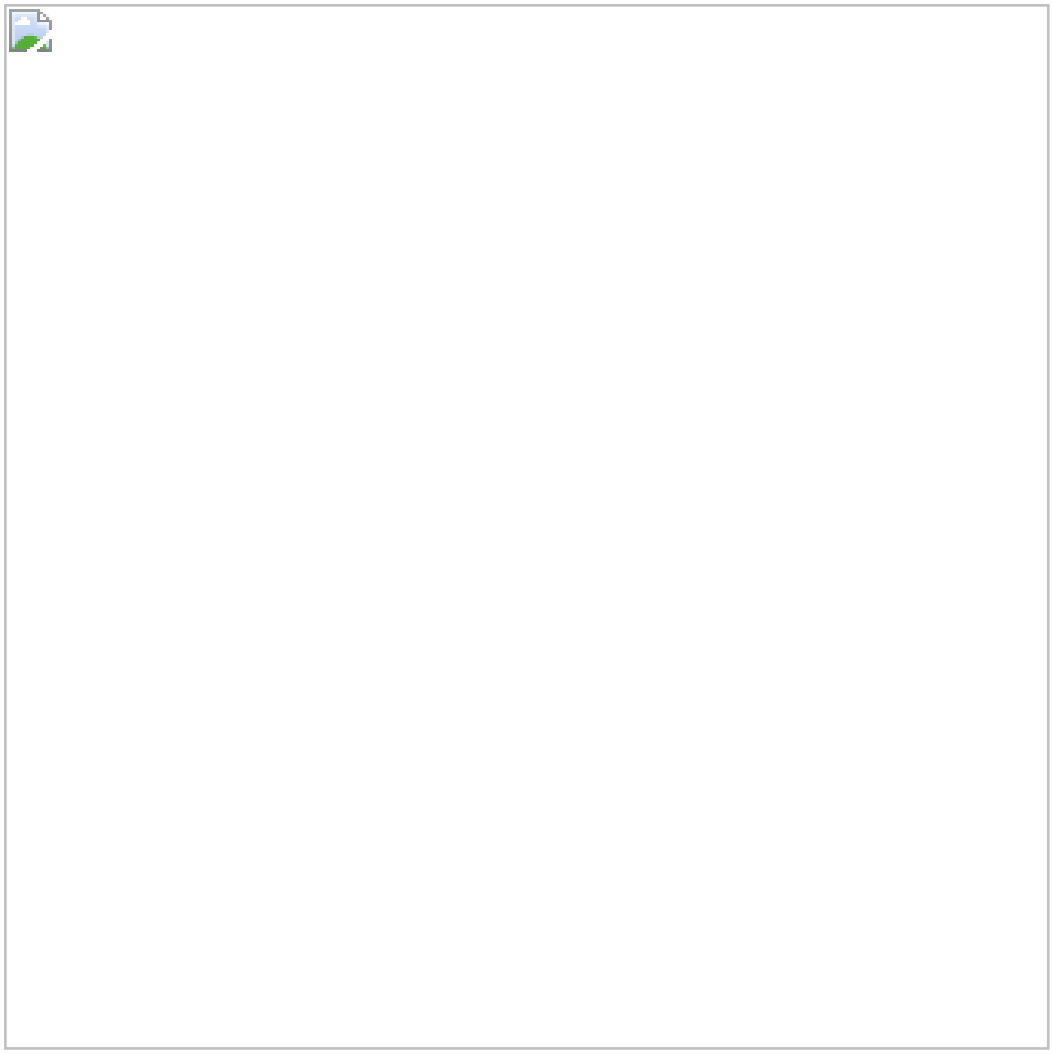

A checklist of lichens from Iraq, with four new records of lichens from Iraq

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A checklist of lichens from Iraq, with four new records of lichens from Iraq

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The lichen species of Iraq are poorly known and no accurate checklist has been produced so far. Here we carried out an extensive review of existing literature and carried out additional field work to expand the knowledge of lichens in Iraq. We present the first checklist of lichens in Iraq which comprises a total of 236 species. The field survey identified four lichen species as new to Iraq. Although this checklist is not a full checklist of the lichens of Iraq it represents the most complete list to date. It is likely that increased sampling will lead to further new records of lichen species in Iraq.

Keywords: checklist, Halabja province, Iraq, lichens, new records

The lichen species of Iraq have been poorly documented for a long time and an accurate checklist to illustrate lichen flora of Iraq has been lacking. This is somewhat due to the fact that the exploration of the lichen flora has relied principally on the occasional visits of scientists visiting from abroad. The first recorded lichen species in Iraq were reported by Steiner (1921) who reported the lichen specimens collected by Handel–Mazzetti during his expedition to Mesopotamia, Kurdistan, Syria and Prinkipo. The majority of lichen species reported here was collected in the Mosul area. Later in 1969, 34 further lichen species were collected from Iraq by Schubert (1973). A study of biological soil crusts of the Middle East by Galun and Garty (2001) reported several species, one of which was *Diploschistes diacapsis*, that was previously reported to Iraq by Reichert (1940); and seven more terrestrial lichens (*Catapyrenium squamulosum*, *Collema crispum*, *Diploschistes diacapsis*, *Fulgensia bracteata*, *Psora decipiens*, *Squamarina lentigera* and *Toninia sedifolia*) studied in the north of Mesopotamia between Baghdad and Fallfar were also reported by Schubert (1973). Two further species of lichen were identified in Iraq by Şenkardeşler et al. (2014). A further contribution was made by Almola et al. (2017), with 37 lichens reported for first time from Iraq. Finally, another annotated list of lichens listed 30 lichen taxa as supplementary data (Aziz and Qadir 2016). Since a full revision up-to-date list of lichen for Iraq is still lacking, a checklist is provided here. However, it must be indicated that the current paper also does not produce a complete account of lichen species. The checklist is a compilation of data from the previous studies listed above in combination with new fieldwork. Through carrying out new fieldwork we have added four new lichen records to Iraq. In this paper we describe the four new species reported in Iraq and provide a comprehensive checklist of lichen taxa known to occur in Iraq comprising 236 species in total.

Material and methods

Lichen specimens were collected from Halabja province and Byara district located in the north of Iraq. During the survey lichen specimens were preserved in a paper bags with a piece of substrate to protect them until observations, identification and photographing the specimens could be carried out. Morphological characters were examined on dry material under a dissecting microscope. Then, we used the keys exists in the books and journals of lichens from Turkey and Iran (Davis 1970, Hale 1979, Goward et al. 1994 Brodo et al. 2001, Dobson 2005, Smith 2009, Coppins and Dobson 2012). The specimens are deposited in the herbarium of Sulaimani polytechnic university in the college of applied science in Halabja province.

In addition, all scientific publications containing information about the lichens of the Iraq have been critically investigated and utilized for compilation of the checklist. As far as practicable, original sources were checked in order

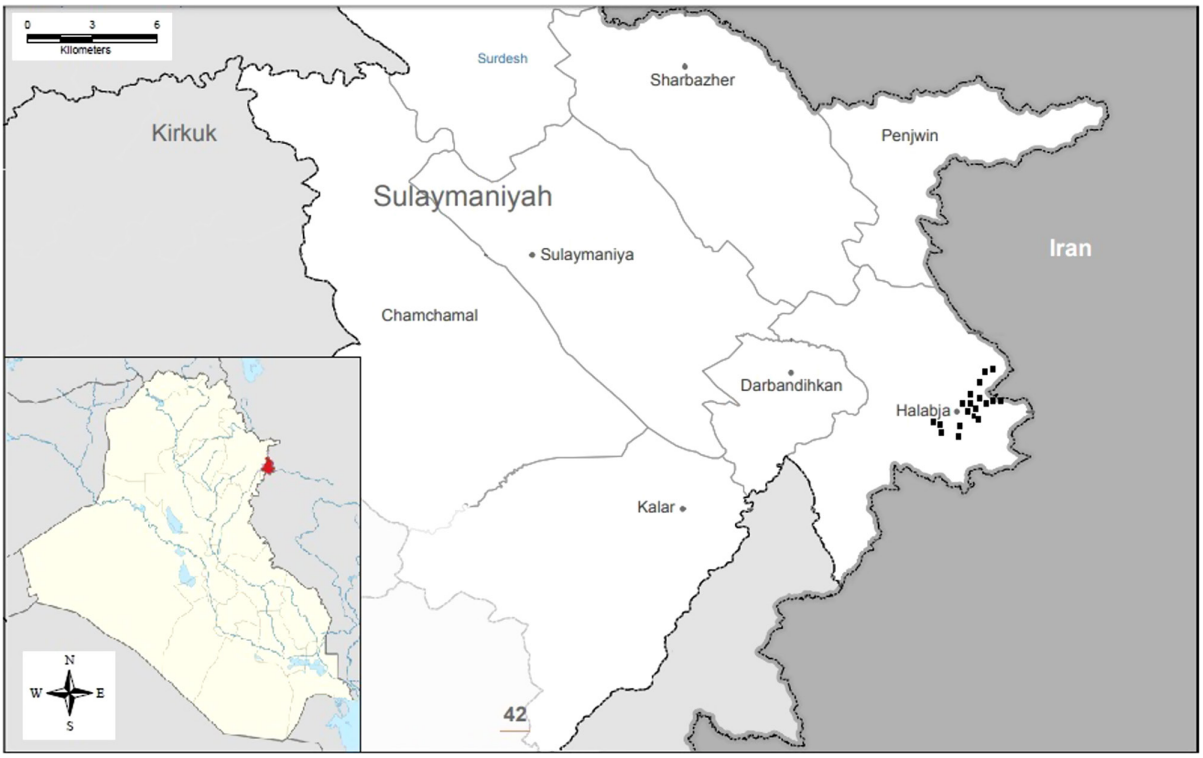

Figure 1. Collection localities of the survey Halabja province and Byara district (Iraq).

to remove those records which have arisen through misunderstanding of the original reference. The scientific publications used to show names of all lichens reported from Iraq are Steiner (1921), Reichert (1940), Schubert (1973), Şenkardeşler et al. (2014), Aziz and Qadir (2016) and Almola et al. (2017).

Results

Through carrying out a literature review of previous lichen studies we found a total of 232 lichen species in Iraq. By carrying out additional fieldwork we found four new species of lichen occurring in Iraq, *Candelaria concolor*, *Dermatocarpon vellereum*, *Diploicia canescens* and *Lichinella nigritella*. In addition, we confirmed 17 of the species that were identified as occurring in Iraq from previous studies.

The present checklist below contains 236 species of lichen from Iraq. The list of lichens presented is a combination of published literature data with those species reported in the current paper. Full details of the newly recorded species are provided below. The species marked by an asterisk (*) in the below list are new reports for Iraq and the species are marked with # also found in the study locations.

The list of lichens from Iraq

Acarospora cervina A. Massal.
Acarospora fuscata (Schrader) Arnold
Acarospora glaucocarpa (Ach.) Körb.
Acarospora hilaris (Dufour) Hue
Acarospora impressula Th. Fr.
Acarospora nodulosa (Dufour) Hue
Acarospora strigata (Nyl.) Jatta
Amphoridium calcisedum (DC.) Servít
Anaptychia desertorum (Rupr.) Poelt #
Aspicilia caesiocinerea (Nyl. ex Malbr.) Arnold
Aspicilia calcarea (L.) Mudd #
Aspicilia candida (Anzi) Hue
Aspicilia cinerea (L.) Körb. #
Aspicilia contorta (Hoffm.) Krempelh.
Aspicilia farinosa Flörke) Flagey
Aspicilia ferruginea (J. Steiner) Szatala
Aspicilia leprosences (Sandst.) Hav.
Aspicilia microspora var. insensibilis Szatala
Aspicilia subpercaena Szatala
Bellemerea aplina (Sommerf.) Clauzade & Cl. Roux
Bellemerea cinereorufescens (Ach.) Clauzade & Cl. Roux
Biatora vernalis (L.) Fr.
Buellia epipolia (Ach.) Mong.
Buellia spuria (Schaer.) Anzi
Caloplaca vitellinula (Nyl.) H. Olivier
Caloplaca aegyptiaca (Müll. Arg.) J. Steiner
Caloplaca arenaria (Pers.) Müll. Arg.
Caloplaca aurantia (Pers.) Hellbom
Caloplaca biatorina (A. Massal.) J. Steiner
Caloplaca bolacina (Tuck.) H. Magn.
Caloplaca chalybaea (Fr.) Müll.Arg.
Caloplaca citrina (Hoffm.) Th. Fr. #
Caloplaca deceptoria (Flagey) J. Steiner
Caloplaca aegyptiaca (Müll. Arg.) J. Steiner
Caloplaca erythrocarpa (Pers.) Zwackh
Caloplaca feracissima H. Magn.
Caloplaca flavorubescens (Hudson) J. R. Laundon
Caloplaca fulgens Körb.
Caloplaca holocarpa (Hoffm.ex Ach.) M. Wade

Caloplaca ignea Arup
Caloplaca inspersa (J. Steiner) J. Steiner
Caloplaca lithophila H. Magn.
Caloplaca murorum (Hoffm.) Th. Fr.
Caloplaca ochracea (Schaer.) Flagey
Caloplaca paepalostoma (Anzi) Jatta
Caloplaca pellodella (Nyl.) Hasse
Caloplaca polycarpoides (J. Steiner) M. Steiner & Poelt
Caloplaca pyracea (Ach.) Zwackh
Caloplaca thallincola (Wedd.) Du Rietz
Caloplaca variabilis (Pers.) Müll. Arg.
Caloplaca velana (A. Massal.) Du Rietz
Caloplaca verruculifera (Vain.) Zahlbr.
***Candelaria corncolor* (Dickson) Stein** *
Candelariella aurella (Hoffm.) Zahlbr. #
Candelariella vitellina (Hoffm.) Müll.Arg.
Candelariella xanthostigma (Ach.) Lettau
Catapyrenium squamulosum (Ach.) Breuss
Coccocarpia erythroxyli (Sprengel) Swinscow & Krog
Collema crispum (Hudson) Weber ex F.H. Wigg.
Collema cristatum (L.) F. H. Wigg.
Collema flaccidum (Ach.) Ach.
Collema fuscovirens (With.) J. R. Laundon
Collema ligerinum (Hy) Harm.
Collema polycarpon Hoffm.
Collema tenax (Sw.) Ach.
Dermatocarpon hepaticum (Ach.) Th.Fr.
Dermatocarpon miniatum (L.) W. Mann
Dermatocarpon monstruosum (Schaer.) Vain.
***Dermatocarpon vellereum* Zschacke** *
Dimelaena oreina (Ach.) Norman
***Diploicia canescens* (Dickson) A. Massal.** *
Diploschistes steppicus Reichert
Diploschistes caesioplumbeus (Nyl.) Vain.
Diploschistes diacapsis (Ach.) Lumbsch
Diploschistes muscorum (Scop.) R. Sant.
Diploschistes ocellatus (Fr.) Norman
Diploschistes scruposus (Schreber) Norman
Diploschistes steppicus Reichert
Diplotomma hedinii (H. Magn.) P. Clerc & Cl. Roux
Dirina catalinariae Hasse
Endocarpon pusillum Hedwig
Fulgensia bracteata (Hoffm.) Räsänen
Fulgensia fulgens (Sw.) Elenkin
Fulgensia schistidii (Anzi) Poelt
Fulgensia subbracteata (Nyl.) Poelt
Graphina peplophora M. Wirth & Hale
Graphis elegans (Borrer ex Sm.) Ach.
Gypsoplaca macrophylla (Zahlbr.) Timdal
Haematomma ventosum (L.) A. Massal. #
Heterodermia crocea R.C. Harris
Heterodermia diademata (Taylor) D. D. Awasthi
Hypogymnia austerodes (Nyl.) Räsänen #
Hypotrachyna livida (Taylor) Hale
Kaernefeltia merrillii (Du Rietz) Thell & Goward
Lecanactis abietina (Ach.) Körb.
Lecanora dispersa (Pers.) Sommerf.
Lecanora hybocarpa (Tuck.) Brodo
Lecanora mutabilis (Ach.) Nyl.
Lecanora xylophila Hue
Lecania koerberiana J. Lahm
Lecania subcaesia (Nyl.) B. de Lesd.
Lecanora albescens (Hoffm.) Branth & Rostrup #
Lecanora argopholis (Ach.) Ach.
Lecanora cinereofusca var. appalachensis Brodo
Lecanora circinata (Pers.) Ach.
Lecanora circumborealis Brodo & Vitik.
Lecanora dispersa (Pers.) Sommerf.
Lecanora garovaglii (Körb.) Zahlbr.
Lecanora hoffmannii (Ach.) Müll.Arg.
Lecanora Kurdistanica J. Steiner
Lecanora lentigera (Weber) Ach.
Lecanora muralis (Schreber) Rabenh. #
Lecanora novomexicana H. Magn.
Lecanora polytropa (Hoffm.) Rabenh.
Lecanora pruinosa Chaub.
Lecanora versicolor (Pers.) Ach.
Lecidea atrobrunnea ((Raymond ex Lam. & DC.) Schaer.
Lecidea cyathoides (Ach.) Ach.
Lecidea deeeptoria Nyl.
Lecidea fuscoatra (L.) Ach.#
Lecidella stigmatea (Ach.) Hertel & Leuckert
Lepraria incana (L.) Ach.#
Lepraria vouauxii (Hue) R.C. Harris
Leptotrema wightii (Taylor) Müll.Arg.
Lichinella cribellifera (Nyl.) Henssen
Lichinella nigritella* (Lettau) P.P. Moreno & Egea
Lobothallia praeradiosa (Nyl.) Hafellner
Megaspora verrucosa (Ach.) Hafellner & V. Wirth
Melanelia disjucta (Erichsen) Essl.
Melanelia glabra (Schaer.) Essl.
Melanelia panniformis (Nyl.) Essl.
Mycoblastus affinis (Schaer.) Schauer
Neofuscelia pulla (Ach.) Essl.
Normandina pulchella (Borrer) Nyl.
Ochrolechia frigida (Sw.) Lynge
Ochrolechia pallescens (L.) Körb.
Ochrolechia tartarea (L.) A. Massal.
Orphniospora moriopsis (A. Massal.) D. Hawksw.
Pachyospora verrucosa (Ach.) Massal.
Pannaria rubiginosa (Thunb.) Delise
Pannaria conoplea (Ach.) Bory
Parmelia acetabulum (Neck.) Duby
Parmelia caperata (L.) Ach.
Parmelia conspersa Ach.
Parmelia quercina (Willd.) Vain. #
Parmelia saxatilis (L.) Ach.
Parmelia tinctina Maheu & A. Gillet
Parmelina quercina (Willd.) Hale
Parmelina tiliacea (Hoffm.) Hale
Parmotrema chinense (Osbeck) Hale & Ahti
Parmotrema perforatum (Jacq.) A. Massal.
Peltula obscurans (Nyl.) Gyelnik
Peltula richardsii (Herre) Wetmore
Pertusaria aspergilla (Ach.) J.R. Laundon
Pertusaria flavicunda Tuck.
Pertusaria lactea (L.) Arnold#
Pertusaria paratuberculifera Dibben
Pertusaria rubefacta Erichsen
Pertusaria subambigens Dibben
Pertusaria subpertusa Brodo
Pertusaria texana Müll.Arg.

Pertusaria trachythallina Erichsen
Pertusaria velata (Turner) Nyl.
Phaeophyscia orbicularis (Necker) Moberg
Physcia aipolia (Ehrh. ex Humb.) Furnr. #
Physcia biziana (A. Massal.) Zahlbr. #
Physcia caesia (Hoffm.) Furnr.
Physcia perisidiosa Erichsen
Physcia pulverulenta (Schreb.) Hampe ex Fürnr.
Physcia semipinnata (J. F. Gmelin) Moberg
Physcia thomsoniana Essl.
Physconia distorta (With.) J. R. Laundon
Physconia distorta (With.) J. R. Laundon
Placidium lacinulatum (Ach.) Breuss
Placocarpus schaereri (Fr.) Breuss
Porpidia flavocaerulescens (Hornem.) Hertel & A. J. Schwab
Psora decipiens (Hedwig) Hoffm.
Psora lurida (With.) DC.
Psora vallesiaca (Schaer.) Timdal
Pyrenula nitida (Weigel) Ach.
Pyrenula pseudobufonia (Rehm) R.C. Harris
Rhizocarpon chioneum (Norman) Th. Fr.
Rhizocarpon chionophilum Th. Fr.
Rhizocarpon disporum (Naeg. ex Hepp) Müll.Arg.
Rhizocarpon geographicum (L.) DC.
Rhizocarpon hochstetteri (Körb.) Vain.
Rhizocarpon macrosporum Räsänen
Rhizocarpon obscuratuni (Ach.) A. Massal.
Rhizocarpon reductum Th. Fr.
Rhizocarpon richardii (Lamy ex Nyl.) Zahlbr.
Rhizocarpon umbilicatum (Ramond) Flagey *Rhizoplaca melanophthalma* (DC.) Leuckert & Poelt
Rhizoplaca marginalis (Hasse) W.A. Weber
Rhizoplaca subdiscrepans (Nyl.) R. Sant.
Rinodina ascociscana (Tuck.) Tuck.
Rinodina atrocinerea (Fr.) Körb.
Rinodina bischoffi (Hepp) A. Massal.
Rinodina immersa (Körb.) Zahlbr.
Rinodina bolanderi H. Magn.
Rinodina populicola H. Magn.
Rinodinu biechoffii (Hepp) A. Massal.
Roccellina conformis Tehler
Sarcogyne regularis Körb.
Squamarina cartilaginea (With.) P. James
Squamarina crassa (Huds.) Poelt
Squamarina lentigera (Weber) Poelt
Squamarina stella-petraea Poelt
Staurothele diffractella (Nyl.) Tuck.
Tephromela grumosa (Pers.) Hafellner & Cl. Roux #
Thelidium pyrenophorum (Ach.) Mudd
Thelomma californicum (Tuck.) Tibell
Toninia alutacea (Anzi) Jatta
Toninia candida (Weber) Th. Fr.
Toninia sedifolia (Scop.) Timdal
Toninia coeruleonigricans (Lightf.) Th. Fr.
Trapelia glebulosa (Sm.) J. R. Laundon
Trapelia placodioides Coppins & P. James #
Trapeliopsis wallrothii (Flörke) Hertel & Gotth. Schneider
Verrucaria amphibia Clemente
Verrucaria attica J. Steiner
Verrucaria baldensis A. Massal. #
Verrucaria beltraminiana (A. Massal.) Trevis.
Verrucaria calcivora Nyl.
Verrucaria calciseda DC.
Verrucaria dolomitica (A. Massal.) Kremp.
Verrucaria glaucina Ach.
Verrucaria macrostoma Dufour ex DC.
Verrucaria marmorea (Scop.) Arnold
Verrucaria maura Wahlenb.
Verrucaria nigrescens Pers.
Verrucaria rupestris Schrader
Verrucaria tristis (A. Massal.) Kremp.
Xanthoparmelia plittii (Gyelnik) Hale
Xanthoria elegans (Link) Th. Fr.
Xanthoria parietina (L.) Th. Fr.
Xanthomendoza fallax (Hepp ex Arn.) Søchting, Kärnefelt & S.Y. Kondr.
Xanthomendoza fulva (Hoffm.) Søchting, Kärnefelt & S.Y. Kondr.

New record species for Iraq

***Candelaria concolor* (Dickson) Stein**

Found on tree barks. The lichen thallus is typically forming small, irregularly spreading discrete suborbicular, sometimes coalescing or in scattered fragments.The thallus appressed, lobes flattened, finely divided, surface flat or some wavy, often somewhat raised and fan-like, the margins distinctly overlapping, entire. The color of thallus lemon yellow to mustard yellow, paling to yellow green in shade and almost white underside. The rhizines scattered, white to pinkish. The species is distinguished by its microfoliose thallus which form distinct rosettes usually with moss habitat on the bark.

Note: the most conspicuous features for the *Candelaria concolor* species were seen on the lower surface, which is white, smooth and does not show any arachnoid structures as in *Candelaria pacifica*. Poelt (1974) described the lower cortex of *Candelaria concolor* as a 3–4 cell thick paraplectenchyma, built of numerous hyphes and with bundles of white rhizines. Furthermore, the production of ascomata could be observed in several specimens having polyspored asci. Above all, the lower surface gives the impression of a compact cortex, in contrast to the arachnoid lower surface in *Candelaria pacifica*. This species was distributed in Byara.

***Dermatocarpon vellereum* Zschacke**

Found on huge stones. The lichen thallus usually monophyllus, foliose, umbilicate, saxicolous, leathery, upper side light brownish to brownish red, white to dark pruinose, lower side black, with dense, thick stumpy, coralloid rhizinomorphs.

Note: widespread in subtropical to lower temperate regions China and eastern Europe, India, Nepal. This species is distributed also in Iraq. This species is located in Byara and Sargat, and it was common in study locations.

***Diploicia canescens* (Dickson) A. Massal.**

Found on stones. The thallus of lichen is crustose, placodioid, continuous, forming rosettes, effigurate lobes: radiating, but sometimes irregular, discrete or confluent; lobe tips: usually rotund or truncate. The surface is white, grey-white or pale blue-grey, plane to convex or concave at the periphery.

Note: this species it has two subspecies which are *Diploicia canescens* subsp. *australasica* and *Diploicia canescens* subsp.

Canescens. Moon et al. (2014) described the *Diploicia canescen* subsp. *australasica* is mainly restricted to the Southern Hemisphere with its center of distribution in Australia and New Zealand, whereas *Diploicia canescens* subsp. *canescens* is widely distributed in the Northern Hemisphere (Bratt 1984, Elix et al. 1988, Dalby 1994, Calatayud et al. 1995, Sipman 2002). The distribution of subsp. *australasica* now extends to Korea. According to Ryan et al. (2004), *Diploicia canescens* is distributed widely in the world including temperate Europe, Mediterranean region, Africa, Hawaii, Japan, Australasia,and western North America. This species also found around Halabja city.

***Lichinella nigritella* (Lettau) P.P. Moreno & Egea**

Found on rocks. The thallus of lichen is black; the lobes of thallus are repeatedly branched and ascending with only the marginal lobes adpressed. The lobe shape is rather variable depending on the stage of branching. Because the lobe presence of numerous globose to scale-like isidia, there surface is rough. The broad, marginal lobes are often ridged.

Note: *Lichinella nigritella* is closely related to *Lichinella cribellifera* which is similar in overall appearance. However, *Lichinella nigritella* in the more narrow and more erect lobes which are deeply branched from the beginning, usually bearing numerous, small, globose or scalelike isidia. Schultz (2005) reports *Lichinella cribellifera* to be restricted to acidic rock, whereas *Lichinella nigritella* was found on acidic as well as calcareous rocks in North America. Also he said both species are widely distributed in the study region, but *Lichinella nigritella* appears to be more common.

For separation from *Lichinella cribellifera* that mature thallus, broad marginal lobe with ascending margin and numerous granules on the surface and the thallus consisting of small rosette with rounded, sparsely branched lobes and numerous, globose isidia on the lobe surface. We found both species in the study area, but *Lichinella cribellifera* is reported to Iraq previously. *Lichinella nigritella* is also distributed around Halabja city.

Discussion

The known species diversity of Iraq at the moment includes 236 species of lichens. Although not all of provinces of Iraq were studied equally, some features of its diversity can be discussed. According to the limited data, the most lichens diverse in Iraq are north of Iraq (Kurdistan region). This seems plausible, since this mountainous region has the greatest diversity of natural conditions, including excellent substrate diversity, with a long geological history. The north of Iraq is also a diverse mountain territory. It is expected that the known lichen flora of this region will increase further through further targeted surveying. As presence of lichen species have still not yet been completely reported in all Iraq districts, our knowledge of lichens stimulated us to do this literature review on lichen species of Iraq, and to conduct surveys in Halabja province and Byara. Therefore, this comprehensive checklist has been made. This checklist is a guide to the presence of lichens in Iraq. The aim of making the list was to follow development records as to their origin and to correct mistaken data that caused by misidentification and incorrect synonymy as far as possible. The old names are revised also into up-to date nomenclature. In our list we have gathered only records that were reliable or at least probably correct.

The increasing importance of lichens in the management and conservation of vegetation systems in Iraq has generated considerable local demand for a checklist of Iraq. However, it must be indicated that the current paper also does not produce a complete account of lichen species. The checklist is a blend of data from recent studies and old studied date gathered.

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