

Synotis jinpingensis (Asteraceae, Senecioneae), a new species with white ray florets from southeastern Yunnan, China

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Abstract

Synotis jinpingensis (Asteraceae, Senecioneae), a new species from Jinping county in southeastern Yunnan province, China, is described and illustrated. This species is distinguished by having white ray florets in the genus *Synotis*, in which only species with yellow ray florets have been hitherto known. In habit and leaf shape *S. jinpingensis* is most closely similar to *S. duclouxii*, a species occurring in southwestern Guizhou, southern Sichuan and northeastern Yunnan, China, but differs, in addition to the color of ray florets, by having fewer lateral veins of leaves, obviously longer bracts of calyculus, and larger phyllaries. The membership of the new species within *Synotis* is strongly corroborated by evidence from floral micromorphology and phylogenetic analyses based on ITS sequence data. Color photographs of living plants, a distribution map, and provisional IUCN status of *S. jinpingensis* are provided.

Key words: Compositae, floral micromorphology, ITS sequence data, taxonomy



Academic editor: Peter de Lange

Received: 5 September 2023

Accepted: 22 October 2023

Published: 20 November 2023

Citation: Zhao L-C, Chen R, Yu Z-Y, Tang M, Yang Q-E (2023) *Synotis jinpingensis* (Asteraceae, Senecioneae), a new species with white ray florets from southeastern Yunnan, China. *PhytoKeys* 235: 199–210. <https://doi.org/10.3897/phytokeys.235.112230>

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Introduction

Synotis (Clarke) C. Jeffrey & Y.L. Chen (Asteraceae, Senecioneae), was segregated from *Senecio* L. based on its sub-shrubby habit and anther bases with sterile tailed auricles. *Synotis* is endemic to the Sino-Himalayan region, except for two species occurring in northwestern China and Kyrgyzstan (Jeffrey and Chen 1984; Li et al. 2018). Sixty species are currently recognized in the genus, with 48 recorded in China (Jeffrey and Chen 1984; Chen 1999; Chen et al. 2011; Tang et al. 2013a, b, c, 2014, 2017, 2022; Tong et al. 2017; Li et al. 2020; Liu et al. 2020, 2021; Tang and Chen 2021; Zhang et al. 2021; Fan et al. 2022a, b).

During a botanical trip in March 2022 to southeastern Yunnan, China, we discovered an unusual population of *Synotis* with white ray florets (Fig. 1) in the Fenshuiling National Nature Reserve in Jinping county (Fig. 2). All the previously known species in *Synotis* have yellow ray florets. The habit and the obovate-lanceolate or elliptic leaves of the plants are most closely similar to those of *S. duclouxii*, a species occurring in southwestern Guizhou, southern

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Sichuan, and northeastern Yunnan, China (Liu et al. 2020) (Fig. 2), but differ by having white florets and several other morphological characters, including fewer nerves on the leaves and longer bracts of calyculus. We conducted floral micromorphological studies and performed phylogenetic analyses based on ITS sequence data to further confirm the membership of the new species within the genus *Synotis*. We therefore determine that the population in question represents a hitherto undescribed species, which we describe below.

Material and methods

Gross morphology

We conducted careful observations of living plants in a population of the new species in Jinping county in southeastern Yunnan, China. All the major morphological characters, including the habit, the shape and size of leaves, involucre, ray and disk florets, and the type of synflorescence, which were observed and photographed on living plants by digital camera (OLYMPUS TG-6, Tokyo).

Floral micromorphology

For the study of three floral micromorphological characters of the new species (voucher: Z. Y. Yu et al. JXAU 01, JXAU), including papillae on style arms, filament collar, and anther endothelial cell thickenings in stamens [(for all these three micromorphological characters were considered taxonomic significance in the *Synotis* reported by Jeffrey and Chen (1984) and Tang (2014)], we followed the method of Tang et al. (2014), and all these characters were observed and photographed under microscope (ZEISS AXIO IMAGER A2M, Germany).

Phylogenetic analyses

Based on the results of previous phylogenetic analyses of the tribe Senecioneae (Pelser et al. 2002, 2003, 2007, 2010), we selected 82 samples representing 79 species in 38 genera within Senecioneae for our analyses. These included 30 species of *Senecio* and 13 species in *Synotis*. *Abrotanella emarginata* Cass. (subtribe Abrotanellinae) was selected as a root, according to the results of Pelser et al. (2007, 2010). We generated new sequences for our new species and its putative close ally *S. duclouxii*, and another species *S. cavaleriei* (H. Lév.) C. Jeffrey & Y.L. Chen, while the sequences of other species were retrieved from GenBank. Voucher information and GenBank accession numbers for the material used in this study are given in Appendix 1.

Total genomic DNA of *Synotis cavaleriei*, *S. duclouxii* and our new species were extracted from silica gel-dried leaves using the modified CTAB method of Doyle and Doyle (1987). The nuclear regions (ITS) were sequenced, with the primer pairs ITS4 and ITS5 (White et al. 1990). Amplification and sequencing reactions followed Tang (2014) and Ren et al. (2017).

All sequences were aligned with MAFFT 7.450 (Katoh and Standley 2013). ModelFinder (Kalyaanamoorthy et al. 2017) was used to select the best-fit model using BIC criterion. Maximum Likelihood (ML) analysis was generated

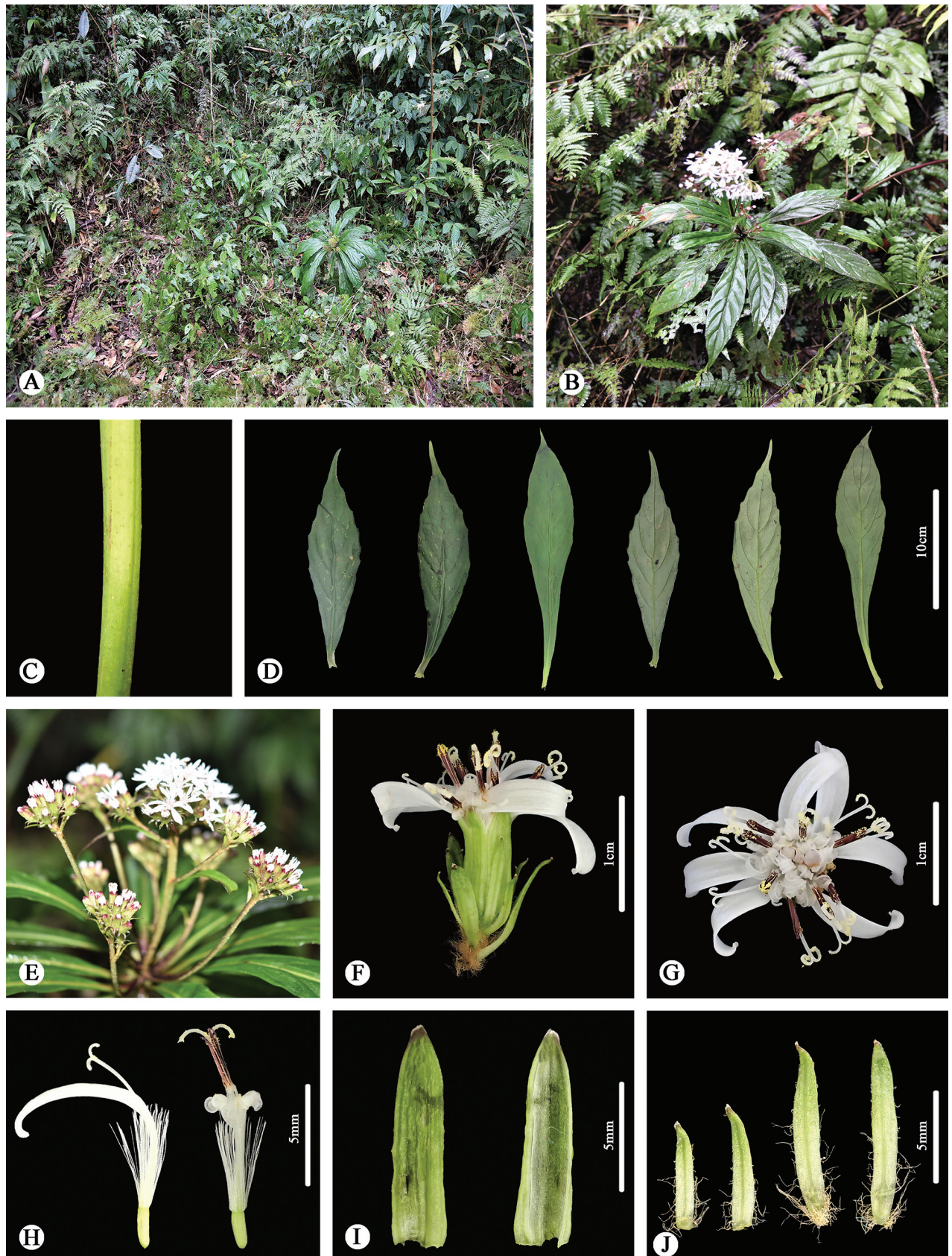


Figure 1. *Synotis jinpingensis* in the wild (Jinping, Yunnan, China) **A** habitat **B** habit **C** portion of stem **D** leaves (left three: adaxial side; right three: abaxial side) **E** synflorescence **F** capitulum (side view) **G** capitulum (top view) **H** florets (left: ray floret; right: disk floret) **I** phyllaries (left: adaxial side; right: abaxial side) **J** bracts of calyx.

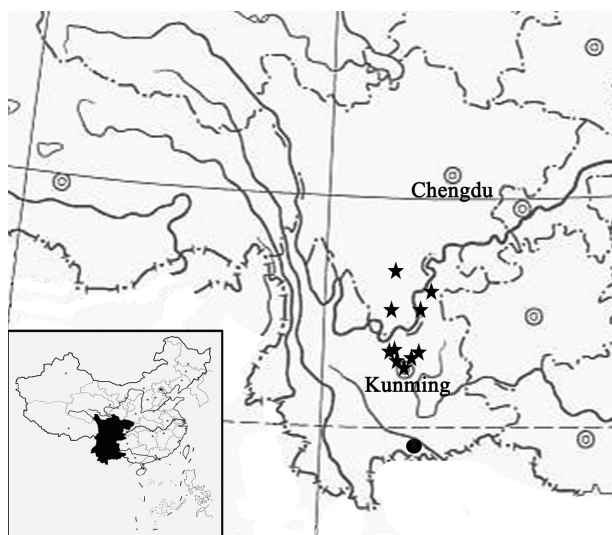


Figure 2. Distribution map of *Synotis jinpingensis* (black dot) and *S. duclouxii* (black star).

by IQ-TREE 2.1.3 (Nguyen et al. 2015), with 20 000 ultrafast bootstraps, under GTR+F+I+R3 model by ModelFinder. Bayesian Inference (BI) (Ronquist et al. 2012) analysis was carried out by MrBayes 3.2.6 (Ronquist et al. 2012), under GTR+F+I+G4 model, with 3 000 000 generations, sampling every 1 000 generations to ensure the convergence (average deviation of split frequencies less than 0.01 and the effective sample sizes over 200), in which the first 25% of sampled data treated were discarded as burn-in and the remaining trees were used to estimate the posterior probabilities (PP). Bootstrap percentage (MLBS) values ≥ 70 (Hillis and Bull 1993) and PP values ≥ 0.95 were regarded as strong support.

Results and discussion

Gross morphology

As shown in Figs 1, 2, our new species has a habit typical of *Synotis* ser. *Synotis* (Jeffrey and Chen 1984), with the leaves clustered at the bottom of the synflorescence, indicating that this species should belong to this series. It is readily distinguishable from all other species within the genus by its white ray florets. From its putative closest ally, *S. duclouxii*, the new species differs additionally by having fewer nerves on the leaves (10–14 vs. 18–20), longer bracts of calyculus (6–8 mm vs. 1–3 mm) and larger phyllaries (8–10 mm long, 2–3 mm broad vs. 5–7 mm long, 1–2 mm broad) [see Liu et al. (2020) for morphological characters of *S. duclouxii*].

Floral micromorphology

The central tuft of papillae on the style arms of our new species is prominent, much longer than laterals (Fig. 3A). The anther collars are balusterform (Fig. 3B), the anther tails are ca. 1.5 times as long as antheropodia (Fig. 3B), and the endothelial cell wall thickenings are radial (Fig. 3C). All these characters match well those reported previously in *Synotis* (Jeffrey and Chen 1984; Tang et al. 2013a, b, 2014; Tang 2014; Li et al. 2018) and further confirm the generic affiliation of our new species.

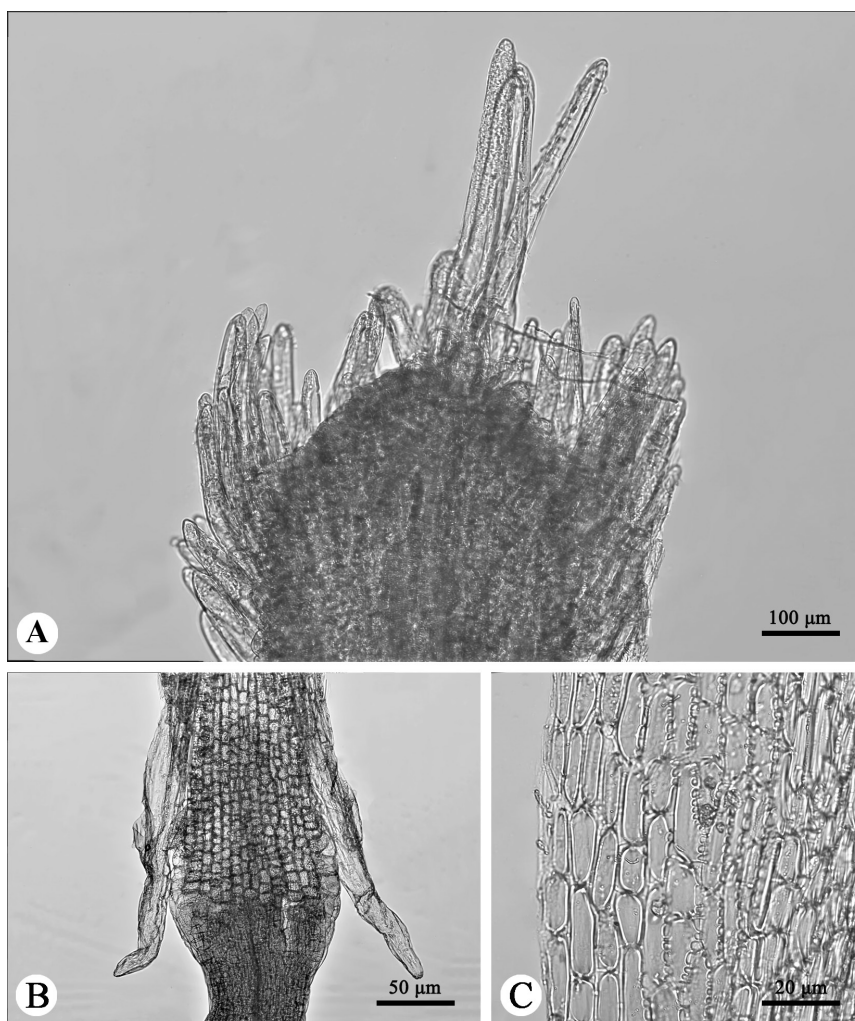


Figure 3. Three micromorphological characters of *Synotis jinpingensis* **A** papillae on style arms **B** anther collar and anther tails **C** anther endothelial cell wall thickenings.

Phylogenetic analyses

Our ML and BI analyses produce almost identical topologies, and they are also consistent with the results of previous studies (Pelser et al. 2007, 2010; Tang et al. 2014; Tong et al. 2017; Li et al. 2018). As shown in the ML tree (Fig. 5), all the sampled species of *Synotis* form a strongly supported clade (MLBS/PP = 99%/1.00) in subtribe Senecioninae and our new species is deeply nested within this clade. The membership of our new species within *Synotis* is thus strongly corroborated by ITS sequence data.

Taxonomic treatment

***Synotis jinpingensis* M.Tang, Z.Y.Yu & Q.E.Yang, sp. nov.**

[urn:lsid:ipni.org:names:77331168-1](https://nomenclature.ipni.org/names/77331168-1)

Figs 1, 4

Type. CHINA. Yunnan province: Jinping county, Fenshuiling National Nature Reserve, Guaitang village, in mixed forests, alt. ca. 2400 m, 22°45'36.87"N, 103°28'4.65"E, 30 March 2022, Z.Y. Yu et al. JXAU 01 (holotype: JXAU; isotypes: IBSC, JXAU). Fig. 4.

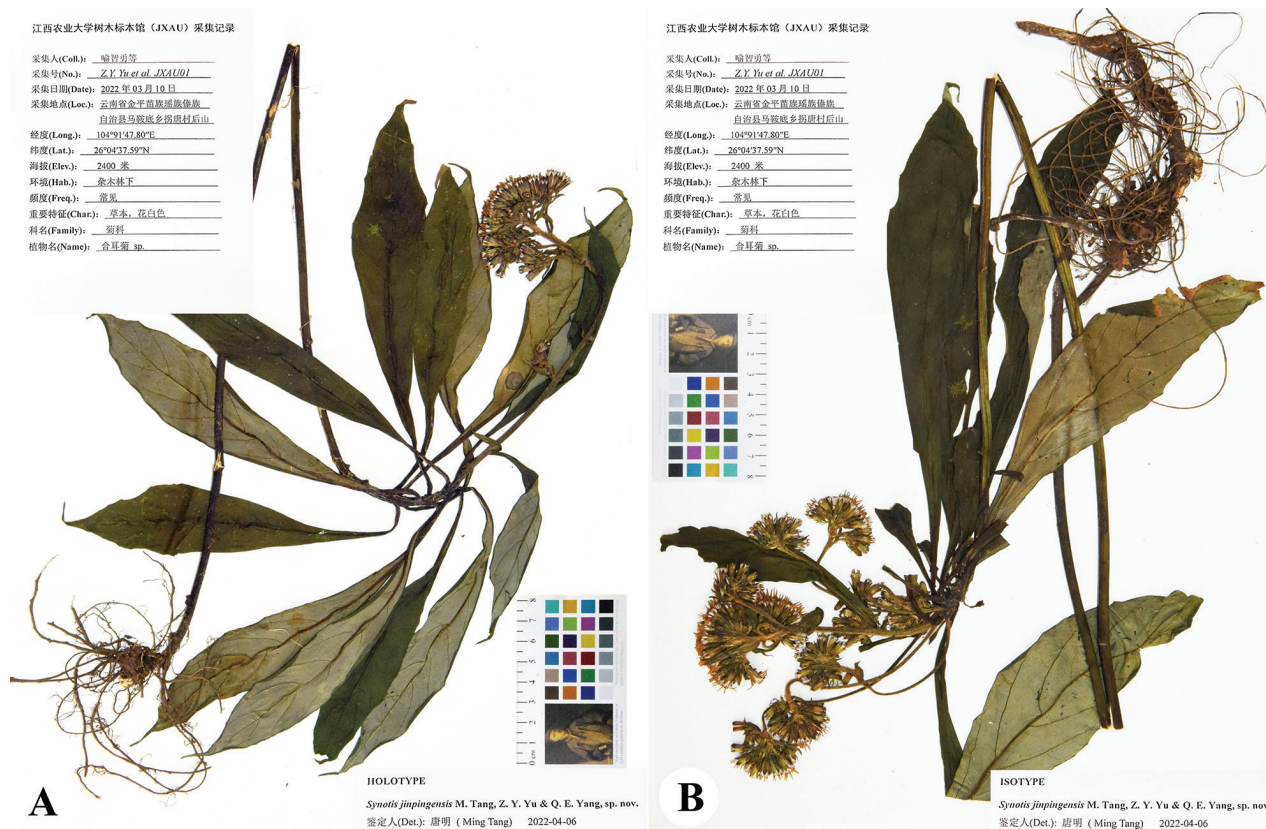


Figure 4. Holotype (A) and isotype (B) sheets of *Synotis jinpingensis*.

Diagnosis. *Synotis jinpingensis* is most closely similar to *S. duclouxii* in habit and leaf shape, but differs by having white (vs. yellow) ray florets, fewer nerves on the leaves (10–14 vs. 18–20), longer bracts of calyculus (6–8 mm vs. 1–3 mm), and larger phyllaries (8–10 mm long, 2–3 mm broad vs. 5–7 mm long, 1–2 mm broad).

Description. Perennial herbs, erect, rhizomatous. Rhizome thick, horizontal. Vegetative stems solitary, simple, rarely branched, erect, 50–100 cm tall, median and lower parts subglabrous, upper part often densely yellowish setulose. Flowering stems solitary, erect, scapiform, 15–30 cm tall, few-branched, fulvous tomentose. Leaves always aggregate at base of fertile shoot; petioles 1–1.5 cm long; blades obovate-lanceolate or elliptic, 12–18 cm long, 2.5–4 cm broad, papyraceous, abaxially glabrous or subglabrous, adaxially sparsely pubescent, pinnately veined, lateral veins 10–14, arcuate-ascending, base cuneate, margin shallowly sinuate-apiculate, apex acute-acuminate. Stem leaves on reproductive shoots few, narrowly lanceolate, remote, much smaller. Capitula radiate, numerous, arranged in an attenuate broadly paniculoid corymb; peduncles 3–5 mm long, fulvous tomentose, 1- or 2-bracteate; bracts below capitula linear, 5–20 mm long. Involucres cylindric-campanulate, 8–10 mm long, 2–3 mm broad, with 7–10 subulate bracteoles at base, bracts of calyculus linear, 6–8 mm long, green, apically purple; phyllaries usually 7 or 8, occasionally 5 or 6, oblong, 2–3 mm broad, green, herbaceous, glabrous, apically acute, purple. Ray florets 7 or 8; corolla tube 3.5–4.5 mm long, glabrous; lamina white, oblong-lanceolate, 6–9 mm long, 1.5–2.5 mm broad, 3–4-veined, apically obtuse, 3-denticulate. Disk florets 8–12, white; corolla 4–5 mm long, with ca. 4.5 mm long tube and funnellform limb; lobes ovate-oblong, 3–3.5 mm long, apically acute. Anthers ca. 3 mm, anther tails ca. 1.5 times as long as antheropodia;

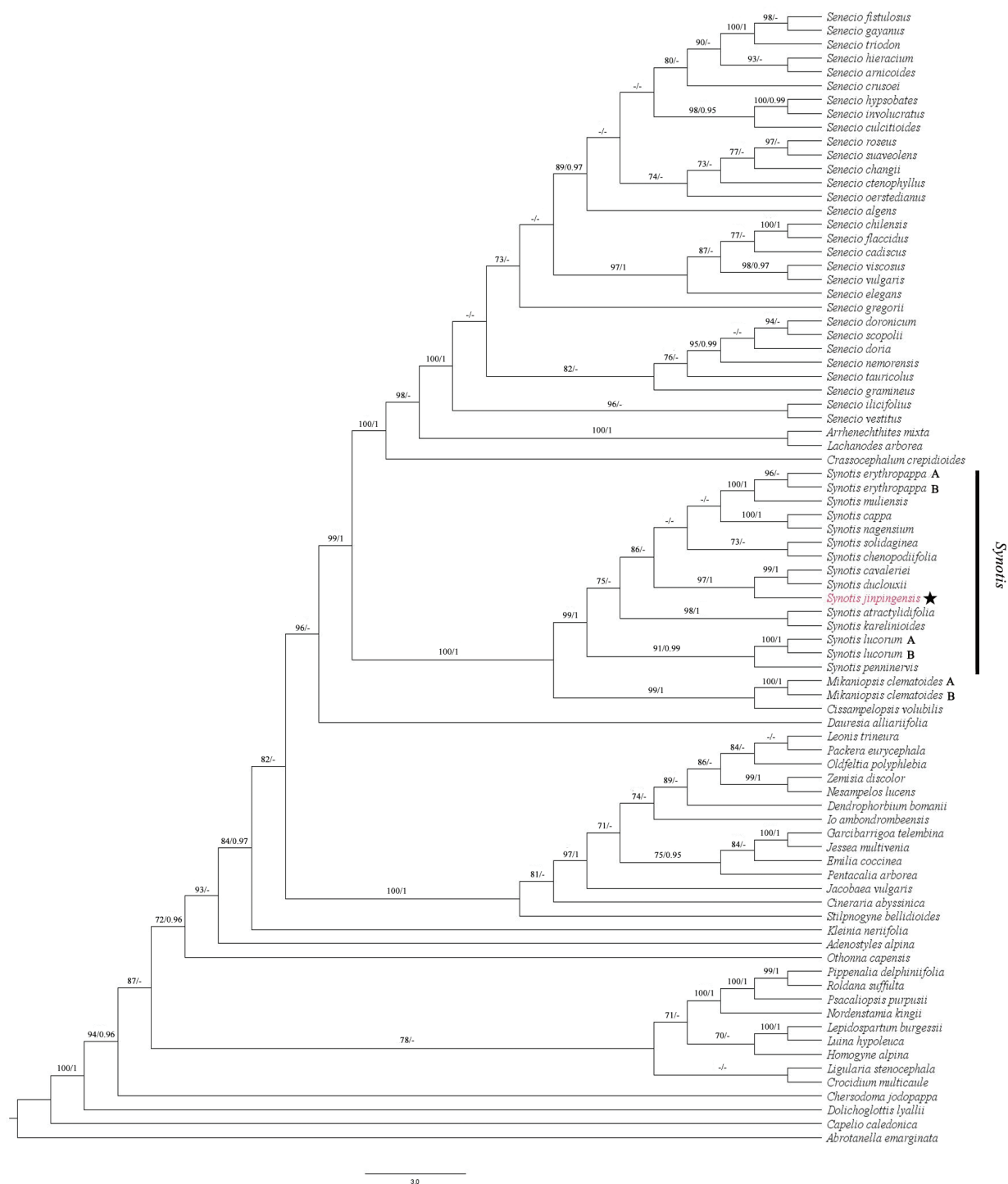


Figure 5. The maximum likelihood tree of tribe Senecioneae based on ITS dataset, with *Synotis jinpingensis* highlighted in red font. Bootstrap values (MLBS) and posterior probabilities (PP) are indicated above the branches. Dashes (-) indicate MLBS < 70% or PP < 0.95.

appendages ovate-oblong; antheropodia slightly dilated at base. Style branches ca. 2 mm long, fringed with long fine papillae, the central tuft prominent, much longer than laterals. Achenes 1.8–2 mm, glabrous. Pappus white, 6–7.5 mm long.

Phenology. Flowering from March to April; fruiting from April to July.

Etymology. The species is named after its type locality, i.e., Jinping county in southeastern Yunnan province, China.

Distribution and habitat. *Synotis jinpingensis* is currently known from its type locality, i.e., Jinping county in southeastern Yunnan province, China (Fig. 2). It grows in mixed forests at an altitude of ca. 2400 m above sea level.

Conservation status. *Synotis jinpingensis* seems currently known only from its type locality. Four small populations of this species, each with ca. 100 individuals, have been discovered there. The habitat of *S. jinpingensis* is now well preserved. The discovery of further populations of this species is to be expected as botanical exploration of southeastern Yunnan proceeds. According to the IUCN Red List Categories and Criteria (IUCN 2022), the new species may better be categorized as Data Deficient (DD).

Acknowledgements

We thank Dr. Patricio Saldivia Pérez and Dr. Rob Smitsen for their helpful comments which helped to improve our manuscript. We also thank Mr. Zongli Liang, Mr. Jianhong Li and Mr. Hailong He with the Fenshuiling National Nature Reserve in Jinping county, Yunnan, China, for their help with the field work.

Additional information

Conflict of interest

The authors have declared that no competing interests exist.

Ethical statement

No ethical statement was reported.

Funding

This work was supported by the National Natural Science Foundation of China (grant no. 31960043).

Author contributions

Data curation: ZYY. Formal analysis: RC, LCZ. Writing – original draft: MT. Writing – review and editing: QEY.

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Data availability

All of the data that support the findings of this study are available in the main text.

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Appendix 1

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

GenBank	Species	Voucher information	Herbarium
MH371137	<i>Synotis atractylidifolia</i> (Y. Ling) C. Jeffrey & Y. L. Chen	M. Tang & L. Wang 361	IBSC
EF538402	<i>Synotis cappa</i> (Buch.-Ham. ex D. Don) C. Jeffrey & Y. L. Chen	Tessier-Yandell 86	IBSC
KJ851593	<i>Synotis chenopodiifolia</i> (DC.) M. Tang et al.	M. Tang & C. Ren 532	IBSC
KU696133	<i>Synotis erythropappa</i> (Bureau & Franch.) C. Jeffrey & Y. L. Chen A	C. Ren 150	IBSC
MH117782	<i>Synotis erythropappa</i> (Bureau & Franch.) C. Jeffrey & Y. L. Chen B	YLDP026D	IBSC
MH371138	<i>Synotis karelinioides</i> (C. Winkl.) C. Ren et al.	H.M. Li & Q.G. Mao 325	IBSC
AY723255	<i>Synotis lucorum</i> (Franch.) C. Jeffrey & Y. L. Chen A	J.Q. Liu 2177	IBSC
KU696134	<i>Synotis lucorum</i> (Franch.) C. Jeffrey & Y. L. Chen B	Q.E. Yang et al. 3128	IBSC
KU696135	<i>Synotis muliensis</i> Y. L. Chen	C. Ren 148	IBSC
AF459922	<i>Synotis nagensium</i> (C. B. Clarke) C. Jeffrey & Y. L. Chen	B. Bartholomew et al. 1991	IBSC
KY347902	<i>Synotis penninervis</i> (H. Koyama) T.J. Tong et al.	M. Tang & C. Ren 626	IBSC
KX549951	<i>Synotis solidaginea</i> (Hand.-Mazz.) C. Jeffrey & Y. L. Chen	2015XZ001-B	IBSC
–	<i>Synotis duclouxii</i> (Dunn) C. Jeffrey & Y. L. Chen	C. Ren & L.Y. Wang 485	IBSC
–	<i>Synotis cavaleriei</i> (H. Lév.) C. Jeffrey & Y. L. Chen	L.Y. Wang 72	IBSC
–	<i>Synotis jinpingensis</i> M. Tang et al.	Y. Yu et al. JXAU01	JXAU
EF538296	<i>Senecio algens</i> Wedd.	S.G. Beck 2879	S
EF538298	<i>Senecio arnicoides</i> Hook. & Arn.	O. Zoellner 3474	L
GU818506	<i>Senecio cadiscus</i> B. Nord. & Pelser	Rourke 1118	S
KU499905	<i>Senecio changii</i> C. Ren & Q. E. Yang	C. Ren et al. WL146	IBSC
EF538313	<i>Senecio chilensis</i> Less.	O. Zollner 2958	S
EF538290	<i>Senecio crusei</i> Pelser	T. Stussey 6560	H
EF538322	<i>Senecio ctenophyllus</i> Phil.	O. Zoellner 3959	U
EF538312	<i>Senecio culcitioides</i> Wedd.	B. Ollgaard & H. Balslev 8822	CHR
AF459946	<i>Senecio doria</i> L.	P.B. Pelser cult. 129	WIS
JX895355	<i>Senecio doronicum</i> (L.) L.	J. Calvo 4000	WIS
GU818642	<i>Senecio elegans</i> L.	Cron & Goodman 687	–
EF538335	<i>Senecio fistulosus</i> Poepp. ex Less.	S.G. Beck & M. Liberman 9672	MJG
EF538336	<i>Senecio flaccidus</i> Less.	J. Thuret s.n.	MJG
GU818649	<i>Senecio gayanus</i> DC.	M. Rosas 2157	–
GU818650	<i>Senecio gramineus</i> Harv.	F.K. Hoener 2104	–
GU818651	<i>Senecio gregorii</i> F. Muell.	D.E. Albrecht 7091	–
GU818652	<i>Senecio hieracium</i> J. Rémy	M. Baeza & L. Finot 3695	–
EF538348	<i>Senecio hypsobates</i> Wedd	B. Ollgaard & H. Balslev 9863	U
GU818662	<i>Senecio ilicifolius</i> L.	Cron & Goodman 686	–
EF538150	<i>Senecio involucratus</i> (Kunth) DC.	B. Nordenstam 9438	L
AF459937	<i>Senecio nemorensis</i> L.	P.B. Pelser cult.102	L
EF538362	<i>Senecio oerstedianus</i> Benth.	B. Nordenstam 9160	S
EF538373	<i>Senecio roseus</i> Sch. Bip.	J. Garcia P. 250	U
JX895384	<i>Senecio scopoli</i> Hoppe & Hornsch. ex Bluff & Fingerh.	J. Calvo 4715	–
EF538222	<i>Senecio suaveolens</i> (L.) Elliott	D.C. Dister s.n.	MJG
GU817570	<i>Senecio tauricolus</i> V. A. Matthews	Budak et al. 1735	–

GenBank	Species	Voucher information	Herbarium
GU818707	<i>Senecio triodon</i> Phil.	F. Luebert & S. Teillier 2266	–
GU818708	<i>Senecio vestitus</i> P. J. Bergius	W. Greuter 21766	–
AF459925	<i>Senecio viscosus</i> L.	P.B. Pelser 300	TEX
AF459924	<i>Senecio vulgaris</i> L.	P.B. Pelser cult. 188	CHR
GU818721	<i>Stilpnogyne bellidioides</i> DC.	P. Goldblatt & L. Porter 11729	–
EF538416	<i>Zemisia discolor</i> (Sw.) B. Nord.	G.L. Webster et al. 8420	S
EF538143	<i>Abrotanella emarginata</i> (Gaudich.) Cass.	R.N.P. Goodall & J. Wood 3352	MU
EF538146	<i>Adenostyles alpina</i> Bluff & Fingerh.	C.H. Uhink 98-189a	MJG
EF538156	<i>Arrhenechthites mixta</i> (A. Rich.) Belcher	M.E. Lawrence 1308	S
GU818508	<i>Capelio caledonica</i> B. Nord.	B. Nordenstam 9644	–
EF538167	<i>Chersodoma jodopappa</i> (Sch. Bip.) Cabrera	I. Hensen 2617	S
GU818512	<i>Cineraria abyssinica</i> Sch. Bip. ex A. Rich.	P.B. Pelser cult. 208	L
EF538172	<i>Cissampelopsis volubilis</i> (Blume) Miq.	Carvalho 3175	US
AF459968	<i>Crassocephalum crepidioides</i> (Benth.) S. Moore	P.B. Pelser cult. 354	S
GU818541	<i>Crocidium multicaule</i> Hook.	B. Bartholomew 5749	–
AF457413	<i>Dauresia alliariifolia</i> (O. Hoffm.) B. Nord. & Pelser	Mueller & Tilson 907	–
EF538181	<i>Dendrophorbium bomanii</i> (R. E. Fr.) C. Jeffrey	M. Dematteis & G. Seijo 722	MU
GU818546	<i>Dolichoglottis lyallii</i> (Hook. f.) B. Nord.	A. Strid 22172	–
AF459966	<i>Emilia coccinea</i> (Sims) G. Don	P.B. Pelser cult. 126	MJG
EF538211	<i>Garcibarrigoa telembina</i> (Cuatrec.) Cuatrec.	L. Holm-Nielsen et al. 6211	S
KU570815	<i>Homogyne alpina</i> Cass.	Comes 11	MJG
GU818559	<i>Io ambondrombeensis</i> (Humbert) B. Nord.	S.T. Malcomber et al. 1380	–
AF459941	<i>Jacobaea vulgaris</i> Gaertn.	P.B. Pelser cult. 6	S
EF538246	<i>Jessea multivenia</i> (Benth.) H. Rob. & Cuatrec.	B. Nordenstam 9161	K
GU818568	<i>Kleinia neriifolia</i> Haw.	P.B. Pelser cult. 216	–
GU818574	<i>Lachanodes arborea</i> (Roxb.) B. Nord.	R. Cairns-Wicks s.n.	–
EF538249	<i>Leonis trineura</i> (Griseb.) B. Nord.	Smith et al. 3238	L
EF538250	<i>Lepidospartum burgessii</i> B.L. Turner	R.D. Worthington 12382	L
AF459961	<i>Ligularia stenocephala</i> (Maxim.) Matsum. & Koidz.	R.R. Kowal 3092	WIS
GU818593	<i>Luina hypoleuca</i> Benth.	W. Greuter 17706	–
GU818595	<i>Mikaniopsis clematoides</i> (Sch. Bip. ex A. Rich.) Milne-Redh. A	W.J.J.O. de Wilde & B.E.E. de Wilde-Duyfjes 9006	–
GU817581	<i>Mikaniopsis clematoides</i> (Sch. Bip. ex A. Rich.) Milne-Redh. B	I. Friis et al. 499	–
EF538266	<i>Nesampelos lucens</i> (Poir.) B. Nord.	Zanoni 45570	JBSD
EF538267	<i>Nordenstamia kingii</i> (H. Rob. & Cuatrec.) B. Nord.	B. Stahl 5572A	S
EF538271	<i>Oldfeltia polyphlebia</i> (Griseb.) B. Nord. & Lundin	B. Nordenstam & R. Lundin 340	S
AF459960	<i>Othonna capensis</i> L. H. Bailey	P.B. Pelser cult. 106	S
GU818608	<i>Packera eurycephala</i> (Torr. & A. Gray) W.A. Weber & Á. Löve	M.A. Vincent 8581	MU
EF538283	<i>Pentacalia arborea</i> (Kunth) H. Rob. & Cuatrec.	B. Ollgaard & H. Balslev 8298	MU
GU818627	<i>Pippenalia delphiniifolia</i> (Rydb.) McVaugh	Spellenberg & Bacon 11048	–
GU818629	<i>Psacaliopsis purpusii</i> (Greenm. ex Brandegees) H. Rob. & Brettell	Panero et al. 2607	–
GU818631	<i>Roldana suffulta</i> (Greenm.) H. Rob. & Brettell	Rzedowski 36569	–