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Source: The Bryologist, 115(3):382-387. 2012.

Published By: The American Bryological and Lichenological Society, Inc.

DOI: <http://dx.doi.org/10.1639/0007-2745-115.3.382>

URL: <http://www.bioone.org/doi/full/10.1639/0007-2745-115.3.382>

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# Contributions to the lichen flora of the Hengduan Mountains, China (5). *Anzia rhabdorrhiza* (Parmeliaceae), a new species

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**ABSTRACT.** *Anzia rhabdorrhiza* Li S. Wang & M. M. Liang is found to be a species new to science from Hengduan Mountains in southwest China. It is characterized by long and thick rhizines covered with spongiostratum, a central chondroid band in the medulla, and production of atranorin and divaricatic acid. The new species belongs to the Sect. *Nervosae* of *Anzia*.

**KEYWORDS.** Chondroid band, rhizinae, Sichuan Province, spongiostratum, Yunnan Province.



The lichen genus *Anzia* Stizenb. was first described by Stizenberger (1861) as one of the most peculiar genera among the Parmeliaceae. The genus is characterized by a foliose thallus, with spongiostratum covering the lower surface and with numerous spores in one ascus. Asahina (1935) divided *Anzia* into three sections, mainly based on medullary structures. Sect. *Nervosae* is well delimited by a chondroid band corresponding to the central axis in *Usnea*. Sect. *Simplices* and Sect. *Duplices* were delimited by having a single-layered and double-layered medulla, respectively. Thirty-four species have been reported from all over the world, including nineteen taxa from Asia, nine of which are from China (Asahina 1935, 1937; Jayalal et al. 2012; Stao 1936, 1954; Wei 1991; Wu & Wang 1992; Wang 1995; Xiao et al. 2007; Yoshimura & Elix 1997). The

authors undertake a program of floristic study of the lichens from the Hengduan Mountains, and some interesting *Anzia* specimens have been collected from this region between 1983 till now. Among them, one of the species is found to be quite unique from other known *Anzia*, and after detailed study, it is confirmed as a new and distinctive species of *Anzia*.

## MATERIALS AND METHODS

In this study, 453 specimens of *Anzia* were examined, 55 of them are different from other *Anzia* species in the world, they are identified as *A. rhabdorrhiza*. The description of the external morphology is based on air-dried material observed under a dissecting microscope (Nikon C-FPS 230). For the anatomical description, sections were made from fragments of dried lichen, thallus mounted with GAW (glycerol:ethanol:water=1:1:1) under a Nikon E200 stereomicroscope, and photographed with a Nikon D200 camera. All spore measurements were made on material mounted in water. Ten ascospores

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DOI: 10.1639/0007-2745-115.3.382

per specimen were measured for ascospore dimensions (all measurements made outside of the ascus). The dimensions of ascospores are generally presented as smallest single value recorded–largest single value recorded. The specimens used in this study are deposited in the Cryptogamic Herbarium of the Kunming Institute of Botany, Academia Sinica (KUN–L).

Chemical analyses were made by thin-layer chromatography (TLC), high-performance liquid chromatography (HPLC) and column chromatography. Methods for the TLC followed Culbertson *et al.* (1970, 1972, 1982) using a single solvent system (toluene:acetic acid=10:1). HPLC analysis was performed on an Agilent 1260 series HPLC system. The reversed-phase column used was Zorbax SB–C 18 (4.6 × 150 mm, i.d., 5 µm). The gradient elution system consisted of 0.5% formic acid (A) and methanol (B). Separation was achieved using the following gradient: 0–20 min. 70–100% B. The column temperature was set at 30°C; the flow rate was 1 ml/min; and the UV detection wavelength was 254 nm. A dried piece of thallus was used for the column chromatography (1.23 g) that extracted with methanol (80 ml × 3) at 40°C for 6 h each. The extract was evaporated and given residue (90 mg), which was separated by middle pressure RP–18 silica gel CC (MeOH: water = 7: 3) to yield divaricatic acid (47 mg).

## TAXONOMY

*Anzia rhabdorrhiza* Li S. Wang & M. M. Liang, *sp. nov.* **Fig. 1**

Mycobank: MB 801141

While this new species resembles *A. physoidea*, it differs in having a central chondroid band in the medulla, a distinct tomentum-free zone along the margins of the lower surface and presence of divaricatic acid.

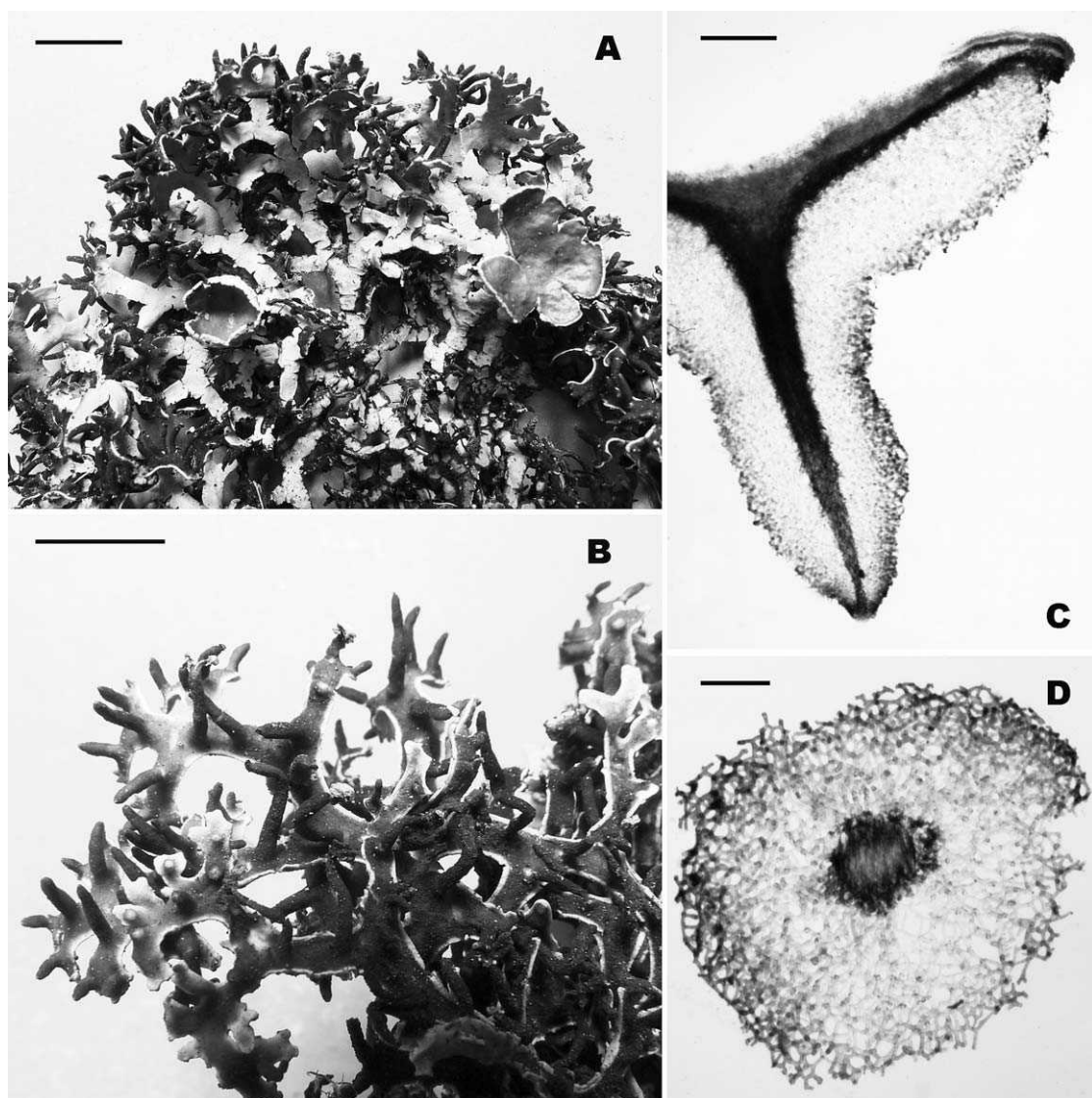
TYPE: CHINA. YUNNAN PROV., Lijiang Co., Jiuhe village, Laojunshan Mt., 26°37'N, 99°43'E, elevation 3860 m. On bark of *Rhododendron* sp., 22 May 2011, Wang Li-song & Liang Meng-meng 11–32047 (KUN–L 20000—holotypus; HMAS–isotypus).

**Etymology.** The epithet “*rhabdorrhiza*” refers to the long and thick rhizinae wrapped by spongiostratum densely present in each internode of the branches.

**External morphology.** Thallus foliose, round flat and loosely attached to the substrate, 3–7 cm wide, lacinate, margin incurved; lobes sub-linear, mostly irregular isotomic branched at the center, becoming dichotomously branched at the apices, internode 2–5 mm long, 1–4 mm wide, with angle between dichotomies obtuse and rounded towards the base (usually less than 90°) and dull toward the apices (ca. 90°–135°), 1.2 mm wide. Upper surface smooth, dim and gray greenish, becoming pale brown in the herbarium, with some cracks that expose the white medulla, without soredia and isidia (**Fig. 1A**). Lower surface covered with thin brownish black, spongiostratum, which occasionally becomes peeled off in the center of the lobes, revealing the white medulla and a narrow tomentum-free zone along the margins, ca. 0.1 mm wide (**Fig. 1B**); the rhizinae are simple, covered with spongiostratum growing from the chondroid, numerous with 2–7 entries per internode, rather long and thick, usually 1–7 mm long, up to 1 mm in diameter.

**Anatomy.** Upper cortex brownish, 20–37 µm thick, with a dark green algae layer below, 30–50 µm thick, green and round algae cell 5–7 µm in diameter. Medulla 75–120 µm thick, composed of separated hyphae and mainly parallel to the surface in various directions (chalaroplectenchyma); includes a flat central chondroid band, c. 75–190 µm thick, compared to the medulla, the hyphae are more densely agglutinated in a longitudinal direction (prosoplectenchyma, **Fig. 1C**). Lower cortex absent. Spongiostratum located on the ventral side of the lobe, 400–850 µm thick, hyphae brown to black, 30 × 4 µm. On the transverse section of the rhizinae, (ca. 0.6–0.8 mm in diam.) a white hyphal core present at the center (ca. 150 µm in diam., **Fig. 1D**); on the longitudinal section, a hyphal band extends from the central chondroid band, throughout the center of spongiostratum (**Fig. 1C**).

Apothecia cup-like, with a short petiole; disc red–brown, shiny, concave when young, flat when close to mature and chapped when mature, 1–17 mm in diameter; margin completely smooth when young, cracked and rough when mature; parathecium has wrinkled ridges, occasionally with some white and round flecks, the color is much lighter than the upper surface of lobe. Hymenium 50–60 µm thick, with its



**Figure 1.** *Anzia rhabdorrhiza* Wang Li-song & Liang Meng-meng *sp. nov.* Holotypus. **A.** Upper surface; **B.** Lower surface; **C.** A rhizine growing from a flat central chondroid band in the medulla; **D.** Transverse section of a rhizine showing a hyphal core at the center. Scales: A = 10 mm; B = 5 mm C = 200  $\mu$ m; D = 100  $\mu$ m.

brown epithecium, 10–13  $\mu$ m thick; subhymenium 15–20  $\mu$ m thick, paraphyses hyaline, 15–20  $\times$  1–2  $\mu$ m; hypothecium 25–30  $\mu$ m thick. Algae layer below the hypothecium dark green, 25–50  $\mu$ m thick, algae cell 5–10  $\mu$ m in diameter. Medulla layer 40–50  $\mu$ m thick, hyphae 2–3  $\mu$ m in diameter. Ascus single, 37.5–43  $\times$  7–10  $\mu$ m. Spores hyaline, single-celled, crescent-shaped and spirally arranged in an ascus, numerous, 7.5–12.5  $\times$  2–5  $\mu$ m.

Pycnidia (0.2–0.8 mm) are black, shiny and roundish, with a hole on the apex, growing on the

margin of the lobes. Conidia have a rod-like shape, hyaline, 4–6  $\times$  1–1.2  $\mu$ m.

**Chemistry.** Cortex K+ yellow, C–, KC–, P–; medulla K+ yellow, C–, KC–, P–. Atranorin and divaricatic acid were identified by TLC, HPLC and column chromatography analyses. The sample used in the HPLC analysis comes from a part of the holotype (11–32047).

**Distribution.** Currently known only from the Hengduan Mountains in southwestern China (Yunnan and Sichuan Provinces, **Fig. 2**)

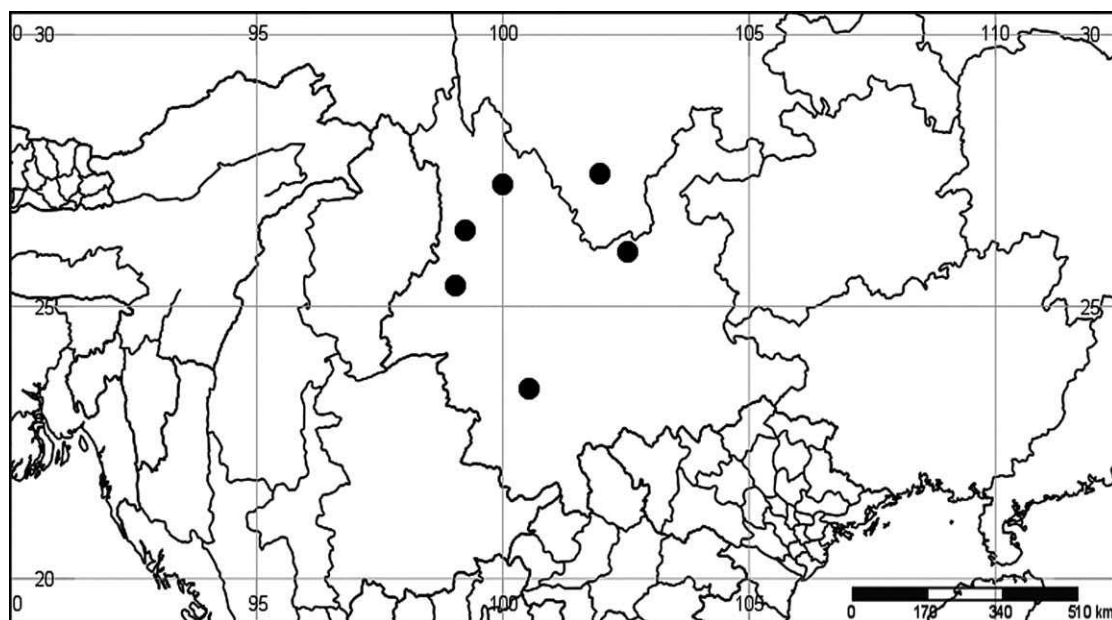


Figure 2. Distribution map of *Anzia rhabdorrhiza* in China.

**Habitat and ecology.** *Anzia rhabdorrhiza* is common on branches and twigs of *Rhododendron* spp. (33 specimens), also on bark of *Abies georgei*, *Picea* sp., and on *Salix* spp.; between elevations of 2400 and 3900 m.

**Remarks.** *Anzia rhabdorrhiza* is distinguished by the long and thick rhizinae wrapped by spongiostratum densely present, with a flat central chondroid band in medulla, distinct tomentum-free zone along the margins of the lower surface, hollow masses of spongiostratum and the presence of divaricatic acid. This combination of characteristics differs from all the other known species of *Anzia* from the world.

The character of rhizinae wrapped by spongiostratum morphologically resembles *A. physioidea* A. L. Smith., which is found in the eastern Himalayas. However, based on descriptions by Smith (1931), Awasthi (1961) and Yoshimura (1997), *A. physioidea* is clearly different from *A. rhabdorrhiza* by lacking both a central chondroid band and tomentum-free zone on the lower surface; and the main compound in *A. physioidea* is lobaric acid (KC+ rose, Yoshimura 1997). Based on these findings, it can be stated with confidence that *A. rhabdorrhiza* is not *A. physioidea* which has previously been described from China, and it is a new species belonging to the Sect. *Nervosae* of *Anzia*.

Further confirmation of the differences between *A. rhabdorrhiza* and other related species is the central chondroid band in medulla and rhizinae with spongiostratum. These characteristics can be found in three South American species, *A. dictyorrhiza* (Massée) Yoshimura, *A. lopezii* Yoshimura, and *A. masonii* Yoshimura. However, all of these species have vegetative reproductive propagules, which are absent in *Anzia rhabdorrhiza*. *A. dictyorrhiza* has sorediate lobules aggregated and developed mostly at lobe apices; *A. lopezii* has sorediate lobules developed along the lobe margin; and *A. masonii* has isidia mostly formed on laminae of lobes (Yoshimura 1995). Two species, *A. parasitica* from South America and *A. centrifuga* from Porta Santo, also have a chondroid axis, contain divaricatic acid and lack vegetative propagules and might be confused with the new species. However, neither of them has rhizines wrapped by spongiostratum. Furthermore, *A. parasitica* (Yoshimura 1987) differs by having a Neotropical distribution, and *A. centrifuga* (Haugan 1992) differs by having pruinose lobe tips, and sparse rhizines which are weakly branched near the apex.

Wang (1995) has examined some *Anzia* specimens from the Hengduan Mountains and formally identified them as *A. physioidea*, mainly because of the rhizines covered with



spongiostrium. However, the name *A. physioidea* clearly corresponds to a distinct species (Awasthi 1961, 1988; Smith 1931; Yoshimura 1997). All the specimens previously reported from China share the same characters as *A. rhabdorrhiza*, and it can be concluded that *A. physioidea* previously reported from the Hengduan Mountains actually represent *A. rhabdorrhiza*. Thus, those specimens previously identified by Wang should correctly be labeled *A. rhabdorrhiza*, and *A. physioidea* likely does not occur in China.

**Representative specimens examined.** All

paratypes in KUN-L unless stated. CHINA: YUNNAN PROV. Hugong Co. The Mountain behind a Qiaomigulu production team, 2200 m elevation, on stump, Wang Li-song, 9 Jun. 1982, 82–611 (KUN-L 3361). JingDong Co., Ailaoshan Mt., Xujiaba village, 23°36'N, 100°44'E, 2400 m elevation, on stump, Wang Li-song, 24 Aug. 1994, 94–14324 (KUN-L 15844), 94–14490 (KUN-L 15845); elevation 2470 m, 19 Feb. 2005, 05–24017; elevation 2450 m, 31 March. 2006, AL-036; 2400 m elevation, 18 Aug. 2008, 08–29628. Caojian Co., Zibenshan Mt., 25°44'N, 99°03'E, on bush of *Salix* sp. Wang Li-song, 12 Jun. 2000, 00–18775 (KUN-L 17892), 00–18895 (KUN-L 18985). Luquan Co., Jiaozixueshan Mt., elevation 3000 m, on *Rhododendron* spp., Wang Li-song, 24 Sept. 2000, 00–20429 (KUN-L 18421). Zhongdian Co., Habaxueshan Mt., 27°20'N, 100°04'E, elevation 3500 m, on stump, Wang Li-song, 26 Oct. 2002, 02–21920 (KUN-L 18815). Lijiang Co., Maanshan Mt., Jiushijulongtian Lake., 26°39'N, 99°46'E, elevation 3400 m, on *Rhododendron* spp., Wang Li-song, 16 Aug. 2000, 00–20080 (KUN-L 18418); elevation 3500 m, 15 Aug. 2000, 00–20158 (KUN-L 18416), 00–20159 (KUN-L 18417), 00–20165 (KUN-L 18419), 00–20195 (KUN-L 18420); 10 Oct. 2003, 03–22671 (KUN-L 18984); Laojunshan Mt., Jiuhe village, 26°39'N, 99°46'E, 3600 m elevation, Wang Li-song, 15 Jun. 2005, 05–24744, on *Rhododendron* spp., 3700 m elevation, 17 May 2005, 05–24419; 26°39'N, 99°46'E, elevation 3450 m, on *Rhododendron* spp., Wang Li-song, 24 Aug. 2006, 06–26473, 06–26486; elevation 3200 m, 18 Oct. 2008, 08–29740; elevation 3516m, 16 Jul. 2010, 10–31529, 10–31531; 26°39'N, 99°46'E, elevation 3570 m, on bark of *Abies* spp. Wang Li-song & Liang Meng-meng, 22 May 2011, 11–31973; on bark of

*Rhododendron* spp., 11–31974, 11–31975, 11–31976, 11–31999, 11–32000, 11–32001, 11–32002, 11–32003; elevation 3860 m, 11–32046, 11–32065, 11–32068, 11–32123, 11–32124, 11–32125, 11–32128, 11–32130, 11–32132, 11–32133; Yulongxueshan Mt., elevation 3200–3600 m, on *Rhododendron* spp., Wang Li-song, 10 Nov. 2009, 09–31195, 09–31216. Sichuan Prov., Miyi Co., Malong village, Beipo Mt., elevation 3000 m, on bark, Wang Li-song, 9 Jul. 1983, 83–921 (KUN-L 4972); elevation 2800 m, 83–1005 (KUN-L 4918); 2900 m elevation, 83–1013a (KUN-L 11680).

**ACKNOWLEDGMENTS**

We are greatly indebted to Prof. Ying-jun Zhang, Dr. Dong Wang, Dr. Zhi-zhi Du, Dr. Min Xu, Dr. Zhi-hong Zhou, Tao Lü and Hong-xia Zhang for their support with chemical analyses and to Prof. Zhi-yun Su, Dr. Wen-zhang Ma for helpful comments on the manuscript. This study was supported by a grant from the National Natural Science Foundation of China (No. 31170023), Foundation of Key Laboratory, CAS (KLBB-201210) and Flora Lichenum Sini-corum (KSCX2-EW-Z-9).

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ms received March 27, 2012; accepted August 13, 2012.