

## *Nuphar saikokuensis* (*Nymphaeaceae*), a New Species from Central to Western Japan

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A new species of *Nuphar* (*Nymphaeaceae*), *N. saikokuensis*, from central to western Japan is described. This new species is characterized by its widely ovate to narrowly ovate floating and emergent leaves, which are 10–30 cm long and 7–20 cm wide. This species is suggested to be of hybrid origin between *N. japonica* DC. and *N. subintegerrima* (Casp.) Makino or *N. oguraensis* Miki, or among these three species based on morphological and genetic studies. Because the plants are fertile, and are widely distributed in central to western Japan, we consider these plants to belong to a distinct species.

**Key words:** Hybrid origin, Japan, new species, *Nuphar saikokuensis*, *Nymphaeaceae*.

*Nuphar* Sm. (*Nymphaeaceae*), the yellow water-lily, is a perennial freshwater, emergent, floating-leaved or submergent macrophyte and is distributed in the temperate zone of the Northern Hemisphere (Beal 1956, Cook 1996, Padgett et al. 1999, Padgett 2007). In Japan, five *Nuphar* species have been noted (Kadono 1994, Shiga et al. 2006); *N. japonica* DC., *N. oguraensis* Miki, *N. pumila* (Timm) DC., *N. subintegerrima* (Casp.) Makino, *N. submersa* Shiga & Kadono, with three varieties and two forms. These taxa excluding *N. pumila*, which is distributed widely in the Old World, are endemic to eastern Asia (Beal 1956, Kadono 1994, Padgett 2007).

Kadono (1994) pointed out the occurrence of morphologically intermediate plants between *N. japonica* and *N. subintegerrima* s.s. in central to western Japan. Although *N. subintegerrima* s.s. is a dwarf plant having roundish floating and

emergent leaves of 4–17 cm long and 4–15 cm wide (Makino 1910, Shiga and Kadono 2004), the plants with widely ovate to narrowly ovate floating and emergent leaves of 15–25 cm long have often been identified as *N. subintegerrima* s.l. (Shiga and Kadono 2005). Morphological and allozyme studies have revealed that the plants are distinguished from *N. subintegerrima* s.s. and supposed to be of hybrid origin between *N. japonica* and *N. subintegerrima* s.s. or *N. oguraensis*, or among these three species (Shiga and Kadono 2004). Shiga and Kadono (2008) suggested that sexual reproduction occurs among the hybrids beyond the F1.

We treat these plants as a new distinct species of *Nuphar* since it is clear that these intermediate plants are more or less fertile, and are widely distributed in central to western Japan. In this paper we describe this new species.

### Taxonomic treatment

*Nuphar saikokuensis* Shiga & Kadono, **sp. nov.** [Figs. 1–3]

*Nuphar saikokuensis* Shiga & Kadono, Field Guide Aquat. Pl. Jap. 44 (2014), nom. nud.

*Nuphar subintegerrimum* auct. non (Casp.) Makino: Tamura, Wild Fl. Jap. 2: pl. 94-1 (1982); Kadono, Aquat. Pl. Jap.: figs. 114–115 (1994).

Haec species nova *Nuphari japonicae* DC. et *N. subintegerrimae* (Casp.) DC. et *N. oguraensis* Makino propinqua; ab eis foliis anguste ovatis ad late ovatis, caulibus teretibus ad teretiusculis non lacunaribus differet.

**Type:** JAPAN. Hyogo Pref., Ono-shi, Oda-cho, 30 May 2001, T. Shiga 3225 (OSA 198746–holotype, Fig. 1; TNS–isotype).

Perennial aquatic herbs. Rhizomes procumbent, branching. Leaves submerged and floating or emergent (Figs. 2E, F, G); submerged leaves roundish to ovate, 7–30 cm long, 5–20 cm wide, membranaceous, margin undulate; floating and emergent leaves widely ovate to narrowly ovate, 10–30 cm long, 7–20 cm wide, base cordate, apex rounded, upper surface glabrous, lower surface slightly pubescent. Petiole usually terete to more or less flattened above without central lacuna (Fig. 2B). Peduncle raised above water. Flowers June to October, yellow, 3–4 cm across (Fig. 2A), protogynous; sepals 5, obovate-orbicular, apex rounded, 1.5–2.5 cm long, subcoriaceous, yellow; petals inconspicuous, obovate-cuneate, 5–8 mm long; anthers many, 4–6 mm long, ratio of pollen sack to filament length ca. 1:1 to 1:2; pistil 1, carpels many, fused; stigmatic rays 2.5–4 mm long; disc of stigma yellow, 4–11 mm across, 5–17 rays, shallowly toothed; fruit green, narrowly ovoid to ovoid (Fig. 2D), 2.5–4 cm long, 1.5–3 cm wide; seeds numerous, ovoid, 3.5–5 mm long, 3–4.5 mm wide (Fig. 2C).

Japanese name: Saikoku-hime-kôhone (Shiga and Kadono 2005)

和名: サイコクヒメコウホネ (志賀・角野 2005).

Etymology: The specific epithet and the

Japanese name derive from a regional name, “Saikoku” in Japanese, which means western Japan and is the center of the distribution range of this new species.

Distribution: Central to western Japan (Fig. 3). Endemic to Japan.

Habitat: Rivers, streams, lakes, and ponds.

Note: Shiga and Kadono (2004) divided *N. saikokuensis* into two morphological types. Although morphological features of both types widely overlapped, the size of stigmatic disc, stigma, filament, and number of stigmas showed different features.

Protection and conservation: *Nuphar subintegerrima* s.l. including *N. saikokuensis* have been designated as endangered species in Japan (Environmental Agency of Japan 2000, Ministry of the Environment 2012). Many populations of *N. saikokuensis* have become extinct recently (Environmental Agency of Japan 2000, Shiga and Kadono 2005). Therefore, *N. saikokuensis* is one of the species in urgent need of protection and conservation.

Specimens examined: JAPAN. **Niigata** Pref.: Ogata-machi, 5 Sept. 1988, M. Sasagawa s.n. (KOBE: Kobe University Herbarium). **Fukui** Pref.: Kanazu-cho, 10 Aug. 2001, T. Shiga 3650, 3651 (OSA); Katsuyama-shi, 10 Aug. 2001, T. Shiga 3648, 3649, 3652 (OSA); Tsuruga-shi, 5 May 1933, Z. Tashiro s.n. (KYO); 18 Jul. 1966, K. Seto 15577 (OSA); 9 Aug. 2001, T. Shiga 3646, 3647 (OSA). **Gifu** Pref.: Shirotori-cho, Jul. 1933, G. Itoshiro s.n. (TNS); 2 Jul. 1933, G. Koidzumi s.n. (KYO); 9 Jun. 2001, T. Shiga 3222 (OSA); 17 Oct. 2003, T. Shiga 3357 (OSA); Kawabe-cho, 17 Jun. 1997, T. Umehara 8087 (OSA); Kani-shi, 18 Jul. 1996, H. Takahashi 16543 (KYO); 1 Oct. 2002, T. Shiga 3654 (OSA); Gifu-shi, 11 Aug. 1971, S. Hamashima s.n. (OSA). **Aichi** Pref.: Toyohashi-shi, 22 May 1949, K. Torii s.n. (KYO); Tatsuta-mura, 4 Oct. 1999, S. Hamashima s.n. (OSA). **Mie** Pref.: Kuwana-shi, 28 Aug. 2003, S. Hamashima s.n. (OSA); Iino-mura, 8 Sept. 1951, G. Nakai 5651 (KYO); Ueno-shi, 9 Jun. 1968, I. Hiura s.n. (OSA); Iga-cho, Sept. 2002, T. Yamaji s.n. (OSA); Miyama-cho, 6 Aug. 1962, K. Seto 11595 (OSA); 17 May 1987, K. Seto 32545 (OSA); 13 Oct. 1994, T. Fujii 4957 (OSA); 13 Oct. 1995, S. Fujii 4718 (OSA). **Shiga** Pref.: Imazu-cho, 24 Aug. 1994, T. Fujii 3973 (OSA); 6 Oct. 1997, S. Fujii 5981 (OSA); 7 Jun. 2002, T. Shiga 3126 (KOBE); Shinasahi-machi, 22 Sept. 1994, S. Fujii 4093 (OSA); 9 Aug. 2001, T. Shiga 3661 (OSA); 7 Jun. 2002, T. Shiga 3124 (OSA); 23 Aug. 2002, T. Shiga 3662 (OSA);



Fig. 1. Holotype of *Nuphar saikokuensis* Shiga & Kadono (JAPAN, Hyogo Pref., Ono-shi, Oda-cho, alt. ca. 100–110 m, 30 May 2001, T. Shiga 3225, OSA 198746). Scale indicates 5 cm.

Takushima-cho, 18 Sept. 1994, T. Fujii 4048 (OSA); Shiga-cho, 30 Jun. 1962, G. Murata 16461 (MAK); 13 Jun. 1975, Y. Kadono 1972 (KOBE); 21 Oct. 1975, Y. Kadono 1856 (KOBE); 16 Dec. 1975, Y. Kadono 1630, 2000 (KOBE); 28 Jun. 1976, Y. Kadono 6024 (KOBE); Komatsu-mura, 15 Aug. 1937, C. Hashimoto 4531 (KYO, TNS); 26 Sept. 1941, C. Kataoka s.n. (OSA); Azuchi-cho, 14 Sept. 1975, K. Nagai s.n. (KYO, OSA); Ohmihachiman-shi, 5 Aug. 2002, S. Fujii 9260 (KYO, OSA); Yōkaichi-shi, 21 Sept. 1951, M. Hutoh 5271 (OSA); 2 Sept. 1988, Y. Kadono 5659 (KOBE); Chuzu-cho, 23 Sept. 1994, S. Fujii 4121 (OSA); 27 Jun. 1996, K. Seto 46144 (OSA); Minakuchi-cho, 15 Oct. 1988, Y. Kadono 5755 (KOBE). **Kyoto Pref.:** Fukuchiyama-shi, 13 Oct. 1975, Y. Kadono 1980 (KOBE); 14 May 1976, Y. Kadono 1999 (KOBE); 29 May 1977, Y. Kadono 25 (KOBE); 4 Jul. 1981, Y. Miyatake s.n. (OSA); Kameoka-shi, 19 Sept. 1976, Y. Kadono 1658, 1928 (KOBE); Kyoto-shi, 26 May 1921, N. Kinashi s.n. (KYO); 22 May 1931, J. Ohwi s.n. (KYO); 2 Aug. 1932, J. Ohtuka 4 (KYO); 14 Sept. 1963, S. Kitamura & G. murata 2270 (MAK); 2 Jun. 1968, K. Nagai 10639 (KYO); 9 Jun. 1977, Y. Kadono 1558 (KOBE); 23 Jul. 1977, S. Kitamura s.n. (KYO); 30 Jul. 1977, G. Murata 32688 (KYO); 21 Sept. 1977, G. Murata et al. 12 (KYO); 11 Oct. 1977, Y. Kadono 308 (KYO), 1925 (KOBE); 16 Oct. 1977, Y. Kadono 1922 (KOBE); 25 Apr. 1978, Y. Kadono 531 (KYO); 4 Jul. 1978, Y. Kadono 1564 (KOBE); 18 Aug. 1978, Y. Kadono 518 (KYO), 1555 (KOBE); 30 May 1979, M. Ito 701 (KYO); 18 Aug. 1979, Z. Sato s.n. (TI); 18 Jul. 1980, K. Seto 26229 (OSA); 10 Oct. 1995, G. Murata 71619 (KYO); 30 Jul. 1998, S. Tsugaru et al. 26637 (KYO, TUS); 11 Sept. 2002, S. Tsugaru et al. 31890 (KYO). **Hyogo Pref.:** Tanba-sasayama, 9 Sept. 1954, Z. Tashiro s.n. (TNS); Kasai-shi, 2 Oct. 1980, Y. Kadono 1244 (KOBE); 10 Sept. 1995, N. Kurosaki & K. Akai 1723 (KYO, MAK, OSA); 17 May 2001, T. Shiga 3221 (OSA); 12 Sept. 2002, T. Shiga 3229 (OSA); Yashiro-cho, 23 Jun. 1987, Y. Kadono 4536 (KOBE); 17 Aug. 1990, Y. Kadono 6805 (KOBE); 15 Jul. 2000, T. Kobayashi 34764 (OSA); Sanda-shi, 11 Sept. 1986, Y. Kadono 3978 (KOBE); 29 May 1998, T. Fujii 9538 (OSA); 11 Aug. 1998, T. Fujii 10031 (OSA); 28 Aug. 1998, T. Fujii 10214 (OSA); Ono-shi, 19 Sept. 1983, Y. Kadono 3193 (KOBE); 4 Oct. 1986, T. Umehara 1349, 1350 (OSA); T. Fujii T-0243 (OSA); 30 May 2001, T. Shiga 3223, 3224 (OSA); 26 Aug. 2001, T. Shiga 3665 (OSA); 27 May 2002, T. Shiga 3099, 3693 (OSA); Takarazuka-shi, 14 Sept. 1997, K. Seto 48072 (OSA); 12 Sept. 1999, H. Kondo 99091201 (OSA); Miki-shi, 26 Jul. 1968, G. Murata & H. Nishimura 301 (KYO); 22 Sept. 1968, G. Murata & H. Nishimura 368 (KYO); 26 Aug. 1982, Y. Kadono 2113 (KOBE); 19 May 1987, I. Yamamoto s.n. (KOBE); I. Yamamoto s.n. (KOBE); 2 Oct. 1994, S. Miyake 3170 (KYO); 5 Aug. 1995, S. Miyake 4338 (MAK); 19 Aug. 1995, S. Miyake 4059 (OSA); Kakogawa-shi, 19 Oct. 1981, Y. Kadono 1380 (KOBE);

21 Aug. 1983, Y. Kadono 3117 (KOBE); 31 Aug. 1984, Y. Kadono 3590 (KOBE); 23 Sept. 1984, N. Kurosaki 14638 (KYO); Y. Kadono 3393, 3397 (KOBE); 27 Sept. 1987, Y. Kadono 5076 (KOBE); Kobe-shi, 15 Aug. 1969, T. Muroi s.n. (TNS); 27 Jul. 1982, Y. Kadono 2301 (KOBE); 22 Aug. 1984, Y. Kadono 3416 (KOBE); 25 Aug. 1984, Y. Kadono 3533 (KOBE); 20 May 1990, Y. Kadono 6667 (KOBE); Goshiki-cho, 24 May 2001, T. Shiga 3220, 3663 (OSA); 12 Sept. 2001, T. Shiga 3664 (OSA). **Nara Pref.:** Nara-shi, 22 May 1949, M. Hutoh 4177 (OSA); 11 Aug. 2002, T. Shiga 3230 (OSA). **Wakayama Pref.:** Kamitondacho, May 1925, J. Nakajima s.n. (TI); Nachikatsuura-cho, 22 Sept. 1996, K. Ohora s.n. (OSA). **Okayama Pref.:** Bizen-shi, 2 Sept. 2001, T. Shiga 3668 (OSA); Kurashiki-shi, 1 Sept. 1991, Y. Obata s.n. (KOBE); 2 Sept. 2001, T. Shiga 3670 (OSA); Saeki-cho, 3 Sept. 2001, T. Shiga 3672 (OSA). **Yamaguchi Pref.:** Miyano-mura, 23 Sept. 1889, S. Nikaidoh 204 (TNS). **Tokushima Pref.:** Komatsushima-shi, 3 Sept. 1990, T. Nakamura 104 (KOBE); 12 Sept. 2001, T. Shiga 3681 (OSA); 13 Sept. 2001, T. Shiga 3675, 3676 (OSA); 17 Aug. 2002, T. Shiga 3246 (OSA); 18 Aug. 2002, T. Shiga 3673, 3674 (OSA). **Kagawa Pref.:** Hiketa-cho, 13 Sept. 2001, T. Shiga 3655 (OSA); Tsuda-cho, 14 Sept. 2001, T. Shiga 3657, 3683 (OSA); Shirotori-cho, 13 Sept. 2001, T. Shiga 3656, 3682 (OSA); Ayakami-cho, 14 Sept. 2001, T. Shiga 3658 (OSA); Ayauta-cho, 14 Sept. 2001, T. Shiga 3659, 3660 (OSA). **Ehime Pref.:** Matsumae-cho, 6 Nov. 2003, T. Shiga 3367, 3368 (OSA). **Fukuoka Pref.:** Fukuoka-shi, 19 Aug. 1935, S. Hatsusima s.n. (KAG). **Kumamoto Pref.:** Hitoyoshi, 20 Aug. 1939, K. Mayebara 3011 (TI, TNS); Sagara-mura, 10 Jun. 1923, K. Mayebara 2551 (TI, TNS); 31 May 1987, Y. Kadono 4510 (KOBE); Nishiki-cho, 5 Sept. 1953, K. Mayebara 5116 (TI, TNS). **Oita Pref.:** Usa-shi, 12 Jun. 1990, T. Nakamura & Y. Kadono 12 (KOBE); 30 Sept. 2002, T. Shiga 3317 (OSA). **Miyazaki Pref.:** Yamanokuchi-cho, 2 Oct. 2002, T. Shiga 3282 (OSA); Shintomi-cho, 8 Nov. 1988, Y. Kadono 5891 (KOBE); Kawanami-cho, 26 May 1987, Y. Kadono 4461 (KOBE). **Kagoshima Pref.:** Sendai-shi, 3 Oct. 1965, S. Hatushima & S. Sako 29832 (MAK).

### Key to the Japanese *Nuphar* species

- A. Leaves always submerged under natural conditions; submerged leaves narrowly oblong-triangular, base slightly cordate-sagittate ..... *N. submersa*
- A. Leaves both emergent or floating as well as submerged; base of leaves with a deep sinus
  - B. Leaves emergent
    - C. Emergent leaves widely ovate to oblong, 10–50 cm long; seeds 3.0–5.5 mm long
    - D. Emergent leaves narrowly ovate to

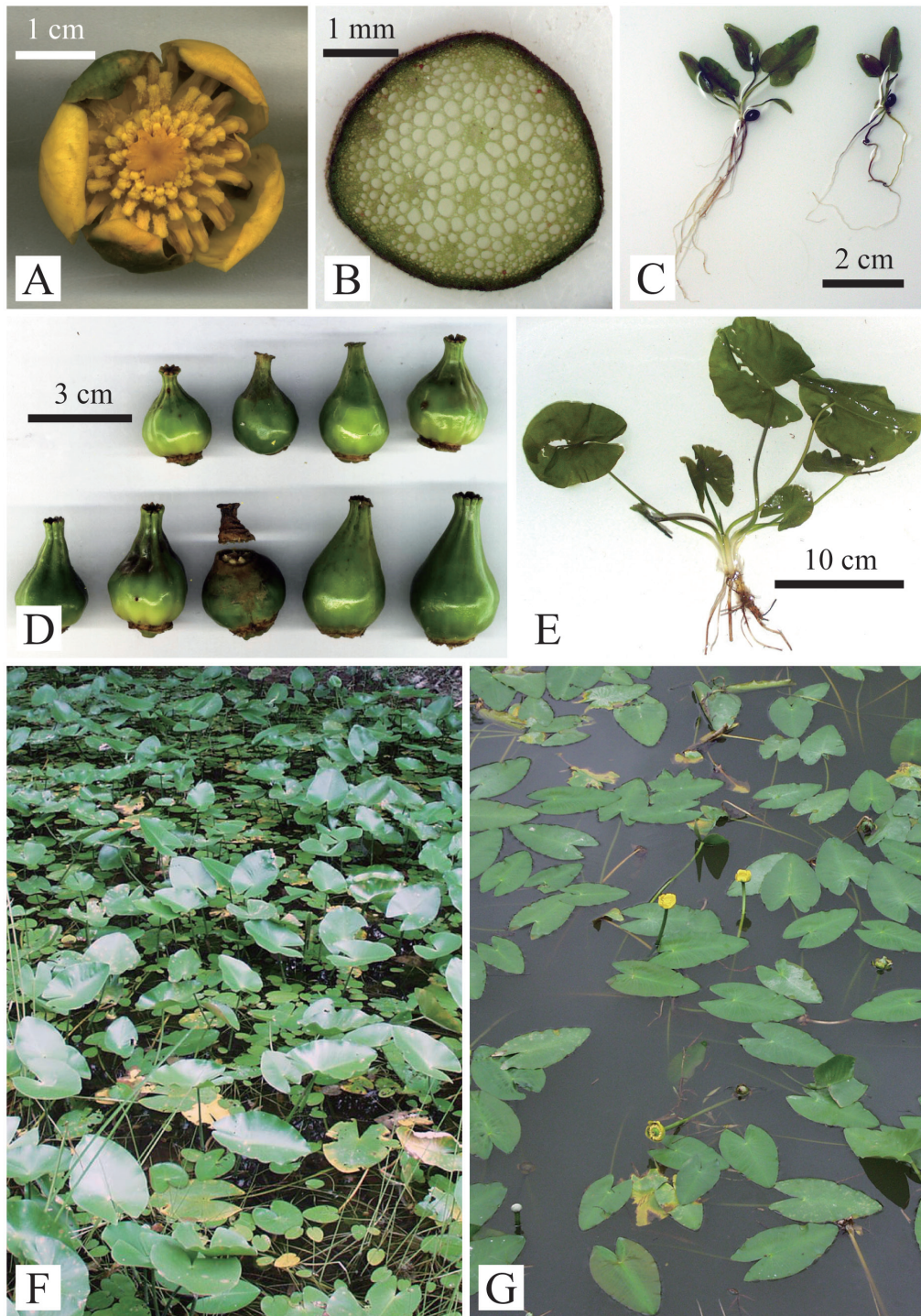


Fig. 2. Morphology and habit of *Nuphar saikokuensis* Shiga & Kadono. A. Flower. B. Transverse section of petiole. C. Wild seedling. D. Fruit. E. Juvenile plant with submerged leaves after ca. three years from germination. F. Emergent form at Oda-cho, Ono-shi, Hyogo Pref. (type locality) on 2 Aug. 2001. G. Floating form at Sakamoto, Hiketa-cho, Kagawa Pref. on 13 Sept. 2001. A–E from the type locality of *N. saikokuensis*.

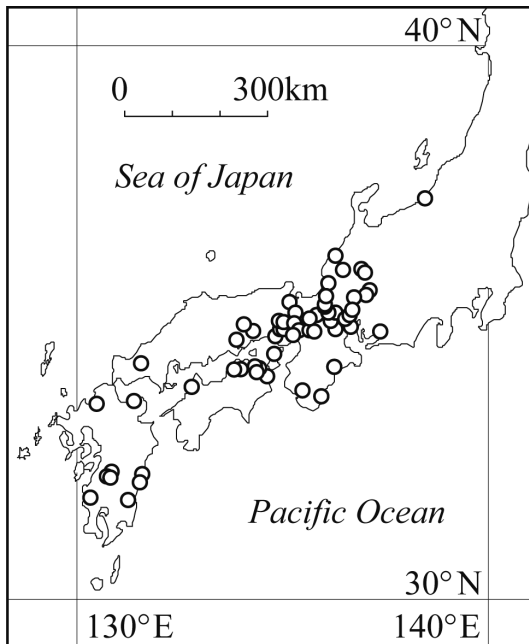


Fig. 3. Distribution of *Nuphar saikokuensis*.

- oblong, 25–50 cm long ..... *N. japonica*
- D. Emergent leaves widely ovate to narrowly ovate, 10–30 cm long.....  
..... *N. saikokuensis*
- C. Emergent leaves rounded, 4–17 cm long;  
seeds 5.5–6.5 mm long.....  
..... *N. subintegerrima*
- B. Leaves floating
- C. Anther and filament length ratio 1:1 to 1:2
- D. Floating leaves rounded, 4–17 cm long;  
seeds 5.5–6.5 mm long .....  
..... *N. subintegerrima*
- D. Floating leaves widely ovate to narrowly  
ovate, 10–30 cm long; seeds 3.0–4.5 mm  
long..... *N. saikokuensis*
- C. Anther and filament length ratio 1:2 to 1:3
- D. Petiole with central lacuna.....  
..... *N. oguraensis*
- D. Petiole without lacuna ..... *N. pumila*

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志賀 隆<sup>a</sup>, 角野康郎<sup>b</sup>: 中部日本から西日本に分布するコウホネ属 (スイレン科) の1新種サイコクヒメコウホネ

新種サイコクヒメコウホネ *Nuphar saikokuensis* Shiga & Kadono を記載した。本種は広卵形から長卵形で、長さ10–30 cm, 幅7–20 cmの浮葉と抽水葉を持つことで特徴づけられ、中部日本から西日本に分布する。形態形質や分子マーカーに基づく著者らの先行研究から、本種はコウホネ *N. japonica* DC. とヒメコウホネ *N. subintegerrima* (Casp.) Makino, オグラコウホネ *N.*

*oguraensis* Miki の3種が関連した複雑な交雑によって起源したと推定されている。サイコクヒメコウホネには多少とも稔性がみられ、中部日本から西日本にかけて広く分布していることから、本稿において独立種として扱った。

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