DOI: 10.1111/curt.12584

PLANT PORTRAIT

CURTIS'S
Botanical Magazine

1117. *Crepidiastrum grandicollum* (Koidz.) Nakai

Compositae
Plants in peril 42

Nicholas Hind[1] | **Masumi Yamanaka**[2] | **Naoko Yasue**[3]

[1]The Herbarium, Royal Botanic Gardens, Kew, Richmond, Surrey, UK

[2]Freelance artist: masumi.yamanaka32@gmail.com

[3]Freelance artist: nao_amatista@yahoo.co.jp

Correspondence
Nicholas Hind, The Herbarium, Royal Botanic Gardens, Kew, Richmond, Surrey, TW9 3AE, UK.
Email: n.hind@kew.org

Summary

Crepidiastrum grandicollum (Koidz.) Nakai (Compositae: Lactuceae: Crepidinae) is described and illustrated. The current synonymy is provided, together with type citations for each of the names and statements of the type material. A selection of verified illustrations of the species in the literature is provided. Statements of the species' distribution, habitat and ecological preferences (with observations on the phytosociological classification), phenology, conservation status, and the etymology of both generic and specific epithets are given along with vernacular names, some of which are apparently literal translations of the Latin binomial. Cultivation, propagation, and availability notes are provided, although the species is Critically Endangered and currently only cultivated Koishikawa Botanical Garden, University of Tokyo, Japan, as part of the Ministry of the Environment's Rare Wild Fauna and Flora Species Protection and Breeding Project. Discussions include pollination syndromes in *Crepidiastrum* in the Bonin Islands, the intricacies of the involvement of the Honey Bee in their pollination (compared with conservation measures) and the displacement of native insect pollinators, mention of seed/achene dispersal and evolution within the genus, conservation proposals, including the use of exclosures to prevent destruction by feral goats (*Capra hircus*), and electric fences, adhesive traps and Teflon™ sheets to help control the lizard known as the Green Anole (*Anolis carolinensis*); typhoon damage and the potential for issues with ants - *Pheidole* (Westwood) spp. (including the African Big-headed Ant, *P. megacephala*) are also mentioned. Some consideration for the rôle of Arbuscular Mycorrhizal (AM) associations with

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the endemics in conservation programmes should not be overlooked. Attention is drawn to observations on some bizarre web sites with somewhat bogus information on the species, and why they should be disregarded.

INTRODUCTION

The Bonin Islands (Ogasawara-Shoto), or officially the Ogasawara Islands, form an isolated archipelago, amounting to some 32 square miles, on the western edge of the Pacific Ocean where it meets the Philippine Sea. Settled in pre-history by an as yet unknown Micronesian people, they were first sighted by the Spanish in the mid 16th century, and at the time considered to be uninhabited. Collectively they were called the Archbishop Islands by the Spanish, but their current name is a later derivation. Other than a shogunate expedition in the late 17th century, the French were next to visit the Islands in the early 1800s. It is through a misunderstanding, or mistranslation, of the Japanese characters, 無人嶋 (meaning 'desert[ed] islands', for them being uninhabited), that the translation into French resulted in them being named Bo-nin Sima (Sima = islands), eventually losing the hyphen and becoming Bonin. The official name, Ogasawara is from 小笠原, literally meaning 'little hat-shaped fields', but used for the Islands to honour an ancestor (Ogasawara Sadayori) of one of the shogunate expedition members. The Islands were finally claimed by a British captain, Captain Frederick William Beechey (1796–1856), of *HMS Blossom* – an 18-gun Cormorant-class sloop-of-war, in 1827. Beechey, incidentally, was the Captain in Hooker & Arnott's account of the plants collected by Lay & Collie during the Pacific expedition in *HMS Blossom*, between 1825 and 1828 (Hooker & Arnott, 1830–1841). Although colonized shortly after by a number of settlers of different nationalities, the islands were reclaimed by the Japanese in 1875, continuing with its multicultural make-up until World War 2; they were returned to Japan in 1969 and remain ethnically Japanese. They are currently administered by the Ogasawara Subprefecture, which also includes the Volcano Islands, and has its seat of government on Chichi-jima. We shall use this spelling of the various Islands/island groups throughout this article, although they have all appeared unhyphenated in many publications. 'Jima' translating as island, and the first part of the name for a family rank, e.g. father (= Chichi, as in Chichi-jima), elder brother (= Ani, as in Ani-jima), mother (= Haha, as in Haha-jima), etc., etc., i.e. there is therefore no need to refer to Chichijima Island – which effectively translates as 'Father Island Island.'

All have a subtropical climate (ranging from humid subtropical to tropical monsoon), with an annual rainfall of a little under 1300 mm (although that appears to be decreasing), a mean annual temperature of 23°C, and are characterized by the conspicuous precipitous ridges and sea cliffs of between 100 and 350 m tall. The Islands are also subjected to annual typhoons, and are historically subject to tsunamis. The penultimate tsunami, in 1960, resulted from a Chilean earthquake, and one of the most recent in 2010, generated by a M_w 7.4 normal-faulting earthquake 150 km east of Chichi-jima; the M_w 6 earthquake in June 2022 had little effect. On Chichi-jima there are two wet periods, one of which is between May and June, and a second is usually seen in October through to November; the driest months are often between January and March. Shimizu (1992) has proposed that the *Distylium* Dry Forest originated from a mesic cloud forest (formed on deeper soils) when the Islands were higher than at present. As plate movement has continued, the Islands have been steadily sinking, taking them below the altitude where the cloud belt usually forms (c. 500 m); the islands have been becoming drier, this stimulating the evolution of endangered species. Fog does form on the highest peaks of both Chichi-jima and Haha-jima, but they are too low for cloud formation, and as a result are much drier and subject to occasional droughts. Combined with an increase in sea level of about 100 m since the last Ice Age, the total area of the Islands has also decreased by two thirds so that *Distylium* Dry Forest is now fragmented, forming several isolated patches, with peripheral areas long-since disappeared.



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Their isolation in the Pacific, relatively recent colonization (other than by man), and rapid evolution of both flora and fauna, together with a favourable climate, has led to a remarkable ecoregion, first designated as a national park in 1972, and relatively recently recognized as a natural World Heritage Site in 2011, following their inscription in 2010 (UNESCO, 2011).

THE GEOLOGICAL ORIGIN OF THE BONIN ISLANDS

The islands of the Bonin archipelago, occurring in four island groups, were formed from submarine volcanic activity to the west of what is now the Izu-Ogasawara Trench (9826 ± 11 m deep) – a little to the north of the Mariana Trench (10,984 ± 25 m deep) – to the east and south east of what is now the Ogasawara Trough. They sit on what is known as the Ogasawara Ridge, formed during the Paleogene, above the subduction zone (the Izu-Bonin-Mariana subduction) where the Pacific Plate subducts under the Philippine Sea Plate. Uplift above sea level occurred before the Middle Pleistocene and, according to Asami (1970), the islands date from c. 4 Myr. The archipelago is located about 1000 km south of Tokyo, and consists of some 30 islands (although numbers vary somewhat in the literature), several of which are uninhabited, reaching a maximum elevation of 326 m on Chichi-jima, and 462 m on Mt. Chibusa (on Haha-jima, in the Haha-jima Island Group).

PLANT DIVERSITY AND THE COMPOSITAE OF THE BONIN ISLANDS

Plant diversity on the Bonin Islands is high and of a total of c. 441 species of native plants (of a probably total cf. UNESCO, 2011 vs. Kobayashi, 1978; Kobayashi & Ono, 1987; Ono, 1991 and Shimizu, 1995), the dicotyledons are represented by 161 endemic species (UNESCO, 2011). Of the total, some 23 genera (using the first author's generic concepts), containing 29 species of Compositae (including 2 vars), originally including 7 endemics. Some 22 species are essentially introduced or widespread pantropical weedy species. Of the endemic Compositae, only three tribes are represented – the Lactuceae (= Cichorieae), Cardueae (= Cynareae) and the Senecioneae. Although first recognised in 1919, *Cirsium toyoshimae* Koidz. (Cardueae) (TOYOSHIMA-AZAMI), a 'forest' species from Chichi-jima, is now extinct, Abe et al. (2008) noting that the species had not been seen since 1936. The remaining species of thistle, *Cirsium boninense* Koidz. (Cardueae) (OGASAWARA-AZAMI = BONIN THISTLE) still survives in coastal areas of Chichi-jima as well as on Muko-jima and Nakōdo-jima, two uninhabited islands where it is apparently increasing, and is now regarded as NT (Near Threatened). *Dendrocacalia crepidifolia* (Nakai) Nakai (Senecioneae) (WADAN-NO-KI, NIGANA-NO-KI) – a particularly interesting dioecious tree (originally described as monoecious), also appearing in this special issue – is one of the two endemic genera in the Bonin Islands (from Haha-jima), and is considered VU (Vulnerable).

The tribe Lactuceae (sometimes called the Cichorieae, but originally published as 'Tribus I. Cichoraceae' – see Lamarck & de Candolle, 1806), with 11 subtribes, is a moderately small tribe in terms of genera (about 98), but extraordinarily difficult to estimate its size in numbers of species, largely because of the two genera, *Hieracium* L. and *Taraxacum* Weber. Including the economically important *Lactuca* L. (LETTUCE), *Tragopogon* L. (GOATSBEARD, SALSIFY), *Scorzonera* L. (BLACK or SPANISH SALSIFY) and *Cichorium* L. (CHICORY, ENDIVE), and the pantropic weeds found in *Sonchus* L. (SOW THISTLE), the tribe has a few horticulturally important taxa including species of *Andryala* L., *Catananche* L. (CUPID'S DART), *Cicerbita* Wallr. (MOUNTAIN SOW THISTLE), *Crepis* L. (HAWK'S BEARD), *Leontodon* L. (HAWKBIT), *Tolpis* Adans., *Urospermum* Scop. (PRICKLY GOLDEN FLEECE). To the list of horticultural taxa can be added a

few species of *Hieracium* and *Pilosella* Hill. Excluding three taxonomically extremely difficult genera (*Hieracium*, *Pilosella* and *Taraxacum*) species numbers for the tribe are estimated at about 1,550.

In the Bonin Islands the greatest number of endemic Compositae is found in the tribe Lactuceae, one species in *Ixeris* (Cass.) Cass., and three in *Crepidiastrum* Nakai. Lack (2006: 183) placed these two genera, along with *Ixeridium* (A. Gray) Tzvelev (for a discussion of the genus see Hind & Johns, 2002) and *Youngia* Cass. in the subtribe Crepidinae. Lack (2006: 183) suggested that the generic limits between these genera were unclear, noting that hybrids between them had been reported. *Paraixeris* Nakai was placed in synonymy under *Crepidiastrum* by Lack, and by Shih & Kilian (2011), a position supported by Peng et al. (2014), finding it nested within *Crepidiastrum*. *Ixeris longirostra* Nakai is currently listed as VU (Vulnerable) and is known from Nishi-jima, Haha-jima and Chichi-jima. The three crepidiastrums are *Crepidiastrum ameristophyllum* (Koidz.) Nakai, listed as EN (Endangered), *Crepidiastrum linguifolium* (A. Gray) Nakai now considered as EN, and the subject of the current plate *Crepidiastrum grandicollum* (Koidz.) Nakai, listed as CR (Critically Endangered) (Kokubugata & Kato, 2008+, based on Kato & Ebihara, 2001).

Crepidiastrum contains about 12 species (see Peng et al., 2014, cf. Shih & Kilian, 2011: 264, who stated 15) from central and eastern Asia and into the N Pacific islands – the Bonin Islands. Lack (2006: 184) effectively diagnosed *Crepidiastrum* as being taprooted annual or perennial herbs, or occasionally subshrubs, with 5–19 florets per capitulum, biseriate phyllaries, yellow to whitish corollas, fusiform and somewhat flattened achenes that are 10–20 ribbed (Lack termed them winged, although these are considerably less pronounced in our species), and possessing deciduous, coarsely barbellate, white or brownish, [uniseriate] pappus setae.

Zhang & Kilian's additions (see Shih & Kilian, 2011) seem to now include a much wider range of chromosome numbers, usually $n = 5$, $2n = 10$ (see Ono, 1975a: 324; Ono & Masuda, 1981; Pak & Kawano, 1990; Shih & Kilian, 2011), at least for the Chinese species – with the addition of *C. diversifolium* (Ledeb. ex Spreng.) J.W. Zhang & N. Kilian ($2n = 15$, 20 – Shih & Kilian, 2011: 269) and *C. akargii* (Kitagawa) J.W. Zhang & N. Kilian ($2n = 42$ – Shih & Kilian, 2011: 269). Peng et al.'s results clearly placed *C. diversifolium* in *Youngia*, but were unable to sample *C. akargii*, and thus unable to comment on its position (Peng et al., 2014).

Nakai (1920: 148) placed our species in *Crepidisastrum* Sect. 2 *Monostemma* Nakai, diagnosed on simple stems and axillary and terminal inflorescences, refined by Pak & Kawano (1992: 50) and diagnosed on possessing 5 inner phyllaries and five florets, with four species – *C. ameristophyllum* (Yuzuriha-wadan) [Chichi-jima, Haha-jima], *C. linguifolium* (Hera-naren) [Chichi-jima & Haha-jima] and *C. taiwanianum* Nakai (Ashibuto-wadan) [Taiwan]; *C. grandicollum* was selected by Pak & Kawano as the sectional type (Pak & Kawano, 1992: 53), but *C. taiwanianum* placed in the type section. It is of some note that Peng et al. (2014: 243) sampled material of *C. taiwanianum* from material from the Bonin Islands (purportedly collected by Goto & Ito, citing four ITS samples, but no collection number) based on unpublished results, where it has not been recorded.

Interestingly, when describing *Cacalia* L. sect. *Dendrocacalia* Nakai in the tribe Senecioneae (Nakai, 1915), Nakai originally considered it contained two species, both from the Bonin Islands: *Cacalia crepidifolia* Nakai and *C. ameristophylla* Nakai. The former now *Dendrocacalia crepidifolia* (Nakai) Nakai, and the latter now belongs in *Crepidiastrum*, as *Crepidiastrum ameristophyllum* (Nakai) Nakai, in the Lactuceae, since it was clear that in indicating it had flowers like *Cacalia crepidifolia* – '*flores ut antea*' – he considered it belonged to the Senecioneae. A closer look at the corollas, style arms, pollen and achenes, would have shown different.

CULTIVATION

For the time being, it would appear that the only cultivated material is that in the Koishikawa Botanical Garden, University of Tokyo, Japan (see Figures 5 & 6), where it is part of a collection of other Bonin Island endemics, including *Dendrocacalia crepidifolia* (Compositae) and many of the other species included in this issue of *Curtis's Botanical Magazine*. Shimizu (1995) summarized the then situation, and indicated that the Botanical Garden was cultivating 83 of the endemic species 'to keep the strains more securely'. Plants growing in Koishikawa Botanical Garden are grown in long Tom-style pots (because of the long tap roots), under glass in full sunlight, and in a well-drained soil. Minimum temperatures are 10°C. Plants are watered only when the compost dries out, with care taken not to water excessively as the plants are prone to root rot. [As an aside: The first author was intrigued at the number of variations of the spelling and form of the long, relatively narrow pots that tap-rooted plants are often planted in. Spellings range from 'Long Toms', 'long Toms', 'long toms', 'long-toms', or just 'longtoms', and there was no consensus within the RHS dictionaries and various web pages, with text usage providing 'long toms', but figure captions as 'Long Toms'. *The Oxford English Dictionary*, and the slightly less hernia-inducing two volume *Shorter Oxford English Dictionary* had no definition. 'Long Tom' often applies to the long-barrelled guns placed midships on galleons, so this offered one possible definition; conversely 'Tom' has historically applied to the larger bells in bellfries, although the terracotta pots are scarcely campanulate!]

Propagation. *Crepidiastrum* is described as a simple stemmed species, but produces several inflorescences in a pseudowhorl at the end of the previous year's growth; vegetative propagation would seem unlikely, but it would be possible to take cuttings before inflorescences are too far advanced, and doubtless carefully removed rosette leaves might be another source of material.

The easiest method of propagation is by seed (achene), and seed sown at about 20–25° C usually takes about one or two months to germinate. When large enough to handle, seedlings can be transplanted into long Tom pots in a nutrient poor, well-drained compost, potting on only when nearly pot bound.

Pest & Diseases. On the Bonin Islands feral goats are the greatest pest, perhaps even to the continued survival of the species, and potentially its extinction. In cultivation, this is unlikely to be a significant issue. The only other natural pest is that of the Tobacco Cutworm or Cotton Leafworm, a night flying moth, although damage might be anticipated in cultivation. The extensive catalogue of fungi from the Bonin Islands (Sato et al., 2010) only indicated the presence of '*Sclerotium rolfsii* Sacc.' (= Agroathelia rolfsii (Sacc.) Redhead & S.-T. Mullineux), a corticoid fungus and a facultative plant pathogen causing Southern Blight of crop plants, on *Crepidiastrum ameristophyllum*. There is no reason to suppose that *C. grandicollum* might not similarly be infected, but there appears to be no record, yet, and plants in Koishikawa Botanical Garden appear unaffected, although common greenhouse pest are to be expected.

Availability. The only material available in cultivation is that in the Koishikawa Botanical Garden, University of Tokyo, Japan, as part of their active *ex situ* conservation programme stemming from the Ministry of the Environment's 'Rare Wild Fauna and Flora Species Protection and Breeding Project' established in 2009.

NOMENCLATURE AND DESCRIPTION

Crepidiastrum grandicollum (Koidz.) Nakai, Bot. Mag. (Tokyo) 34 (No. 406): 149 (1920).

Lactuca grandicolla Koidz., Bot. Mag. (Tokyo) 33 (No. 396): 217 (1919). Type: 'Nom. Jap. Kohelanalen. Distr. Bonin Islands: insl. Chichishima.' – no collection/s cited. Note: Tuyama (1936: 377) is the only author to have mentioned the apparent type collection:

'Bonin: Ins. Titizima [= Chichi-jima]: Kiyose (leg. ? Nov. 1910 – Typus in Herb. Univ. Imp. Tokyo.)', TI, in the University of Tokyo, although it is unclear whether this is the only material seen by Koidzumi. See also note in Discussions below.
Ixeris grandicolla (Koidz.) Stebbins, J. Bot. 75 (No. 890): 45 (1937). See Discussions below.

ILLUSTRATIONS. Tuyama, Bot. Mag. (Tokyo) 50 (No. 595): Figure 31 (1936) (halftone); Abe, Ann. Bot. 98 (2): 322, Figure 2Q (2006) (col); Abe, Pl. Sp. Biol. 36 (2): 362, Figure 1 (2020) (col), Narita et al., Conserv. Gen. 22 (5): 718, Figure 1c (2021) (col).

Taprooted perennial herb or subshrub. *Stems* (2–8)10–30(− 40) cm tall (see comments under Conservation Status below) × 1–1.5 cm diam., often reddish, with marcescent leaf bases, densely rufescent/ferruginous-tomentose at apex (and visible between central rosette leaves), glabrescent beneath marcescent leaf bases, hairs eglandular. *Leaves* densely rosulate, few to several per rosette, sessile or pseudopetiolate, pseudopetiole narrowly- to broadly-winged, lamina linear-oblanceolate, spathulate-oblanceolate or oblong, 5–15 cm long × 1–3 cm wide, subfleshy, glabrous, glaucous, base cuneate, midrib prominent beneath, reddish or paler than lamina, margins entire and undulate, apex acute, obtuse or emarginate. *Inflorescences* lateral and subterminal, often few to several (5–10+) around central leaf rosette, erect, glaucous, peduncles usually reddish to within 3 or 4 bracts of apical corymb and then greenish, densely corymbose at apex, c. 20 + −headed, bracted throughout, bracts alternate, 1.5–3 cm long, auriculate at base and amplexicaul, midrib prominent beneath, usually paler than lamina, venation scarcely pinnate in lower bracts, reticulate in upper bracts, glaucous at first, margins entire, undulate, apices obtuse or mucronate, capitula pedicellate, pedicels minutely bracteolate, bracteoles scale-like. *Capitula* homogamous and ligulate, 10–11 mm tall, c. 9 mm diam., 5-flowered; involucre c. 8 mm tall, c. 3.5 mm diam., narrowly-cylindrical in bud to narrowly campanulate when in full flower; *phyllaries* biseriate, outer highly reduced, 2–5, inner phyllaries 5, c. 4 mm long × 0.8–1.3 mm wide, imbricate, subulate or oblong-subulate, alternate phyllaries with translucent, scarious margins, others green and herbaceous to margins, upper



FIGURE 1 *Crepidiastrum grandicollum* in full flower, showing whorl of axillary inflorescences. Material grown in Koishikawa Botanical Garden, University of Tokyo, Japan. Photo © M. Yamanaka.



FIGURE 2 *Crepidiastrum grandicollum* post-flowering, with insert of detail of centre of leaf rosette showing dense ferruginous-tomentose indumentum between leaf bases (arrowed in red). Material grown in Koishikawa Botanical Garden, University of Tokyo, Japan. Photo © M. Yamanaka.

part of margins ciliate, apices more densely so; *receptacle* small, flat, glabrous, epaleaceous. *Florets* hermaphrodite, fertile, corollas ligulate, ligule c. 4 mm long × 3 mm wide, spreading when in full flower, glabrous, yellow, strongly 5-lobed, lobes subequal, often with deeper sinuses between some

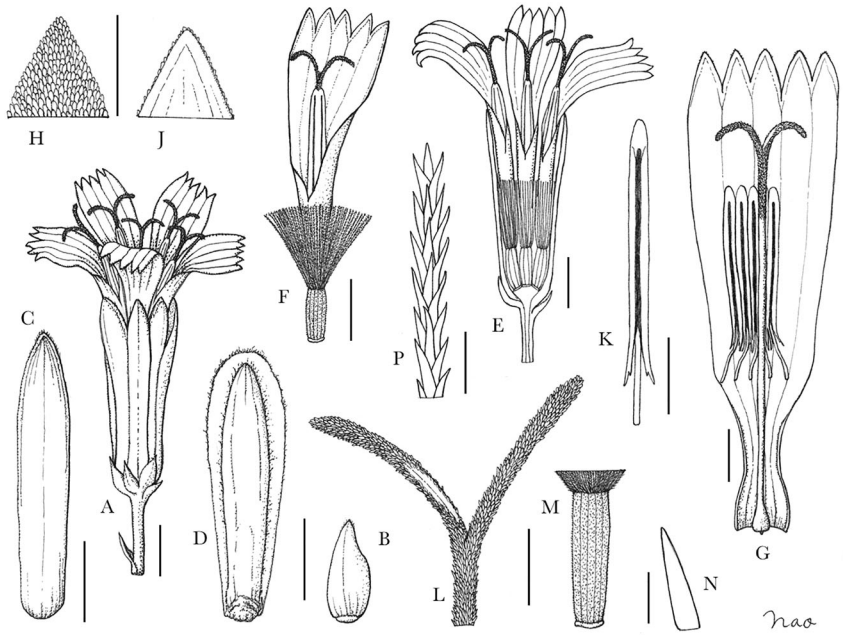


FIGURE 3 *Crepidiastrum grandicollum*. A, flowering capitulum with stalk and scale-like bracteole on pedicel; B, outer phyllary; C, inner phyllary with very narrow scarious margins; D, inner phyllary with broad scarious, ciliate margins; E, l.s. capitulum; F, ligulate floret; G, floret corolla opened up to show attachment point of anther filaments and style; H, abaxial surface of apex of corolla lobe; J, adaxial surface of apex of corolla lobe; K, stamen; L, style arms and apex of style shaft; M, achene (showing only base of pappus setae); N, detail of achene setula; P, detail of apex of pappus seta. Scale bars: A – F = 2 mm, G, K = 1 mm, H, J, L, M = 0.5 mm, $p = 0.1$ mm. Drawn by Naoko Yasue from material grown in Koishikawa Botanical Garden, University of Tokyo, Japan, with details based on *Tuyama* s.n., 14 Nov. 1935 (K002110930).

lobes, longest c. 1 mm long; anther filaments connected to upper part of corolla tube, glabrous, anther cylinder strongly exserted from corolla tube, yellow at first, becoming brownish at maturity, apical anther appendages broad-triangular, basal anther appendages c. 0.5 mm long, sagittate, obtuse, often laciniate; style markedly exserted from anther cylinder; style shaft glabrous, style arms yellow, becoming strongly recurved at maturity. *Achenes* homomorphic, fusiform, obcompressed, (3–4 mm – see Nakai, 1920: 149) 18–22 (26–35.8 – see Pak & Kawano, 1990: 115) mm long × 4.4–5.4 mm wide, brownish, 12–14-ribbed, ribs relatively shallow (although scarcely as prominent as seen in other species – see Pak & Kawano, 1990), erostrate, body moderately densely very short-setuliferous (setulae just visible under ×50 dissecting microscope – see also Pak & Kawano, 1990: p. 114 Figure 4), setulae concolorous with body, antrorse, apices undivided, acute; carpopodium a narrow annulus, slightly paler than body, sometimes scarcely evident around concave base of achene; *pappus setae* uniseriate, c. 3 mm long (on immature achenes), deciduous, coarsely barbellate, straw-coloured to dirty fawn, apical cells acute. x = 5, 2n = 10 (Ono, 1975b; Ono & Masuda, 1981; Pak & Kawano, 1990: 113). (Figures 1, 2, 3, 5 & 6).

Distribution. Japan: Bonin Islands: Ogasawara-shoto (Chichi-jima – literally Father Island, formerly Main Island or Peel Island; referred to as Titizuma (a phonetic transcription) by Tuyama (1936: 377) and Ani-jima (an uninhabited island in the archipelago) – see Figures 4 & 5. Note: Described by Ono (1991: 99) as a schizoendemic, along with *C. ameristophyllum* and *C. linguifolium*, versus the other species in the genus.

Habitat & ecology. Old lava flows (see Figures 4 & 5); c. 290 m. Pak & Kawano (1990: 113) described the habitat as 'lithophilous mountain slope', also noting that it grows sporadically in

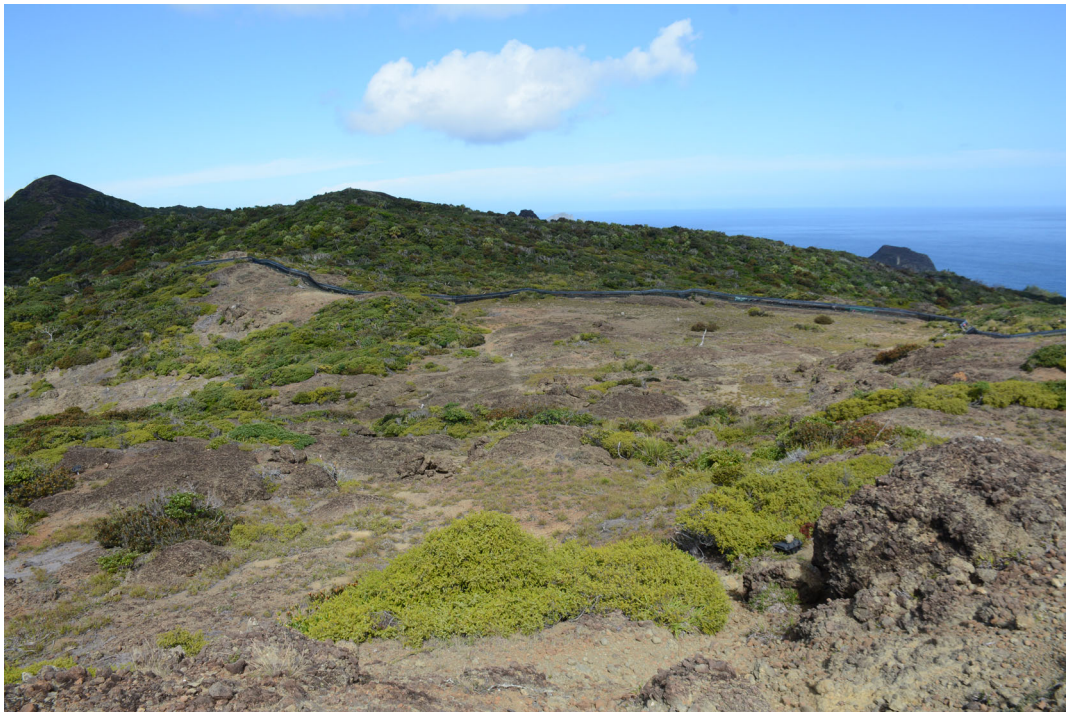


FIGURE 4 A habitat vista of *Crepidiastrum grandicollum* on Ani-jima, Bonin Islands, showing the stark contrast between habitat destruction caused largely by feral goats and the regenerating scrubland on the other side of the fence. Having eradicated the feral goats, the black fence is now an electric fence used to keep out the GREEN ANOLE lizards. A black 'rat trap' (with a rock on top) can be seen in the lower right next to a low shrub, adjacent to the rock outcrop. Photo © Atsushi Kawakita.

drier open rocky habitats on slopes, mostly in *Distylium-Pouteria* dry scrub (Shimizu, 1995: 158) (now usually termed *Distylio lepidoti-Pouterietum dubiae* Yamazaki 1970 – Shimaisnoki-Kobanoakatetsu group), a sclerophyllous scrub community dominated by *Distylium lepidotum* Nakai (Hamamelidaceae) and *Pouteria obovata* (R.Br.) Baehni (= Planchonella obovata (R.Br.) Pierre – Sapotaceae), as well as *Rhaphiolepis indica* (L.) Lindl. var. *umbellata* (Thunb.) H. Ohashi. (sometimes recognised as *Rhaphiolepis umbellata* (Thunb.) Makino – Rosaceae). This 'unknown' Community was placed under the broader 'Subtropical evergreen broad-leaved forest (Ogasawara Islands)' by Fujiwara (1996: 29), forming part of the single Alliance '*Boninio-Machilion boninensis*' of the Order '*Boninio-Machiletalia boninensis* Ohba & Sugawara 1977', Class *Camellietea japonicae* Miyawaki & Ohba 1963' (see Noriyuki et al., 2021). Noriyuki et al. (2021: 11) did note, however, that the order could be considered as 'undecided' within the Class.

FLOWERING TIME/PHENOLOGY. November – December, corresponding to the second seasonal rainy period on the Islands, their autumn – see Figures 1 & 2 in cultivation, and Figures 5 & 6 in habitat – all photographed in November.

CONSERVATION STATUS. The species is considered Critically Endangered (CR) in some areas and with the number of individuals decreasing (Government of Japan, 2010) – Government Ordinance No. 238 (July 25, 2008) (Enforcement: August 15, 2008). Abe (2020: 362) reported that only dozens of individuals on both islands remained, and that populations reported in the early twentieth century by Tuyama (1936: 377 – 'Ins. Titizima: Kiyose and Okumura') were now extinct. Recently, it was reported that following survey work in 2021, the population on Chichi-jima stood at 30 mature



FIGURE 5 *Crepidiastrum grandicollum* in habitat on Ani-jima, Bonin Islands, seen growing on almost bare ground on an old lava flow (early November 2023). Photo © Atsushi Kawakita.



FIGURE 6 *Crepidiastrum grandicollum* in full flower (early November 2023) in a 'rat proof' cage in the conservation area of Chichi-jima, Bonin Islands. Photo © Atsushi Kawakita.

plants, and 150 plants on Ani-jima, with 300 seedlings (Ogasawara World Heritage Centre, 2024). This same report suggested that in addition to feral goats, rats were causing 'feeding damage'. Abe (2020), following a detailed five-year study of the two remaining populations, described the impact of feral goats, and moth damage (by *Spodoptera litura* (Fabricius, 1775) – TOBACCO CUTWORM/COTTON LEAFWORM) on these populations. Exclosures are insufficient to conserve the species and feral goat eradication and population restoration are mandatory to reduce the extinction risk of the species – see Figures 2 & 3. Abe (2020: 365) also noted that whilst Koidzumi's description, and other later ones, suggested quite tall plants, his own observations suggested that no such individuals existed as the feral goats had clearly decapitated the larger plants over time. Moth damage was considered by Abe to be variable, year-on-year. It was also listed as CR on the Ministry of the Environment's Red List in 2020.

Also, year-on-year ecosystem damage has been caused by almost annual typhoons that certainly cause declines in numbers of reproductive individuals (see Abe, 2020; Abe et al., 2020). With wind speeds often in the region of 150–160 kmph, vegetation damage is often significant, together with heavy rainfall. See also Discussions below.

Abe (2020: 366) also highlighted another potential threat to the continued existence of *C. grandicollum* on Chichi-jima, and that is the presence of the introduced GREEN ANOLE, *Anolis carolinensis* (Voigt, 1832), a small- to medium-sized tree dwelling lizard native of the southeastern United States. It was listed as an Invasive Alien Species in 2005, with conservation proposals covering the elimination of this species (via adhesive traps, exclosure fencing of Teflon™ sheets, etc., within 'nature restoration areas', and preventing dispersal between islands from the ports – but not apparently the electric fences used today – see Figure 4) from Chichi-jima by its elimination from the island (Kanto Regional Environment Office of Japan, 2010). Abe proposed that this lizard had effectively removed the native flower visitors from Chichi-jima, as well as stating that the native flower visitors were unknown. However, this was omitting observations made earlier (Abe, 2006: 333, Table A1) where clearly other native visitors were recorded for the crepidiastrums on other islands. It is highly likely that, other than hand pollination (see Conservation proposals below), the HONEY BEE now offers an optional pollinator/flower visitor to overcome the loss of the native ones. Clearly, long-term restoration of the native insect fauna is a desirable goal, alongside the elimination of some of the invasive species, but there is an intricate interconnectivity which needs to be borne in mind.

VERNACULAR NAMES: KOHELANALEN (Koidzumi, 1919: 217); KO-HERA-NAREN (Nakai, 1920: 149); Ko-heramaren (Tuyama, 1936: 377, based apparently upon Koidzumi's paper). One web site (apparently based in Kenya) also provided the following: LARGE-HEADED CREPIDIASTRUM, LARGE-COLLARED CREPIDIASTRUM and LARGE-COLLARED FALSE DAISY, presumably in an attempt to translate the Latin binomial, yet no other botanical reference has ever suggested these common names. However, that same web site also suggested that it was an annual herb growing to 1 m tall, had 'white, daisy-like flowers with yellow centers', was a 'native of South Africa' and 'can be found in the Mediterranean region from Portugal to Turkey, and in North Africa' 'in grasslands and disturbed areas'. It is apparently also used as 'an ornamental plant and as a source of food for wildlife'. Clearly, not all web sites can, or should, be believed!

DISCUSSIONS

If Tuyama's citation of the type material of our species is correct, then it is likely that material will be amongst the 'Sympetalae', now housed in the Botanic Garden, TI-BG. Stafleu & Cowan (1979: 608), in a rather brief entry for Gen-Iti Koidzumi (1883–1953), had suggested his herbarium was in KYO, with other material in E and TI, but there is little reason to doubt Tuyama. Regrettably, there appears to be no KYO virtual herbarium and that of TI appears yet to have any Compositae imaged.

Stebbins (1937: 45) clearly suggested that the basionym of his combination *Ixeris grandicolla* was Nakai's *Crepidiastrum grandicollum*, based on its appearance in *The Botanical Magazine* (Tokyo) in October 1920. This is the more interesting as unlike other combinations, which always appear to have basionym references cited, Nakai only mentioned '*Lactuca grandicollum* [sic!], Koidzumi'. Koidzumi's paper appeared in December 1919 and his *Lactuca* the first taxon described in the paper, albeit without specifying a type or types, which was a not uncommon feature in this whole series of papers.

Pollination syndromes in *Crepidiastrum* in the Bonin Islands

Kato et al. (1999), as the result of an extensive set of observations on the impact of the [European] Honey Bee (*Apis mellifera* (Linnaeus, 1758)), provided results from pollen collection from one feral hive (on Ani-jima) and two managed hives (on Chichi-jima – that were later destroyed by an infestation of a wax moth, *Galleria* sp.), as well as observations of Honey Bees on various plant species. The Honey Bee had apparently been introduced to Chichi-jima in the 1880s, to promote apiculture (briefly summarized by Abe, 2006: 318). Whilst non-specific observation of visits on Haha-jima were recorded for *Crepidiastrum* species, only *C. ameristophyllum* and *C. linguifolium* occur on that island. This did not preclude the Honey Bee visiting *C. grandicollum*, but something later noted by Abe (2006: 333, Table A1). Kato et al. (1999: 227, Figure 6) also effectively showed that the Honey Bee had become the dominant forager (although not specified whether for pollen and/or nectar) on both Chichi-jima and Haha-jima; it was recorded as a minimal forager on Ani-jima and the Haha-jima satellite islands. Interestingly, as a slightly lapsed beekeeper, the first author of the current paper notes that Kato et al. (1999: 223, Figure 4) noted the seasonal changes in pollen sources between Ani-jima and Chichi-jima, highlighting the collection of pollen from 'anemophilous' species. This comes as no surprise – Honey Bees are unaware of the definitions of anemophily and entomophily as pollination syndromes; the plants are merely good sources of pollen at times when pollen is clearly needed by the hives. The first author would point out that spring time collection of pollen in temperate regions frequently includes *Salix* spp. (Salicaceae) and *Alnus glutinosa* (L.) Gaertn. (Betulaceae), and various grasses have been observed by him in the tropics with Honey Bees collecting pollen.

Abe (2006) provided extensive observations and analysis of the 'floral traits and pollinators' of the native plants on the Bonin (Ogasawara) Islands. This was in an attempt to demonstrate the potential impact of 'alien pollinators' disturbing the 'native plant-pollinator relationships'. Abe also determined that the plant (species and familial) composition and observations of native flower visitors in the Islands supported the 'island syndrome' for 'pollination and floral traits'. He concluded that the introduced Honey Bee (*Apis mellifera*) would change plant reproductive success but also future pollinator-mediated selection for the Bonin flora, suggesting that the Honey Bee was out-competing the native pollinators. However, *Apis*-apart, Abe (2006: 333, Table A1) recorded odd differences between the three species of *Crepidiastrum*, with *C. linguifolium* having the most diverse range of pollinators, and *C. grandicollum* the least – just the Honey Bee and ants (later specified as the alien *Technomyrmex brunneus* (Forrel, 1895) – the White-footed ant (see Abe, 2020)). The first author has an issue with both the concept of 'pollinators', and the lack of any mention of flower visitors in Abe's work. The first author is well aware of the somewhat Catholic nature of the Honey Bee's foraging behaviour, as well as the day-time needs of the hive. There are four products that a bee hive, whether man made or feral, require: nectar, pollen, propolis (or bee glue) and water (from most sources except for sea water). It is the foraging worker bees that collect them, the selection and amount

depending upon the hive requirements, the annual cycle, and daily conditions. As a general rule, pollen collection can start at lower temperatures than foraging for nectar – nectar flow and sugar concentration in the nectar increases with higher temperatures. Abe's photograph was taken in full sun, and the HONEY BEE is clearly only foraging for nectar – there is no pollen in the pollen basket (Abe, 2006: 322, Figure 2Q; Abe, 2020: 362, Figure 1c). This strongly suggests that at that point in the day the HONEY BEE would have been a nectar forager and thus a flower visitor and accidental pollinator. Abe offered no evidence of pollen collection, which would have been relatively straightforward for domestic HONEY BEE hive, although a little difficult, but not impossible, for feral colonies (cf. Kato et al., 1999). Abe (2020: 366) concluded that 'pollen dispersal of *C. grandicollum* is [now] dependent on introduced honeybees.' and was considered 'a clear rescue effect by an alien pollinator species'.

Ants are typically nectar feeders/robbers, and would usually be considered as accidental pollinators, just like the HONEY BEES. The absence of butterflies, and moths (whether night or day flying was not stated), traditionally considered nectar feeders, and the presence of beetles, generally considered blunder feeders (mostly on pollen), amongst the other two species of *Crepidiastrum*, is a little unusual. The presence of all the flower visitors, found on *C. linguifolium*, on all three species might have been expected, so their absence in our species may be due to poor, or limited, observation times. Microanalysis of the nectar would sensibly be an avenue for future research to see if the nectar is an additional source of protein, and whether there is a difference in the sugar (and protein, if present) concentration between the three species. It was an easy undergraduate-style exercise that reaped rewards in understanding some aspects of 'pollination' syndromes and can still be.

SEED/ACHENE DISPERSAL IN *CREPIDIASTRUM* AND SUBSEQUENT EVOLUTION IN THE GENUS

Ono (1991: 103) considered that, along with the Bonin Islands' endemic species of *Callicarpa* L., and *Pittosporum* Banks ex Gaertn., the three endemic crepidiastrums had bird-mediated seed dispersal of what he termed the 'BI type' – 'eaten by birds and carried internally'. As he proposed, this is almost certainly the predominant method amongst the angiosperm floras of the Samoan, Hawaiian, Galapagan and Easter Island archipelagos. Ono further suggested that 'bird-internal dispersal' might 'accelerate the adaptive radiation' after the plants migrated to an isolated island or island group, although in the case of the Bonin Islands there are relatively few 'ecological niches' to occupy.

Early evolutionary/phylogenetic research on the Bonin Islands crepidiastrums was under taken in the 1990s by Ito & Ono. Their allozyme studies (Ito & Ono, 1990) sampled a few hundred individuals from 14 populations of the three endemic species (4 populations) alongside four other Japanese species (7 populations), and *Youngia denticulata* (Houtt.) Kitam. (= Crepidiastrum denticulatum (Houtt.) Pak & Kawano) (3 populations). Later chloroplast DNA restriction site analysis (Ito & Pak, 1996), and ITS and chloroplast DNA analysis (Peng et al., 2014), showed (especially in the latest analysis) that *Paraixeris* nested within *Crepidiastrum*. The three Bonin Islands' endemic species clustered in the same clade (now considered to be *Crepidiastrum* sect. *Monostemma*), probably originating from the same ancestor, with our species basal to the *C. ameristophyllum*-*C. linguifolium* pairing. Evolution of the Bonin Islands' species occurred within the last 1.5 Myr, *C. grandicollum* from 'the other species' (either a single common ancestor, or something derived from *C. lanceolatum* Nakai – see Ito & Pak, 1996) with an estimated 'divergence time' of 1.44 Myr, whereas *C. ameristophyllum* from *C. linguifolium*, about 0.05 Myr; the migration to the Islands was estimated at 3.15 Myr, consistent with the age of the Islands themselves (c. 4 Myr), according to Asami (1970).

Conservation proposals

An extraordinarily detailed 'Ecosystem Conservation Action Plan' has been proposed for the whole archipelago (see Kanto Regional Environment Office of Japan, 2010). Island-by-island the proposed conservation methods are tabulated, and cover the major groups posing a threat to the Islands' vegetation. Some of the more notable pests and other problems are discussed below. However, it is interesting to note that the potential threat from invasive ant species was not mentioned.

In an effort to provide public information, the Ogasawara World Heritage Centre (2024) has an extensive, well-illustrated, web site explaining the various conservation measures they are adopting for plants, land snails, birds and insects. *In situ* protection is against feral goats and rats (that also predate on land snails and chicks and eggs of native birds). The latter is being controlled by use of rodenticide (since 2006), both from packet-based rodenticide, bait boxes, as well as aerial application (by helicopter) on the uninhabited Ani-jima, in addition to plant-centered exclosure netting over individual mature plants (see Figure 6). Exclosure netting, and what are termed 'barrier fences', are used on both Chichi-jima and Ani-jima (see Figure 4 – which shows the electric fence used to keep out the Green Anole lizards), the larger meshed fencing against feral goats and the 'barrier fences' against rat damage; nothing is mentioned about rodenticide use on Chichi-jima. Hand-pollination is carried out in the field, and sowing achenes in relevant habitats is clearly having some effect, with some 300 seedlings (or 'new buds' as the web side proclaims) beginning to establish themselves on Ani-jima. The active ex situ programme in Koishikawa Botanical Garden also employs hand-pollination, and is successfully growing and flowering several plants of our plant (see Figures 1 & 2).

The feral goat (*Capra hircus* (Linnaeus, 1758)) is clearly one of the main dangers to *Crepidiastrum grandicollum* (Abe, 2020), and their eradication is certainly mandatory if our species, or indeed the other two endemic species are to survive. Little can be done about the destructive force of typhoons, although *ex situ* conservation would clearly be a sensible option as is being undertaken by Koishikawa Botanical Garden, University of Tokyo, Japan – see plants in cultivation in Figures 5 and 6. The scrub communities where *C. grandicollum* is found occupy a total area of 60% of Ani-jima (see Figures 2 & 4) and about 20% of the total area of Chichi-jima (Government of Japan, 2010: 41) (see Figure 3 of a plant in a 'rat proof' cage in Chichi-jima), suggesting some potential for re-introduction if *ex situ* propagation continues to be successful.

Yamamoto et al. (2018) have also raised the spectre of two invasive ant species in the genus *Pheidole* (Westwood 1839) (Insecta: Hymenoptera: Formicidae: Myrmicinae): the '*Pheidole parva* Mayr complex' species, recorded since 2000 (widespread on Chichi-jima, Ana-Jima and Ototo-jima, islands in the Chichi-jima Group, as well as on Haha-jima in the Haha-jima Group), and *Pheidole megacephala* (Fabricius, 1793) (African Big-headed Ant, Big-headed Ant, Coastal Brown Ant or Lion Ant), so far only recorded on Chichi-jima. *Pheidole megacephala* is regarded as one of the world's worst invasive ant species (Global Invasive Species Database, 2022). Both species are considered as omnivorous, capturing and killing invertebrates (e.g. land snails), small vertebrates (e.g. bird hatchlings), harvesting seeds and tending phytophagous insects, especially Hemiptera, for honeydew. The potential impact of these two species should be closely monitored on all islands and, if considered necessary, some form of preventative measures be put in place to eradicate them if the habitats containing our species are threatened.

Hamabata et al. (2019) have clearly shown that there is also a potential, albeit cryptic, threat. In comparison with 'non-endangered' taxa, 'endangered island endemic' taxa appear to accumulate deleterious variation in addition to a clear loss of genetic diversity as population sizes dwindle. Their estimates on the number of individuals of our species suggest that less than

100 mature plants still exist, with little recruitment from seedlings and juveniles. The authors also pointed out that *in situ* conservation projects have not achieved successful propagation in the wild, pointing out that seedlings are fragile and no natural regeneration has [yet] occurred.

Whilst there are relatively few studies directly concerned with the Bonin Islands, one avenue of research that needs to be considered, especially amongst the endemic flora, are the symbiotic fungal relationships that most certainly exist, especially with Arbuscular Mycorrhiza (AM), also known as Vesicular-arbuscular Mycorrhiza (VAM). AM associations are considered very common amongst higher plants (see Brundrett, 2002) so it might not be unexpected to find them amongst the Bonin Islands' endemics (see Sakata, 2009). Sakata (2009) sampled 27 of the archipelago's endemics, and recorded the presence of AM fungi in several endemic Compositae, including *Cirsium boninense*, *Crepidiastrum ameristophyllum* and *Dendrocacalia crepidifolium*. It would not be unreasonable, following continued studies, to expect that all of the Islands' endemics in the Compositae showing similar associations. Indeed, the rôle of AM fungi in the success of invasive members of the Compositae have been investigated (Sokornova et al., 2022), and it would be safe to assume that both *in situ* and *ex situ* conservation measures should consider the rôle of AM fungi in establishing plants.

Web sites and bogus information

Preparation for this article required a moderate amount of background research, including checking a number of web sites for information and images. To the first author's surprise one site (on 'Ogasawara humid tropics') returned an image supposedly of *C. grandicollum*, but interestingly with added text which, in translation, suggested that the species was considered extinct on the IUCN Red List – excepting that the image provided was most clearly not of *C. grandicollum*, but another species with far laxer inflorescences, and pedicels lacking bracteoles – *C. chelidoniifolium* (Makino) Pak & Kawano, which is a relatively widely distributed species from China, Japan, Korea and eastern Russia. *Crepidiastrum grandicollum* does not appear on the main IUCN Red List, but does appear on the 'Global Red List of Japanese Threatened Plants' (Kokubugata & Kato, 2008+) and is still considered Critically Endangered, and was certainly not on the UNESCO (2011) inscription of the Ogasawara Islands for World Heritage Site status under extinct species. *Melastoma tetramerum* Hayata (Melastomataceae) is indicated as not having been evaluated, which is also untrue, especially as it has also been listed as Critically Endangered (see Kokubugata & Kato, 2008+, and Hamabata et al., 2019). Yet another web site suggested that rats were a threat, but also suggested that our species was a 'semi-grassy shrub' … Other, more reliable research papers show 'exclosure fencing' (designed to keep out the feral goats), and this would certainly not preclude rats entering as suggested by this web site unless finer fencing is used – see also Figure 6, where 'rat proof' netting is now used around individual plants.

ACKNOWLEDGEMENTS

The first author would like to thank one of the co-authors in this article, Masumi Yamanaka, for providing four colour images of the plant she used to produce the colour plate for this article. They helped immensely in augmenting the description, and provided proof-positive that *ex situ* conservation by the Koishikawa Botanical Garden, University of Tokyo, Japan, can produce excellent results. The first author would also like to thank Dr Atsushi Kawakita for providing free use of the habitat images used in the article, and to Yoshiteru Komaki of the Koishikawa Botanical Garden for providing relevant cultivation notes.

ORCID

Nicholas Hind https://orcid.org/0000-0002-0399-1909

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How to cite this article: Hind, N., Yamanaka, M. & Yasue, N. (2024) 1117. *Crepidiastrum grandicollum* (Koidz.) Nakai: Compositae. *Curtis's Botanical Magazine*, 41(3), 395–414. Available from: https://doi.org/10.1111/curt.12584