

Arthonia phaeobaea (Arthoniaceae, Ascomycota) new to Asia and Russia from the Sakhalin Region

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Abstract. During the study of the lichen biota of Sakhalin Island, *Arthonia phaeobaea* was identified basing of morphological and anatomical data. This is the first record of this rare saxicolous coastal lichen in Asia and Russia; the species was previously recorded only in Central and Northern Europe (including Arctic) and North America. The species is characterized by its thin, smooth, brown-gray continuous thallus without lichen compounds, usually with numerous black pycnidia and small, black, rounded to elongated, weakly convex apothecia, dark brown epithecium K–, pale hypothecium, colorless, (2)3–4 cross-septate ascospores constricted centrally and usually with unequal cells, hyaline conidia, narrowly ellipsoid or oblong. The maritime distribution of the species has been noted. The differences from other coastal saxicolous *Arthonia* species in a global scale, as well as saxicolous *Arthonia*, known in Russia, are discussed.

Keywords: biogeography, coastal lichens, new records, Russian Far East, Sakhalin Island.

Arthonia phaeobaea (Arthoniaceae, лишенизированные Ascomycota) — новый вид для Азии и России из Сахалинской области

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Резюме. В ходе изучения лишенобиоты о. Сахалин на основании морфологических и анатомических данных был выявлен новый для Азии и России вид — *Arthonia phaeobaea*. Этот редкий лишайник, произрастающий на прибрежных силикатных скалах, ранее был отмечен только в Центральной и Северной Европе (включая Арктику) и Северной Америке. Вид характеризуется тонким, гладким, коричневато-серым сплошным талломом без лишайниковых веществ, обычно с многочисленными черными пикнидами и с мелкими, черными, округлыми или удлинёнными, слабовыпуклыми апотециями, темно-коричневым эпитецием, не реагирующим с КОН, светлыми гипотецием, бесцветными, поперечно-септированными аскоспорами с (2)3–4 перегородками, суженными в центре и обычно с неравными размерами клеток, бесцветными, узко эллипсоидными или продолговатыми конидиями. Отмечено приморское распространение вида. Обсуждаются его отличия от других эпилитных видов рода *Arthonia*, обитающих на прибрежных скалах по всему миру, а также отличия от известных в России эпилитных видов *Arthonia*.

Ключевые слова: биогеография, приморские лишайники, новые находки, о. Сахалин, российский Дальний Восток.

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Arthonia Ach. is a cosmopolitan genus of ca. 500 species which includes lichenized taxa on all types of substrates, non-lichenized fungi, lichenicolous parasites as well as other lichen-associated entities (Sundin *et al.*, 2012; Cannon *et al.*, 2020). The lichenized representatives of the genus are crustose lichens with irregular or stellate (rarely rounded) ascocarps with hyaline to finally brownish, muriform to transversely septate (often unequally) ascospores (Cannon *et al.*, 2020). In Northern Hemisphere the genus is common in oceanic forests particularly on smooth bark of shrubs, deciduous and coniferous trees with a small minority of saxicolous species (McCune, 2017; Cannon *et al.*, 2020).

Among thirty-nine lichenized species of *Arthonia* included in the checklist of Russia (Spisok..., 2010), only five are saxicolous: *Arthonia aggregata* Vain. was recorded on granite, *A. atomaria* (Lyngé) H. Kiliás, *A. fusca* (A. Massal.) Hepp, *A. calcarea* (Turner ex Sm.) Ertz et Diederich are inhabit calcareous substrates, and *A. arthonioides* (Ach.) A. L. Sm. grows on siliceous rock, and also is known as an epiphyte. In this paper, the sixth species, *A. phaeobaea*, is recorded for Russia and discussed in details.

Material and Methods

The specimens were collected by the second author in Sakhalin Is. in 2023. All geographical coordinates are given in the coordinate system WGS 1984. The specimens were examined using a stereomicroscope (Zeiss Stemi 2000-C) 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 conidia are presented as minimum–maximum value observed. Measurements of 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.

Lichen substances were studied using spot tests with K, sodium hypochlorite solution (C) and 1,4-p-phenylenediamine (PD), and by high performance thin layer chromatography (HPTLC) with solvent systems A (toluene : 1,4-dioxane : acetic acid, 180 : 45 : 5), B' (hexane : methyl tert-butyl ether : formic acid, 140 : 72 : 18), and C (toluene : acetic acid, 170 : 30) following Orange *et al.* (2001). The specimens were deposited in the lichen herbarium of Altai State University (ALTB).

Results

A rare coastal saxicolous lichen previously known only from Central and North Europe (including Arctic) and North America, *Arthonia phaeobaea*, is recorded to Russia from siliceous seashore rocks in the southern part of Sakhalin Is. (south of the Russian Far East).

Arthonia phaeobaea (Norman) Norman, 1869, Flora, Regensburg 52: 525. ≡ *Sege-strella phaeobaea* Norman, 1868, Kgl. Norske Vidensk. Selsk. Skr. 5: 367. ≡ *Allarthonia*

phaeobaea (Norman) Zahlbr., 1922 (1924), Cat. Lich. Univers. 2: 115. – Holotype: [Ireland], “Galway, on exposed maritime rocks, abundant in a single pot, VIII 1877, Charles du Bois Larbalestier” (BM–000974384, digital photo!).

Description of studied specimens. Thallus crustose, epilithic, continuous to weakly rimose, brownish-grey to pale grey, smooth, somewhat shiny, thin (up to 100 μm thick), and up to 3 cm in diam. Alga chlorococcoid, up to 12.5 μm in diam. Prothallus not apparent. Apothecia solitary, rounded, broadly ellipsoid or irregular in outline, 0.18–0.25 mm in diam. ($n = 20$) and up to 125 μm high; disc dull black, plane to slightly convex, smooth to slightly uneven, epruinose. Epithemium dark brown, K–. Hymenium hyaline, up to 50 μm thick, not interspersed with granules or oil droplets, I+ blue. Hypothecium hyaline. Proper excipulum vestigial, up to 15 μm thick, brownish, K–. Paraphysoids with abundant anastomoses, coherent, up to 1.5 μm wide, apices swollen and brown. Asci 8-spored, broadly clavate to pyriform, *Arthonia*-type. Ascospores colorless, (2)3–4-septate, narrowly ellipsoid to oblong, then sometimes with a broader distal end, constricted at middle septa, with rounded ends, or the proximal end subacute, thin-walled, with distinct episore, lacking a halo, (15.0)17.5–25.5(28.5) \times 6.5–8.0 μm ($n = 35$); locules similar in size or often 1–2 cells are broader. Pycnidia, if present, abundant, solitary, immersed in the thallus, black, punctiform, K+ olive-brown. Conidia hyaline, straight, narrowly ellipsoid or oblong 3.5–5.0 \times 1.5–2.0 μm ($n = 35$). Chemistry: no substances detected by HPTLC.

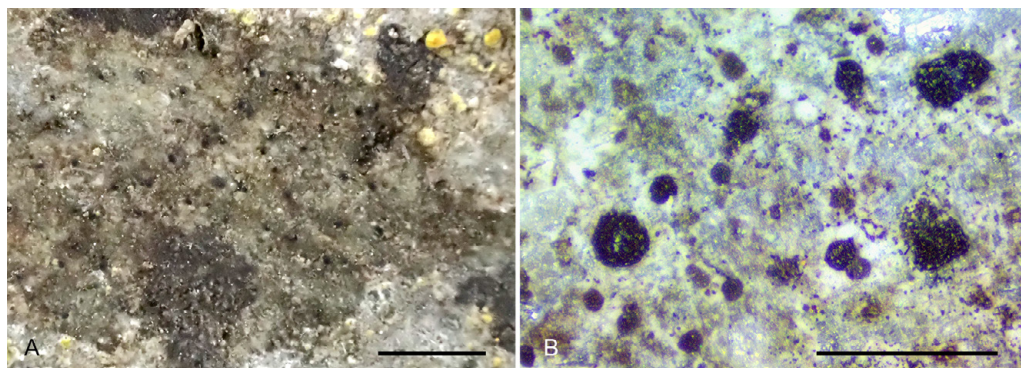


Fig. 1. *Arthonia phaeobaea*: A – thallus with pycnidia (E. A. Davydov 19601). B – thallus with apothecia (E. A. Davydov 19602). Scale bars: A = 1 mm; B = 0.5 mm.

Distribution and ecology. *Arthonia phaeobaea* is a rare coastal species growing on hard non-carbonate rocks in the lower supralittoral zone (splash zone) (Brodo, Sloan, 2004). The species is known from Central and Northern Europe – Ireland, Britain, Germany, Sweden, Finland, Norway (including Arctic coast) and Pacific North West of North America (Foucard, 2001; Brodo, Sloan, 2004; Kristinsson *et al.*, 2010; Schiefelbein *et al.*, 2010; Wirth *et al.*, 2013; McCune, 2017; Cannon *et al.*, 2020;

Westberg *et al.*, 2021). In Asia it is recorded for the first time from Sakhalin Is., Russian Far East (here).

Specimens examined: Russia, Sakhalin Region, Sakhalin Is., Anivsky District, Aniva Bay, Konabeevka Cape, 46°04'22.3"N, 142°11'25.4"E, 0 m a. s. l., seashore, seaside meadow, rocks at the mouth of the stream, on a boulder, 19 VIII 2023, *Davydov 19590* (ALTB), 19594 (hb. of E. A. Davydov); *ibid.*, 46°04'13.1"N, 142°11'31.8"E, 20 m a. s. l., seaside rocks, on E exposed rocks, 19 VIII 2023, *Davydov 19601* (ALTB); *ibid.*, 46°03'51.2"N, 142°11'17.9"E, 21 m a. s. l., seaside rocks, on rocks 20 VIII 2023, *Davydov 19602* (ALTB), 22247 (hb. of E. A. Davydov).

Discussion

The studied samples are fully corresponded to the protologue (Norman, 1869) and detailed descriptions published in Makarevich (1977), Foucard (2001), Wirth *et al.* (2013), McCune (2017), Cannon *et al.* (2020) having apothecia up to 0.25 mm in diam. in our material [up to 0.3(0.5) mm in diam. in mentioned literature], conidia 3.5–5.0 × 1.5–2.0 µm in our material (vs. 3.0–5.5 × 1.0–2.0 in literature), and (2)3–4 cross-septate ascospores (15.0)17.5–25.5(28.5) × 6.5–8.0 µm in our material with distinct epispore and without halo [vs. ascospores (1)3–5 septate, 16.0–30.0 × 5.0–9.0 µm, usually with distinct epispore or halo in literature]. The thallus color varies from typical brown-grey to pale grey. Both fertile and sterile specimens with pycnidia were found.

In Sakhalin Island *Arthonia phaobaea* grows on sheltered, coarse-grained, siliceous seashore rocks and on siliceous boulders in the mouth of the unnamed stream near the seashore. During our work with coastal lichens (Davydov *et al.*, 2021), as well as freshwater lichens (Yakovchenko *et al.*, 2024), we have never encountered cases of these specialized species growing in other habitats with the exception of *Ramalina intestiniformis* Kashiw. et K. H. Moon (Davydov, Yakovchenko, 2023). We have not found any mentions in the literature about the presence of *Arthonia phaobaea* in freshwater habitats. However, some saltwater species, e. g. *Hydropunctaria alaskana* Thüs et Pérez-Ort., also occur in freshwater habitats (Spribille *et al.*, 2020).

Worldwide, there are a few coastal saxicolous *Arthonia* species. *Arthonia cryptica* P. M. McCarthy et Elix described from sheltered, coarse-grained, siliceous seashore rocks from Australia differs by its whitish effuse thallus associated with *Trentepohlia* and smaller 3-septate ascospores 12.0–16.0 × 4.0–6.5 µm (McCarthy, Elix, 2019). Another saxicolous species, former *Arthonia*, is *Reichlingia dendritica* (Leight.) Ertz et Sanderson (syn. *Arthonia atlantica* P. James) known from the coastal siliceous rocks in North-Western Europe, which has (2)3–4 septate ascospores similar in size, 16–24 × 6–7 µm, but with upper cell enlarged and old ascospores becoming brown. It is also different from *A. phaobaea* by its whitish cracked-areolate often pruinose thallus with usually elongate or stellate ascomata, while two chemosyndromes contain either confluent acid or stictic acid (Cannon *et al.*, 2020). *Arthonia gerhardii* Egea et Torrente occurring on strongly maritime habitats near Pacific Ocean (southern California and coastal Baja California) differs by its grey thick verrucose thallus (with psoromic and

confluent acids) sometimes delimited by broad dark prothallus with larger convex apothecia 0.6–2.5 mm in diam. and smaller 2–3 septate ascospores, 15–18 × 6–7 μm (Egea, Torrente, 1995; Grube, 2007). *Arthonia madreana* Egea et Torrente, known from the coastal rocks in southern California, has white thallus, thicker than the thallus of *A. phaeobaea*, sometimes delimited by black prothallus and containing confluent acid. The ascomata are immersed and larger, up to 1.2 in diam. with smaller and narrower 1–3 septate ascospores 11.0–15.0 × 4.0–5.0(5.5) μm and filiform curved conidia 14–20 × 1 μm (Egea, Torrente, 1995; Grube, 2007). Another coastal species, *A. saxistellata* Aptroot et M. Cáceres described from Brasilia differs by its pale ochraceous to pale orange thallus associated with *Trentepohlia* with apothecia eventually confluent in groups, and smaller 3-septate clavate ascospores 12.0–13.0 × 3.0–4.5 μm (Aptroot, Cáceres, 2018).

Among five saxicolous *Arthonia* species recorded in Russia, only *A. fusca* is associated with non-*Trentepohlia* photobiont. It differs from *A. phaeobaea* by its dark brown hypothecium, 1-septate ascospores and bacilliform conidia, up to 6 μm long and ca. 1 μm thick, as well as occurring on limestones.

Arthonia phaobaea is a very inconspicuous species which was collected purely by chance as accompanying species to *Caloplaca* Th. Fr., *Buellia* De Not., *Rinodina* (Ach.) Gray, *Lecanora* Ach., and *Verrucaria* Schrad. Nevertheless, the species is distinguished by its typical smooth, brown-grey continuous thallus visible as a thin flecks on the rocks. With a high probability, the species can be found in other coastal regions within East Asia and the Russian Far East.

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