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The genus *Anthracothecium* (Pyrenulaceae) in Russia

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Summary. The genus *Anthracothecium* is re-reported for the territory of Russia. The article discusses that *A. speciosum* f. *speciosum* was mistakenly included in the lists of lichens of Russia, of the south of the Far East and of Shikotan Isl., and also that *A. speciosum* f. *iturupiens*e morphologically and anatomically corresponds more closely to the genus *Pyrenula*. Thus, the tropical genus *Anthracothecium* is represented in Russia by one species, *Anthracothecium australiense* reported here to the Kunashir Island. This is a first record of the species in Russia which has previously been known to Australia, Oceania (New Guinea), Asia (Japan and China), North and South America (Brazil, Argentina). The species is characterized by large, brown muriform ascospores with thin walls, as well as immersed, erumpent, and semi-immersed, black, globose perithecioid ascomata (0.5–)0.7–1.0 mm wide with a short neck and lateral ostiole. The data on distribution, ecology, and distinctive features of the species as well as photos are provided.

Род *Anthracothecium* (Pyrenulaceae) в России

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Ключевые слова: остров Кунашир, пиренолишайники, распространение, Российский Дальний Восток, Сахалинская область, тропические виды, флористические находки, эпифитные лишайники, *Anthracothecium australiense*, *Anthracothecium speciosum* f. *iturupiense*, *Anthracothecium speciosum* f. *speciosum*, Pyrenulaceae.

Аннотация. Род *Anthracothecium* вновь зарегистрирован на территории России. В статье обсуждается, что *A. speciosum* f. *speciosum* был ошибочно включён в списки лишайников России, юга Дальнего Востока и Шикота-

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на, а также что *A. speciosum* f. *iturupiense* морфолого-анатомически больше соответствует роду *Pyrenula*. Таким образом, тропический род *Anthracothecium* представлен в России одним видом *Anthracothecium australiense*, обнаруженным нами на острове Кунашир. Это первое сообщение об этом виде в России, который ранее был известен в Австралии, Океании (Новой Гвинея), Азии (Япония, Китай), Северной и Южной Америке (Бразилия, Аргентина). Для этого вида характерны крупные коричневые муральные аскоспоры с тонкими стенками, а также погруженные, прорывающиеся и полупогруженные чёрные шаровидные перитециоидные плодовые тела (0,5–)0,7–1,0 мм шириной, с короткой шейкой и боковым остиолем. Представлены информация о распространении, экологии и отличительных особенностях вида, а также фотографии.

Introduction

The genus *Anthracothecium* Hampe ex A. Massal. (Pyrenulaceae Rabenh.) includes corticolous pyrenocarpous lichens distributed mostly in tropical regions. The representatives of the genus are characterized by brown murifom ascospores with thin walls (euseptate) and gelatinous sheath as well as hamathecium of unbranched and persistent filaments (Aptroot, 2009). *Anthracothecium* comprises five species (Aptroot, 2012; Hyde et al., 2024), namely *Anthracothecium australiense* (Müll. Arg.) Aptroot, *A. prasinum* (Eschw.) R.C. Harris, *A. macrosporum* (Hepp) Müll. Arg., *A. gregale* (C. Knight) Aptroot, and *A. interlatens* (Nyl.) Aptroot (Aptroot, 2012). To date, only two taxa of the genus have been reported in Russia: *Anthracothecium speciosum* Zahlbr. f. *speciosum* (Makarevich, 1977; Tchabanenko, 2002; Urbanavichus, 2010, with the question mark; Chesnokov, Konoreva, 2022) and *A. speciosum* f. *iturupiense* Blum (Blum, 1970; Makarevich, 1977; Tchabanenko, 2002; Chesnokov, Konoreva, 2022). Aptroot (2012) synonymized *A. speciosum* to *Pyrenula breutelii* (Müll. Arg.) Aptroot while *A. speciosum* f. *iturupiense* was placed with the question mark in *Anthracothecium prasinum* (Eschw.) R. C. Harris, however the morphological characters of *A. speciosum* f. *iturupiense* are not matched to the genus *Anthracothecium*. Here we reported a new finding, *Anthracothecium australiense* and re-reported *Anthracothecium* as a new genus for Russia.

Material and methods

The specimens of *Anthracothecium australiense* were collected by A. K. Ezhkin on the Kunashir Isl. in 2013, 2015 and 2017. The materials were processed according to standard methods (Stepanchikova, Gagarina, 2014) at Altai State University using a stereomicroscope (Olympus SZ-61) and a compound microscope (Zeiss Axio Lab.A1). Anatomical examination was undertaken using hand cut sections mounted in water with following reagents: 10 % KOH (K) and Lugol's solution (I). Measurements of ascocarps and ascospores are presented as: (extreme minimum value observed) minimum–maximum including 85 % of the variation (extreme maximum value observed) following M. Westberg (2005). Measurements of other parameters are given as maximum value. The measurements of anatomical structures were made to the nearest 0.5 μm. The names of the taxa are provided according to Aptroot (2012). All geographical coordinates are given in the coordinate system WGS 1984. Samples are stored in the herbarium of the Institute of Marine Geology and Geophysics of the Far Eastern Branch of the Russian Academy of Sciences (SAK). The duplicate of the specimen *Anthracothecium australiense* SAK 2465 is deposited in the ALTB (Altai State University, Barnaul). Herbarium citations in this work follow the standard acronyms: G (Conservatoire et Jardin botaniques de la Ville de Genève), BRI (Queensland Herbarium & Biodiversity Science), W (Naturhistorisches Museum Wien), and TNS (National Museum of Nature and Science).

Results and discussions

Anthracothecium australiense (Müll. Arg.) Aptroot, 1997, in Aptroot, Diederich, Sérusiaux et Sipman, Bibl. Lichenol. 64: 17 (Fig. 1).

≡ *Pleurothelium australiense* Müll. Arg., 1891, Nuovo Giorn. Bot. Ital. 23: 401; *Pleurotheliopsis australiensis* (Müll. Arg.) Zahlbr., 1922, Cat. Lich. Univ. 1: 513.

Type: "Qld, locality unknown, F. M. Bailey 562" (holo – G, not seen).

= *Parmentaria subastroidea* var. *subsimplex* Müll. Arg., 1895, Rep. Australas. Assoc. Advancem. Sci. 1895: 463.

Type: "Qld, locality unknown, 1875, J. Shirley" (iso – BRI, not seen).

= *Pleurotheliopsis nana* Zahlbr., 1935, Ann. Mycol. 33: 40; *Parmentaria nana* (Zahlbr.) R. C. Harris, 1987, in R. S. Egan, Bryologist 90: 164; *Anthracothecium nanum* (Zahlbr.) R. C. Harris, 1989, Mem. New York Bot. Gard. 49: 79.

Type: Sanford, Florida, U.S.A., Rapp 72; (lecto – W, fide R. C. Harris, loc. cit., not seen).

= *Pleurotheliopsis erigens* Kashiw.

= *Anthracothecium erigens* (Kashiw.) H. Harada.

Anthracothecium erigens (Kashiw.) H. Harada, 2004, in Harada, Okamoto et Yoshimura, Lichenology 2(2): 131.

Type: "Japan. Mt. Chibusa, Haha-jima Island, The Bonin Islands, on bark of *Leucaena glauca*, elev. ca. 300 m. H. Kashiwadani 14103" (holo – TNS, not seen).

Specimens examined: "Russia, Sakhalin Region, Kunashir Island, Yuzhno-Kurilskiy District, Lagunnoye Lake vicinity, 44°2′49″N, 145°45′59″E, 65 m a. s. l., old-growth mixed coniferous-broad leaved forest, on bark of *Ulmus laciniata*. 17 VIII 2013. Ezhkin" (SAK 4017); *ibid*., "Tretyakova Village vicinity, old growth mixed coniferous-broad leaved forest, 43°58′28″N, 145°39′49″E, 163 m, on bark of *Quercus crispula*. 22 VI 2015. Ezhkin" (SAK 4018); *ibid*., "Dubovoye Village vicinity, oak forest, 43°46′28″N, 145°31′00″E, 58 m a. s. l., on bark of *Quersus crispula*. 23 VIII 2017. Ezhkin" (SAK 2461, 2465).

Morphological description based on the specimens studied

Thallus crustose, more or less immersed in the bark, continuous, smooth, silvery white, without pseudocyphellae or pigments, with black prothallus. Perithecia black, solitary, 0.5–0.7(–1.0) mm wide, globose with short neck and lateral ostiole, immersed to erumpent and semi-immersed forming projections on the thallus. Hamathecium filaments unbranched and persistent, I+ blue, KOH–. Ascospores muriform, brown, euseptate, lumina cubical, (50.0–)87.5–97.0(–102.0) × (17.5–)25.0–27.5(–30.0) µm; 4–6(–8) ascospores per ascus. Photobiont *Trentepohlia*. Spot tests: thallus K–, C–, KC–, P–, UV–.

Ecology and distribution: The species is mainly pantropical, occurs on trees in coastal, lowland to upland rainforest and in more open areas (Aptroot, 2009). It has previously been recorded in Oceania – New Guinea, Australia (Aptroot et al., 1997), South America – Brazil, Argentina (Aptroot, Ferraro, 2005, as *A. nanum*), North America (Henssen, 1970, as *Pleurotheliopsis australiensis*; Harris, 1989, as *Anthracothecium nanum*), and in Asia – Japan (Ohmura, Kashiwadani, 2018), China (Wei, 2020, as *A. nanum*) and Russia. The Russian localities are the northernmost points of the distribution of the species.

The Russian material fits the morphological description well, having large, solitary ascomata with a lateral ostiole. However, the number of ascospores per ascus exceeds two, and the ascospores are much smaller in size compared to those described in the protologue: up to 175 long and 40 µm wide (Müller Argoviensis, 1891), with Australian material: (130–)160–175 × 35–40 µm (Aptroot, 2009) and with North America material: 120–140 µm long (Henssen, 1970).

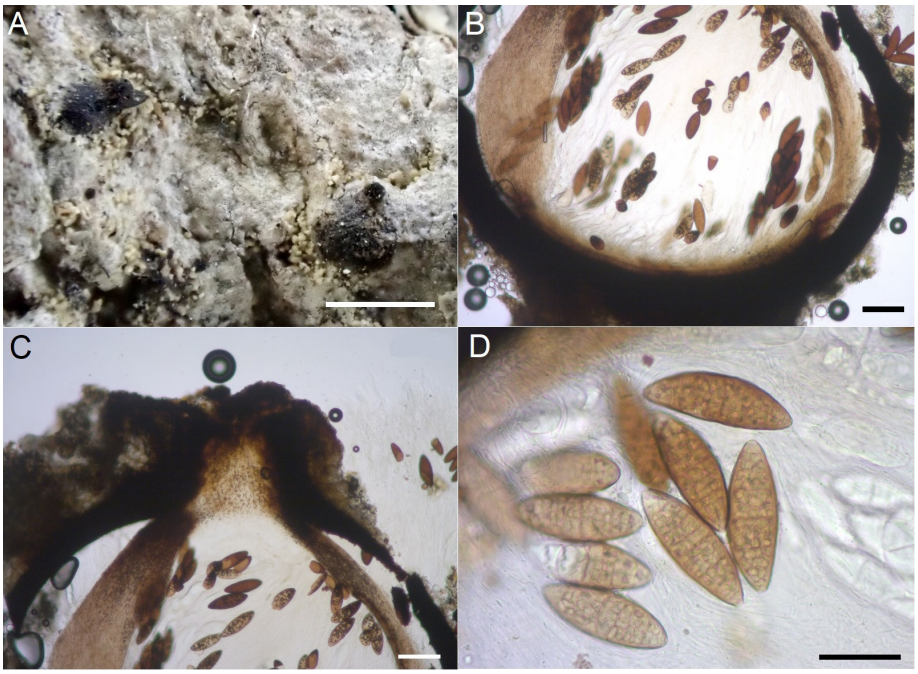

Fig. 1. *Anthracothecium australiense* (SAK 2465): A – thallus with ascomata; B – ascomata section, lower part; C – ascomata section, upper part; D – ascospores. Scale bars: A = 1 mm, B, C = 100 µm, and D = 50 µm.

Anthracothecium nanum (Zahlbr.) R. C. Harris included as synonym has even larger ascospores, 150–200 × 40–50 mm for Argentinean material (Aptroot, Ferraro, 2005) and 130–180(–225) × 38–50 for North American material (Harris, 1989). However, in the synonym list, we found a Japanese name *Anthracothecium erigens* (Kashiw.) H. Harada (Kashiwadani, 1978; Harada et al., 2004). This species has shorter ascospores measuring 50–75 × 22–23 μm with 6–8 spores per ascus, which is more similar to specimens from Russia. It seems *Anthracothecium australiense* is various regarding ascospores' size and their number per ascus as well as is characterized mainly by the single ascomata with lateral ostiole (Aptroot, 2012).

Discussion

The genus was reported for the first time for Russia by O. B. Blum (1970) who had described a new form, *Anthracothecium speciosum* f. *iturupiense*, from Kurils (Russian Far East). According to the protologue, it differs from *A. speciosum* A. Zahlbr. f. *speciosum* by a thicker thallus (0.6–0.8 mm vs. 0.25–0.33 mm), slightly larger and more immersed, exclusively spherical or oval perithecia with always continuous more or less even exciple and smaller ascospores (30–)40–53 × (13–)16–18.6, arranged mostly in a single row (Blum, 1970). Herewith, the author did not possess a specimen of *Anthracothecium speciosum* in Russia, but the holotype of *Anthracothecium speciosum* from China (Yunnan Province) was sent to him by Dr. Riedl, an employee of the Vienna Natural History Museum, for investigation. However, two forms of *Anthracothecium speciosum*, i. e., f. *iturupiense* and f. *speciosum* were included in the Handbook of the lichens of the USSR (Makarevich, 1977) from the Russian Far East (Kuril Islands) without specifying their exact localities. Then, in the "Checklist of the lichen flora of the South of the Russian Far East" (Tchabanenko, 2002) two taxa were also included not only for Iturup Isl. but for Shikotan Isl. as well based on Blum (1970) only despite the fact that there was no mention of the presence of the species on Shikotan in the mentioned publication. Due to this confusion, it is most likely that G. P. Urbanavichus (2010) included *Anthracothecium speciosum* with a question mark in a checklist of the lichen flora of Russia, however *Anthracothecium speciosum* f. *iturupiense* was not included. Conducting his world-scale revision of the genera *Anthracothecium* and *Pyrenula*, Aptroot (2012) transferred *Anthracothecium speciosum* to the genus *Pyrenula* (= *P. breutilii* (Müll. Arg.) Aptroot) mainly on the base of distoseptate ascospores with notably thickened endospore and rounded lumina. Surprisingly, *Anthracothecium speciosum* f. *iturupiense*, which differs from *A. speciosum* only in the thickness of its thallus and the size of its spores (Blum, 1970), was synonymized with *A. prasinum* (Eschw.) R. C. Harris (Aptroot, 2012), which has much larger euseptate ascospores measuring 60–90 μm × 27–40 μm with angular lumina (Harris, 1989). According to the picture of ascospores from the protologue (Blum, 1970), both *Anthracothecium speciosum* f. *iturupiense* and *A. speciosum* f. *speciosum* belong to *Pyrenula* genus however, it is currently impossible to clarify the identity of *A. speciosum* f. *iturupiense* since the type specimens kept in Kiev is not available for study. Finally, in the most recent regional checklist (Chesnokov, Konoreva, 2022) the nomenclature changes made by Aptroot (2012) were not taken into account, and erroneous information about the species' presence on the Shikotan Island, as mentioned by Tchabanenko (2002), was included. Thus, the tropical genus *Anthracothecium* is represented in Russia by one species, *Anthracothecium australiense* found by us in the Kunashir Island and here is newly reported to Russia. *Anthracothecium speciosum* f. *speciosum* should be excluded from the list of lichens of Russia and regional check-lists as well as the synonimization of *A.* f. *iturupiense* should be reviewed after the type material will be available for study.

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