

A PRELIMINARY STUDY OF RHIZOCARPON MACROSPORUM IN RAZAVI KHORASAN PROVINCE (NE IRAN)

M. Haji Moniri, S. Kamyabi & S. R. Clayden

Received 07 03 2010. Accepted for publication 12 05 2010

Haji Moniri, M., Kamyabi, S. & Clayden, S. R. 2010 06 30: a preliminary study of *Rhizocarpon macrosporum* in Razavi Khorasan province (NE Iran). -*Iran. J. Bot.* 16 (1): 185-189. Tehran.

The present paper is a part of a more extensive investigation of *Rhizocarpon* based on collections made since 2007 in Razavi Khorasan province in northeastern Iran. Here, we provide details of the morphology, anatomy and lichen substances *R. macrosporum*. A distribution map is also presented.

Mahroo Haji Moniri (correspondence, m.h.moniri@mshdiau.ac.ir) & Saleh Kamyabi, Department of Biology, Faculty of Science, Islamic Azad University, Mashhad Branch, Mashhad, Iran, Rahnamaie St., Mashhad. -Stephen R. Clayden, Botany and Mycology Section, New Brunswick Museum, New Brunswick, Canada 277 Douglas Avenue, Saint John, NB E2K 1E5, e-mail: stephen.clayden@nbm-mnb.ca

Keywords. Lichenized fungi, *Rhizocarpon macrosporum*, Razavi Khorasan, Iran.

مطالعه مقدماتی *Rhizocarpon macrosporum* در استان خراسان رضوی (شمال شرق ایران)

دکتر مهرو حاجی منیری، استادیار گروه زیست شناسی دانشگاه آزاد اسلامی واحد مشهد.

صالح کامیابی، کارشناس ارشد زیست شناسی گیاهی، دانشگاه آزاد اسلامی واحد مشهد.

استیون کلایدن، مدیر بخش گیاه شناسی و قارچ شناسی موزه نیوبرونسویک کانادا.

مقاله حاضر بخشی از بررسی وسیع جنس *Rhizocarpon* Ramond ex DC. بر اساس جمع آوری انجام شده در طول سال ۲۰۰۷ از استان خراسان رضوی واقع در شمال شرق ایران می باشد. جزئیات مورفولوژی، آناتومی و ترکیبات گلسنگی برخی نمونه های *R. macrosporum* در اینجا آمده است. نقشه توزیع گونه نیز ارائه می گردد.

Introduction

Understanding the diversity and taxonomy of Iran's lichens has never been more important than it is today, and this is undoubtedly the most exciting subject to be studied in the cryptogamic flora of the country. The early history of lichenological investigation in the northeast of Iran was documented by Szatala (1940, 1957). Checklists of lichens for Iran by Seaward et al. (2004, 2008) provided an up-to-date perspective on lichen biodiversity in several provinces.

The cosmopolitan genus *Rhizocarpon* includes ca. 200 species (Feuerer 1978) occurring on siliceous and calcareous rocks. *Rhizocarpon* species were traditionally divided into two groups differing in thallus color. The yellow-green species, containing rhizocarpic acid, were assigned to subgenus *Rhizocarpon*, and the non-yellow-green (white, gray, orange and brown) species to subgenus *Phaeothallus* (Thomson 1967). It is now known that these groups are polyphyletic (Ihlen & Ekman 2002). The yellow-green *Rhizocarpon* species have been monographed by Runemark (1956) for

European and occur mainly in arctic-alpine areas (Magnusson 1927; Lynge 1928, 1932, 1935).

Rhizocarpon was first recorded in Iran by Müller (1892). By 2008, four species had been reported for Razavi Khorasan province (Seaward et al. 2008), but the list has been recently revised (Moniri et al. 2009). According to the last reference, there are 10 species of the genus in Iran, including six species and one subspecies in Razavi Khorasan. One of these new records is *R. macrosporum* Räsänen, a yellow-green species very similar to *R. geographicum* (L.) DC. but recognizable by its larger ascospores.

Material and Methods

Razavi Khorasan province, with an area of c. 127,432 km², is located in the northeast of Iran. Thirty mountainous localities in the province were investigated; these range from ca. 900 to 2300 m. Three thalli of *R. macrosporum* were found on Binaloud Mt., Zoshk, 27 km west of Mashad, at 1750 m elevation (Fig. 1). The samples were examined with

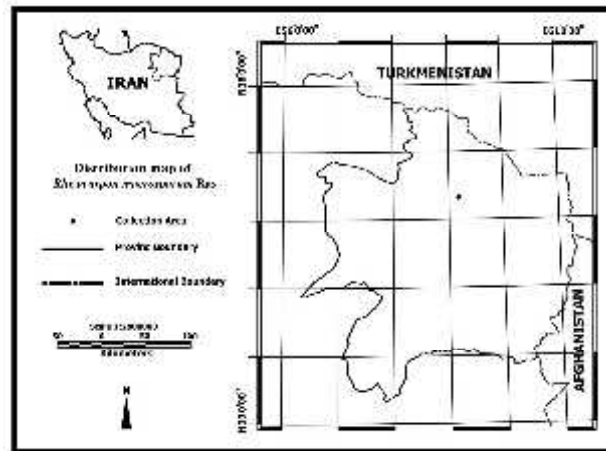


Fig. 1. Distribution map of *Rhizocarpon macrosporum* in Razavi Khorasan province (Kamyabi, 2009).

light microscopy, standard chemical spot-test reagents and TLC (Orange *et al.*, 2001). TLC was done on one sample by M. Kukwa (Gdansk, Poland), and another by S. R. Clayden (New Brunswick Museum, Canada). The original material is deposited in the lichen collection of M. Haji Moniri, with duplicates at NBM and the herbarium of M. Kukwa. The most important references for identification were Runemark (1956) and Fletcher *et al.* (2009).

Results and Discussion

Rhizocarpon macrosporum Räsänen

Description. *Thallus* to 5 cm in diam., of closely spaced areoles separated by thin lines of prothallus; black prothallus distinct at the thallus margin (Figs. 2a-b; 6a). Areoles 0.5-1.4 mm in diam., light yellow to yellow, plane to slightly convex, surface pruinose, matt (Figs. 3a-b), with limited secondary fissuring of areoles; secondary areoles angular, cortex ca. 25-30 μm thick, medulla white, 70-90 μm thick, I + violet; distinct hypothallus 80-150 μm thick (Fig. 4); sorediate absent. Apothecia 0.3-0.7 mm in diam., black, thick, angular to roundish, usually plane or slightly convex, more or less pruinose, not surrounded by crescent-shaped areoles, with 50-80 μm thick proper excipulum. Subhymenium usually 30-200 μm , brown. Hymenium 150-220 μm tall, colourless to light brown. Epihymenium 30-100 μm thick, reddish brown, K+ more reddish; without black granules. Spores 8/ascus, muriform, long ellipsoid, dark olivaceous to brown, 32-60 \times 15-22 μm (Figs. 5, 6b-d).

Lichen substances. Rhizocarpic acid and an bourgeanic acid, identified by TLC.

Rhizocarpon macrosporum is part of the *Geographicum* group of species (Runemark 1956a). These have multiseptate, mostly muriform, ascospores,

an epihymenium lacking dark granules, and a medulla reacting positively with Lugol's iodine (I+ blue). Within this group, *R. macrosporum* is distinguished mainly by its large ascospores, each with an average of about 30 cells visible in optical section (Feuerer 1978). *Rhizocarpon sphaerosporum* Räsänen reportedly differs in lacking reddish-brown, K+ more reddish, pigmentation in the epihymenium, in its more rounded areolae, and in having a more diverse medullary chemistry (Runemark 1956a). However, Timdal and Holtan-Hartwig (1988) found that these two species could not be consistently separated, and they synonymized *R. sphaerosporum* with *R. macrosporum*. Runemark (1956a) inferred that specimens of *R. macrosporum* reacting negatively with paraphenylenediamine (PD) lacked any characteristic secondary metabolites other than the cortical pigment rhizocarpic acid. However, with refined TLC methods, many PD specimens of *R. macrosporum* proved to contain the aliphatic depside bourgeanic acid as the main medullary compound (Clayden, 2004). The Iranian collections reported here belong to this bourgeanic acid chemotype. If the synonymy of *R. sphaerosporum* and *R. macrosporum* is accepted, then *R. macrosporum* includes three additional chemotypes: with psoromic acid, stictic acid, or barbatic acid (Runemark, 1956a; Timdal and Holtan-Hartwig, 1988). *Rhizocarpon macrosporum* has a broad, but discontinuous, range in temperate areas of North America and western Eurasia. It is also known from Morocco in North Africa (Runemark 1956b). It occurs as far north as southern Scandinavia, but is apparently absent from areas with oceanic climates, including the British Isles. Records from Greenland and Arctic North America (Thomson 1997) are in need of critical

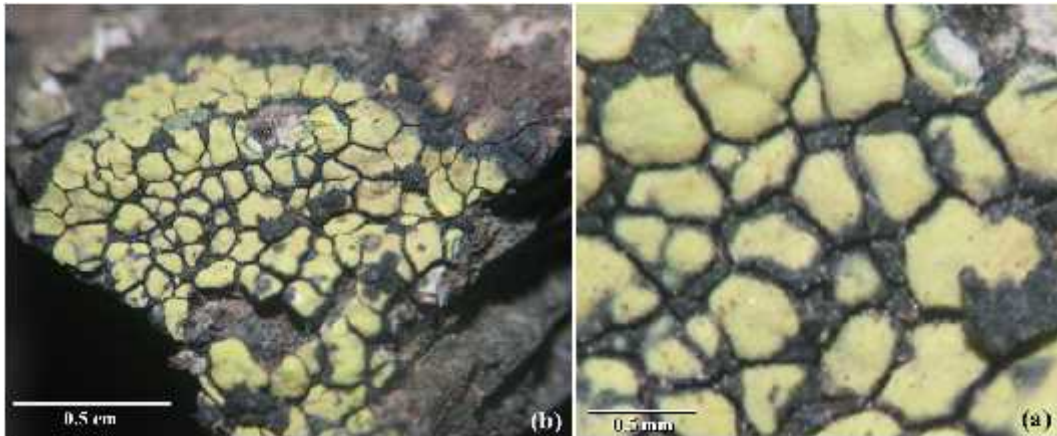


Fig. 2. (a). Secondary areoles and (b) thallus in *Rhizocarpon macrosporum* (Kamyabi, 2009).



Fig 3. (a) Primary areole on the prothallus and (b) Thick prothallus in the margin of *Rhizocarpon macrosporum* (Kamyabi, 2009).

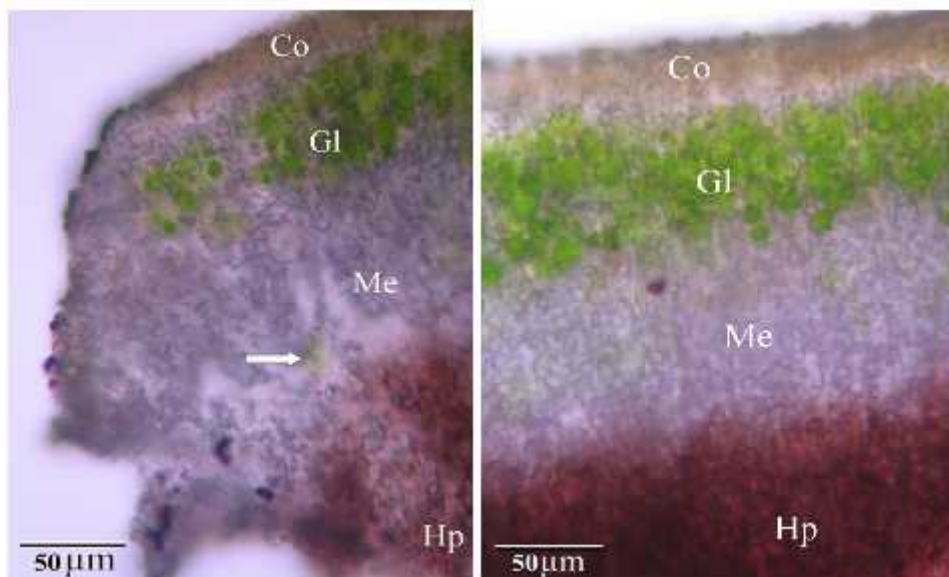


Fig 4. Longitudinal section of an areole of *Rhizocarpon macrosporum*, Co: cortex, Gl: algal layer, Me: medulla with lemon yellow crystal of (probably) rhizocarpic acid (Kamyabi, 2009).

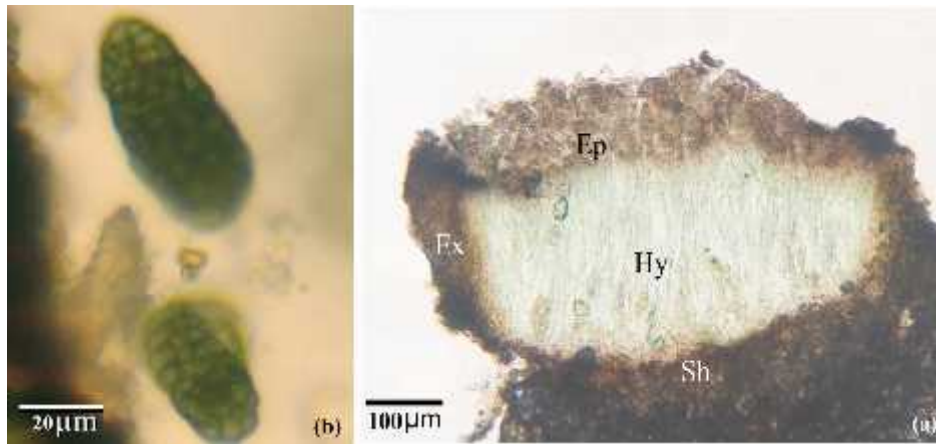


Fig. 5. (a): Longitudinal section of apothecium, Ep: epihymenium, Ex: exciple, Hy: hymenium, Sh: subhymenium and (b) Muriform ascospores in *Rhizocarpon macrosporium* (Kamyabi, 2009).

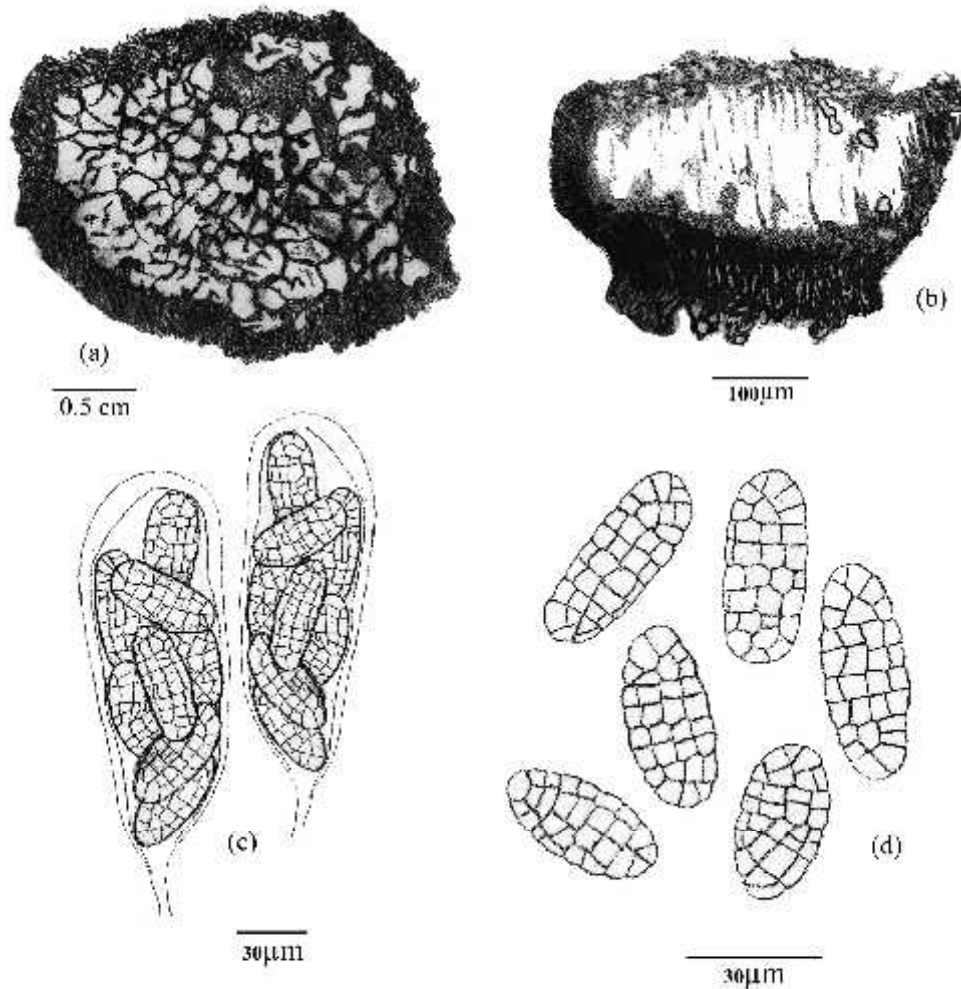


Fig 6. Schematic pictures of thallus and reproductive organ in *Rhizocarpon macrosporium*: (a). Thallus, (b). Longitudinal section of apothecium, (c). Ascus containing 8 muriforme ascospores and (d). Different shapes of ascospores (Kamyabi, 2009).

reevaluation. In Eurasia, the easternmost documented occurrences of *R. macrosporum* are in Afghanistan (Steiner & Mayrhofer 1987, sub *R. sphaerosporum*) and Tajikistan (Kudratov & Mayrhofer 2002). The collections from Iran reported here fill in a gap in the known range between these two countries to the east, and Turkey and Georgia to the west. All collections from this general region were made in montane areas, with elevations above 1600 m. *Collection examined*. Binaloud Mt., Zoshk, 27 km west of Mashad, UTM 40S, 696399 4022685, 1750 m elev., 6. Sept. 2007, *Saleh Kamyabi 2425b* (NBM, hb. Haji Moniri, hb. Kukwa).

Acknowledgment

The authors would like to thank Dr. M. Kukwa (Gdansk) for his analysis of a specimen with TLC.

References

- Clayden, S. R. 2004: The yellow-pigmented taxa of *Rhizocarpon* (lichen-forming Ascomycota) in Snowdonia, North Wales: diversity and life history studies. Ph.D. thesis. -University of London, UK.
- Feurerer, T. 1978: Zur Kenntnis der Flechtengattung *Rhizocarpon* in Bayern. -Berichte der Bayerischen Botanischen Gesellschaft 49: 59-135.
- Fletcher, A., Gilbert, O. L., Clayden, S. R. & Fryday, A. M. 2009: *Rhizocarpon Ramond ex DC.* (1805). In *The Lichens of Great Britain and Ireland* (C. W. Smith, A. Aptroot, B. J. Coppins, A. Fletcher, O. L. Gilbert, P. W. James & P. A. Wolseley, eds): 992-808. -London: The British Lichen Society.
- Ihlen, P. G. & Ekman, S. 2002: Outline of phylogeny and character evolution in *Rhizocarpon* (*Rhizocarpaceae*, lichenized Ascomycota) based on nuclear ITS and mitochondrial SSU ribosomal DNA sequences. -Biological Journal of the Linnean Society 77: 535-546.
- Kamyabi, S. 2009: Investigation of biodiversity of *Rhizocarpon* Lam. ex DC. in Razavi Khorasan province, MSc thesis. -Islamic Azad University, Mashad.
- Kudratov, I., Mayrhofer, H. 2002: Catalogue of the lichenized and lichenicolous fungi of Tajikistan. -Herzogia 15: 91-128.
- Lynge, B. 1928: Lichens from Novaya Zemlya. Report of the scientific results of the Norwegian Expedition to Novaya Zemlya 43. -Oslo.
- Lynge, B. 1932: A revision of the genus *Rhizocarpon* in Greenland. *Skrifer om Svalbardog Ishavet* 47. -Oslo
- Lynge, B. 1935: Lichens collected during the Danish fifth Thule expedition through Arctic Canada
- Report of the Fifth Thule Expedition 1921-1924 II: 3. -Copenhagen.
- Magnusson, A. H. 1927: Description of new or not properly defined Lichens. -Meddelelser fran Göteborgs Botaniska Trädgård 3: 11-23.
- Moniri, M. H., Kamyabi, S. & Fryday, A. M. 2009: *Rhizocarpon saurinum* new to Asia, and other reports of *Rhizocarpon* species from Razavi Khorasan Province, Iran. -Mycologica balcanica 6: 89-92.
- Müller, J. 1892: Lichenes Persici a cl. Dr. Stapf in Persia lecti. -Hedwigia 31: 151-159.
- Orange, A., James, P. W. & White, F. J. 2001: Microchemical methods for the identification of lichens. -British Lichen Society, London, 101 pp.
- Runemark, H. 1956: Studies in *Rhizocarpon*. I. Taxonomy of the yellow species in Europe. -Opera Botanica 2(1): 1-152.
- Runemark, H. 1956b: Studies in *Rhizocarpon*. II. Distribution and ecology of the yellow species in Europe. -Opera Botanica 2 (2): 1-150.
- Seaward, M. R. D., Sipman, H., Schultz, M., Maassoumi, A., Haji Moniri, M. & Sohrabi, M. 2004: A preliminary lichen checklist for Iran. -Willdenowia 34: 543-576.
- Seaward, M. R. D., Sipman, H. J. M. & Sohrabi, M. 2008: A revised checklist of lichenized, lichenicolous and allied fungi for Iran. -Sauteria 15: 459-520.
- Steiner, M., Mayrhofer, H. 1987: Flechten aus Afghanistan - IV. Die Gattungen *Buellia*, *Dimelaena* und *Rinodina*. -Nova Hedwigia 45: 315-326.
- Szatala, S. 1940: Lichenes. In: K. H. Rechinger, J. Baumgartner, F. Petrak & S. Szatala, *Ergebnisse einer botanischen Reise nach dem Iran, 1937*. -Annales des Naturhistorischen Museums in Wien 50: 521-533.
- Szatala, S. 1957: Prodröm einer Flechtenflora des Irans. -Annales Historico-Naturalis Musei Nationalis Hungarici, series nova 8: 101-154.
- Thomson, J. W. 1967: Notes on *Rhizocarpon* in the Arctic. -Nova Hedwigia 14: 421-481.
- Thomson, J. W. 1997: *American Arctic Lichens, 2. The Microlichens*. -Madison, Wisconsin: University of Wisconsin Press.
- Timdal, E., Holtan-Hartwig, J. 1988: A preliminary key to *Rhizocarpon* in Scandinavia. -Graphis Scripta 2: 41-54.