

M. Temina, S. P. Wasser & E. Nevo

## A contribution to the species diversity of lichens in Israel

### Abstract

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Eighteen new lichen species (*Acarospora cervina*, *Arthonia lapidicola*, *Aspicilia calcarea*, *A. cinerea*, *Caloplaca chalybaea*, *Fulgensia schistidii*, *Hymenelia prevostii*, *Lecanora albescens*, *L. rupicola* ssp. *rupicola*, *Lecidella stigmataea*, *Placynthium subradiatum*, *Psorotichia schaeferi*, *Rinodina gennarii*, *R. immersa*, *Sarcogyne privigna*, *Verrucaria calciseda*, *V. muralis* and *V. nigrescens*) are first recorded for Israel. The biggest number of species was collected around Mt. Hermon. For the first time two lichen species are recorded from the region of Akko Plain. Fourteen species were found on calcareous rocks and two – on basaltic rocks. *Rinodina gennarii* occurred on both substrates. *Fulgensia schistidii* was found among moss on calcareous rocks. Most lichen species have worldwide distribution. *Aspicilia cinerea*, *Fulgensia schistidii*, *Hymenelia prevostii* and *Sarcogyne privigna* are distributed from the Boreal zone to the Mediterranean mountains. In Israel, they occur predominantly in mountainous regions. We present synonyms, descriptions, ecological peculiarities, localities and habitats in Israel, general distribution, as well as some taxonomic remarks.

### Introduction

Lichens represent a conspicuous element among the natural biota of Israel. The earliest papers dedicated specially to lichens in Israel were published by Professor I. G. Reichert (Reichert, 1937a, 1937b, 1940). Subsequently the lichenological investigations were proceeded with Professor Margalith Galun and her colleagues and students (Reichert & Galun 1958; Galun & Reichert 1960, 1965; Galun 1966, 1967, 1970; Galun & Lavee 1966; Galun & Marton 1970; Galun & Garty 1972; Alon & Galun 1971; Marton & Galun 1974, 1981; Galun & Mukhtar 1996). Contributions to the study of lichens in Israel have also been made by scientists of other countries (Servit 1948, 1950; Egea 1989; Breuss 1990; Giralt & al. 1993; Insarov & Isarova 1995).

During the last few years, intensive lichenological investigations have been carried out by collaborators of the Institute of Evolution, University of Haifa and lichenologists of M. G. Kholodny Institute of Botany, National Academy of Sciences of Ukraine. As a result, a few papers dealing with lichens of Israel have been published (Wasser & al. 1995; Navrotskaya & al. 1999; Kondratyuk & al. 1996). To date, the list of lichen-forming,

lichenicolous and allied fungi of Israel includes 258 taxa from 86 genera and 39 families.

The present paper is a further contribution to the lichen flora of Israel. Detailed descriptions of 18 new taxa of lichens to Israel, locations and dates of collections in Israel, ecological peculiarities, distribution, as well as taxonomic remarks are given below.

## Materials and Methods

The paper is based on the results of some expeditions to various regions of Israel during the year 2000. Lichen species were collected by M. Temina in 8 localities from the following natural regions: Mt. Hermon, Golan Heights, Upper Galilee, Akko Plain, Mt. Carmel and Central Negev. The natural regions of Israel are given according to Zohary & Feinbrun-Dothan, 1966-1986 (Fig. 1).

### Localities:

- 1) Hermon: Har Habushit (ski centre), 1600-2000 m alt., NW slope, (33°17'N; 35°44'E), 26 September 2000.
- 2) Hermon: NE vicinity of Majdal Shams, 1400 alt., EEN slope, old fruit garden, (33°16'N; 35°46'E), 27 September 2000.
- 3) Golan Heights: S vicinity of Mas'ada, 800-900 m alt., old (a. 600-year old) oak forest, (33°13'N; 35°45'E), 20 September 2000.
- 4) Upper Galilee: Lower Nahal Keziv - "Evolution Canyon" II, (33°02'N; 35°11'E), 23 August 2000.
- 5) Upper Galilee: the vicinity of Mi'ilya, (33°01'N; 35°14'E), 5 December 2000.

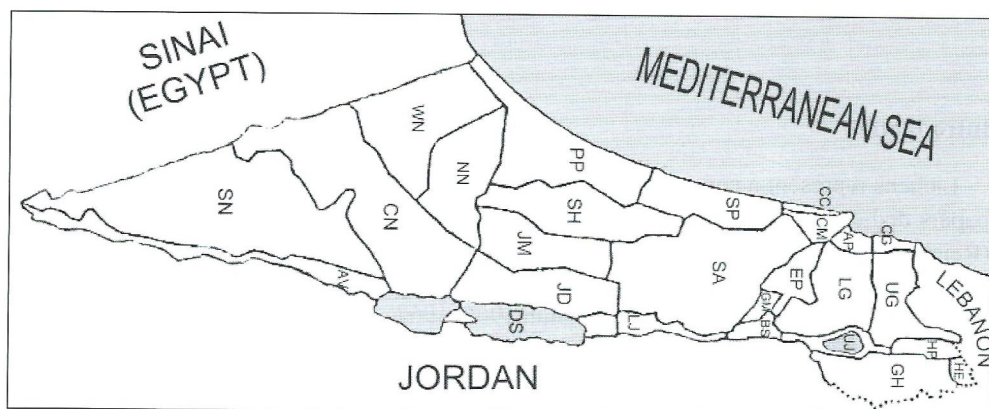


Fig. 1. Map of natural regions of Israel: AP – Akko Plain; AV – Arava Valley; BS – Bet Shean Valley; CC – Carmel Coast; CM – Mount Carmel; CN – Central Negev; DS – Dead Sea Area; EP – Esdraelon Plain; GC – Galilee Coast; GH – Golan Heights; GM – Gilboa Mountains; HE – Hermon; HP – Hula Plain; JD – Judean Desert; JM – Judean Mountains; LG – Lower Galilee; LJ – Lower Jordan Valley; NN – Northern Negev; PP – Philistine Plain; SA – Samaria; SH – Shefela; SN – Southern Negev; SP – Sharon Plain; UG – Upper Galilee; UJ – Upper Jordan Valley; WN – Western Negev.

- 6) Akko Plain: SE area of Kiryat Bialik, Ha Hagana str., (32°49'N; 35°05'E), 12 July 2000.
- 7) Mount Carmel: Mount Carmel National Park, Lower Nahal Oren - "Evolution Canyon" I, (32°43'N; 34°58'E), 22-24 September 2000.
- 8) Central Negev: Negev Highland, Makhtesh Ramon Nature Reserve, 900-1000 m alt., (30°37'N; 34°54'E), 29 September 2000.

During identification of the Israeli material discoveries were made based on lichenological collections of the Institute of Botany and Ecology at the University of Tartu (TU, Estonia).

Herbarium specimens are deposited at the herbaria of the Institute of Evolution, University of Haifa (HAI, Israel).

### List of species

The list of species contains information on synonyms, descriptions, ecological peculiarities, localities and habitats in Israel, general distribution, and taxonomic remarks.

*Acarospora cervina* A. Massal., Ric. Auton. Lich. Crost.: 28, 1852.

*Description:* Thallus consisting of scattered, or more or less continuous, almost squamulose, rather thin areolae, which are grey-brown, usually with a white margin, often pruinose, 0.5-2.5 mm wide, usually incisional or slightly lobed. Algal layer irregular, discontinuous, tooth-like below. The apothecia are sunken in the areoles, 0.3-1 mm diam., with a thick, smooth margin, and dark brown-red,  $\pm$  naked disc. Hymenium 80-100  $\mu$ m tall. Paraphyses 2-3  $\mu$ m thick. Ascospores more than 100 per ascus, 4-6 x 2-4  $\mu$ m, simple, colourless, cylindrical. Thallus K-, KC-, C-; hymenium I+ blue.

*Ecology:* On calciferous rocks. Somewhat nitrophilous.

*Locality and habitat in Israel:* HE: Har Habushit - on calcareous rocks (HAI, 001231); Majdal Shams - on calcareous rocks (HAI, 001211; 001221).

*General distribution:* Europe (widespread), Asia (Afghanistan, Armenia, Azerbaijan, Georgia, Iran, Israel, Kazakstan, Kyrgyzstan, Tajikistan, Turkmenistan, Uzbekistan), Africa (Morocco, Tunisia, South Africa), North America, Australia.

*Note:* *Acarospora cervina* is closely related to *A. glaucocarpa* (Ach.) Körb., but that species is characterized by a thick, usually continuous thallus, with areolae which are not incisional or squamulose, and by large, often densely chalky blue-grey-pruinose apothecia (Golubkova 1988; Purvis & al. 1992). *A. cervina* is distinguished from *A. glaucocarpa* by a thin, scattered thallus and immersed, small, apothecia with  $\pm$  naked disc.

*Arthonia lapidicola* (T. Taylor) Branth & Rostr., Bot. Tidskr., 3: 245, 1869.

*Basionym:* *Lecidea lapidicola* T. Taylor (in Mackay), Fl. Hibern., 2: 124, 1869.

*Synonyms:* *Allarthonia lapidicola* (T. Taylor) Zahlbr.; *Arthonia fusca* (A. Massal.) Hepp.

*Description:* Thallus thin and partly immersed to irregularly scurfy granular-verrucose, grey-brown or olive-brown, dull. Photobiont cells 6-17  $\mu$ m diam., green (not *Trentepohlia*), mostly  $\pm$  globose. Apothecia innate in the substratum or adnate, angular or rounded, to 0.8 mm diam., flat to convex; disc black. Epithecium to 15  $\mu$ m tall, brownish black.



Hymenium 50-60  $\mu\text{m}$  tall, yellowish; hypothecium to 50  $\mu\text{m}$  tall, reddish-brown. Paraphyses loose, slightly branched, tips slightly thicker and browned. Asci broadly clavate. Ascospores 11-18 x 4-7  $\mu\text{m}$ , 1-septate, ovoid, or constricted at septum and sole-shaped with upper cell  $\pm$  rounded and elongated; lower cell narrower, colourless. Pycnidia 40-50  $\mu\text{m}$  diam., few to numerous, immersed, the wall reddish-brown; conidia 4.5-6 x 1  $\mu\text{m}$ , elongate. Hymenium I+ red.

*Ecology*: On limestone and calcareous silicate rocks, especially on small stones, stony soil and man-made substrates (roofing slates, etc.).

*Locality and habitat in Israel*: HE: Har Habushit - on calcareous rocks (HAI, 001232); UG: Mi'ilya - on calcareous rocks (HAI, 002421).

*General distribution*: Europe (widespread), Asia (Israel, Russia), Africa, North America.

*Note*: *Arthonia lapidicola* is closely related to *A. calcicola* Nyl., which has an endolithic thallus and coal black hypothecium, (Poelt 1969; Nimis 1993).

***Aspicilia calcarea* (L.) Mudd, Man. Brit. Lich.: 161, 1861.**

*Basionym*: *Lichen calcareus* L., Sp. Pl.: 1140, 1753.

*Synonym*: *Lecanora calcarea* (L.) Sommerf.

*Description*: Thallus rather thick, forming  $\pm$  circular patches, continuous or usually cracked-areolated; areoles mostly radially orientated at least in outer part of thallus, white to chalky-white, prothallus usually delimiting, darkish grey,  $\pm$  zoned. Apothecia 0.2-1 mm diam.,  $\pm$  immersed, rounded or angular; thalline exciple slightly raised; disc black, often white-pruinose. Asci 2-4-spored, clavate. Ascospores 18-30 x 14-27  $\mu\text{m}$ , broadly ellipsoid to subglobose, simple, colourless. Cortex and medulla K-; hymenium I+ blue, soon changing into brown-red.

*Ecology*: On calcareous rocks.

*Locality and habitat in Israel*: HE: Har Habushit - on calcareous rocks (HAI, 001233); Majdal Shams - on calcareous rocks (HAI, 001212; 001222); UG: Lower Nahal Keziv - "Evolution Canyon" II, S-slope, Station 1 - on calcareous rocks (HAI, 0024111); Mi'ilya - on calcareous rocks (HAI, 002422); CM: Mount Carmel National Park, Lower Nahal Oren - "Evolution Canyon" I, N-slope, Station 5 - on calcareous rocks (HAI, 0005151); CN: Negev Highland, Makhtesh Ramon Nature Reserve - on calcareous rocks (HAI, 000611).

*General distribution*: Europe (widespread), Asia (Armenia, Azerbaijan, Georgia, India, Israel, Russia, Syria, Turkey), North Africa (Morocco, Tunisia), North America, South America (Argentina), Australia.

*Note*: *Aspicilia calcarea* is related to *A. contorta* (Hoffm.) Kremp. and *A. farinose* (Flörke) Arnold. It is distinguished from *A. contorta* by having a dark, continuous prothallus (Fröberg 1989; Purvis & al. 1992). *A. farinose* is separated from *A. calcarea* by having a farinose thallus, 8-spored asci and smaller ascospores. According to Oxner (1971) ascospores of *A. farinose* are 11-16 x 7.5-10.5  $\mu\text{m}$ .

***Aspicilia cinerea* (L.) Körb., Syst. Lich. Germ.: 164, 1855.**

*Basionym*: *Lichen cinereus* L., Mantissa Pl., 1: 132, 1767.

*Synonym*: *Lecanora cinerea* (L.) Sommerf.

*Description*: Thallus ashy grey, chunky-areolated, thinner at margin, and there indistinctly



radiate, areolae to 1 mm broad, flat to slightly convex, with deep cracks between areolae; black prothallus often present and ringing thallus. Apothecia 0.4–1.2 mm diam., concave to flat, at first immersed, later sometimes becoming sessile, round or irregular, disc black, margin ashy grey; exciple exterior brown, interior pale. Hymenium 100–115  $\mu\text{m}$  tall, brownish-yellow. Paraphyses 2  $\mu\text{m}$  thick, slender, upper part distinctly moniliform and 3  $\mu\text{m}$  thick. Asci 8-spored, clavate. Ascospores 12–22 x 8–12  $\mu\text{m}$ , oblong to broadly ellipsoid, simple, colourless. Conidia 13–22 x 1  $\mu\text{m}$ . Thallus K+ red, Pd+ orange; hymenium I+ brown-yellow or blue-green.

*Ecology*: On exposed siliceous rocks.

*Locality and habitat in Israel*: GH: Mas'ada oak forest - on basaltic rocks (HAI, 001011).

*General distribution*: Europe (widespread), Asia (India, Israel, Russia, Turkey), Africa, North America, South America (Argentina).

*Note*: *Aspicilia cinerea* is related to *A. intermutans* (Nyl.) Arnold, but differs in size of ascospores and conidia. According to Purvis & al. (1992) ascospores of *A. intermutans* are 20(22)–28 x (11)12–14  $\mu\text{m}$ , conidia 7–11 x 1  $\mu\text{m}$ .

***Caloplaca chalybaea*** (Fr.) Müll. Arg., Mem. Soc. Phys. Hist. Nat. Geneve, 16: 388, 1862.

*Basionym*: *Parmelia chalibaea* Fr., Lichenogr. Eur. Ref.: 123, 1831.

*Synonym*: *Caloplaca variabilis* f. *chalybaea* (Fr.) Clauzade & Cl. Roux.

*Description*: Thallus distinct, smooth, even, markedly coarsely-rimose-areolated, white-grey to lead-grey, rarely dark grey, well delimited by  $\pm$  conspicuous black prothallus. Apothecia immersed, 0.1–0.8 mm wide, closely scattered, several per areole; thalline exciple  $\pm$  distinct, often paler than the disc; epithecium grey, with colourless crystals; disc flat,  $\pm$  level with areole surface, when mature, black, rarely pruinose. Paraphyses broadening towards the tips, to 4  $\mu\text{m}$  thick. Asci 8-spored, clavate. Ascospores ellipsoid, polarilocular, colourless, 9–16 x 6–8  $\mu\text{m}$ , with a 3–6  $\mu\text{m}$  thick septum. Thallus and apothecia K- or K+ pale violet; epithecium and upper part of the hymenium K+ pale violet.

*Ecology*: On hard calcareous rocks.

*Locality and habitat in Israel*: HE: Majdal Shams - on calcareous rocks (HAI, 001213; 001223); UG: Mi'ilya - on calcareous rocks (HAI, 002423).

*General distribution*: Central and South Europe, Asia (Israel, Syria, Turkey), North Africa (Morocco, Tunisia).

*Note*: *Caloplaca chalybaea* is related to *C. variabilis* (Pers.) Müll. Arg., but that species has a dark thallus and sessile apothecia (Fröberg 1989; Purvis & al. 1992). *C. chalybaea* is distinguished from *C. variabilis* by having a lead-grey thallus and immersed apothecia. Also *C. chalybaea* superficially resembles an *Aspicilia calcarea* but easily distinguished by the polarilocular ascospores.

***Fulgensia schistidii*** (Anzi) Poelt, Mitt. Bot. Staatss. München, 5: 595, 1965.

*Basionym*: *Gyalolechia schistidii* Anzi, Cat. Lich. Sondr.: 38, 1860.

*Synonym*: *Caloplaca schistidii* (Anzi) Zahlbr.

*Description*: Thallus yellow-orange, verrucose to forming small squamulose lobules, more or less convex. Apothecia adnate, numerous, crowded or scattered, 0.5–2 mm diam.; margin thick, paler than disc; disc orange to orange-brown, flat to  $\pm$  convex. Hymenium 70  $\mu\text{m}$  tall, colourless. Ascospores 15–23 x 5–8  $\mu\text{m}$ , 1-septate, colourless. Thallus and apothecia K+ purple.

*Ecology:* On small cushion-producing mosses of the genera *Grimmia*, *Schistidium* and *Orthotrichum* over calcareous rocks.

*Locality and habitat in Israel:* HE: Har Habushit - on moss on calcareous rocks (HAI, 001234); Majdal Shams - on moss on calcareous rocks (HAI, 001224).

*General distribution:* Europe (in mountainous regions), Asia (India, Israel, Russia, Turkey), North Africa (Morocco, Tunisia).

***Hymenelia prevostii*** (Duby) Kremp., *Flora*, 35: 25, 1852.

*Basionym:* *Urceolaria prevostii* Duby, *Bot. Gall.*, 2: 671, 1830.

*Synonyms:* *Aspicilia prevostii* (Duby) Anzi; *Ionaspis prevostii* (Duby) Arnold; *Lecanora prevostii* (Duby) Th. Fr.

*Description:* Thallus immersed or thin and scurfy, light grey or pale brown, effuse. Photobiont trebouxoid. Apothecia 0.1-0.4 mm diam., scattered to continuous; immersed in pits in the substratum or thallus; disc concave, pale pink or yellow-grey to almost white, transparent when wet. Hymenium 120-160  $\mu\text{m}$  tall. Ascospores globose to broadly ellipsoid, simple, colourless, 12-22 x 7-11  $\mu\text{m}$ . Hymenium I+ blue.

*Ecology:* On calciferous rocks in somewhat shaded habitats.

*Locality and habitat in Israel:* HE: Har Habushit - on calcareous rocks (HAI, 001235); CM: Mount Carmel National Park, Lower Nahal Oren - "Evolution Canyon" I, N-slope, Station 6 - on calcareous rocks (HAI, 0005161).

*General distribution:* Europe (widespread), Asia (Israel, Russia), North America.

*Note:* *Hymenelia prevostii* is similar to *Ionaspis epulotica* (Ach.) Blomb. & Forssell, but distinguished by the trebouxoid photobionts, and the different iodine reaction in the hymenium (Fröberg 1989).

***Lecanora albescens*** (Hoffm.) Branth. & Rostr., *Bot. Tidskr.*, 3: 196, 1869.

*Basionym:* *Psora albescens* Hoffm., *Deutchl. Flora*, 2: 165, 1796.

*Description:* Thallus to 1 cm diam., thick, in usually rounded rosettes, sometimes almost lobe-like and notched at the margins, usually white, rarely greyish white, surface slightly rough to granular. Apothecia 0.1-0.7 mm diam., abundant, generally compacted in the center, sessile, broad at the base; thalline exciple persistent, even to crenulate to wavy; disc pale brown to dark brown, white-pruinose or not; epithecium brownish or  $\pm$  colourless, N-. Hymenium 50-80  $\mu\text{m}$  tall. Paraphyses branched and anastomosed, 1-2  $\mu\text{m}$  thick, with upper part slightly thickened or not, 1.5-3  $\mu\text{m}$  thick. Ascospores 7-11 x 3-6  $\mu\text{m}$ , broadly ellipsoid, simple, colourless. Conidia 20-25 x 1  $\mu\text{m}$ . Thallus K-, KC-, C-; hymenium I+ blue.

*Ecology:* On calcareous rocks and man-made substrata (cement, mortar, brick etc.), mainly in dusty places.

*Locality and habitat in Israel:* HE: Majdal Shams - on calcareous rocks (HAI, 001225); AP: Kiryat Bialik - on calcareous rocks (HAI, 000111); CN: Makhtesh Ramon Nature Reserve - on calcareous rocks (HAI, 000612).

*General distribution:* Europe (widespread), Asia (India, Israel, Russia, Turkey), North Africa (Morocco, Tunisia), North America, South America (Argentina).

*Note:* *Lecanora albescens* is related to *L. dispersa* (Pers.) Sommerf. and *L. pruinosa* Chaub. It is distinguished from *L. dispersa* by the white, well developed, almost placodi-



oid, thallus, and from *L. pruinosa* by the negative reactions of thallus with K and C. According to Galun (1970) and Purvis & al. (1992) *L. pruinosa* has the K+ yellow and C+ orange thallus.

***Lecanora rupicola* (L.) Zahlbr. subsp. *rupicola*, Cat. Lich. Univ., 5: 525-529, 1928.**

*Basionym:* *Lichen rupicola* L., Mantissa Pl.: 132, 1767.

*Description:* Thallus forming continuous patches, clearly delimited, cracked-areolated, often thick and uneven, areoles flat to slightly convex, whitish grey to greenish or brownish grey, surface  $\pm$  smooth. Apothecia 0.5-2 mm diam., partly immersed to adnate; margin entire, flexuous, to becoming excluded, concolorous with thallus; disc pinkish to brownish, flat to convex, densely pale grey to blue-grey-pruinose; epithecium pale brown to dark olivaceous brown. Hymenium 80-100  $\mu$ m tall. Paraphyses 2-3  $\mu$ m thick, sparsely branched, apices to 3.5  $\mu$ m, slightly thickened or not, colourless. Ascospores 9-15 x 6-7  $\mu$ m, ellipsoid, simple, colourless. Conidia 14-25 x 1  $\mu$ m, thread-like to arc-like. Thallus K+ yellow, C-; apothecial disc C+ yellow; hymenium I+ blue.

*Ecology:* On siliceous rocks.

*Locality and habitat in Israel:* GH: Mas'ada oak forest - on basaltic rocks (HAI, 001012).

*General distribution:* Europe (widespread), Asia (Armenia, Israel, Russia, Syria), Africa, North America, South America (Argentina), Australia, New Zealand.

*Note:* *Lecanora rupicola* subsp. *rupicola* is distinguished from *L. rupicola* subsp. *subplanata* (Nyl.) Leuckert & Poelt by a negative reaction of thallus with C. According to Leuckert & Poelt (1989) *L. rupicola* subsp. *subplanata* has a C+ orange-red thallus.

***Lecidella stigmathea* (Ach.) Hertel & Leuckert, Willdenowia, 5, 3: 375, 1969.**

*Basionym:* *Lecidea stigmathea* Ach., Lich. Univ.: 161, 1810.

*Description:* Thallus very variable, white to dirty grey-green, dark grey-brown, blackish or rust-red to brown, immersed or superficial and then continuous, faintly rimose-cracked or granular-verrucose. Apothecia to 1.5 mm diam., sessile, flat or rarely convex, black, bare; margin black, shining, persistent or sometimes disappearing; outer part of exciple and epithecium dark blue-green or dark brown, inner part of exciple and hypothecium  $\pm$  colourless. Hymenium 60-80  $\mu$ m tall, colourless. Ascospores 10-16 x 6-10  $\mu$ m, ellipsoid, simple, colourless. Thallus K-; hymenium I+ blue.

*Ecology:* On siliceous and calciferous rocks.

*Locality and habitat in Israel:* HE: Har Habushit - on calcareous rocks (HAI, 001236).

*General distribution:* Europe (widespread), Asia (Armenia, India, Israel, Lebanon, Russia, Turkey), Africa (Morocco, Tunisia, South Africa), North America, South America (Venezuela, Peru, Argentina), Australia, New Zealand.

*Note:* According to Nimis (1993) *Lecidella stigmathea* is very variable and ecologically wide-ranging species.

***Placynthium subradiatum* (Nyl.) Arnold, Flora, 67: 240, 1884.**

*Basionym:* *Pannaria subradiata* Nyl., Act. Soc. Linn. Bordeaux, 21: 314, 1856.

*Description:* Thallus to 1.5 cm diam., forming  $\pm$  complete rosettes or marginal lobes forming rings or narrow arcs, dying away from the center, 2.5 cm x 3 mm broad, olive to dark-brown, matt, sometimes sparingly bluish-white pruinose. Margin of flattened to  $\pm$  unevenly convex, radiating or parallel, tightly packed lobes, 2 x 0.05-0.2 mm wide; prothallus



lacking. Apothecia very rare, to 0.5 mm diam., black. Ascospores 10-15 x 4-7  $\mu$ m, 1-septate, ellipsoid, colourless. Hymenium I+ blue.

*Ecology*: On dry to irrigated, well-illuminated, often vertical calcareous rocks.

*Locality and habitat in Israel*: HE: Majdal Shams - on calcareous rocks (HAI, 001214; 001226).

*General distribution*: Europe (widespread), Asia (Israel, Syria), North Africa (Morocco), North America, Australia.

***Psorothichia schaeferi*** (Massal.) Arnold, *Flora*, 52: 265, 1869.

*Basionym*: *Pannaria schaeferi* Massal., *Ric. Auton. Lich. Crost.*: 114, 1852.

*Description*: Thallus effuse, dark dull green to dark brown or black, areolate; areolae 0.2-1 mm wide with more or less granular surface, usually with 1-3 apothecia per areola. Apothecia 0.2-0.6 mm diam., at first immersed with a flat disc, later emergent with a  $\pm$  convex disc; thalline exciple crenulate to granular, usually persistent but sometimes excluded; true exciple  $\pm$  evident, paler than disc; disc reddish brown to black (then red-brown when wet). Hymenium 95-150  $\mu$ m tall, colourless, or yellowish brown in uppermost part. Paraphyses rather few, simple to sparingly branched, 1.5-2  $\mu$ m thick, upper 1- to several cells swollen to 5  $\mu$ m wide. Asci 80-120 x 12-17  $\mu$ m. Ascospores 12-21 x 6-11  $\mu$ m, ellipsoid or  $\pm$  ovoid, simple, colourless. Conidia 3-4 x 1  $\mu$ m. Hymenium I+ blue.

*Ecology*: On siliceous and calciferous rocks.

*Locality and habitat in Israel*: HE: Har Habushit - on calcareous rocks (HAI, 001237); UG: Lower Nahal Keziv - "Evolution Canyon" II, S-slope, Station 3 - on calcareous rocks (HAI, 0024131); AP: Kiryat Bialik - on calcareous rocks (HAI, 000112).

*General distribution*: Europe (widespread), Asia (Israel, Russia, Syria, Yemen), North Africa (Morocco), North America.

***Rinodina gennarii*** Bagl., *Comment Soc. Critt. Ital.* 1: 17, 1861.

*Synonyms*: *Rinodina demissa* s. auct.; *Rinodina salina* Degel.; *Rinodina subexigua* (Nyl.) H. Olivier.

*Description*: Thallus thin, pale to dark grey, often tinged olive or brown, continuous or more usually rimose-cracked, flat, sometimes inconspicuous, effuse or not; prothallus indistinct. Apothecia 0.35-0.6 mm diam., sessile, rarely  $\pm$  immersed; thalline exciple concolorous with thallus, persistent; disc dark brown-black, flat, becoming  $\pm$  convex. Hymenium 70-95  $\mu$ m tall, colourless; hypothecium 25-95  $\mu$ m tall. Asci 50-70 x 15-21  $\mu$ m, inner walls uniform. Ascospores 11-20 x 7-11  $\mu$ m, brown, 1-septate, tending to swell around the middle in K, *Dirinaria*-type. Conidia 4-5 x 1  $\mu$ m.

*Ecology*: On  $\pm$  calcareous, nutrient-rich and -enriched substrata, especially on rocks, mortar, concrete, cement, more rarely on wood; a pollution tolerant species.

*Locality and habitat in Israel*: HE: Har Habushit - on calcareous rocks (HAI, 001238); GH: Mas'ada oak forest - on basaltic rocks (HAI, 001013).

*General distribution*: Europe (widespread), Asia (Israel, Syria), North Africa (Morocco, Tunisia), North America, Australia.

***Rinodina immersa*** (Körb.) Arnold, *Flora*, 67: 319, 1884.

*Basionym*: *Rinodina bischoffii* var. *immersa* Körb., *Parerga Lichenol.*: 75, 1859.

*Description*: Thallus immersed, or rarely thin, finely granular, whitish to pale grey.

Apothecia to 1 mm diam., immersed in deep depressions in the substratum, with isolated groups of algae in the thalline exciple; epithecium dark brown. Hymenium 100  $\mu$ m tall, without oil drops; hypothecium to 100  $\mu$ m tall, colourless. Ascospores 15-20 x 9-13  $\mu$ m, brown, 1-septate, thin-walled at apices with a heavily pigmented band around the central part, *Bischoffii*-type.

*Ecology*: On calcareous rocks.

*Locality and habitat in Israel*: HE: Har Habushit - on calcareous rocks (HAI, 001239); Majdal Shams - on calcareous rocks (HAI, 001215; 001227).

*General distribution*: Europe (widespread), Asia (Iran, Israel, Syria, Turkey), North Africa (Morocco, Tunisia).

*Note*: *Rinodina immersa* is closely related to *R. bischoffii* (Hepp.) Massal., and separated from it by the immersed apothecia and the hymenium lacking oil droplets (Fröberg 1989; Purvis & al. 1992).

***Sarcogyne privigna*** (Ach.) Massal., Geneac. Lich.: 10, 1854.

*Basionym*: *Lecanora milvina* var. *privigna* Ach., Lich. Univ.: 359, 1810.

*Description*: Thallus  $\pm$  immersed and inconspicuous, sometimes grey or  $\pm$  gelatinous. Apothecia sessile 0.5-1 mm diam., disc flat, red-brown to reddish black, not pruinose; true exciple black, persistent,  $\pm$  raised, not crenulate, sometimes angular by compression, to 0.3 mm thick. Hymenium 60-85  $\mu$ m tall, hypothecium colourless to pale brown. Paraphyses 1.7-2  $\mu$ m wide, capitate, coherent, tips 3-3.5  $\mu$ m thick. Asci 45-55 x 10-12  $\mu$ m, narrowly clavate, 100-spored. Ascospores 3.5-5 x 1-1.5  $\mu$ m, cylindrical, simple, colourless.

*Ecology*: On acid or calcareous rocks.

*Locality and habitat in Israel*: HE: Har Habushit - on calcareous rocks (HAI, 0012310); Majdal Shams - on calcareous rocks (HAI, 001228).

*General distribution*: Europe (widespread), Asia (India, Israel, Kazakhstan, Kyrgyzstan, Russia, Saudi Arabia, Tajikistan), North Africa (Tunisia), North America.

***Verrucaria calciseda*** DC., Flora Française, 3, 2: 317, 1805.

*Description*: Thallus immersed, chalky-white to pale grey, smooth, continuous, sometimes with minute dots, usually with a dark brown prothallus. Perithecia 0.15-0.4 mm diam., almost entirely immersed, simple, black; centrum rounded, true exciple black, thick, without involucrellum. Ascospores 13-28 x 7-15  $\mu$ m, ellipsoid, simple, colourless. Hymenium I+ blue (soon partly changing into red).

*Ecology*: On calcareous rocks.

*Locality and habitat in Israel*: HE: Har Habushit - on calcareous rocks (HAI, 0012311); Majdal Shams - on calcareous rocks (HAI, 001216; 001229); UG: Lower Nahal Keziv - "Evolution Canyon" II, S-slope, Station 3 - on calcareous rocks (HAI, 0024132); Mi'ilya - on calcareous rocks (HAI, 002424); CM: Mount Carmel National Park, Lower Nahal Oren - "Evolution Canyon" I, S-slope, Station 1 - on calcareous rocks (HAI, 0005111).

*General distribution*: Europe (widespread), Asia (Israel, Lebanon, Syria, Turkey), Africa (Morocco, Ethiopia), North America, Central America (Cuba), Australia.

*Note*: *Verrucaria calciseda* is similar to *Bagliettoa parmigera* (J. Steiner) Vezda & Poelt but distinguished from it by the absence of an involucrellum (Fröberg 1989; Nimis 1993).



***Verrucaria muralis*** Ach., Meth. Lich.: 115, 1803.

*Synonym:* *Verrucaria rupestris* Schrad.

*Description:* Thallus immersed to superficial, very variable, pale grey, grey-green, grey-brown or reddish brown, indistinct, continuous, finely rimose to areolate, delicately pitted. Perithecia  $\frac{3}{4}$  immersed to almost superficial, compound, 0.2-0.4(0.5) mm diam.; involucrellum dimidiate, or occasionally, extending to exciple-base level, black; centrum rounded, true exciple colourless to pale brown. Ascospores 15-25(28) x 8-15  $\mu$ m, ellipsoid, simple, colourless.

*Ecology:* On a variety of substrata, from limestone to dust-covered siliceous rocks, and also on nutrient-enriched, man-made substrata such as mortar, brick and cement, on walls and on small pebbles.

*Locality and habitat in Israel:* HE: Har Habushit - on calcareous rocks (HAI, 0012312); UG: Lower Nahal Keziv - "Evolution Canyon" II, S-slope, Station 3 - on calcareous rocks (HAI, 0024133).

*General distribution:* Europe (widespread), Asia (India, Israel, Russia, Turkey), North Africa (Morocco, Tunisia), North America, South America (Bolivia), Australia.

***Verrucaria nigrescens*** Pers., Usteri's Ann. Bot., 14: 36, 1795.

*Description:* Thallus superficial, dark brown, green-black or black (frequently bright green when wet), areolate; areoles 0.2-0.8 mm wide, usually smooth, flat to slightly convex, occasionally with sorediate or isidiate margins; prothallus black, also visible beneath the areoles (thin section), occasionally forming a black rim to the areoles. Perithecia compound,  $\frac{1}{2}$ - $\frac{3}{4}$  immersed; 0.2-0.4 mm diam.; involucrellum well developed, dimidiate or extending down to the prothallus, black; centrum rounded, true exciple dark brown. Ascospores (17)19-27(30) x 8-14  $\mu$ m, ellipsoid, simple, colourless.

*Ecology:* On calcareous rocks, walls and mortar, more rarely on siliceous rocks.

*Locality and habitat in Israel:* HE: Har Habushit - on calcareous rocks (HAI, 0012313); Majdal Shams - on calcareous rocks (HAI, 001217); UG: Lower Nahal Keziv - "Evolution Canyon" II, S-slope, Station 3 - on calcareous rocks (HAI, 0024134); CM: Mount Carmel National Park, Lower Nahal Oren - "Evolution Canyon" I, S-slope, Station 3 - on calcareous rocks (HAI, 0005131).

*General distribution:* Europe (widespread), Asia (Armenia, Israel, Lebanon, Russia, Syria, Turkey), Africa (Morocco, Tunisia, South Africa), North America, Australia.

## Discussion

*Systematic of the new species.* — As Table 1 shows, the collected lichens belong to 6 orders, 9 families and 13 genera. The main species diversity is presented in the orders *Lecanorales* (10 species) and *Verrucariales* (3 species). The remaining orders are represented by 1-2 species each.

*Ecology of the new species.* — Among the lichen species mentioned in this study 14 were found on calcareous rocks and 2 — on basaltic rocks. *Rinodina gennarii* was recorded on both substrates. *Fulgensia schistidii* was collected among moss on calcareous rocks. *Acarospora cervina*, *Aspicilia calcarea*, *Caloplaca chalybaea*, *Hymenelia prevostii*,



*Lecanora albescens*, *Placynthium subradiatum*, *Rinodina immersa* and *Verrucaria calciseda* - are the obligate calcicolous species. *Aspicilia cinerea* and *Lecanora rupicola* subsp. *rupicola* - are the exclusively siliceous species. Species occurring on both calcareous and siliceous substrates are *Arthonia lapidicola*, *Lecidella stigmataea*, *Psorotichia schaeferi*, *Rinodina gennarii*, *Sarcogyne privigna*, *Verrucaria muralis* and *V. nigrescens*.

The main factors influencing the lichens in arid areas are light exposure and moisture. Information on light and moisture conditions of the collected lichen species is presented in Tables 2 and 3.

As Tables 2 and 3 show, most studied lichen species occur in sun exposed and dry habitats. *Lecanora albescens* and *Verrucaria muralis* have wide ecological amplitude of light and humidity, and are generalist species to these factors. *Hymenelia prevostii* is shade-requiring species and it grows on both humid and dry substrates.

*Distribution of the new species.* — The collected species were subdivided into three phytoclimatic groups, mainly on the basis of their latitudinal and longitudinal distribution in Europe. These groups are presented in Table 4. As Table 4 shows, most studied lichens belong to a group of widespread Temperate species occurring from the Arctic to the Mediterranean zones. *Aspicilia cinerea*, *Fulgensia schistidii*, *Hymenelia prevostii* and *Sarcogyne privigna* are distributed from the Boreal to the Mediterranean zones. Here, however, these species occur predominantly in the mountains.

Table 5 shows the general distribution of the studied lichens. As it can be seen in Table 5, most lichen taxa have worldwide distribution, i.e. they are cosmopolitan or subcosmopolitan species. Only four species are recorded from three continents in the Northern Hemisphere: *Caloplaca chalybaea*, *Fulgensia schistidii*, *Rinodina immersa* occur in Europe, Asia and North Africa, *Hymenelia prevostii* - in Europe, Asia and North America.

According to Zohary & Feinbrun-Dothan (1966-1986), the territory of Israel is subdivided into 26 natural regions (Fig. 1). Of the six regions mentioned in present study, lichen flora of Upper Galilee, Mount Carmel and Central Negev was investigated the most thoroughly. Number of lichen species recorded from Upper Galilee are 119; from Carmel Mountains - 81; from Central Negev - 65; from Golan Heights - 15; from Mt. Hermon - 9 (Galun & Mukhtar 1996; Kondratyuk & al. 1996). Information is not available on lichen species from the region of Akko Plain.

Table 6 reports the number of new taxa found in each investigated natural region. As it can be seen in Table 6, the biggest number of lichen species was collected on Mt. Hermon and in Upper Galilee.

New species found on Mt. Hermon: *Acarospora cervina*, *Arthonia lapidicola*, *Aspicilia calcarea*, *Caloplaca chalybaea*, *Fulgensia schistidii*, *Hymenelia prevostii*, *Lecanora albescens*, *Lecidella stigmataea*, *Placynthium subradiatum*, *Psorotichia schaeferi*, *Rinodina gennarii*, *R. immersa*, *Sarcogyne privigna*, *Verrucaria calciseda*, *V. muralis* and *V. nigrescens*. Most species were collected on sun exposed and both moderately humid and moderately dry surfaces of calcareous rocks. *Hymenelia prevostii* occurred in shaded and humid habitat. Lichens collected on Mt. Hermon belong to three phytoclimatic groups: 11 species - to the group of widespread Temperate species, 3 species - to the group of northern Temperate species and 2 species - to the group of southern Temperate species.

New species found in Golan Heights: *Aspicilia cinerea*, *Lecanora rupicola* subsp. *rupicola* and *Rinodina gennarii*. They were collected on basalts, in sun exposed and dry habitats. *Lecanora rupicola* ssp. *rupicola* and *Rinodina gennarii* belong to the group of widespread Temperate species. *Aspicilia cinerea* is a northern Temperate species.

New species found in Upper Galilee: *Arthonia lapidicola*, *Aspicilia calcarea*, *Caloplaca chalybaea*, *Psorotichia schaereri*, *Verrucaria calciseda*, *V. muralis* and *V. nigrescens*. All these species were collected on sun exposed and dry surfaces of calcareous rocks. Most lichens (6 species) belong to the group of widespread Temperate species. *Caloplaca chalybaea* is a southern Temperate species.

New species found in Akko Plain: *Lecanora albescens* and *Psorotichia schaereri*. Both species were found on well-lighted and periodically wetted calcareous rocks. They belong to the group of widespread Temperate species.

New species found in Mount Carmel: *Aspicilia calcarea*, *Hymenelia prevostii*, *Verrucaria calciseda* and *V. nigrescens*. Three lichen species (*Aspicilia calcarea*, *Verrucaria calciseda* and *V. nigrescens*) were collected on sun exposed and dry surfaces of calcareous rocks. *Hymenelia prevostii* occurred in shaded and dry habitat. *Hymenelia prevostii* is a northern Temperate species. *Aspicilia calcarea*, *Verrucaria calciseda* and *V. nigrescens* belong to the group of widespread Temperate species.

New species found in Central Negev: *Aspicilia calcarea* and *Lecanora albescens*. Both species were found on calcareous rocks in sun exposed and dry habitats. These species belong to the group of widespread Temperate species.

## Conclusions

Here we presented eighteen lichen species as new for Israel. The collected lichens belong to 6 orders, 9 families and 13 genera. The main species diversity is presented in the orders *Lecanorales* (10 species) and *Verrucariales* (3 species).

Fourteen species were found on calcareous rocks (of which 8 are obligate calcicolous) and 2 on basaltic rocks (both species are exclusively siliceous). *Rinodina gennarii* was recorded on both substrates. *Fulgensia schistidii* was collected among moss on calcareous rocks. Most studied lichen species occur in sun exposed and dry habitats. Two taxa have wide ecological amplitude of light and humidity, and can be regarded as generalists to these factors. *Hymenelia prevostii* is shade-requiring species and it grows on both humid and dry substrates.

Most collected lichens are cosmopolitan or subcosmopolitan species. They are distributed from the Arctic to the Mediterranean zones and occur on all or almost all continents. *Aspicilia cinerea*, *Fulgensia schistidii*, *Hymenelia prevostii* and *Sarcogyne privigna* are distributed from the Boreal to the Mediterranean zones; here, however, these species occur predominantly in the mountains.

The biggest number of new taxa was collected on Mt. Hermon (16 species) and in Upper Galilee (7 species). For the first time two lichen species are recorded from the region of Akko Plain.



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Address of the authors:

Dr. Marina Temina, Prof. Solomon P. Wasser & Prof. Eviatar Nevo, Institute of Evolution, University of Haifa, Mount Carmel, Haifa 31905, Israel.