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Algae new for Israel from the Upper Nahal Oren River

Abstract

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We studied algal assemblages from the Nahal Oren River for the purpose of revealing biodiversity of a natural aquatic ecosystem in northern Israel. In 94 samples of periphyton and phytoplankton we found 231 species from seven algal divisions. About 15% of the species (34) are new for the algaeflora of continental Israel and six of them represent the first recorded genera.

Introduction

The impressively rapid recent progress of algological studies in Israel has revealed 1357 species of 11 divisions (Nevo & Wasser 2000; Vinogradova & al. 2000a, b; 2001; Masyuk & al. 2001; Mihailuk & al. 2001a, b; Tsarenko & al. 2001; Kovalenko & al. 2002a, b). Our reconnaissance studies show, however, that overall species richness of algaeflora might have been much greater than that. Most significant contributions can be expected from studies of relatively little altered algal communities of natural preserves. One such perspective water source is the Nahal Oren River draining the territory of the Alon Natural Park. For the last ten years the Lower Nahal Oren basin designated "Evolution Canyon" (Nevo 1994, 1995, 1997, 2001) serves as a model object for biodiversity studies involving a wide range of organisms from cyanoprocaryota to mammals. The complex research program, including the diversity of freshwater algae, was started in 1994.

In Nahal Oren the river channel is filled with water only in the rainy winter period. Intermittent water bodies periodically appear in the lower reaches of the river. Permanent water bodies occur in the upper reaches within the protected area. Here the river is one to five meters wide. The velocity of flow is up to 0.5 m/sec. The bottom of the channel is formed of limestone boulders and pebbles. The shores are covered with a thick growth of oleanders. Downstream there are two small ponds about 1 m deep. Three collector basins are constructed in the upper and lower parts of the water-filled channel. Runoff from the collectors contributes to the water flow in rainy period. Nahal Oren also receives water from four tributaries, three of which are fed from pipelines and one is natural, with Fe-rich water.

Up to now, 60 algal species were listed from the Nahal Oren Basin, all collected on rock

cliffs along the river (Wasser & al. 1995; Nevo & Wasser 2000). The aquatic algal community was not systematically studied.

Material and methods

Material for this study came from 94 samples of phytoplankton and periphyton from water bodies of the Nahal Oren basin (Fig. 1). The sampling was conducted during seven collecting trips encompassing all seasons from March 2002 to August 2003. We sampled the permanent water flow of the upper reaches, tributaries, collector basins, and intermittent water bodies of the lower reaches. The samples were obtained by scooping up for phytoplankton and by scratching for periphyton and were fixed in 3% formaldehyde. Algae were studied with a dissecting Swift microscope under magnifications 740–1850 and were photographed with the digital camera Inspector 1. The diatoms were prepared with the peroxide technique (Swift 1967) modified for glass slides (Barinova 1988). The diatoms were studied both under light microscope and scanning electron microscope JEOL JSM 35C.

The taxonomy of this study mainly follows the systems adopted in the “Süswasserflora von Mitteleuropa” (Komarek & Anagnostidis 1998; Krammer & Lange-Bertalot 1991a, b, c, d; Starmach 1985; Perestenko 1994; Ettl 1978; Popova 1966) and Green Algae on K. R. Mattox and R. D. Stewart (1984) with additions for individual taxa (Ettl & Gartner 1988; Krause 1997; Moshkova & Gollerbach 1986; Palamar-Mordvintseva 1982).

In parallel with sampling for algae we measured conductivity, mineralization and pH with HANNA HI 9813.

The algal abundances (Table 1) were assessed on the basis of 6-score Wisloukh's scale (Korde 1956). Saprobity indices were obtained for each algal community (Pantle & Buck 1955; Sladek 1986) and then used for integral assessment of the species habitats. Ecological characteristics of the species are summed up in our database (Barinova & al. 2000).

For phytogeographic analysis, the species ranges were plotted against the phytogeographic divisions of global (Takhtajan 1978), Mediterranean (Zohary & Feinbrun-Dothan 1966) and regional Israeli (Zohary 1966) classifications.

Table 1. Species frequencies according to Wisloukh's scale (Korde 1956).

Score, Wisloukh's scale	Visual estimate	Cell numbers per liter (Kuzmin, 1976)	Cell number per slide
1	Occasional	1- 103 cells/liter	1-5 cells per slide
2	Rare	103-104 cells/liter	10-15 cells per slide
3	Common	104- 105 cells/liter	25-30 cells per slide
4	Frequent	105- 106 cells/liter	1 cell over a slide transect
5	Very frequent	106- 107 cells/liter	Several cells over a slide transect
6	Abundant	More than 107 cells/liter	In each field of view

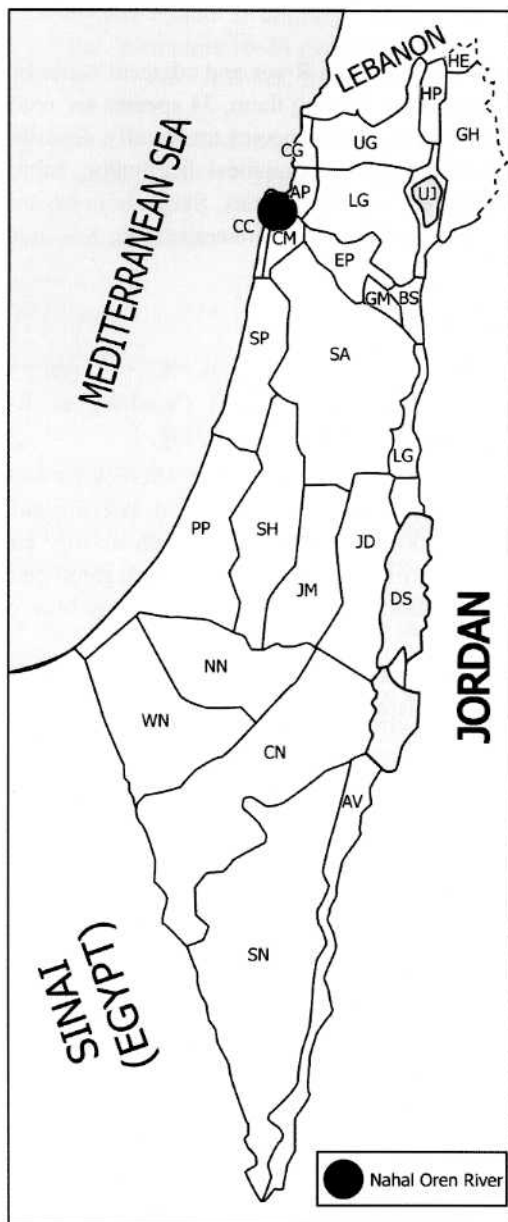


Fig. 1. Site of Nahal Oren River in the map of natural regions of Israel: AP - Akko Plane; AV - Arava Valley; BS - Bet Shean Valley; CC - Carmel Coast; CM - Mount Carmel; CN - Central Negev; DS - Dead Sea Area; EP - Esdraelon Plain; GC - Galilee Coast; GH - Golan Heights; GM - Gilboa Mountains; HE - 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.

Results and discussion

In the samples from the Nahal Oren River and adjacent water bodies we revealed 231 species of algae from 7 divisions. Among them, 34 species are recorded for the first time in freshwater habitats of Israel. These species are briefly described below. Taxonomic synonyms, ecological characteristics, geographical distribution, habitats, and environmental conditions are indicated for each of the species. Symbols in systematic descriptions are: pH – water acidity, C – conductivity, M – mineralization, S – index of saprobity on the Pantle-Buck methods.

CYANOPROCARYOTA

Aphanocapsa Nägeli 1849

1. *Aphanocapsa holsatica* (Lemmermann) Cronberg & Komarek 1994. Arch. Hydrobiol. 105 (Algolog. Stud. 75): 333. — Pl. 1, Fig. 1.

Synonym: *Clathrocystis holsatica* Lemmermann; *Microcystis holsatica* Lemmermann.

Description: Young colonies more or less spherical, later irregular, lobate, elongate or clathrate, up to more than 300 μ m in diameter, with usually clearly visible colorless mucilage of irregular outline; more or less densely aggregated cells, having in the mass impale grayish blue-green color. Cells spherical, pale gray-blue or grayish blue-green, about 1 μ m in diameter.

Occurrence: Planktonic in eutrophic freshwater bodies (also in Baltic Sea).

Distribution and habitat in Israel: CM: Mount Carmel, Upper Nahal Oren, in plankton of collector basins — 1-2; pH — 7.3-9.5; C — 0.44-0.71 Sm/cm; M — 324-510 mg/l; S — 1.2-1.9.

General distribution: Cosmopolitan.

Cyanobacterium Rippka & Cohen-Bazire 1983

2. *Cyanobacterium synechococcoides* Komarek 1998. Süßwasserflora von Mitteleuropa, 19/1: 46, Fig. 2B/f. — Pl. 1, Fig. 4.

Description: Cells solitary or aggregated in irregular clusters (mats), but without gelatinous envelopes. Cells cylindrical with more or less rounded ends, with blue-green, homogeneous or slightly lengthwise striated or finely granular content, 2-8(25) x 1.0-2(3) μ m.

Occurrence: Planktonic-benthic, in clean stagnant water.

Distribution and habitat in Israel: CM: Mount Carmel, Upper Nahal Oren, periphyton on limestone in collector basins — 1; pH — 8.0-8.2; C — 0.69-0.7 Sm/cm; M — 498 mg/l; S — 1.9-2.0.

General distribution: Holarctic.

Leptochaete Borzi 1895

3. *Leptochaete stagnalis* Hansg. 1888. Nova Notar. 3: 399. — Pl. 1, Fig. 3.

Description: Colonies as blue-green thin membranous, rounded or discoid films. Filaments closely oppressed, 3-4.5 μ m wide at the base, gradually attenuated into the apical

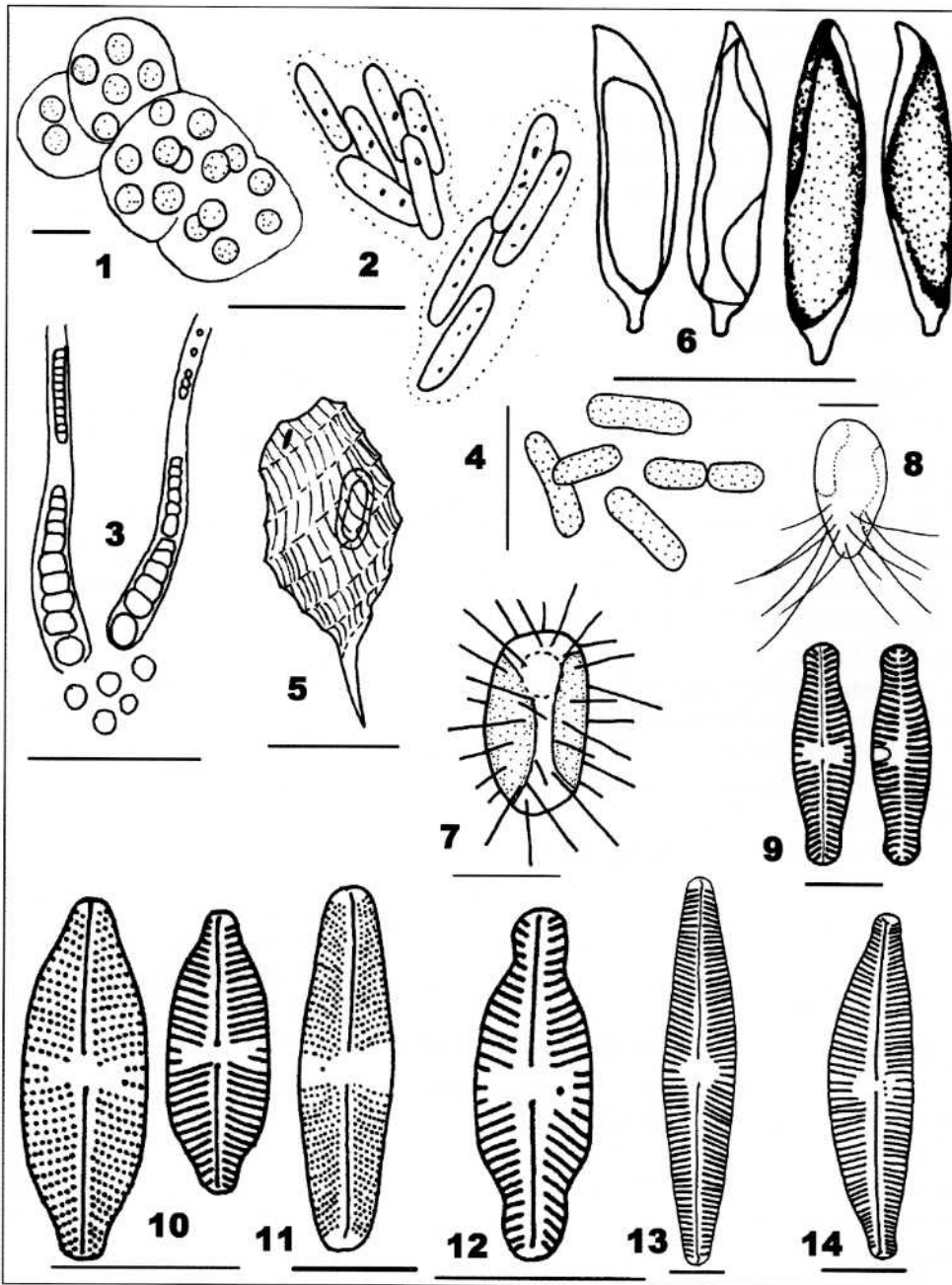


Plate 1. New taxa of algae from Nahal Oren River basin. 1 – *Aphanocapsa holsatica*; 2 – *Rhabdogloea smithii*; 3 – *Leptochaete stagnalis*; 4 – *Cyanobacterium synechococcoides*; 5 – *Phacus costatus*; 6 – *Characiopsis minuta*; 7 – *Mallomonas radiata*; 8 – *Mallomonas alpina*; 9 – *Achnanthes lanceolata* var. *haynaldii*; 10 – *Lenticula muticopsis*; 11 – *Lenticula mutica*; 12 – *Lenticula paramutica*; 13 – *Navicula peregrina*; 14 – *Cymbella tumidula*. Scale bar = 10 μ m.

hair, sometimes bluntly pointed, mostly 30-50 $\frac{1}{4}$ m long. Sheaths colorless, thin. Cell squarish, or about 2 times wider than long. Cells of chroococcoid mass form a thin plate at the base of the filament.

Occurrence: On rocks and trunks in still and running water.

Distribution and habitat in Israel: CM: Mount Carmel, Upper Nahal Oren, periphyton on the walls of collector basins — 3; pH — 7.8; C — 0.59-0.71 Sm/cm; M — 434-510 mg/l; S — 1.2-1.4.

General distribution: Asia.

Rhabdogloea Schröder 1917

4. ***Rhabdogloea smithii*** (R. & F. Chodat) Komarek 1983. *Taxon*, 32(3): 465; Chodat, R. & Chodat, F. 1925. *Veröff. Geobot. Inst. Rübel Zürich* 3: 453, Figs 11, 12. — Pl. 1, Fig. 2.

Synonyms: *Dactylococcopsis raphidioides* Hansgirg *sensu* G.M. Smith; *D. smithii* R. & F. Chodat.

Description: Colonies microscopic, more or less ellipsoidal or irregular, with a small number or up to more than thirty widely separated cells, more or less oriented in one direction within the colony. Mucilage is colorless, homogeneous, diffluent. Cells irregularly spindle-shaped, usually slightly curved or sigmoid, tapering to acute-rounded ends, pale blue-green or greyish green, 3.9-12 x 1.7-2.5 $\frac{1}{4}$ m.

Occurrence: Planktonic in large, cold, clear (oligotrophic to mesotrophic) freshwater lakes, rarely in clear small water bodies.

Distribution and habitat in Israel: CM: Mount Carmel, Upper Nahal Oren, periphyton of limestone and plants — 2-3; pH — 8.2-8.6; C — 0.69-0.84 Sm/cm; M — 496-604 mg/l; S — 1.4-2.4.

General distribution: Cosmopolitan.

EUGLENOPHYTA

Phacus Dujardin 1841

5. ***Phacus costatus*** W. Conrad 1914. *Ann. Biol. Lacustr.* 7: 135, Fig. 3. — Pl. 1, Fig. 5.

Synonyms: *Monomorphina pyrum* var. *costata* T. G. Popova, *Phacus pyrum* var. *costata* W. Conrad., *Euglena pyrum* Ehrenberg.

Description: Cells 6-16 $\frac{1}{4}$ m wide, 20-36 $\frac{1}{4}$ m long, longitudinally spindle-shaped; anterior end slightly narrowing, posterior end narrowing into a sharp, thin tail-piece; pellicle spirally ribbed and connected by transverse striae; chloroplasts numerous; paramylon of 2 large and several small bodies.

Occurrence: In lakes, ponds, swamps and small rivers, rare.

Distribution and habitat in Israel: CM: Mount Carmel, Upper Nahal Oren, collector basin, among the green filamentous algae — 1; pH — 8.2-8.6; C — 0.69-0.84 Sm/cm; M — 496-604 mg/l; S — 1.4-2.4.

General distribution: Cosmopolitan.

XANTHOPHYTA

Characiopsis Borzi 1895

6. *Characiopsis borziana* Lemmermann 1910. Arch. Hydrobiol. und Planktonk. 5: 291-338. — Pl. 3, Fig. 5.

Synonym: *Characiopsis minuta* Borzi non *Ch. borziana* Cedercreutz.

Description: Cells variable, ellipsoid to fusiform, occasionally with one side convex, the other side flat, often slightly curved, 12-30 $\frac{1}{4}$ μ m long, up to 10 $\frac{1}{4}$ μ m wide. The apex rounded, rarely acuminate, the base rounded or slightly constricted, with a short thin stalk and a small disk. The envelope is thin. Chromatophores 4 - 8 (in immature cells single), discoid.

Occurrence: In various reservoirs on filamentous algae.

Distribution and habitat in Israel: CM: Mount Carmel, Upper Nahal Oren, periphyton on limestone pebbles — 3; pH — 7.5-8.2; C — 0.68-0.87 Sm/cm; M — 490-623 mg/l; S — 1.4-2.2.

General distribution: Cosmopolitan.

7. *Characiopsis minuta* (A. Braun in Kützing) Lemmermann 1910. Arch. Hydrobiol. Planktonk. 5: 291-338. — Pl. 1, Fig. 6.

Basionym: *Characium minutum* A. Braun in Kützing.

Synonyms: *Characium acutum* Schroder; *Ch. tenue* Harman; *Ch. subulatum* G. S. West; non *Characiopsis minuta* Borzi; *Ch. ambiguum* Herman.

Description: Cells cylindrical to spindle-shaped, tapering at apices, with a short stalk having a small basal attachment disc, apex sometimes somewhat hooked, up to 7 $\frac{1}{4}$ μ m wide and 12-20 $\frac{1}{4}$ μ m long, 2.5 to 4.5 times as long abroad; chloroplasts 1 or 2, parietal, sometimes elongated or band-shaped, pale; reproduction by biflagellate zoospores, usually 4 per cell.

Occurrence: Epiphytic on filamentous algae, diatoms, and aquatic macrophytes.

Distribution and habitat in Israel: CM: Mount Carmel, Upper Nahal Oren, periphyton on limestone pebbles — 2; pH — 7.5-8.2; C — 0.68-0.87 Sm/cm; M — 490-623 mg/l; S — 1.4-2.2.

General distribution: Probably cosmopolitan.

CHRYSOPHYTA

Mallomonas Perty 1851

8. *Mallomonas alpina* Pascher & Ruttner emend. Asmund & Kristiansen. 1986. Opera Bot. 85: 73; Svensk. Bot. Tidskr. 6(2): 277, Fig.3. — Pl. 1, Fig. 8.

Synonyms: *Mallomonas tonsurata* var. *alpina* Pascher & Ruttner; *M. tonsurata* Teiling.

Description: Cells spherical to ovoid, 11-30 x 6-14 $\frac{1}{4}$ μ m bristles forming an apical tuft, a group of short curved bristles surrounded by some longer straight ones, the latter often directed backwards cysts oblong, 12-15 $\frac{1}{4}$ μ m wide and up to 25 $\frac{1}{4}$ μ m long.

Occurrence: Planktonic in ponds and rivers.

