



Sedum yangjifengensis (Crassulaceae), a new species from Jiangxi, China



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Abstract

Sedum yangjifengensis (Crassulaceae), a new species from Jiangxi Province, China, was described and compared after introductory cultivation and morphological studies. The morphological characters of this species were found to vary considerably between growth periods: during the vegetative growth period, it has short, slender, tufted stolons, small leaves and during the reproductive growth period, it has long internodes below the inflorescence and with much larger bract leaves. It is similar to *S. makinoi* but exhibits extremely varied in leaf sizes and the length of internodes, and to *S. concarpum* and *S. lipingense*, but has connate follicles only at 1mm and no rosette leaves present.

Keywords: Morphology, *Sedum*, taxonomy

Introduction

Sedum Linnaeus (1753: 430) is a complex genus within the Crassulaceae family in terms of species, morphology, and taxonomy (De la Cruz López *et al.* 2019). Most *Sedum* species have fleshy stems, small flowers, and a large variation in leaves. The leaves of dried specimens are prone to falling off, making it difficult to identify (Jin *et al.* 2010). Due to its morphological diversity and similarities in phenotypic characters, the phylogenetic structure of *Sedum* and its relating genera is still unclear (Zhang *et al.* 2018; Zhu 2021). The current morphological classification of *Sedum* mainly relies on differentiating plant species based on similarities and differences in the external morphological characteristics of the plants, such as roots, stems, leaves, flowers, and fruits (Zhang *et al.* 2018).

There are approximately 470 species of the genus *Sedum*, mainly found in the northern hemisphere, with some species in the southern hemisphere in Africa and Latin America (Thiede J 2007). They are native to a variety of habitats, including rocky or sandy areas, meadows, cliffs, and forests. In general, *Sedum* species prefer well-draining soils and full sun to partial shade, although some species can tolerate more shade or moisture. Some *Sedum* species are also adapted to harsh environments, such as alpine or desert habitats, where they can survive extreme temperatures and low water availability. *Sedum* species are known for their succulent leaves and stems, which allow them to store water and tolerate dry conditions. They often have a low, spreading habit and can form dense mats or clumps. They produce clusters of small, star-shaped flowers in shades of pink, yellow, white, or red, often accompanied by low lichens and mosses (Thiede J 2007), making them easy to spot. In recent years, some new species of *Sedum* have been reported in China, i.e., *S. fanjingshanensis* C.D. Yang *et al.* X.Y. Wang (2012: 389), *S. kuntsunianum* X.F. Jin, S.H. Jin & B.Y. Ding (2013: 34), *S. tarokoense* H.W. Lin & J.C. Wang (2013: 2), *S. plumbizincicola* X.H. Guo *et al.* S.B. Zhou *et al.* L.H. Wu (2013: 492), *S. spiralifolium* D.Q. Wang, D.M. Xie & L.Q. Huang (2014: 177), *S. peltatum* M.L. Chen *et al.* X.H. Cao (2017: 847), *S. kwanwuense* H.W. Lin, J.C. Wang & C.T. Lu (2019: 426), *S. taiwanalpinum* H.W. Lin, J.C. Wang & C.T. Lu (2019: 426), *S. lipingense* R.B. Zhang & R.X. Wei (2019: 129), *S. ichangensis* Y.B. Wang (2019: 92),

S. nanlingense Yan Liu & C.Y. Zou (2020: 182), *S. matsuense* C.T. Lu & W. Y. Wang (2023: 135) and *S. jinglanii* Yan S.Huang & Q.Fan (2023: 122). In China, now there are 165 species of *Sedum*, 100 of which are endemic (Fu & Ohba 2001; Fu & Fu 1984), mainly distributed in Southwest China and 25 species are found in Jiangxi Province (Peng *et al.* 2021).

The Yangjifeng National Nature Reserve is located on the middle northwest slope of the Wuyi Mountains, which is famous with Danxia Landform and as a source of numerous type specimens of plant and insect species in Southeastern China. In June 2019, during a field survey of the plant resources in the reserve, we encountered a strange *Sedum* species grew on a stone wall, having slender creeping stolons with pairs of tiny leaves, and erect stronger flowering stems with few long internodes and much larger leaves and bracts below the inflorescent. Through morphological comparison with similar *Sedum* species, we identify it as a new species and report it here.



FIGURE 1. Habit and habitat of *Sedum yangjifengensis*. A. Habitat. B. A flowering individual with a single flower stem on barren stonewall habitat. C. A flowering individual with many flower stems in slightly fertile habit. D. Part of flowering plant, showing fruit.

Material and methods

We investigate the populations in the reserve. To observe their growth, we transplant some individuals to Shanghai city in nursery, which is located north of type locality but has lower elevation (20 m vs. 400–800 m). This choice was

made to ensure similar climates and to allow the transplanted individuals to continue their life cycle smoothly (Figs. 3, 5). Throughout an entire growth cycle, we meticulously observed the morphological characteristics and employed Nikon Z6II and Olympus E-M1MarkIII cameras for microscopic photography. All hundreds of the photos have been deposited on the Chinese Field Herbarium website (<https://www.cfh.ac.cn/album/ShowSpAlbum.aspx?spid=94981>). The morphological characters of similar species were examined based on their original descriptions ((Maximowicz, C.J. 1888; Fu & Ohba 2001; Zhang *et al.* 2019), digitized specimens data from the National Plant Specimen Resource Center of China(<https://www.cvh.ac.cn/>) and living photos from the Chinese Field Herbarium website(<https://www.cfh.ac.cn/>).

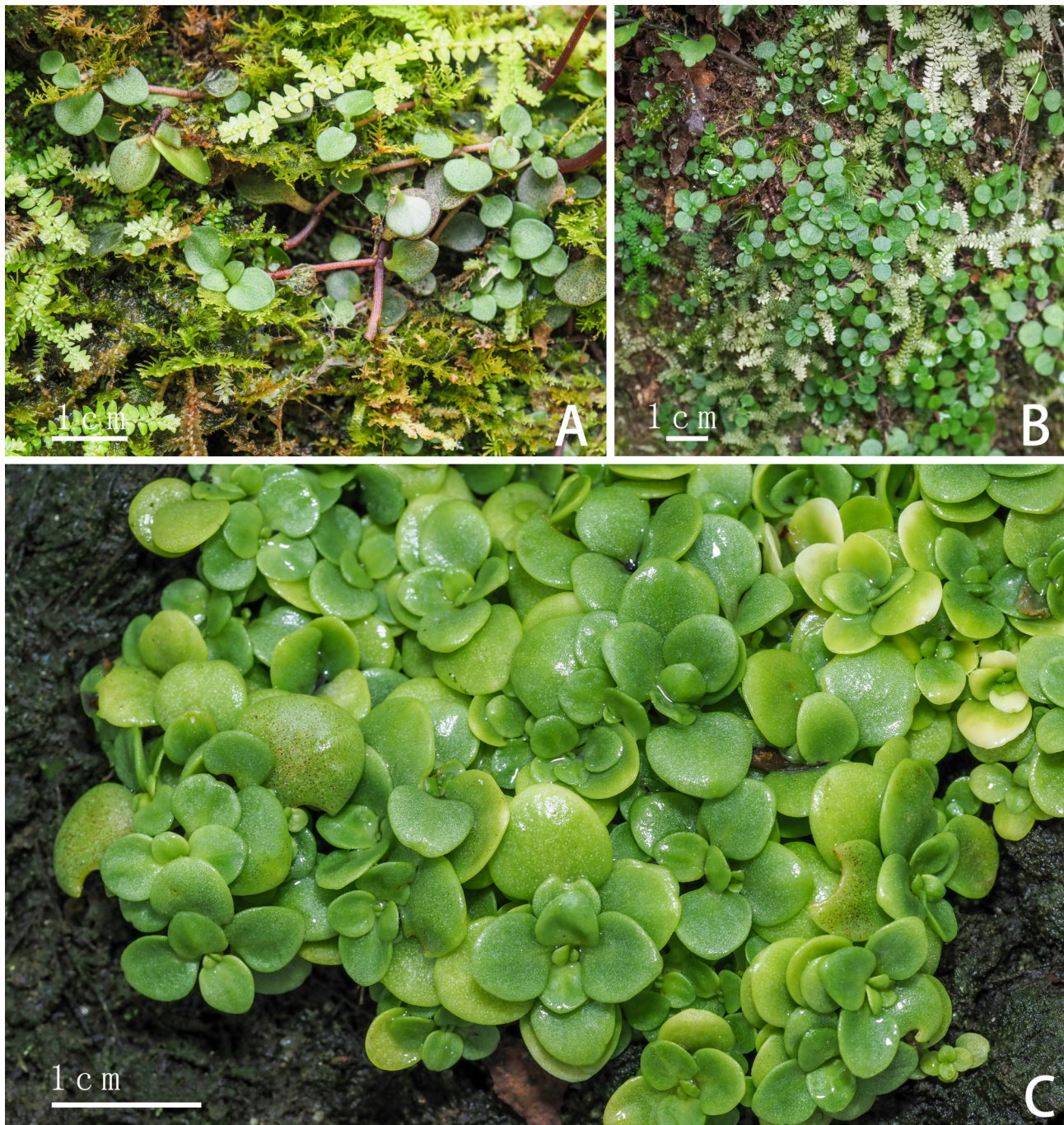


FIGURE 2. Vegetative growth of *Sedum yangjifengensis*. A, B. Sterile stem in shaded habitat. C. Sterile stem in full sunlight habitat.

Result

The putative new species is only distributed in the Yangjifeng National Natural Reserve. The growth cycles of populations in the wild and under cultivation are generally synchronized, with distinct stages of nutritional growth

and reproductive growth exhibiting significant differences in plant morphology. The nutritional growth stage begins in June, during which the plants grow slender, branched sterile stems with dramatically varied internode lengths ranging from long (up to 1 cm) to short (1–2 mm) in response to increasing sunlight conditions in their habitats. These stems form loose to dense mats. Starting from October, flowering stems emerge from the top and leaf axils of sterile stems with very short internodes. These flowering stems have much larger, clustered, opposite but uneven leaves, with the largest ones being bract leaves. This growth pattern results in dense clumps of plants that persist throughout the winter. In the following March, the nodes of the flowering stems rapidly elongate to their full length shortly before blooming. Prior to the ripening of fruits in June to July, the bract leaves remain the main organs of photosynthesis. Weak sterile stems persist for a relatively short time, while strong erect flowering stems begin growing early and dominate the major part of the life cycle in terms of biomass, nutritional function, and duration, making it very unique among *Sedum* species. Additionally, we observed a wide variation in individual plant sizes across habitats, ranging from a single flowering stem to hundreds of stems.

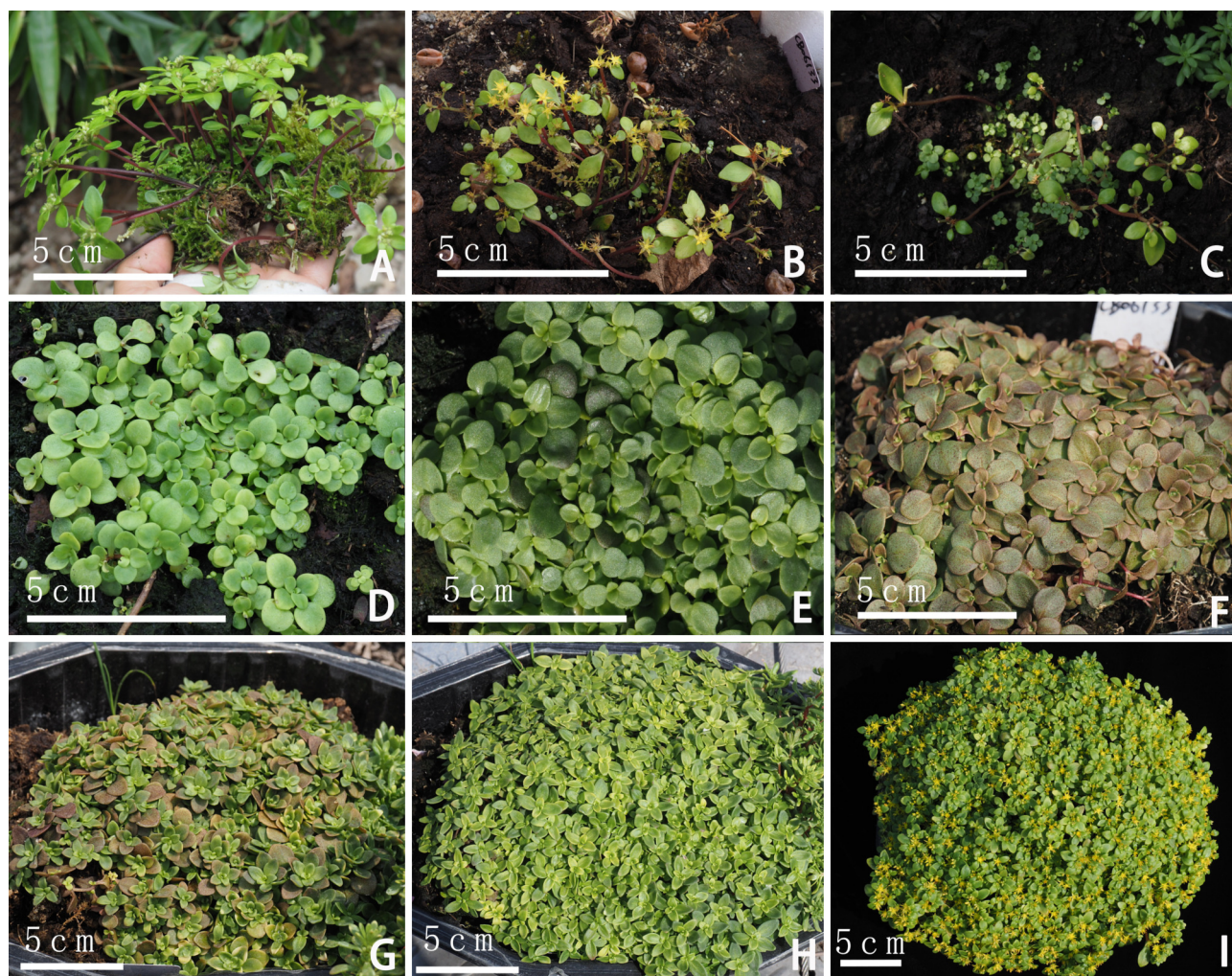


FIGURE 3. Full growth cycle of a transplanted individual. A. Collected the individual in wild, 8th June, 2021. B–I. Transplanted to Shanghai City, the dates were 26th June, 19th August, 22nd September, 7th November, 11th December of 2021 and 11th March, 2nd April, 15th June of 2022.

The vegetative growth period of putative new species is similar to that of *S. makinoi* by having opposite leaves, but differs by having relative weak of vegetative growth (very thin sterile stems and smaller leaves vs. strong sterile stems and larger leaves), very few nodes of flowering branch (1–3 nodes vs. much many nodes), very long internode length of flowering branch (up to 4 cm vs. 1–2 cm) and the relative size of bract leaf of inflorescence (much larger than sterile stem leaves vs. smaller than sterile stem leaves). In the reproductive growth period, it resembles the branching mode of *S. concarpum*, but having inconspicuous or shorter pseudopetiole (shorter than 1/3 of leaf blade vs. as long as leaf blade), thin sterile stems (vs. no sterile stems), and shorter carpels (base connate for ca. 1 mm vs. base connate for ca. 3 mm); It resembles *S. lipingense* by having very few nodes of flowering stem, but having no rosette leaves when flowering (vs. having rosette leaves), sterile stems (vs. absent). Full comparisons are given in Table 1.

TABLE 1. Diagnostic characters distinguishing *Sedum yangjifengensis* from *S. makinoi*, *S. concarpum* and *S. lipingense*.

Characters	<i>S. yangjifengensis</i>	<i>S. makinoi</i>	<i>S. concarpum</i>	<i>S. lipingense</i>
Rosette leaves during florescence	absent	absent	absent	present
sterile stem	creeping, slender	absent	erect	absent
cauline leaves	1 to 3 pairs with unequal length of internodes	many pairs and dense	absent	1 to 2 pairs
nectar scales	inverted trapezoid	rectangular-spatulate	linear-spatulate	broadly cuneate
phyllotaxis	aggregated shoot apex or branching	decussate opposite	upper branch	bottom rosette leaves and upper branch
internode	long	short	long	long
carpel	connate for 1mm at base	connate for 1mm at base	connate for 3mm at base	connate for 1mm at base

Discussion

The morphological classification of *Sedum* has always been challenging to handle. Coupled with the variable growth characteristics of *Sedum* in different habitats, we believe that the best approach to studying its morphology is by transplanting and observing its complete growth cycle. Initially, this new species was identified as either *S. concarpum* or *S. makinoi*. However, after a period of observation, we quickly distinguished and isolated them.

The putative new species is predominantly distributed in habitats with damp rock walls and loose soil which are common in wild, but it is only sporadically found in few canyons nearby the type locality. This indicates that habitat isolation or dispersal limitation might be the primary factor limiting the distribution range of species. With the exception of a few widely distributed species, most *Sedum* species are confined to their original distribution areas. This limitation is also one of the reasons why *Sedum* rarely appears in papers concerning new distribution records.

Taxonomic treatment

Sedum yangjifengensis B. Chen & Z.W. Zhu *sp. nov.*, Figs. 1, 2, 3, 4, 5.

Type:—CHINA. Jiangxi: Guixi City, Huangsha Town, Donggang, on stonewall, elev. 450m, 7 July 2022, Zhu Zongwei, XL00466 (holotype CSH!); Shanghai City: Songjiang District, collected from cultivated individual, elevation ca. 20m, 15 June 2022, Chen Bin CB05718(paratype CSH!).

Diagnosis:—*Sedum yangjifengensis* resembles *S. makinoi* Maximowicz (1888: 487) during the vegetative growth period by having opposite leaves, but has slender, tufted stolons, and during the reproductive growth period, has very long internodes below the inflorescence and much greater variation on leaf size, in which the bract leaves of inflorescence are the largest ones. In reproductive period, it is similar to *S. concarpum* Fröd (1935: 122) and *S. lipingense* by having long internodes, but has stolons, connate follicles only at 1mm and no rosette leaves present.

Description:—Biennial or perennial fleshy herb, glabrous throughout the entire plant. Roots fibrous. Sterile stems creeping, clustered, 0.5–1 mm in diam., 5–30 mm long, internodes up to 10 mm long when shaded. Flowering stems grow out from the top or leaf axils of vegetative stems, seldomly branched at the base, erect, 7 cm to 15 cm high, 1–3 mm in diam., internodes 1–4 cm long. Leaves many pairs on vegetative stems, opposite; petioles 2–3 mm long; leaf blades 5–8 mm wide, suborbiculate or spatulate, margin entire, base rounded, rarely truncate, apex rounded. Leaves 1–3 pairs on flowering stems, opposite or seldomly alternative on upper part, 2–4 clustered on the top of the branches form into bract leaves of the florescence; leaf blades turn larger from the base to the top of the branches, 5–12mm wide, 10–20mm long, elliptic or obovate, entire, apically rounded and sinuate, base attenuate into short petiole with short broad spur. Cyme 3–5—branched, corymbiform, 3–6 cm diam., few flowered. Flower bracts similar with the inflorescence ones but gradually turn smaller. Flowers sessile, mostly 5- sometimes 4- or 6-merous; sepals uneven in size from 1 mm to 2 mm wide and 2mm to 4mm long, with a rod or spoon shape, rounded and thick on the top; petals yellow, lanceolate, 5–6 mm long, 1.5mm wide at the middle, acuminate to apex, abaxially raised into ridge and apically

0.5 mm protruding into a horn shape; stamens in two whorls, with the antepetalous stamens inserted about 1 mm from the petal base. The nectar scales inverted trapezoid, about 0.5 mm long, 0.5 mm wide. Carpels narrowly ellipsoid, ca. 5 mm, base connate ca 1 mm; styles 1.5–2 mm. Follicles stellately divergent, many seeded. Seeds narrowly ovoid, about 0.8 mm long, brown papilliferous.

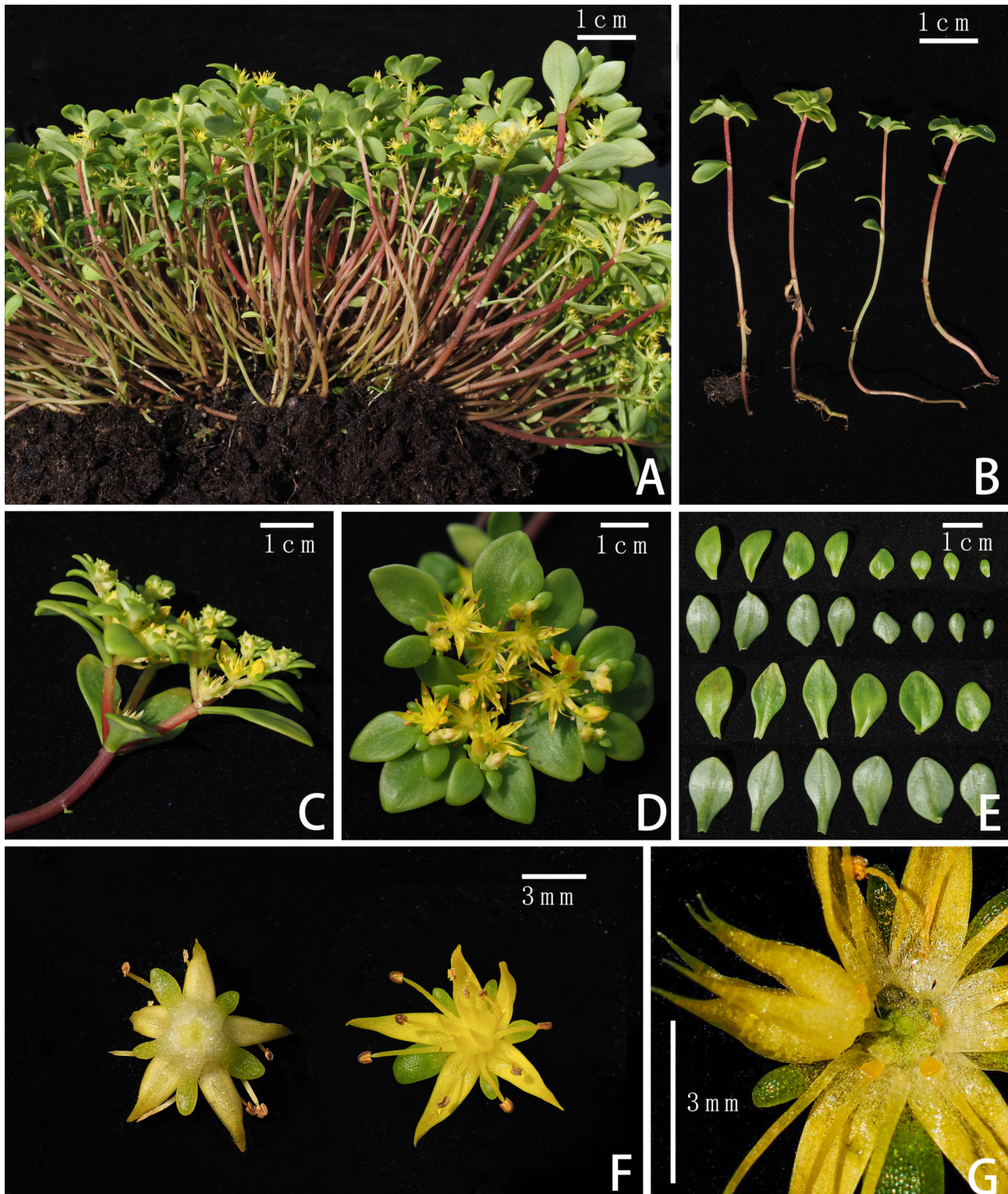


FIGURE 4. Morphology of *Sedum yangjifengensis*. A. The bottom view a cultivated individual. B. Flower stems. C. Side view of a cyme. D. Overlook of a cyme. E. Bract leaves from a cyme. F. Flowers, showing the sepals and petals. G. Flower, showing the nectar scales, carpels and follicles etc.

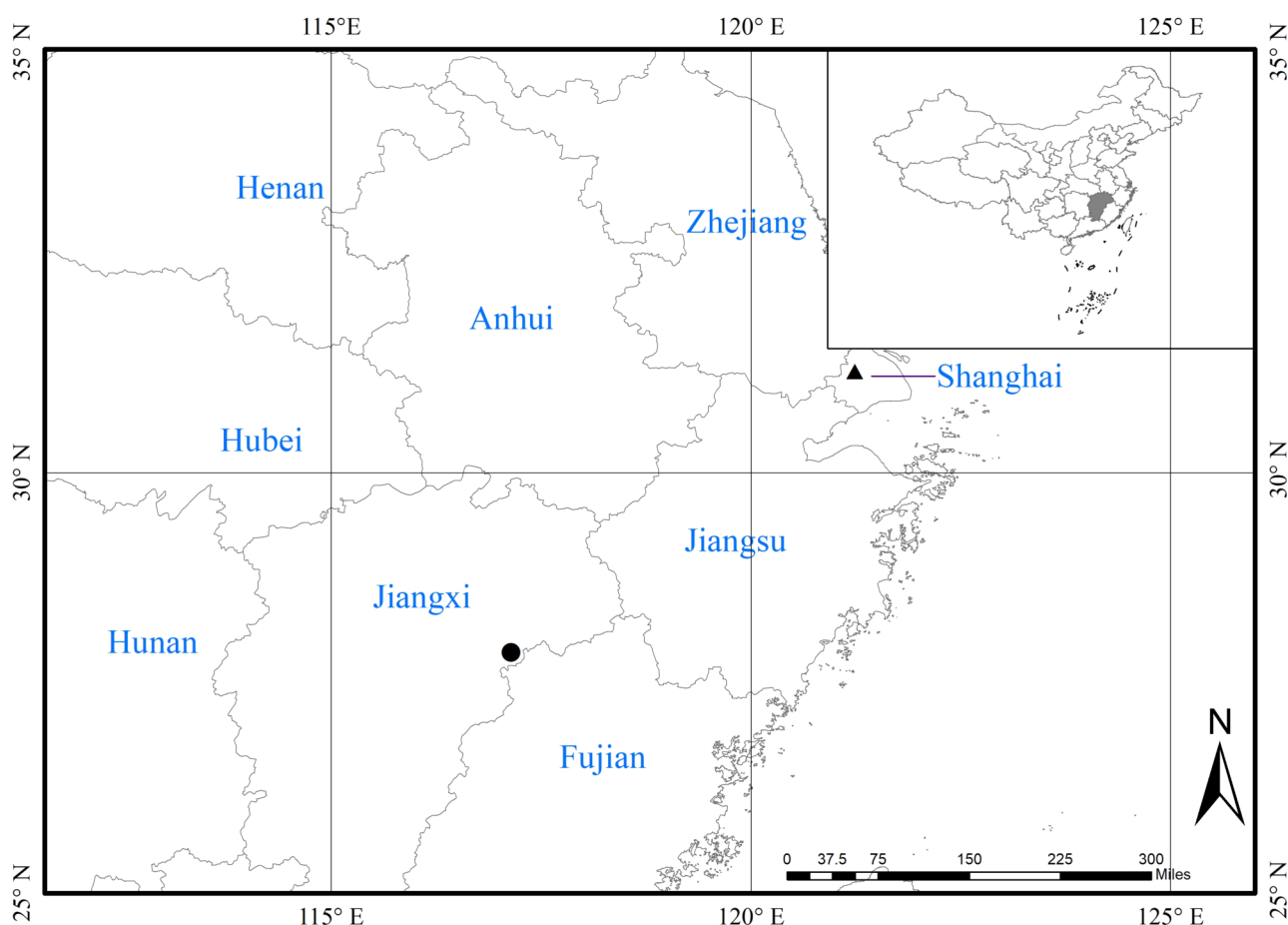


FIGURE 5. Distribution map of *Sedum yangjifengensis* sp. nov. (●) and transplant location (▲).

Distribution and Habitat:—This species is exclusively found in the valley environment and rock walls of a few adjacent valleys in Donggang, Huangsha Township, Guixi City in eastern Jiangxi Province, China (as depicted in Figure 5), elevation ca. 400–800m. The surrounding vegetation includes species such as *Pilea cavaleriei* Léveillé (1912: 65), *Selaginella heterostachys* Baker (1885: 177), *Oreocnide frutescens* Tunberg (1867: 131), *Saxifraga stolonifera* Meerburgh (1777: 23) and other mossy plants that thrive in damp environments.

Phenology:—Flowering from June to July; fruiting from June to August.

Etymology:—The specific epithet is derived from the type locality of Yangjifeng National Nature Reserve, Guixi City, Jiangxi Province, China.

Vernacular name:—Yáng Jì Fēng Jǐng Tiān (阳际峰景天).

Conservation status:—The populations of *Sedum yangjifengensis* at the type locality comprises ca. 1000 individuals in several valleys nearby. More information of its distribution and number of individuals needs to be obtained for accurate assessment. According to the IUCN Red List Categories and Criteria (IUCN 2012), the new species should be considered as Data Deficient (DD).

Other specimens examined:—*Sedum makinoi*: JAPAN. Nagasaki, Maximowicz, C.J. 2540(holotype: K000732544); Limu City, Miyoshi Furuse 54759(PE01135677, PE01135687); Ganshan County, Miyoshi Furuse 53825(PE01135681, PE01135672). CHINA. Yunnan Province, Yan L.C. C090201(HITBC0030803); Hubei Province, Li S.L. GanQL1296(KUN1458009), Li H.J. 947(PE00885968); Sichuan Province, Zhang X.S., Ren Y.X. 4695(PE00914017, PE00914018); Zhejiang Province, Ding B.Y., 171(ZMNH0009599); Jiangxi Province, Liao Y.Q., TCM2471(JJF00043455). *S. concarpum*: CHINA. Yunnan Province, Rock, J.F. 5434(holotype: A00042584; isotype: US00100686; syntype: K000838649, K000838650), Qin R.C. 23964(PE00885797, PE00885798, PE00885799, PE00885802, PE00885803, PE00885804), Qin R.C. 30991(PE00885805, PE00885801), Yu D.J. 15525(PE00885800), ZHUX.X. et al. ZXX191298(KUN1485246); Hubei Province, Wang Y.M. 4985(PE01802440), Li H.J. 6688(PE00885790), Liu K.R. 0185(PE00885789); Jiangxi Province, Jian C.P. et al. 401357(PE 01269246).

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