

Petrosavia (Petrosaviaceae) in Taiwan and Hainan

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ABSTRACT: *Petrosavia* is known in Taiwan and newly recorded from Hainan. *Petrosavia sinii* is treated as identical with *P. sakurii*. Taxonomic history of *Petrosavia* is reviewed and the genus is recognized as representing a distinct family, Petrosaviaceae.

KEY WORDS: Distribution, *Petrosavia*, Petrosaviaceae, Taxonomy.

INTRODUCTION

Petrosavia is not definitely recognized in Taiwan. It is not recorded in the first edition of Flora of Taiwan (Huang, 1979). During the preparation of the second edition of Flora of Taiwan, Professor Huang (pers. com.) noted that *Protolirion sakurii* (Makino) Dandy is recorded from Taiwan in Ohwi's Flora of Japan (1953, 1965), although no specimens of the species were found in Taiwan. Then, I have studied the genus in order to prepare a manuscript of the genus for the Flora of Taiwan, second edition, volume 5 (ed. by Huang *et al.*, 2000).

In this study, herbarium specimens kept in University of Tokyo (TI), National Science Museum (TNS), and Tohoku University (TUS) were examined.

Petrosavia in Taiwan

Ohwi (1953, 1965) listed Taiwan simply as one of the areas of distribution of *Protolirion sakurii* which is a synonymous name of *Petrosavia sakurii* in this paper. Also, Chen (1980) cited Taiwan as a locality of distribution of *Petrosavia sakurii*. There is one specimen (two duplicates), Suzuki-Tokio ST21365 27 Aug. 1941, of *Petrosavia sakurii* in TI and TNS in Japan. Ohwi (1953) apparently based on a specimen kept in TNS for the new record of occurrence of this species in Taiwan. Further careful plant collections are needed in Taiwan.

Petrosavia in Hainan

Petrosavia of China was reviewed by Chen (1980) for the Flora Reipublicae Popularis Sinicae. He recognized the following two species: *P. sinii* (Krause) Gagnepain. from central Guangxi and *P. sakurai* (Makino) Dandy from Guangxi and Sichuan. Later, *P. sinii* was recorded in Yunnan (Wu, 1984; Li, 1991). Professor J. Murata of the University of Tokyo who found the species at Maguan in southern Yunnan in 1994 (Fig. 1). During our botanical expedition in Hainan in 1993, a specimen of a *Petrosavia* was collected (Tateishi *et al.* 1029042 TUS, IBSC). This is a new record of the genus from Hainan.

Comparing our Hainan collection with specimens of *P. sinii* and *P. sakurii*, I think these two species are identical. The former was distinguished from the latter in having the bracts longer than the subtending pedicel and the ovary free from the perianth above the half (above two third in the latter). These diagnostic characters appear to be variable and continuous in both species. Accordingly, *P. sinii* should be included in *P. sakurii*. Possibility of both species to be identical was already suggested by Jessop (1979), Ohba (1984), and Murata (pers. com.), but they did not decide. As the result, *Petrosavia* composes only two species.

Taxonomic position of *Petrosavia*

The taxonomic position of *Petrosavia sakurii* has been a matter of discussion on its genus and family for a long time. Makino (1903) described a new genus *Miyoshia* to accommodate this species and considered its position as near to *Aletris* of Liliaceae. He suggested at the same time that "perhaps better to establish for it a new family, Miyoshiaceae." Soon after he (1903) noted that *Miyoshia* is identical with *Protolirion* Ridley (1895) or *Petrosavia* Beccari (1871), but still kept the concept that the genus should be regarded to be a distinct family, Protolirionaceae or Petrosaviaceae. Krause (1930) recognized *Protolirion* and *Petrosavia* as distinct and included *Miyoshia sakurai* into *Protolirion*. This view has been followed by Dandy (1931), Maekawa (1939), Melchior (1964), Dahlgren and Clifford (1982), and Dahlgren *et al.* (1985). Hutchinson (1933), on the other hand, compared type specimens of *Petrosavia stellaris* and *Protolirion paradoxum* to each other and concluded both belong to the same species. The three genera are, therefore, congeneric under the oldest name *Petrosavia*. This view has mostly been accepted by succeeding taxonomists (Jessop, 1979; Chen, 1980; Ohba, 1984; Brummitt, 1992; Tamura, 1998; Tamura and Takahashi, 1998). Also, I adopt this concept for the genus in this paper. Only Nakai (1941) treated *Miyoshia*, *Petrosavia* and *Protolirion* to be distinct and established a new family and order to accommodate these genera, i. e., family Miyoshiaceae and order Miyoshiales.

Petrosavia was classified first into Melanthiaceae (Beccari, 1871), and has often been accommodated in Liliaceae in a broad sense, i. e., Liliaceae (Bentham and Hooker, 1883 as tribe Nartheciaceae; Engler, 1887 as subfam. Melanθοideae tribe Tofieldiaceae; Makino, 1903 as *Miyoshia*; Krause, 1930; Melchior, 1964 as subfam. Melanθοideae tribe Petrosaviaceae; Jessop, 1979; Chen, 1980 as tribe Petrosaviaceae; Ohba, 1984), Melanthiaceae (Lotsy, 1911; Dahlgren, and Clifford, 1982; Dahlgren *et al.*, 1985; Brummitt, 1992), Nartheciaceae (Thorne, 1992; Tamura, 1998 as tribe Petrosaviaceae in subfam. Todioidioideae), etc. The genus is also regarded as representing a distinct family Petrosaviaceae (Hutchinson, 1934; Nakai, 1941 as Miyoshiaceae; Cronquist, 1968, 1981, 1988 as in order Triuridales; Takhtajan, 1997 as order Petrosaviales Takhtajan in superorder Triuridanae of subclass Triurididae). Hutchinson (1959) considered *Petrosavia* to be close to *Scheuchzeria* of Scheuchzeriaceae (both family in order Alismatales) and then "tending towards the Triuridaceae (of Triuridales) in its saprophytic habit." The family Petrosaviaceae is regarded to be close to Triuridaceae (Cronquist, 1968; 1981, 1988; Stant, 1970; Takhtajan, 1997), but I don't agree with such view because I think their similarity may be convergence due to their saprophytic life form.

In a recent consensus phylogenetic tree of the monocotyledons summarizing DNA evidence for relationships (Fig. 19 in Kubitzki *et al.*, 1998), *Petrosavia* belongs to a clade with Nartheciaceae, Burmanniaceae, Dioscoreaceae and Taccaceae, but is distinct from these families, although the genus was included in Nartheciaceae in their classification system (Kubitzki *et al.*, 1998; Tamura, 1998). This fact supports that the treatment of Petrosaviaceae as a distinct family, and suggests that Petrosaviaceae is closely related to these families.



Fig. 1. *Petrosavia sakurarii* (Makino) J. J. Smith ex Steenis, at Maguan in southern Yunnan in 1994 (Photo by J. Murata).

Dahlgren *et al.* (on page 210, 1985) considered that "carpels of *Petrosavia* (including *Protolirion*), largely free, have been taken as an indication that these genera form a very primitive group of Liliiflorae." Tamura (1998) classified *Petrosavia* into tribe Tofieldieae of subfamily Tofieldioideae in Nartheciaceae on the basis of the following common characters: basic chromosome number, $x=15$ (Tamura and Takahashi, 1998), largely free carpels, and septicidal capsules. I think *Petrosavia* is an advanced genus representing a distinct family derived from a common ancestor of Tofieldieae (Nartheciaceae) by acquiring saprophytic life form.

Taxonomic Treatment

PETROSAVIACEAE

Hutchinson, *Fam. Fl. Pl.* 2: 36 (1934), loc. cit. ed. 2, 2: 546 (1959); Cronquist, *Evol. Clas. Fl. Pl.*: 330 (1968), & *Integr. Syst. Clas. Fl. Pl.*: 1074 (1981); H. Li in *Flora Yunnanica* 5: 694 (1991); Cronquist, *Evol. Clas. Fl. Pl.* ed. 2: 467 (1988).

The family consists only one genus, *Petrosavia*.

PETROSAVIA

Beccari in *Nuov. Giorn. Bot. Ital.* 3: 7, t. 1 (1871); Krause in *Nat. Pflanzenfam.* ed. 2, 15a: 256 (1930); Hutch. in *Kew Bull.* 1933: 156 (1933) & *Fam. Fl. Pl.* ed. 2, 2: 546 (1959); Nakai in *J. Japan. Bot.* 17: 191 (1941); Melchior in *Engler, Syllabus Pflanzenfam.* ed. 12, 2: 516 (1964); Jessop in *Fl. Males. I*, 9: 198 (1979); S.-C. Chen in *Fl. Reip. Popul. Sin.* 14: 12 (1980); H. Li in *Flora Yunnanica* 5: 694 (1991); Dahlgren and Clifford, *Monocot.*: 172

(1982); Dahlgren *et al.*, *Fam. Monocot.*: 209 (1985); Cronquist, *Evol. Clas. Fl. Pl. ed. 2*: 467 (1988); Tamura in *Fam. & Gen. Fl. Pl.* 3: 389 (1998).

Protolirion Ridley in *Ann. Bot.* 9: 56 (1895) & *Fl. Malay Pen.* 4: 322 (1924); Krause in Engler, *Pflanzenfam. ed. 2*, 15a: 257 (1930); Nakai in *J. Japan. Bot.* 17: 191 (1941); Ohwi, *Fl. Jap.*: 282 (1953), *Fl. Jap. ed. Engl.*: 280 (1965); Melchior in Engler, *Syllabus ed. 12*, 2: 516 (1964); Satake in *Wild Flow. Jap. Herb. Pl.* 1: 23 (1982); Dahlgren & Clifford, *Monocot.*: 172 (1982); Dahlgren *et al.*, *Fam. Monocot.*: 209 (1985); Ohwi & Kitagawa, *New Fl. Jap. rev. ed.*: 386 (1992).

Miyoshia Makino in *Bot. Mag. (Tokyo)* 17: 144, t. 5 (1903); Nakai in *J. Japan. Bot.* 17: 191 (1941).

Pale yellowish saprophytic herbs lacking chlorophyll, glabrous. Rhizome slender, with contiguous scales. Stems erect, unbranched. Leaves scaly, alternate, sessile, entire. Inflorescences racemose, rarely branched at base, or corymbose, terminal, simple; bracts similar to scale-leaves. Pedicels solitary, with 0-2 alternate bracteoles, not articulated. Flowers funnel-shaped; tepals connate with the abaxial base of ovary, persistent after flowering, outer 3 deltoid ovate, smaller than the inner ones, inner 3 ovate to deltoid-ovate, spreading. Stamens 6, connate with inner tepal at base; filaments subulate, 1-nerved; anthers dorsifixed, introrse. Ovary semi-inferior; carpels 3, connate each other for 1/4 to 1/2 their length at adaxial side and adnate to tepal at abaxial side, free above the tepal; styles 1 on each carpel, capitate; ovules attached to adaxial side, numerous. Capsules recurved, dehiscent along the adaxial suture, with persistent tepals. Seeds numerous, elliptical, outer seed coat transparent, membranous, loose; inner coat with 3-4 longitudinal ridges; endosperm with minute embryo elliptical, hilum at an end. Basic chromosome number $x=15$.

Petrosavia is composed of only two species: *P. stellaris* Becc. in Malesia (N. Sumatra, Borneo: Sabah and Sarawak, central Celebes) and *P. sakurarii* (Makino) J. J. Smith *ex Steenis* in Burma, N. Sumatra, Vietnam, China, Taiwan, and Japan. According to Jessop (1979), both species seem to be found together only in Sumatra (West Coast Res.).

Petrosavia sakurarii (Makino) J. J. Smith *ex Steenis*, *Trop. Natur.* 23: 52 (1934); Masamune in *Trans. Nat. Hist. Soc. Form.* 28: 46 (1938); Jessop in *Fl. Males. I*, 9: 200 (1979); S.-C. Chen in *Fl. Reip. Popul. Sin.* 14: 13 (1980), *ut "sakurai"*; Ohba in *J. Japan. Bot.* 59: 108 (1984); Ono *et al.*: 842 (1989); Murata in *Asahi Plant World* 11: 131 (1997); Takahasi in *Fl. Nagano Pref.*: 1194 (1997).

Miyoshia sakurarii Makino in *Bot. Mag. (Tokyo)* 17: 145, t. 5 (1903); Nakai in *J. Japan. Bot.* 17: 191 (1941).

Protolirion miyoshia-sakurarii Makino in *Bot. Mag. (Tokyo)* 17: 208 (1903), *nom. nud.*; Krause in Engler, *Pflanzenfam. ed. 2*, 15a: 257 (1930); Makino, *Illust. Fl. Nippon*: Fig. 2275 (1940). The name was based on *Miyoshia sakurarii* Makino, but created the new specific epithet *miyoshia-sakurarii* (as *Miyoshia-Sakurarii*) without type. The name is neither a new combination nor a new substitute name, but illegitimate.

Protolirion miyoshi sakurarii Makino, *Nippon-Shokubutsu-Zukan* 678, Fig. 1305 (1925), *ut Miyoshi Sakurarii, cum desc. jap., nom. illeg.* The name must erroneously be used for *Protolirion miyoshia-sakurarii* Makino.

Petrosavia miyoshia-sakurarii Makino [in *Bot. Mag. (Tokyo)* 17: 208 (1903), *nom. nud., pro syn., ut Miyoshia-Sakurarii*] *ex Makino & Nemoto*, *Nippon-Shokubutsu-Sôran*: 1272 (1925), *nom. illeg.*; Makino & Nemoto, *loc. cit.* 2nd ed.: 1561 (1930). Illegitimate name as in *Protolirion miyoshia-sakurarii* Makino.

Protolirion sinii Krause Notizbl. Bot. Gart. Mus. Berlin-Dahlem 10: 806 (1927), *syn. nov.*

Protolirion sakurii (Makino) Dandy in J. Bot. 69: 53 (1931); Maekawa in J. Japan. Bot. 15: 147 (1939); Ohwi, Fl. Jap.: 282 (1953), Fl. Jap. ed. Engl.: 281 (1965), Fl. Jap. ed. rev.: 332 (1965); Maekawa et al., Makino's New Illust. Fl. Jap.: 827 (1961), as erroneously "*Petrosavia sakurii* Dandy"; Kitamura et al., Col. Illust. Herb. Pl. Jap. Monocot.: 157, Fig. 272 (1964); Hatusima, Fl. Ryukyus: 780 (1971); Okuyama, Terasaki's Illust.: Fig. 3316 (1977); Satake in Wild Flow. Jap. Herb. Pl. 1: 23, pl. 13-2 (1982); Dahlgren et al., Fam. Monocot.: 210 (1985); Ohwi & Kitagawa, New Fl. Jap. rev. ed.: 386 (1992).

Petrosavia sinii (Krause) Gagnep. in Fl. Gén. Indo-Chine 6: 802 (1934); Iconogr. Cormop. Sin. 5: 424 (1976); S.-C. Chen in Fl. Reip. Popul. Sin. 14: 12 (1980); C.-Y. Wu, Ind. Fl. Yunnan.: 2: 1888 (1984); H. Li in Fl. Yunnan. 5: 694, Fig. 213 (1991), *syn. nov.*

Miyoshia sinii (Krause) Nakai in J. Japan. Bot. 17: 191 (1941), *syn. nov.*

Aerial stems 7-22 cm long, erect, with rhizomes. Leaves membranous, scaly, loose on upper part, broadly to narrowly ovate, 1-nerved, subobtusate, 2-5 mm long. Racemes 1.5-6 cm long, several to more than 10-flowered, loose; pedicels ascending, 2-5 mm long; bracts narrowly ovate, 2-3 mm long, shorter to slightly longer than the pedicel. Flowers 3-4 mm across, tepals 6; outer 3 deltoid-ovate, acute, ca. 1 mm long, about half as long as inner 3, inner ones 1.5-3 mm long, ovate to deltoid-ovate, subacute. Stamens 1.5-2 mm long. Capsules ca. 3 mm long, with a persistent style. Seeds elliptic-oblong, 0.5-0.7 mm long, with wing-like outer seed coat, endosperm with minute embryo brown.

Distribution: Burma, N. Sumatra, Vietnam (Tonkin), China (Yunnan, Guangxi, Hainan, Sichuan), Taiwan, and Japan (Amami-ôshima and central Honshu: SW. Nagano, Gifu, Ishikawa, Kyoto and Fukui Prefectures). Original record from Burma was not confirmed, although Jessop (1979) cited the region only for species, not for genus.

Specimens examined: **Taiwan.** Hsinchu: Chutung, northern part of Mt. Rulin, above Pabunbagayu. Alt. 1400 m. Suzuki-Tokio ST21365. 27 Aug. 1941 (TI, TNS). **Hainan.** Tongshi City, Wuzhishan District, from Yabing village to the top of Mt. Wuzhi. Long. 18.70N, Lat. 109.50E. Alt. 750-1800 m. Y. Tateishi, F. W. Xing, T. Nemoto & H. G. Ye 1029042. 29 Oct. 1993 (TUS, IBSC).

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台灣及海南所產的櫻井草屬 (*Petrosavia*) 植物

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摘 要

櫻井草屬為櫻井草科 (Petrosaviaceae) 的單屬植物，1941 年在台灣曾採集記錄過，在海南島則於 1993 年由筆者等初次發現。本屬植物原有三種，筆者認為其中 *P. sinii* 應納入 *P. sakurii* 中，因此櫻井草屬僅包含兩種，即 *P. stellaris* (馬來西亞) 及 *P. sakurii* (馬來西亞、緬甸、越南、中國、台灣及日本)。櫻井草 *P. sakurii* 為紀念初次發現者櫻井半三郎而命名。櫻井草為腐生植物，在親緣關係上與納茜菜科 (Nartheciaceae)、水玉簪科 (Burmanniaceae)、薯蕷科 (Dioscoreaceae)、田代薯科 (Taccaceae) 較為接近。

關鍵詞：分佈，櫻井草屬，櫻井草科，分類學。