

NEW LICHEN RECORDS FROM NORTH-EAST OF IRAN

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Samples of Lichen were collected in North-East (NE) of Iran (Khorasan Razavi Province, Torghabeh city) and studied with morphological, anatomical and ecological characteristics. Accordingly, *Anema prodigulum* (Nyl.) Henssen (Lichinaceae) and *Pyrenodesmia microstepposa* (Frolov, Nadyeina, Khodos. & Vondrák) Hafellner & Türk (Teloschistaceae) are reported for the first time from Iran.

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Key words: *Anema*, *Caloplaca*, Morphology, *Pyrenodesmia*, Torghabeh

گزارش گلشن‌های جدید از شمال شرق ایران

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در این تحقیق، نمونه‌های گلشن از شمال شرق ایران (خراسان رضوی، طرهبه) جمع‌آوری شد و براساس ویژگی‌های مورفولوژی، آناتومی و اکولوژی مورد بررسی قرار گرفت. براساس نمونه‌های جمع‌آوری شده، گونه‌های *Anema prodigulum* (Nyl.) Henssen و *Pyrenodesmia microstepposa* (Frolov, Nadyeina, Khodos. & Vondrák) Hafellner & Türk برای اولین بار در ایران گزارش می‌شوند.

INTRODUCTION

Lichen species belonging to the families Lichinaceae, Lecanographaceae and Teloschistaceae have an extensive diversity and large distribution and most have very specific habitat requirements (Cannon & Kirk 2007). The taxonomical position of the genera and species in these families has been revised partly in recent studies (Seaward & al. 2008).

The genus *Anema* Nyl. ex Forssell (Lichinaceae)

contains at least 13 species world-wide (Cannon & Kirk 2007). The most recent checklist of Iranian lichens (Seaward & al. 2008) recognizes two species for Iran. Haji Moniri & Sipman (2009) report *Anema nodulosum* (Nyl.) Forssell as additional species for Iran. Recently, an additional species of *Anema* has been reported in adjacent Europe, *A. tumidulum* Henssen ex P.M.Jørg., M.Schultz & Guttová (Jørgensen & al. 2013), which has to be looked for in Iran.

More than sixty species of *Caloplaca* Th. Fr. (Teloschistaceae) is reported from Iran and the genus is estimated to have about 510 species in the world (Seaward & al. 2008, Sharnoff and Raven 2014). Currently, the taxonomy of the family Teloschistaceae, and especially *Caloplaca*, is in a flux after Arup & al. (2013) showed it to be heterogenous, and here we follow provisionally the traditional concept (Arup & al. 2013, Vondrak & al. 2009, Gökhan Halici & Kocakaya 2012, Vondrak & al. 2015). Recently some surveys have been carried out on lichen flora of Iran and reported new taxa from the genus *Caloplaca* for example, *C. citrine* (Hoffm.) Jatta. in the north of Iran (Golestan province) (Kazemi & Ghahremaninejad 2008), *C. agardhiana* (Flot.) Flagey in the northwest of Iran (Zanjan province) (Sohrabi & al. 2010), *C. pyracea* (Ach.) Th. Fr. in the northeast of Iran (Northern Khorasan province) (Haji Moniri & Sipman 2011), *C. decipiens* (Arnold) Blomb. & Forssell and *C. persica* (J. Steiner) M. Steiner & Poelt (Haji Moniri & al. 2011). Muchnik & al. (2014) described two new

species in Russia and seven new species for European part of Russia. *Pyrenodesmia microstepposa* distributed in Turkey, Russia, western Kazakhstan, Ukraine and Czech Republic along with the taxa of the genera *Caloplaca*, *Aspicilia*, *Candelariella*, *Diplotomma* and *Lecanora* (Frolov & al. 2016).

Based on collected specimens from NE of Iran, we introduced new records of *Anema* and *Pyrenodesmia* for Iran. Details of morphological and anatomical characters for new records are provided.

MATERIAL AND METHODS

Collecting sites

Lichen samples were collected from natural populations growing in Khorasan Razavi province in the NE of Iran, Torghabeh region, during April 2019. This province is located at the border with Turkmenistan and Afghanistan (fig. 1). Voucher specimens from all material studied were deposited in the lichen personal collection belongs to M. Haji Moniri (MHM).

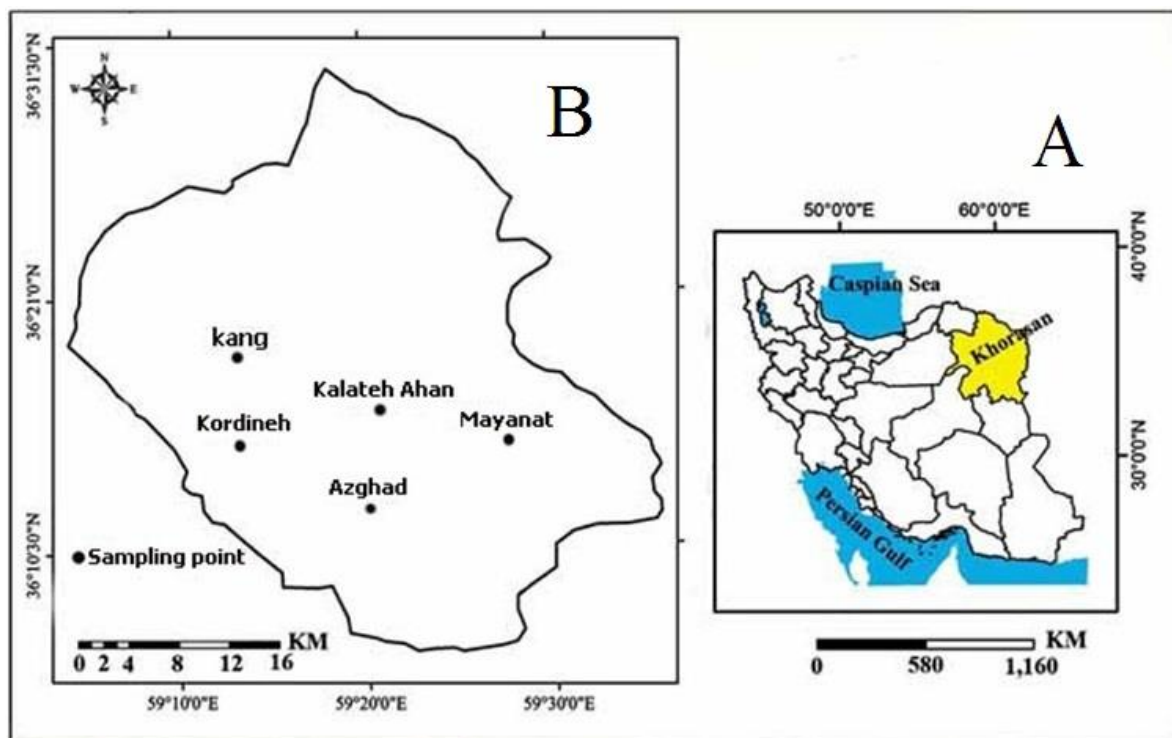


Fig. 1. Map of Khorasan Razavi province (A) in northeast of Iran (Torghabeh region) (B) and collection localities (black dots).

Experimental observations

To separate the species of lichens, it is necessary to carefully examine the anatomy of the specimens. These, specimens were identified by light microscope and stereo-microscope using morphological characters

and spot tests (K, C, KC, N and KOH/I) (Orange & al. 2001). The identification of calcareous and siliceous rocks in this study was performed with the help of 10% hydrochloric acid. Identifications were made using Sipman (2003), Temina & al. (2005).

Analyses of the morphological, anatomical and ecological characters

The MVSP software (Multi Variate Statistical Package) along with the UPGMA method (Unweighted Pair Group Analysis) based on Euclidean distances was applied for construction of a dendrogram of *Anema* species (Kovach 1999).

RESULTS AND DISCUSSION

The following species were identified as new records to the lichen flora of Iran.

1. *Anema prodigulum* (Nyl.) Henssen, (fig. 2 & table 1)

Thallus black, crustose to squamulose; attachment

by a central bundle of rhizohyphae. Apothecia 1 per squamule, 0.09-0.36 mm wide; disc dark red, black, slightly depressed; thalline margin persisting; exciple 11.4-14.2 μm thick, hyaline; epihymenium faintly yellowish; hymenium hyaline, amyloid, 99.7-114 μm high; paraphyses septate; hypothecium to 22.8 μm thick; asci 8-spored; ascospores simple, hyaline, 8.5-11.4 (-14.2) \times 2.8-5.7 μm (Czeika & al. 2004). Chemistry: Thallus K-, C-, KC-; apothecia K-. Secondary metabolites: unknown. Habitat: On siliceous rock, On sunny seepage tracks, steep or on the surface of boulders on rocky slopes; Geographical distribution: central and southern Europe, northwest of Africa and southwest and North America (Nash & al. 2003)

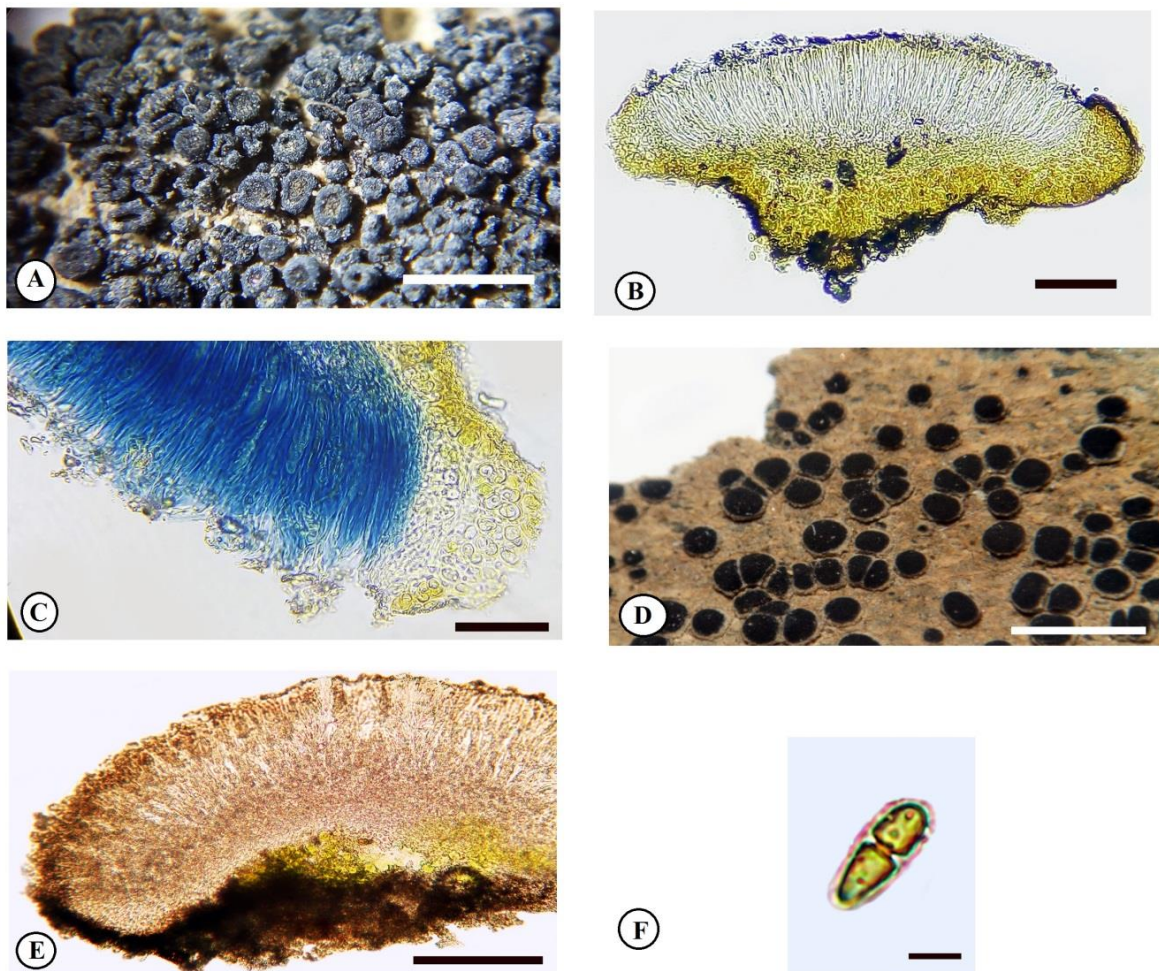


Fig. 2. Morphological and anatomical characters of the investigated species. A-C, *Anema prodigulum* (Nyl.) Henssen; A, Thallus, B, cross section of apothecium, C, cross section of apothecium (true exciple non-amyloid (I), hymenium amyloid (I+blue)); D-F, *Pyrenodesmia microstepposa* (Frolov, Nadyeina, Khodos. & Vondrák) Hafellner & Türk; D, thallus and habitat; E, cross section of apothecia; F, ascospores polarilocular, with rounded ends, cytoplasmic channel within septum always rather broad. Scale bar: A and D: 0.5 cm; B, C and E: 50 μm , F: 70 μm .

Table 1. Comparison of morphological, anatomical and ecological characters of *Anema* species.

Features	<i>A. decipiens</i> (Egea & Fernández 1992)	<i>A. nummularium</i> (Egea & Fernández 1992)	<i>A. nodulosum</i> (Haji Moniri & Sipman 2009)	<i>A. prodigulum</i> (present research)
Thallus	cushion-like	cushion-like	cushion-like	not cushion-like
Thallus color (dry)	black	black	black	blue black
Squamule diameter	1-2 mm	3-10 mm	3-4 mm	0.25-1 mm
Ascomata per squamule	1 or 2	3-10 (15)	1	1
Thalline margin	thin	thick	very thin	thick
Apothecia diameter	up to 0.5 mm	0.3-0.8 (1)mm	up to 0.5 mm	up to 0.7
Ascospore size	11-14 × 7-10 μm	9-15 × 7-12 μm	10-13 × 6- 9 μm	8.5-14.2 × 2.8-5.7 μm
Hymenium diameter	50-100 μm	80-150 μm	70-120 μm	99-114 μm
Habitat	calcareous rocks	calcareous rocks	calcareous- siliceous rocks	siliceous rocks

Examined specimens: Kordineh, N: 36° 14' 18.35", E: 59° 13' 17.27", 1979 m, April 2019, Haji Moniri 3304. Low Mayanat, N: 36° 12' 00.41", E: 59° 22' 20.41", 1646 m, April 2019, Haji Moniri 3305.

analysis of the characters in table 2, three groups were detected: group 1: *A. nummularium*, group 2: *A. prodigulum* as new record species and group 3: *A. decipiens* and *A. nodulosum* (fig. 3, table 2).

According to the dendrogram obtained from

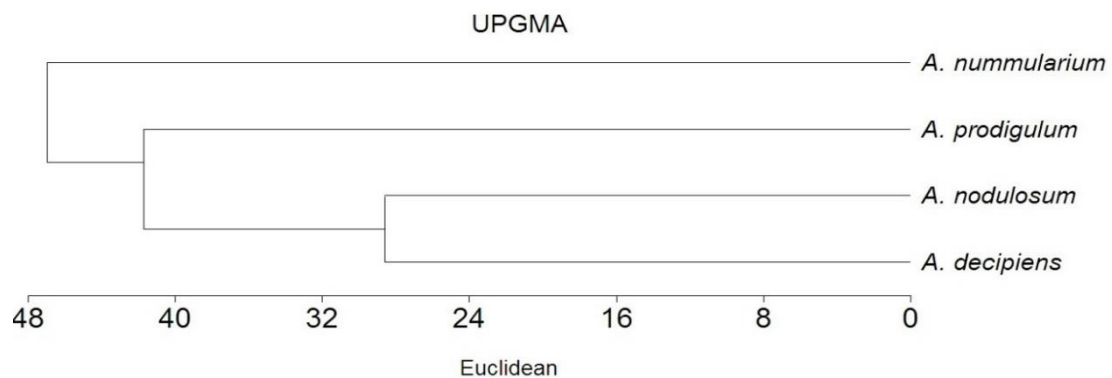


Fig. 3. Dendrogram obtained from the analysis of morphological, anatomical and ecological data in the studied species of the genus *Anema*.

Table 2. The morphological, anatomical and ecological characters (variables) and the studied species (cases) analyzed by MVSP software with UPGMA method and Euclidean distance for construction of dendrogram. DS (Dissimilarity).

CLUSTER ANALYSIS				
Analyzing 14 variables x 4 cases				
UPGMA				
Euclidean				
Node	Group 1	Group 2	DS	Objects in group
1	<i>A. decipiens</i>	<i>A. nodulosum</i>	28.57	2
2	Node 1	<i>A. prodigulum</i>	41.72	3
3	Node 2	<i>A. nummularium</i>	46.97	4

The previous lichen checklist by Seaward & al. (2004) listed *Anema decipiens* (A. Massal.) Forssell and *A. nummularium* (Dufour ex Durieu & Mont.) Nyl. *Anema nodulosum* was reported as a new species from Iran by Haji Moniri and Sipman (2009). Our research added *A. prodigulum* as new record to the lichen flora of Iran. An UPGMA analysis based on main selected characters, recognized three different entities in the studied species which confirmed to segregate new record species in this genus. Moreover, we present an identification key for the studied species based on the main morphological and anatomical characters.

Key to the *Anema* species known from Iran:

- 1- Thallus not cushion-like; thalline margin thick ***A. prodigulum***
 1- Thallus cushion-like; thalline margin thin or thick .2
 2- Apothecia 3- 10 (15) per squamule
 ***A. nummularium***
 2- Apothecia less than 3 per squamule 3
 3- Hymenium 50-100 µm; epithecium ascospores 11-14 × 7-10 µm ***A. decipiens***
 3- Hymenium 70-100 µm; epithecium orange; ascospores 10-13×6-9 µm..... ***A. nodulosum***

2. *Pyrenodesmia microstepposa* (Frolov, Nadyeina, Khodos. & Vondrák) Hafellner & Türk

Syn.: *Caloplaca microstepposa* Frolov, Nadyeina, Khodos. & Vondrák, (fig. 2)

Thallus crustose, brownish, thin, rimose-areolate; prothallus usually absent or poorly developed. Apothecia 0.4-0.8 mm diameter, rounded, flat to convex, mature apothecia suppressed to adnate, rarely immersed or sessile; true exciple same colour as disc; thalline margin same colour as thallus, proper margin hyaline, visible; exciple hyaline; hymenium hyaline, K-, 114-159 µm tall, with numerous extracellular oil drops; epithecium slightly brown; paraphyses branched; ascospore 14.2-17.1 × 5.7 µm (Frolov & al. 2016). Chemistry: Thallus K-, C-; apothecium K-, C-. Secondary metabolites: No substances detected.

Habitat: on siliceous rocks, often in sunny places at the altitudes up to 1900 m.

Geographical distribution: inland arid and semi-arid regions of Asia and from dry inland localities throughout Europe in altitudes up to 1000 m.

It is common in deserts of the western Kazakhstan and in the steppe and forest-steppe zone of Russia and Ukraine (Nadyeina 2009).

Morphologically it is similar to *Caloplaca albopruinosa* (Arnold) H. Olivier introduced in checklist by Seaward & al. 2008 in Iran with the following characteristics: thallus endolithic, grey or white; apothecia usually white pruinose; epihymenium

grey, K+ violet; ascospore septum wider, thalline exciple indistinct (Frolov & al. 2016).

Examined specimens: Kang, N: 36° 17' 34.5", E: 59° 13' 13.3", 1880 m, April 2019, Haji Moniri 3306; Azghad, N: 36° 13' 17.5", E: 59° 20' 53.6", 1721 m, April 2019, Haji Moniri 3307

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