



## A synopsis of the genus *Chamaelirium* (Melanthiaceae) with a new infrageneric classification including *Chionographis*

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**ABSTRACT:** Two closely allied genera *Chamaelirium* Willd. and *Chionographis* Maxim. distributed disjunctively in eastern North America and eastern Asia are taxonomically reexamined, and a new classification is presented. *Chionographis* is included in *Chamaelirium*, and the latter comprises two sections *Chamaelirium* and *Chionographis* (Maxim.) N. Tanaka (comb. nov.). The former is monotypic (*C. luteum*), while the latter is subdivided into two subsections *Chionographis* and *Cathayana* N. Tanaka (subsect. nov.). The former subsection comprises four species indigenous to Japan and Korea, and the latter has four species native to Vietnam, Laos and China. A total of 14 new combinations at or below the rank of species (eight at specific, three at subspecific, and three at varietal rank) are circumscribed. Sect. *Stenotepalon* F. Maek. is reduced to a synonym of sect. *Chionographis*. *Chamaelirium luteum* Miq. f. *gracilis* Miq. is also reduced to a synonym of *Chamaelirium japonicum* (Willd.) N. Tanaka. *Chamaelirium* (s.l.) and its infrageneric taxa (two sections and two subsections) are regarded respectively as monophyletic on the basis of morphological and phenological data.

**KEY WORDS:** *Chamaelirium*, *Chionographis*, Diversity, Melanthiaceae, Monophyly, Phylogeny, Taxonomic revision.

### INTRODUCTION

*Chamaelirium* Willd. is a monotypic genus (*C. luteum* (L.) Willd.) distributed in eastern North America (Utech, 2002). *Chionographis* Maxim. is a genus of at least eight species occurring in Vietnam, Laos, China, Japan and Korea (Hara, 1968; Chen, 1980; Tanaka, 2003, 2013, 2016a; Huang *et al.*, 2011; Averyanov and Tanaka, 2014; Wu *et al.*, 2016). These genera are regarded as closely related (Maximowicz, 1867; Miquel, 1870; Hara, 1968; Kawano, 1976; Dahlgren *et al.*, 1985; Tanaka, 1985, 2003; Takhtajan, 1997, 2009; Utech, 2002; Wu *et al.*, 2016) and classified in the tribe Chionographideae (Dahlgren *et al.*, 1985; Takhtajan, 2009) or Heloniadeae (Hutchinson, 1934; Tamura, 1998). *Chionographis* has been widely accepted as an independent genus by many botanists (Baker, 1879; Bentham, 1883; Engler, 1887; Baillon, 1894; Krause, 1930; Hutchinson, 1934; Hara, 1968; Dahlgren *et al.*, 1985; Takhtajan, 1997).

The two genera share tuberous perennial rhizomes; basal rosulate evergreen leaves; scapiform stems sprouting in spring; white, non-nectariferous, ebracteate flowers; trilocular ovaries bearing ovules vertically or obliquely pendent from axile placentae; three distinct styles; and loculicidal capsules. They also possess unique tetraporate pollen grains (Takahashi and Kawano, 1989) and the same chromosome number  $2n = 24$  (Sato, 1942; Hara and Kurosawa, 1962; Kawano, 1976; Tanaka and Tanaka, 1977, 1979, 1980, 1985; Tanaka, 1985; Pellicer *et al.*, 2014) (Table 1).

*Chionographis* has been distinguished from *Chamaelirium* often by its zygomorphic flowers with

unequal tepals (vs. actinomorphic flowers with equal tepals) (Engler, 1887; Hara, 1968; Tanaka, 2003). However, two recently described species of *Chionographis*, *C. shiwandashanensis* Y. F. Huang et R. H. Jiang (Huang *et al.*, 2011) from southern China and *C. actinomorpha* Aver. et N. Tanaka (Averyanov and Tanaka, 2014) from central Vietnam and Laos, have actinomorphic flowers with equal tepals. Another newly described species, *C. nanlingensis* L. Wu, Y. Tong et Q. R. Liu (Wu *et al.*, 2016) from southern China, has nearly actinomorphic flowers with equal tepals, although the tepals are reduced to 3 (rarely 4). These findings indicate that the two genera do not differ in floral symmetry and tepal length. *Chionographis* had also been distinguished from *Chamaelirium* by having sessile flowers (vs. pedicellate flowers) (Baker, 1879; Hutchinson, 1934; Hara, 1968), but both *C. shiwandashanensis* (Huang *et al.*, 2011, Fig. 1B) and *C. actinomorpha* (Averyanov and Tanaka, 2014, Fig. 1f) have shortly pedicellate flowers.

Populations of *Chionographis* are either hermaphroditic (including andromonoecious and male individuals in addition to hermaphroditic ones) or gynodioecious (Tanaka, 1985, 2003, 2013, 2016a, b; Maki, 1993), while those of *Chamaelirium* are dioecious (Gray, 1837; Miquel, 1867; Britton and Brown, 1896; Fernald, 1950; Gleason, 1952; Meagher, 1980; Meagher and Antonovics, 1982) or occasionally polygamodioecious (Utech, 2002). Since dioecy is often regarded as derived from gynodioecy (Darwin, 1877; Charlesworth and Charlesworth, 1978; Freeman *et al.*, 1977; Charlesworth, 1999; Webb, 1999; Dorcken and Barrett, 2004), the two genera possessing the two



sexual systems may likely be phylogenetically proximate to each other. Evidence from plastid DNA sequence analyses (Fuse and Tamura, 2000; Rudall *et al.*, 2000; Maki, 2012; Pellicer *et al.*, 2014) has resolved the two genera as sister groups. *Chamaelirium* and *Chionographis* are also distinct in several fruit and seed characters, such as the number of ovules per locule, shape of seeds, and the arrangement of seeds within an ovarian locule and of seed body within the testa (Hara, 1968; Tanaka, 2017) (Table 1), but it is reported that there are strong evolutionary relationships between those divergent character states (Tanaka, 2017).

In this study, the two genera are taxonomically reexamined on the basis of my own observations on various characters (e.g. Tanaka and Tanaka, 1977; Tanaka 1985, 2016a, b, 2017) and data hitherto published by many botanists. The results are outlined herein.

## MATERIALS AND METHODS

The following two taxa are not dealt with here; *Chionographis japonica* var. *kurokamiana* H. Hara ( $\equiv$  *C. koidzumiana* var. *kurokamiana* (H. Hara) Maki) and *C. koidzumiana* var. *mikawana* Ohwi et Okuyama. These taxa need further study and will be focused on elsewhere.

Living plants of *Chamaelirium luteum* were obtained from Far North Gardens, Michigan, U.S.A., Sunshine Farm and Gardens, West Virginia, U.S.A., and Chūgai Shokubutsuen, Kanagawa, Japan. Those of *Chionographis*, *C. japonica* (Willd.) Maxim., *C. hisauchiiana* (Okuyama) N. Tanaka, *C. koidzumiana* Ohwi, and *C. cordifolia* N. Tanaka, occurring in Japan, were collected myself in their habitats, while those of *C. japonica* from Korea were obtained through Farm Taeguk, Chungbuk, Korea. They were cultivated at Hachioji, Tokyo, Japan, and comparatively studied mainly from morphological and phenological aspects. Many of them are kept as dried specimens at the author's herbarium. Dried herbarium specimens held at many herbaria were also examined chiefly from phenotypical and phytogeographical aspects. Specimens cited here with an exclamation mark (!) indicate that they were seen by this author.

## RESULTS

While markedly differing in several characters, *Chamaelirium* and *Chionographis* are basically similar in many respects (Table 1). As a result of an overall comparison of their morphological and phenological characters, a new classification is presented here (Table 2). In this system, *Chionographis* is included as a section of *Chamaelirium*, and the section *Chionographis* (comb. nov.) is subdivided into two

**Table 1.** Comparison of several characters between *Chamaelirium* (s.str.) and *Chionographis* (s.str.).

Character	<i>Chamaelirium</i>	<i>Chionographis</i>
Number of species	1	8
Distribution	E North America	E and SE Asia
Population	dioecious	hermaphroditic, gynodioecious
Plant	perennial herb	perennial herb
Rhizome	cylindric	cylindric
Foliage leaves	basal, rosulate, evergreen	basal, rosulate, evergreen
Floral bract	absent	absent
Pedicel	present	present, absent
Flower		
Direction <sup>1)</sup>	u. ascending, horizontal	ascending, horizontal, descending
Symmetry	actinomorphic	actinomorphic, zygomorphic
Nectary	absent	absent
Tepal		
Number/flower	6	6–1 (r. 0)
Length	equal	equal, unequal
Shape	n. obclavate (spatulate)	n. obclavate (spatulate), filiform
Color	white	white, purple, greenish
Anther	bilocular	bilocular, unilocular
Pistil		
Carpo-gynophore	absent	absent, present
Ovary	syncarpous	syncarpous, semicarpous
Placentation	axile	axile
Ovule		
Number/locule	6–12	2
Arrangement within locule	obliquely or nearly vertically pendent from placentae	vertically pendent from placentae
Form	intermediate between anatropous and hemitropous	nearly hemitropous
Styles	distinct	distinct
Capsule	loculicidal	loculicidal
Seed		
Shape (incl. testa) (in outline)	oblong, elliptic	fusiform
Body		
Shape	n. ellipsoid	n. ellipsoid
Arrangement within testa	obliquely set	axially set
Pollen	spherical, tetraporate	spherical, tetraporate
Chromosome number (2n)	24	24, 44, 42

<sup>1)</sup> At early to mid-anthesis. **Abbreviations:** incl., including; n., narrowly; r., rarely; u., usually.

subsections, *Chionographis* and *Cathayana* (subsect. nov.), each with four species.

**Table 2.** Outline of the new infrageneric classification of *Chamaelirium* (s.lat.) proposed in this paper.

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Genus *Chamaelirium* Willd.

Sect. 1. *Chamaelirium*

1. *C. luteum* (L.) A. Gray

Sect. 2. *Chionographis* (Maxim.) N. Tanaka, **comb. nov.**

Subsect. 1. *Cathayana*, **subsect. nov.**

2. *C. actinomorphyum* (Avery. et N. Tanaka) N. Tanaka et Avery, **comb. nov.**

3. *C. shiwandashanense* (Y. F. Huang et R. H. Jiang) N. Tanaka, **comb. nov.**

4. *C. nanlingense* (L. Wu, Y. Tong et Q. R. Liu) N. Tanaka, **comb. nov.**

5. *C. chinense* (K. Krause) N. Tanaka, **comb. nov.**

Subsect. 2. *Chionographis*

6. *C. cordifolium* (N. Tanaka) N. Tanaka, **comb. nov.**

7. *C. hisauchianum* (Okuyama) N. Tanaka, **comb. nov.**

    subsp. *hisauchianum*

    subsp. *minoense* (H. Hara) N. Tanaka, **comb. nov.**

    subsp. *kurohimense* (Ajima et Satomi) N. Tanaka, **comb. nov.**

8. *C. japonicum* (Willd.) N. Tanaka, **comb. nov.**

    subsp. *japonicum*

    subsp. *yakusimense* (Masam.) N. Tanaka, **comb. nov.**

        var. *yakusimense*

        var. *koshikiense* (N. Tanaka) N. Tanaka, **comb. nov.**

        var. *koreanum* (F. T. Wang et Tang) N. Tanaka, **comb. nov.**

9. *C. koidzumianum* (Ohwi) N. Tanaka, **comb. nov.**

    var. *koidzumianum*

    var. *leiophyllum* (N. Tanaka) N. Tanaka, **comb. nov.**

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## TAXONOMIC TREATMENT

*Chamaelirium* Willd. in Mag. Neuesten Entdeck. Gesammten Naturk. Ges. Naturf. Freunde Berlin 2: 18 (1808). Type: *C. carolinianum* Willd., nom. illeg. (*Helonias pumila* Jacq.).

*Ophiostachys* Delile in Redouté, Liliac. 8: t. 464 (1815). Type: *O. virginica* Delile, nom. illeg. (*Veratrum luteum* L.). — *Diclinotrys* Raf., Neogenyton 3 (1825). Type: *Veratrum luteum* L. — *Dasurus* Salisb., Gen. Pl. 51 (1866). Type: *Veratrum luteum* L.

2 sections with 9 species.

Distribution. — E North America and E and SE Asia.

Note. — This genus, including *Chionographis*, is a distinct taxon (e.g. Takhtajan, 2009, as Chionographideae) characterized by many features. Among others, it is unique in having spherical, tetraporate pollen grains (Takahashi and Kawano, 1989). In *Helonias* s.l. (Tanaka, 1998), which is regarded as most closely allied to *Chamaelirium* here recircumscribed (Gray, 1837, as to *Helonias* s.str. and *Chamaelirium* s.str.; Tanaka, 1997), pollen grains are ellipsoidal and monosulcate (Takahashi and Kawano, 1989). No other genera of the Melanthiaceae have such unusual pollen grains as those of *Chamaelirium* (s.l.), either (Takahashi and Kawano, 1989). The features of pollen grains of *Chamaelirium* (s.l.) are evidently apomorphic, and the genus is hence monophyletic.

### Key to the sections

- 1a. Plants (usually) male or female, forming dioecious populations.  
Flowers pedicellate, actinomorphic. Tepals 6, equal in length.

Ovules 6–11 (reportedly to 12) per locule. Capsules ellipsoid or obovoid, 4.5–11.5 (reportedly to 14) mm long. Seeds (incl. testa) obliquely or nearly vertically pendent within capsular locule, (elliptic-)oblong, usually obtuse at ends, 2–5.3 (reportedly to 6) mm long; body of seed winged (with testa) around, obliquely set within testa ..... Sect. 1. *Chamaelirium*

1b. Plants hermaphroditic, andromonoecious, male or female, forming hermaphroditic or gynodioecious populations. Flowers shortly pedicellate or sessile, actinomorphic or zygomorphic. Tepals 6 or fewer, equal or unequal in length. Ovules 2 per locule. Capsules ellipsoid, ovoid or (narrowly) obovoid, 2.5–4.8 mm long. Seeds (incl. testa) vertically (axially) pendent within capsular locule, (sub)fusiform, sharply pointed at least at one end, 2.2–4.1 mm long; body of seed winged (with testa) at ends, axially set within testa ..... Sect. 2. *Chionographis*

### Sect. 1. *Chamaelirium*

Comprises 1 species.

Distribution. — SE Canada and E U.S.A.

Note. — This section is viewed as sexually more advanced than sect. *Chionographis*, since its dioecy is likely to be a derived character state against gynodioecy and hermaphroditism of *Chionographis* (Tanaka, 1985). Possessing this apomorphy indicates that the plants of this section are monophyletic.

**1. *Chamaelirium luteum* (L.) A. Gray, Man. Bot. N. Unit. States 503 (1848).**

*Veratrum luteum* L., Sp. Pl. 2: 1044 (1753). **Type:** Habitat in Virginia, Canada. *P. Kalm s.n.* (Lectotype designated by J. L. Reveal in C. E. Jarvis (2007), Order Out of Chaos, p. 914: LINN. 1210. 3, photo!). — *Melanthium luteum* (L.) Thunb., Fl. Jap. 152 (1784); see the note below. — *Helonias lutea* (L.) Ker Gawl. in Bot. Mag. 27: t. 1062 (1807). — *Ophiostachys virginica* Delile in Redouté, Liliac. 8: t. 464 (1815), nom. illeg. — *Diclinotrys albiflorum* Raf., Neogenyton 3 (1825), nom. illeg. — *Abalon albiflorum* Raf., New Fl. N. Amer. 1: 33 (1836), nom. illeg.



*Helonias pumila* Jacq., Icon. Pl. Rar. 2: t. 453 (1786–1793); Coll. 2: 260 (1789–1796). **Type:** in Carolina [U.S.A.] (BM? n.v.) — *Chamaelirium carolinianum* Willd. in Mag. Neuesten Entdeck. Gesammten Naturk. Ges. Naturf. Freunde Berlin 2: 19 (1808), nom. illeg.

*Melanthium dioicum* Walter, Fl. Carol. 126 (1788). **Type:** Carolina [U.S.A.] (Holotype: BM? n.v.). — *Helonias dioica* (Walter) Pursh, Fl. Amer. Sept. 1: 243 (1814).

*Chamaelirium obovale* Small in Torreya 1: 108 (1901). **Type:** U.S.A. West Virginia. White Sulphur Springs, 19 Aug. 1890, *N. L. Britton s.n.* (Holotype: NY 319617, photo!).

English name. — Fairy's wand; devil's bit; blazing star.

Distribution. — CANADA; southern Ontario (rare). U.S.A.; Alabama, Arkansas, Connecticut, Delaware, District of Columbia, Florida, Georgia, Illinois, Indiana, Kentucky, Louisiana, Maryland, Massachusetts, Michigan, Mississippi, New Jersey, New York, North Carolina, Ohio, Pennsylvania, South Carolina, Tennessee, Virginia, West Virginia (Utech, 2002).

Other selected specimens examined: **U.S.A.: Delaware:** Rocky Woodlands near Wilmington, June, no year, *Canby s.n.* (K). **Florida:** Lake Co., vicinity of Eustis, 16–31 July 1894, *Nash s.n.* (K); **Georgia:** Murray Co., North of Cowpen Gap, 7 June 1983, *Coile 3676* (K, BM 1118018); Stephens Co., Toccoa, 14 May 1980, *Koyama et al. 6733* (TNS 407824). **Louisiana:** New Orleans, 1832, *Drummond 354* (K). **N. Carolina:** Onslow Co., Jacksonville, 16 May 1930, *Moldenke 1245* (K); Asheville, 15 June 1963, *Soma s.n.* (TNS 1063026). **Pennsylvania:** Yan, no date, *Sartwell s.n.* (K). **Tennessee:** Blount Co., 24 May 1963, *Campbell 31319* (BM 1118020). **Virginia:** Amherst Co., 15 May 1947, *Freer 1439* (GH). **West Virginia:** Pocahontas Co., June 1969, *Hinkle s.n.* (MAK 97266); Preston Co., near Masontown, 21 June 1943, *Phillips 48* (BM 1118019).

Note. — The name *Melanthium luteum* (L.) Thunb. applied to a Japanese plant by Thunberg (1784) was based on *Veratrum luteum* L. from North America. It is, accordingly, a nomenclatural (homotypic) synonym of *Chamaelirium luteum* (L.) A. Gray. Though recognized by him as conspecific with *V. luteum*, *M. luteum* from Japan is quite a distinct entity from *C. luteum*, as later pointed out by many botanists (e.g. Willdenow, 1808; Rafinesque, 1838; Maximowicz, 1867). The Japanese plant is here assigned to *C. japonicum* (Willd.) N. Tanaka subsp. *japonicum*.

*Chamaelirium luteum* is rarely polygamo-monoecious (Radford *et al.*, 1968) or polygamodioecious (Utech, 2002), but data on polygamous plants in populations of this species are few.

#### Sect. 2. *Chionographis* (Maxim.) N. Tanaka, **comb. nov.**

*Chionographis* Maxim. in Bull. Acad. Imp. Sci. Saint-Petersbourg 11: 435 (1867); nom. conserv. **Type:** *Chionographis japonica* (Willd.) Maxim. (*Melanthium japonicum* Willd.). — *Siraitos* Raf., Fl. Tellur. 4: 26 (1838), nom. rejic. vs. *Chionographis* Maxim. **Type:** *S. aquaticus* Raf. — Sect. *Euchionographis* F. Maek. in J. Jpn. Bot. 11: 379 (1935).

Sect. *Stenotepalon* F. Maek. in J. Jpn. Bot. 11: 379 (1935), **syn. nov.** **Type:** *Chionographis sparsa* F. Maek.

Comprises 2 subsections each with 4 species.

Distribution. — E and SE Asia; Vietnam, Laos, China, Japan, Korea.

Note. — This section has ovaries bearing only two ovules per locule, ovules (seeds) vertically pendent from axile placentae, and one-sided, fusiform seeds with reduced lateral wings (Tanaka, 2017). These features appear to be derived character states against the corresponding states of sect. *Chamaelirium* (Table 1; Tanaka, 2017). Sect. *Chionographis* is therefore regarded as monophyletic. The genus *Chamaelirium* s.l. thus appears to comprise two diverged monophyletic sections, *Chionographis* and *Chamaelirium* (see the note under sect. *Chamaelirium*).

#### Key to the subsections

- 1a. Flowers bloom in March to April, shortly pedicellate or sessile, ascending, horizontal, or slightly descending at early to mid-anthesis, actinomorphic or zygomorphic. Tepals 6 or 3 (rarely 4) and equal in length in actinomorphic flowers; 6 or fewer and unequal in length in zygomorphic flowers (of the six tepals, the lower 2 or 3 shorter, and 1 or 2 sometimes lacking). Ovary or capsule ellipsoid, subobovoid or (narrowly) obovoid. Styles and filaments very slender, less than 0.15 mm wide. Fruits ripen in (May to) June (in species known for this character). Range in the subtropical to tropical zone ..... Subsect. 1. *Cathayana*
- 1b. Flowers usually bloom in late April to June (July), sessile and slightly descending at early to mid-anthesis, zygomorphic. Tepals 6 or fewer, the lower 2 shorter or sometimes vestigial or lacking. Ovary and capsule ovoid or ellipsoid-ovoid. Styles 0.15 mm or more wide. Filaments ca. 0.2 mm or more wide. Fruits ripen in October to November. Range in the temperate zone ..... Subsect. 2. *Chionographis*

#### Subsect. 1. *Cathayana* N. Tanaka, **subsect. nov.**

Characterized by the features shown in the above key (see also the note below).

**Type:** *Chionographis chinensis* K. Krause.

Comprises 4 species.

Distribution. — Vietnam, Laos, and China; Fujian, Guangdong, Guangxi, Hainan, Hunan, Jiangxi.

Note. — Besides the features in the above key, *Chamaelirium chinense* (K. Krause) N. Tanaka, a species of this subsection, differs from subsect. *Chionographis* by the somewhat smaller, narrowly obovoid capsule with a carpo-gynophore (Tanaka, 2017). The three capsular locules (carpels) of this species are proximally free from one another due to the presence of the carpo-gynophore (vs. locules connate dorsally along the entire length of ventral sutures of carpels) and indehiscent proximally (vs. dehiscent fully along the dorsal suture of carpels). The seeds are also somewhat smaller, 2.2–2.3 mm long (vs. 2.4–4.1 mm long) and 0.6–0.7 mm wide (vs. 0.6–1.1 mm wide), and acute proximally (vs. acute distally) (Tanaka, 2017).

The fruits of *Chamaelirium chinense* ripen in May to June (Hara, 1968; Chen, 1980, as June; Tanaka, 2017). Those of *C. nanlingense* also appear to ripen in the same season, according to specimens cited in Wu *et al.* (2016). Subsection *Cathayana* is therefore strikingly different in



ripening season from subsect. *Chionographis* (see the above key) and sect. *Chamaelirium* (ripening in October to November; Tanaka, 2017).

Fruit (ovary) and seed (ovule) characters in members other than *Chamaelirium chinense* (Tanaka, 2017) of subsect. *Cathayana* are unfortunately poorly known.

Plants of *Chamaelirium chinense* are hermaphroditic, andromonoecious, male, or female, forming gynodioecious populations (Tanaka, 2016b). It is very likely that *C. nanlingense* is also gynodioecious, judging from figures in Wu *et al.* (2016) (see the relevant note under this species below).

The styles and filaments of subsect. *Cathayana* are more slender than those of subsect. *Chionographis* (see the above key) and sect. *Chamaelirium* of which the styles are 0.3–0.35 mm wide and the filaments are 0.25–0.4 mm wide. This feature is considered to be a synapomorphy. Early ripening fruits and gyno-carpophores as aforementioned are also viewed as apomorphies. These observations suggest the monophyly of subsect. *Cathayana*.

#### Key to the species of subsect. *Cathayana*

- 1a. Tepals spatulate or narrowly (spatulate-)obclavate, equal or unequal in length. Anthers (sub)bilocular ..... 2
- 1b. Tepals filiform, equal in length. Anthers unilocular ..... 3
- 2a. Flowers very shortly pedicellate and ascending at early to mid-anthesis, actinomorphic. Tepals equal in length, spatulate ..... 2. *C. actinomorphum*
- 2b. Flowers sessile and slightly descending at early to mid-anthesis, zygomorphic. Tepals unequal in length (lower 2 or 3 shorter, and 1 or 2 sometimes lacking), narrowly (spatulate-)obclavate ..... 5. *C. chinense*
- 3a. Inflorescence rachis greenish. Flowers shortly pedicellate at early to mid-anthesis. Tepals 6 ..... 3. *C. shiwandashanense*
- 3b. Inflorescence rachis white. Flowers sessile at early to mid-anthesis. Tepals 3, rarely 4 ..... 4. *C. nanlingense*

#### 2. *Chamaelirium actinomorphum* (Avery. et N. Tanaka) N. Tanaka et Avery., **comb. nov.**

*Chionographis actinomorpha* Avery. et N. Tanaka in *Taiwania* **59**(1): 13 (2014). **Type:** Vietnam. Quang Binh Prov., Minh Hoa Distr., Dan Hoa municipality, Giang Man Mountain, Vietnam-Laotian border, about 6 km to North of Cha Lo borders station, 17°41'09"N, 105°45'54"E, elev. 1000–1100 m, 19 Apr. 2008, L. Averyanov, P. K. Loc, N. T. Vinh, N. S. Khang, HAL 11722 (Holotype: LE, photo!). Isotypes: LE, photo!; Herbarium of the Center for Plant Conservation, Hanoi (HN), n.v.).

Distribution. — VIETNAM; Quang Binh Province, Minh Hoa District. LAOS; Khammouan Province, Nakai District.

No other specimens examined.

#### 3. *Chamaelirium shiwandashanense* (Y. F. Huang et R. H. Jiang) N. Tanaka, **comb. nov.**

*Chionographis shiwandashanensis* Y. F. Huang et R. H. Jiang in *Nordic J. Bot.* **29**(5): 605(–607; Fig. 1) (2011). **Type:** China. Guangxi. Fangchenggang City, Fulong Town, growing in dense evergreen broad-leaved forest, alt. 790 m, 21 Mar. 2010, *Shiwandashan Exped. 2018* (Holotype: IBK, n.v. Isotype: GXMI, n.v.).

Chinese name. — 十萬大山白絲草 (**nov.**).

Distribution. CHINA; Guangxi, Fangchenggang City.

No specimen examined.

Note. — The photograph of a young inflorescence of *Chamaelirium shiwandashanense* in Fig. 3E of Wu *et al.* (2016, as *Chionographis*) shows the green rachis. This differs from the white rachis of a young inflorescence of *C. nanlingense* (Figs. 3A, 3C, 3D) and *C. chinense* (Fig. 3F) in the same paper. The tepals of young flowers of *C. shiwandashanense* are also slightly greenish, and *C. koidzumianum* (Ohwi) N. Tanaka from Japan also has a green rachis and often greenish tepals at early to mid-anthesis (Tanaka, 2016a, as *Chionographis*).

The styles (stigmas) of *Chamaelirium shiwandashanense* are often nearly upright in posture (or closed or least expanded) even at early to middle stages of flowering (Fig. 1 in Huang *et al.*, 2011; Fig. 3E in Wu *et al.*, 2016). Those of *C. nanlingense* also show this habit (see also the relevant note under *C. nanlingense* below).

#### 4. *Chamaelirium nanlingense* (L. Wu, Y. Tong et Q. R. Liu) N. Tanaka, **comb. nov.**

*Chionographis nanlingensis* L. Wu, Y. Tong et Q. R. Liu in *Pak. J. Bot.* **48**(2): 601(–606) (2016). **Type:** China. Guangdong: Ruyuan County, Nanling National Nature Reserve, under dense forests on hill slopes, alt. 300 m, 12 Apr. 2013 (fl.), L. Wu and Y. Tong 3187 (Holotype; BNU, n.v. Isotype: BNU, IBSC, n.v.).

Chinese name. — 南嶺白絲草 (**nov.**).

Distribution. — CHINA; N Guangdong.

No specimen examined.

Note. — The flowers of *Chamaelirium nanlingense* usually have three long filiform tepals. It is evident from Figs. 1C, 3C, 3D and descriptions in Wu *et al.* (2016) that the tepals are of the inner whorl. This mode of tepal reduction is unique to this species. In species such as *C. japonicum* and *C. koidzumianum*, tepals of both whorls in the lower portion of a flower are vestigial or lacking (Tanaka, 2003, 2016a; as *Chionographis*).

It is very likely that this species is gynodioecious, judging from figures in Wu *et al.* (2016). The flowers in Figs. 3C and 3D have well developed stamens and pistils, and are likely to be hermaphroditic (the flower in Fig. 1C also appears hermaphroditic, though the pistil is somewhat small). In contrast, in the flowers in Figs. 1D and 3B (and probably also 3A), the stamens are very small (rudimentary), while the pistil is well developed with long styles. These flowers are judged to be female (pistillate). All the specimens cited in their paper are from Ruyuan county in Guangdong province, implying that plants of both sexual types (hermaphrodites and females) occur there as members of gynodioecious populations. Further, the styles (stigmas) of at least two flowers in Fig. 3D are upright



in posture (or closed or least expanded), though the flowers are still at their peak. Early closing styles similar to them (i.e. styles that close soon after their full expansion at early stages of flowering) are also characteristically found in pollinated flowers of hermaphroditic, self-compatible plants of a gynodioecious species *C. hisauchianum* (Okuyama) N. Tanaka (Tanaka, unpublished; for such closed styles see Fig. 1B in Tanaka, 2003).

**5. *Chamaelirium chinense* (K. Krause) N. Tanaka, comb. nov.**

*Chionographis chinensis* K. Krause in Notizbl. Bot. Gard. Berlin **10**: 807 (1929). **Type**: S. China. Kwangsi, Yaoshan, 950 m, Apr. 1929, S. S. *Sin* 8088 (Lectoparatype: B, not extant, n.v.); 1300 m, May 1929, S. S. *Sin* 8962 (Lectotype designated in Lin *et al.* (2014): PE 1644655-00035489, photo!; isolectotype: B, not extant, n.v.); 1150 m, May 1929, S. S. *Sin* 9038 (Lectoparatype: B, not extant, n.v.). — *Siraitos chinensis* (K. Krause) F. T. Wang et Tang in Contr. Inst. Bot. Nat. Acad. Peip. **6**: 109 (1949).

*Chionographis merrilliana* H. Hara in J. Jpn. Bot. **43**(9): 264 (1968). **Type**: China. Guangdong (Kwangtung). Sin-fung Distr., Sai-lin-shan Village, Ngok Shing Shan, 1–16 Apr. 1938, fl., Y. W. *Taam* 453 (Holotype: A, n.v., photo! in Hara, loc. cit. Isotype: P 1619479, photo!).

Chinese name. — 中國白絲草.

Distribution. — CHINA; Fujian, Guangdong, Guangxi, Hainan, Hunan, and Jiangxi.

Other selected specimens examined. — CHINA.

**Fujian**: Sui-an xian, Xingcun-gongshe, 700 m, 25 Apr. 1981, *Wuyi Exp.* 2226 (PE 01939755, photo). **Guangdong** (Kwangtung): Tsengshing Distr., Naam Kwan Shan, 30 Apr. 1932, *Tsang* 20386 (A; IBSC; K; P 1619478, photo; TI; TNS; UC); Ts'ung-hwa (Tsung-fa) Distr., Ch'an Woh T'ung Village, Mt. Sam-kok-shan, 1–25 May 1935, *Tsang* 25214 (A). **Guangxi** (Kwangsi): Ping-nan, Yaoshan, Luoxiang, Zhu-tou-ya-shan, 8 May 1936, *Huang* 39123 (IBSC); Jinxiu Xian, Luoxiang, 800 m, 11 Apr. 1982, *Dayaoshan-zonghe-dui* 14085 (IBK 194981, photo). **Hainan**: Baoting, Da-diao-luo-shan, 7 Feb. 1952, *Chen* 7796 (IBSC 199756); Five Finger Mt., 1 May 1922, *McClure* 9392 (K, P 1619480, photo). **Hunan**: Yizhang xian, 580 m, 22 Apr. 2005, *Xiao* 4009 (PE 00868474, photo). **Jiangxi**: Suichuan xian, Chuzhou-gongshe, 750 m, 13 May 1970, *236-Remwuzu* 684 (PE 00111319, photo).

Note. — Features of this species are given in the above key, in the note under subsect. *Cathayana*, and in Tanaka (2016b).

Subsect. 2. *Chionographis*

Comprises 4 species.

Distribution. — Japan and Korea.

Note. — This subsection has zygomorphic flowers that are evidently more advanced than actinomorphic ones found in sect. *Chamaelirium* and subsect. *Cathayana*. Having this feature, subsect. *Chionographis* is regarded as monophyletic. *Chamaelirium chinense* of subsect. *Cathayana* also has zygomorphic flowers, but the flowers are likely to have developed independently of those of subsect. *Chionographis* as a result of parallel evolution. The section *Chionographis* is thus considered to comprise two diverged monophyletic subsections,

*Chionographis* and *Cathayana*.

**Key to the species of subsect. *Chionographis***

- 1a. Tepals filiform ..... 9. *C. koidzumianum*  
 1b. Tepals narrowly obclavate (spatulate) ..... 2  
 2a. Leaf blade cordate. Anthers unilocular ..... 6. *C. cordifolium*  
 2b. Leaf blade elliptic, lanceolate or oblanceolate. Anthers bilocular ..  
 ..... 3  
 3a. Tepals 6, the lower 2 half or slightly less than half as long as the  
 upper ..... 7. *C. hisauchianum*  
 3b. Upper tepals usually 4, sometimes 3 or 2 (1, 0), the lower 2  
 vestigial or lacking ..... 8. *C. japonicum*

**6. *Chamaelirium cordifolium* (N. Tanaka) N. Tanaka, comb. nov.**

*Chionographis cordifolia* N. Tanaka in J. Jpn. Bot. **88**: 30 (2013). **Type**: Japan. Honshû, Kii Peninsula, Mie Pref., Hinodedake – Momonoki, Ôsugidani, alt., 800 m, 4 June 1973, *T. Yamazaki, F. Yamazaki, M. Sugiyama & T. Morita. s.n.* (Holotype: TI!).

Japanese name. — Kii-hime-shiraitosô.

Distribution. — JAPAN; SW Honshû, Kii Peninsula, Nara and Mie Pref.

For other specimens I examined, see Tanaka (2013).

Note. — The extremely small habit and cordate leaf blades of this species are obviously derived character states.

**7. *Chamaelirium hisauchianum* (Okuyama) N. Tanaka, comb. nov.**

*Chionographis japonica* var. *hisauchiana* Okuyama in J. Jpn. Bot. **27**(9): 268 (1952). **Type**: Japan. Honshû. Prov. Musashi [Tokyo pref.]: Kasumi-mura, 3 June 1951, *T. Satow* 7594 (Holotype: TNS!). — *C. japonica* subsp. *hisauchiana* (Okuyama) H. Hara in J. Jpn. Bot. **43**: 263 (1968). — *C. hisauchiana* (Okuyama) N. Tanaka in *Novon* **13**: 212 (2003).

Japanese name. — Azuma-shiraitosô.

Distribution. — JAPAN; central to N Honshû.

Consists of the following three, allopatric subspecies. For a key to them, see Tanaka (2003).

**7a. *Chamaelirium hisauchianum* subsp. *hisauchianum*.**

Japanese name. — Azuma-shiraitosô.

Distribution. — JAPAN; central Honshû, Kantô distr., Saitama and Tokyo Pref.

Other selected specimens examined. — JAPAN. **Honshû**. Saitama Pref.: Iruma-gun, Ogamiyama, 25 May 1952, *Mizushima s.n.* (TI); Naguri-mura, Kawamata, 29 Jun. 1941, *Hiyama* 10850 (TNS 59931); Kawamata, 6 Jun. 1965, *Kazami s.n.* (TI). Tokyo pref. (Musashi): Ôme, 12 Jun. 1955, *Satow* (TNS 100000).

Note. — Occurs in a very narrow area in central Honshû with significantly less snow than the habitats of two other allied subspecies, *minoense* and *kurohimense* (Tanaka, 1985). The plant is slender, and the leaf blades are dull (opaque) and thinner than those of the last two subspecies, probably adapting to a different climate. Flowers are comparatively small with upper tepals 2.7–5.7 mm long (Tanaka, 2003).



**7b. *Chamaelirium hisauchianum* subsp. *minoense***  
(H. Hara) N. Tanaka, **comb. nov.**

*Chionographis japonica* var. *minoensis* H. Hara in J. Jpn. Bot. **36**: 271 (1961). **Type:** Japan. Honshû. Prov. Mino [Gifu Pref.]: Yokokura-mura, prope Kanbara, ca. 300 m, 5 Jun. 1961, H. Hara & S. Kurosawa s.n. (Holotype: TI!). — *C. japonica* subsp. *minoensis* (H. Hara) H. Hara in J. Jpn. Bot. **43**: 263 (1968). — *C. hisauchiana* subsp. *minoensis* (H. Hara) N. Tanaka in Novon **13**: 213 (2003).

Japanese name. — Mino-shiraitosô.

Distribution. — JAPAN; Honshû, Chûbu Distr., Gifu Pref.

Other selected specimens examined. — JAPAN.

**Honshû.** Gifu Pref.: Mino, Kitayama-mura, 20 May 1956, Inami (KYO); Ibi-gun, Kuze-mura, Ozu, ca. 250 m, 24 May 1992, Yoshida 920558 (TNS 588960, 588961); Motosu-gun, Neo-mura, 27 May 1990, Kobayashi (TNS 953675).

Note. — Occurs in a very narrow area in central Honshû with a lot of snow (Tanaka, 1985). The leaf blades are comparatively thick and adaxially glossy, probably adapting to heavy snow in the area. Flowers are small with upper tepals 3.6–6.9 mm long (Tanaka, 2003).

**7c. *Chamaelirium hisauchianum* subsp. *kurohimense***  
(Ajima et Satomi) N. Tanaka, **comb. nov.**

*Chionographis japonica* var. *kurohimensis* Ajima et Satomi in J. Geobot. **24**: 48 (1976). **Type:** Japan. Honshû. Niigata Pref.: Nishi-kubiki-gun, Mt. Kurohime, 21 Jun. 1975, T. Ajima 4546 (Holotype: KANA 083861!). — *C. hisauchiana* subsp. *kurohimensis* (Ajima et Satomi) N. Tanaka in Novon **13**: 213 (2003).

Japanese name. — Kurohime-shiraitosô.

Distribution. — JAPAN; central to N Honshû; Akita, Niigata and Nagano Pref.

Other selected specimens examined. — JAPAN.

**Honshû.** Akita Pref.: Yuri-gun, honjô-shi, Otomo-mura, Jun. 1976, Masada s.n. (TI); Yurihonjyô-shi, Ishizawa-kyô, 6 June 2007, Kokubugata 975 (TNS 9533219). Niigata Pref.: Kariwa-gun, Mt. Hachikoku, 30 May 1952, Iwano s.n. (KANA 13338); Mt. Yoneyama, 12 Jun. 1906, Saito s.n. (MAK 137174); Santô-gun, Oginôjô-yama, Nakamura s.n. (TNS 73558).

Note. — Occurs in snowy regions of central and northern Honshû facing the Sea of Japan (Tanaka, 1985). The leaf blades are comparatively thick and adaxially glossy, probably adapting to heavy snowfall in the regions. Upper tepals are 3.7–12 mm long and usually longer than those of two other subspecies (Tanaka, 2003).

**8. *Chamaelirium japonicum* (Willd.) N. Tanaka, **comb. nov.****

*Melanthium luteum* (L.) Thunb., Fl. Jap. 152 (1784); in Skriv. Nat. Selsk. kjøbenhavn **4**(2): 17, t. 8 (1798), p.p., excl. plants of *Veratrum luteum* L. (basonym); see the notes below and under *C. luteum*.

*Melanthium japonicum* Willd. in Mag. Neuesten Entdeck. Gesammten Naturk. Ges. Naturf. Freunde Berlin **2**: 22 (1808); applied to the plant described as *Melanthium luteum* in Thunberg (1784, 1798, op. supra cit.). **Type:** [Japan. Kyûshû] E Japonia, in aquis juxta Nagasaki, C. P. Thunberg (Holotype: UPS V-008945, photo!). — *Helonias ? japonica* (Willd.) Schult. et Schult. f., Syst. Veg. **7**: 1567 (1830). — *Siraitos aquaticus* Raf., Fl. Tellur. **4**: 27 (1838); applied to the plant described as *Melanthium luteum* in Thunberg (1784, op. supra cit.). **Type:** [Japan. Kyûshû] E Japonia, in

aquis juxta Nagasaki, C. P. Thunberg (Holotype: UPS V-008945, photo!). — *Chionographis japonica* (Willd.) Maxim. in Bull. Acad. Imp. Sci. Saint-Petersbourg **11**: 436 (1867). — *Chamaelirium luteum* Miq. in Ann. Mus. Bot. Lugduno-Batavi **3**: 144 (1867), Prolus. Fl. Jap. 308 (1867), non A. Gray, nom. illeg. — *Chionographis lutea* Baill., Hist. Pl. **12**: 593 in adnot. (1894). — *Siraitos luteus* F. T. Wang et Tang in Contr. Inst. Bot. Nat. Acad. Peip. **6**: 108 (1949).

*Chamaelirium luteum* Miq. f. *gracilis* Miq. in Ann. Mus. Bot. Lugduno-Batavi **3**: 204 (1867), Prolus. Fl. Jap. 368 (1867), **syn. nov.** **Type:** [Japan, collected by Kaizô HIRAI]. Herbarium generale iaponicum auctore medico Kaiso in Mikawa degenis, voluminibus 4, no. 622 (Holotype: L, photo!).

Japanese name. — Shiraitosô.

Distribution. — JAPAN; central and SW Honshû, Shikoku, Kyûshû. S KOREA.

Note. — *Chamaelirium japonicum* from Japan and *C. luteum* from North America are quite distinct species. Thunberg (1784) once identified them as *Melanthium luteum* (L.) Thunb., but nomenclaturally Thunberg's name is applied only to *C. luteum*, since it is a homotypic synonym for *C. luteum* (basonym: *Veratrum luteum* L.), as stated earlier (under *C. luteum*). The citation of *M. luteum* in the above list is just to show the taxonomic identification by Thunberg.

Miquel (July 1867) treated *Chamaelirium japonicum* (as *C. luteum* Miq) as distinct from *C. luteum* (L.) A. Gray. However, he (1870) later regarded them as conspecific. He (1867, 1870) consistently identified the Japanese plant (*C. japonicum*) as *Chamaelirium*, not *Chionographis*, even after the description of the latter genus by Maximowicz (May 1867).

Miquel (1867) described *Chamaelirium luteum* f. *gracilis* on the basis of a collection by Kaiso (Kaizô HIRAI; 1809–1883). This form was characterized by him as having long linear cauline leaves. The type specimen is only a stem bearing a young dense spike and many small slender (linear-elliptic or narrowly lanceolate) leaves to 4.6 cm or slightly longer. *Chamaelirium japonicum* is very variable in characters including the length and shape of cauline leaves, so the Miquel's form is hardly distinguishable from the typical form of *C. japonicum* (subsp. *japonicum*). Ohba et al. (2005) later identified the same specimen as *Chionographis japonica* Maxim. subsp. *minoensis* (H. Hara) H. Hara (Hara, 1961) (= *Chamaelirium hisauchianum* subsp. *minoense* in the present treatment). However, this taxon is inconsistent with the specimen (*C. japonicum*) in having shorter cauline leaves (up to 3 cm long vs. to 8 cm long in *C. japonicum*; data from Hara, 1968, under *Chionographis*). Their assignment is therefore unsupported.

Consists of the following two subspecies whose ranges are geographically close to each other but disjunct. For a key to them, see Tanaka (2016a).

**8a. *Chamaelirium japonicum* subsp. *japonicum***

Japanese name. — Shiraitosô.

Distribution. — JAPAN; central and SW Honshû, Shikoku, Kyûshû excluding islands Yaku(shima) and Shimokoshiki(-jima).

Other selected specimens examined. — JAPAN. **Honshû.** Aichi Pref.: Kitashitara-gun, Midono-mura (Tôei-chô), Kakino, 17 Oct. 1954, *Torii s.n.* (KYO). Hyôgo Pref.: Awaji, Inohana-dani, 3 Nov. 1949, *Kono s.n.* (KYO). Ishikawa Pref.: Ishikawa-gun, inter Hinomiko et Kuragatake, 13 Oct. 1953, *Masamune* (KANA 60010). Shiga Pref.: Hikone-shi, Sôgen-ji, 28 Oct. 1973, *Kurosaki 5893* (KYO). Shizuoka Pref.: Inasa-gun, Shibukawa, 23 Sept. 1959, *G. Murata* (KYO); Honkawane-mura, Sumatakyô, 18 Oct. 1969, *Yoshikawa s.n.* (TNS 253970). **Kyûshû.** Kagoshima Pref.: Isl. Sakura, Nov. 1926, *T. Nakai* (TI). **Shikoku.** Kagawa Pref.: Isl. Syôdo-shima, 19 Nov. 1968, *Togashi* (TI). Kôchi Pref.: Takaoka-gun, Sakawa-chô, Nov. 1892, *T. Makino* (MAK 137199).

Note. — This subspecies is the most widespread in subject. *Chionographis*, and highly variable especially in overall size, as earlier pointed out by Hara and Kurosawa (1962). It is distinguishable from subsp. *yakusimense* by its earlier flowering and four upper long tepals (vs. three or fewer upper tepals) (Tanaka, 2016a).

**8b. *Chamaelirium japonicum* subsp. *yakusimense* (Masam.) N. Tanaka, comb. nov.**

*Chionographis japonica* var. *yakusimensis* Masam. in Mem. Fac. Sci. Agr. Taihoku Imp. Univ. **11** (Bot. 4): 550 (1934). **Type:** Japan. Kyûshû. Kagoshima Pref.: Isl. Yakushima, 7 July 1928, *G. Masamune* (Holotype: unlocated presently; not found at TI). — *C. japonica* subsp. *yakusimensis* (Masam.) N. Tanaka in Makinoa N.S. **11**: 4 (2016). — *C. koidzumiana* var. *yakusimensis* (Masam.) Masam. in Trans. Nat. Hist. Soc. Formos. **26**: 53 (1936), '*koidzumii*'.

Japanese name. — Yakushima-shiraitosô.

Distribution. — JAPAN; Kyûshû, Kagoshima Pref., Yaku(shima) Isl., Shimokoshiki(jima) Isl. KOREA; Cheju Isl.

Note. — Distinguished from subsp. *japonicum* by the flowers blooming in the somewhat later season (usually June through July vs. April through May; Tanaka, 2016a) and by the three or fewer upper tepals (vs. four in subsp. *japonicum*).

Comprises the following three, insular varieties, each of which is endemic to an island. For a key to them, see Tanaka (2016a).

**8b1. *Chamaelirium japonicum* subsp. *yakusimense* var. *yakusimense*.**

Japanese name. — Yakushima-shiraitosô.

Distribution. — JAPAN; Kyûshû, Kagoshima Pref., Yaku(shima) Isl.

For other selected specimens I examined see Tanaka (2016a).

Note. — Small in habit with stems to 22 (–30) cm long (in flower or in fruit). Leaf blades are to 4.7(–6.5)

cm long and usually acute or subacute at the apex. Upper tepals are usually 2, sometimes 3 or 1, rarely absent, and up to 12.5 mm long (Tanaka, 2016a).

**8b2. *Chamaelirium japonicum* subsp. *yakusimense* var. *koshikiense* (N. Tanaka) N. Tanaka, comb. nov.**

*Chionographis japonica* subsp. *yakusimensis* (Masam.) N. Tanaka var. *koshikiensis* N. Tanaka in Makinoa N. S. **11**: 7 (2016). **Type:** Japan. Kyûshû. Kagoshima Pref., Isl. Shimokoshiki-jima, Mt. Otake, collected on 25 July 1983, transplanted at Hachioji, dried and pressed on 19 July 1984, *Noriyuki Tanaka s.n.* (Holotype: TI!).

Japanese name. — Koshiki-shiraitosô.

Distribution. — JAPAN; Kyûshû, Kagoshima Pref., Shimokoshiki Isl.

For other selected specimens I examined see Tanaka (2016a).

Note. — Comparatively large in habit with stems to 55 cm long (in flower or in fruit). Leaf blades are often elliptic and ca. 3.5–9.5 cm long. Upper tepals are usually 3, sometimes 4 or 2, ca. (5.5–)8–15 mm long (Tanaka, 2016a).

**8b3. *Chamaelirium japonicum* subsp. *yakusimense* var. *koreanum* (F. T. Wang et Tang) N. Tanaka, comb. nov.**

*Chionographis koreana* F. T. Wang et Tang in Bull. Fan. Mem. Inst. Biol. Peiping **7**: 82 (1936). **Type:** Korea. Isl. Quelpaert [Isl. Jeju-do], in sylvis Hallaisan, alt. 1000 m, Jul. 1908, *Taquet 1619* (Lectotype designated by Hara (1968) as "Type": K 852616, photo!); *ibid.*, Oct. 1908, fr., *Taquet 1616* (Lectoparatype: K 852617, photo!). — *C. japonica* var. *koreana* (F. T. Wang et Tang) Okuyama in J. Jpn. Bot. **19**: 130 (1943). — *Siraitos koreanus* (F. T. Wang et Tang) F. T. Wang et Tang in Contr. Inst. Bot. Nat. Acad. Peip. **6**: 109 (1949). — *C. japonica* subsp. *yakusimensis* (Masam.) N. Tanaka var. *koreana* (F. T. Wang et Tang) N. Tanaka in Makinoa N. S. **11**: 5 (2016).

Korean name. — Jeju-silkkotpul (**nov.**).

Japanese name. — Saisyu-shiraitosô.

Distribution. — S KOREA; Isl. Chejudo.

For other selected specimens I examined see Tanaka (2016a).

Note. — Small in habit with stems to 15.5 cm long (in flower or in fruit). Leaf blades are to 5 cm long and obtuse or rounded at the apex. Upper tepals are (usually) 3, to 5.8 mm long (Tanaka, 2016a).

**9. *Chamaelirium koidzumianum* (Ohwi) N. Tanaka, comb. nov.**

*Chionographis koidzumiana* Ohwi in Bot. Mag. (Tokyo) **44**: 565 (1930). **Type:** Japan. Honshû. Prov. Kii [Wakayama Pref.]: Mt. Nachi, 12 May 1929, *J. Ohwi* (Holotype: KYO!, photo! in Ohwi, Fl. Jap., rev. ed., 1965, pl. 8. Isotypes: TI!, TNS 43153!, 231361!, P 730560 in photo!). — *Siraitos koidzumianus* (Ohwi) F. T. Wang et Tang in Contr. Inst. Bot. Nat. Acad. Peip. **6**: 110 (1949).

*Chionographis sparsa* F. Maek. J. Jpn. Bot. **11**(6): 378, f. 9 (1935). **Type:** Japan. Kyûshû. Prov. Osumi [Kagoshima Pref.], Isl. Yakushima, *T. Terazaki* legit et rettulit in anno 1934, et floruerunt in Hort. Bot. Koisikawense in Apr. [15], 1935 (Holotype: TI!). — *Siraitos sparsus* (F. Maek.) F. T. Wang et Tang in Contr. Inst. Bot. Nat. Acad. Peip. **6**: 110 (1949).





*Siraitos formosanus* F. T. Wang et Tang in Contr. Inst. Bot. Nat. Acad. Peip. **6**: 110 (1949). **Type**: [Japan. Kyūshū. Kagoshima Pref.] Isl. Yakushima, 6 June 1928, G. Masamune (Holotype: PE 00035265, photo!).

Japanese name. — Chabo-shiraitosō.

Distribution. — JAPAN; SW Honshū, Shikoku, Kyūshū.

Note. — According to the protologue of *Siraitos formosanus* (Wang and Tang, 1949), the type was collected by G. Masamune in Taiwan (Formosa). However, Hara (1968) suggested on the basis of the protologue and information from Dr. Masamune that the specimen must have been collected from Yakushima Isl., southern Japan. Recently, I had the opportunity to examine a photograph (digital image) of the type specimen kept at PE and found that the specimen had come from Yakushima, which justifies Hara's previous suggestion regarding the type locality.

Consists of the following two varieties the ranges of which are close to each other, but disjunctive. For a key to them see Tanaka (2016a).

#### 9a. *Chamaelirium koidzumianum* var. *koidzumianum*

Japanese name. — Chabo-shiraitosō.

Distribution. — JAPAN; SW Honshū, Shikoku, Kyūshū excluding Isl. Shimokoshiki.

Other selected specimens examined. — **JAPAN**. **Honshū**. Wakayama Pref.: Prov. Kii ad cataractam Natchi, May, *T. Sugawa* 123, ex Herb. T. Ito (dated 12 Aug. 1919) (TNS). **Kyūshū**. Miyazaki Pref.: Higashi-usuki-gun, Mt. Ochimizu, 25 June 1974, *Haginiwa* (TNS 989882). **Shikoku**. Kōchi Pref.: Kamedani silvis Yanaze oppidi Umazi, 1 May 1950, *Yamanaka* (KYO).

#### 9b. *Chamaelirium koidzumianum* var. *leiophyllum* (N. Tanaka) N. Tanaka, **comb. nov.**

*Chionographis koidzumiana* Ohwi var. *leiophylla* N. Tanaka in Makinoa N. S. **11**: 11 (2016). **Type**: Japan. Kyūshū. Kagoshima Pref., Isl. Shimokoshiki-jima, Mt. Odake, 3 Jun. 1985, *Noriyuki Tanaka s.n.* (Holotype: TI!. Isotype: BM!, GH!, KYO!, TI!).

Japanese name. — Koshiki-chabo-shiraitosō.

Distribution. — JAPAN; SW Kyūshū, Isl. Shimokoshiki.

For other selected specimens I examined see Tanaka (2016a).

Note. — Distinguished from var. *koidzumiana* mainly by the glossier, often wider leaf blades and somewhat larger habit with stems ca. 25–52 cm long (vs. 5.5–25(–38.5) cm) (in flower or in fruit), upper tepals (12–)16–23(–28) mm long (vs. 10–17(–26) mm) and leaf blades 4–10 cm long (vs. 1.3–7.5 cm) (Tanaka, 2016a). The glossy blades are likely to be apomorphic against the dull (opaque) blades of var. *koidzumiana*.

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## LITERATURE CITED

- Averyanov, L. and N. Tanaka.** 2014. New species of *Chionographis* (Melanthiaceae) from eastern Indochina. *Taiwania* **59**(1): 13–17.
- Baillon, H.** 1894. Liliacées. In: *Histoire des Plantes* **12**: 403–600 (*Chionographis* on p. 593, *Chamaelirium* on pp. 593–594). Librairie Hachette & Cie, Paris, France. 611 pp.
- Baker, J.D.** 1879. A synopsis of Colchicaceae and the aberrant tribes of Liliaceae. *J. Linn. Soc., Bot.* **17**(103): 405–510.
- Bentham, G.** 1883. Liliaceae. In: *Bentham, G. et J. D. Hooker (eds.), Genera Plantarum* **3**(2): 748–836. L. Reeve and Co., Williams and Norgate, London, England.
- Britton, N.L. and H.A. Brown.** 1896. An Illustrated Flora of the Northern United States, Canada and the British Possessions. **1** (*Chamaelirium* on p. 402). Charles Scribner's Sons, New York, USA. 612 pp.
- Charlesworth, B. and D. Charlesworth.** 1978. A model for the evolution of dioecy and gynodioecy. *Amer. Nat.* **112** (988): 975–997.
- Charlesworth, D.** 1999. Theories of the evolution of dioecy. In: Geber, M.A., T.E. Dawson and L.F. Delph (eds.), *Gender and Sexual Dimorphism of Flowering Plants*, pp. 33–50. Springer-Verlag, Berlin, Germany. 305 pp.
- Chen, S.-C.** 1980. *Chionographis*. In: Wang, F.T. et T. Tang (eds.), *Flora Reipublicae Popularis Sinicae* **14**: 13–15. Science Press, Beijing. 308 pp. plus 3 non-paginated leaves at the end (in Chinese).
- Dahlgren, R.M.T., H.T. Clifford and F. Yeo.** 1985. *The Families of the Monocotyledons*. Springer, Berlin, Germany. 520 pp.
- Darwin, C.** 1877. *The Different Forms of Flowers on Plants of the Same Species*. John Murray, London, England. 352 pp.
- Dorcken, M.E. and C.H. Barrett.** 2004. Sex determination and the evolution of dioecy from monoecy in *Sagittaria latifolia* (Alismataceae). *Proc. Roy. Soc. London, B.* **271**(1535): 213–219.
- Engler, A.** 1887. Liliaceae. In: Engler, A. und K. Prantl (eds.), *Die Natürlichen Pflanzenfamilien II-5*: 10–91. Verlag von W. Engelmann, Leipzig, Germany.
- Fernald, M.L.** 1950. *Gray's Manual of Botany*, 8th edition. American Book Company, New York, USA. 1632 pp.
- Freeman, D.C., J. Lovett Doust, A. El-Keblawy, K.J. Miglia and D. McArthur.** 1977. Sexual specialization and inbreeding avoidance in the evolution of dioecy. *Bot. Rev.* **63**(1): 65–92.



- Fuse, S. and N. Tamura.** 2000. A phylogenetic analysis of the plastid *matK* gene with emphasis on Melanthiaceae sensu lato. *Pl. Biol. (Stuttgart, Germany)* **2(4)**: 415–427.
- Gleason, H.A.** 1952. The New Britton and Brown Illustrated Flora of the Northeastern United States and Adjacent Canada **1**. New York Bot. Gard., Hafner Press, New York, USA. 482 pp.
- Gray, A.** 1837. Melanthacearum Americae septentrionalis revisio. *Annals of the Lyceum of Natural History of New York* **4(1)**: 105–140.
- Hara, H.** 1961. A new *Chionographis* from central Honshu. *J. Jpn. Bot.* **36**: 238–239.
- Hara, H.** 1968. A revision of the genus *Chionographis* (Liliaceae). *J. Jpn. Bot.* **43**: 257–267, pls. 17, 18.
- Hara, H. and S. Kurosawa.** 1962. Morphological and chromosomal variations in *Chionographis japonica* Maxim. *Acta Phytotax. Geobot.* **20**: 34–38 (in Japanese with English summary).
- Huang, Y.-F., R.-H. Jiang, D.-X. Nong and W.-B. Xu.** 2011. *Chionographis shiwandashanensis* sp. nov. (Melanthiaceae) from southern Guangxi, China. *Nordic J. Bot.* **29(5)**: 605–607.
- Hutchinson, J.** 1934. The Families of Flowering Plants II. Monocotyledons. MacMillan, London, England. 243 pp.
- Kawano, S.** 1976. Nihon no flora [Flora of Japan] **9**. Shokubutsu to Shizen (The Nature and Plants) **10(12)**: 6–11 (in Japanese).
- Krause, K.** 1930. Liliaceae. In: Engler, A. (ed.), *Die Natürlichen Pflanzenfamilien* **15a**: 227–386. Wilhelm Engelmann, Leipzig, Germany. 707 pp.
- Lin, Y., Z. Yang, X. Zhang, Q. Sun, Q. Du, T. Wu, S. Bi, H. Li.** 2014. Lectotypifications of eighteen names in monocotyledons. *Acta Bot. Boreal.-occident. Sin.* **34(2)**: 411–415 (*Chionographis* on p. 413).
- Maki, M.** 1993. Floral sex ratio variation in hermaphrodites of gynodioecious *Chionographis japonica* var. *kurohimensis* Ajima et Satomi (Liliaceae). *J. Pl. Res.* **106(2)**: 181–186.
- Maki, M.** 2012. Nihon-san Shiraitosô-zoku [*Chionographis* from Japan]. In: Tobe, H. and M. Tamura (eds.), *Atarashii Shokubutsu Bunruigaku [New Plant Taxonomy]* **1**: 189–194. Kodansha, Tokyo, Japan (in Japanese).
- Maximowicz, C.J.** 1867. Diagnoses breves plantarum novarum Japoniae et Mandshuriae **3**. *Bull. Acad. Imp. Sci. Saint-Petersbourg* **11**: 433–439.
- Meagher, T.R.** 1980. Population biology of *Chamaelirium luteum*, a dioecious lily. I. Spatial distributions of males and females. *Evolution* **34(6)**: 1127–1137.
- Meagher, T.R. and J. Antonovics.** 1982. The population biology of *Chamaelirium luteum*, a dioecious member of the lily family: Life history studies. *Ecology* **63(6)**: 1690–1700.
- Miquel, F.A.W.** 1867. Prolusio florum japonicarum. In: *Ann. Mus. Bot. Lugduno-Batavi* **3**: 1–66, 91–209 (*Chamaelirium luteum* Miq. f. *gracilis* Miq. on p. 204).
- Miquel, F.A.W.** 1870. Contributions à la flore du Japon. *Arch. Néerl.* **5**: 89–96 (*Chamaelirium* on p. 91).
- Ohba, H., S. Akiyama and G. Thijsse.** 2005. Miquel's new taxa of the vascular plants described from Japan in *Prolusio Florae Japonicae* and some other works. In: Ohba, H. and D.E. Boufford (eds.), *The Botanical Collections: Proceeding of the Symposium 'Siebold in the 21st Century'* held at the University Museum, the University of Tokyo, in 2003. *Bull. Univ. Mus., Univ. Tokyo* **41**: 31–140.
- Pellicer, J., L.J. Kelly, I.J. Leitch, W.B. Zomlefer and M.F. Fay.** 2014. A universe of dwarfs and giants: genome size of chromosome evolution in the monocot family Melanthiaceae. *New Phytologist* **201(4)**: 1484–1497.
- Radford, A.E., H.E. Ahles and C.R. Bell.** 1968. Manual of the Vascular Flora of the Carolinas (*Chamaelirium* on p. 301, fig. p. 300). Univ. North Carolina Press, Chapel Hill, USA. 1183 pp.
- Rafinesque, C.S.** 1838. *Flora Telluriana* **4** (*Siraitos* on pp. 26–27). H. Probasco, Philadelphia, USA. 135 pp.
- Rudal, P.J., K.L. Stobart, W.P. Hong, J.G. Conran, C.A. Furness, G.C. Kite and M.W. Chase.** 2000. Consider the Lilies: Systematics of Liliales. In: Wilson, K. L. and D. A. Morrison (eds.), *Monocots: Systematics and Evolution*. CSIRO, Melbourne, Australia. 728 pp.
- Sato, D.** 1942. Karyotype alteration and phylogeny in Liliaceae and allied families. *Jap. J. Bot.* **12**: 57–161.
- Takahashi, M. and S. Kawano.** 1989. Pollen morphology of the Melanthiaceae and its systematic implications. *Ann. Missouri Bot. Gard.* **76(3)**: 863–876.
- Takhtajan, A.** 1997. Diversity and Classification of Flowering Plants. Columbia Univ. Press, New York, USA. 643 pp.
- Takhtajan, A.** 2009. Flowering Plants. Second edition. Springer. 871 pp.
- Tamura, M.N.** 1998. Melanthiaceae. In: Kubitzki, K. (ed.), *The Families and Genera of Vascular Plants* **3**: 369–380. Springer-Verlag, Berlin, Germany. 478 pp.
- Tanaka, N. (initials as N.Y.) and N. Tanaka.** 1977. Chromosome studies in *Chionographis* (Liliaceae) I. On the holokinetic nature of chromosomes in *Chionographis japonica* Maxim. *Cytologia* **42(3-4)**: 753–763.
- Tanaka, N. (initials as N.Y.) and N. Tanaka.** 1979. Chromosome studies in *Chionographis* (Liliaceae) II. Morphological characteristics of the somatic chromosomes of four Japanese members. *Cytologia* **44(4)**: 935–949.
- Tanaka, N. (initials as N.Y.) and N. Tanaka.** 1980. Chromosome studies in *Chionographis* (Liliaceae) III. The mode of meiosis. *Cytologia* **45(4)**: 809–817.
- Tanaka, N. (initials as N.Y.) and N. Tanaka.** 1985. Fluorescent banding in the chromosomes of *Chionographis* and *Chamaelirium*. *La Kromosomo* **II-37**: 1161 (abstract of a presentation at the 35th annual meeting of the Society of Chromosome Research in Japan; in Japanese).
- Tanaka, N.** 1985. Shiraitosô zoku no seiteki hen'i [Sexual variation of *Chionographis*]. *Shuseibutsugaku-kenkyû* **9**: 11–19 (in Japanese).
- Tanaka, N.** 1997. Phylogenetic and taxonomic studies on *Helonias*, *Ypsilandra* and *Heloniopsis* II. Evolution and geographical distribution. *J. Jpn. Bot.* **72**: 329–336.
- Tanaka, N.** 1998. Phylogenetic and taxonomic studies on *Helonias*, *Ypsilandra* and *Heloniopsis* III. Taxonomic revision. *J. Jpn. Bot.* **73**: 102–115.
- Tanaka, N.** 2003. New status and combinations for Japanese taxa of *Chionographis* (Melanthiaceae). *Novon* **13(2)**: 212–215.
- Tanaka, N.** 2013. A new species of *Chionographis* (Melanthiaceae) from Japan. *J. Jpn. Bot.* **88**: 30–35.



- Tanaka, N.** 2016a. Two new varieties and two nomenclatural revisions in *Chionographis japonica* and *C. koidzumiana* (Melanthiaceae). *Makinoa N. S.* **11**: 1–16.
- Tanaka, N.** 2016b. The occurrence of gynodioecy in a Chinese species of *Chionographis* (Melanthiaceae). *J. Jpn. Bot.* **91**: 122–128.
- Tanaka, N.** 2017. Diversity in fruit and seed characters of *Chamaelirium* and *Chionographis* (Melanthiaceae). *Taiwania* **62(1)**: 67–74.
- Thunberg, C.P.** 1784. *Flora Japonica (Melanthium luteum* on pp. 152–153). Lipsiae, Bibliopolio Mülleriano, Germany. 418 pp., plus 2 additional non paginated pages.
- Utech, F.H.** 2002. *Chamaelirium*. In: *Flora of North America* Editorial Committee (ed.), *Flora of North America North of Mexico* **26**: 68–69, fig. on p. 65. Oxford Univ. Press, New York, USA. 723 pp.
- Wang, F.T. and T. Tang.** 1949. Notes on Chinese Liliaceae VIII. *Contr. Inst. Bot. Nat. Acad. Peip.* **6(2)**: 105–114.
- Webb, C.J.** 1999. Empirical studies: Evolution and maintenance of dimorphic breeding systems. In: Geber, M.A., T.E. Dawson and L.F. Delph (eds.), *Gender and Sexual Dimorphism of Flowering Plants*, pp. 33–50. Springer-Verlag, Berlin, Germany. 305 pp.
- Willdenow, C.L.** 1808. Nähere Bestimmung einiger Liliengewächse, besonders aber derjenigen, die zur sechsten Klasse und dritten Ordnung des Linnéschen Systems gehören. *Mag. Neuesten Entdeck. Gesammten Naturk. Ges. Naturf. Freunde Berlin* **2**: 14–30.
- Wu, L., Y. Tong, R.-Y. Yan and Q.-R. Liu.** 2016. *Chionographis nanlingensis* (Melanthiaceae), a new species from China. *Pak. J. Bot.* **48(2)**: 601–606.