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Thismia kobensis (Burmanniaceae), a new and presumably extinct species from Hyogo Prefecture, Japan

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Introduction

Thismia Griffith (1844: 221), Thismiaceae J. Agardh or Burmanniaceae sensu APG VI (2016), is one of the most species-rich mycoheterotrophic genera, consisting of ca. 80 species (Jonker 1948, Merckx *et al.* 2013). Considering that most of these species were collected only once (Jonker 1948) and that many new species have recently been discovered in various Asian countries (e.g. Suetsugu *et al.* 2017, 2018), many more undescribed species are likely in these regions.

Oxygyne Schlechter (1906: 140) is a rare, mycoheterotrophic plant genus that consists of six species. It has one of the most remarkable distributions of all angiosperm genera and is disjunct between Japan and western Central Africa (Cheek *et al.* 2018). Although *O. hyodoi* Abe & Akasawa (1989: 161) was described based on the specimens discovered in Ehime Prefecture, Kobayashi & Kurosaki (1993) noted that a specimen that was morphologically similar to *O. hyodoi* was also discovered in Kobe City, Hyogo Prefecture. However, the specimen differed from *O. hyodoi* in many features. As noted by Tsukaya (2016), characters such as the prominent annulus on the perianth tube suggested that it may not even belong to the genus *Oxygyne*. In addition, although it was identified as *O. hyodoi* based on its short perianth lobes (Kurosaki, personal communication), such flowers have also been noted in the genus *Thismia* (Tsukaya 2016). Therefore, it is highly probable that the specimen collected in Kobe was not *O. hyodoi*, but a *Thismia* species (Tsukaya 2016).

So far, only one specimen of the putatively unknown *Thismia* species has been found, and two of the three inner perianth-lobes in this specimen were broken. In addition, the population was almost certainly destroyed during construction of an industrial complex, and no additional specimens have been found. Fortunately, the other parts of this specimen, including an inner perianth-lobe and all three of the outer perianth-lobes were completely preserved, so we conducted a taxonomic investigation using this specimen. Careful examination revealed that the unknown plant actually belongs to the genus *Thismia.* Here, we describe it as a new species, *Thismia kobensis* Suetsugu, as this specimen was found to have a significantly different floral morphology from the other known *Thismia* species. In addition, the unknown species belonged to the section *Rodwaya* Schlechter (1921: 38), as it had the vermiform, creeping roots, the inner perianth lobes without free filiform appendages and inner perianth lobes connivent at their apex. Here, we describe it as a new species, with discussions on the taxonomic validity of the section *Glaziocharis* (Taub. ex Warm.) Hatusima (1976: 4).

Taxonomic Treatment

Thismia kobensis Suetsugu, *sp. nov*. (Figs. 1, 2)

Type:— JAPAN, Hyogo Prefecture, Kobe City, Nishi-ku, Oshibedani-cho, Komi, 34°44’ N, 135°05’ E, alt. 200 m, 10 June 1992, *Nakanishi & Kobayashi 22380* (holotype: HYO, in spirit collection).

Thismia kobensis is close to *T. huangii* Jiang & Hsieh (2011: 139) from Taiwan but differs in having a hexagonal prismatic perianth tube, white tepals and free stamens.

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FIGURE 1. *Thismia kobensis* (holotype) from the type locality.

Terrestrial, achlorophyllous, mycoheterotrophic herbs. Roots creeping, vermiform, branched, ca. 1 mm in diameter, whitish when young, pale brown when old. Stem erect, ca. 1 mm long. Leaves glabrous, whitish, scale-like, narrowly triangular to ovate, 1.0–5.0 × 0.4–3.0 mm, apex obtuse to acute; largest leaves just below flower. Involucral bracts, white, similar to upper leaves. Flower solitary, subsessile, pubescent. Perianth actinomorphic with 6 tepals fused to form a basal perianth tube. Perianth tube white, hexagonal prismatic apically and urceolate basally, 8 × 3–7 mm, narrowing just above the ovary, widest at the upper apex; inner surface without transverse bars; apex with a broad, prominent, hexagonal annulus. Inner tepals 3, larger than outer tepals, white, ca. 5.4 × 1.1–1.3 mm, arching inward distally and connate apically to resemble a mitre, apex acuminate; outer tepals 3, white, ca. 4 × 1 mm, apex acuminate. Stamens 6, free from each other, pendulous from the annulus, annulus dark orange, connective yellow; each stamen rectangular with 4 thecae; each theca oblong, ca. 0.6 × 0.1 mm; nectariferous gland absent; connective of stamens without lateral appendages, not forming a skirt-like appendage; apex of each stamen truncate with long hairs. Ovary inferior, cup-shaped, 2.5 × 1.5 mm, pubescent; style ca. 0.45 mm long; stigma trilobed, ca. 1.0 mm long; stigma lobes triangular or arrow-shaped with a long hair on each lobe.

Distribution:—Japan (so far known from only type locality).

Preliminary conservation status:—Extinct (EX). *Thisima kobensis* is known from only a single individual at Kobe City, Hyogo Prefecture. The specimen was collected in secondary forest dominated by *Quercus serrata* and *Q. glauca* in 10 June 1992. Although intensive surveys of the population discovered in June were conducted from 1992 to 1999, we did not discover additional *T. kobensis* plants. In 1999, the area was completely destroyed during the construction of an industrial complex. Since then, we have searched the surrounding intact areas in June each year but have failed to record any individuals. It is highly likely that the last individual has died, and this taxon is presumed extinct, although we need further efforts to discover additional individuals.

Notes:—According to Jonker (1938), *T. kobensis* belongs to the section *Rodwaya*, as it has vermiform and creeping roots, inner perianth lobes without free filiform appendages and inner perianth lobes that are connivent apically. In the section *Rodwaya*, *T. kobensis* is most similar to *T. huangii* from Taiwan, in having a dark-orange annulus, yellow

and truncate connectives with hairs, stigma lobes with hairs and no nectaries. However, it is easily distinguished from *T. huangii* in having a hexagonal prismatic and less hairy perianth tube (vs. urn-shaped and densely hairy perianth tube), white tepals (vs. pale orange to yellow), and stamens free from each other (vs. adnate, forming a tube around the style).

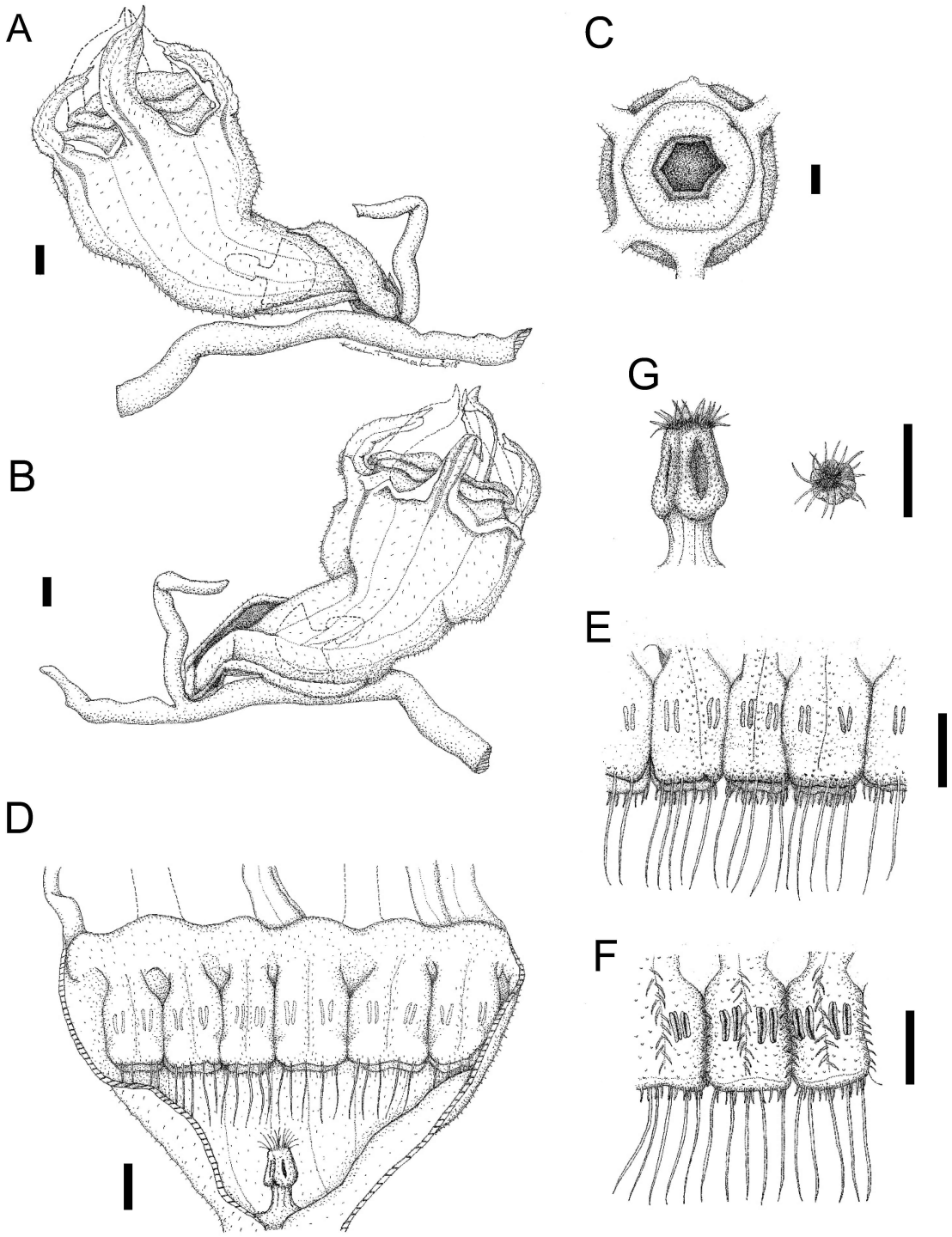

FIGURE 2. *Thismia kobensis* (from the holotype). A–B. Flowering plant. C. Flower, upper view. D. Flattened perianth tube. E. Stamens, inner view. F. Stamens, outer view. G. Style and stigma. Two broken inner perianth lobes are indicated by the dotted lines in A, B and D. Drawn by Kumi Hamasaki. Bar = 1 mm.

In addition, in having the stamens free from each other, *T. kobensis* is somewhat similar to *T. abei* (Akasawa) Hatusima (1976: 7) that belongs to the section *Glaziocharis*. So far, free stamens have not been reported in any species of *Thismia* except *T. abei*. However, *T. kobensis* clearly differs from *T. abei* in having a hexagonal prismatic perianth tube (vs. urn-shaped perianth tube), dark orange prominent annulus (white inconspicuous annulus), yellow rectangular connective (vs. white spatulate connective), outer perianth lobes without filiform appendages (vs. outer perianth lobes with long filiform appendages). Because appendages of the outer perianth lobes are considered a diagnostic character to distinguish sections *Glaziocharis* and *Rodwaya* (Kumar *et al.* 2017), we believe that *T. kobensis* is a member of *Rodwaya*. However, it should also be noted that several recent molecular studies suggested that the appendages of perianth lobes have little systematic significance in *Thismia* (Hunt *et al.* 2014, Merckx & Smets 2014, Kumar *et al.* 2017, Sochor *et al.* 2018). Actually, molecular results have clearly suggested that section *Glaziocharis* is not monophyletic and should be incorporated in section *Rodwaaa* (Hunt *et al.* 2014, Merckx & Smets 2014, Kumar *et al.* 2017). Both our results (i.e., similarity of stamen morphology between *T. kobensis* and *T. abei*) and molecular analyses indicate that it is not necessary to distinguish *Glaziocharis* and *Rodwaya* as distict sections.

Given that mycoheterotrophic plants are highly dependent on the activities of both the fungi and the trees that sustain them (Suetsugu *et al.* 2014, 2017b), they are particularly sensitive to environmental disturbance. Therefore, most mycoheterotrophic species are rare and seriously endangered. Furthermore, our study clearly indicated that some mycoheterotrophic plants have become extinct before being described. As the precise identification of most mycoheterotrophic plants requires detailed observations of floral organs that are hidden in the perianth tube (Tsukaya & Hidayat 2016, Suetsugu 2017a, b), re-examination of herbarium specimens will be useful for understanding both past and current diversity of the mycoheterotrophic flora.

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