

Distribution of *Glycine tabacina* (Labill.) Benth. in the West-Central Pacific

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Abstract—The genus *Glycine* subgenus *Glycine* is represented in Taiwan, South China and the Ryukyu Islands by *G. tabacina* and *G. tomentella*. *Glycine clandestina* has been reported from the Pescadores, Ryukyu and Mariana Islands in the West-Central Pacific. Morphological examination of herbarium material and living collections suggests that those specimens identified as *G. clandestina* from the Pescadores and Ryukyus are narrow-leaved forms of *G. tabacina*. Cytological analysis indicates that both broad and narrow-leaved collections of *G. tabacina* from the area are tetraploid ($2n=80$). *Glycine* was collected in the Mariana Islands and found to be *G. tabacina*, not *G. clandestina* as previously reported. Morphologically it resembles the broad-leaved *G. tabacina* which occurs in the Ryukyus, and is also tetraploid.

Introduction

The genus *Glycine* Willd. is composed of two subgenera, *Glycine* and *Soja* (Moench) F. J. Herm. *Soja* includes the agriculturally important soybean *G. max* (L.) Merr., and its wild ancestor *G. soja* Sieb. & Zucc., both of which are annual and diploid with 40 chromosomes. The soybean is found only under cultivation while *G. soja* occurs naturally in Japan, Korea, China, the U.S.S.R. and Taiwan. The subgenus *Glycine* includes seven perennial species which are concentrated in Australia. *Glycine canescens* F. J. Herm., *G. clandestina* Wendl., *G. falcata* Benth., *G. latifolia* (Benth.) Newell & Hymowitz (Newell and Hymowitz, 1980) and *G. latrobeana* (Meissn. in Lehm.) Benth. are diploids ($2n=40$) restricted in distribution to Australia. *Glycine tabacina* (Labill.) Benth. and *G. tomentella* Hayata are predominantly tetraploid ($2n=80$) with occasional diploid, or in the case of *G. tomentella*, aneuploid populations (Newell and Hymowitz, 1978a). *Glycine tomentella* is found in Papua New Guinea, the Philippines, Taiwan, and South China as well as Australia. *Glycine tabacina* occurs in Taiwan, the islands of Quemoy and Amoy just off the coast of Fujian Province, China, opposite Taiwan, and the Ryukyu Islands in the West Pacific. In the South Pacific it is found in Australia and the islands of Tonga, Niue, Fiji, and New Caledonia (Hermann, 1962; Sykes, 1970).

Taiwan and the Ryukyu Islands

Glycine clandestina is the third species of the subgenus *Glycine* reported to occur outside Australia (Fosberg et al., 1979; Hermann, 1962; Walker, 1976). In 1919,

Hayata described *G. pescadrensis* based on a specimen from the Penghu Island group, or Pescadores, west of Taiwan (*Kawakami s.n.*—TI, holo.). This was later reduced to synonymy with *G. clandestina* (Hermann, 1962; Hosokawa, 1935) since it was deemed morphologically similar to that species. Several collections have thus been identified as *G. clandestina* or *G. pescadrensis* from Ie Jima (*Kamisu 7823*—KYO; *Hatusima* and *Miyagi 37546*, *Niuro s.n.*, *Sonohara 7696*, *Tamaki s.n.*, *Tamashiro s.n.*, *Uezy 7823*—URO) and Okinoerabu Jima (*Hatusima 30994*—TI; *Hatusima* and *Miyagi 39062*—URO; *Ohba s.n.*, *Oniwa s.n.*—KYO) in the Ryukyu Islands. A similar collection from Amoy Island (*Sampson 13061*—K) was determined as *G. tabacina* by F. J. Hermann.

Living material from Penghu (Plant Introduction [P.I.] 320545) and Quemoy (P.I. 319697 and 320549) Islands as well as Ie Jima (P.I. 393533) in the Ryukyus has been studied morphologically and cytologically (Newell and Hymowitz, 1978a, 1978b).

Both the living material and herbarium specimens listed above possess narrow, oblong leaflets similar to those exhibited by some accessions of *G. clandestina*. A diagnostic feature of *G. clandestina* often used to separate it from *G. tabacina* is the digitate arrangement of the leaf, whereby the three leaflets arise from a common point on the petiole. The narrow-leaved forms from Taiwan and the Ryukyu Islands vary in leaf type from almost digitate to distinctly pinnate, where the rachis subtending the terminal leaflet may be several millimeters in length. The rachis is often better developed on the upper parts of the stems. Other morphological features characteristic of *G. tabacina* rather than *G. clandestina* include a longer inflorescence rachis, larger flowers and stouter pods, and more robust growth habit. All *G. clandestina* accessions from Australia studied so far are diploid ($2n=40$). Those narrow-leaved specimens from Taiwan and Ie Jima which have been examined cytologically (P.I. 319697, 320545, 320549 and 393533) are tetraploid ($2n=80$).

It is therefore suggested, on morphological and cytological grounds, that true *G. clandestina* is restricted to Australia, whereas the forms usually identified as *G. clandestina* from islands west of Taiwan and the Ryukyus are narrow-leaved variants of the *G. tabacina* which is found throughout the area.

Another species of *Glycine* with broadly elliptic leaves, *G. koidzumii*, was described by Ohwi in 1943 based on a specimen from Miyako Jima in the Ryukyus (*Koidzumi s.n.*—KYO, holo.). While Ohwi considered *G. koidzumii* to show affinity with *G. pescadrensis* Hayata, Hermann (1962) later reduced it to possible synonymy with *G. tabacina*. Similar broad-leaved forms have been variously collected as *G. koidzumii* or *G. tabacina* from Irabu Jima (*Nakasone s.n.*—KYO), *Ishigaki Jima* (*Furuse 2011*—URO), *Kurima Jima* (*Ikeda 4222*, *Shimabuku 2545*—URO), and *Miyako Jima* (*Furuse 4634*—URO; *Hatusima 24072*—NA; *Kawakami s.n.*, *Miyagi, Higa* and *Hatusima 38562*, *Miyagi, Nakada* and *Hatusima 36920*, *37036*—URO) in the Ryukyus. Two specimens from Miyako Jima labelled as *G. membranacea* Ohwi *nomen nudum* (*Koidzumi s.n.*, *Nakasone s.n.*—KYO) fall into the same category, with broad, elliptic but somewhat more membranaceous leaflets than usual.

Plants from these locations possess pinnate leaves with broadly elliptic to

obovate leaflets, long inflorescences, and short, stout pods. Living material obtained from Miyako Jima (P.I. 393534) fell within the range of *G. tabacina* from Australia in all morphological characters examined, and furthermore was similar to a collection of *G. tabacina* from Viti Levu, Fiji, in the South Pacific (Newell and Hymowitz, 1978a, 1978b). Both accessions were tetraploid with $2n=80$. Crossing experiments are currently being carried out to ascertain genetic relationships between the broad and narrow-leaved forms of *G. tabacina* from Taiwan and the Ryukyus.

Mariana Islands

Glycine clandestina was also reported by the Japanese botanist T. Hosokawa to occur in the Marianas (Hosokawa, 1934, 1935), a chain of 17 islands in the West Pacific running north and south between latitudes 13° and 20° N and longitudes 144° and 146° E. To the north, the island arc is continued by the Volcano and Bonin Islands. Hosokawa (1935) listed the islands of Tinian, Saipan (although with a question mark, as if there was some doubt about Saipan) and Pagan as locations for *G. clandestina*. An herbarium specimen collected by him from Tinian (Hosokawa 7377—UC, BISH) was confirmed as *Glycine*.

The Marianas, therefore, form the northeastern limit of *Glycine* distribution recorded so far. Botanical excursions conducted to the area since Hosokawa's time, however, have apparently not confirmed the presence of *Glycine* on the islands, and a recent treatise of the flora of the Northern Marianas (Fosberg et al., 1975) still refers to the 1935 citation of Hosokawa.

One of the aims of a biosystematic study of wild perennial *Glycine* currently being carried out at the University of Illinois at Urbana-Champaign is to build up a representative collection of *Glycine* accessions from all parts of the distribution range. Since no living material from the Marianas was available for analysis, a collecting trip to the islands was organized in 1980 in the hopes of obtaining seed and herbarium specimens of *Glycine*.

During early September 1980 the author visited the islands of Tinian, Saipan and Rota in the Marianas. Wild *Glycine* was found along the north-east coast of Tinian growing on a flat coral limestone cliff north of Asiga Point. The conspicuous feature of this particular part of the coastline was its open grassy aspect, which contrasted strongly with the dense shrub growth common over much of the island's perimeter. The main grass present was *Zoysia*; other plants in the area included *Phyllanthus*, *Ipomoea pes-caprae* and *Wedelia biflora*. *Glycine* formed small, intermittent patches for approximately a mile along the coast where *Zoysia* persisted, but could not be found once the grass gave way to dense shrub cover such as *Scaevola*. Perennial *Glycine* has a thickened tap root from which several stems arise, and stems were found growing through the mat of *Zoysia* for up to three feet before the tips appeared above the grass tufts. Plants are able to spread vegetatively through an area by rooting at the stem nodes and forming new tap roots.

The site north of Asiga Point where *Glycine* was collected by the author was

apparently not the same as that specified by Hosokawa (1935). His location for specimen No. 7737 from Tinian was an open grassland by the sea shore near the village of Tyuro, equivalent to Chulu in the native Chamorro language (D. R. Smith, pers. comm.), which was situated close to Lake Hagoi on the north-western side of Tinian.

Glycine was also found growing on the island of Saipan to the north of Tinian. The Banzai Cliff area at the extreme northern tip of the island provided a suitable habitat, with an exposed grassy area on a flat coral limestone cliff overlooking the sea. Several large patches of *Glycine* were evident among the grass. The plant had a more robust appearance than that seen on Tinian, with larger leaflets and seed pods, possibly due to more fertile growing conditions; the soil on Banzai Cliff appeared deeper and richer than the sparse soil cover at the Tinian location. Other plants in the habitat included *Cynodon*, *Wedelia biflora*, *Tridax procumbens*, *Ipomoea pes-caprae*, *Phyllanthus* and *Alysiocarpus*. The site was apparently burned over frequently during the dry season, as attested by blackened stalks and charred plant material on the surface. This did not seem to affect *Glycine*, however, which presumably could survive either through seed buried in the soil or by sprouting from perennial root stocks.

Pagan was the third island mentioned by Hosokawa (1935) in connection with *Glycine*, but unfortunately it was not possible to confirm this report. A brief visit was made instead to the island of Rota south of Tinian. Although an open grassy cliff of coral limestone at the northern tip of the island again afforded a suitable habitat, a thorough examination of the area failed to reveal *Glycine*.

Discussion

The *Glycine* collected from Tinian (Newell IL 624, IL 625—CEL) and Saipan (Newell IL 626—CEL) turned out to be *G. tabacina*, and not *G. clandestina* as determined by Hosokawa (1935). The plants exhibit the pinnate leaves, broadly elliptic to obovate leaflets, long inflorescences, and several branches arising from a single rootstock characteristic of *G. tabacina* (Fig. 1). Chromosome numbers obtained from root tip cells undergoing mitosis indicate that the plants are tetraploid with $2n=80$.

Results from the collecting trip therefore confirm two of Hosokawa's records and establish the continued presence of *Glycine* in the Mariana Islands, despite the devastation suffered by the vegetation during the second world war and subsequent agricultural development. The species is a broad-leaved form of tetraploid *G. tabacina*, morphologically similar to those broad-leaved forms evident in herbarium collections and living material from the Ryukyu Islands in the West Pacific, and also Tonga, Fiji, and New Caledonia in the South Pacific.

Although not abundant on Tinian or Saipan, *G. tabacina* can apparently tolerate a certain amount of disturbance to its habitat. The flat, grassy cliff top of Tinian was easily accessible to people and vehicles, and had been used as a site for maneuvers by

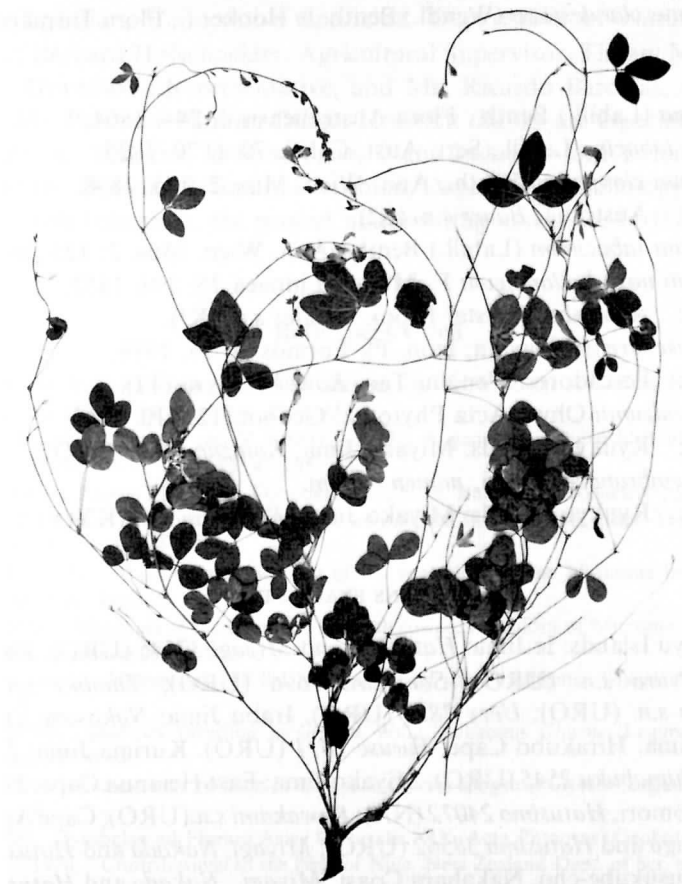


Fig. 1. *Glycine tabacina* (Newell IL 624) from Tinian, Mariana Islands.

the U.S. Marines just prior to the author's visit. On Saipan, *G. tabacina* is able to withstand burning of the vegetation during the dry season; while on Tonga, it has been found growing in lawns subjected to frequent mowing (G. Buelow, pers. comm.). Whether it is native, or of recent introduction as believed by Fosberg et al. (1979), hardiness of this sort evidently has facilitated the establishment and survival of *G. tabacina* in the Pacific Islands.

Synonymy

Glycine clandestina Wendl., Bot. Beobacht. 54. 1798.

Teramnus clandestinus (Wendl.) Sprengel, Syst. Veg. 3: 235. 1826.

Leptolobium clandestinum (Wendl.) Benth., Ann. Wien. Mus. 2: 125. 1838.

Leptolobium microphyllum (Sieber) Benth., Ann. Wien. Mus. 2: 125. 1838.

Leptocyamus clandestinus (Wendl.) Benth. in Hooker f., *Flora Tasmaniae* 1: 102. 1860.

Glycine tabacina (Labill.) Benth., *Flora Australiensis* 2: 244. 1864.

Kennedyia tabacina Labill., *Sert. Aust.-Caled.* 70, t. 70. 1825.

Leptolobium elongatum Benth., *Ann. Wien. Mus.* 2: 125. 1838.

Type: Australia, *Bauer s.n.* (K!).

Leptolobium tabacinum (Labill.) Benth., *Ann. Wien. Mus.* 2: 125. 1838.

Desmodium novo-hollandicum F. Müller, *Linnaea* 25: 394. 1852.

Type: Australia: Crystal Brook, *Müller s.n.* (K!).

Glycine pescadrensis Hayata, *Icon. Pl. Formos.* 9: 26. 1919.

Type: Pescadores: P'enghu Tao, *Kawakami s.n.* (TI).

Glycine koidzumii Ohwi, *Acta Phytotax. Geobot.* 12: 110. 1943.

Type: Ryukyu Islands: Miyako Jima, *Koidzumi s.n.* (KYO!).

Glycine membranacea Ohwi, *nomen nudum*.

Type: Ryukyu Islands: Miyako Jima, *Koidzumi s.n.* (KYO!).

SPECIMENS EXAMINED

Japan. Ryukyu Islands: Ie Jima: *Hatusima* and *Miyagi* 37546 (URO); *Kamisu* 7823 (KYO); *Niuro s.n.* (URO); *Sonohara* 7696 (URO); *Tamaki s.n.* (URO); *Tamashiro s.n.* (URO); *Uezy* 7823 (URO). Irabu Jima: *Nakasone s.n.* (KYO). Ishigaki Jima: Hirakubo Cape, *Furuse* 2011 (URO). Kurima Jima: *Ikeda* 4222 (URO); *Shimabuku* 2545 (URO). Miyako Jima: East Heianna Cape, *Furuse* 4634 (URO); Tomori, *Hatusima* 24072 (NA); *Kawakami s.n.* (URO); Cape Agarihenna, *Miyagi*, *Higa* and *Hatusima* 38562 (URO); *Miyagi*, *Nakada* and *Hatusima* 36920 (URO); Gusukube-cho, Nakahara Coast, *Miyagi*, *Nakada* and *Hatusima* 37036 (URO); *Nakasone s.n.* (KYO). Okinoerabu Jima: *Hatusima* and *Miyagi* 39062 (URO); *Ohba s.n.* (KYO); Osumi, *Oniwa s.n.* (KYO).

Mariana Islands. Tinian: *Hosokawa* 7737 (BISH, UC).

Taiwan. Amoy: *Sampson* 13061 (K).

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