

A.D. Myrzakhan^{1*}, Y.V. Rakhimova², A.A. Ametov³

^{1,2}*Institute of Botany and Phytointroduction, Almaty, Kazakhstan;*

³*Al-Farabi Kazakh National University, Almaty, Kazakhstan*

*Corresponding author: myrzakhan_anel@mail.ru

New species for the lichen biota of Kazakhstan from the western part of the Chulak ridge

This article presents information on two newly identified lichen species in Kazakhstan: *Scytinium palmatum* (Huds.) Gray and *Anaptychia roemeri* Poelt. Both species were located on the Chulak (Sholak) ridge, the southern extension of the Dzhungar Alatau. Both species are accompanied by synonyms, nomenclatural citations of primary sources, original anatomical and morphological descriptions, specific location points (including coordinates, collection date, and collector's name), environmental characteristics, and general distribution (including adjacent territories). The original descriptions document noted the life form, coloration, and characteristics of the upper and lower surfaces of the thallus; the presence, nature, and positioning of attachment organs; and the type, dimensions, and location of soredia, isidia, and pycnidia on the thallus. Additionally, they specify the type of thallus, the shape and size of asci, the presence and structure of paraphyses, and the type, color, size, and quantity of ascospores within each ascus. The outcomes of chemical staining are also shown. *Scytinium palmatum* is observed to be sterile throughout Kazakhstan and the majority of Europe. The species is uncommon in southeastern Kazakhstan and is included in the Catalog of rare and endangered flora of the Almaty area. No apothecia were seen in the thalli of *Anaptychiaroemeri*. The origin of the *Protoanaptychia* section, to which this species belongs, is presumed to be linked to the hilly areas of Central Asia. Moreover, there exist strong correlations between the lichen floras of the Caucasus and Central Asia, since all four kinds of the section are documented in these areas.

Keywords: apothecium, ascospore, ascus, epithecium, hymenial layer, hypothecium, paraphysis, thallus.

Introduction

In 1821, the lichen genus *Scytinium* (Ach.) Gray (Collemataceae Zenker, Peltigerales Walt. Watson, Lecanoromycetes O.E. Erikss. & Winka, Ascomycota Caval. -Sm.) was introduced under the name "Scytenium". Subsequently, the species of this genus were reclassified as *Leptogium* (Ach.) Gray. The taxonomic status of these exceedingly heterogeneous genera can now be accurately determined through the application of contemporary molecular genetics research methodology [1, 2]. The genus *Scytinium*, which presently comprises 51 species (as per the Mycobank database [3]), has been confirmed by M.A. Otálora and coworkers [2]. It is the third most diverse genus in the Collemataceae family, following the genera *Leptogium* and *Collema* Weber ex F.H. Wigg.

In 1848, the genus *Anaptychia* Körb. (Physciaceae Körb., Caliciales Nannf., Lecanoromycetes, Ascomycota) was first described. The genus *Anaptychia* was comprised of over 450 taxa, as indicated by the Mycobank database [3]. However, a significant number of these taxa were subsequently transferred to the genera *Leucodermia* Kalb, *Heterodermia* Trevis., *Seiropora* Poelt, *Poeltonia* S.Y. Kondr., Lökös & Hur, *Physciella* Essl., *Phaeophyscia* Moberg, *Physconia* Poelt, *Xanthoparmelia* (Vain.) Hale, *Tornabea* Østh., *Teloschistes* Norman, *Klauskalbia* S.Y. Kondr., Lökös, E. Farkas & Hur, *Physcia* (Schreb.) Michx., *Kurokawia* S.Y. Kondr., Lökös & Hur, *Dirinaria* (Tuck.) Clem., and *Polyblastidium* Kalb.

At present, Russia is across to eight species of the *Anaptychia s. s.* genus [4–6].

Our objective was to provide morphological descriptions, ecological and geographical data, and illustrations of lichen species that are novel to Kazakhstan and originating from the western region of the Chulak ridge.

Experimental

The samples were collected in the central and western regions of the Chulak ridge from 2022 to 2023. The GPS (Germin) was employed to register the geographical coordinates of the sample collection sites. The majority of the samples were obtained from boulders and mountain outcrops, while a significantly smaller number were collected from branches of shrubs and semi-shrubs.

The morphological and anatomical characteristics, as well as the chemical reactions that are characteristic of lichens, were used to identify the species. The subsequent morphological characteristics were assessed: life form; color and character of the upper and lower surfaces of the stratum; presence, nature, and location of attachment structures; type, size, and location of fruit bodies on the stratum, or soredia, isidium, pycnidium, etc. [7]. The microscopic examination of narrow sections of thallus and fruiting bodies was employed to identify anatomical features. The following characteristics were assessed in these sections: the thallus type, the structure and systematic position of the photobiont, the type and features of the internal structure of the fruiting bodies, the shape and size of the asci, the presence of paraphyses and their structure, the type, color, and size of the spores, as well as their quantity within the asci. Utilizing a Levenhuk MED D45T LSD light microscope, the anatomical and morphological characteristics of lichens were investigated.

Biochemical characteristics have been identified, which are essential diagnostic indicators. A saturated aqueous solution of calcium hypochlorite, an alcoholic solution of iodine, and a 10 % aqueous solution of potassium hydroxide were employed to conduct the staining. The species was identified by employing specific criteria [4, 8]. The species inventory has been verified and is organized in accordance with the Mycobank Database's system [3]. The following are provided for both species: anatomical-morphological original descriptions, synonyms, nomenclatural citations from primary sources, specific locality data (including coordinates, collection dates, and collector's surname), ecological characteristics, and general distribution (including neighboring territories). Literary sources are employed to extract data regarding the species' ecology and distribution.

Results and Discussion

Scytinium palmatum (Huds.) Gray [as "Scytenium"], in Natural Arrangement of British Plants, 1821, (London) 1: 398.

Examined Specimens. "Kazakhstan, Almaty Region, Kerbulak District, Chulak Ridge, expansive gorge leading to the plateau, on soil and rocks, p. 466, 778 m a.s.l., N43°55'22.9", E077°48'35.4", 27.05.2022. Collected and identified by Y.V. Rakhimova".

Description. The thallus of *Scytinium palmatum* is medium-sized, lobed, and forms thick turf (Fig. 1–3), reaching heights of 1–1.5 cm, with a somewhat glossy, chestnut-brown appearance, paler on the underside. The blades are broad, deeply notched, with edges curved downward, and horn-shaped tips at the ends (Fig. 1–3).

Apothecia are absent in our samples; literature indicates [9] they can reach up to 0.5 mm in diameter and are either sessile or adnate to the bottom surface. The disk is often concave, sometimes flat, reddish-brown, with a smooth edge. The excipule is paraplectenchymatous, transparent, and is 12–65 µm in thickness. The hypothecium is whitish and measures 25–50 µm in thickness. The hymenial layer is transparent and is 125–300 µm in thickness. The epithecium has a brownish hue. Paraphyses are uncomplicated and measure 1 µm in diameter. Asci are club-shaped, measuring 130–185 x 16–25 µm, containing 8 spores. Ascospores are ellipsoidal, smooth, featuring 5–9 transverse and 1–2 longitudinal septa, with dimensions of 27–56 × 10–20 µm. The hymenial layer exhibits a blue coloration with the application of an alcoholic iodine solution.

Ecological characteristics and distribution. On soil and moss-covered rocks, infrequently on tree bark. In the plains and mountains of Ukraine, Western Siberia, Europe, Asia, North Africa, the Canary Islands, North America, South America, and Australia. *Scytinium palmatum* is exclusively documented along the Black Sea coast of the Krasnodar territory in the Caucasus and has not been identified in other areas [10]. Formerly recognized in Russia from the Kaliningrad oblast [11], it has been documented in the Krasnoyarsk krai, as well as the Altai, Tuva, and Khakassia Republics [12]. In the Crimean Reserve, only four specimens of the closely related genus *Leptogium* have been documented: *L. gelatinosum* (With.) J.R. Laundon, *L. lichenoides* (L.) Zahlbr., *L. schraderi* (Ach.) Nyl. And *L. tenuissimum* (Dicks.) Körber [13]. Five species of the genus *Leptogium* are emblematic of the Altai Krai [14, 15]. Five species of the genus *Scytinium* have been identified in Belarus; however, *S. palmatum* has not been recorded [16].



Figure 1. The thallus of *Scytinium palmatum* on rocks



Figure 2. Fragment of the thallus *Scytinium palmatum*

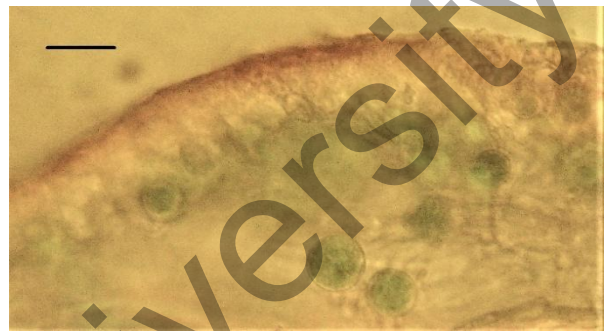


Figure 3. Upon sectioning the thallus of *S. palmatum*, algal cells become discernible. The measurement is 10 microns

Seven species of the genus *Scytinium* are present in Albania: *Scytinium imbricatum* (P.M. Jørg.) Otálora, P.M. Jørg. & Wedin (*Leptogium imbricatum* P.M. Jørg.), *S. gelatinosum* (With.) Otálora, P.M. Jørg. & Wedin (*L. gelatinosum* (With.) J.R. Laundon), *S. lichenoides* (L.) Otálora, P.M. Jørg. & Wedin (*L. lichenoides* (L.) Zahlbr.), *S. palmatum* (Huds.) Gray (*L. palmatum* (Huds.) Mont.), *S. pulvinatum* (Hoffm.) Otálora, P.M. Jørg. & Wedin (*L. pulvinatum* (Hoffm.) Otálora), *S. schraderi* (Ach.) Otálora, P.M. Jørg. & Wedin (*L. schraderi* (Bernh.) Nyl.) and *S. tenuissimum* (Dicks.) Otálora, P.M. Jørg. & Wedin (*L. tenuissimum* (Dicks.) Körb.) [17]. *Scytinium palmatum* has been identified in Southern Albania National Park, among a mixed forest of spruce, fir, and oak, on soil atop limestone formations, at an elevation of 1200 meters above sea level [17]. Seven species of the genus *Scytinium* have been documented in Montenegro: *S. gelatinosum*, *S. lichenoides*, *S. magnussonii* (Degel. & P.M. Jørg.) Otálora, P.M. Jørg. & Wedin, *S. massiliense* (Nyl.) Otálora, P.M. Jørg. & Wedin, *S. plicatile* (Ach.) Otálora, P.M. Jørg. & Wedin (*L. plicatile* (Ach.) Leight.), *S. schraderi*, *S. tenuissimum* [18]. Only four species are prevalent in Albania. In Sweden, five species have been recorded: *S. gelatinosum*, *S. lichenoides*, *S. magnussonii*, *S. palmatum*, *S. teretiusculum* (Wallr.) Otálora, P.M. Jørg. & Wedin [19]. In Fennoscandia, there are 19 species of the genus *Scytinium*, with *S. palmatum* being found in Sweden and Norway [20]. The lichen biota of Portugal includes a significant representation of the genera *Scytinium* and *Leptogium*, comprising 13 species of *Scytinium* (*S. aragonii* (Otálora) Otálora, P.M. Jørg. & Wedin (*L. aragonii* Otálora), *S. biatorinum* (Nyl.) Otálora, P.M. Jørg. & Wedin (*L. biatorinum* (Nyl.) Leight.), *S. ferax* (Durieu & Mont.) Otálora, P.M. Jørg. & Wedin (*L. ferax* (Durieu & Mont.) Rabenh.), *S. gelatinosum*, *S. lichenoides*, *S. magnussonii*, *S. palmatum*, *S. plicatile*, *S. pulvinatum*, *S. rivale* (Tuck.) Otálora, P.M. Jørg. & Wedin (*L. rivale* Tuck.), *S. schraderi*, *S. subtile* (Schrad.) Otálora, P.M. Jørg. & Wedin (*L. subtile* (Schrad.) Torss.), *S. tenuissimum*) and 12 species of *Leptogium* [21]. Twenty species of the genus *Scytinium* have been documented in Britain and Ireland: *S. biatorinum*, *S. callopismum* (A. Massal.) Otálora, P.M. Jørg. & Wedin, *S. fragile* (Taylor) Otálora, P.M. Jørg. & Wedin, *S. fragrans* (Sm.) Otálora, P.M. Jørg. & Wedin, *S. gelatinosum*, *S. imbricatum* (P.M. Jørg.) Otálora, P.M. Jørg. & Wedin, *S. intermedium* (Arnold) Otálora, P.M. Jørg. & Wedin, *S. lichenoides*, *S. magnussonii*, *S. massiliense* (Nyl.) Otálora, P.M. Jørg. & Wedin, *S. palmatum*, *S. parvum* (Degel.) Otálora, P.M. Jørg. & Wedin, *S. plicatile*, *S. pulvinatum*, *S. schraderi*, *S. subtile*, *S. subtorulosum* (Nyl. ex Stizenb.) Otálora, P.M. Jørg. & Wedin, *S. tenuissimum*, *S. teretiusculum*, *S. turgidum*; along with 10

species of the genus *Leptogium*. The species *S. Palmatum* predominantly inhabits Western and Northern Britain, typically located on moss amid stones, on the ground in ancient dunes, along pathways in wastelands, on derelict airfields, and post-industrial areas, and infrequently on tree trunks. The species is dispersed and deemed uncommon [22]. Bulgaria hosts 12 species of the genus *Scytinium*, including *S. palmatum* linked to hilly areas such as the Balkan Mountains, the Rhodope Mountains, and Strandzha Mountain [23]. This species is found in soil, rocks, and moss throughout much of France, including Corsica [24]. The northern distribution boundary of the species *Scytinium fragile* extends across Estonia [25]. One species of the genus *Leptogium* has been identified in Gauja National Park, Latvia [26]. In Majella National Park (Central Italy), two species of the genus *Leptogium* (*L. hildenbrandii* (Garov.) Nyl. and *L. saturninum* (Dicks.) Nyl.) and four species of the genus *Scytinium* (*S. gelatinosum* (With.) Otálora, P.M. Jørg. & Wedin, *S. imbricatum* (P.M. Jørg.) Otálora, P.M. Jørg. & Wedin, *S. lichenoides* and *S. schraderi* (Ach.) Otálora, P.M. Jørg. & Wedin) have been documented [27].

Scytinium lichenoides, *S. pulvinatum*, *S. turgidum* (Ach.) Otálora, P.M. Jørg. & Wedin (*L. turgidum* (Ach.) Cromb.), together with five species of the genus *Leptogium*, have been identified in Iran [28]. *S. lichenoides* and *S. plicatile* have been observed in China [29]. Seven species of the genus *Scytinium* have been identified in Turkey, including *Scytinium palmatum* documented in the province of Bitlis [30].

The lichen biota of the United States and Canada includes 39 species of the genus *Leptogium* and 33 species of the genus *Scytinium*, with *S. palmatum* being documented [31].

Scytinium lichenoides and kindred species *Leptogium cyanescens* (Ach.) Körb. and *Leptogium saturninum* (Dicks.) Nyl. have been seen in the southeastern mountainous regions of Kazakhstan, namely in the Ile Alatau and Kungey Alatau [7]. In eastern Kazakhstan, namely in the Altai area, four species of the genus *Scytinium* have been identified: *S. lichenoides*, *S. plicatile*, *S. subtile* (Schrad.) Otálora, P.M. Jørg. & Wedin (*L. subtile* (Schrad.) Torss.) and *S. tenuissimum* [12]. Species prevalent in Kazakhstan and Kyrgyzstan encompass *Scytinium lichenoides*, *Leptogium saturninum* and *S. tenuissimum* [32].

Endnotes. The species has resemblance to *S. gelatinosum*, however, the lobes are bigger, and their margins distinctly curve inward, becoming tubular, particularly at the tips [22].

Scytinium palmatum is sterile not just in Kazakhstan but also over a broader region of Europe [33], nevertheless, Portugal is an exception, where some specimens produce a considerable quantity of apothecia [21]. Apothecia are nonexistent in Great Britain and Ireland; their presence is recorded just in Morea [22].

Scytinium palmatum is an uncommon species found in southeastern Kazakhstan and is documented in the Catalog of rare and endangered flora of the Almaty area [34].

Anaptychia roemeri Poelt., *Mitteilungen aus der Botanischen Staatssammlung München* 7: 228 (1968)

Examined Specimens. “Kazakhstan, Almaty Region, within the jurisdiction of the akimat of Konaev city, northeast of Chingeldy village, Chulak Ridge, near the pond, riverside, p. 29, 961 m a.s.l., N44°04'56.7", E077°52'22.0", 23.05.2023. Collected by Y.V. Rakhimova and identified by I.V. Evdokimov”.

Description. The thallus is foliose, rosette-shaped, and sometimes uneven in our specimens (Fig. 4), measuring 2×4 mm, generally loosely attached to the substrate; devoid of soredia and isidia. Lobes are profoundly incised and thin, measuring up to 0.6 mm in width (Fig. 4). Frequently marginally enlarged and segmented into diminutive sections (lobules) near the extremities, elevated. Prominent short spines are seen near the apices of the lobules. The thallus's top surface is irregular owing to the fissured epinecral layer, exhibiting dark gray-brown or light brown hues. The medulla is characterized by the presence of calcium oxalate crystals and exhibits a bright appearance. The inferior surface of the thallus is pale, featuring uncomplicated rhizines. Apothecia absent, pycnidia submerged, conidia cylindrical, measuring 5-6 µm in length.



Figure 4. The thallus of *Anaptychia roemeri* on rocks

Ecological characteristics and distribution. It is located on the surface of boulders in high-altitude arid regions, where it is found on a scant layer of sediment or moss. Considered a cryophyte species. The Vakhn Range, located in northeastern Afghanistan, is described at an elevation of approximately 3200 meters above sea level. It is found in the Caucasus (Georgia, Armenia, North Ossetia, Dagestan) and Asia (Kazakhstan, Kyrgyzstan, Tajikistan, Mongolia, Syria, Iran, Afghanistan) at elevations exceeding 3000 meters above sea level [5, 6, 35–39].

Tree bark, boulders, and soil are the habitats of species of the genus, which are found in all natural zones of the Northern Hemisphere but are uncommon in the Arctic. They are commonly found in association with mosses and lichens. The Crimea Nature Reserve is home to only two members of the *Anaptychia* genus: *A. ciliaris* (L.) Körb. and *A. setifera* (Mereschk.) Räs. [13]. The most extensively distributed species in Belarus is *Anaptychia ciliaris*, while the same two species of the genus *Anaptychia* have been recorded [16, 26]. Two members of the *Anaptychia* genus are distinctive to the Altai region: *Anaptychia bryorum* Poelt and *A. setifera* [14].

Anaptychia ciliaris is the most extensively distributed of the seven species of the genus *Anaptychia* that are encountered in France [24]. This species is also prevalent in Poland [40] and Bulgaria, however, only four species are documented in this location [23]. Two species of the *Anaptychia* genus are present in Sweden, Norway, and Finland within Fennoscandia [20]. *A. ciliaris* is the sole species identified in the Majella National Park (Central Italy) [27]. In Afghanistan, 4 species of the genus *Anaptychia* were found, of which *Anaptychia roemeri* was recorded in only one province Badakshan [39].

The genus *Anaptychia* is represented by five species in the lichen biota of the United States and Canada: *Anaptychia bryorum*, *A. crinalis* (Schlich. ex Schaer.) Vzd. ex J. Nawak, *A. elbursiana* (Szatala) Poelt, *A. palmulata* (Michaux) Vain. and *A. ulothricoides* (Vain.) Vain. [31].

A. ulothricoides is also documented in the mid-mountain and high-mountain steppes of Uzbekistan, Tajikistan, and Turkmenistan [32].

Upon examining the distribution of species in the *Protoanaptychia* section of the genus *Anaptychia*, certain authors [5] propose that the group's origin is linked to the mountainous regions of Central Asia (including the territories of Tajikistan and Afghanistan). It is precisely in these regions (as well as the Caucasus) that all four species of the section are observed. This phenomenon, in conjunction with the presence of species such as *Anaptychia elbursiana* and *A. roemeri* in the Caucasus, may suggest a close relationship between the lichen flora of the Caucasus and Central Asia [5].

Endnotes. The foliose thallus of *A. roemeri* is characterized by the uplifted ends of the lobes, which are profoundly divided into terminal lobules. The most closely related species are *A. elbursiana* (Szatala) Poelt, *A. mereschkowskii* (Tomin) Kulakov (which is distinguished by the presence of soredia), and *A. Desertorum* (Rupr.) Poelt (which has lobe tips that are faintly divided into tiny lobules).

In the Red Book of the Republic of Dagestan [41], *A. roemeri* is classified as a 3 (VU) (vulnerable species) species and is included in the inventory of plant, animal, and parasitic species.

Conclusion

This study focuses on the lichens of the arid lowlands in southeastern Kazakhstan. The article's content was derived from the authors' personal collections; literature data was utilized to compare and evaluate species traits and distribution. Two lichen species, *Scytinium palmatum* (Huds.) Gray and *Anaptychia roemeri* Poelt, were identified on the Chulak Ridge, a southwestern extension of the Dzhungar Alatau, both of which are new to Kazakhstan. Both species are accompanied by synonyms, nomenclatural citations of primary sources, original anatomical-morphological descriptions, specific location points (including coordinates, collection date, and collector's name), ecological characteristics, and general distribution (encompassing adjacent territories). The initial descriptions detail the organism's life form, coloration, and attributes of the thallus's upper and lower surfaces, the existence, nature, and positioning of attachment organs, the classification, dimensions, and configuration of soredia, isidia, and pycnidia on the thallus, thallus type, morphology, and size of the ascus, the presence and structure of paraphyses, as well as the type, coloration, and dimensions of spores, their quantity within the ascus, and the outcomes of chemical staining. The outcomes of chemical staining are also shown. *Scytinium palmatum* and *Anaptychia roemeri* are observed to be infertile in Kazakhstan. *Scytinium palmatum* is an uncommon plant in southeastern Kazakhstan and is included in the Catalog of rare and endangered flora of the Almaty area. The *Protoanaptychia* section, which includes the *Anaptychiaroemeri* species, is linked to the hilly areas of Central Asia, including Tajikistan and Afghanistan. The acquired data are crucial for evaluating biodiversity within Kazakhstan's region.

Acknowledgments

The authors express profound gratitude to Igor Evdokimov (Karaganda, Kazakhstan) and Jason Holinger (The Edgewood Institute, USA) for their support in identifying lichen species.

References

- 1 Otálora M.A.G. et al. Disentangling the *Collema-Leptogium* complex through a molecular phylogenetic study of the Collemataceae (Peltigerales, lichen-forming Ascomycota) / M.A.G. Otálora et al. // Mycologia. — 2010. — Vol. 102. — No 2. — P. 279–290. <https://doi.org/10.3852/09-114>
- 2 Otálora M.A.G. A revised generic classification of the jelly lichens, Collemataceae / M.A.G. Otálora, P.M. Jørgensen, M. Wedin // Fungal diversity. — 2014. — Vol. 64. — P. 275–293. <https://doi.org/10.1007/s13225-013-0266-1>
- 3 MYCOBANK Database. Fungal Databases, Nomenclature & Species Banks. — [Electronic resource]. — Access mode: <https://www.mycobank.org/>
- 4 Определитель лишайников России. Вып. 10. Agyriaceae, Anamylopsoraceae, Aphanopsidaceae, Arthrurhaphidaceae, Brigantiaeaceae, Chrysotrichaceae, Clavariaceae, Ectilechiaceae, Gomphillaceae, Gypsoplacaceae, Lecanoraceae, Lecideaceae, Mycoblastaceae, Phlyctidaceae, Physciaceae, Pilocarpaceae, Psoraceae, Ramalinaceae, Stereocaulaceae, Vezdaeaceae, Tricholomataceae / отв. ред. Н.С. Голубкова. — СПб.: Наука, 2008. — 515 с.
- 5 Урбанавичюс Г.П. Род *Anaptychia* (Physciaceae, Ascomycota) во флоре лишайников России и сопредельных стран. 1. Секция *Protoanaptychia* / Г.П. Урбанавичюс // Ботанический вестник Северного Кавказа. — 2022. — № 2. — С. 22–32. https://doi.org/10.33580/24092444_2022_2_22
- 6 Ismailov A.B. New lichenized fungi for Russia from Dagestan (East Caucasus) / A.B. Ismailov, G.P. Urbanavichus, J. Vondrak // Folia Cryptogamica Estonica. — 2019. — Vol. 56. — P. 7–10. <https://doi.org/10.12697/fce.2019.56.02>
- 7 Андреева Е.И. Флора споровых растений Казахстана / Е.И. Андреева. — Алма-Ата: Наука, 1978. — Т. 11, кн. 1. Лишайники. — 264 с.
- 8 Определитель лишайников СССР. Вып. 3. Калициевые — Гиалектовые / отв. ред. И.И. Абрамов. — Л.: Изд-во «Наука» Ленингр. отд., 1975. — 275 с.
- 9 Урбанавичюс Г.П. Род *Scytinium* (Ach.) Gray (Coollemtaceae, Lichenized Ascomycota) в лихенофлоре Кавказа / Г.П. Урбанавичюс // Ботанический вестник Северного Кавказа. — 2016. — № 1. — С. 56–71.
- 10 Урбанавичюс Г.П. Предварительные сведения о лишайниках Хостинской тисо-самшитовой рощи (Кавказский заповедник) / Г.П. Урбанавичюс, И.Н. Урбанавичене // Новости систематики низших растений. — 2002. — Т. 36. — С. 181–185.
- 11 Урбанавичюс Г.П. Список лихенофлоры России / Г.П. Урбанавичюс. — СПб, 2010. — 194 с.
- 12 Седельникова Н.В. Видовое разнообразие лихенобиоты Алтае-Саянского экорегиона / Н.В. Седельникова // Растительный мир Азиатской России: Вестник Центрального сибирского ботанического сада СО РАН. — 2013. — № 2. — С. 12–54.
- 13 Hodosovtsev A.Yt. An Annotated List of the Lichen Forming Fungi of the Crimean Nature Reserve / A.Yt. Hodosovtsev, O.V. Bogdan // Chornomorsk Bot. J. — 2006. — Vol. 1. — No. 1. — P. 95–117.

- 14 Davydov E.A. The first checklist of lichens, lichenicolous and allied fungi of Altaysky krai (Siberia, Russia) / E.A. Davydov // *Mycotaxon*. — 2014. — Vol. 129. — No. 2. — P. 1–67.
- 15 Davydov E.A. New and noteworthy records of Plants, Lichens and Lepidoptera in Altai Territory and Republic of Altai (Southern Siberia) / E.A. Davydov et al. // *Acta Biologica Sibirica*. — 2023. — Vol. 9. — P. 243–264. <https://doi.org/10.5281/zenodo.7865738>
- 16 Яцына А.П. Флора Беларуси / А.П. Яцына, В.В. Голубков, Д.Е. Гимельбрант, Л.А. Конорева, Е.С. Кузнецова, С.В. Чесноков. — Минск: Беларуская навука, 2019. — Т. 1. Лишайники. — 341 с.
- 17 Svoboda D. A contribution to the knowledge of lichenized and lichenicolous fungi in Albania / D. Svoboda et al. // *Herzogia*. — 2010. — Vol. 25. — No. 2. — P. 146–165. <https://doi.org/10.13158/hea.25.2.2010.146>
- 18 Knežević B. Catalogue of the lichenized and lichenicolous fungi of Montenegro / B. Knežević, H. Mayrhofer // *Phyton; annales rei botanicae*. — Europe PMC Funders. — 2009. — Vol. 48. — No 2. — P. 283.
- 19 Stridvall L. Lavfloran på kyrkogårdar i Västra Götalands län / L. Stridvall, A. Stridvall // *Lavbulletinen*. — 2010. — Vol. 1. — P. 1–87.
- 20 Westberg M. Santesson's checklist of Fennoscandian lichen-forming and lichenicolous fungi / M. Westberg et al. — Uppsala, 2021. — 993 p.
- 21 de Silanes M.E.L. The genus *Leptogium* (Collembataceae, Ascomycotina) in mainland Portugal / M.E.L. de Silanes et al. // *Sydowia*. — 2012. — Vol. 6. — P. 67–102.
- 22 Cannon P. Peltigerales: Collembataceae: including the genera *Blennothallia*, *Callome*, *Collema*, *Enchylium*, *Epiphloea*, *Lathagrium*, *Leptogium*, *Pseudoleptogium*, *Rostania* and *Scytinium* / P. Cannon et al. // *Revisions of British and Irish Lichens*. — 2020. — Vol. 2. — P. 1–38. <https://doi.org/10.3929/ethz-b-000450927>
- 23 Denchev C.M. Checklist of the lichenized and lichenicolous fungi in Bulgaria / C.M. Denchev et al // *Mycobiota*. — 2022. — Vol. 12. — P. 1–106. <https://doi.org/10.12664/mycobiota.2022.12.01>
- 24 Roux C. Association française de lichénologie. Catalogue des lichens et champignons lichénicoles de France métropolitaine / C. Roux. — Fontainebleau: Association française de lichénologie, 2014. — 540 p.
- 25 Suija A. Updates to the list of Estonian lichenized, lichenicolous and allied fungi / A. Suij et al. // *Folia Cryptogamica Estonica*. — 2021. — Vol. 58. — P. 243–250. <https://doi.org/10.12697/fce.2021.58.23>
- 26 Yatsyna A. Lichens and allied fungi from the Gauja National Park (Latvia), including new records for the country / A. Yatsyna, R. Moisejevs, P. Degtjarenko // *Folia Cryptogamica Estonica*. — 2021. — Vol. 58. — P. 135–144. <https://doi.org/10.12697/fce.2021.58.16>
- 27 Gheza G. The lichens of the Majella National Park (Central Italy): an annotated checklist / G. Gheza et al. // *MycKeys*. — 2021. — Vol. 78. — P. 119. <https://doi.org/10.3897/mycokeys.78.62362>
- 28 Seaward M. R. D. et al. A preliminary lichen checklist for Iran / M. R.D. Seaward // *Willdenowia*. — 2004. — Vol. 34. — No 2. — P. 543–576. <https://doi.org/10.3372/wi.34.34218>
- 29 Liu H.J. Three non-hairy species of *Leptogium* from China / H.J. Liu et al. // *Mycotaxon*. — 2013. — Vol. 122. — No 1. — P. 483–490. <http://dx.doi.org/10.5248/122.483>
- 30 Yazıcı K. Lichens and lichenicolous fungi from Bitlis province in Turkey / K. Yazıcı et al. // *Lindbergia*. — 2020. — Vol. 43. — P. 1–12. <https://doi.org/10.25227/linbg.01126>
- 31 Esslinger T.L. A cumulative checklist for the lichen-forming, lichenicolous and allied fungi of the continental United States and Canada, version 24 / T.L. Esslinger // *Opuscula Philolichenum*. — 2021. — Vol. 20. — P. 100–394.
- 32 Бредкина Л.И. Аннотированный список лишайников Центрального Тянь-Шаня (Киргизия) / Л.И. Бредкина, И.И. Макарова // *Новости систематики низших растений*. — 2005. — [Электронный ресурс]. — Режим доступа: <https://cyberleninka.ru/article/n/annotirovannyu-spisok-lishaynikov-tsentralnogo-tyan-shanya-kirgiziya>
- 33 Aragón G. New data on the genus *Leptogium* (lichenized ascomycetes) in the Iberian Peninsula / G. Aragón, M. A.G. Otálora, I. Martínez // *Nova Hedwigia*. — 2005. — Vol. 80. — No. 1–2. — P. 199–226.
- 34 Веселова П.В. Каталог редких и исчезающих видов флоры Алматинской области / П.В. Веселова, Г.М. Кудабаева, Г.Т. Ситпаева, В.Г. Эпиктетов, Е.В. Рахимова, И.Г. Отрадных, И.А. Съедина, Н.Г. Гемеджиева, Э.С. Саметова, С.Б. Нурашов, Г. Сыпабеккызы. — Алматы, 2023. — 180 с.
- 35 Урбанавичюс Г.П. К лихенофлоре Северо-Осетинского заповедника (Северная Осетия-Алания). II. Кластер «Карца» / Г.П. Урбанавичюс, И.Н. Урбанавичене // *Новости систематики низших растений*. — 2022. — Т. 56. — С. 141–159.
- 36 Moniri M.H. Lichens from three mountain sites in Khorasan provinces, Iran, including four species new to Iran / M.H. Moniri, H. J.M. Sipman // *Cryptogamie, Mycologie*. — 2011. — Vol. 32. — No 2. — P. 145–150. <https://doi.org/10.7872/crym.v32.iss2.2011.145>
- 37 Gasparyan A. A contribution to the lichen-forming and lichenicolous fungi flora of Armenia / A. Gasparyan, H. J.M. Sipman, W. Von Brackel // *Willdenowia*. — 2014. — Vol. 44. — No 2. — P. 263–267. <https://doi.org/10.3372/wi.44.44208>
- 38 Hollinger J. Two new species of *Anaptychia* (Physciaceae) from western North America, with notes on the other species of section *Protoanaptychia* / J. Hollinger et al. // *The Bryologist*. — 2022. — Vol. 125. — No 4. — P. 571–601. <https://doi.org/10.1639/0007-2745-125.4.571>
- 39 Mayrhofer H. The lichenized and lichenicolous fungi of Afghanistan / H. Mayrhofer et al. // *Plant and Fungal Systematics*. — 2023. — Vol. 68. — No 2. — P. 440–461. <https://doi.org/10.35535/pfsyst-2023-0026>

40 Kukwa M. Materiały do rozmieszczenia porostów i grzybów naporostowych Polski, 1 / M. Kukwa et al. // Wiadomsci Botanic. — 2021. — Vol. 64(1). — P. 1–29. <https://doi.org/10.5586/wb.645>

41 Перечень (список) объектов растительного и животного мира, а также грибов, занесенных в Красную книгу Республики Дагестан. Утвержден постановлением Правительства Республики Дагестан от 28 декабря 2020 г. № 288 (интернет-портал правовой информации Республики Дагестан). — [Электронный ресурс]. — Режим доступа: <https://www.pravo.e-dag.ru>

А.Д. Мырзахан, Е.В. Рахимова, А.А. Аметов

Шолақ жотасының батыс бөлігінен Қазақстан лихенобиотасына арналған жаңа түрлер

Мақалада Қазақстан үшін қынаның екі жаңа түрі: *Scytinium palmatum* (Huds.) Gray және *Anaptychia roemeri* Poelt туралы мәліметтер берілген. Түрлердің екеуі де Жоңғар Алатауының оңтүстік-батыс сілемінің Шолақ жотасының аумағынан табылды. Екі түр үшін де синонимдер, бастапқы дереккөздердің номенклатуралық дәйексөздері, анатомиялық және морфологиялық түпнұсқа сипаттамасы, нақты орналасқан жерлердің нүктелері (координаталары, жиналған күні және коллектордың атауы көрсетілген), экологиялық сипаттамалары, жалпы таралуы (соның ішінде іргелес аумақтар бойынша) берілген. Түпнұсқа сипаттамаларда талломның жоғарғы және төменгі беттерінің тіршілік формасы, түсі мен сипаты, бекіну органдарының болуы, сипаты мен орналасуы, талломдағы соредиялардың, изидиялардың, пикнидтердің түрі, мөлшері мен орналасуы, талломның түрі, қалталардың пішіні мен өлшемдері, парафиздер және олардың құрылымы, споралардың түрі, түсі мен мөлшері, олардың қалталарының саны көрсетілген. Сонымен қатар, химиялық бояудың нәтижелері берілген. *Scytinium palmatum* тек Қазақстанда ғана емес, сонымен қатар кейбір үлгілері апотецияның айтарлықтай санын құрайтын Португалияны қоспағанда, Еуропаның басым бөлігінде стерильді екендігі атап өтілген. Түр Қазақстанның оңтүстік-шығысында сирек кездеседі және Алматы облысының Қызыл кітабына енгізілген. *Anaptychia roemeri*-ге келетін болсақ, оның талломында апотеция табылған жоқ. Бұл түрге жататын *Protoanaptychia* бөлімінің шығу тегі Орталық Азияның таулы аймақтарымен (Тәжікстан мен Ауғанстан аумақтары) байланысты деген болжам бар. Сонымен қатар, Кавказ бен Орталық Азияның лихенофлоралары арасында тығыз байланыс бар, өйткені дәл осы аймақтарда бөлімнің барлық 4 түрі байқалған.

Кілт сөздер: апотеция, аскоспора, гипотеция, парафиздер, балдыр, қалта, таллом, эпитеция.

А.Д. Мырзахан, Е.В. Рахимова, А.А. Аметов

Новые виды для лихенобиоты Казахстана из западной части хребта Чулак

В предлагаемой статье приводятся данные о двух новых для Казахстана видах лишайников *Scytinium palmatum* (Huds.) Gray и *Anaptychia roemeri* Poelt. Оба вида обнаружены на территории хр. Чулак (Шолақ), являющегося юго-западным отрогом Джунгарского Алатау. Для обоих видов приведены синонимы, номенклатурные цитаты первоисточников, анатомо-морфологическое оригинальное описание, точки конкретных местонахождений (с указанием координат, даты сбора и фамилии коллектора), экологическая характеристика, общее распространение (в том числе на сопредельных территориях). В оригинальных описаниях отмечены жизненная форма, цвет и характер верхней и нижней поверхности таллома, наличие, характер и расположение органов прикрепления, тип, размер и расположение на талломе соредий, изидий, пикнид, тип таллома, форма и размеры сумок, наличие парафиз и их строение, тип, цвет и размеры спор, их количество в сумках. Кроме того, приведены результаты химического окрашивания. Отмечено, что *Scytinium palmatum* стерилен не только в Казахстане, но и на большей территории Европы, исключение составляет Португалия, где некоторые образцы формируют значительное количество апотециев. Вид является редким на юго-востоке Казахстана и занесен в Красную книгу Алматинской области. Что касается *Anaptychia roemeri*, то апотеции в его талломах не обнаружены. Имеется предположение, что происхождение секции *Protoanaptychia*, куда относится этот вид, связано с горными регионами Центральной Азии (территории Таджикистана и Афганистана). Кроме того, существуют тесные связи лихенофлор Кавказа и Центральной Азии, поскольку именно в этих регионах отмечены все 4 вида секции.

Ключевые слова: апотеций, аскоспора, гипотеций, парафиза, слоевище, сумка, таллом, эпитеций.

References

- 1 Otálora, M.A.G. et al. (2010). Disentangling the *Collema-Leptogium* complex through a molecular phylogenetic study of the Collemataceae (Peltigerales, lichen-forming Ascomycota). *Mycologia*, 102(2), 279–290. <https://doi.org/10.3852/09-114>.
- 2 Otálora, M.A., Jørgensen, P.M., & Wedin, M. (2014). A revised generic classification of the jelly lichens, Collemataceae. *Fungal diversity*, 64, 275–293. <https://doi.org/10.1007/s13225-013-0266-1>.
- 3 MYCOBANK Database. Fungal Databases, Nomenclature & Species Banks. Retrieved from <https://www.mycobank.org/>
- 4 Golubkova, N.S. (Ed.). (2008). *Opredelitel lishainikov Rossii [Handbook of the lichens of Russia]. Issue 10. Agyriaceae, Anamylopsoraceae, Aphanopsidaceae, Arthrorhaphidaceae, Brigantiaeaceae, Chrysotrichaceae, Clavariaceae, Ectilechiaceae, Gomphillaceae, Gypsoplacaceae, Lecanoraceae, Lecideaceae, Mycoblastaceae, Phlyctidaceae, Physciaceae, Pilocarpaceae, Psoraceae, Ramalinaceae, Stereocaulaceae, Vezdaeaceae, Tricholomataceae*. Saint Petersburg: Nauka [in Russian].
- 5 Urbanavichus, G.P. (2022). Rod *Anaptychia* (Physciaceae, Ascomycota) vo flore lishainikov Rossii i sopedelnykh stran. 1. Sektsiia *Protoanaptychia* [The genus *Anaptychia* (Physciaceae, Ascomycota) of the lichen flora of Russia and neighbouring countries. 1. Section *Protoanaptychia*]. *Botanicheskii vestnik Severnogo Kavkaza — Botanical Bulletin of the North Caucasus*, 2, 22–32. https://doi.org/10.33580/24092444_2022_2_22 [in Russian]
- 6 Ismailov, A.B., Urbanavichus, G.P., & Vondrak, J. (2019). New lichenized fungi for Russia from Dagestan (East Caucasus). *Folia Cryptogamica Estonica*, 56, 7–10. <https://doi.org/10.12697/fce.2019.56.02>.
- 7 Andreeva, E.I. (1978). *Flora sporovykh rastenii Kazakhstana [Flora of spore plants of Kazakhstan]*. Vol. 11, book 1: *Lishainiki [Lichens]*. Saint Petersburg: Nauka [in Russian].
- 8 Abramov, I.I. (Ed.). (1975). *Opredelitel lishainikov SSSR. Kalitsievye — Gialektovye [Handbook of the lichens of the USSR. Caliciaceae — Gyalectaceae]*. Vol. 3. Leningrad: Izdatelstvo “Nauka” Leningradskoe otdelenie [in Russian].
- 9 Urbanavichus, G.P. (2016). Rod *Scytinium* (Ach.) Gray (Collemataceae, Lichenized Ascomycota) v likhenoflore Kavkaza [The genus *Scytinium* (Ach.) Gray (Collemataceae, Lichenized Ascomycota) in the lichen flora of the Caucasus]. *Botanicheskii vestnik Severnogo Kavkaza — Botanical Bulletin of the North Caucasus*, 1, 56–71 [in Russian].
- 10 Urbanavichus, G.P., & Urbanavichene, I.N. (2002). Predvaritelnye svedeniia o lishainikakh Khostinskoi tiso-samshitovoi roshchi (Kavkazskii zapovednik) [The Preliminary Information On Lichens Of Khosta Yew-Box Grove (Caucasian Reserve)]. *Novosti sistematiki nizshikh rastenii — News of taxonomy of lower plants*, 36, 181–185 [in Russian].
- 11 Urbanavichus, G.P. (2010). *Spisok likhenoflory Rossii [A checklist of the lichen flora of Russia]*. Saint Petersburg: Nauka [in Russian].
- 12 Sedelnikova, N.V. (2013). Vidovoe raznoobrazie likhenobioty Altae-Saianskogo ekoregiona [Species diversity of lichen biota of the Altai-Sayan ecological region]. *Rastitelnyi mir Aziatskoi Rossii: Vestnik Tsentralnogo sibirskogo botanicheskogo sada Sibirskogo otdeleniia Rossiiskoi Akademii nauk — Flora and Vegetation of Asian Russia: Bulletin of the Central Siberian Botanical Garden of the Siberian Branch of the Russian Academy of Sciences*, 2(12), 12–54 [in Russian].
- 13 Hodosovtsev, A.Yt., & Bogdan, O.V. (2006). An Annotated List of the Lichen Forming Fungi of the Crimean Nature Reserve. *Chornomorsk Bot. J.*, 1(1), 95–117.
- 14 Davydov, E.A. (2014). The first checklist of lichens, lichenicolous and allied fungi of Altaisky krai (Siberia, Russia). *Mycotaxon*, 129(2), 1–67.
- 15 Davydov, E.A., Kosachev, P., Golyakov, P., Zalutsky, T., Svirin, E., Kudrov, O., ... & Yakovlev, R. (2023). New and noteworthy records of Plants, Lichens and Lepidoptera in Altai Territory and Republic of Altai (Southern Siberia). *Acta Biologica Sibirica*, 9, 243–264. <https://doi.org/10.5281/zenodo.7865738>
- 16 Jacyna, A.P., Golubkov, V.V., Gimelbrant, D.E., Konoreva, L.A., Kuznecova, E.S., & Chesnokov, S.V. (2019). *Flora Belarusi [Flora of Belarus]*. Vol. 1. *Lishainiki [Lichens]*. Minsk: Belaruskaja nauka [in Russian].
- 17 Svoboda, D., Bouda, F., Maliček, J., & Hafellner, J. (2010). A contribution to the knowledge of lichenized and lichenicolous fungi in Albania. *Herzogia*, 25(2), 146–165. <https://doi.org/10.13158/hea.25.2.2010.146>
- 18 Knežević, B., & Mayrhofer, H. (2009, February). Catalogue of the lichenized and lichenicolous fungi of Montenegro. In *Phyton; annales rei botanicae*, 48(2), 283. Europe PMC Funders.
- 19 Stridvall, L., & Stridvall, A. (2010). Lavfloran på kyrkogårdar i Västra Götalands län. *Lavbulletinen*, 1, 1–87.
- 20 Westberg, M., Moberg, R., Myrdal, M., Nordin, A., & Ekman, S. (2021). *Santesson's checklist of Fennoscandian lichen-forming and lichenicolous fungi*. Uppsala.
- 21 de Silanes, M.L., Paz-Bermúdez, G., Carballal, R., & Marques, J. (2012). The genus *Leptogium* (Collemataceae, Ascomycotina) in mainland Portugal. *Sydowia*, 6, 67–102.
- 22 Cannon, P., Garcia Otalora, M.A., Košuthová, A., Wedin, M., Aptroot, A., Coppins, B., & Simkin, J. (2020). Peltigerales: Collemataceae: including the genera *Blennothallia*, *Callome*, *Collema*, *Enchylium*, *Epiphloea*, *Lathagrium*, *Leptogium*, *Pseudoleptogium*, *Rostania* and *Scytinium*. *Revisions of British and Irish Lichens*, 2, 1–38. <https://doi.org/10.3929/ethz-b-000450927>
- 23 Denchev, C.M., Shivarov, V.V., Denchev, T.T., & Mayrhofer, H. (2022). Checklist of the lichenized and lichenicolous fungi in Bulgaria. *Mycobiota*, 12, 1–106. <https://doi.org/10.12664/mycobiota.2022.12.01>
- 24 Roux, C. (2014). *Association française de lichénologie. Catalogue des lichens et champignons lichénicoles de France métropolitaine*. Fontainebleau: Association française de lichénologie.

- 25 Suija, A., Gerasimova, J., Jüriado, I., Löhmus, P., Marmor-Ohtla, L., Martin, L., ... & Zhdanov, I.S. (2021). Updates to the list of Estonian lichenized, lichenicolous and allied fungi. *Folia Cryptogamica Estonica*, 58, 243–250. <https://doi.org/10.12697/fce.2021.58.23>
- 26 Yatsyna, A., Moisejevs, R., & Degtjarenko, P. (2021). Lichens and allied fungi from the Gauja National Park (Latvia), including new records for the country. *Folia Cryptogamica Estonica*, 58, 135–144. <https://doi.org/10.12697/fce.2021.58.16>
- 27 Gheza, G., Di Nuzzo, L., Vallese, C., Benesperi, R., Bianchi, E., Di Cecco, V., ... & Nascimbene, J. (2021). The lichens of the Majella National Park (Central Italy): an annotated checklist. *MycKeys*, 78, 119. <https://doi.org/10.3897/mycokeys.78.62362>
- 28 Seaward, M.R., Sipman, H.J., Schultz, M., Maassoumi, A.A., Anbaran, M.H.M., & Sohrabi, M. (2004). A preliminary lichen checklist for Iran. *Willdenowia*, 34(2), 543–576. <https://doi.org/10.3372/wi.34.34218>
- 29 Liu, H. J., Cao, J., Guan, S., & Wu, Q.F. (2013). Three non-hairy species of *Leptogium* from China. *Mycotaxon*, 122(1), 483–490. <http://dx.doi.org/10.5248/122.483>
- 30 Yazici, K., Aslan, A., Aptroot, A., Etayo, J., Karahan, D., & Sipman, H. (2020). Lichens and lichenicolous fungi from Bitlis province in Turkey. *Lindbergia*, 43, 1–12. [linbg.01126. https://doi.org/10.25227/linbg.01126](https://doi.org/10.25227/linbg.01126)
- 31 Esslinger, T.L. (2021). A cumulative checklist for the lichen-forming, lichenicolous and allied fungi of the continental United States and Canada, version 24. *Opuscula Philolichenum*, 20, 100–394.
- 32 Bredkina, L.I., & Makarova, I.I. (2005). Annotirovannyi spisok lishainikov Tsentralnogo Tian-Shania (Kirgiziia) [Annotated list of lichens of the Central Tien Shan (Kyrgyzstan)]. *Novosti sistematiki nizshikh rastenii — News of taxonomy of lower plants*. Retrieved from <https://cyberleninka.ru/article/n/annotirovannyi-spisok-lishaynikov-tsentralnogo-tyan-shanya-kirgiziya> [in Russian].
- 33 Aragón, G., Otálora, M.A.G., & Martínez, I. (2005). New data on the genus *Leptogium* (lichenized ascomycetes) in the Iberian Peninsula. *Nova Hedwigia*, 80, 1–2, 199–226.
- 34 Veselova, P.V., Kudabaeva, G.M., Sitpaeva, G.T., Jepiktetov, V.G., Rakhimova, E.V., Otradnyh, I.G., Sedina, I.A., Gemedzhieva, N.G., Sametova, E.S., Nurashov, S.B., & Sypabekkyzy, G. (2023). *Katalog redkikh i ischezaiushchikh vidov flory Almatinskoi oblasti [Catalog of rare and endangered species of flora of the Almaty region]*. Almaty [in Russian].
- 35 Urbanavichus, G.P., & Urbanavichene, I.N. (2022). K likhenoflore Severo-Osetinskogo zapovednika (Severnaia Osetiia-Alaniia). II. Klaster «Kartsa» [To the lichenophlora of the North Ossetian Reserve (North Ossetia-Alania). II. The Karts Cluster]. *Novosti sistematiki nizshikh rastenii — News of taxonomy of lower plants*, 56, 141–159 [in Russian].
- 36 Moniri, M.H., & Sipman, H.J. (2011). Lichens from three mountain sites in Khorasan provinces, Iran, including four species new to Iran. *Cryptogamie, Mycologie*, 32(2), 145–150. <https://doi.org/10.7872/crym.v32.iss2.2011.145>
- 37 Gasparyan, A., Sipman, H.J., & Von Brackel, W. (2014). A contribution to the lichen-forming and lichenicolous fungi flora of Armenia. *Willdenowia*, 44(2), 263–267. <https://doi.org/10.3372/wi.44.44208>
- 38 Hollinger, J., Noell, N., Gasparyan, A., Rockefeller, A., & Leavitt, S.D. (2022). Two new species of *Anaptychia* (Physciaceae) from western North America, with notes on the other species of section *Protoanaptychia*. *The Bryologist*, 125(4), 571–601. <https://doi.org/10.1639/0007-2745-125.4.571>
- 39 Mayrhofer, H. et al. (2023). The lichenized and lichenicolous fungi of Afghanistan. *Plant and Fungal Systematics*, 68(2), 440–461. <https://doi.org/10.35535/pfsyst-2023-0026>
- 40 Kukwa, M. et al. (2021). Materiały do rozmieszczenia porostów i grzybów naporostowych Polski, 1. <https://doi.org/10.5586/wb.645>
- 41 (2020). Perechen (spisok) obektov rastitelnogo i zhivotnogo mira, a takzhe gribov, zanesennykh v Krasnuiu knigu Respubliki Dagestan. Utverzhen postanovleniem Pravitelstva Respubliki Dagestan ot 28 dekabria 2020 g. № 288 (internet-portal pravovoi informatsii Respubliki Dagestan) [The list of objects of flora and fauna, as well as fungi listed in the Red Book of the Republic of Dagestan. Approved by Decree of the Government of the Republic of Dagestan dated December 28, 2020. No. 288 (Internet portal of legal information of the Republic of Dagestan)]. Retrieved from <https://www.pravo.e-dag.ru> [in Russian]

Information about the authors

Myrzakhan Anel Daurenkyzy — Master student, Al-Farabi Kazakh National University, Institute of Botany and Phytointroduction, Almaty, Kazakhstan; e-mail: myrzakhan_anel@mail.ru; ORCID: <https://orcid.org/0009-0004-9155-9308>

Rakhimova Yelena Vladimirovna — Doctor of Biological Sciences, Associate Professor, Chief Researcher, Institute of Botany and Phytointroduction, Almaty, Kazakhstan; e-mail: evrakhim@mail.ru; ORCID: <https://orcid.org/0000-0003-1112-1214>

Ametov Abibulla Ametovich — Docent, Candidate of Biological Sciences, Al-Farabi Kazakh National University, Almaty, Kazakhstan; e-mail: ametov@kaznu.kz; ORCID: <https://orcid.org/0000-0002-4123-8096>