. Female flowers sessile; spathe absent or rarely present; perianth persistent. Fruit an elliptic-oblong achene; pericarp thin, membranous, indehiscent, persistent. Seeds without endosperm; testa hard, brittle, pitted; embryo straight.

About 40 species: cosmopolitan; eleven species (one endemic) in China.

One of the Fl. China editorial committee, Wu Zhengyi, prefers to keep the Najadaceae separate because of its distinct morphology in having superior ovaries and nuclear endosperms.

- 1a. Plants dioecious; stems and abaxial surface of leaves usually spiny; areoles on seeds irregularly arranged 1. *N. marina*
- 1b. Plants monoecious; stems and abaxial surface of leaves usually not spiny; areoles on seeds longitudinally arranged.
 - 2a. Anthers 1-theous.
 - 3a. Seeds with many transversely elongated ladderlike pits; areoles fusiform; fruit narrowed and slightly curved at apex 2. *N. minor*
 - 3b. Seeds with many longitudinally elongated pits; areoles rectangular or polygonal; fruit usually straight.
 - 4a. Auricles broadly triangular; leaves in pseudowhorls of 3 5. *N. browniana*
 - 4b. Auricles orbicular or obcordate; leaves in pseudowhorls of 5.
 - 5a. Male spathe present 3. *N. gracillima*
 - 5b. Male spathe absent 4. *N. pseudogracillima*
 - 2b. Anthers 4(or rarely 2)-theous.
 - 6a. Auricles broadly triangular to linear.
 - 7a. Male flowers without spathe 10. *N. graminea*
 - 7b. Male flowers with spathe 11. *N. pseudograminea*
 - 6b. Auricles rounded to obcordate.
 - 8a. Fruit semilunate; female flowers with spathe 6. *N. ancistrocarpa*
 - 8b. Fruit elliptic; female flowers without spathe.
 - 9a. Areoles hexangular, transversely elongated, arranged in ladderlike manner 7. *N. oguraensis*
 - 9b. Areoles rectangular or irregularly arranged.
 - 10a. Auricles orbicular; testa with apparently raised cell walls 8. *N. chinensis*
 - 10b. Auricles obcordate; testa without raised cell walls 9. *N. foveolata*

1. *Najas marina* Linnaeus, Sp. Pl. 2: 1015. 1753.

大茨藻 *da ci zao*

Stems 30–100 cm or more tall, 1–4.5 mm in diam., mostly armed with spines, spines sometimes absent except apically. Leaves 1.5–3 cm × 2–3.5 mm, fleshy, abaxial side of midvein usually with spines; sheath ca. 3 mm, entire or serrulate with 1–3 spine cells on upper side without auricle, leaf acute at apex, with 2–10 conspicuous teeth on each side of margin; teeth 1–2 mm. Plants dioecious; flowers yellowish green. Male flowers ca. 5 × 2 mm; spathe with a short neck; anther 4-theous. Female flowers 2–4.5 mm; style ca. 1 mm; stigmas 2- or 3-lobed. Fruit elliptic to obovoid-elliptic, 4–6 × 3–4 mm. Seeds ovoid; testa pitted; areoles polygonal, irregularly arranged. Fl. and fr. Sep–Nov. $2n = 12^*, 24, 48, 60^*$.

Ponds, lakes, slow-moving rivers; below 2700 m. Anhui, Guangdong, Guangxi, Hebei, Heilongjiang, Henan, Hubei, Hunan, Jiangsu, Jiangxi, Jilin, Liaoning, Nei Mongol, Shandong, Shanxi, Taiwan, Xinjiang, Yunnan, Zhejiang [India, Japan, Kazakhstan, Korea, Kyrgyzstan, Malaysia, Mongolia, Myanmar, Pakistan, Russia, Sri Lanka, Tajikistan, Turkmenistan, Uzbekistan, Vietnam; Africa, SW Asia, Aus-

tralia, Europe, North and South America].

- 1a. Stems without spines except at apex; abaxial side of leaf midvein without spines 1c. var. *brachycarpa*
- 1b. Stems with spines; abaxial side of leaf midvein with spines.
 - 2a. Seeds 2.5–4 mm; style and stigma 0.2–1.4 mm; anther 1–3.3 mm 1d. var. *intermedia*
 - 2b. Seeds 4–6 mm; style and stigma 2–3 mm; anther ca. 4 mm.
 - 3a. Margins of leaves with 4–10 conspicuous teeth; stems with spines 1a. var. *marina*
 - 3b. Margins of leaves with 2 or 4 teeth; stems with only 1 or 2 spines under nodes ... 1b. var. *grossidentata*

1a. *Najas marina* var. *marina*

大茨藻(原变种) *da ci zao (yuan bian zhong)*

Ittnera major (Allioni) C. C. Gmelin; *Najas major* Allioni; *N. major* var. *angustifolia* A. Braun; *N. marina* var. *angustifolia*

(A. Braun) K. Schumann.

Stems mostly armed with spines. Leaves with 4–10 conspicuous teeth on margin, abaxial side of midvein with spines ca. 2 mm. Style and stigma 2–3 mm; anthers 3.8–4 mm. Seeds 4.5–5.7 × 2–2.8 mm.

Ponds, lakes, slow-moving rivers; below 2700 m. Anhui, Guangdong, Guangxi, Hebei, Heilongjiang, Henan, Hubei, Hunan, Jiangsu, Jiangxi, Jilin, Liaoning, Nei Mongol, Shandong, Shanxi, Taiwan, Xinjiang, Yunnan, Zhejiang [India, Japan, Korea, Malaysia, Russia, Tajikistan; Africa, Australia, Europe, North America].

1b. *Najas marina* var. *grossidentata* Rendle, Trans. Linn. Soc. London, Bot. 5: 396. 1899.

粗齿大茨藻 cu chi da ci zao

Stems stout, with only 1 or 2 spines under nodes. Margins of leaves with 2 or 4 teeth, abaxial side of midvein with sparse spines. Style and stigma 2–3 mm; anthers 3.8–4 mm. Seeds 4–4.5 × 2.2–2.4 mm.

Ponds, lakes. Heilongjiang, Jilin, Liaoning [Korea].

1c. *Najas marina* var. *brachycarpa* Trautvetter, Bull. Soc. Imp. Naturalistes Moscou 40(3): 97. 1867.

短果茨藻 duan guo ci zao

Najas intramongolica Y. C. Ma; *N. marina* subsp. *brachycarpa* (Trautvetter) Tzvelev.

Stems slightly slender, with spines only at apex. Leaves smaller, abaxial side of midvein without spines. Style and stigma 0.2–1.4 mm; anthers 1–3.3 mm. Seeds 2.2–2.5 × 1.5–1.8 mm.

Ponds. Nei Mongol, Xinjiang [C Asia].

1d. *Najas marina* var. *intermedia* (Gorski) Ascherson, Fl. Brandenburg 1: 670. 1864.

小果大茨藻 xiao guo da ci zao

Najas intermedia Gorski in Eichwald, Naturhist. Skizze, 126. 1830; *N. marina* subsp. *intermedia* (Gorski) Casper.

Stems only slightly spiny. Leaves with 4–8 conspicuous teeth on margin, abaxial side of midvein with spines. Style and stigma 0.2–1.4 mm; anthers 1–3.3 mm. Seeds 2.5–4 × 1.2–2 mm.

Ponds. Yunnan [cold to warm-temperate areas from Europe to C Asia, extending to a few subtropical parts of Asia].

2. *Najas minor* Allioni, Auct. Syn. Meth. Stirp. Horti Regii Taur. 3. 1773.

小茨藻 xiao ci zao

Caulinia minor (Allioni) Cosson & Germain; *Fluvialia minor* (Allioni) Persoon; *Itnera minor* (Allioni) C. C. Gmelin; *Najas moshanensis* N. Z. Wang.

Stems 4–25 cm tall, 0.5–1 mm in diam. Leaves recurved, 1–3 cm × 0.5–1 mm; sheath ca. 2 mm; auricles truncate to rounded, with more than 10 teeth on upper and outer sides of leaf margin, each side serrulate with 6–12 teeth, apex acuminate.

Plants monoecious; flowers yellowish green. Male flowers elliptic, 0.5–1.5 mm; spathe with a short neck, with brownish spine cells at apex; anther 1-theous. Female flowers ca. 2 mm; style 1–1.7 mm; stigmas 2-lobed. Fruit linear-ellipsoid, 2–3 × ca. 0.5 mm, narrowed and slightly curved at apex. Seeds narrowly ellipsoid, with many rows of transversely elongated ladderlike pits; areoles fusiform. Fl. and fr. Jun–Oct. $2n = 12^*$, 24^* , 36, 46, 56.

Ponds, lakes, paddy fields and channels; below 2700 m. Anhui, Fujian, Guangdong, Guangxi, Hainan, Hebei, Heilongjiang, Henan, Hubei, Hunan, Jiangsu, Jiangxi, Jilin, Liaoning, Nei Mongol, Shandong, Taiwan, Xinjiang, Yunnan, Zhejiang [Afghanistan, India, Indonesia (Java), Japan (including Ryukyu Islands), Kazakhstan, Korea, Nepal, Pakistan, Philippines, Sri Lanka, Tajikistan, Thailand, Uzbekistan, Vietnam; Africa, SW Asia, Europe; introduced in North America].

3. *Najas gracillima* (A. Braun ex Engelmann) Magnus, Beitr. Kenntn. Najas, 23. 1870.

纤细茨藻 xian xi ci zao

Najas indica (Willdenow) Chamisso var. *gracillima* A. Braun ex Engelmann in A. Gray, Manual, ed. 5, 681. 1867; *N. japonica* Nakai.

Stems 8–20 cm tall, 0.3–0.5 mm in diam. Leaves often in pseudowhorls of 5, ca. 2 cm × 0.3–0.5 mm; sheath 1–2 mm; auricles orbicular to slightly obcordate, short, minutely serrulate with 6 or 7 teeth, upper margin on each side minutely serrulate with 7–11 teeth. Plants monoecious; flowers 1–4 per axil, male flowers in upper axils and female ones throughout. Male flowers elliptic, 1–1.5 mm; spathe with a short neck, with brownish spine cells at apex; anther 1-theous. Female flowers conspicuous, 2–3 mm; style 1–2 mm; stigmas 2-lobed. Fruit linear-ellipsoid, 2–3 × ca. 0.5 mm. Seeds narrowly ellipsoid, with more than 20 rows of pits; areoles oblong, longitudinally elongated. Fl. and fr. Jun–Aug. $2n = 12, 24$.

Paddy fields, shallow water of ponds and channels; below 1800 m. Fujian, Guangxi, Guizhou, Hainan, Hebei, Hubei, Jiangxi, Jilin, Liaoning, Nei Mongol, Taiwan, Yunnan, Zhejiang [Japan; North America].

Najas gracillima is most similar to *N. minor*, especially in vegetative condition. However, *N. gracillima* can be separated from *N. minor* by its fruit often straight and the areoles of its seeds longer than broad.

4. *Najas pseudogracillima* Triest, Mém. Acad. Roy. Sci. Outre-Mer, Cl. Sci. Nat. Méd., Collect. 8vo. 22: 98. 1988.

拟纤细茨藻 ni xian xi ci zao

Stems ca. 10 cm tall, ca. 0.3 mm in diam. Leaves often in pseudowhorls of 5, 9–11 × ca. 0.3 mm; sheath 1–2 mm; auricles orbicular to slightly obcordate, short, minutely serrulate with 3–5 teeth, upper margin on each side minutely serrulate with 6–10 teeth. Plants monoecious; flowers 1–3 per axil, male flowers in upper axils and female ones below. Male flowers elliptic, 0.6–0.8 mm; spathe absent; anther 1-theous. Female flowers inconspicuous, ca. 1 mm; style ca. 1 mm; stigmas 2- or 3-lobed. Fruit 1.6–2 × ca. 0.5 mm. Seeds elliptic-oblong, with more than 25 rows of pits; areoles oblong, longitudinally elongated; cell walls

not raised. Fl. and fr. Jul–Nov.

- Known only from ponds on Chung Chi Campus, Hong Kong.

Najas pseudogracillima is most similar to *N. gracillima*, especially in vegetative condition. It differs by having male flowers without a spathe, whereas *N. gracillima* has male flowers with a spathe.

5. *Najas browniana* Rendle, Trans. Linn. Soc. London, Bot. 5: 420. 1899.

高雄茨藻 gao xiong ci zao

Stems 20–30 cm tall, ca. 1 mm in diam. Leaves often in pseudowhorls of 3, linear, 1–2 cm × 0.5–1 mm; sheath shortly auriculate; auricles triangular, ca. 2 mm, minutely serrulate with several teeth on apex; leaf margin on each side minutely serrulate with 10–20 teeth. Plants monoecious; flowers solitary or 2 or 3 together. Male flowers ca. 1 mm; spathe with a short neck, with brownish spine cells at apex; anther 1-theous. Female flowers linear-ellipsoid, ca. 1 mm; style short; stigmas 2-lobed. Fruit linear-ellipsoid, 1.5–1.7 mm. Seeds narrowly ellipsoid, with many rows of pits; areoles squarish to pentangular. Fl. and fr. Aug–Nov. $2n = 12^*$.

Brackish water. Guangdong, Guangxi, Taiwan [India, Indonesia, New Guinea; Australia].

According to Triest (Mém. Acad. Roy. Sci. Outre-Mer, Cl. Sci. Nat. Méd., Collect. 8vo. 22: 118. 1988), *Najas browniana* is found only in Australia.

6. *Najas ancistrocarpa* A. Braun ex Magnus, Beitr. Kenntn. Najas, 7. 1870.

穹果茨藻 wan guo ci zao

Caulinia ancistrocarpa (A. Braun ex Magnus) Nakai; *Najas poyangensis* S. F. Guan & Q. Lang.

Stems 10–30 cm tall, 0.5–1 mm in diam. Leaves narrowly linear or linear, 1–2 cm × ca. 0.5 mm; sheath 1–1.5 mm; auricles rounded, minutely serrulate with 5–8 teeth on upper side; leaf margin minutely serrulate with 4–16 (or more) spiny teeth on each side. Plants monoecious; flowers solitary. Male flowers 0.5–1.5 mm; spathe with a short neck, with 4 or 5 brownish spine cells at apex; anther 4-theous. Female flowers recurved, with a spathe; neck of spathe with brownish spine cells at apex; style ca. 0.5 mm; stigmas 2-lobed. Fruit semilunate, 1–2 × ca. 0.5 mm. Seeds curved, fusiform, with many rows of pits; areoles oblong. Fl. and fr. Jul–Oct. $2n = 12^*$, 24.

Still water. Fujian, Hubei, Jiangxi, Taiwan, Zhejiang [Japan].

7. *Najas oguraensis* Miki, Bot. Mag. (Tokyo) 49: 775. 1935.

澳古茨藻 ao gu ci zao

Caulinia oguraensis (Miki) Nakai.

Stems 20–30 cm tall, 1–2.5 mm in diam. Leaves narrowly linear to subulate, 1–2 cm × 1–3 mm, slightly curved; midvein sometimes with spines; sheath 3–5 mm; auricles orbicular to obcordate, short, minutely serrulate with several teeth at apex; leaf margin serrulate with 7–14 teeth on each side. Plants monoecious; flowers solitary, male flowers usually in upper

axils, female ones throughout. Male flowers elliptic, ca. 1 mm; spathe with a neck, with several brownish spine cells at apex; anther 4-theous. Female flowers ca. 3 mm; style ca. 0.5 mm; stigmas 2-lobed. Fruit narrowly ellipsoid, 3–4 × ca. 1 mm, narrowed and curved at apex. Seeds narrowly ellipsoid, with many rows of transversely elongated ladderlike pits; areoles hexangular. Fl. and fr. Jul–Nov. $2n = 24$, 60*.

Still water. Hubei, Jiangxi, Taiwan [India, Japan, Korea, Nepal, Pakistan].

8. *Najas chinensis* N. Z. Wang, J. Wuhan Bot. Res. 3: 32. 1985.

东方茨藻 dong fang ci zao

Najas orientalis Triest & Uotila.

Stems 10–15 cm tall, 0.5–1 mm in diam. Leaves linear to narrowly lanceolate, 1–3 cm × 0.2–1 mm; sheath ca. 2 mm; auricles rounded, minutely serrulate with several teeth on each side; leaf margin minutely serrulate with 6–20 teeth on each side. Plants monoecious; flowers solitary or sometimes 2 together, male flowers in upper axils and female ones throughout. Male flowers elliptic, ca. 1 mm; spathe with a neck, with several brownish spine cells at apex; anther 4-theous. Female flowers 2–2.5 mm; style ca. 1 mm; stigmas 2–4(or 5)-lobed. Fruit narrowly ellipsoid, 2–2.5 × ca. 0.5 mm. Seeds slightly reniform, with ca. 20 rows of pits; areoles regularly arranged, subsquare; cell walls apparently raised. Fl. and fr. May–Aug. $2n = 12^*$.

Ponds, channels, paddy fields, slow-moving rivers; below 1800 m. Fujian, Guangdong, Guangxi, Hainan, Hubei, Jiangxi, Jilin, Liaoning, Taiwan, Yunnan, Zhejiang [Japan; Europe].

Najas chinensis is similar to *N. foveolata* but can be easily separated by its rounded sheath and apparently raised cell walls of the seed coat.

9. *Najas foveolata* A. Braun ex Magnus, Beitr. Kenntn. Najas, 7. 1870.

多孔茨藻 duo kong ci zao

Caulinia foveolata (A. Braun ex Magnus) Nakai.

Stems 10–20 cm tall, 0.5–1 mm in diam. Leaves linear, slender, 2–2.5 cm × 0.2–0.5 mm; sheath 2–2.5 mm; auricles obcordate, minutely serrulate with 4–9 teeth at apex and outer side; leaf margin on each side minutely serrulate with 6–24 teeth. Plants monoecious; flowers solitary, male flowers in upper axils and female flowers throughout. Male flowers elliptic, ca. 1 mm; spathe with a short neck, with several brownish spine cells at apex; anther 4-theous. Female flowers ca. 2.5 mm; style ca. 1 mm; stigmas 2-lobed, unequal. Fruit narrowly ellipsoid, ca. 1.5 × 0.5 mm. Seeds narrowly ellipsoid, with ca. 20 rows of pits; areoles subsquarish to polygonal. Fl. and fr. Aug–Sep. $2n = 12^*$, 24, 36.

Ponds. Anhui, Guangxi, Hubei, Taiwan, Zhejiang [India, ?Indonesia, Malaysia].

Previously, this species was known only in China from S Guangxi.

10. *Najas graminea* Delile, Descr. Égypte, Hist. Nat. 2: 282.

1813.

草茨藻 *cao ci zao*

Stems 10–20 cm tall, 0.5–1 mm in diam. Leaves narrowly linear to linear, 1–2.5 cm × 0.4–1 mm; sheath 1.5–3 mm, deeply auriculate; auricles narrowly triangular or lanceolate, 1–2 mm, serrulate with several teeth on each side, apex acute; leaf margin minutely and densely serrulate with 30–50 inconspicuous teeth on each side, consisting of brownish spine cells only. Plants monoecious; flowers solitary, or sometimes 2 or 3 together. Male flowers usually more toward upper axils, ca. 1 mm, elliptic; spathe absent; anther 4-theous. Female flowers 1.5–2 mm; style ca. 1 mm; stigmas 2–4-lobed. Fruit oblong, 1.5–2 × ca. 0.8 mm. Seeds ellipsoid-oblong, with ca. 30 rows of pits; areoles hexangular and irregularly polygonal toward ends, or rectangular. Fl. and fr. Jun–Sep. $2n = 12^*$, 24, 36*, 48, 72.

Ponds, paddy fields, usually in still or slow-moving water; below 1800 m. Anhui, Fujian, Guangdong, Guangxi, Hainan, Hebei, Henan, Hubei, Jiangsu, Liaoning, Sichuan, Taiwan, Yunnan, Zhejiang [Afghanistan, Bangladesh, India, Indonesia, Japan (including Ryukyu Islands), Kazakhstan, Korea, Malaysia, Myanmar, Nepal, New Guinea, Pakistan, Philippines, Sri Lanka, Tajikistan, Thailand, Uzbekistan, Vietnam; Africa, SW Asia, Australia, Europe; introduced in North America].

- 1a. Fruit not curved; areoles hexangular to polygonal 10a. var. *graminea*
- 1b. Fruit curved toward apex; areoles oblong 10b. var. *recurvata*

10a. *Najas graminea* var. *graminea*

草茨藻(原变种) *cao ci zao* (*yuan bian zhong*)

Caulinia graminea (Delile) Tzvelev.

Leaves ca. 1 mm wide; auricles narrowly triangular. Fruit usually straight. Seeds with hexangular or irregularly polygonal areoles.

Ponds, paddy fields, usually in still or slow-moving water. Anhui, Fujian, Guangdong, Guangxi, Hainan, Hebei, Henan, Hubei, Jiangsu, Liaoning, Taiwan, Yunnan [India, ?Indonesia, Japan (including Ryukyu Islands), Korea, Malaysia, Myanmar, Philippines; Africa, Australia, Europe; introduced in North America].

10b. *Najas graminea* var. *recurvata* J. B. He, L. Y. Zhou & H. Q. Wang, Bull. Bot. Res., Harbin 8(3): 126. 1988.

弯果草茨藻 *wan guo cao ci zao*

Leaves less than 0.5 mm wide; auricles shortly lanceolate. Fruit recurved at apex. Seeds with apparently oblong areoles.

- Paddy fields. Hubei, Zhejiang.

11. *Najas pseudograminea* W. Koch, Ber. Schweiz. Bot. Ges. 44: 339. 1935.

拟草茨藻 *ni cao ci zao*

Najas tenuifolia R. Brown subsp. *pseudograminea* (W. Koch) W. J. de Wilde.

Stems ca. 10 cm tall, ca. 1 mm in diam. Leaves often in pseudowhorls of 3, 16–20 × 0.6–0.9 mm; sheath 1–2 mm; auricles linear, short, minutely serrulate with 3–9 teeth, upper margin on each side minutely serrulate with 30–50 teeth. Plants monoecious; flowers 1–3 per axil, male flowers in upper axils and female ones below. Male flowers elliptic, 1.4–2.3 mm; spathe with short neck; anther 4-theous. Female flowers inconspicuous, ca. 1 mm; style ca. 1 mm; stigmas 2- or 3-lobed. Fruit 1–1.3 × ca. 0.4 mm. Seeds elliptic-oblong, with more than 20 rows of pits; areoles squarish to hexagonal or rectangular; cell walls not raised. Fl. and fr. Jul.

Known in China only from ponds on Chung Chi Campus, Hong Kong [East Timor, Indonesia, Philippines, Thailand; Australia].

