Bot. Bull. Academia Sinica 28: 191-209 (1987)

A SYNOPSIS TO THE AQUATIC ANGIOSPERMOUS PLANTS OF TAIWAN

YUEN-PO YANG

Division of Forest Biology, Taiwan Forestry Research Institute
53, Nan-Hai Rd., Taipei, Taiwan, Republic of China

(Received August 20, 1986; Accepted April 3, 1987)

Abstract

Thirty-one families with 125 species of aquatic Angiospermous plants recorded or expected from Taiwan are listed in this report. The aquatic plants are here circumscribed as plants submerged or floating in water throughout most of their life cycle. A key to the families and a species list are provided. Distribution of the species on this island are catagorized as very rare, rare, common, and very common.

Introduction

Aquatic is basically an ecological term to describe a specific habitat in which water is an essential environmental factor. The continuous change of water content in or on the soil ranging from a sandhill to a pond or from a forest to a lake throughout the seasons makes it difficult to define "aquatic" precisely. Any interpretation of the aquatic environment therefore becomes arbitrary whenever one wishes to specify with confidence a particular habitat as being aquatic or not.

Various definitions were given to aquatics in the past years in spite of the lacking of a boundary between aquatic and non-aquatic habitats (Arber, 1920; Muenscher, 1944; Fassett, 1967; Sculthorpe, 1967; Aston, 1973; Cook, 1974), but none has been accepted universally. In this treatment, those plants which are submerged or floating in water during most of their life cycle are regarded as aquatics.

Generally speaking, the identification and classification of aquatic plants are difficult because of the extraordinary populational morphological variability, fluctuation in size as well as floral structures and so forth. Besides, the hard field work in marshes, ponds and lakes results in the paucity of the herbarium specimens. The same situation occurs not only in Taiwan but in many other places of the world.

In the past decades in Taiwan, some aquatic species may have become extinct

due to water pollution and population growth which intensified the need for more land for agriculture and housing. Genera like *Alisma*, *Euryale*, and *Aponogeton* are examples. On the other hand, a number of aquatic families, such as **Sparganiaceae, Isoetaceae,** and **Zosteraceae** have been added to the flora of Taiwan recently (Devol, 1972; Wang *et al.*, 1972; Yang, 1978). The facts elucidate the demand of an incessant investigation for local aquatic flora. A general definition as well as a species list are necessary to serve as a frame for future investigation.

In this report 125 herbaceous species of flowering plants which fall into the previously mentioned definition of aquatic plants are listed. Undoubtedly the exclusion of some species from the following list are somewhat arbitrary because there are too many borderline species that may or may not be included. Some species that are widely distributed in the vicinity of Taiwan and expected to be found on this island are also given in the list.

An artificial key to the aquatic plant families of Taiwan is given below. Keys to the genera and species are not provided because they are available in the **Flora of Taiwan** (Li *et al.*, 1975-1979).

Specific distribution in Taiwan are ranked into four levels, namely very rare, rare, common, and very common. Very rare is defined as the range of a species strictly limited at one or two localities; rare is limited at several localities to one or two counties; common is distributed at several counties or scattered in the whole island; very common is abundant throughout the island. Since the locality of each species was enumerated in the Flora of Taiwan (Li *et al.*, 1975-1979), it is not repeated in this report unless additional localities appeared in recent years.

Key to the Families

1. Leaves net-veined; flowers 4- or 5-merous; cotyledons two.
   2. Plants thalloid, at least basal portion of thallus firmly attached to and flattened against a hard substrate.....Podostemaceae*
   2. Plants not thalloid.
      3. Leaves simple, monomorphic or dimorphic.
         4. Leaves deltoid, rhomboid, orbicular, ovate-orbicular, or peltate.
            5. Leaves deltoid or rhomboid, usually with a bladder at the lower part of petiole.....Trapaceae
            5. Leaves peltate, orbicular, or ovate-orbicular.
               6. Leaves peltate.....Nymphaeaceae
               6. Leaves orbicular or ovate-orbicular.
                  7. Leaves ovate-orbicular, more than 10 cm in diameter; anthers numerous.....Nymphaeaceae
                  7. Leaves orbicular, less than 6 cm in diameter; anthers 5..... .....Gentianaceae

4. Leaves linear, lanceolate, elliptic, or ovate.
8. Leaves with distinct sheath.....Polygonaceae
8. Leaves without sheath.
9. Leaves somewhat rosulate, with traps .....Lentibulariaceae
9. Leaves distinctly cauline, without traps.
10. Perianth not present.....Callitrichaceae
10. Perianth present.
11. Ovary inferior .....Onagraceae
11. Ovary superior.
12. Leaves with stipules.....Elatinaceae
12. Leaves without stipules .....Lythraceae
3. Leaves parted or compound, at least for those submerged leaves.
13. leaves alternate, with traps.....Lentibulariaceae
13. Leaves opposite or verticillate (submerged at least).
14. Leaves dichotomously forked.....Ceratophyllaceae
14. Leaves pinnatifid or bipinnatifid.
15. Flowers mostly unisexual; sepals 4; petals separate; stamens 8 or 4 .....Haloragaceae
15. Flowers bisexual; calyx 5-lobed; petals united into a tube; stamens 4, didynamous .....Scrophulariaceae
1. Leaves parallel-veined; flowers usually 3-merous; cotyledon one.
16. Plants thalloid.....Lemnaceae
16. Plants not thalloid.
17. Plants in fresh water.
18. Plants submerged, with submerged leaves only.
19. Leaves rosulate.
20. Leaves petiolate, ovate to cordate .....Hydrocharitaceae
20. Leaves sessile, linear.
21. Leaves acuminate.
22. Leaves 3-5-veined; flowers solitary, with inferior ovary .....Hydrocharitaceae
22. Leaves without distinct veins; flowers in a head, with superior ovary.....Eriocaulaceae
21. Leaves obtuse or acute.
23. Plants with stolons .....Hydrocharitaceae
23. Plants without stolons .....Alismataceae
19. Leaves cauline.
24. Ovary inferior.....Hydrocharitaceae
24. Ovary superior.
25. Fruit with a stipe.

26. Fruit with teeth on the back; flowers unisexual ..... Zannichelliaceae
26. Fruit smooth on the back; flowers bisexual ..... Ruppiaceae
25. Fruit sessile.
27. Fruit on a peduncle .....Potamogetonaceae
27. Fruit solitary, axillary.....Najadaceae
18. Plants emerged, floating, or submerged with floating leaves.
28. Plants submerged with floating leaves.
29. Leaves rosulate; perianth 2; anthers 6.....Aponogetonaceae
29. Leaves cauline; perianth 4; anthers 4.....Potamogetonaceae
28. Plants emerged or floating.
30. Leaves floating.
31. Leaves glabrous, swollen at sheath or petiole.
32. Leaves swollen at sheath, not more than 2 cm wide .....Poaceae
32. Leaves swollen at petiole, more than 5 cm wide..... .....Pontederiaceae
31. Leaves pubescent, not swollen.....Araceae
30. Leaves emerged.
33. Leaves reduced, without blade or with scale like blade.
34. Flowers without perianth or with 3 to many bristles or of scaly segments.....Cyperaceae
34. Flowers with 6 perianth-segments which in two series .....Juncaceae
33. Leaves not reduced, blade distinct.
35. Leaves laterally compressed or nearly so.
36. Inflorescence a spike; leaves more than 7 mm wide ..... Philydraceae
36. Inflorescence a head; leaves less than 5 mm wide .....Juncaceae
35. Leaves not laterally compressed.
37. Petiole and blade differentiated.
38. Leaves with 5-15 veins.....Alismataceae
38. Leaves without distinct veins ....Pontederiaceae
37. Petiole and blade not differentiated.
39. Flowers unisexual.
40. Flowers in a solitary terminal spike..... .....Typhaceae

40. Flowers in burlike heads...Sparganiaceae
39. Flowers bisexual.
41. Leaves subterete at lower portion.....
..... Alismataceae
41. Leaves flattened.
42. Leaves 3-ranked; stem usually triangular, solid; leaf sheath closed, without ligule.....Cyperaceae
42. Leaves 2-ranked; stem terete mostly hollow; leaf sheath always split, usually with a ligule.....Poaceae

17. Plants in salt water.
43. Leaves with petiole and blade differentiated.....Hydrocharitaceae
43. Leaves without petiole and blade differentiated.
44. Leaves terete.....Cymodoceaceae*
44. Leaves flattened.
45. Leaves more than 12 mm wide; rhizomes covered by stiff fibers.....Hydrocharitaceae
45. Leaves less than 11 mm wide; rhizomes not covered by stiff fibers.
46. Leaves less than 2.5 mm wide.....Zannichelliaceae
46. Leaves more than 3 mm wide.
47. Flowers inferior .....Hydrocharitaceae
47. Flowers superior .....Cymodoceaceae*

* Plants not as yet collected, but expected.

Species List

1. Alismataceae

(1) **Alisma canaliculatum** A. Braun et Bouche, Ind. Sem. Hort. Berol. 4. 1867; Liu *et al.* in Li *et al.*, Fl. Taiwan **5**: 6. 1978.
Plant emerged; probably extinct; collected in Taoyuan County.

(2) **Caldesia grandis** Samuel in Svensk Bot. Tidskr. **24**: 116, f. 1, a & b. 1930; Liu *et al.* in Li *et al.*, Fl. Taiwan **5**: 7. 1978.
Plant emerged; very rare; in Ilan County.

(3) **Sagittaria guayanensis** HBK. subsp. **lappula** (D. Don) Bogin in Mem. N. Y. Bot. Gard. **9**: 192, f. 5. 1955; Hartog in van Steenis, Fl. Mal. I, **5**: 328. 1957.
Syn.: *Lophotocarpus formosana* Hayata, Ic. Pl. Form. **5**: 249. 1915; Liu *et al.* in Li *et al.*, Fl. Taiwan **5**: 10. 1978.

Plant submerged, floating leaves present; very rare; recently collected in Yang-mei, Taoyuan County (Sheng-Horn Yen, pers. comm.).

Since the achenes of *Lophotocarpus formosana* and *Sagittaria guayanensis* ssp. *lappula* are very similar, I agree with Bogin (1955) and Hartog (1957) that the Formosan plants are treated as the latter binomial.

(4) **Sagittaria pygmea** Miq. in Ann. Mus. Bot. Lugd. Bat. **2**: 138. 1866; Liu *et al.* in Li *et al.*, Fl. Taiwan **5**: 13. 1978.

Plant submerged, with some leaves nearly emerged; rare; recently collected in San-sha, Taipei County (S.-H. Yen, pers. comm.) and Yang-mei, Taoyuan County.

(5) **Sagittaria trifolia** L., Sp. Pl. 993. 1753; Liu *et al.* in Li *et al.*, Fl. Taiwan **5**: 13. 1978.

Plant emerged; very common.

2. Aponogetonaceae

(1) **Aponogeton taiwanensis** Masamune in Contr. Syst. Bot. Pl. Oecolog. **1**: 1. 1941.

Syn.: *Aponogeton natans* sensu Masamune in Hokuriku Journ. Bot. **5**(2): 23. 1956. excl. syn.; Yang in Li *et al.*, Fl. Taiwan **5**: 25. 1978. excl. syn.; non Engl. et Krause.

Plant submerged, floating leaves present; probably extinct; collected in Taoyuan County.

According to H. W. E. van Bruggen (pers. comm.), the Formosan plant does not belong to *A. natans*. It is very close to *A. lakhonensis* A. Camus. Because no specimens are available for examination, Masamune's name is retained here. The problem whether the two species are conspecific needs further investigation.

3. Araceae

(1) **Pistia stratiotes** L., Sp. Pl. 963. 1753; Liu et Huang in Li *et al.*, Fl. Taiwan **5**: 810. 1978.

Plant floating; common.

4. Callitrichaceae

(1) **Callitriche japonica** Engelm. ex Hegelm. in Verh. Bot. Ver. Brandenb. **10**: 113. 1868; Hsu et Yang in Li *et al.*, Fl. Taiwan **4**: 436. 1978.

Plant submerged or emerged; common.

(2) **Callitriche palustris** L., Sp. Pl. 969. 1753; Cheng in Fl. Reip. Pop. Sin. **45**(1): 12. 1980.

Syn.: *Callitriche verna* L., Fl. Suec. ed. 2. **2**: 2. 1755; Hsu et Yang in Li *et al.*, Fl. Taiwan **4**: 437. 1978.

Plant submerged or emerged; common.

5. Ceratophyllaceae

(1) **Ceratophyllum demersum** L., Sp. Pl. 992. 1753; Liu in Li *et al.*, Fl. Taiwan **2**: 549. 1976. excl. pl. 404, 1.

(a) var. **demersum**

Plant floating in water; common.

(b) var. **quadrispinum** Makino in Journ. Jap. Bot. **1**(6): 21. 1917, Liu in Li *et al.*, Fl. Taiwan **2**: 551. 1976.

Plant floating in water; rare; scattered.

(2) **Ceratophyllum submersum** L., Sp. Pl. ed. 2. 1409. 1763; Liu in Li *et al.*, Fl. Taiwan **3**: 551. 1976.

Plant floating in water; common.

6. Cymodoceaceae

(1) **Cymodocea rotundata** Ehrenb. et Hempr. ex Aschers. in Sitzungsb. Ges. Naturf. Fr. Berlin **1870**: 84. 1870.

Plant expected on this island.

(2) **Cymodocea serrulata** (R. Br.) Aschers. et Magnus in Sitzungsb. Ges. Naturf. Fr. Berlin **1870**: 84. 1870.

Plant expected on this island.

(3) **Syringodium isoetifolium** (Aschers.) Dandy in Journ. Bot. Brit. & For. **77**: 116. 1939.

Plant expected on this island.

7. Cyperaceae

(1) **Bolboschoenus planiculmis** (F. Schmidt) T. Koyama in Li *et al.*, Fl. Taiwan **5**: 207. 1978.

Plant emerged; rare; in Yunlin County.

(2) **Cyperus haspan** L., Sp. Pl. 45. 1753; T. Koyama in Li *et al.*, Fl. Taiwan **5**: 273. 1978.

Plant emerged; common.

(3) **Cyperus serotinus** Rottb., Descr. Pl. Rar. Progr. 18. 1772; T. Koyama in Li *et al.*, Fl. Taiwan **5**: 276. 1978.

Plant emerged; common.

(4) **Eleocharis acicularis** (L.) Roem. et Schult., Syst. Veg. **2**: 154. 1817; T. Koyama in Li *et al.*, Fl. Taiwan **5**: 219. 1978.

Plant emerged; common.

(5) **Eleocharis acutangula** (Roxb.) Schult. in Romer et Schultes, Mantissa **2**: 91. 1824; T. Koyama in Li *et al.*, Fl. Taiwan **5**: 225. 1978.

Plant emerged; common.

(6) **Eleocharis dulcis** (Burm. f.) Trin. ex Henschel, Vita Rumph. 186. 1833; T. Koyama in Li *et al.*, Fl. Taiwan **5**: 225. 1978.

Plant emerged; common.

(7) **Eleocharis ochrostachys** Steud., Synops. Pl. Glumac. **2**: 80. 1855; T.

Koyama in Li *et al.*, Fl. Taiwan **5**: 223. 1978.

Plant emerged; common.

(8) **Fimbristylis miliacea** (L.) Vahl, Enum. Pl. 2: 287. 1806; T. Koyama in Li *et al.*, Fl. Taiwan **5**: 234. 1978.

Plant emerged; common.

(9) **Fimbristylis quinquangularis** (Vahl) Kunth, Enum. Pl. **2**: 229. 1837; T. Koyama in Li *et al.*, Fl. Taiwan **5**: 234. 1978.

Plant emerged; common.

(10) **Fimbristylis umbellaris** (Lam.) Vahl, Enum. Pl. **2**: 291. 1806; T. Koyama in Li *et al.*, Fl. Taiwan 5: 236. 1978.

Plant emerged; common.

(11) **Mariscus compactus** (Retz.) Druce in Rep. Bot. Exch. Club Brit. Isls. 1916, 634. 1917; T. Koyama in Li *et al.*, Fl. Taiwan **5**: 286. 1978.

Plant emerged; common.

(12) **Schoenoplectus grossus** (L. f.) Palla in Allg. Bot. Zeitschr. **17**: Beibl. 3. 1911; T. Koyama in Li *et al.*, Fl. Taiwan **5**: 208. 1978.

Plant emerged; rare; scattered in Tainan and Pingtung Counties.

(13) **Schoenoplectus mucronatus** (L.) Palla ssp. **robustus** (Miq.) T. Koyama in Li *et al.*, Fl. Taiwan **5**: 214. 1978.

Plant emerged; common.

(14) **Schoenoplectus validus** (Vahl) T. Koyama in Li *et al.*, Fl. Taiwan **5**: 209. 1978.

Plant emerged; common.

8. Elatinaceae

(1) **Elatine triandra** Schkuhr, Bot. Handb. ed. 1. 345. pl. 109b. f. 2. 1791.

Plant submerged or sometimes emerged; rare; scattered in Taipei and Taoyuan Counties (S.H. Yen and C.I. Peng, pers. comm.).

9. Eriocaulaceae

(1) **Eriocaulon buergerianum** Koern. in Miq., Ann. Mus. Bot. Lugd. Bat. **3**: 163. 1867; Chang in Li *et al.*, Fl. Taiwan **5**: 180. 1978.

Plant emerged; common.

(2) **Eriocaulon chishingsanensis** Chang in Li *et al.*, Fl. Taiwan **5**: 180. 1978.

Plant emerged; very rare; in Taipei County.

(3) **Eriocaulon cinereum** R. Br., Prodr. Fl. Nov. Holl. 254. 1810; Walker, Fl. Okinawa South. Ryuk. Isl. 293. 1976.

Syn.: *Eriocaulon cinereum* var. *sieboldianum* (S. et Z.) Koyama in Ohwi, Fl. Japan 266. 1965; Chang in Li *et al.*, Fl. Taiwan **5**: 183. 1978.

Plant emerged; common.

(4) **Eriocaulon merrillii** Ruhl. ex Perkins, Frag. Fl. Philia **1**: 116. 1904; Chang

in Li *et al.*, Fl. Taiwan **5**: 183. 1978.

(a) var. **merrillii**

Plant emerged; very rare; in Pingtung County.

(b) var. **suishaense** (Hayata) Chang in Li *et al.*, Fl. Taiwan **5**: 185. 1978.

Plant emerged; common.

(5) **Eriocaulon nantoense** Hayata, Icon. Pl. Form. **10**: 51. f. 28. 1921; Chang in Li *et al.*, Fl. Taiwan **5**: 185. 1978.

(a) var. **nantoense**

Plant emerged; rare; scattered in Taipei and Pingtung Counties.

(b) var. **trisetum** (Satake) Chang in Li *et al.*, Fl. Taiwan **5**: 187. 1978.

Plant emerged; very rare; in Nantou County.

(6) **Eriocaulon sexangulare** L., Sp. Pl. 87. 1753; Koyama in Li *et al.*, Fl. Taiwan **5**: 187. 1978.

Plant emerged; common.

10. Gentianaceae

(1) **Nymphoides aurantiacum** (Dalz.) Kuntze, Rev. Gen. Pl. **2**: 429. 1891; Liu et Kuo in Li *et al.*, Fl. Taiwan **4**: 181. 1978.

Plant submerged, floating leaves present; probably extinct.

(2) **Nymphoides coreana** (Lev.) Hara in Journ. Jap. Bot. **13**: 26. 1937; Liu et Kuo in Li *et al.*, Fl. Taiwan **4**: 182. 1978.

Plant submerged, floating leaves present; common.

(3) **Nymphoides cristata** (Roxb.) Kuntze, Rev. Gen. Pl. **2**: 429. 1891; Liu et Kuo in Li *et al.*, Fl. Taiwan **4**: 182. 1978.

Plant submerged, floating leaves present; common.

(4) **Nymphoides indica** (L.) Kuntze, Rev. Gen. Pl. **2**: 429. 1891; Liu et Kuo in Li *et al.*, Fl. Taiwan **4**: 182. 1978.

Plant submerged, floating leaves present; common.

11. Haloragaceae

(1) **Myriophyllum spicatum** L., Sp. Pl. **2**: 992. 1753; Huang in Li *et al.*, Fl. Taiwan **3**: 903. 1977.

Plant floating in water; common.

(2) **Myriophyllum propinquum** Cunn. in Ann. Nat. Hist. I, **3**: 30. 1839; van der Meijden et Caspers in van Steenis, Fl. Malesiana I, **7**: 252. 1971.

Syn.: *Myriophyllum ussuriense* (Regel.) Maxim. in Bull. Acad. Sci. St. Petersb. **19**: 182. 1873; Huang in Li *et al.*, Fl. Taiwan **3**: 903. 1977.

Plant emerged; rare; in Taoyuan County.

12. Hydrocharitaceae

(1) **Blyxa auberti** Rich. in Mem. Inst. Paris **12**(2): 19. 1812; Yang in Li *et al.*, Fl. Taiwan **5**: 15. 1978.

Plant submerged; common.

(2) **Blyxa echinosperma** (C.B. Clarke) Hook. f., Fl. Brit. Ind. **5**: 661. 1881; Yang in Li *et al.*, Fl. Taiwan **5**: 15. 1978.

Plant submerged; common.

(3) **Blyxa japonica** (Miq.) Maxim. ex Aschers. et Gurke in Engl. et Prantl, Nat. Pflanzenfam. **2**(1): 253. 1889; Yang in Li *et al.*, Fl. Taiwan **5**: 17. 1978.

Plant submerged; common.

(4) **Enhalus acoroides** (L. f.) Royle, Ill. 453. 1840.

Plant expected in Taiwan.

(5) **Halophila ovalis** (R. Br.) Hook. f., Fl. Tasm. **2**: 45. 1858; Yang in Li *et al.*, Fl. Taiwan **5**: 17. 1978.

Plant submerged in salt water; rare; in Taitung and Penghu Counties.

(6) **Hydrilla verticillata** (L. f.) Royle, Ill. Bot. Himal. pl. 376. 1839; Yang in Li *et al.*, Fl. Taiwan **5**: 19. 1978.

Plant submerged; common.

(7) **Hydrocharis dubia** (Blume) Backer, Handb. Fl. Java. **1**: 64. 1925; Yang in Li *et al.*, Fl. Taiwan **5**: 20. 1979.

Plant floating; very rare; in Taoyuan County.

(8) **Ottelia alismoides** (L.) Pers., Syn. Pl. **1**: 400. 1805; Yang in Li *et al.*, Fl. Taiwan **5**: 20. 1978.

Plant submerged; common.

(9) **Thalassia hemprichii** (Ehrenb.) Aschers. in Peterman's Mitt. **17**: 242. 1871; Yang in Li *et al.*, Fl. Taiwan **5**: 22. 1978.

Plant submerged in salt water; rare; in Pingtung and Taitung Counties.

(10) **Vallisneria americana** Michaux, Fl. Bor. Am. **2**: 220. 1803; Lowden in Aquatic Bot. **13**: 289. 1982.

Syn.: *Vallisneria gigantea* Graebn. in Bot. Jahrb. **49**: 68. 1912; Yang in Li *et al.*, Fl. Taiwan **5**: 24. 1978.

Plant submerged; probably extinct.

13. Juncaceae

(1) **Juncus effusus** L. var. **decipiens** Buchen., Monogr. Juncac. 229. 1890; Kao et DeVol in Li *et al.*, Fl. Taiwan **5**: 150. 1978.

Plant emerged; common.

(2) **Juncus monticola** Steud., Syn. Pl. Glum. **2**: 301. 1855; Walker, Fl. Okinawa South. Ryukyu Isl. 302. 1976.

Syn.: *Juncus leschenaultii* J. Gay ex Fr. et Sav., Enum. Pl. Jap. **2**: 98, 553. 1879.

Plant emerged; common.

(3) **Juncus wallichianus** Laharpe Monogr. Juncac. 139. 1827; Kao et DeVol in Li *et al.*, Fl. Taiwan **5**: 153. 1978.

Plant emerged; rare; scattered.

14. Lemnaceae

(1) **Lemna aequinoctialis** Welwitsch, Apontam. Phytogeogr. Fl. Prov. Angola, Ann. Conselho Ultram. n. **55**: 578. 1859; Landolt in Veroff. Geobot. Inst. ETH Stiftung Rubel **70**: 18 & 48. 1980.

Syn.: *Lemna perpusilla* sensu auct.; non Torr.

Lemna paucicostata Hegelm.,

Lemnac. 139. 1868; Yang in Li *et al.*, Fl. Taiwan **5**: 817. 1978.

Plant floating; very common.

(2) **Lemna trisulca** L., Sp. Pl. 970. 1753; Yang in Li *et al.*, Fl. Taiwan **5**: 817. 1978.

Plant submerged; rare; in Ilan and Taitung Counties.

(3) **Spirodela polyrhiza** (L.) Schleid. in Linnaea **13**: 392. 1839; Yang in Li *et al.*, Fl. Taiwan **5**: 818. 1978.

Plant floating; very common.

(4) **Spirodela punctata** (G.F.W. Meyer) Thompson in Rep. Mo. Bot. Gard. **9**: 28. 1897; Yang in Li *et al.*, Fl. Taiwan **5**: 817. 1978.

Plant floating; rare; in Taipei and Ilan Counties.

(5) **Wolffia arrhiza** (L.) Wimmer Fl. Schles. 140. 1857; Yang in Li *et al.*, Fl. Taiwan **5**: 818. 1978.

Plant floating; common.

15. Lentibulariaceae

(1) **Utricularia aurea** Lour., Fl. Cochinch. 26. 1790; Hsiao in Li *et al.*, Fl. Taiwan **4**: 694. 1978.

Plant submerged; rare; in Taipei County.

(2) **Utricularia australis** R. Br., Prod. Nov. Holl. 430. 1810; P. Taylor in van Steenis, Fl. Malesiana I, **8**: 299. 1977.

Syn.: *Utricularia vulgaris* L. var. *formosana* Kuo in Biol. Bull. Taiwan Norm. Univ. **3**: 24. 1968. nom. illeg.; Hsiao in Li *et al.*, Fl. Taiwan **4**: 698. 1978.

Plant submerged; common.

The two specimens (leg. *Kuo, F.* **s. n.** Aug. 22, et 26, 1967, Hsinchu) deposited in TAI have the characters coincidental with the description of Malesian plants made by P. Taylor (1979).

(3) **Utricularia bifida** L., Sp. Pl. 18. 1753; Hsiao in Li *et al.*, Fl. Taiwan **4**: 694. 1978.

Plant emerged; common.

(4) **Utricularia caerulea** L., Sp. Pl. 18. 1753; P. Taylor in van Steenis, Fl. Malesiana I, **8**: 287. 1977.

Syn.: *Utricularia racemosa* Wall., Cat. n. 1496. 1829. nom. nud.; Walpers in Meyen, Observ. Bot. Nov. Acta **19**: 401. 1843; Hsiao in Li *et al.*, Fl. Taiwan **4**: 696. 1978.

Plant emerged; rare; scattered in Taipei and Taoyuan Counties.

(5) **Utricularia exoleta** R. Br., Prodr. Fl. Nov. **1**: 466, 1810; Hsiao in Li *et al.*, Fl. Taiwan **4**: 696. 1978.

Plant submerged; rare; scattered in Taipei and Taoyuan Counties.

(6) **Utricularia minor** L., Sp. Pl. 18. 1753; Yang *et al.* in Bot. Bull. Academia Sinica **28**: 51. 1987.

Plant submerged; very rare; in Ilan County.

(7) **Utricularia striatula** J. Sm. in Rees, Cyclop. **37**: n. 17. 1819; P. Taylor in van Steenis, Fl. Malesiana I. **8**: 289. 1977.

Syn.: *Utricularia orbiculata* Wall., Cat. n. 1500. 1829. nom. nud.; Hsiao in Li *et al.*, Fl. Taiwan **4**: 696. 1978.

Plant emerged; rare; in Taipei, Taichung, Nantou, Pingtung (Peng, pers. comm.) and Hualien Counties.

(8) **Utricularia uliginosa** Vahl, Enum. **1**: 203. 1804; P. Taylor in van Steenis, Fl. Malesiana I, **8**: 282. 1977.

Syn.: *Utricularia affinis* Wight in Journ. Bot. Kew Misc. **1**: 373. pl. 1580 & 1581. 1849; Hsiao in Li *et al.*, Fl. Taiwan **4**: 694. 1978.

Plant emerged; rare; in Taoyuan County.

Note: A taxon described and recorded as *U. vulgaris* L. var. *tenuicaulis* Miki in Kuo's report (1968) cannot be traced to its original publication. The binomial is thus in doubt. Hsiao (1978) assumed that Kuo first treated the species *U. tenuicaulis* Miki as a variety of *U. vulgaris* L. and cited it as *U. vulgaris* L. var. *tenuicaulis* (Miki) Kuo. According to Taylor (1977), the name *U. vulgaris* was misapplied to the species *U. australis* R. Br. which is known as a widespread species in temperate Eurassia including Japan. Based on Ohwi (1965), *U. tenuicaulis* is restricted to Japan and similar to *U. japonica* Makino (=*U. australis*, by Taylor). Therefore, the name is reasonably to be altered to *U. australis* R. Br. var. *tenuicaulis* (Miki) Yang (comb. nov.) if the varietal rank is followed.

However, no specimens of this genus corresponding to the drawing of this taxon in Kuo's report (page 31) were found in the herbaria TAI and TAIF. Nor the specimen (Mori s.n. in 1942) cited in Hsiao's treatment (1978) could be seen in the two herbaria. Furthermore, based on the drawing given by Kuo, the plant appears to resemble *U. minor* L. Kuo's taxon is however under reinvestigation.

16. Lythraceae

(1) **Rotala indica** (Willd.) Koehne, Bot. Jahrb. **1**: 172. 1880; Cook in Boissiera

29: 108. 1979.

Syn.: *Rotala indica* (Willd.) Koehne var. *uliginosa* (Miq.) Koehne in Bot. Jahrb. **1**: 173. 1880; Huang in Li *et al.*, Fl. Taiwan **3**: 821. 1977.

Plant emerged; common.

(2) **Rotala mexicana** Cham. et Schlecht. in Linnaea **5**: 567. 1830; Huang in Li *et al.*, Fl. Taiwan **6**: 98. 1979.

Plant emerged; rare; in Hsinchu County.

(3) **Rotala rotundifolia** (Wall. ex Roxb.) Koehne in Engler, Bot. Jahrb. **1**: 175. 1880; Huang in Li *et al.*, Fl. Taiwan **3**: 823. 1977.

Plant emerged; common.

(4) **Rotala wallichii** (Hook. f.) Koehne in Engler, Bot. Jahrb. **1**: 154. 1881; Huang in Li *et al.*, Fl. Taiwan **6**: 99. 1979.

Plant emerged; very rare; in Pingtung County.

17. Najadaceae

(1) **Najas ancistrocarpa** A. Br. ex Magnus, Beitr. 7, pl. 3. f. 1-5. 1870; Yang in Li *et al.*, Fl. Taiwan **5**: 36. 1878.

Plant submerged; probably extinct.

(2) **Najas browniana** Rendle in Trans. Linn. Soc. **2**. Bot. **5**: 420. pl. 42. f. 163-169. 1899; Yang in Li *et al.*, Fl. Taiwan **5**: 37. 1878.

Plant submerged; very rare; in Kaohsiung County.

(3) **Najas graminea** Del., Descr. Egypt. Hist. Nat. **2**: 282. pl. 50. f. 3. 1813; Yang in Li *et al.*, Fl. Taiwan **5**: 37. 1978.

Plant submerged; common.

(4) **Najas indica** (Willd.) Cham. in Linnaea **4**: 501. 1829; Yang in Li *et al.*, Fl. Taiwan **5**: 37. 1978.

Plant submerged; common.

(5) **Najas japonica** Nakai in Journ. Jap. Bot. **13**: 853. 1937.

Plant submerged; common.

(6) **Najas marina** L., Sp. Pl. 1015. 1753; Yang in Li *et al.*, Fl. Taiwan **5**: 37. 1978.

Plant submerged; very rare; in Kaohsiung County.

(7) **Najas minor** Allioni, Fl. Ped. **2**: 221. 1785; Yang in Li *et al.*, Fl. Taiwan **5**: 39. 1978.

Plant submerged; common.

18. Nymphaeaceae

(1) **Brasenia schreberi** Gmel., Syst. **2**: 853. 1791; Li in Li *et al.*, Fl. Taiwan **2**: 546. 1976.

Plant submerged, floating leaves present; very rare; in Ilan County.

(2) **Euryale ferox** Salisb. in Kon. et Sims., Ann. Bot. **2**: 74. 1806; Li in Li *et al.*, Fl. Taiwan **2**: 547. 1976.

Plant probably extinct.

(3) **Nelumbo nucifera** Gaertn., Fruct. & Sem. **1**: 73. pl. 19, f. 2. 1788; Li in Li *et al.*, Fl. Taiwan **2**: 541. 1976.

Plant emerged; cultivated; common.

(4) **Nuphar shimadai** Hayata, Icon. Pl. Form. **6**: 2. pl. 1. 1916; Li in Li *et al.*, Fl. Taiwan **2**: 542. 1976.

Plant submerged, floating leaves present; very rare; in Taoyuan County.

(5) **Nymphaea lotus** L. var. **pubescens** (Willd.) Hook. f. et Thoms. in Hook. f., Fl. Brit. Ind. **1**: 114. 1872; Anonymous in Fl. Reip. Pop. Sinic. **27**: 10. 1979.

Syn.: *Nymphaea nouchali* Burm. f., Fl. Ind. 120. 1786; Li in Li *et al.*, Fl. Taiwan **2**: 544. 1976.

Plant probably extinct.

(6) **Nymphaea tetragona** Georgi in Reise Russ. Reich. **1**: 220. 1775; Li in Li *et al.*, Fl. Taiwan **2**: 545. 1976.

Native plant probably extinct.

19. Onagraceae

(1) **Ludwigia adscendens** (L.) Hara in Journ. Jap. Bot. **28**: 290. 1953; Peng in Bot. Bull. Acad. Sinica **24**: 131. 1983.

Plant emerged; rare; in Hualien County (Peng. 1983). Some plants were recently collected in Tainan and Pingtung Counties (C. I Peng, pers. comm.).

(2) **Ludwigia octovalvis** (Jacq.) Raven in Kew Bull. **15**: 476. 1962. et in Li *et al.*, Fl. Taiwan **3**: 893. 1977.

Plant emerged; common.

(3) **Ludwigia ovalis** Miq. in Ann. Mus. Bot. Lugd. Bat. **3**: 95. 1867; Raven in Li *et al.*, Fl. Taiwan **3**: 895. 1977.

Plant emerged; rare; scattered in Taipei, Ilan, Taoyuan, and Pingtung (C. I Peng, pers. comm.) Counties.

(4) **Ludwigia peploides** (HBK.) Raven subsp. **stipulacea** (Ohwi) Raven in Reinwardtia **6**: 397. 1963. et in Li *et al.*, Fl. Taiwan **3**: 896. 1977.

Plant emerged; common. Only triploid populations were known on this island (C. I Peng, pers. comm.).

(5) **Ludwigia epilobioides** Maxim. subsp. **epilobioides** in Mém. Acad. Sci. St. Petersb. Sav. Etrang. **9**: 104. 1859; Ravenin Li *et al.*, Fl. Taiwan **3**: 892. 1977.

Plant emerged; common.

20. Philydraceae

(1) **Philydrum lanuginosum** Banks et Sol. ex Gaertn., Fruct. **1**: 62. 1788; Yang in Li *et al.*, Fl. Taiwan **5**: 146. 1978.

Plant emerged; rare; in Hsinchu (Peng, 1986), Taoyuan, and Ilan Counties.

21. Poaceae

(1) **Echinochloa crus-galli** (L.) Beauv., Ess. Agrost. 53, 161. 169. 1812; Hsu in Li *et al.*, Fl. Taiwan **5**: 552. 1978.

Plant emerged; very common.

(2) **Hygroryza aristata** (Retz.) Nees ex Wight et Arn. in Edinb. New Phil. Journ. **15**: 380. 1833; Hsu in Li *et al.*, Fl. Taiwan **5**: 375. 1978.

Plant probably extinct.

(3) **Hymenachne pseudo-interrupta** C. Muell. in Bot. Zeit. **19**: 333. 1861; Hsu in Li *et al.*, Fl. Taiwan **5**: 558. 1978.

Plant emerged; rare; in Kaohsiung to Taitung County.

(4) **Isachne globosa** (Thunb.) Kuntze, Rev. Gen. Pl. **2**: 778. 1891; Hsu in Li *et al.*, Fl. Taiwan **5**: 519. 1978.

Plant emerged; common.

(5) **Leersia hexandra** Sw., Prodr. Veg. Ind. Occ. 21. 1788; Hsu in Li *et al.*, Fl. Taiwan **5**: 377. 1978.

Plant emerged; common.

(6) **Panicum paludosum** Roxb., Hort. Beng. 8. 1814, nom. nud., et Fl. Ind. **1**: 310. 1820, descr.; Hsu in Li *et al.*, Fl. Taiwan **5**: 576. 1978.

Plant emerged; common.

(7) **Paspalidium punctatum** (Burm. f.) A. Camus in Lecomte., Fl. Gen. de L'Indochine **7**: 419. 1922; Hsu in Li *et al.*, Fl. Taiwan **5**: 579. 1978.

Plant emerged; rare; in Tainan and Kaohsiung Counties.

(8) **Pseudoraphis spinescens** (R. Br.) Vickery in Proc. Roy. Soc. Queensl. 62. n. 7, 69. 1952; Hsu in Li *et al.*, Fl. Taiwan **5**: 594. 1978.

Plant floating or emerged; rare; in Taipei, Ilan, and Tainan Counties.

(9) **Sphaerocaryum malaccense** (Trin.) Pilg. in Fedde, Repert. Sp. Nov. **45**: 2. 1938; Hsu in Li *et al.*, Fl. Taiwan **5**: 514. 1978.

Plant emerged; common.

22. Podostemaceae

(1) **Cladopus nymani** Moeller in Ann. Jard. Buitenz. **16**: 115. 1899.

Plant expected on this island. This species (sensu lato) is distributed in Southeast and East Asia including Malesiana, Siam, Hainan, Kwantung, Fukien, and Ryukyu Is. (van Steenis *et al.*, 1972).

23. Polygonaceae

(1) **Polygonum hydropiper** L., Sp. Pl. ed. 1, **1**: 361. 1753; Liu *et al.* in Li *et al.*, Fl. Taiwan **2**: 271. 1976.

Plant emerged; very common.

24. Pontederiaceae

(1) **Eichhornia crassipes** (Mart.) Solms in A. DC. Monogr. Phaner. **4**: 527. 1883; Yang in Li *et al.*, Fl. Taiwan **5**: 138. 1978.

Plant floating or emerged; very common.

(2) **Monochoria vaginalis** (Burm. f.) Presl, Rel. Haenk. **1**: 128. 1827; Yang in Li *et al.*, Fl. Taiwan **5**: 140. 1978.

Plant emerged; very common.

25. Potamogetonaceae

(1) **Potamogeton crispus** L., Sp. Pl. 126. 1753; Yang in Li *et al.*, Fl. Taiwan **5**: 26. 1978.

Plant submerged; common.

(2) **Potamogeton cristatus** Regel et Maack in Regel, Tent. Fl. Ussur. 153. pl. 10. f. 3-6. 1861; Yang in Li *et al.*, Fl. Taiwan **5**: 28. 1978.

Plant submerged, submerged and floating leaves present; rare; in Taipei and Taoyuan Counties.

(3) **Potamogeton malaianus** Miq., Fl. Arch. Ind. 46. 1871; Yang in Li *et al.*, Fl. Taiwan **5**: 28. 1978.

Plant submerged; common.

(4) **Potamogeton distinctus** Bennett in Journ. Bot. **42**: 72. 1904; Yang in Li *et al.*, Fl. Taiwan **5**: 28. 1978.

Plant submerged, floating leaves present; common.

(5) **Potamogeton maackianus** Bennett in Journ. Bot. 42: 74. 1904; Yang *et al.* in Bot. Bull. Academia Sinica **28**: 49. 1987.

Plant submerged; very rare; in Ilan County.

(6) **Potamogeton octandrus** Poir. in Lam., Encycl. Suppl. **4**: 534. 1861; Yang in Li *et al.*, Fl. Taiwan **5**: 30. 1978.

Plant submerged, submerged and floating leaves present; common.

(7) **Potamogeton oxyphyllus** Miq. in Ann. Mus. Bot. Lugd. Bat. **3**: 161. 1867; Yang in Li *et al.*, Fl. Taiwan **5**: 30. 1978.

Plant probably extinct.

(8) **Potamogeton pectinatus** L., Sp. Pl. 126. 1753; Yang in Li *et al.*, Fl. Taiwan **5**: 30. 1978.

Plant submerged; common.

(9) **Potamogeton pusillus** L., Sp. Pl. 127. 1753; Yang in Li *et al.*, Fl. Taiwan **5**: 30. 1978.

Plant submerged; common.

26. Ruppiaceae

(1) **Ruppia maritima** L., Sp. Pl. 127. 1753; Yang in Li *et al.*, Fl. Taiwan **5**: 31. 1978.

Plant submerged; common; in Taichung and Pintung Counties.

27. Scrophulariaceae

(1) **Limnophila heterophylla** (Roxb.) Benth., Scroph. Ind. 25. 1835; Anonymous in Fl. Reip. Pop. Sinic. **67**(2): 107. 1979.

Plant recorded, no specimens examined, distribution unknown.

(2) **Limnophila indica** (L.) Druce, Rep. Bot. Exch. Club. Brit. Isles 1913, **3**: 420. 1914.

Syn.: *Limnophila trichophylla* sensu Li, Scrophulariaceae in Li *et al.*, Fl. Taiwan **4**: 570. p. p.; non Komarov.

Plant emerged; rare; in Taoyuan and Ilan Counties.

Both emerged and submerged leaves of the species are distinctly different from those of the following species. A key to the two species is given as follows:

1. Leaves on submerged stem obtuse to rounded at apex; flowers sessile, ebracteate ..... *L. sessiliflora*
1. Leaves on submerged stem apiculate at apex; flowers with 0.5-10 mm pedicels, bracteolate ..... *L. indica*

(3) **Limnophila sessiliflora** (Vahl) Blume, Bijdr. 749. 1826.

Syn.: *Limnophila trichophylla* (Komarov) Komarov; Li, Scrophulariaceae in Li *et al.*, Fl. Taiwan **4**: 570. 1978. p. p.

Plant emerged; rare; in Taoyuan County.

28. Sparganiaceae

(1) **Sparganium fallax** Graebner in Allg. Bot. Zeitschr. **4**: 32. 1898; Yang et Hsu in Li *et al.*, Fl. Taiwan **5**: 824. 1978.

Plant emerged; rare; in Ilan County.

29. Trapaceae

(1) **Trapa bispinosa** Roxb. var. **iinumai** Nakano in Engl., Bot. Jahrb. **50**: 455. 1913; Raven in Li *et al.*, Fl. Taiwan **3**: 899. 1977.

Plant floating; rare; in Taipei County.

(2) **Trapa natans** L. var. **japonica** Nakai in Journ. Jap. Bot. **18**: 429. 1942; Raven in Li *et al.*, Fl. Taiwan **3**: 899. 1977.

Plant floating; rare; in Nantou County.

(3) **Trapa taiwanensis** Nakai in Journ. Jap. Bot. **18**(8): 424. 1942; Raven in Li *et al.*, Fl. Taiwan **3**: 899. 1977.

Plant floating; rare; in Tainan County.

30. Typhaceae

(1) **Typha angustifolia** L., Sp. Pl. 971. 1753; Yang in Li *et al.*, Fl. Taiwan **5**: 825. 1978.

Plant emerged; rare; in Taitung County.

(2) **Typha orientalis** Presl, Epim. Bot. 329. 1849; Yang in Li *et al.*, Fl. Taiwan **5**: 825. 1978.

Plant emerged; common.

31. Zannichelliaceae

(1) **Halodule pinifolia** (Miki) Hartog in Blumea **12**: 309. 1964; Yang in Li *et al.*, Fl. Taiwan **5**: 33. 1978.

Plant submerged in salt water; very rare; in Pingtung County.

(2) **Halodule uninervis** (Forsk.) Aschers. in Boiss., Fl. Orient. **5**: 24. 1882; Yang in Li *et al.*, Fl. Taiwan **5**: 34, 1978.

Plant submerged in salt water; rare; in Pingtung and Penghu Counties.

(3) **Zannichellia palustris** L., Sp. Pl. 969. 1753; Yang in Li *et al.*, Fl. Taiwan **5**: 34. 1978.

Plant submerged; rare; in Pingtung and Kaohsiung Counties.

32. Zosteraceae

(1) **Zostera japonica** Aschers. et Garebner in Engl., Pflanzenr. **31**: 32. 1907; Yang in Li *et al.*, Fl. Taiwan **5**: 35. 1978.

Plant submerged in salt water; common; in Chiayi and Kaohsiung Counties.

Acknowledgements

I wish to extend my deep gratitude to Dr. John D. Dwyer for critically reading an early draft of the manuscript at the Missouri Botanical Garden, Saint Louis, Missouri. Without his encouragement, this paper could never have been completed. I thank Dr. Ching-I Peng for valuable suggestions in the review of this manuscript and Mr. Sheng-Horn Yen for offering additional localities of some species. Special thanks are due to Miss Li-Huei Chen and Miss Chia-Yi Cheng for their assistance and typing the manuscript.

Literature Cited

Arber, A. 1920. Water Plant: A Study of Aquatic Angiosperms. Univ. Press, Cambridge.

Aston, H.I. 1973. Aquatic Plants of Australia. Melbourne Univ. Press, Melbourne.

Bogin, C. 1955. Revision of the genus *Sagittaria* (Alismataceae). Mem. N.Y. Bot. Gard. 9(2): 179-233.

Cook, C.D.K. 1974. Water Plant of the World. Pitman Press, England.

Den Hartog, C. 1957. Alismataceae. *In* C.G.G.J. van Steenis (ed.), Flora Malesiana, Ser. I, Vol. 5, part 3. Noordhoff-kolff N.V. Djakarta, pp. 318-334.

DeVol, C.E. 1972. *Isotes* found on Taiwan. Taiwania **17**(1): 1-7.

Fassett, N.C. 1940. A Manual of Aquatic Plants. The McGraw-Hill Book Co., Inc., N.Y.

Kuo, F.T. 1968. Studies on Lentibulariaceae of Taiwan. Biol. Bull. Natl. Norm. Univ. 3: 23-42.

Li, H.L., T.S. Liu, T.C. Huang, T. Koyama, and C.E. DeVol. 1976-1979. Flora of Taiwan I-VI. Epoch Publishing Co., Ltd., Taiwan.

Muenscher, W.C. 1944. Aquatic Plants of the United States. Comstock Publishing Co., Ithaca, New York.

Ohwi, J. 1965. Flora of Japan (in English). Smithonian Institution, Washington, D.C.

Peng, C. I. 1983. Triploidy in *Ludwigia* in Taiwan, and the discovery of *Ludwigia adscendens* (Onagraceae). Bot. Bull. Academia Sinica 24: 129-134.
Peng, C. I., S. F. Yen, and J. Y. Guo. 1986. Notes on the chromosome cytology of some rare, threatened, or endangered plants of Taiwan (1). Bot. Bull. Academia Sinica 27: 219-235.
Sculthorpe, C. D. 1967. The Biology of Aquatic Vascular Plants. St. Martin's Press, New York.
Taylor, P. 1977. Lentibulariaceae. *In* C. G. G. J. van Steenis (ed.), Flora Malesiana Ser. I, Vol. 8, part 2. Sijthoff & Noordhoff International Publ., the Netherlands, pp. 275-300.
Van Steenis, C. G. G. J. and collaborators. 1972. Addenda to volumes 4, 5 and 6. *In* C. G. G. J. van Steenis, Flora Malesiana Ser. I, Vol. 6. part 6, Wolters-Noordhoff Publ., Groningen, the Netherlands, pp. 915-984.
Walker, E. H. 1976. Flora of Okinawa and the Southern Ryukyu Islands. Smithsonian Institution Press, Washington, D. C.
Wang, C. K., T. Liu, K. S. Hsu, and Y. P. Yang. 1972. A plant family new to Taiwan and its Associate. Quart. Journ. Chinese Forest. 5(4): 1-5.
Yang, Y. P. 1978. Zosteraceae. *In* H. L. Li, T. S. Liu, T. C. Huang, T. Koyama, and C. E. DeVol (eds.), Flora of Taiwan, Vol. 5. Epoch Publ. Co., Taipei, p. 35.
Yang, Y. P., S. H. Yen, and S. Huang. 1987. Two new additions of aquatic plants of Taiwan: *Potamogeton maackianus* and *Utricularia minor*. Bot. Bull. Academia Sinica 28: 49-53.

臺灣水生被子植物要覽

楊 遠 波

臺灣省林業試驗所森林生物系

本文以必需長期浸於水中或浮於水面而完成生活史者界定水生被子植物之範疇。共列出三十一科一百二十五種植物，其中包括少數本省可能存在但尙無紀錄者。文中並予科之檢索表及依各種在本省所瞭解之分佈情形區劃爲極稀少、稀少、常見和極常見四級。