Youngia hangii (Asteraceae, Crepidinae), a new species from Hubei, China

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Academic editor: Alexander Sennikov | Received 5 July 2021 | Accepted 23 August 2021 | Published 14 September 2021

Citation: Liu Q, Huang G-Y, Zhang D-G, Zhang J-W, Deng T, Li Z-M (2021) Youngia hangii (Asteraceae, Crepidinae), a new species from Hubei, China. PhytoKeys 182: 27–38. https://doi.org/10.3897/phytokeys.182.71063

Abstract
Youngia hangii T.Deng, D.G.Zhang, Qun Liu & Z.M.Li, sp. nov., a new species of Asteraceae, is described and illustrated. It was collected in Wufeng County, Hubei Province, Eastern Central China. Youngia hangii is morphologically most similar to Y. rubida, but can be easily distinguished from the latter by capitula with 8–10 florets and the hairy leaf surface. Phylogenetic analyses, based on the internal transcribed spacers (ITS) and one chloroplast marker (rps16), showed that Y. hangii and Y. rubida were sister species with good support. The results of both phylogenetic analysis and the morphological data support the specific rank of Y. hangii.

Keywords
Crepidinae, Hubei, molecular phylogeny, morphology, new species, Youngia

* The authors contributed equally to this study.
**Introduction**

*Youngia* Cass. (Cassini 1831) (Asteraceae; Cichorieae) is an East Asian genus with about 32 species (Babcock and Stebbins 1937; Shih 1997; Shih and Kilian 2011; Urbatsch et al. 2013; Deng et al. 2014; Peng et al. 2014, 2015; Ke and Chen 2016; Chen 2018). Most of the diversity of the genus is confined to China, and their diversity is especially high in the Hengduan Mountains (Peng et al. 2017). Most species of *Youngia* in China have a narrow distribution, especially several new species of *Youngia* which have been described in recent years (Deng et al. 2014; Peng et al. 2015; Ke and Chen 2016; Chen 2018). At the same time, there are two species of *Youngia* with incorrect taxonomic status. *Youngia japonica* (L.) DC. subsp. *longiflora* Koh Nakam. & C.I. Peng is distinct from *Y. japonica* subsp. *japonica*, which is supported by micromorphological and cytological evidence (Choi et al. 2020). *Youngia nansiensis* Y.Z. Zhao & L. Ma was nested in the *Crepidiastrum* clade and, therefore, should be considered as *Crepidiastrum akagii* (Kitagawa) J.W. Zhang & N. Kilian (Shih and Kilian 2011; Peng et al. 2014).

A lack of conspicuous distinguishing morphological features makes the Cichorieae, especially the Crepidinae, taxonomically difficult (Babcock and Stebbins 1937; Shih 1997; Peng et al. 2013). The related genera, *Youngia* and *Crepidiastrum* Nakai (1920: 147) are particularly difficult to distinguish through morphological and palynological features like pollen morphology, the epidermis morphology of leaf and achenes (Babcock and Stebbins 1937; Shih 1993, 1997; Gao 2007; Sennikov and Illarionova 2008; Wang et al. 2009). First, the molecular phylogenetic studies supported *Youngia* to be part of subtribe Crepidinae Cass. ex Dumort. with the inclusion of subtribe Ixeridinae Sennikov (Kilian et al. 2009; Zhang et al. 2011; Tremetsberger et al. 2012). Then, the results of some investigations (Urbatsch et al. 2013; Liu et al. 2013; Peng et al. 2014) and the most comprehensive Crepidinae phylogeny (Wang et al. 2020) supported close relationships between *Youngia* and *Crepidiastrum* being sister groups to each other, but they are phylogenetically distant to *Ixeris*, *Ixeridium* and *Askellia*, and *Youngia* is polyphyletic. However, the circumscription of sections in *Youngia*, so far, still lacks molecular evidence (Babcock and Stebbins 1937; Shih 1997; Peng et al. 2014). Sennikov and Illarionova (2008) proposed to divide *Youngia* into four sections (*Youngia*, *Cineripappae* Sennikov, *Paleaceae* Sennikov [= *Mesomeris* Babcock & Stebbins, nom. inval.] and *Pinnatifidae* Sennikov), based on the sculpturing of the fruit surface, which was supported by the morphological structure of the achenes in the Cichorieae (Zhu et al. 2006; Zhang et al. 2013). These two studies currently lack the support of molecular results.

Due to the many floristic surveys dedicated to the flora of Hubei, a centre of Metasequoia Flora (Chen et al. 2018), many new species have been recently described from Hubei Province and the adjacent area (Lin et al. 2019; Zhang et al. 2019; Chen et al. 2020; Lv et al. 2020; Sun et al. 2020; Liu et al. 2021; Zhang et al. 2021). When conducting plant surveys in Houhe, we collected some interesting
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plants of Youngia from a cave in Wufeng County, Hubei (Fig. 4). After comparing them with the known species, we determined that they represent a new taxon, which we hereby describe as *Y. hangii*.

**Material and methods**

**Morphological assessment**

We compared the shape, lobes and size of the leaves, leaf surface, phyllaries, number of florets, achenes and pappus of the new collections with *Y. rosthornii*, *Y. rubida* and *Y. heterophylla* and with descriptions in literature, in the Herbarium of the Kunming Institute of Botany (KUN). Eight individuals of the new species were examined.

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**Figure 1.** Bayesian consensus tree of *Youngia hangii* and related species. The BP tree is constructed, based on the combined matrix of ITS and *rps16* sequences. Numbers below branches are ML bootstraps and MP bootstraps and numbers above branches indicate Bayesian posterior probability. *Youngia hangii* is shown in bold.
For molecular analysis, we sampled a sample from one population of the unknown species and obtained 38 samples from 26 related species from GenBank (Appendix 1). Voucher information and GenBank accession numbers are presented in Appendix 1. Total genomic DNA was extracted from dried leaves using a Plant Genomic DNA Kit DP305 (Beijing, China) and used as the template in the polymerase chain reaction (PCR). Two sequences (ITS and rps16) were combined by Sequence Matrix v.1.7.8 for later analysis (Vaidya et al. 2011). Multiple-sequence was aligned using the programme CLUSTAL_W v.1.4 (Rédéi 2008), followed by manual adjustment in BioEdit v.7.0.5.3 (Hall 1999). Gaps were treated as missing data.

Phylogenetic trees were constructed using Bayesian Inference (BI), Maximum Likelihood (ML) and Maximum Parsimony (MP). MP analyses were conducted us-
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Results

Taxonomic treatment

*Youngia hangii* T. Deng, D.G. Zhang, Qun Liu & Z.M. Li, sp. nov.

urn:lsid:ipni.org:names:77219670-1

**Type.** CHINA. Hubei: Wufeng County, Renheping, 30°06'27"N, 110°16'31"E, karst cave of karst topography, 500–800 m alt., 5 August 2018, *Daigui Zhang & Qun Liu HAC 001* (holotype KUN (KUN1511675); isotypes KUN (KUN1511676), JSU (HHE 3256)).

**Description.** Herbs, perennial, 20–35 cm tall. Taproot straight or slightly oblique, fleshy, with lateral roots (Fig. 2D). Stems erect, branched from the base, with sparse white simple hairs; stem base ribbed, with 1 or 2 leaves similar to basal leaves. Basal leaves crowded at the caudex base; petiole 2–3 cm long; blade oblanceolate, 6–18 × 2–4 cm, both surfaces short pubescent with white hairs 0.1–0.3 mm long (pubescence more evident on veins), bipinnate to pinnatifid, apical lobe halberd-shaped, apex acute-acuminate, margin deeply lobed; lateral lobes 5–10 pairs, opposite or slightly skewed, irregularly halberd-shaped (lateral lobes tapering to the base, serrate, lowermost lobes narrowly triangular), often with 1–3 pairs of triangular or oblique-ovate lobes between lateral lobes. Synflorescence corymbiform; capitula 7–10. Involucre ampullate, 3–4 mm long, 3 mm in diameter. Phyllaries in 4 rows, greyish-green; outer phyllaries 5–7, ovoid-triangular, ca. 1 × 1 mm, apex acute; inner phyllaries 7–9, lanceolate, 2–4 × 0.5–1 mm, margin white-membranous, apex acute; florets 8–10, ligules 4–6 × 1–2 mm, teeth 0.2–0.4 mm long, tube 3–4 mm; anther tube ca. 2.5 mm long; style branches ca. 0.5 mm long. Outer achenes black, fusiform, 2 mm long, apex attenuate to shortly beaked and expanded again into the pappus disc; ribs 12–14; pappus white, bristles rough, 3 mm long; inner achenes similar to the outer ones, 2.5 mm long.
Figure 3. *Youngia hangii* T. Deng, D.G. Zhang, Qun Liu & Z.M. Li. A, B capitula C floret D habit E leaf with hairs F achene (drawing by Jianing Yang).
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**Phenology.** Flowering and fruiting April to October.

**Vernacular name.** 五峰黄鹌菜, wǔ fēng huáng ān cài in Chinese Pinyin.

**Etymology.** The species epithet honours Prof. Hang Sun (b. 1963), a Chinese botanist who has conducted research on plant taxonomy, floristics, biogeography and evolutionary biology and inspired many people through his work. He has also given a lot of support to the plant research work in Hubei.

**Distribution and habitat.** Youngia hangii is known only from the type locality, Renheping in Wufeng Xian, Hubei, China; 500–1000 individuals are known along the edge of some small caves at the base of the karst hillside (Fig. 2A, B, C); at altitudes of 500–800 m.

**Morphological assessment.** Morphological characteristics suggest that Y. hangii is related to Y. rubida and Y. heterophylla owning 10–25 florets and resembles Y. rosthornii with bipinnately deeply partite leaves. The achenes of Y. hangii and Y. rubida are attenuated into a short beak, which is widened into the pappus disc. Several unique features including the shape, lobes and size of the leaves, the leaves with white simple hairs (Fig. 2E, F, G; Fig. 3F, G), phyllaries, number of florets and achenes differentiate Y. hangii from Y. rubida and Y. heterophylla (Table 1).

**Phylogenetic analysis.** The Bayesian tree showing PP support, ML bootstrap (LP) and MP bootstrap (BP) values for each clade are presented in Fig. 1. The species in clade I form a monophyletic group with PP = 0.97, but LP are with weak support and BP are in conflict with PP and they were instead with “−”, respectively in Fig. 1. Youngia hangii is nested within Clade I as sister to Y. rubida with strong support (PP = 1, LP = 83, BP = 88).
Owning only 8–10 florets supports a placement of Youngia hangii in Y. sect. Youngia and its small involucres and achenes further support that Y. hangii is related to Y. rubida. However, there are some obvious differences between Y. hangii and Y. rubida and other species in the shape, lobes and size of the leaves and in white pubescent surfaces of the leaves. Moreover, Y. rosthornii also has bipinnately deeply partite leaves, but its leaves with a large apical part are different from Y. hangii.

Based on the combined datasets of the ITS and rps16 sequences, BI, MP and ML trees with similar topologies were constructed. Youngia hangii was clustered with Y. rubida and nested in Y. sect. Youngia with strong support (PP = 1, LP = 87, BP = 74) and was sister to the clade of Y. rubida with strong support (PP = 1, LP = 83, BP = 88). The results from the phylogenetic analysis are consistent with the morphological comparisons. Although only one sample of Y. hangii was included in the phylogenetic analysis, Y. hangii and Y. rubida have obvious differences in morphology, so the morphological data and phylogenetic results altogether support our hypothesis of Y. hangii being a new species.

### Table 1. Comparison of morphological characteristics between Youngia hangii and related species.

| Character          | Y. hangii | Y. rubida | Y. heterophylla | Y. rosthornii |
|--------------------|-----------|-----------|-----------------|--------------|
| Basal leaf shape   | oblongate, bipinnately partite | oblongate, pinnately deeply or completely partite | elliptic or oblone lanceolate, pinnately deeply or completely partite | long elliptic, bipinnately deeply partite with a large apical part |
| lobes shape        | apical lobes halberd-shaped, apex acute, with a tapered tip, margin middle to deep lobed; lowest lobes narrowly triangular | apical lobes triangle, apex acute, with a tapered tip, margin serrate; lowest lobes serrate | apical lobes elliptic, irregularly elliptic, ovate or lanceolate, apex acute, with a tapered tip, margin entire, almost entire or serrate; lowest lobes narrowly halberd | apical lobes triangular, apex acute, with a tapered tip, margin entire, almost entire or serrate; lowest lobes narrowly triangular |
| number of lateral lobes | 5–10 pairs | 2–3 pairs | 1–8 pairs | 5–7 pairs |
| size               | 6–18 × 2–4 cm | 3–7 × 1.5–3 cm | 13–23 × 6–7 cm | 20 × 8 cm |
| surface            | with white pubescent hairs on both surfaces, especially dense on veins | glabrous on both surfaces | sparsely pubescent on both surfaces | glabrous on both surfaces |
| Phyllaries         | 4 rows | 4 rows | 4 rows | 4 rows |
| Number of florets  | 8–10 | 13–15 | 11–25 | 20 |
| Achenes colour     | black | red | brown-purple | brown-purple |
| shape              | fusiform, attenuated into a narrow neck, with a conical beak | fusiform, attenuated into a narrow neck, with a conical beak | fusiform, attenuated into a narrow neck, without a beak | fusiform, attenuated into a narrow neck, without a beak |
| length             | 2 mm | 2.8 mm | 3 mm | 3.5 mm |
| ribs               | 12–14 ribs with small bristles | 12 ribs with small bristles | 14–15 ribs with small bristles | 14–15 ribs with small bristles |
| Pappus             | white, rough, 3 mm | white, rough, 3.5 mm | white, rough, 3–4 mm | white, rough, 3.5 mm |

**Discussion**

Owning only 8–10 florets supports a placement of Youngia hangii in Y. sect. Youngia and its small involucres and achenes further support that Y. hangii is related to Y. rubida. However, there are some obvious differences between Y. hangii and Y. rubida and other species in the shape, lobes and size of the leaves and in white pubescent surfaces of the leaves. Moreover, Y. rosthornii also has bipinnately deeply partite leaves, but its leaves with a large apical part are different from Y. hangii.
Acknowledgements

We are grateful to Dr. David E. Boufford for revising this manuscript. This study was supported by grants from the National Natural Science Foundation of China (31960046 and 31670206), the National Natural Science Foundation of China-Yunnan joint fund to support key projects (U1802232), the Strategic Priority Research Program of Chinese Academy of Sciences (XDA20050203), National Key R & D Program of China (2017YFC0505200), Major Program of the National Natural Science Foundation of China (31590820), Youth Innovation Promotion Association of the Chinese Academy of Sciences (2019382), Yunnan Ten-thousand Talents Plan Young & Elite Talent Project (YNWR-QNBJ–2019–154), Young Academic and Technical Leader Raising Foundation of Yunnan Province (2019HB039) and the Chinese Academy of Sciences “Light of West China” Program.

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### Appendix I.

#### Table A1. Voucher information and GenBank accessions of species used in our study.

| Species                  | Herbarium vouchers | GenBank accessions |
|--------------------------|--------------------|--------------------|
| **Askella flexuosa**     | (1)L.Peng & L.J.Tong1078(CDBI)/(2)X.F.Gao,Z.M.Zhu,X.J.Zhu14954(CDBI) | KC968078(1) KR733629(2) |
| **Crepidiastrum akagii** |                    |                    |
| 1 = Youngia nanuienis 1 | (1)/Y.L.Peng,L.J.Tong1151-1-3(CDBI)/(2)/Y.L.Peng & L.J.Tong1151-3(CDBI) | KC968064(1) KC968154(2) |
| 2 = Youngia nanuienis 2 | (1)/L.J.Tong11513/Y.L.Peng & L.J.Tong1131-3(CDBI) | KC968064(1) KC968148(2) |
| **Crepidiastrum chelidoniifolium** |                    |                    |
| (1)-                    | -                  | AB002627(1)        |
| **Crepidiastrum denticulatum** |                    |                    |
| 1 = Youngia nansiensis 1 | (1)/L.Peng12011052701 | AB002623(1) KC968107(2) |
| 2 = Youngia nansiensis 2 | (1)/L.Peng12011052701 | AB002622(1) KC968107(2) |
| **Crepidiastrum diversifolium** |                    |                    |
| 1 = Youngia nansiensis 1 | (1)/L.Peng12011072605-6(CDBI)/(2) | KC968072(1) KC968150(2) |
| 2 = Youngia nansiensis 2 | (1)/L.Peng12011072604/(3)/L.Peng12011072605 | KC968072(1) KC968149(3) |
| **Crepidiastrum lanceolatum** |                    |                    |
| (1)-                    | -                  | AB002624 AB598601(1) |
| **Crepidiastrum pinnatifolium** |                    |                    |
| (1)/Y.L.Peng325-6/2/Y.L.Peng325 | (1) | KC968061(1) KC968151(2) |
| **Crepidiastrum platyphyllum** |                    |                    |
| (1)/K2-CR 1267(2)- |                       | AB598764(1) AB598599(2) |
| **Crepidiastrum sonchifolium** |                    |                    |
| 1 = Youngia nansiensis 1 | (1)/L.Peng12011072605 | KC968064(1) KC968148(3) |
| 2 = Youngia nansiensis 2 | (1)/L.Peng12011072604/(3)/L.Peng12011072605 | KC968072(1) KC968149(3) |
| **Crepidiastrum tenuifolium** |                    |                    |
| (1)-                    | -                  | EU363645(1)        |
| **Scorzonera austriaca** | (1)/Y.L.Peng & L.J.Tong1123-3-1(CDBI)/(2)/L.Peng & L.J.Tong1123-2(CDBI) | KC968059(1) KC968135(2) |
| **Youngia cineripappa** |                    |                    |
| 1 = Youngia nansiensis 1 | (1)/W.W. Zhang & W.D. Zhu ZZ09041 (KUN)/(2)/Z.M.Zhu682(CDBI)(3)- | LT722046(1) KR733617(2) |
| **Youngia erythrocarpa** |                    |                    |
| 1 = Youngia nansiensis 1 | (1)/X.F.Gao14517-9/(2)/L.Peng12011082607-2/(3) | KC968076(1) KC968155(2) |
| **Youngia gracilipes** |                    |                    |
| (1)/X.F.Gao14517-9/(2)/L.Peng12011082607-2/(3) | X.F.Gao14517 | KC968076(1) KC968126(3) |
| **Youngia heterophylla** |                    |                    |
| 1 = Youngia nansiensis 1 | (1)-/(2)/X.F.Gao,Y.L.Peng,B.Xu & X.Zheng11937-2/(3) | AB598561(1) KC968123(2) |
| **Youngia humifusa**     |                    |                    |
| 1 = Youngia nansiensis 1 | (1)/L.Tong1012/(3)/X.F.Gao,Y.L.Peng,B.Xu & X.Zheng13147(CDBI)/(4)/Y.L.Peng & L.J.Tong981-1/(5)- | AB598566(1) KC968123(2) |
| 2 = Youngia nansiensis 2 | (1)-/(2)/ZhangJW 388 (KUN)/(3) | AB598557(1) KC968153(2) |
| **Youngia japonica**     |                    |                    |
| subsp. formosana         | (1)-/(2)/L.Peng12011072001-6/(3)/X.F.Gao,Y.L.Peng,B.Xu & X.Zheng11605 | AB598561(1) KC968122(3) |
| **Youngia japonica**     |                    |                    |
| subsp. japonica 1        | (1)-/(2)/L.Peng12011072001-6/(3)/X.F.Gao,Y.L.Peng,B.Xu & X.Zheng11605 | AB598561(1) KC968122(3) |
| subsp. japonica 2        | (1)-/(2)/L.Peng12011072001-6/(3)/X.F.Gao,Y.L.Peng,B.Xu & X.Zheng11605 | AB598561(1) KC968122(3) |
| **Youngia longiflora**   |                    |                    |
| (1)-                    | -                  | AB598558(1)        |
| **Youngia pallescens**   |                    |                    |
| 1 = Youngia nansiensis 1 | (1)-/(2)-/(3)/L.Peng p082605-1(CDBI)/(4)/L.Peng p082605-1(CDBI)/(5)- | KJ502310(1) KJ502311(2) |
| **Youngia rubida**       |                    |                    |
| (1)/Y.L.Peng93-3(CDBI)/(2)/L.Peng p082605-1(CDBI)/(1) | HHE 3256(KUN) | KC968048(1) KC968326(2) |
| **Youngia thunbergiana** |                    |                    |
| (1)-                    | -                  | KC539465(1)        |
| **Youngia zhengyiiana**  |                    |                    |
| (1)-                    | -                  | KJ502314(1)        |