KEW BULLETIN (2018) 73:31
DOI 10.1007/S12225-018-9756-3

ISSN: 0075-5974 (print)
ISSN: 1874-933X (electronic)

Rohdea harderi (Asparagaceae), a new species from northern Vietnam

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Summary. *Rohdea harderi* N. Tanaka, D. P. Hannon & Aver., a new species from northern Vietnam, is described and illustrated. It is most closely allied to *R. verruculosa* from SW China, but differs mainly by the narrower annular appendage at the throat of the perianth tube, explanate, subacute, crenulate, externally smooth perianth segments, smaller stigma and obovoid ovary. Its affinity is briefly discussed on the basis of floral traits. A key to the species known from Vietnam is also provided.

Key Words. Convallarieae, Indochina, phenotypic traits, *Tupistra*.

Introduction

Rohdea Roth is a genus founded on one species *R. japonica* (Thunb.) Roth (1821) from Japan. Its generic circumscription was later enlarged by Tanaka (2003, 2010a), incorporating *Campylandra* Baker and *Gonioscypha* Baker. It is often classified along with several other related genera such as *Aspidistra* Ker Gawl., *Tupistra* Ker Gawl. and *Reineckea* Kunth in the Convallarieae of the Convallariaceae (Conran & Tamura 1998), or in the Asparagaceae (e.g. Tanaka 2010a). In a subfamilial classification of Asparagaceae by Chase *et al.* (2009), neither *Rohdea* nor *Reineckea* are mentioned, but their related genera such as *Tupistra* and *Aspidistra* are placed in the Nolinoideae of Asparagaceae.

Rohdea is most closely allied to *Tupistra* (Ker Gawler 1814; Tanaka 2010b), from which it differs mainly by its leaves with a relatively wide, indistinct petiole, green or greenish perianth (vs purplish, whitish or fulvous perianth), and a relatively short style that is narrower than the ovary. *Rohdea* invariably bears smooth, red or orange fruits (Tanaka 2010a), while *Tupistra* has muricate, brownish or dark coloured fruits except for *T. siphonantha* N. Tanaka, Vislobokov & D. P. Hannon that produces orange fruits (Tanaka 2010b; Tanaka *et al.* 2018).

Rohdea currently comprises about 20 species distributed mostly in subtropical or warm temperate regions of Asia, encompassing Bhutan, China, India, Japan, Laos, Myanmar, Nepal, Taiwan, Thailand and Vietnam (Tanaka 2010a; Averyanov *et al.* 2014, 2017). Approximately 15 species (about three quarters of the total species) of *Rohdea* are concentrated in the south-western part of China (Tanaka 2010a), implying that the region has been the primary centre for diversification of the genus.

To date, five species of *Rohdea* have been reported from eastern Indochina (see Tanaka 2010a): two from Laos — *R. dracaenoides* Aver. & N. Tanaka and *R. siamensis* (Yamashita & M. N. Tamura) Yamashita & M. N. Tamura; and three from northern Vietnam — *R. filosa* Aver. & N. Tanaka, *R. tonkinensis* (Baill.) N. Tanaka and *R. wattii* (C. B. Clarke) Yamashita & M. N. Tamura. No species of *Rohdea* has been reported from Cambodia.

While botanically exploring north-western Vietnam, two of us (Averyanov and Harder) came across unusual plants of *Rohdea* in two provinces and after a close examination of the sampled material, we found them to be a new species. We named it *R. harderi* and describe it in detail with illustrations and relevant taxonomic and ecological data in this paper. Its affinity is also discussed briefly on the basis of floral traits.

Materials and methods

In situ observations of the plants of *Rohdea* and their habitat conditions were made by Averyanov in Dien Bien en province and by Harder in Son La province, respectively. A few plants were sampled for living material, or as herbarium specimens for further study of phenotypical and phenological

Accepted for publication 23 May 2018.

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Published online: 19 June 2018

aspects. One plant originally from Son La province (*Harder et al.* 7276) has been cultivated at Huntington Botanical Gardens (accession number 90679), California, U.S.A., and was used as the main material for description and illustrations. An inflorescence from this plant was fixed and preserved in FAA (a medium consisting of formaldehyde, glacial acetic acid, ethanol, and water) and used for closer observations, measurements and drawings of the floral parts with the aid of a stereomicroscope equipped with an eyepiece micrometer. The description of the plant given below includes some measurements (such as inflorescence length, peduncle length, and leaf width) taken from the herbarium specimen from Dien Bien province: *Averyanov et al. as CPC* (The Center for Plant Conservation of the Vietnam Union of Science and Technology Associations, Hanoi, Vietnam) 2115 (LE).

Taxonomic Treatment

Rohdea harderi *N. Tanaka, D. P. Hannon & Aver.* **sp. nov.** Type: Vietnam, Son La province, *D. K. Harder et al.* 7276, dried herbarium specimen prepared by *D. P. Hannon* s.n. on 21 April 2017 from a plant cultivated at Huntington Botanical Garden (HBG 90679) (holotype, HNT 13048!).

http://www.ipni.org/urn:lsid:ipni.org:names:77178688-1

Herb glabrous, rhizomatous, monopodial, evergreen, perennial. *Rhizome or rhizome-like portion* below leafy stem (aged portion of stem) cylindrical, 2.5 – 3.5 cm in diam., brown, densely annulate with leaf scars, bearing fleshy thick roots to 5 mm in diam. *Stem* nearly erect, cylindrical, to 9 cm long, densely covered with leaves and scaly leaves. *Scaly leaves (cataphylls)* 5 – 8 at base of annual tuft of foliage leaves, lanceolate, slightly wider at base, often laterally involute, acute, 6 – 12 cm long, 5 – 20 mm wide midway, thinner and withering earlier than foliage leaves. *Leaves* congested, subdistichous, spreading-ascending, ultimately deflexed, narrowly oblanceolate or narrowly oblanceolate-elliptic, attenuate and flat to weakly canaliculate towards base, basally amplexicaul, margins entire, weakly wavy, distally mostly acuminate (sometimes acute), recurved, to 49 cm long and 7.5 cm wide, subcoriaceous, weakly glossy on both sides; adaxial surface medium green, abaxial surface somewhat paler; midrib adaxially sunken and slightly paler, abaxially prominently raised; secondary parallel veins numerous, slightly raised on both sides; petiole indistinct. *Peduncle* half-terete with a flat side (nearly semicircular in cross section), 2-angulate, 2 – 5 cm long, 0.4 – 0.5 cm wide, distally bracteate; *sterile bracts* on peduncle 4 – 7, ascending, narrowly triangular or triangular-ovate, partly clasping at base, entire, acuminate or acute, distally often conduplicate, 5 – 22 mm long, 4.5 – 8 mm wide at base (when expanded). *Inflorescence* a spike, cylindrical, 4.5 – 5 (– 8) cm long, 1 – 1.7 cm in diam., densely many-flowered, apically cristate with many sterile bracts 4 – 5 mm long; rachis fleshy, ridged, 4 – 4.5 (– 7.7) cm long. *Floral bracts* 2 per flower, borne directly on rachis, green, margins membranous, whitish and irregularly minutely crenulate-serrulate; *outer bract* borne shortly below flower with U- or V-shaped base, cucullate, narrowly ovate-triangular or narrowly triangular, acuminate, acute or caudate, 7 – 8.5 mm long, 4 – 6 mm wide at base (when expanded), ascending, mostly abruptly inflexed at subbasal to middle portion, distally recurved (bracts on basal portion of inflorescence not recurved), exceeding flowers and buds; *inner bract* (*bracteole*) smaller, borne lateral to flower, ovate-triangular, acuminate, distally acroscopic, 3 – 4 mm long, 2 – 3 mm wide (at base), membranous. *Flowers* (nearly) actinomorphic, hermaphroditic, sessile, borne on sunken portions between ridges on rachis, opening acropetally, mostly horizontal; *perianth* syntepalous, distally 6-cleft, salverform, distal limb 7.5 – 9 mm in diam., fleshy, light green, turning yellow to orange at late anthesis; *tube* (proximal syntepalous part) turbinate or subterete, (2.2 –) 2.5 – 3 mm long, 2.3 – 2.8 mm in diam. in middle, externally usually 6-ribbed (rib corresponds to midvein of tepal), apical portion with inwardly protruded annular appendage 0.5 mm wide, green, and whitish at distal margins; *segments* explanate, often slightly recurved, orbicular-ovate, ovate or deltoid, 3 – 3.8 mm long, 2.5 – 3.3 mm wide, proximally imbricate, margins irregularly crenulate, membranous, whitish, apical portion subacute or shortly acuminate. *Stamens* 6, each arising from base of perianth segment, distally connivent and adjacent (young, indehiscent) anthers usually laterally contiguous (not connate); *filaments* incurved, nearly terete, 1.5 – 2 mm long, 0.4 – 0.5 mm in diam., green, distal portion whitish, somewhat bullate dorsally, 0.5 – 0.6 mm wide; *anthers* dorsifixed, biloculate, orbicular ovate, retuse at both ends, 1.1 – 1.3 mm long and wide, facing downwards, introrse, cream-coloured; thecae ellipsoid, becoming dry and strongly shrunk after dehiscence. *Pistil* 1, tricarpellate, superior, upright, 2.2 – 3 mm long, included; *ovary* obovoid, often slightly compressed laterally, 2 – 2.3 mm long, 1.4 – 1.8 mm broad (at distal broadest portion), sometimes slightly trisulcate distally, trilocular; *ovules* 4 per locule, biseriate and nearly collateral on axile

placentae, anatropous, c. 0.5 mm long; *style* shortly cylindric or subconic (slightly narrowing above), (0.2 –) 0.5 (– 0.8) mm long; *stigma* positioned slightly lower than annulus at throat of perianth, trisected, 0.7 – 0.8 mm across, each lobe oblong-elliptic, 0.4 – 0.7 mm long, 0.4 – 0.5 mm wide, descending, surface papillulate. *Fruit* a berry, ellipsoid, 1.7 cm long, 1.1 cm wide, pericarp fleshy, surface bright orange and glossy, 1-seeded. *Seed* ellipsoid, 1.2 cm long, 0.9 cm wide, waxy pale brown. Figs 1, 2.

RECOGNITION. Most closely allied to *Rohdea verruculosa* (Q. H. Chen) N. Tanaka (Tanaka 2003: 332, excluding *Tupistra annulata* H. Li & J. L. Huang and its homotypic synonym), but differs from it chiefly by the narrower annulus (0.5 vs 1 – 1.5 mm wide) at the throat of the perianth tube, explanate, crenulate, subacute, smooth perianth segments (vs incurved, nearly entire, caudate(-filose), externally verruculose segments), smaller stigma (0.7 – 0.8 vs c. 1.3 mm across), and obovoid ovary (vs ovoid or globose ovary). Table 1.

DISTRIBUTION. Endemic to NW Vietnam: Dien Bien and Son La provinces.

SPECIMENS EXAMINED. VIETNAM. **Dien Bien prov.**, Muong Cha distr., Hua Ngai municipality, Thien Pa village, around point 21°52'27"N 103°09'45"E, highly degraded primary evergreen broadleaved humid forest on very steep slopes of remnant mountains composed of solid limestone at elevations 1100 – 1300 m a.s.l., lithophytic and terrestrial herb to 0.3 m tall on very steep, shady slope, flowers light greenish to full orange, locally common, 8 April 2011, *L. V. Averyanov, P. K. Loc, N. Q. Hieu, N. T. Vinh, CPC* 2115 (LE). **Son La prov.**, Yen Chau distr., Muong Lum municipality, On Oc village, collection along N-S ridge along western side, from along trail from agricultural fields to secondary vegetation to primary forest with some timber species removed (*Burretiodendron*) along ridgetop of crystalline limestone, 1468 m, 20°59'06"N 104°28'46"E (GPS coordinates at top of ridge), herb, occasional, leaves light green, petals light green, anthers dull yellow-brown; fruit bright orange juicy with white seed, 4 March 2001, *D. K. Harder, P. K. Loc & N. T. Huong* 7276 [herbarium specimen prepared by *D. P. Hannon* s.n. on 21 April 2017 from a plant cultivated at Huntington Botanical Gardens (HBG 90679)] (holotype HNT 13048).

HABITAT. In Dien Bien province, *Rohdea harderi* occurs on shady forest floor or among rocks in humid, highly degraded primary evergreen broadleaved forest on very steep slopes of mountains composed of solid limestone at elevations 1100 – 1300 m a.s.l. (*Averyanov et al. as CPC* 2115, LE).

In Son La province, it occurs as undergrowth on light to heavily shaded forest floor in secondary or primary forest with some timber species (mainly *Burretiodendron* Rehder and conifers) removed along ridgetop of crystalline limestone around 1468 m in elevation (*Harder et al.* 7276 as *D. P. Hannon* s.n., HNT 13048).

CONSERVATION STATUS. In the habitat of Dien Bien province, *Rohdea harderi* was common, but the primary forest surrounding it was highly degraded in 2011 (*Averyanov et al. as CPC* 2115, LE). In the habitat of Son La province, which lies in the southeast of Dien Bien province, the plant was occasional in frequency of occurrence. The forest area where the plant was found was actively impacted by timber extraction and agricultural activities (cultivation, forest conversion, fires). When revisited (by Harder in 2011) 10 years after the first visit (in 2001), the area was further degraded. In many locations in Vietnam, human disturbances to the natural vegetation or ecosystem as aforementioned have become more intense for the last 15 years and continue to be a major threatening factor for many endemic species including *R. harderi*. Judging from our observations above, the populations of *R. harderi* may be assessed as "Vulnerable (VU)", according to the criteria set out in IUCN (2001). Further assessment based on more quantitative data on the occurrence of the species in a wider area is needed.

In addition to being Vulnerable in the wild, *Rohdea harderi* is currently very rare in cultivation. It is anticipated that efforts by Huntington Botanical Gardens will allow the original plant of *Harder et al.* 7276 to be propagated asexually and distributed to multiple suitable collections. The plant appears self-compatible, since the lone plant bears fruits with viable seeds (Fig. 1). It is hoped therefore that seeds or seedlings (produced by self-fertilisation) will also be distributed as part of an overall ex situ conservation strategy.

PHENOLOGY. Flowering: March – April. Fruit ripening: around March – May of the following year of anthesis.

ETYMOLOGY. The specific epithet honours Dr Daniel K. Harder as founder of the Missouri Botanical Garden's Viet Nam Botanical Conservation Program, who discovered, collected and brought the new species into cultivation, thereby greatly contributing to the improvement of our knowledge on the plant.

NOTES. Huang & Li (1990: 57) founded *Tupistra* sect. *Annulatae* H. Li & J. L. Huang on the basis of two species, *T. verruculosa* Q. H. Chen (Chen 1987: 69) from Guizhou, China, and *T. annulata* (Huang & Li

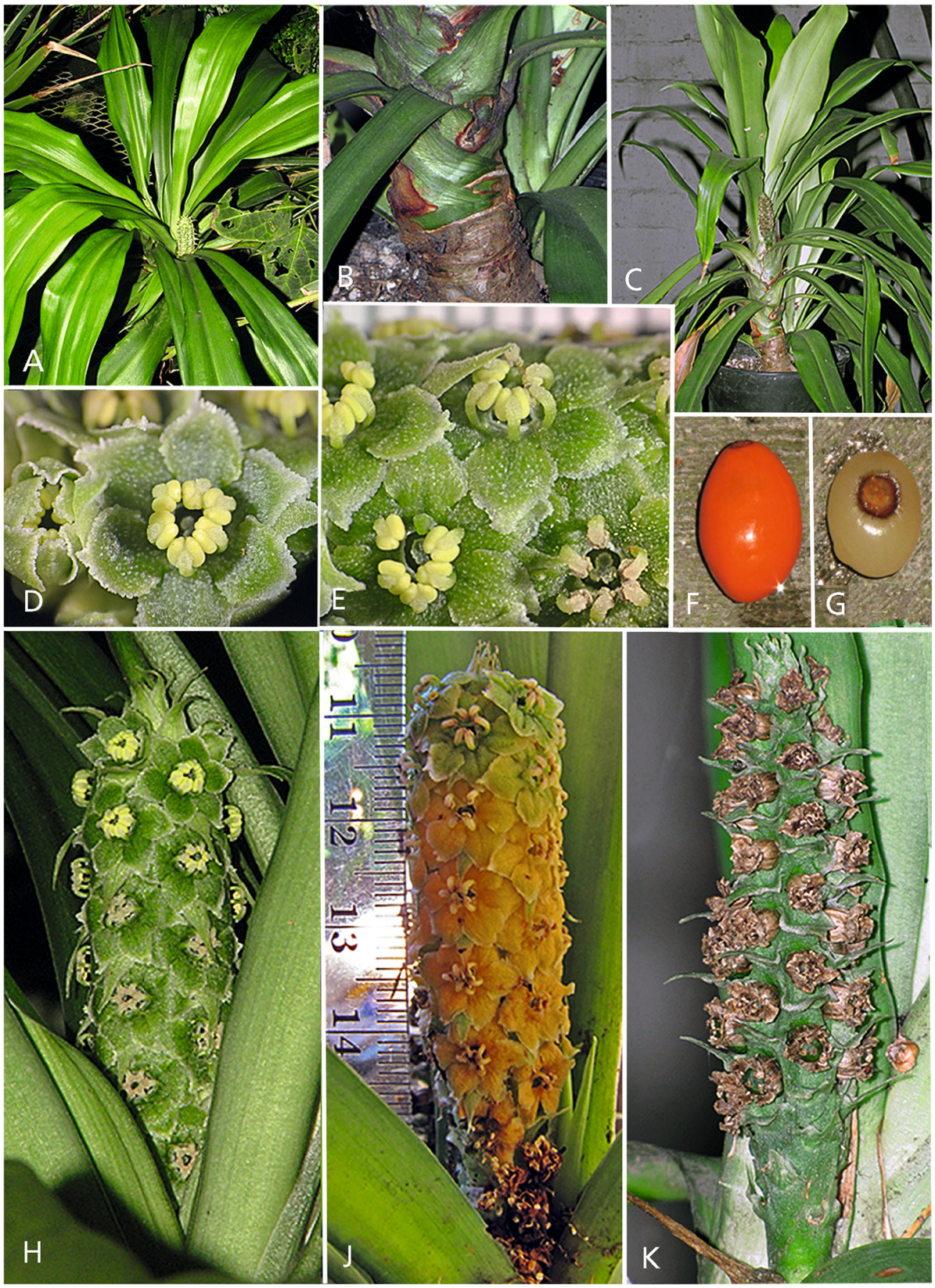

Fig. 1. *Rohdea harderi*. **A** habit with flowering scape; **B** aerial basal portion of plant; **C** habit with scape after flowering; **D** & **E** flowers; **F** fruit; **G** seed; **H** inflorescence; **J** inflorescence in late anthesis; **K** inflorescence after flowering. PHOTOGRAPHS **A – C, F – K** BY D. P. HANNON, **D** & **E** BY S. C. LAHMEYER. LAYOUT BY N. TANAKA.

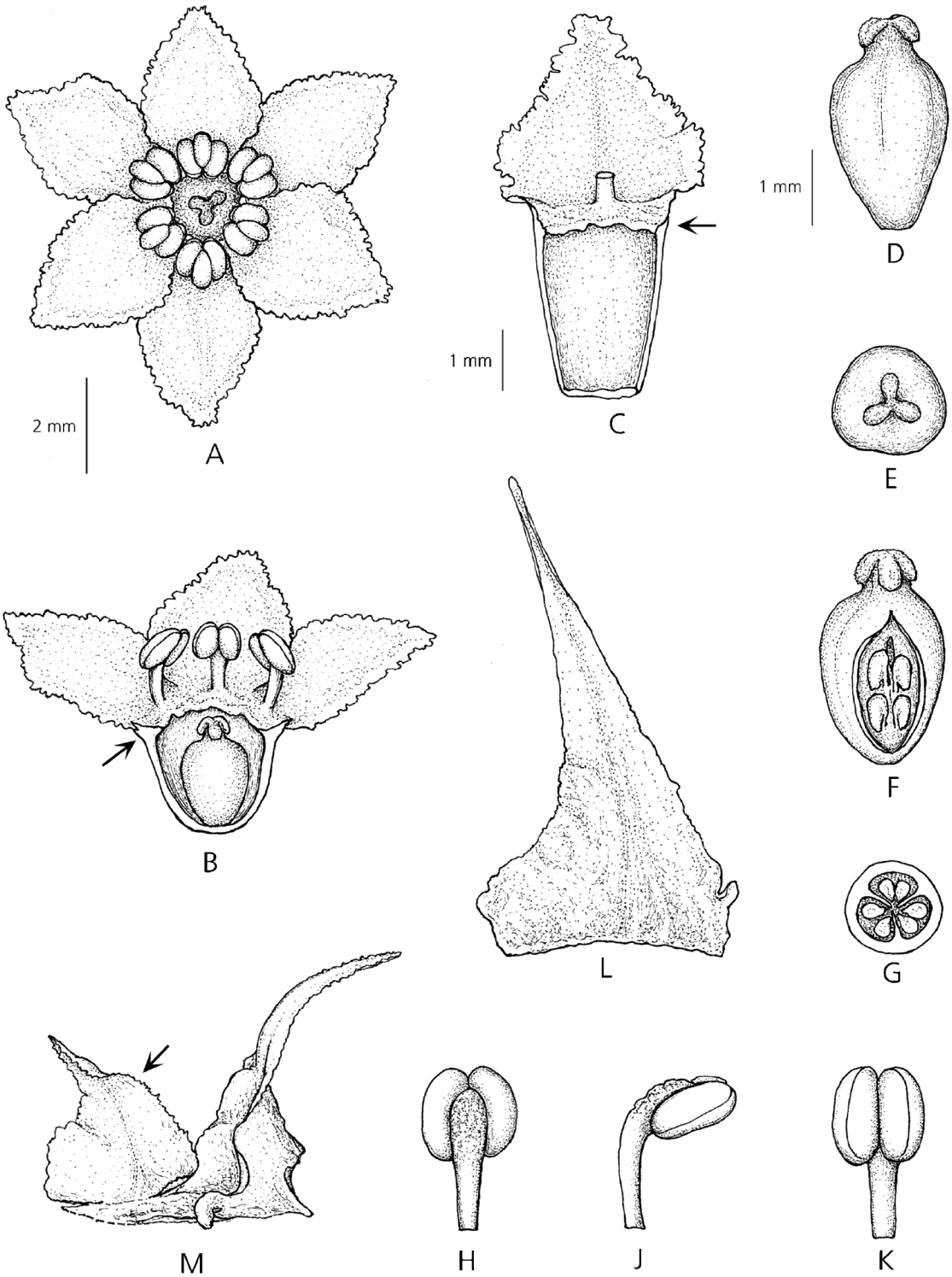

Fig. 2. Flower and bracts of *Rohdea harderi*. **A** flower, front view; **B** flower vertical section with intact pistil inside perianth tube, annulus arrowed; **C** partial perianth with stamen removed from near base, ventral view with annulus arrowed; **D – G** pistil, **D** side view; **E** trisect stigma on top, view from above; **F** ovary torn to show locular interior bearing 4 ovules on placentae; **G** ovary, cross-section, showing interior with ovules; **H – K** stamens: **H** dorsal view; **J** side view; **K** ventral view; **L** sterile bract from distal portion of peduncle, ventral view, expanded; **M** floral bract (right) and bracteole (left; arrowed) on part of rachis. Scale bar at **A** for **A, B, L, M**; at **D** for **D – K**. Drawn from a cultivated plant at Huntington Botanical Gardens (accession number 90679). DRAWN BY N. TANAKA.

Table 1. Comparison of several floral characters in four species of *Rohdea*

Character	*R. harderi* (N Vietnam)	*R. verruculosa* (Guizhou, China)	*R. annulata* (Yunnan, China)	*R. filosa* (N Vietnam)
Perianth				
Tube, shape	turbinate, subterete	turbinate, subterete	broadly obconic	broadly obconic
Annulus				
width (mm)	0.5	1 – 1.5	1.5 – 2	1.4 – 2
thickness	thin	thin	incrassate	incrassate
Segments				
Expansion	explanate	incurved	incurved	incurved
Margin	(sub)crenulate	entire[a]	entire[a]	entire[a]
Apex	subacute	caudate(-filose)	caudate-filose	filose
Abaxial surface	smooth	verruculose[b]	verruculose[b]	verruculose[b]
Pistil				
Ovary, shape	obovoid	ovoid, globose	globose	globose
Stigma, size (diam. in mm)	0.7 – 0.8	c. 1.3	1.5 – 2	1 – 1.2

[a] Often somewhat denticulate at microscopic level (hardly visible to the naked eye)
[b] Verrucula microscopically minute

1990: 51) from Yunnan, China. These species were later transferred to *Rohdea* as *R. verruculosa* and *R. annulata* (H. Li & J. L. Huang) Yamashita & M. N. Tamura (Yamashita & Tamura 2004: 369), respectively. Both species are characterised by the annular appendage at the throat of the perianth tube. Sharing a similar annulus with them, *R. harderi* and *R. filosa* from northern Vietnam also belong to the same section, although the taxonomic position and rank of the section may require further study. The floral traits of the four species are compared in Table 1.

Rohdea harderi and *R. verruculosa* share a turbinate or subterete perianth tube, while *R. annulata* and *R. filosa* have a broadly obconic tube. The annulus of *R. harderi* and *R. verruculosa* is comparatively narrow and thin (fleshy but not particularly incrassate), while that of *R. annulata* and *R. filosa* is wide and conspicuously incrassate along with the wall of the tube below it (Huang & Li 1990; Averyanov *et al.* 2017). It is narrowest in *R. harderi*, and (usually) narrower in *R. verruculosa* than in *R. annulata* or *R. filosa* (Table 1). These features suggest that *R. harderi* is closer to *R. verruculasa* than to *R. annulata* or *R. filosa*. The main differences between *R. harderi* and *R. verruculosa* are noted in the above 'Recognition' section.

The annulus seen in *Rohdea annulata*, *R. verruculosa*, *R. filosa* and *R. harderi* is rather an unusual floral structure, not only in *Rohdea*, but also in related genera such as *Tupistra*, *Reineckea* and *Aspidistra*. It is therefore likely that it has evolved secondarily in the lineage of the four species as an additive, specialised structure. The four species sharing this (presumably) derived (apomorphic) structure may be regarded as monophyletic.

From the viewpoint of evolutionary advancement of structure, the narrowest, thin, lamellar annulus of *Rohdea harderi* appears to be the simplest and more primitive than the annulus of the three other congeners which is either wider (*R. verruculosa*) or wider and more conspicuously thickened (*R. annulata* and *R. filosa*). The subacute, abaxially smooth perianth segments of *R. harderi* are far more common in *Rohdea* (Tanaka 2010a) and *Tupistra* (Tanaka 2010b), and evidently less specialised than the apically narrowly caudate or filose, abaxially verruculose segments of the three allied species. *Rohdea harderi* thus appears to be the most primitive in this plant group at least as to these floral characters, and the three other congeners are likely to have been derived from the ancestral lineage of *R. harderi* in the course of evolution.

Compared with the specimen of *Rohdea harderi* from Son La province (*Harder et al.* 7276 as *D. P. Hannon* s.n., HNT 13048), the specimen from Dien Bien province (*Averyanov et al. as CPC* 2115, LE) has a somewhat longer peduncle (to 5 cm vs to 3 cm) and spike (to 8 cm vs to 5 cm). These differences may represent local variations of *R. harderi*.

The occurrence of *Rohdea harderi* and *R. filosa* in northern Vietnam and *R. verruculosa* and *R. annulata* in adjacent south-western China suggests not only their close phyletic ties, but also the existence of a strong floristic connection between the two regions. The two Vietnamese species are

similar in inhabiting highlands above c. 1000 m in elevation, but are allopatric in geographical range (*R. filosa* is known from Tuyen Quang province east of the range of *R. harderi*). Two other species of *Rohdea* recorded from Vietnam, *R. tonkinensis* and *R. wattii*, are also confined to the northern part (Tanaka 2010a). A key to all these Vietnamese species is provided below.

Key to the four species of *Rohdea* known from Vietnam

1. Perianth tube with annular appendage at its throat 2
1. Perianth tube without annular appendage at its throat 3
2. Perianth biturbinate; tube broadly obconic with annulus 1.4 – 2 mm wide; segments strongly incurved, nearly entire, apically filose. Ovary globose . . . . . **R. filosa**
2. Perianth salverform; tube subterete or turbinate with annulus 0.5 mm wide; segments explanate, (sub)crenulate, subacute. Ovary obovoid . . . . . **R. harderi**
3. Aerial stem to 23 cm long, with 1 or 2 scaly leaves sheathing tuft of annually developing foliage leaves. Bract under flower narrowly lanceolate or narrowly deltoid, often minutely denticulate, to 2 cm long . . . . . **R. wattii**
3. Aerial stem to 29 cm long, with no scaly leaves sheathing foliage leaves. Bract under flower subulate, entire, to 4.5 cm long . . . . . **R. tonkinensis**

Acknowledgements

Daniel K. Harder would like to acknowledge grant support for the collections from the National Science Foundation and the National Geographic Society. Leonid V. Averyanov carried out part of his laboratory work in the framework of institutional research project of the Komarov Botanical Institute of the Russian Academy of Sciences. The authors sincerely thank two anonymous reviewers for their valuable comments and advice on our manuscript.

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