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Taxonomic notes on genus *Trapa* L. (Trapaceae) in China

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Abstract: The genus *Trapa* L. (Trapaceae) is a kind of aquatic and polymorphic plants. Based on literature survey, field work, specimen examination and cultivation observations, taxonomic significance of major morphological characters was evaluated. The sizes of fruit bodies and crowns are found to be the reliable diagnostic characters for circumscription of the species, while the sizes of fruit beaks and numbers of horns for identification of the varieties. Consequently, two species, *Trapa incisa* and *T. natans*, with the six varieties of *T. natans*, are recognized with descriptions. The names of the four varieties of *T. natans* are newly combined with exception of var. *bispinosa*, viz. *T. natans* var. *quadricaudata*, var. *complana*, var. *magnicorona* and var. *komarovii*. The names of ten species and twelve varieties are newly reduced to synonyms. Lectotypes are designated for *T. amurensis*, *T. bispinosa*, *T. dimorphocarpa*, *T. japonica* and *T. manchurica*.

Key words: *Trapa* L. in China, new combination, new synonym, lectotypification, taxonomic revision
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中国菱属(菱科)植物的分类研究

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摘 要: 菱科(Trapaceae)仅菱属(*Trapa* L.)1 属,该属是典型的水生多型植物,中国乃至全球以往的分类处理分歧很大。基于文献查阅、野外采集、标本鉴定和栽培观察,对菱属植物分类的主要形态性状作了系统评价。果体大小和果冠变异稳定,可以用于属内种的划分,果喙大小和角的数目则可以用于种下变种的划分。在此基础上,对中国菱属作了分类处理,承认了细果野菱(*T. incisa*)和欧菱(*T. natans*)2 个种,并将欧菱划分为 6 个变种,对其中 4 个变种作了新的组合。将 10 个种名和 12 个变种名处理为异名,并对 5 个名称(*Trapa amurensis*, *T. bispinosa*, *T. dimorphocarpa*, *T. japonica*, *T. manchurica*)作了后选模式标定。

关键词: 中国菱属, 新组合, 新异名, 后选模式, 分类修订

Trapaceae, with a single genus *Trapa* L., is morphologically sufficiently similar to Lythraceae and Onagraceae but is considered as a distinct family based on morphological, embryological anatomical and palynological studies, as well as its numerical and cytological taxonomy (Manasl, 1954; Ram, 1956; Trela-Swicka, 1965; Kadono & Schneider, 1986; Kadono, 1987; Oginuma et al., 1996). The molecular evidence and precise observa-

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tions on ovary, fruit and seed suggested that Trapaceae was merged in Lythraceae with Punicaceae and Sonneratiaceae (APG III, 2009; Graham & Graham, 2014; APG IV, 2016). *Trapa*, containing more than 150 scientific names belonging to approximately 30 species, is distributed in temperate to subtropical regions of Europe, Asia and Africa (Chen et al., 2007). East Asia is the diversity hotspot of *Trapa*, and 15 species and several intraspecific taxa were reported in China, especially in middle and lower catchment of Yangtzi River (Wan, 2000). Many taxa of *Trapa* are widly cultivated for their fruits, which contain abundant starch, and this genus is one of the important, aquatic and economic plants.

Trapa was established in species *Platarum*, with only one species, *Trapa natans* L. (Linnaeus, 1753). Later, some new species or varieties were described by Carl Linnaeus (1782), Loureiro (1790), Flerov (1925), Nakai (1942), Vassiljev (1947) and Nakano (1964), and some of these new species or varieties were also distributed in China.

In China, Forbes & Hemsley (1903) recognized only one species, *Trapa natans*, in the enumeration of the plants in China. In *Symbolae Sinicae*, *Trapa maximowiczii* Korsh. with two varieties were recorded (Handel-Mazzetti, 1933). In *Lineamenta Florae Manshuricae*, three species of *Trapa*, *T. bispinosa* Roxb., *T. maximowiczii* Korsh. and *T. natans*, were recorded. Li & Chang (1977) recognized seven species and a form in North-east China, including a new species *Trapa arcuata* S. H. Li & Y. L. Chang. Yan (1983) recognized eleven speices in China, while Diao (1990a) recognized thirteen species, three varieties and one form, including one new species. Diao (1990b) described another new species *Trapa dimorphocarpa*. Wan (1984) proposed a taxonomic revision on Chinese *Trapa*, and thirteen species, four varieties and one form were recognized. Later, Wan (1991, 2000) described two new varieties and a combination: *Trapa quadrispinosa* Roxb. var. *yongxiuensis* W. H. Wan, *T. pseudoincisa* var. *nanchangensis* W. H. Wan and *T. macropoda* var. *bispinosa* (Roxb.) W.H. Wan. Xiong (1985) treated *Trapa quadrispinosa*, *T. bispinosa*, *T. taiwanensis* and *T. acornis* as the varieties of *T. bicornis*, and *T. japonica* var. *magnicorona* Z. T. Xiong, *T. japonica* var. *longicollum* Z. T. Xiong, *T. pseudoincisa* var. *aspinfa* Z. T. Xiong, *T. pseudoincisa* var. *complana* Z. T. Xiong were described as new varieties. Guan & Lang (1987) described a new variety, *Trapa litwinowii* var. *chihuensis* S. F. Guan & Q. Lang. In FRPS, Wan (2000) recognized fifteen species and eleven varieties of *Trapa*, while another treatment contained only two species in *Flora of China* (Chen et al., 2007).

Species delimitation of *Trapa* is debated till now. In *Flora of Europe*, Tutin & Heywood (1968) only considered one polymorphic species, *Trapa natans*, and merged thirteen species in it. Vassiljev (1949) recognized ca. 70 species worldwide, while ca. 30 species were recognized by some taxonomists (Li & Chang, 1977; Yan, 1983; Kak & Durani, 1988; Wu, 1991). Cook (1990) gave an uncertain viewpoint: the genus *Trapa* containing one single polymorphic species or ca. 20 species.

How many species are there in the genus *Trapa*? One or more? One of the authors (Ding) joined to edit the Trapaceae of *Flora of China* and accepted only two species: *Trapa incisa* Siebold & Zucc. and *T. natans*, in China, but six varieties of *T. natans* were herein recognized for reflection of the species differentiation as well as daily application for agricultural cultivation and usage, species protection, etc.

The current revision is based on our previous studies: (1) The observation of the pollen micromorphology of nine *Trapa* species, with a preliminary study on the pollination biology (Ding et al., 1991, 1996); (2) Taxonomy of *Trapa* in *Flora of Zhejiang* (Fang & Ding, 1993); (3) Variation pattern of the *Trapa* fruits in Tangsun Lake (Jin & Ding, 1995); (4) Chromosome numbers of 23 population belonging nine species (Huang et al., 1996); (5) Seedling morpholohy of ten *Trapa* species (Ding et al., 1999); (6) Morphological variation and taxonomic significance (Hu et al., 2001; Wang et al., 2006); (7) Relationship among *Trapa* species detected by RAPD markers (Jiang & Ding, 2004). The aims of this present taxonomic revision were to: (1) Answer the abovementioned question "How many species of *Trapa* in China?", based on a comprehensive result with all evidences of morphology, palynology, chromosome numbers and DNA markers; (2) Clarify the infra-specific taxa of *T. natans* and their identifying characters, and supply the differentiation pattern of morphological characters for further usage.

1 Morphological Characters

The diagnostic characters used to identify species or infra-species of *Trapa* in China are as follows: horn numbers of fruits, horn shape and position, fruit shape and size, shape and size of fruit crowns, beak height, bulge number, leaf shape and size, indumentum (Li & Chang, 1977; Yan, 1983; Wan, 2000). Other characters, such as annual floating herbs, phyllotaxis, flower solitary, 4-merous, ovary partly inferior, drupe etc., show the stability among species and varieties and are not used for identification.

Field works were carried out in East, Central, South, Southwest, North and Northeast China, and 41 populations from fifteen provinces were collected. The data used for variation analysis and principal component analysis (PCA) were mainly obtained from these populations, and its taxonomic implications were also evaluated (Jin & Ding, 1995; Hu et al., 2001; Wang et al., 2006). Ten species from 33 populations were cultivated, and the developmental progress, seedling morphology, pollination experiments and morphological variation were carefully observed (Ding et al., 1996, 1999).

Herein, the principal diagnostic characters used to identify species and varieties of *Trapa* are listed in the key.

Key to the species and varieties

1. Plants small and thin, leaves less than 3 cm both in length and width; flowers pink; fruit bodies less than 1.2 cm high and less than 1.5 cm broad ····· 1. **Trapa incisa**
1. Plants stout, leaves often over 4 cm in length and width; flowers whitish or sometimes pink at beginning flowering; fruit bodies more than 1.2 cm high and 1.5 cm broad ····· 2
2. Fruits(horns excluded) more than 1.5 cm × 2 cm × 1 cm (height × width × thickness); crowns larger, more than 6 mm in diam.; flowers white; native or cultivated ····· 3
2. Fruit (horns excluded) 1.2−1.5 cm × 1.5 −2 cm × 0.8−1 cm; crowns smaller, 3−5 mm in diam.; flowers white or sometimes pink at beginning flowering; native ····· 6
3. Fruit beaks well-developed, more than 3 mm high, reflexed at apex; fruits 4-horned or 2-horned ····· 4
3. Fruit beaks inconspicuous, plane or sightly protuberant, not reflexed at apex; fruits 4-horned, 2-horned or 0-horned ····· 5
4. Fruits 4-horned; 2 lower horns (pseudohorns) sharp and barbellate, or obtuse. ····· 2a. **Trapa natans** var. **natans**
4. Fruits 2-horned; 2 lower horns degenerative, or bulged ····· 2b. **Trapa natans** var. **magnicorona**
5. Fruits 4-horned, or without horns (degenerate to 4-bulged), slightly side-flat, thichness *vs* width > 0.5 ····· 2c. **Trapa natans** var. **komarovii**
5. Fruits 2-horned, conspicuously side-flat, thichness *vs* width < 0.5 ····· 2d. **Trapa natans** var. **bispinosa**
6. Fruits conspicuously 4-horned; 2 lower horns sharp or obtuse ····· 2e. **Trapa natans** var. **quadricaudata**
6. Fruits 2-horned; lower horns degenerative to bulged ····· 2f. **Trapa natans** var. **complana**

2 Taxonomic Treatment

Based on literature survey, field work, specimen examination and cultivation observations, taxonomic revision of *Trapa* from China were proposed and two species, *T. incisa* and *T. natans* were recognized. For the infra-species of *T. natans*, another five varieties were recognized as well.

Trapa L., Sp. Pl. 1: 120. 1753. ***Type***: *T. natans* L.

Herbs annual, aquatic. Stem submerged, branched or unbranched, internodes elongate. Leaves dimorphic; submerged leaves opposite, sessile, simple, linear, caducous; floating leaves alternate but aggregated, petiolate; leaf blades rhombic to reniform, petioles inflated at the middle; stipules linear, deciduous. Flowers solitary in upper leaf axils, 4-merous. Sepals 4, usually persistent as horns of fruit. Petals 4, white or pink, deciduous. Stamens 4, antesepalous. Ovary semi-inferior at anthesis, subsequently becoming inferior in fruit. Fruits

2-or 4-horned, rarely 0-horned, rhombic or triangular-rhombic, exocarp succulent, endocarp stony; crowns conspicuous, tetragonal or rounded, rarely dome-shape, or crownless and inconspicuous, apex conspicuously beaked, or beakless. Seed 1; cotyledons unequal, one large starchy, and the other small, scale-like; endosperm absent.

Two species: *Trapa incisa* and *T. natans*, and *T. natans* were divided into six varieties in China, mainly distributed in middle and lower catchment of the Yangtzi River.

1. **Trapa incisa** Siebold & Zucc., in Abh. Math.-Phys. Cl. Königl. Bayer. Akad. Wiss. 4 (2): 134. 1845. ≡ *T. bispinosa* Roxb. var. *incisa* (Siebold & Zucc.) Franch. & Sav., Enum. Pl. Jap. 1: 171. 1875. ≡ *T. natans* L. var. *incisa* (Siebold & Zucc.) Makino, Bot. Mag. (Tokyo) 11: 283. 1897. ***Type***: JAPAN, without precise locality, *P. F. Siebold s. n.* (lectotype: M, designated by S. Akiyama et al. in 2016: 20).

细果野菱 **Fig.** 1

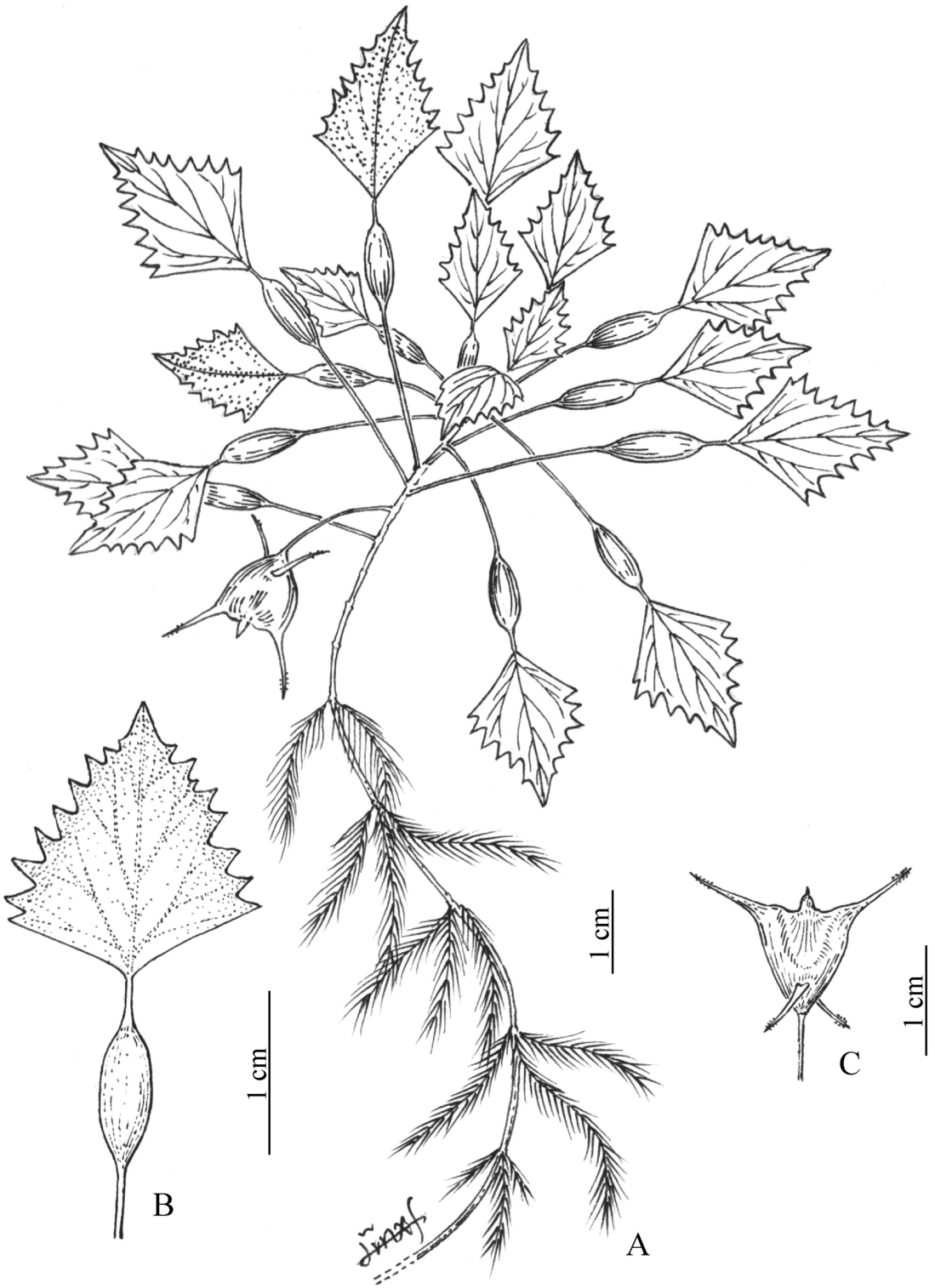
Herbs annual, floating. Stem slender, 1−2.5 mm in diam. Leaves dimorphic: Floating leaves alternate, crowned at tops of stems or branches, rosette; leaf blades triangular-ovate, 1.5−2.5 cm × 2−3 cm, incised-dentate at upper margin and entire at lower margin, broadly cuneate at base; petioles slender, slightly inflated at middle. Submerged leaves small, caducous. Flowers pink, solitary in leaf axils; pedicel 1− 2 cm long. Sepals 4; petals 4, disk entire; stamens 4, filaments slender, anthers introrse, versatile; ovary partly inferior, style subulate, stigma capitates. Fruits triangular-rhombic, 1−1.2 cm tall; pedicels ca. 2.5 cm long; 4-horned, 2 upper horns slightly obliquely horizontal, barbellate, 2 lower horns downward, barbellate; beaks ca. 3 mm long, crownless. Fl. May-Sept. and fr. Jun.−Oct.

Additional collections studied. **China. Anhui**: Anqing, *H. Migo s. n.* (NAS); Chaohu Lake, *B. Y. Ding et al.* 6221 (HZU); Dangtu, *Dangtu Exped.* 1011 (NAS!); Jingxian, *H. Zhang* 843 (NAS); Shucheng, *East China Exped.* 4065 (PE); Wuhu, *H. Migo s. n.* (NAS). **Fujian**: Fuzhou, *M. S. Li* 1100 (IBSC); Nanjing, *S. M. Hwang* 190047 (IBSC). **Guangdong**: Dinghu, *G. L. Shi* 13412 (IBSC, WUK); Huizhou, *W. Chen* 9685 (IBSC). **Guizhou**: Jingping, *C. Y. Wang* 770012 (JXU). **Hebei**: Anxin, Baiyangdian, *Z. Y. Cao* 54 (PE). **Heilongjiang**: Songjiang, *G. Z. Wang et al.* 1282 (IFP). **Henan**: Mt. Funiushan, *Henan For. Bur. Exped.* 514 (PE). **Hubei**: Jingshan, *anonymous* 225 (JXU). **Hunan**: Qianyang, *anonymous* 491 (PE). **Jiangsu**: Gaoyou, *East China Exped.* 2608 (NAS); Liyang, *C. C. Chang* 1673 (NAS); Suining, *anonymous* 20297 (NAS); Suzhou, *H. Migo s. n.* (NAS!). **Jiangxi**: Ji'an, *B. Y. Ding & T. Huang* 6400 (HZU); Linchuan, *Y. Tsiang* 9794 (NAS, IBSC); Nanchang, *W. H. Wan* 770005 (JXU), *H. Migo s. n.* (NAS), *X. X. Yang* 10780 (IBSC). **Jilin**: Fuyu, *Y. L. Chang & S. D. Zhao* 2751 (IFP); Chunhua, *Z. Y. Wang et al.* 2108 (IFP). **Liaoning**: Shenyang, *G. Q. Guan s. n.* (SYAU); Kaiyuan, *P. Y. Fu & Y. L. Chang* 3061 (IFP), 3071 (IFP). **Shaanxi**: Nanzheng, *K. T. Fu* 5486 (PE). **Shanghai**: Liuhe, *H. Migo s. n.* (NAS). **Yunnan**: Dali, *C. W. Wang* 63487 (KUN, NAS). **Zhejiang**: Deqing, *T. N. Liou* 7942 (PE); Hangzhou, *B. Y. Ding & Q. M. Zhang* 1816 (HZU), 2120 (HZU), *B. Y. Ding* 2001 (HZU), 2287 (HZU); Jinhua, *B. Y. Ding* 3983 (HZU); Jinyun, *B. Y. Ding* 4877 (HZU); Pujiang, *B. Y. Ding & W. S. Yao* 4449 (HZU); Shaoxing, *B. Y. Ding & Q. M. Zhang* 1798 (HZU), 1806 (HZU), 2176 (HZU), *B. Y. Ding & M. Z. Shi* 6201 (HZU); Tiantai, *Zhejiang Bot. Exped.* 28406 (HZU); Yinxian, *B. Y. Ding & M. Z. Shi* 6211 (HZU); Yiwu, *W. H. Huang* 8358 (HZU).

Distribution. from south to north region of East China, also in Myanmar, Indonesia, Japan, Korea, Loas, East Russia, Thailand and Vietnam.

Note. The name, *Trapa maximowiczii*, was misused in this entity by some Chinese scholars (Yan, 1983; Wan, 1984, 2000; Yu, 1994). *Trapa incisa* is a distinct species, with smaller leaves, flowers and fruits. The floating leaves of *Trapa incisa* are rhombic, incised-dentate on upper margin, flowers pink, fruit 4-horned, with 2 upper horns barbellate, and beak conspicuous.

2. **Trapa natans** L., in Sp. Pl. 1: 120. 1753. ***Type***: ITALY, Mantua, 2 Sept.1902, *A. Fiori et al.* 471



A. Matural habit; **B**. Floating leaf; **C**. Fruit.

Fig. 1　**Trapa incisa** Siebold & Zucc. (Drawn by JIN Xiaofeng)

(neotype K!; isoneotype BM, designated by Verdcourt in 1986: 448).

欧菱

Herbs annual, floating. Stem 3.5 – 7 mm in diam. Leaves dimorphic: Floating leaves alternate, crowned at tops of stems or branches, rosette; leaf

blades triangular-rhombic, rhombic to reniform, 2–6 cm × 2.5–8 cm, incised-dentate or/and thinly dentate at upper margin and entire at lower margin, broadly cuneate at base; petioles 5–18 cm long, inflated at middle, brown-pubescent. Submerged leaves small, caducous. Flowers white, sometimes pink at beginning flowering, solitary in leaf axils, 1–2 cm in diam. Sepals 4; petals 4, disk entire; stamens 4, filaments slender, anthers introrse, versatile; ovary partly inferior, thickened at base. Fruits rhombic, 1.8–2.8 cm tall, 2.5–4.5 cm wide; 4- or 2-horned, rarely 0-horned; beaks conspicuous or inconspicuous, crowned or crownless. Fl. Jul. – Oct. and fr. Aug.–Nov.

2a. **Trapa natans** L. var. **natans**

Synonym: *Trapa amurensis* Flerov, in Izv. Glavn. Bot. Sada R. S. F. S. R. 24: 34. 1925. ***Type***: RUSSIA, Bakharev at the site of Bura river, 22 Jul. 1891, *Korshinsky s.n.* [lectotype: LE (barcode 01026022), here designated!].

Trapa manchurica Flerov, Izv. Glavn. Bot. Sada R. S. F. S. R. 24: 37. 1925. ***Type***: CHINA, Manschuria [North-east China], near city Harbin, bank Songari river, 8 Jul. 1903, *Litwinov s.n.* (lectotype: LE, here designated!); *syn. nov.*

Trapa potaninii V. N. Vassil. in Komarov, Fl. URSS 15: 693. 1949. ***Type***: CHINA, China boreali-occidentalis. Inter Ta-tsien-lu et Li-fan-du in valle fl. Tungho supra pagum Huang-ni-pu, 22 Jul. 1905, *G. N. Potanin s.n.* (holotype: LE!).

Trapa sibirica Flerov var. *saissanica* Flerov, Izv. Glavn. Bot. Sada R.S.F.S.R. 24: 33. 1925. ≡ *T. saissanica* (Flerov) Vassiljev, Nov. Sist. Vys. Rast. 2: 429. 1965. ***Type***: RUSSIA, Tomsk province, Mariinsk, beside Lake Cherishtukol, near tent, lower Skoblin, 2 Jul. 1908, *Drobov Exped.* 57 (holotype: LE!; isotypes: LE!); *syn. nov.*

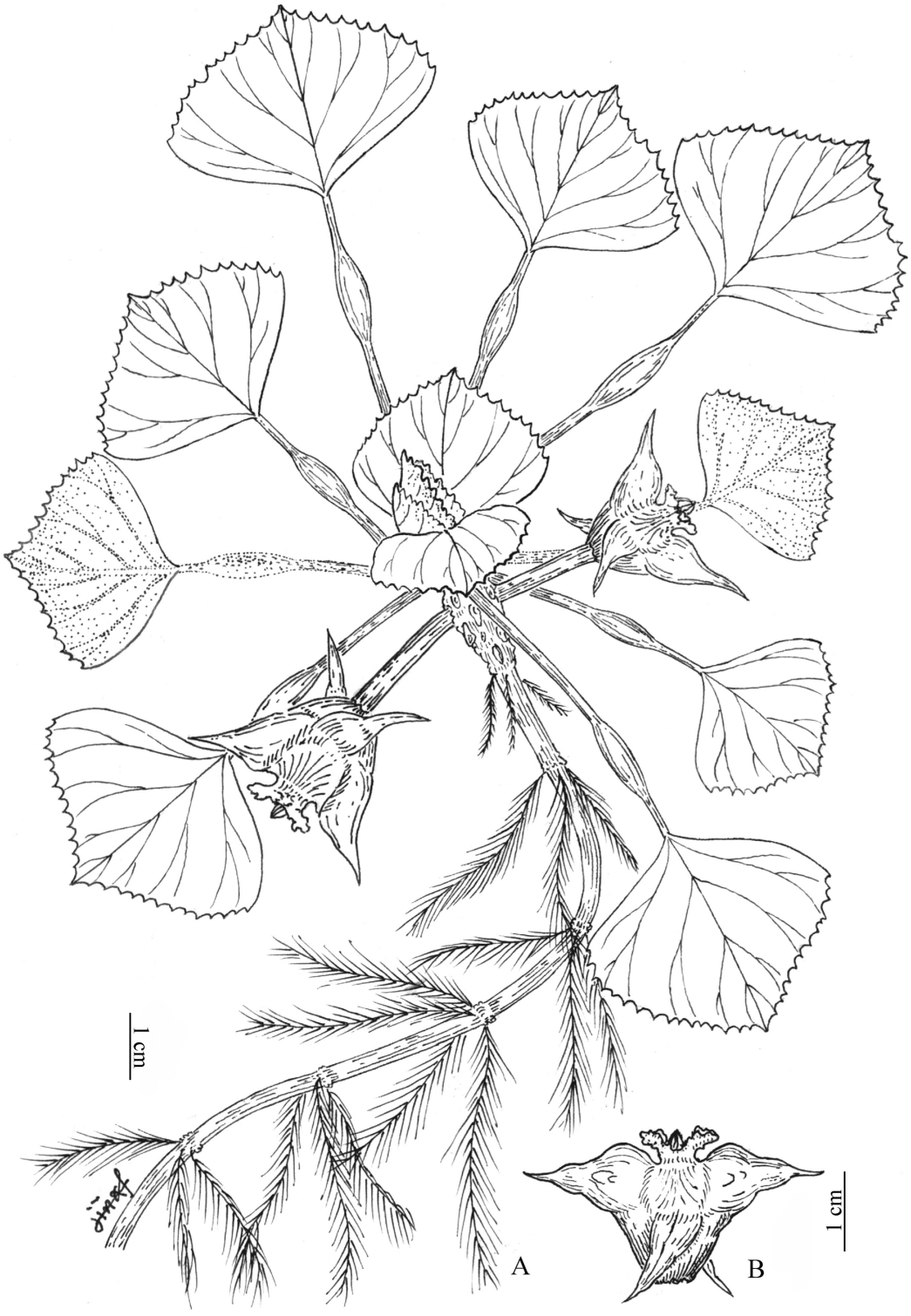
欧菱(模式变种) **Fig.** 2

Trapa natans, with mid-sized leaves, flowers and fruits, is widely distributed in the northern Hemisphere and various in morphology. *T. natans* has compressed rounded leaves, incised-dentate and thinly dentate at margin in luxuriantly growing status, flowers white, fruits 4-horned and barbellate at apex, crowns and beaks conspicuous, fresh exocarps green.

Additional collections studied. **China. Beijing**: Haiding, *anonymous* 325 (PE). **Hebei**: Chengde, *T. N. Liou* 5084 (IBSC); Xushui, Baiyangdian, *Hebei Agr. Univ. Exped.* 44214 (PE). **Heilongjiang**: Acheng, *S. D. Zhao & Y. L. Chang* 2773 (IFP); Dailing, *G. D. Cui* 4 (NEFI), *D. M. Wang et al.* 6 (NEFI); Harbin, *C. Z. Zheng* 6337 (HZU), *Y. L. Chang & S. D. Zhao* 2763 (IFP), 2767 (IFP), *B. Skovclyr* 1202 (IFP); Qiqihaer, *C. S. Wang* 947 (IBSC), *Y. B. Chang* 6030 (NEFI); Yichun, *T. N. Liou* 3483 (PE, IBSC). **Hubei**: Jingmen, *H. Migo s.n.* (NAS); Yangxin, *H. Migo s.n.* (NAS). **Jiangsu**: Baoying Lake, *East China Exped.* 2511 (PE, NAS, IBSC); Hongze Lake, *P. L. Yang* 56 (NAS); Jiangpu, *anonymous* 8472 (NAS); Nanjing, *C. L. Tso* 1368 (PE); Qidong, *anonymous* 15372 (NAS); Yixing, *J. Shen* 569 (NAS). **Jiangxi**: Linchuan, *Y. Tsiang* 9792 (NAS, IBSC). **Jilin**: Antu, *T. N. Liou* 3658 (IBSC); Chunhua, *C. S. Wang et al.* 2408 (IFP); Fuyu, *Y. L. Chang & S. D. Zhao* 2729 (IFP), 2731 (IFP), 2733 (IFP), 2736 (IFP). **Liaoning**: Beizhen, *Y. L. Chang et al.* 2785 (IFP); Jinxian, *Y. L. Chang et al.* 2794 (IFP); Shenyang, *Y. L. Chang & X. D. Cui* 2709 (IFP); Xinjin, *Z. S. Qin & C. F. Fang* 154 (IFP); Zhangwu, *C. Wang* 2737 (IBSC). **Shaanxi**: Meixian, *C. H. Wang* 154 (WUK, PE); Yangxian, *T. N. Liou & P. C. Tsoong* 3938 (PE). **Shandong**: Weishan Lake, *T. Y. Cheo et al.* 6915 (NAS). **Xinjiang**, Ehebuerjin, *H. Yu s.n.* (HZU).

Distribution. China (Hebei, Heilongjiang, Hubei, Jiangsu, Jiangxi, Jilin, Liaoning, Shaanxi, Shandong and Xinjiang), Japan, Korea, Russia and Europe, Africa.

Note. Li & Chang (1977), Yu (1994) recognized *Trapa manchurica* as a distinct species, which has larger fruits (width *vs.* height = 0.5–1). From protologue, *Trapa manchurica* had the fruits relatively larger and beaks more conspicuous than those of *T. natans*. Fruit morphology of *Trapa manchurica* and *T. amurensis* are in variance range of *T. natans*, and the former two species were consequently reduced to *T. natans*. *Trapa potaninii* was distinguished in two lower horns obtuse, not acute and barbellate, which



A. Matural habit; **B**. Fruit.

Fig. 2　**Trapa natans** L. var. **natans** (Drawn by JIN Xiaofeng)

was variable in different growing periods under cultivation, as well as *T. natans* var. *quadricaudata*.

2b. **Trapa natans** L. var. **magnicorona** (Z. T. Xiong) B. Y. Ding & X. F. Jin, **comb. nov.**

Basionym: *Trapa japonica* Flerov var. *magnicorona* Z.T. Xiong, in J. Wuhan Bot. Res. 3: 161. 1985. ***Type***: CHINA, Hubei, Yangxin, 1982, *Z. T. Xiong* 316 (holotype: WH!).

Synonym: *Trapa japonica* Flerov var. *longicollum* Z.T. Xiong, in J. Wuhan Bot. Res. 3: 161. 1985. ***Type***: CHINA, Hubei, Xiaogan, 1982, *Z. T. Xiong* 443 (holotype: WH!); *syn. nov.*

Trapa litwinowii V. N. Vassil. in Komarov, Fl. URSS 15: 694. 1949. ***Type***: RUSSIA, Vallis fl. Ussuri inter Dsoadsa et Kinda, 18 Aug. 1855, *C. Maximowicz s.n.* (holotype: LE!).

Trapa litwinowii V. N. Vassil. var. *chihuensis* S. F. Guan et Q. Lang, Bull. Bot. Res. (Harbin) 7 (1): 77. 1987. ***Type***: CHINA, Jiangxi, Chihu Lake, 20 Sept. 1984, *Y. D. Chen, S. F. Guan & Q. Lang* 779 (holotype: PE!).

冠菱 **Fig.** 3: **C**

This variety is similar to *Trapa natans* var. *natans* in having the fruits with conspicuous beaks, crowns large and reflexed, but differs in having the fruits laterally compressed, with two lower horns degenerated.

Additional collections studied. **China. Heilongjiang**: Harbin, *C. Z. Zheng* 6332 (HZU), *Y. L. Chang & S. D. Zhao* 2766 (IFP); Qiqihaer, *Z. S. Qin & C. F. Fang* 101 (IFP); Songjiang, *D. C. Zhao et al.* 1310 (IFP), *Y. L. Chou* 1310 (IBSC). **Hubei**: Wuchang, Tangsun Lake, *B. Y. Ding & R. Y. Hu* 6261 (HZU). **Jiangxi**: Yongxiu, *W. H. Wan s.n.* (JXU). **Jilin**: Fuyu, *S. D. Zhao & Y. L. Chang* 2734 (IFP), 2742 (IFP!), *Y. L. Chang & S. D. Zhao* 2758 (IFP), 2759 (IFP), *S. D. Zhao & Y. L. Chang* 2735 (IFP).

Distribution. China (Heilongjiang, Henan, Hubei, Jiangxi, Jilin, Liaoning), Japan, Korea and Russia.

Note. *Trapa japonica* var. *magnicorona*, *T. japonica* var. *longicollum*, *T. litwinowii* var. *chihuensis* and *T. macropoda* var. *bispinosa*, which had the fruits with conspicuous beaks and crowns (Xiong, 1985; Guan & Lang, 1987; Wan, 1991). These four varieties are synonymized here, as well as *T. octotuberculata*.

2c. **Trapa natans** L. var. **komarovii** (Skvortzov) B. Y. Ding & X. F. Jin, **comb. nov.**

Basionym: *Trapa amurensis* Flerov var. *komarovii* Skvortzov, in Bull. Jard. Bot. Princip. 26: 630. 1927. ≡ *T. manshurica* Flerov f. *komarovii* (Skvortzov) S.H. Li & Y.L. Chang, in Fl. Pl. Herb. Chin. Bor. Or. 6: 137. 1977. ***Type***: CHINA, near Harbin and Taolaizao Station, collector and number unknown.

Synonym: *Trapa acornis* Nakano, in Bot. Mag. (Tokyo) 77: 165. 1964. ≡ *T. bicornis* Osbeck var. *acornis* (Nakano) Z.T. Xiong, in J. Wuhan Bot. Res. 3: 160. 1985. ***Type***: CHINA, near Shanghai, *Nakano s.n.* (holotype: Nakano Herbarium); *syn. nov.*

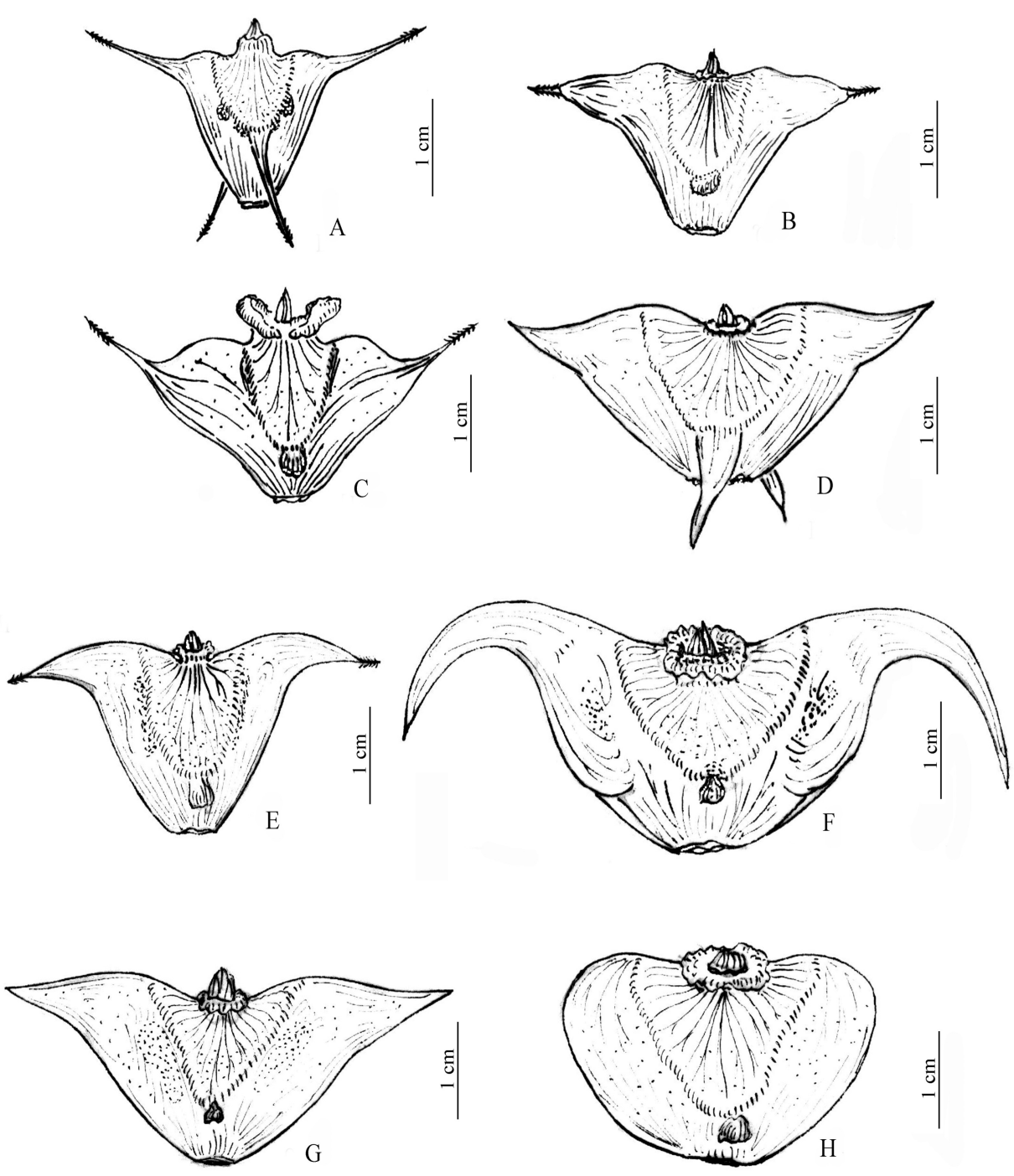
Trapa quadrispinosa Roxb., Hort. Bengal. 11. 1814. ≡ *T. bicornis* Osbeck var. *quadrispinosa* (Roxb.) Z.T. Xiong, in J. Wuhan Bot. Res. 3: 160. 1985. ***Type***: KASHMIR, Dal Lake, 2 Aug. 1917, *R. R. Stewart* 3315/2 (lectotype: K, designated by Vassiljev in 1960); *syn. nov.*

Trapa quadrispinosa Roxb. var. *yongxiuensis* W. H. Wan, in J. Jiangxi Univ. (Nat. Sci.) 15(2): 75. 1991. ***Type***: CHINA, Jiangxi, Yongxiu, Jiangyi, *W. H. Wan* 780008 (holotype: JXU!); *syn. nov.*

四角菱 **Fig.** 3: **D**, **H**

This variety has 4-horned fruits, but differs from *Trapa natans* var. *natans* in having fruits inconspicuously beaked and crowned. The fruit body, horn shape and length, and exocarp color of *T. natans* var. *komarovii* are various and unstable, especially in cultivated individuals. This variety is wildly distributed in China, as well as India, and many cultivated types occur now.

Additional collections studied. **China. Anhui**: Quanjiao, *East China Exped.* 3506 (PE); Wuhu, *B. Y. Ding et al.* 6217 (HZU). **Fujian**: without precise locality, *S. T. Dunn* 2726 (IBSC). **Hainan**: Lingshui, *Z. S. Diao s.n.* (YZU). **Hebei**: Anxin, Baiyangdian, *B. Y. Ding* 6340 (HZU). **Hubei**: Jingmen, *H. Migo s.n.* (IBSC); Wuchang, Tangsun Lake, *B. Y. Ding & R. Y. Hu* 6246 (HZU). **Hunan**: Jiangpu, *Z. S. Diao* 2022 (YZU). **Jiangsu**: Hongze, *B. Y. Ding & X. D. Lu* 6440 (HZU), *B. Y. Ding et al.* 6232 (HZU); Jiangning, *anonymous* 6591 (NAS); Nanjing, *J. J. Gong* 801 (NAS); Wuxi, *Y. W. Law* 3029 (NAS). **Jiangxi**: Nanchang, *W. H. Wan* 79006 (JXU); Yongxiu, *W. H. Wan* 780008



A. **Trapa natans** var. **quadricaudata**; B. **T. natans** var. **complana**; C. **T. natnas** var. **magnicorona**; D, H. **T. natans** var. **komarovii**; E,F,G. **T. natans** var. **bispinosa**.

Fig. 3　Fruit shape of five varieties of **Trapa natans** L. (Drawn by JIN Xiaofeng)

(JXU). **Jilin**: Fuyu, *Y. L. Chang & S. D. Zhao* 2756 (IFP); Xinmin, *Y. C. Zhu & C. Q. Lin* 1170 (IFP). **Shanghai**: Songjiang, *H. Migo s. n.* (NAS). **Yunnan**: without precise locality, *E. E. Maire* 2879 (IBSC). **Zhejiang**: Deqing, *anonymous* 2161 (HZU); Dongyang, *W. H. Huang* 8356 (HZU); Hangzhou, *B. Y. Ding & Q. M. Zhang* 1699, 1700 (HZU), *B. Y. Ding* 2032 (HZU); Huzhou, *Zhejiang Bot. Exped.* 29732 (NAS), 29734 (NAS), *B. Y. Ding & Q. M. Zhang* 2141 (HZU); Jiaxing, Nanhu Lake,

Y. Y. Fang & B. Y. Ding 2289 (HZU), *B. Y. Ding & J. Xia* 6434 (HZU), 6435 (HZU), *B. Y. Ding & X. H. Yao* 6274 (HZU), *W. H. Wan* 79003 (JXU), 791004 (JXU), *Zhejiang Bot. Exped.* 29701 (HZU, NAS), 29704 (NAS); Jinyun, *B. Y. Ding & Q. M. Zhang* 1832 (HZU), *B. Y. Ding* 1999 (HZU), 2000 (HZU); Lanxi, *B. Y. Ding* 6276 (HZU), 6277 (HZU); Pinghu, *W. H. Wan s.n.* (JXU); Pujiang, *B. Y. Ding & W. S. Yao* 4432 (HZU), 4433 (HZU); Shaoxing, Donghu Lake, *B. Y. Ding* 2179 (HZU), 2181 (HZU), 2191 (HZU), *Q. M. Zhang & B. Y. Ding* 1748 (HZU), *B. Y. Ding & M. Z. Shi* 6204, 6205 (HZU); Xiaoshan, *C. Z. Zheng & B. Y. Ding* 3368 (HZU); Yiwu, *B. Y. Ding* 4493 (HZU); Yongkang, *B. Y. Ding* 2250 (HZU); Yuhang, *B. Y. Ding & S. J. Sheng* s.n. (HZU), *B. Y. Ding & K. F. Dong* 6433 (HZU).

Distribution. China (Anhui, Fujian, Hainan, Hebei, Hubei, Hunan, Jiangsu, Jiangxi, Jilin, Liaoning, Shanghai, Yunnan, Zhejiang), Japan, Thailand, Far Eastern Region of Russia and India (Northeast).

Note. *Trapa acornis* Nakano, with 0-horned fruits, was described as a new species. Based on the cultivation, the fruits of *T. acornis* are 4-bulged, sometimes with four obtuse horns, which had the similar fruit body to *T. natans* var. *komarovii*. It only occurs in cultivated individuals which distributed in Nanhu Lake of Jiaxing, Zhejiang Province and adjacent regions, and 0-horned fruits are maintained under breeding. *T. quadrispinosa* var. *yongxiuensis* W.H. Wan (1991) had the fruits with four short horns, which is reduced to synonym here. Diao (1990a) established a new species, *T. uncinata* Diao, but he did not give Latin diagnosis and designate the type.

2d. **Trapa natans** L. var. **bispinosa** (Roxb.) Makino, Bot. Mag. (Tokyo) 11: 283. 1897.

Basionym: *Trapa bispinosa* Roxb., in Hort. Bengal. 11. 1814. ≡ *T. bicornis* L. f. var. *bispinosa* (Roxb.) Nakano, in Bot. Mag. (Tokyo) 77: 165. 1964. ≡ *T. bicornis* Osbeck var. *bispinosa* (Roxb.) Z. T. Xiong, in J. Wuhan Bot. Res. 3: 160. 1985. ***Type***: CHINA, without precise locality, *anonymous* 6339*b* [lectotype: K (barcode 001123627), here designated].

Synonym: *Trapa arcuata* S. H. Li et Y. L. Chang, in Fl. Pl. Herb. Chin. Bor.-Or. 6: 291. 1977. ***Type***: CHINA, Heilongjiang, E'cheng, 12 Sept. 1974, *S. D. Zhao & Y. L. Chang* 2775 (holotype: IFP!).

Trapa bicornis Osbeck, in Dagb. Ostind. Resa 191. 1757. ≡ *T. bicornis* L. f., in Suppl. Pl. 128. 1782. ≡ *T. chinensis* Lour., in Fl. Cochinch. 1: 86. 1790. ***Type***: UNITED KINGDOM, without precise locality, *anonymous s. n.* (holotype: Linn; isotype: Linn); *syn. nov.*

Trapa cochinchinensis in Lour., in Fl. Cochinch. 1: 86. 1790. ≡ *T. bicornis* Osbeck var. *cochinchinensis* (Lour.) Glück. ex Steenis, in Fl. Malesia. 4(1): 43. 1949. ***Type***: VIETNAM, without precise locality, 1 Jul. 1890, *B. Balansa* 4926 (holotype: G); *syn. nov.*

Trapa dimorphocarpa Diao, in J. SW Agric. Univ. 12(1): 70. 1990. ***Type***: CHINA, Fujian, Putian, Jun. 1985, *L. Su* 1989 (lectotype: YZU!, here designated). CHINA, Fujian, Fuzhou, 3 Nov. 1984, *Z. S. Diao* 1989 (syntype: YZU!); Putian, 2 May 1985, *Fujian Agri. College* 1911 (syntype: YZU!), Jun. 1985, *L. Su* 1989 (syntype: YZU!).

Trapa japonica Flerov, in Izv. Glavn. Bot. Sada R.S.F.S.R. 24: 39. 1925. ***Type***: JAPAN, Iokohama, Aug. 1862, *C. Maximowicz s.n.* (lectotype: LE, here designated).

Trapa jeholensis Nakai, in J. Jap. Bot. 18: 427. 1942. ***Type***: CHINA, Jehe, 21 Aug. 1933, *T. Nakai* et al. s. n. (holotype: TI!).

Trapa taiwanensis Nakai, in J. Jap. Bot. 18: 424. 1942. ≡ *T. bicornis* Osbeck var. *taiwanensis* (Nakai) Z. T. Xiong, in J. Wuhan Bot. Res. 3: 160. 1985. ***Type***: CHINA, Taiwan, Mato, Nov. 1915, *Y. Simada s. n.* (holotype: TI!); *syn. nov.*

菱 **Fig.** 3: **E**, **F**, **G**

The vatiety differs from the typical entity in having fruits laterally compressed, 2-horned (with 2 lower horns degenerated), both beaks and crowns inconspicuous.

Additional collections studied. **China. Anhui**: Anqing, *Q. S. Xu* 6418 (HZU); Dangtu, *Dangtu Exped.* 1010 (NAS); Hefei, *Z. S. Diao* 2024 (YZU); Quanjiao, *East China Exped.* 3508

(NAS). **Beijing**: the Summer Palace, *W. P. Wang* 346 (PE). **Chongqing**: Baxian, *Z. S. Diao s. n.* (YZU). **Fujian**: Fuzhou, *H. H. Chung* 3068 (PE). **Guangdong**: Dinghu, *G. Q. Ding & G. L. Shi* 972 (IBSC, WUK, NAS), *G. L. Shi* 2509 (IBSC); Guangzhou, *W. Y. Chun* 8347 (PE, NAS), 8281 (IBSC), *S. Q. Chen* 8130 (IBSC), 8419 (IBSC), *C. Huang* 0082 (IFP); Wenyuan, *S. K. Lau* 24412 (PE, NAS, IBSC), 24995 (IBSC, IBK). **Guangxi**: Guilin, *anonymous* 23028 (IBK). **Heilongjiang**: Acheng, *S. D. Zhao & Y. L. Chang* 2772, 2774 (IFP); Harbin, *C. Z. Zheng et al.* 6333 (HZU), *Y. L. Chang & S. D. Zhao* 2764 (IFP), 2765 (IFP), *S. D. Zhao et al.* 2768 (IFP), *G. Z. Wang* 1202 (PE, IBSC); Hulin, *G. Z. Wang & Z. H. Zhang* 3091 (IFP); Wusuli River, *anonymous* 1001 (IFP). **Hebei**: Anxin, Baiyangdian, *B. Y. Ding & R. Y. Hu* 6339 (HZU), *S. Z. Yan* 7911 (IBSC); Chengde, *Y. L. Chang* 2784 (IFP), *T. N. Liou* 5082 (IBSC). **Henan**: Mt. Funiushan, *Hennan For. Bur. Exped.* 279 (PE); Mt. Jigongshan, *anonymous* 1417 (WNU). **Hongkong**: without precise locality, *W. Y. Chun* 8347 (IBK). **Hubei**: Jiangling, Changhu Lake, *H. Migo s. n.* (NAS); Jingmen, *H. Migo s. n.* (NAS); Jingshan, *anonymous* 212 (JXU); Shashi, Jingzhou, *B. Y. Ding et al.* 6254 (HZU), 6256 (HZU); Wuchang, Donghu Lake, *X. Z. Sun* 1990 (WH), *Z. H. Qian* 2684 (WH), *anonymous* 2 (JXU), *B. Y. Ding & R. Y. Hu* 6262 (HZU). **Jiangsu**: Baoying, *anonymous* 15970 (NAS); Caojing, *H. Migo* s. n. (NAS); Hongze, *B. Y. Ding et al.* 6231 (HZU), 6233 (HZU), 6234 (HZU), 6235 (HZU); Nanjing, *B. Q. Chen s. n.* (NAS); Suzhou, *H. Migo s. n.* (NAS); Xuyi, *anonymous* 21294 (NAS). **Jiangxi**: Nanchang, *W. H. Wan* 770001 (JXU), *H. Migo s. n.* (NAS); Xinjian, *W. H. Wan* 79002 (JXU); Yongfeng, *X. X. Yang* 830960 (IBSC); Yongxiu, *W. H. Wan s. n.* (JXU), *T. Huang* 6287 (HZU), *B. Y. Ding & R. Y. Hu* 6268 (HZU). **Jilin**: Antu, *Y. L. Chou* 3658 (PE); Fuyu, *S. D. Zhao & Y. L. Chang* 2732 (IFP), 2739 (IFP), 2754 (IFP); Tumen, *C. Z. Zheng et al.* 6331 (HZU). **Liaoning**: Jinxian, *Y. L. Chang et al.* 2793 (IFP); Shenyang, *G. Q. Guan s. n.* (SYAU), *Y. L. Chang & X. D. Cui* 2799 (IFP), Yuguo, *Y. L. Chang & X. D. Cui* 2711 (IFP), 2713 (IFP); Xinmin, *Y. L. Chang & X. D. Xiang* 2717 (IFP), *S. H. Li* 1507 (IFP), 1511 (IFP), *Y. C. Zhu* 1153 (IFP), 1162 (IFP), *C. F. Fang* 3079 (IFP); Zhangwu, *C. Wang et al.* 2737 (IFP). **Shaanxi**: Shenmu, *North Shaanxi Exped.* 232 (WNU). **Shandong**: Weishan, Weishan Lake, *B. Y. Ding & R. Y. Hu* 6345 (HZU). **Sichuan**: Qionglai, *Z. P. Huang* 2167 (WUK). **Taiwan**: Taihoku, *T. Suzuki ST*19283 (IBSC). **Yunnan**: Dali, *B. Y. Ding et al.* 6247 (HZU); Kunming, *B. Y. Qiu* 57133 (KUN, NAS). **Zhejiang**: Deqing, *B. Y. Ding* 6439 (HZU); Hangzhou, *B. Y. Ding* 2002 (HZU); Huangyan, *B. Y. Ding* 4711 (HZU); Huzhou, *B. Y. Ding* 2123 (HZU), 6437 (HZU), *Zhejiang Bot. Exped.* 29760 (PE), *Q. M. Zhang & B. Y. Ding* 2141 (HZU); Putuo, Zhujiajian, *S. J. Sheng* 1579 (HZU); Shaoxing, *B. Y. Ding* 2181 (HZU), 2192 (HZU); Xiaoshan, *K. F. Dong* 6443 (HZU); Yuhang, *B. Y. Ding* 4909 (HZU).

Distribution. Wild-distributed in China, North, East, Central and South China wild cultivated, also in Japan, Korea, Russia, Indonesia, Malaysia, Phillippines, Vietnam, Laos.

Note. This vatiety is various, especially in cultivation, in fruit size, horn length and shape, exocarp color. Consequently, *Trapa bicornis*, *T. taiwanensis*, *T. cochinchinensis* and *T. arcuata* were described as new species by different scholars. *Trapa bicornis* and *T. taiwanensis* are cultivated species, with two upper horns down-curving, but *T. taiwanensis* had fruit exocarp green to greenish black, four sepals ciliate. *Trapa bispinosa* had the fruits smaller than *T. bicornis* and *T. taiwanensis*, occurring wild or cultivated, whereas *T. arcuata* only in wild water. Yu (1994) reduced *T. arcuata* to the synonymy of *T. japonica*, and we hereby reduced both *T. arcuata* and *T. japonica* to synonyms. Based on the submerged leaf shape, Diao (1990b) described *Trapa dimorphocarpa* as a new species, but he failed to designate the holotype. Wan (2000) reduced it as synonym, which is here accepted. Herein we used the earliest name of the variety rank.

This variety is both in wild water or cultivation. Two cultivated groups were recognized: *Trapa bicornis* group and *T. bispinosa* group.

2e. **Trapa natans** L. var. **quadricaudata** (Glück.) B. Y. Ding & X. F. Jin, **comb. nov.**

Basionym: *Trapa incisa* Siebold & Zucc. var. *quadricaudata* Glück in Handel-Mazzatti, Symb. Sin. 7 (2): 605. 1929. ***Type***: CHINA, Sichuan, Ningyüen, 27 Oct. 1915, *H. Hand.-Mazz.* 1922 (holotype: WU).

Synonym: *Trapa maximowiczii* Korsh., Trudy Imp. S.-Peterburgsk. Bot. Sada 12: 336. 1892. ***Type***: RUSSIA, without precise locality, *Birula s. n.* (holotype: LE!; photo: P!); *syn. nov.*

Trapa natans L. var. *pumila* Nakano, Bot. Mag. (Tokyo) 77: 166. 1964. ***Type***: VIETNAM, without precise locality, Dec. 1891, *B. Balansa* 7421 (holotype: Nakano's Herbarium; isotype: K!); *syn. nov.*

野菱 **Fig.** 3: **A**

Compared with *Trapa natans*, var. *quadricaudata* has relatively smaller fruits and leaves. Leaves of *T. natans* var. *quadricaudata* are rhombic, but compressed rounded, incised-dentate and thinly dentate at margin in luxuriantly growing status. Flowers are white, rarely pink in early flowering status. Fruits are frequently bulged; crowns are small, beaks conspicuous, four horns acute and barbellate, sometimes with two lower horns degenerated, and fresh exocarps green or red.

Additional collections studied. **China. Anhui**: Chuzhou, *anonymous* 195 (NAS); Jinzhai, *anonymous* 0661 (NAS); Quanjiao, *East China Exped.* 3507 (NAS); Shucheng, *East China Exped.* 4413 (PE, NAS); Wuhu, *B. Y. Ding et al.* 6216 (HZU), 6220 (HZU); Xuancheng, *anonymous* 585 (NAS); Yixian, *B. Y. Ding & T. Huang* 6374 (HZU), 6376 (HZU); Yuexi, *anonymous* 2095 (NAS). **Fujian**: without precise locality, *H. H. Chung* 3068 (NAS), 4579 (PE). **Guizhou**: Liping, *S. M. Chang* 3066 (JXU); Tianzhu, *G. X. Ren* 770076 (JXU); Weining, *S. M. Chang* 2322 (IBSC), *Y. Tsiang* 9165 (PE). **Hebei**: Changping, *X. Y. Liu & Z. S. Zhang s. n.* (PE); Fangshan, *Fangshan Exped.* 663 (PE). **Henan**: Xuchang, *K. S. Hao* 3271 (PE), 3288 (PE); Mt. Funiushan, *Henan For. Bur. Exped.* 285 (PE). **Hubei**: Shashi, *B. Y. Ding et al.* 6250 (HZU); Wuchang, Tangsun Lake, *B. Y. Ding & R. Y. Hu* 6263 (HZU). **Hunan**: Hanshou, *W. X. Wang* 14 (WH); Hengyang, *B. Y. Ding & T. Huang* 6390 (HZU); Xiangyin, *B. Y. Ding & R. Y. Hu* 6266 (HZU). **Jiangsu**: Baoying, Baima Lake, *S. L. Liu et al.* 156 (NAS); Changshu, *T. Y. Cheo* 2178 (NAS); Dongtai, *F. X. Liu* 7372 (NAS); Kunshan, *H. Migo s. n.* (NAS); Nanjing, Xuanwu Lake, *S. L. Chen* 24 (NAS); Suzhou, *H. Migo* s.n. (NAS); Wujiang, *F. X. Liu* 1555 (NAS); Wuxi, *Y. H. Law* 3029 (NAS); Zhenjiang, *East China Exped.* 2934 (NAS). **Jiangxi**: Guixi, *M. X. Nie et al.* 3848 (WUK); Guangde, *Guangde Bot. Exped.* 3163 (NAS); Ji'an, *B. Y. Ding & T. Huang* 6401 (HZU); Jiujiang, *H. Migo s. n.* (NAS); Nanchang, *W. H. Wan* 770003 (JXU); Tangshan, *W. H. Wan s. n.* (JXU). **Shanghai**: Hongqiao, *H. Migo s.n.* (NAS); Minhang, *H. Migo s. n.* (NAS), *C. H. Tao* 328 (NAS). **Sichuan**: Huihai, *T. T. Yu* 1578 (PE, IBSC); Leibo, *Z. S. Diao* 2504 (YZU); Xichang, *S. Y. Chen* 10005 (NAS). **Yunnan**: Dali, *B. Y. Ding et al.* 6248 (HZU); Erhai, *Z. S. Diao* 2637 (YZU), *B. Y. Qiu* 61150 (KUN); Fohai, *C. W. Wang* 74239 (KUN, PE), 77210 (KUN, PE); Jianchuan, Jianhu Lake, *B. Y. Qiu* 61192 (KUN); Xiaguan, Erhai Lake, *B. Y. Qiu* 60802 (KUN, IBK), 60823 (KUN, IBK), 60882 (KUN, IBK); Xishuangbanna, *K. M. Feng* 20493 (KUN); Yongning, *Z. S. Diao* 2577 (YZU). **Zhejiang**: Hangzhou, *B. Y. Ding* 2197 (HZU), 2288 (HZU), 4184 (HZU), *S. Y. Chang* 1587 (NAS); Kaihua, *L. Hong* 1533 (HZU); Lishui, Mt. Nanmingshan, *Y. H. He* 5981 (HZU), *B. Y. Ding* 6280 (HZU); Ningbo, *B. Y. Ding et al.* 5786 (HZU); Shaoxing, *M. Z. Shi & R. Y. Hu* 6237 (HZU), 6238 (HZU), *B. Y. Ding* 2190 (HZU); Yinxian, *M. Z. Shi & R. Y. Hu* 6237 (HZU), *B. Y. Ding & K. F. Dong* 6429 (HZU), *B. Y. Ding & M. Z. Shi* 6210 (HZU); Putuo, *H. Migo s. n.* (NAS); Tiantai, *Y. Y. Ho* 28230 (NAS), *Zhejiang Bot. Exped.* 28406 (NAS); Wenzhou, *B. Y. Ding* 4763 (HZU); Wuxing,

F. X. Liu 1656 (NAS); Yiwu, *B. Y. Ding & W. S. Yao* 4503 (HZU); Zhuji, *B. Y. Ding & W. S. Yao* 4507 (HZU).

Distribution. China (Anhui, Fujian, Guizhou, Henan, Hubei, Hunan, Jiangsu, Jiangxi, Shanghai, Sichuan, Yunnan, Zhejiang), Japan and Vietnam.

Note. The phototype of *Trapa maximowiczii* in P was checked by the authors. Although the fruits showed immature, leaf size and shape indicated it should be reduced to synonym. *Trapa mammillifera* was distinguished in its 4-bulged fruits, which was an unstable morphological character. In China, the name *Trapa incisa* in this entity were misused, but *Trapa incisa* was the species with small fruits and incise-dentate leaves (Nakano, 1964; Xiong, 1985; Kadono, 1987).

2f. **Trapa natans** L. var. **complana** (Z. T. Xiong) B.Y. Ding & X.F. Jin, **comb. nov.**

Basionym: *Trapa pseudoincisa* Nakai var. *complana* Z. T. Xiong, in J. Wuhan Bot. Res. 3: 163. 1985. ***Type***: CHINA, Hubei, Wuchang, 1982, *Z. T. Xiong* 431 (holotype: WH!).

Synonym: *Trapa komarovii* V. N. Vassil. in Komarov, Fl. URSS 15: 693. 1949. ***Type***: RUSSIA, Oriens Extremus, Regio Austro-Ussuriensis, prope urb. Voroschilov-Ussur, 9 Aug. 1930, *V. L. Komarov s.n.* (holotype: LE!)

Trapa pseudoincisa Nakai, in J. Jap. Bot. 18: 436. 1942. ***Type***: CHINA, Manshur, Jehe, Chengte, 21 Aug. 1933, *T. Nakai et al. s.n.* (holotype: TI!).

Trapa pseudoincisa var. *aspinta* Z.T. Xiong, in J. Wuhan Bot. Res. 3: 162. 1985. ***Type***: CHINA, Hubei, Wuchang, 1982, *Z. T. Xiong* 076 (holotype: WH!); *syn. nov.*

Trapa pseudoincisa var. *nanchangensis* W. H. Wan, in J. Jiangxi Univ. (Nat. Sci.) 15(2): 75. 1991. ***Type***: CHINA, Jiangxi, Nanchang, Tangshan, *W. H. Wan* 780012 (holotype: JXU!); *syn. nov.*

格菱　**Fig.** 3: **B**

This variety differs from the typical one in having the fruits lateral compressed, without lower horns, or being degenerated to bulges. Sometimes 2 upper horns were degenerated in later Autumn.

Additional collections studied. **China. Anhui**: Anqing, *H. Migo s. n.* (NAS); Chaohu Lake, *B. Y. Ding et al.* 6222 (HZU); Dangtu, *Dangtu Exped.* 1020 (NAS); Wuhu, *B. Y. Ding et al.* 6218 (HZU), 6219 (HZU). **Hebei**: Chengde, *Y. L. Chang* 2783 (IFP). **Heilongjiang**: Qiqihaer, *P. Y. Fu* 315 (IFP); Yilan, *Y. L. Chang* 1847 (IFP, IBSC, IBK). **Hubei**: Wuchang, Donghu Lake, *anonymous* 79005 (JXU). **Hunan**: without precise locality, *L. J. Lee* 499 (IBSC). **Jiangsu**: Zhenjiang, *H. Migo s. n.* (NAS). **Jiangxi**: Nanchang, *W. H. Wan s. n.* (JXU); Yongxiu, *B. Y. Ding & R. Y. Hu* 6268 (HZU). **Jilin**: Antu, *Y. L. Chou* 3658 (IFP); Chunhua, *C. S. Wang et al.* 2739 (IFP), 2408 (NAS). **Liaoning**: Andong, *Y. Z. Dong* 25 (IFP, NAS); Haicheng, *C. F. Fang* 116 (IFP); Kaiyuan, *P. Y. Fu* 3061 (IFP); Shenyang, *C. Z. Zheng et al.* 6301 (HZU), *G. Q. Guan s. n.* (SYAU); Tieling, *Y. C. Zhu & C. F. Fang* 536 (IFP, IBK); Xinmin, *C. Z. Zheng et al.* 6309 (HZU), 6310 (HZU). **Shaanxi**: Ankang, *K. T. Fu* 11814 (WUK), *P. Y. Li* 1228 (WUK); Nanzheng, *K. T. Fu* 5486 (WUK, IBK); Yangxian, *J. X. Yang* 1379 (WUK), 1648 (WUK); Yulin, *T. P. Wang* 18241 (NAS). **Shandong**: Weishan, Weishan Lake, *B. Y. Ding & R. Y. Hu* 6346 (HZU). **Shanghai**: Wusong, *H. Migo s.n.* (NAS). **Zhejiang**: Hangzhou, West Lake, *W. H. Wan* 781003 (JXU); Yinxian, *M. Z. Shi & R. Y. Hu* 6236 (HZU).

Distribution. China (Anhui, Heilongjiang, Hubei, Hunan, Jiangsu, Jiangxi, Jilin, Liaoning, Shaanxi, Shandong, Shanghai, Zhejiang), Japan, Korae and Far Eastern Region of Russia.

Note. Based on the specimens with the fruits being 2 compressed and upper-curved horned, or with degenerated upper horns, Xiong (1985) respectively described two new varieties: *Trapa pseudoincisa* var. *complana* and *T. pseudoincisa* var. *aspinta*. Wan (1991) described *Trapa pseudoincisa* var. *nanchangensis* mainly based on the shape of the fruits. These varieties were considered as the various types, and thus reduced to synonyms here.

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