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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

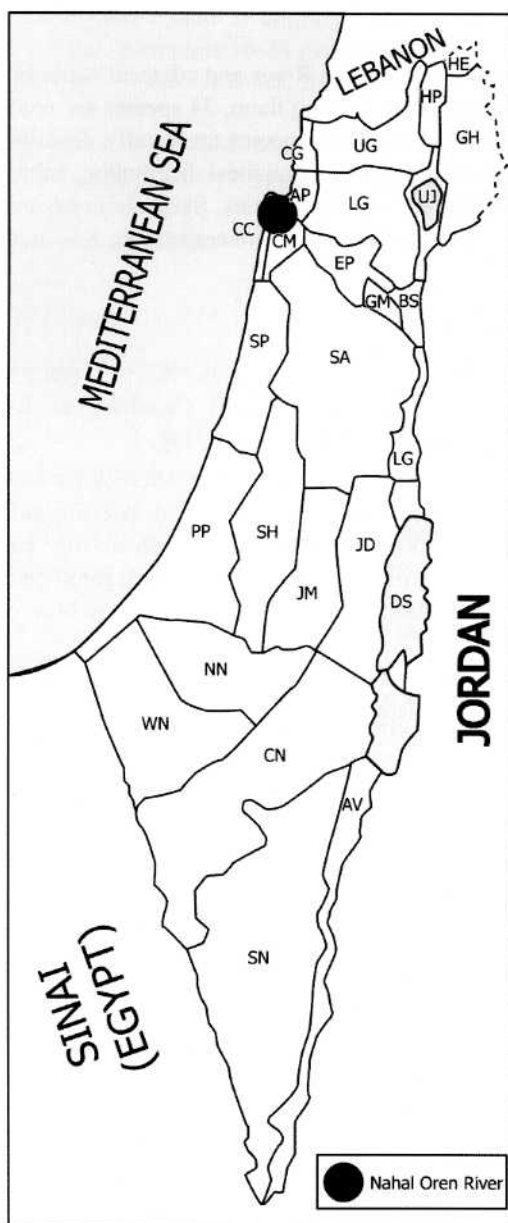


Fig. 1. Site of Nahal Oren River in the map of natural regions of Israel: AP - Akko Plane; AV - Arava Valley; BS - Bet Shean Valley; CC - Carmel Coast; CM - Mount Carmel; CN - Central Negev; DS - Dead Sea Area; EP - Esdraelon Plain; GC - Galilee Coast; GH - Golan Heights; GM - Gilboa Mountains; HE -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

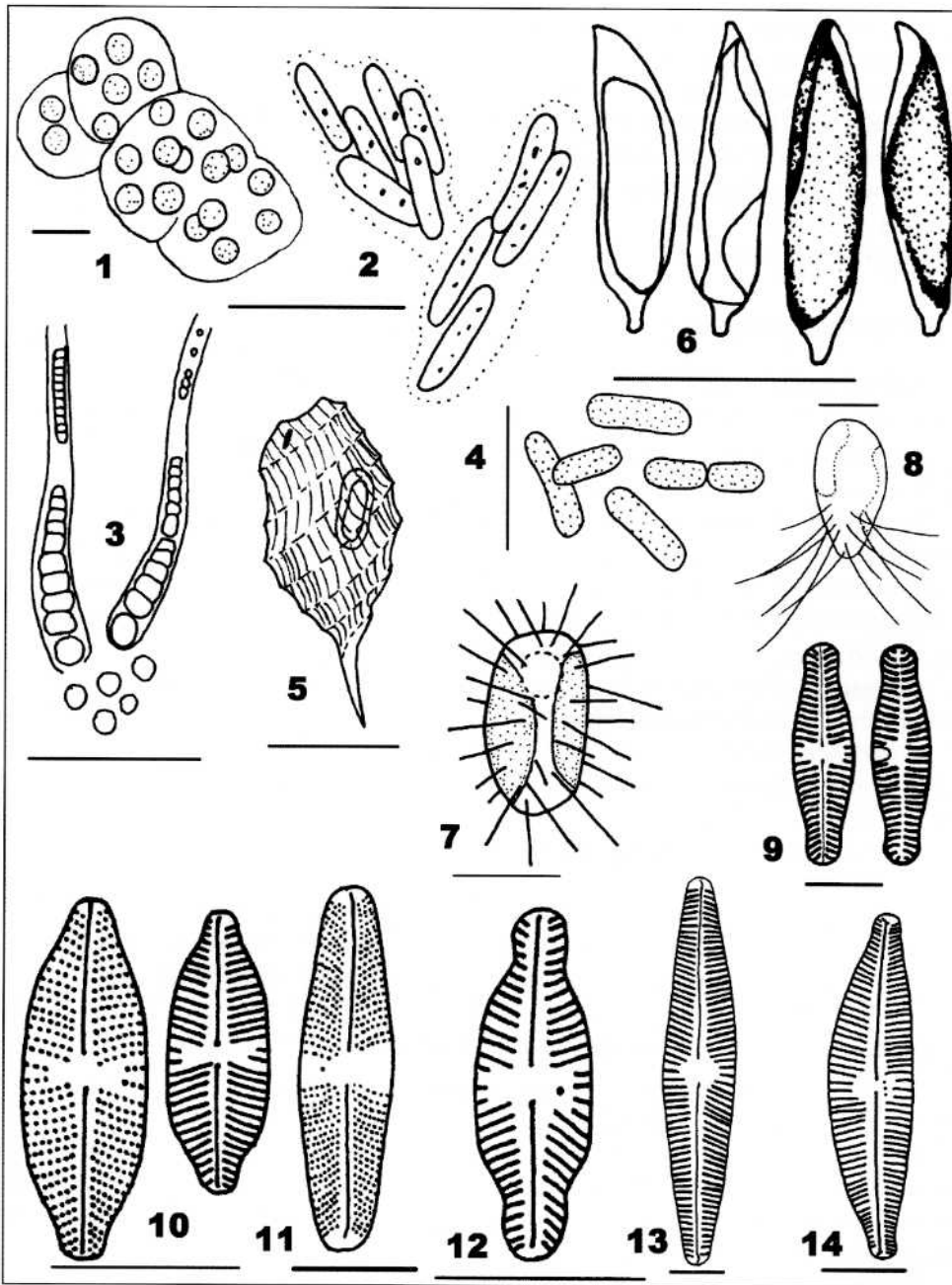


Plate 1. New taxa of algae from Nahal Oren River basin. 1 – *Aphanocapsa holsatica*; 2 – *Rhabdogloea smithii*; 3 – *Leptochaete stagnalis*; 4 – *Cyanobacterium synechococcoides*; 5 – *Phacus costatus*; 6 – *Characiopsis minuta*; 7 – *Mallomonas radiata*; 8 – *Mallomonas alpina*; 9 – *Achnanthes lanceolata* var. *haynaldii*; 10 – *Luticola muticopsis*; 11 – *Luticola mutica*; 12 – *Luticola 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 as broad; 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.

Distribution and habitat in Israel: CM: Mount Carmel, Upper Nahal Oren, in pools among limestone boulders — 1; pH — 7.5-8.2; C — 0.68-0.87 Sm/cm; M — 490-623 mg/l; S — 1.4-2.2.

General distribution: Europe, Asia (Russia, Israel), probably cosmopolitan.

9. *Mallomonas radiata* Conrad 1933. Chod. Mem. Mus. Hist. Nat. Belgique. 56: 1-82. Pl. 1, Fig. 7.

Description: Cells ellipsoidal, 15-21 $\frac{1}{4}$ m long, 7-10 $\frac{1}{4}$ m wide, broadly rounded on both ends. Scales circular, arranged in slightly oblique rows. Spines are numerous, smooth, shorter than cells, radially spreading. Flagella is shorter than cell. Chromatophores two. Pulsating vacuoles three at the fore end of the cell. Nucleus at the hind end. Cysts rounded brownish, with scattered sparkling punctures, with a short neck and a conical plug.

Occurrence: Planktonic in still, brackish waters, halophilous.

Distribution and habitat in Israel: CM: Mount Carmel, Upper Nahal Oren, pools among boulders and in collector basin — 1; pH — 7.3-9.5; C — 0.44-0.85 Sm/cm; M — 324-613 mg/l; S — 1.6-2.2.

General distribution: Europe (Latvinia and Belgium), Asia (Israel).

BACILLARIOPHYTA

Achnanthes Bory 1822

10. *Achnanthes lanceolata* var. *haynaldii* (Schaarsch.) Cleve *sensu* Patrick & Reimer, 1966. Diatom United States, 1: 271. Pl. 18, Figs 20-21. — Pl. 1, Fig. 9.

Synonyms: *Achnanthes haynaldii* Schaarsch., *A. lanceolata* var. *haynaldii* (Schaarsch.) Cl., *A. lanceolata* var. *capitata* O. Müll.

Description: Valve body elliptical-lanceolate or nearly elliptical with protracted, capitate ends, 15-21 $\frac{1}{4}$ m long, 4.5-5.0 $\frac{1}{4}$ m wide. Other features as in the nominate variety. Striae about 12 per 10 $\frac{1}{4}$ m on both valves.

Occurrence: Periphytic, in lakes, streams; circumneutral and alkaliphilous, β - α mesosaprob.

Distribution and habitat in Israel: CM: Mount Carmel, Upper Nahal Oren, periphyton of limestone and walls of collector basin — 1-4; pH — 7.2-9.5; C — 0.44-0.61 Sm/cm; M — 324-604 mg/l; S — 1.4-2.4.

General distribution: Cosmopolitan.

Cymbella Agardh 1830

11. *Cymbella tumidula* Grunow in A. Schmidt & al. 1875. Atlas Diatomaceen-kunde: 361. Fig. 668. — Pl. 1, Fig. 14.

Description: Valves mostly dorsiventral, dorsal valves thicker than the ventral ones that are slightly convex or flat, mostly slightly arched in the middle, lanceolate. Ends always extended. Length 17-42 μ m, width 6-10 μ m. Raphe slightly lateral. Axial field narrow linear to lanceolate. Central field dorsally expanded and rounded, proximally with a distinct

central pore, in small valves reduced to two short striae or lacking. One to four, typically two stigma occur on ventral side of central nodule. Striae in central part of valve slightly radial, on ends likewise slightly radial or parallel, indistinctly punctated, dorsally 11-15 per 10 μm in the middle, 16-20 at the ends, punctures 28-32 per 10 μm .

Occurrence: Lowlands to mountains, in particular in carbonate springs of the Alps and in karst caverns in Balkans. Oligohalob-indifferent, alkaliphilous.

Distribution and habitat in Israel: CM: Mount Carmel, Upper Nahal Oren, periphyton on limestone pebbles — 1; pH — 7.6-8.0; C — 0.71-0.84 Sm/cm; M — 511-607 mg/l; S — 1.6-2.2.

General distribution: Europe, Asia, N. America.

Eunotia Ehrenberg 1838

12. *Eunotia glacialis* Meister 1912. Beitr. Kryptogamenfl. Schweiz. 4/1: 85, Table 10, Figs 2, 3. — Pl. 2, Fig. 6.

Synonym: *Himantidium gracile* Ehrenberg;

Description: Frustule broadly rectangular in girdle view, with few bands. Proximal end of raphe enclosed in the long and relatively wide hyaline fields. Numerous short striae occur on the margin of the valve mantle bordered by the girdle. Ventral margin of valve slightly concave, dorsal margin parallel to it or slightly convex, gradually sloping and slightly extended on the ends, which are narrower than valve, constricted, bluntly rounded and typically dorsally deflected. Valve 30-200 μm long, 3-7.5(10) μm wide. Distal end of raphe protruding deep in the valve, with terminal nodules bent to the poles. Ventral field slightly decurrent on ventral margin and mostly transparent. Striae 9-15 per 10 μm .

Occurrence: In still water, oligohalob-indifferent, low acidophilous.

Distribution and habitat in Israel: CM: Mount Carmel, Upper Nahal Oren, periphyton of limestone — 1; pH — 8.0-8.3; C — 0.74-0.85 Sm/cm; M — 530-613 mg/l; S — 1.7-2.2.

General distribution: Cosmopolitan.

Note: A solitary find of a valve.

Fallacia Stickle & Mann 1990

13. *Fallacia subhamulata* (Grun. in V. H.) D. G. Mann in Round & al. 1990. Diatoms: 672; Hartley 1996. An Atlas of British Diatoms: 344. Pl. 146, Fig. 9. — Pl. 2, Fig. 1; Pl. 3, Figs 6-8.

Synonym: *Navicula subhamulata* Grun. in V. H.

Description: Valve narrow elliptical with parallel or slightly convex margins, broadly rounded on ends, 12-16 μm long, 4-5.5 μm wide. Striae slightly radial, minutely punctate or lineate, 26-30 per 10 μm , commonly more distinct in the middle of the valve. Raphe filamentous, straight or slightly curved, distinct due to the broadly curved hook-like terminal fissures and large well-marked central pores. Inner raphe-fissures fairly narrow. Axial field appears narrow, linear or strongly expanded when the striae are indistinct near the axial field in this part of the valve. Central field ill-marked. Conopeum pores distinct

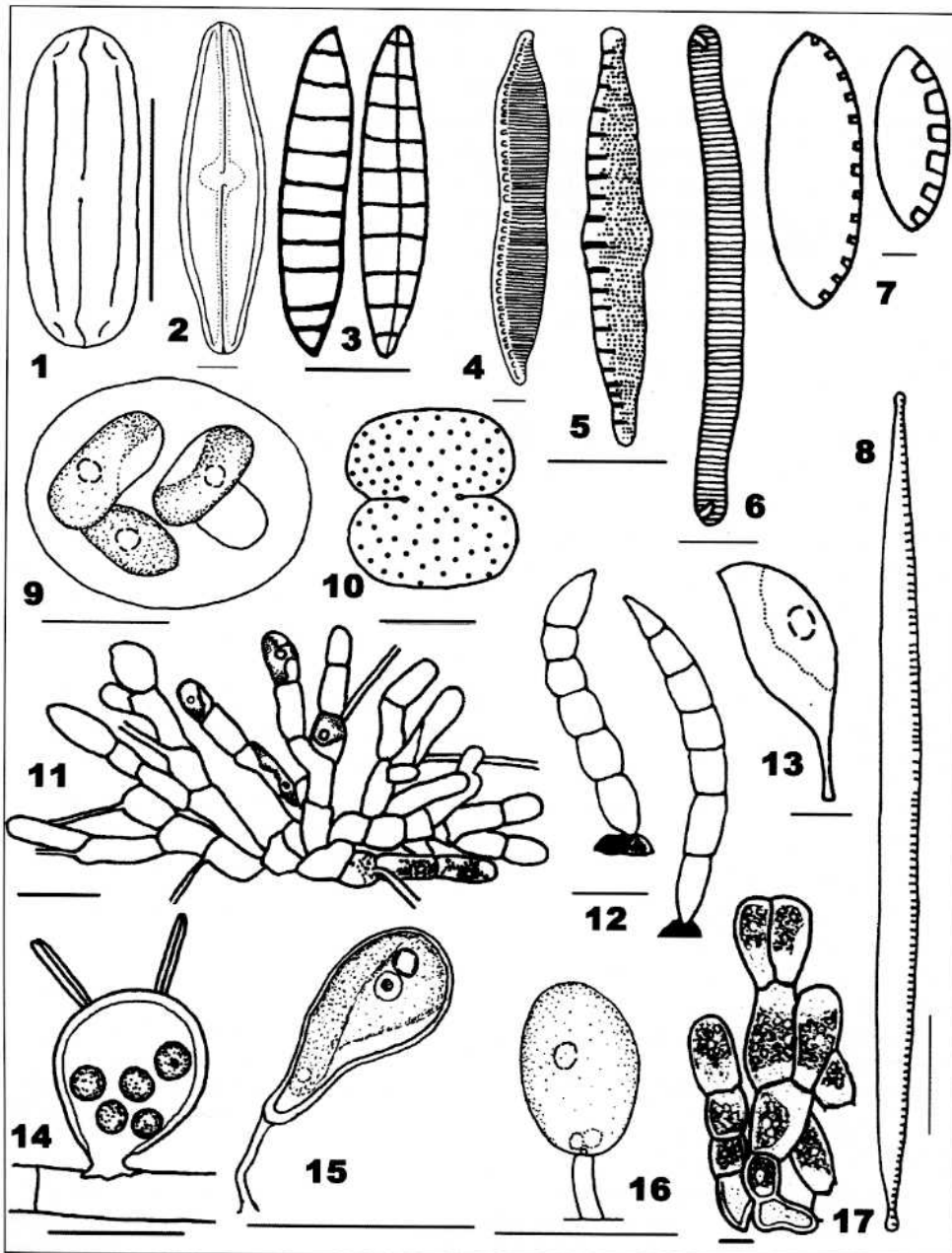


Plate 2. New taxa of algae from Nahal Oren River basin. 1 - *Fallacia subhamulata*; 2 - *Neidium ampliatum*; 3 - *Nitzschia grandifera*; 4 - *Nitzschia commutata*; 5 - *Nitzschia sinuata*; 6 - *Eunotia glacialis*; 7 - *Nitzschia laevis*; 8 - *Nitzschia subtilis*; 9 - *Nephrocytium perseverans*; 10 - *Cosmarium punctulatum*; 11 - *Coleochaete pulvinata*; 12 - *Uronema intermedium*; 13 - *Characium ornithocephalum*; 14 - *Apicystis caput-medusae*; 15 - *Chlorangiopsis piriformis*; 16 - *Chlorangium minus*; 17 - *Gongrosira debaryana*. Scale bar = 10 μ m.

in SEM, disposed on ends of the valve on both sides of the raphe. Pores wanting in the central part of valve.

Occurrence: In waters of various types, rare, oligohalob-indifferent, pH-indifferent.

Distribution and habitat in Israel: CM: Mount Carmel, Upper Nahal Oren, periphyton on limestone pebbles — 1-3; 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.

Luticola D. G. Mann in Round 1990

14. *Luticola mutica* (Kützing) Mann in Round & al. 1990. Diatoms: 670; Iconog.: Kützing. 1844. Bacillarien.: 93, Pl. 3, Fig. XXXII. — Pl. 1, Fig. 11.

Synonym: *Navicula mutica* Kützing

Description: Valve rhombic-elliptical to broadly elliptical or rhombic-lanceolate, ends broadly rounded to bluntly cuneate, 6-30 μm long, 4-9 μm wide. Raphe filamentous, with outer raphe-fissures curved to one side. Middle field narrow, linear to lanceolate. Central field relatively broad, sometimes expanded at valve margins. Stigma punctate or slightly transversely stretched, situated opposite the shortened middle striae on one side of the field. Striae punctuate radial over the whole valve, 14-20 per 10 μm . Punctae distinct, variable density about 15/10 μm .

Occurrence: In brackish and fresh water, α - β -mesosaprobic.

Distribution and habitat in Israel: CM: Mount Carmel, Upper Nahal Oren, periphyton on limestone pebbles — 4; pH — 7.5; C — 0.65 Sm/cm; M — 468 mg/l; S — 1.6.

General distribution: Cosmopolitan.

15. *Luticola muticopsis* (Van Heurck) G. S. Mann in Round & al. 1990. Diatoms: 671; Rumrich, Lange-Bertalot, Rumrich, 2000: 362, Pl. 61, Figs 9-12. — Pl. 1, Fig. 10.

Synonym: *Navicula muticopsis* Van Heurck.

Description: Valves sub-elliptical, with lateral margins extended or subparallel; endings rostrate to slightly capitate. Length: 17-26 μm , width: 6-8 μm . Axial area present, widening towards the central region of the valve. Central area typically elliptical or oval shaped but occasionally stauroform; usually with a single row of poroids around the outer edge. A solitary stigma present in the central area. Raphe straight, inner raphe-fissures straight, the outer fissures slightly hooked in the opposite direction of the stigma. Striae radiate throughout, 15-18 per 10 μm , consisting of 3-5 distinct puncta except in the median portion of the valve and at the poles.

Occurrence: Very abundant in lakes, ponds, and streams.

Distribution and habitat in Israel: CM: Mount Carmel, Upper Nahal Oren, periphyton of limestone in the river and tributary with Fe-rich water — 1; pH — 6.8-7.3; C — 0.99-1.04 Sm/cm; M — 714-751 mg/l; S — 1.6.

General distribution: Cosmopolitan.

16. *Luticola paramutica* (Bock.) Mann in Round & al. 1990. Diatoms: 671; Hartley 1996. An Atlas of British Diatoms: 262. Pl. 551, Fig. 14. — Pl. 1, Fig. 12.

Synonym: *Navicula paramutica* Bock.

Description: Valvae elliptical lanceolate, with broadly rounded beak-like to capitate, in the middle slightly convex or concave, 10-22 μm long, 4-6 μm wide. Raphe branches slightly arched, scarcely distinguishable at ends. Axial field narrow, linear. Central field is broad, sometimes expanded toward the margins of the valve. Stigma indistinct. Striae radial over the whole valve, 17-22 per 10 μm , distinctly punctuate.

Occurrence: On boulders in oxygenated periodically wet sites.

Distribution and habitat in Israel: CM: Mount Carmel, Upper Nahal Oren, periphyton on limestone pebbles — 1; 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.

Navicula Bory 1822

17. *Navicula peregrina* (Ehrenberg) Kützing 1844. Die kieselschaligen Bacillarien oder Diatomeen: 152, Table 28, Fig. 52. — Pl. 1, Fig. 13.

Synonym: Pinnularia peregrina Ehrenberg.

Description: Valve lanceolate, occasionally with slightly extended bluntly pointed ends, 40-180 μm long, 10-30 μm wide. Raphe lateral, with the inner and outer branches running parallel to the central pore. Axial field proximally slightly expanded. Central field large, obliquely rectangular to nearly obliquely elliptical. Striae radial, slightly convergent distally, 5-7 per 10 μm , Lineolae strong, 18-25 per 10 μm .

Occurrence: Oligosaprobic, mesohalobic, alkaliphilous.

Distribution and habitat in Israel: CM: Mount Carmel, Upper Nahal Oren, periphyton on limestone pebbles and in the stream from collector basin — 1-3; pH — 7.5-8.3; C — 0.59-0.87 Sm/cm; M — 486-623 mg/l; S — 1.4-2.2.

General distribution: Cosmopolitan.

Neidium Pfitzer 1871

18. *Neidium ampliatum* (Ehrenberg) Krammer 1985. Mikrokosmos, 74: Figs 105: 2-6; 106: 1-7; 107: 1,2. — Pl. 2, Fig. 2.

Synonyms: *Navicula ampliata* Ehrenberg; *Neidium iridis* var. *ampliata* (Ehrenberg) Cleve; *N. iridis* var. *arallela* Krieger; *N. iridis* f. *vernalis* Reichelt ex Hustedt; *N. iridis* var. *obtusa* Hustedt; *N. affine* var. *elegans* A. Mayer.

Description: Valves variable in shape, linear to elliptical or linear-lanceolate. Valve margins parallel, slightly convex, in the middle. Ends bluntly pointed, broadly rounded or wedge-shaped, more or less extended, rarely capitate or not extended at all, 40-100 μm long, 14-24 μm wide. Branches of the raphe lateral in the middle, forking on ends. Central branch as thin side outgrowth of the central nodule, occupying about $\frac{1}{3}$ to $\frac{1}{4}$ of the width of the central field, straight or slightly bent toward the branch of the raphe. Axial field narrow linear or slightly expanded in the middle of the branch of the raphe. Central field obliquely elliptical, occupying $\frac{1}{3}$ to $\frac{1}{2}$ of the valve. Longitudinal canals marginal or submarginal partly expanded or, in large forms, marked by distinct double lines. Striae distinct, coarsely

punctate, in the middle slightly radial or slightly oblique, on ends mostly oblique or convergent, 16-20 per 10 μm , punctures 16-24 per 10 μm .

Occurrence: In piedmonts, in littoral zones, β - α -mesosaprobic, oligohalob-indifferent, pH-indifferent.

Distribution and habitat in Israel: CM: Mount Carmel, Upper Nahal Oren, periphyton on limestone pebbles and in the pond — 1-3; pH — 7.5-8.6; C — 0.61-0.87 Sm/cm; M — 437-623 mg/l; S — 1.4-2.4.

General distribution: Cosmopolitan.

Nitzschia Hassel 1845

19. *Nitzschia commutata* Grunow in Cleve & Grunow 1880. Kngl. Sven. Vet.-Akad. Handl. 17: 79, Pl. LIX, Figs 13,14. — Pl. 2, Fig. 4.

Synonyms: *Nitzschia dubia* W. Smith pro parte (excl. Typus); *N. hybrida* Grunow pro parte (excl. Typus); *N. ostensfeldii* Hustedt non Van Heurck; *N. pamirensis* Hustedt; *N. piscinarum* Hustedt; *N. subamphioxoides* Hustedt; *N. pseudoamphioxoides* Gandhi.

Description: Frustule in the girdle view with many interstitial bands, in the middle more or less concave. Valve linear, margin in the middle distinctly concave, as a rule more distinctly so on the keel side. Ends wedge-shaped, attenuate, at angle to the plane of the valve, asymmetrically beak-like or capitate, 45 to more than 100 μm long, 5-8 μm wide. Raphe keel with 9-12 fibulae per 10 μm , the median of which more regular and wider spaced. Fibulae narrowed from the broad base, separated by 2-3 rows of striae proximally, by only one transapical row distally. Striae appear relatively strongly contrasted, more or less distinctly punctate, (18)19-23(24) per 10 μm , punctures up to 25 per 10 μm . A feebly developed longitudinal fold indistinct or scarcely distinguishable at all.

Occurrence: Mesohalobic.

Distribution and habitat in Israel: CM: Mount Carmel, Upper Nahal Oren, periphyton on limestone pebbles — 1-3; pH — 7.5-8.3; C — 0.74-0.87 Sm/cm; M — 490-623 mg/l; S — 1.4-2.2

General distribution: Cosmopolitan.

20. *Nitzschia grandifera* Hustedt 1930. Süßwasserflora von Mitteleuropa. 10: 416, Fig. 793. — Pl. 2, Fig. 3.

Description: Valves linear-lanceolate, 30-40 μm long, 7-8 μm wide. Cell ends beak-like. Keel central, keel points as transverse ridges traversing the valve, 4-5 in 10 μm . Alveoles extremely delicate, scarcely visible. In side view the valve narrowly linear, cuneiform bluntly pointed at both ends.

Occurrence: Benthic in brackish water, halophilous.

Distribution and habitat in Israel: CM: Mount Carmel, Upper Nahal Oren, periphyton on limestone pebbles — 1; pH — 7.5-8.2; C — 0.68-0.87 Sm/cm; M — 490-623 mg/l; S — 1.4-2.2.

General distribution: Holarctic.

21. *Nitzschia laevis* Hustedt 1939 non *N. levis* Frenguelli 1923. — Pl. 2, Fig. 7.

Description: Valve broadly linear to linear-lanceolate, cuneate to slightly beak-like

attenuate on ends, 12-26 μm long, 5-7 μm wide. Keel fibulae 10-14 per 10 μm , relatively distant in the middle of the valve. Striae 32-36 per 10 μm .

Occurrence: Benthic, halophilous

Distribution and habitat in Israel: CM: Mount Carmel, Upper Nahal Oren, periphyton on limestone pebbles in the river and tributary with Fe-rich water — 1; pH — 6.8-8.2; C — 0.68-1.04 Sm/cm; M — 490-751 mg/l; S — 1.4-2.2.

General distribution: Europe, Asia (Israel), South Africa.

22. *Nitzschia sinuata* (Thwaites in W. Smith) Grunow in Cleve & Grunow 1880. K Svenska Vetensk Akad. Handl. 17: 82, Pl. LX, Fig. 11. — Pl. 2, Fig. 5.

Synonyms: *Denticula sinuata* Thwaites in W. Smith; *Nitzschia tumida* Hantzsch ex Rabenhorst.

Description: Valve from narrowly lanceolate to rhombic, partly in the middle swollen gradually decreasing to acute or capitate ends, 10-50 μm long, 3-8 μm wide. Raphe keel with 5-8 fibulae per 10 μm , slightly irregularly arranged, the median two of them relatively wider spaced. Fibulae nearly extend to the middle of the valve, terminally expanded or forked into two stalks divided by one or more transapical ridges. Striae coarsely punctate, 18-25 per 10 μm .

Occurrence: β - α -mesosaprobic, halophilous.

Distribution and habitat in Israel: CM: Mount Carmel, Upper Nahal Oren, periphyton on limestone pebbles — 2; pH — 7.7; C — 0.61 Sm/cm; M — 439 mg/l; S — 1.7.

General distribution: Cosmopolitan.

23. *Nitzschia subtilis* Grunow in Cleve & Grunow 1880 Arkt. Diat.: 95. Pl. 68, Figs 7,8. — Pl. 2, Fig. 8.

Synonym: *Nitzschia linearis* var. *subtilis* (Grunow) Hustedt

Description: Valve linear-lanceolate, 35-70 μm long, 2.5-3.0 μm wide, fibulae 8-17 per 10 μm , striae 33-37 per 10 μm .

Occurrence: Benthic, oligohalob-indifferent, pH-indifferent.

Distribution and habitat in Israel: CM: Mount Carmel, Upper Nahal Oren, periphyton on limestone pebbles — 1; 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.

CHLOROPHYTA

Apiocystis Nägeli in Kützing 1849

24. *Apiocystis caput-medusae* (Bohlin) Korschikoff 1953. Vzn. Prsn. Vodor. Ukr. RSR 5: 111, Fig. 53. — Pl. 2, Fig. 14.

Synonym: *Apiocystis brauniana* var. *caput-medusae* Bohlin, A. globosa Korschikoff.

Description: Envelope more or less spherical, attached by a constricted basal area or sessile, up to 75 μm gross. Cells few, typically only 8-16, diameters 6-10 μm . Cell mucilage envelope fairly thick, distinctly lamellate, five times longer than the body.

Occurrence: Epiphytic on aquatic macrophytes and filamentous algae (Cladophora, Vaucheria).

Distribution and habitat in Israel: CM: Mount Carmel, Upper Nahal Oren, periphyton on limestone pebbles in the tributary on algae Cladophora — 1; pH — 7.2-7.7; C — 0.66-0.71 Sm/cm; M — 477-514 mg/l; S — 1.6-2.0.

General distribution: Europe, Asia (Russia, India, Israel).

Chara Linné 1753

25. *Chara tenuispina* A. Braun 1835. Flora Bad. Crypt. 18: 68. Krause, 1997. Süßwasserflora von Mitteleuropa. 18: 202, Fig. 37. — Pl. 3, Fig. 9-16.

Synonym: *Chara globularis* var. *tenuispina* (A. Braun) R. D. Wood

Description: Thallus monoecious, fairly robust, up to 50 cm high, slightly or moderately branched, often incrustated with lime, yellowish-green, young parts olive-green. Stems slender, flexible to fairly stout, 340-490 µm in diameters. Internodes up to four times longer than leaves except distally where they are equal to the leaves. Cortex with three distinct ridges. Spines solitary, long and massive or short and slender, cylindrical, acuminate. Stipules in two-tier whorl, two pairs for each of the leaves, well-developed in both tiers, but often longer in the upper tier, similar to spines, occasionally irregular. Leaf whorls of 8-10 members, moderately spread, leaves straight or slightly incurved. Terminal cell of leaves conical, acutely pointed. Leaflets 4-7 at leaf nodes, well developed, cylindrical, pointed. Gametangia solitary in 3-4 lower leaf nodes, occasionally at leaf bases. Oogonia ellipsoid, slightly ovate, 485-600 µm long (without the crown), 126-430 µm wide. Spiral cells of 11-14 coils, crown dense, 68-85 µm long, 120-130 µm wide at base, straight or slightly conical. Cells rectangular or slightly distally constricted. Oospores broadly ovate, 500-582 µm long, 407-417 µm wide, brown, with 11-14 thin distinct ribs prolonged as minute teeth or a basket at base. Antheridia 250-270 µm long.

Occurrence: In still freshwater small ponds.

Distribution and habitat in Israel: CM: Mount Carmel, Upper Nahal Oren, in the small pond Sekher Pool — 6; pH — 8.3-8.8; C — 0.23-0.27 Sm/cm; M — 167-197 mg/l; S — 1.86-1.89.

General distribution: Suds-West Europe, Asia (Turkey, Uzbekistan, Israel).

Characium A. Braun 1849

26. *Characium ornithocephalum* A. Braun 1855. Alg. Unicel. Gen. Nova & Minus. 2: 42, Table 3, Figs 1-11. — Pl. 2, Fig. 13.

Description: Cells 6-16 µm wide, 23.0-35.4 µm long (excluding stalk), asymmetrical crescent-shaped or almost semicircular arising obliquely on a narrow short stalk and attached by a distinct disc; apex acute with a short colorless point.

Occurrence: Epiphytic on filamentous green algae.

Distribution and habitat in Israel: CM: Mount Carmel, Upper Nahal Oren, periphyton of green filaments — 1; pH — 8.0-8.3; C — 0.74-0.85 Sm/cm; M — 530-613 mg/l; S — 1.7-2.1.

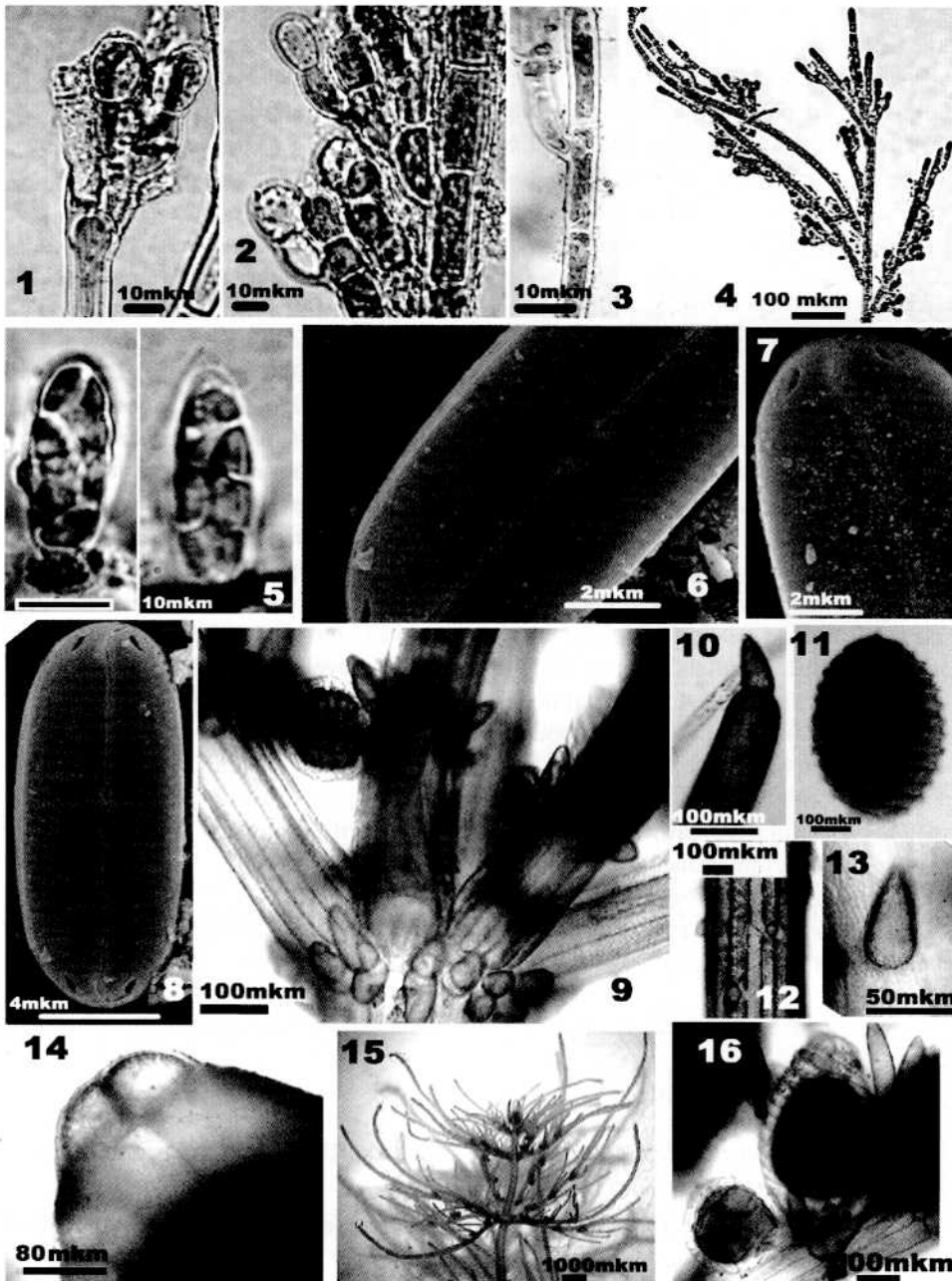


Plate 3. New taxa of algae from Nahal Oren River basin. 1-4 – *Audouinella pygmaea*; 5 – *Characiopsis borziana*; 6-8 – *Fallacia subhamulata*; 9-16 – *Chara tenuispina*: 9 – branching and cortex; 10 – terminal cell; 11 – oospore; 12 – cortex; 13 – cortex cell; 14 – apex of oogonium; 15 – thallus; 16 – oogonia and antheridia. Scale bar 1, 2, 3, 5 = 10 μm; 4, 9, 10, 11, 12, 16 = 100 μm; 6, 7 = 2 μm; 8 = 4 μm; 13 = 50 μm; 14 = 80 μm; 15 = 1000 μm. 6-8 – SEM.

General distribution: Probably cosmopolitan.

Chlorangiopsis Korschikoff 1953

27. *Chlorangiopsis piriformis* (Korschikoff) Korschikoff 1953. Vzn. Prsn. Vodor. Ukr. RSR 5: 87, Fig. 29. — Pl. 2, Fig. 15.

Synonyms: *Chlorangiochloris piriformis* Korschikoff, *Chlorangium piriforme* (Korschikoff) Ettl.

Description: Cells solitary, elongate pyriform, about 22 μm long, 14 μm wide, at base broadly rounded, in the distal third abruptly narrowed and irregularly clustered, with a short mucilaginous stalk showing two flabella at the point of attachment, their insertion to protoplasts is scarcely discernible. Flagella attached to substrate with mucilage pollsters. Cell walls delicate, slightly swollen over the protoplasts, without papillae. Chloroplast parietal, asymmetrically cup-shaped, with a basal thickening, with spherical pyrenoids. Stigma lacking. Cell nucleus central. Vacuoles two at the beak-like posterior extension of protoplasts. Reproduction not known, probably as in other species of genus *Chlorangiopsis*.

Occurrence: Epiphytic on planktonic algae, oligohalob-indifferent.

Distribution and habitat in Israel: CM: Mount Carmel, Upper Nahal Oren, periphyton of green filaments — 2; pH — 8.0-8.3; C — 0.74-0.85 Sm/cm; M — 530-613 mg/l; S — 1.7-2.1.

General distribution: Europe, Asia (Russia, Israel).

Chlorangium Stein 1878

28. *Chlorangium minus* (Korschikoff) Ettl 1958. Algolog. Stud.: 291, Fig. 22.

Synonym: *Chlorangiopsis minor* Korschikoff. — Pl. 2, Fig. 16.

Description: Cells ellipsoid to ovoid, up to 8.5 μm long, 6 μm wide, with short stalks about one half of the cell length, consisting of two-fused flagella. Chloroplast parietal. Vacuoles two, apical. Reproduction not known.

Occurrence: Epiphytic on planktonic algae in still fresh water.

Distribution and habitat in Israel: CM: Mount Carmel, Upper Nahal Oren, periphyton of green filaments — 2; pH — 8.0-8.3; C — 0.74-0.85 Sm/cm; M — 530-613 mg/l; S — 1.7-2.1.

General distribution: Europe (Russia, Ukraine), Asia (Israel).

Coleochaete Brébisson 1844

29. *Coleochaete pulvinata* A. Braun in Kützing 1849. Phycol. Germ.: 245; Sp. Alg.: 425; Graham & Wilcox 2000: 525, Fig. 21-56, c. — Pl. 2, Fig. 11.

Description: Filaments forming hemispherical, cushion-like growths (2-4 mm across) of irregularly branched erect filaments radiating from a common center; cells (17-)20-50 μm wide, 1 to 3 times longer than wide, irregularly cylindrical, typically bearing bristles.

Occurrence: Epiphyte on submerged aquatic vegetation growing along the shallow margins of lakes and ponds.

Distribution and habitat in Israel: CM: Mount Carmel, Upper Nahal Oren, periphyton on limestone pebbles — 2; pH — 7.6-8.0; C — 0.71-0.84 mS/cm; M — 511-607 mg/l; S — 1.6-2.2.

General distribution: Cosmopolitan.

***Cosmarium* Corda 1835**

30. *Cosmarium punctulatum* Brébisson 1856. Liste. N.24: 129. T.1, Fig.16. — Pl. 2, Fig. 10.

Synonym: *Cosmarium subpunctulatum* Nordst.

Description: Cells 20-38 μm wide, 22-40 μm long. Sinus narrow, linear, slightly dilated inside. Semicells oblong-trapeziform, basal angles rounded, lateral margins curving inwards to broad, truncate apex. Walls granulate, 23-24 granules around margin, on face disposed in vertical or oblique series, irregular at center.

Occurrence: Planktonic-benthic, oligohalob-indifferent, pH-indifferent.

Distribution and habitat in Israel: CM: Mount Carmel, Upper Nahal Oren, periphyton on limestone pebbles in the river and tributary — 2-4; pH — 7.2-8.6; C — 0.59-0.84 Sm/cm; M — 434-623 mg/l.

General distribution: Cosmopolitan.

***Gongrosira* Kützing 1843**

31. *Gongrosira debaryana* Rabenhorst 1883. Kryptogamenflora von Deutschland, Österreich und der Schweiz; Iconog.: John, Whitton & Brook, 2002: 441, Fig.109E. — Pl. 2, Fig. 17.

Description: Thallus consists of pale green, disc-like or irregular crusts; prostrate system pseudoparenchymatous and erect system clearly filamentous, all filaments dichotomously divided; cells 15-20 μm wide, 1 to 2.5 times longer than wide (often very variable in size), frequently somewhat rounded and thick-walled; pyrenoid single, large.

Occurrence: Grows as greenish patches on rock surfaces along the marginal shallows of streams and rivers.

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

General distribution: Europe, Asia (Russia, Israel), N. America.

***Nephrocytium* Nägeli 1849**

32. *Nephrocytium perseverans* Printz 1914. Skr. Vidensk. Selsk. Kristiania, Mat.-Naturv. Kl., 1913 (6): 62, Pl. V, Fig. 125-127. — Pl. 2, Fig. 9.

Description: Colonies of (2)-4-8 cells, oval or irregularly ovoid, typically forming a row of adnate cells. Mucilage envelope persistent, seldom filled with slime. Cells oval, slightly

asymmetrical or reniform, biconvex or from one side slightly concave. Cell wall distinct, smooth. Chloroplast parietal with a solitary pyrenoid. Reproduction by (2)-4 autospores. Dimensions: cells 8.4-14 x 2-8.3 μm , colonies up to 30 μm long.

Occurrence: Planktonoc-benthic in still water.

Distribution and habitat in Israel: CM: Mount Carmel, Upper Nahal Oren, periphyton of the walls of collector basin — 2; pH — 7.3-9.5; C 0.44-0.61 Sm/cm; M — 324-440 mg/l; S — 1.8-1.9.

General distribution: Europe, Asia (Israel).

Uronema Lagerheim 1887

33. *Uronema intermedium* Bourrelly 1962. Phycos, 1(1): 39, Figs 8-17. — Pl. 2, Fig. 12.

Description: Filament straight, distally constantly crescent-shaped. Cells cylindrical, 5.8-8 μm wide, 7-25 μm long, terminal cell acuminate, beak-like, the basal cell distinctly constricted to the point of attachment, 10-15(25) μm long. Dermoid hemispherical with entire margins, typically brown. Chloroplast is with 2 pyrenoids.

Occurrence: In fresh water on filamentous algae (Oedogonium, Cladophora).

Distribution and habitat in Israel: CM: Mount Carmel, Upper Nahal Oren, periphyton on limestone pebbles, in the stream from collector basin — 1-4; pH — 7.5-8.6; C — 0.59-0.87 Sm/cm; M — 486-623 mg/l; S — 1.4-2.4.

General distribution: Europe (Ukraine), Asia (Israel).

RHODOPHYTA

Audouinella Bory 1823

34. *Audouinella pygmaea* (Kützing) Weber-van Bosse 1921. Liste des algues du Siboga. II. Rhodophyceae. Première partie. Protofloridae, Nemalionales, Cryptonemiales. Exed. 59:191; Iconog.: John, Whitton & Brook, 2002: 131, Fig. 25C. — Pl. 3, Fig. 1-4.

Basionym: *Chantransia pygmaea* Kützing 1843. Phyc. Gen. 285.

Synonyms: *Audouinella leibleinii* (Kützing) T. C. Palmer; *Chantransia leibleinii* Kützing; *Chantransia chalybea* Roth.

Description: Cells with blue-colored chloroplasts, (6.5-)10-15 μm wide, 12.5-38 μm long; monosporangia ovoid, (6.5-)7.5-10 μm wide, (7.5-)10-13 μm long; gametangia or tetrasporangia unknown.

Occurrence: Periphytic and benthic in lakes and seas.

Distribution and habitat in Israel: CM: Mount Carmel, Upper Nahal Oren, periphyton on limestone — 1-6; 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.

Conclusion

Species first recorded in Israel constitute 15% of aquatic flora in the Nahal Oren basin.

Of 88 genera 5 are new for Israel. They are represented by *Leptochaete stagnalis* (Cyanoprocarvota), *Characiopsis borziana*, *Characiopsis minuta* (Xanthophyta), *Apiocystis caput-medusae*, *Chlorangiopsis piriformis*, *Chlorangium minus* (Chlorophyta). Except *Leptochaete stagnalis*, they are all epiphytes on filamentous algae.

Our findings indicate that natural aquatic ecosystems of Israel were richer in algal biodiversity than previously suspected. Species are added at different taxonomic levels and to different higher taxa proportionally to their representation in the flora. This means that our inventory of the total species richness is so far not exhaustive (Barinova & al. 2002). Ecological characteristics of species constituting the Nahal Oren algaeflora comply with their clean-water alkaline habitats. Carbonate rocks drained by the Nahal Oren River, contribute to high pH levels of surface waters (Meybeck & Helmer 1989), which is typical for the entire mountainous Mediterranean. New finds are partly due to collecting in all seasons comprising round-the-year changes of algal communities.

We employed the scanning electron microscopy for study of blue-green, green, and diatom algae. This method greatly extended the range of rare small-celled species such as *Fallacia subhamulata*, which are hard to determine with light microscopy alone. Of a considerable interest is a red alga *Audouinella pygmaea* found for the first time in the Nahal Oren River. Previously the genus was recorded from Lake Kinneret (Dor 1974), but the species was not identified.

Remarkable from an ecological point of view is a considerable number of small epiphytes among the first recorded species. Together with the first recorded rare species, the epiphyte diversity attests to a high representativeness of our samples.

Phytogeographically, most of the first recorded species are cosmopolites. Of a special interest is *Chara tenuispina*, previously known from southwestern Europe, Turkey, and Uzbekistan. *Chara* species occur in clean alkaline waters and are rare in industrial countries. In Israel, three species of *Chara* were last encountered 50 years ago (Rayss 1951). Nahal Oren is the southernmost locality of *Chara tenuispina*. This pollution-sensitive species, together with the red alga *Audouinella pygmaea*, provide for the employment of Nahal Oren as a model not only for evolution of biodiversity in natural ecosystems, but also as a reference water source in studies of anthropogenic impacts on aquatic ecosystems in Israel.

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References

- Asmund, B., Kristiansen, J. 1986: The genus *Mallomonas* (Chrysophyceae). — *Opera Botanica* **85**: 5-128.
- Barinova, S. S., Anissimova, O. V., Vinogradova, O. N. & Tsarenko, P. M. 2002: Ecological and geographical analysis of the diatom algaefloras of continental Israel. — *Abstr. Int. Symp. "Morphology, ecology and biogeography of Diatom algae"*, Borok, IBIW: 8-9.
- 1988: Polymorphism of connective structures in diatom algae. *Evolutionary Research*. — *Vavilov's Themes*. Vladivostok: Acad. Sci. USSR, Far East Branch: 110-122.

- & Medvedeva, L. A. & Anissimova, O. V. 2000: Algae as indicators of environmental quality. — Moscow.
- Bourrelly, P. 1962: *Ulothricales* d'eau douce rares ou nouvelles. — *Phykos* **1(1)**: 29-35.
- Braun, A. 1855: *Algarum Uncellularium Genera Nova et Minus Cognita* 2 edn. — Lipsiae.
- 1835: Übersicht der genauer bekannten Chara-Arten. — *Flora* **18**: 49-73.
- Breisson, A. 1863: Liste des Desmidiées observées en Basse-Normandie par Alphonse de Breisson. — Avec 2 planch. litt. Paris. **24**: 129.
- Chodat, R. & Chodat, F. 1925: Veröff. Geobot. Inst. Rübel Zürich **3**: 453.
- Cleve, P. T. & Grunow, A. 1880: Beiträge zur Kenntnis der arktischen Diatomeen. — *Kngl. Sven. Vet.-Akad. Handl.* **17(2)**: 121.
- Conrad, W. 1914: Algues, Schizophycées et Flagellates recoltés par M.W. Reckert aux environs de Libau (Courland, Russie). — *Ann. Biol. Lacustr.* **7**: 135.
- 1933: Revision du genre *Mallomonas* Perty (1815) et *Pseudomallomonas* Chod. — *Mem. Mus. Hist. Nat. Belgique* **56**: 1-82.
- Cronberg, G. & Komarek, J. 1994: Planktic cyanoprocaryotes found in south Swedish lakes during the 12th International Symposium of Cyanophyte Research, 1992. — *Arch. Hydrobiol./Algolog. Stud.* **75**: 323-352.
- Dor, I. 1974: Considerations about the composition of benthic algal flora in Lake Kinneret. — *Hydrobiol.* **44**: 252-264.
- Ettl, H. 1958: Einige Bemerkungen zur Systematik der Ordnung Chlorangiales. — Pp.291-336 in: J. Komárek et H. Ettl: *Algologische Studien*, nakl. SAV. — Praha.
- 1978: *Xanthophyceae*. Teil 1. Süßwasserflora von Mitteleuropa 3. — Stuttgart & New York.
- & Gartner, G. 1988: *Chlorophyta* Teil 2. Tetrasporales, Chlorococcales, Gloeodendrales. Süßwasserflora von Mitteleuropa 10. G. Fischer. — Stuttgart & New York.
- Graham, L. E. & Wilcox, L. W. 2000: *Algae*. Prentice Hall. — London.
- Hansgirg, A. 1888: Synopsis generum subgenerumque *Myxophycearum* (*Cyanophycearum*) hucusque cognitorum, cum descriptione generis. — *Notarisia* **3**: 399.
- Hartley, B. 1996: *An Atlas of British Diatoms*. — Bristol.
- Hustedt, F. 1930: *Süßwasserflora von Mitteleuropa*. — Jena.
- 1938-1939: Systematisch und ökologische Untersuchungen über die Diatomeenflora von Java, Bali und Sumatra. — *Arch. Hydrobiol. Suppl.* **15**: 131-177.
- John, D. M., Whitton, B. A. & Brook, A. J. 2002: *The freshwater algal flora of the British Isles. An identification guide to freshwater and terrestrial algae*. — Cambridge.
- Komarek, J. 1983: *Rhabdogloea*, the correct name of cyanophycean *Dactylicocopsis* sensu auct., non Hansgirg (1888). — *Taxon* **32(3)**: 464-466.
- & Anagnostidis, K. 1998: *Cyanoprocaryota* 1. Teil: Chroococcales. — *Süßwasserflora von Mitteleuropa* 19/1 — Jena.
- Korde, N. V. 1956: The methods of biological studies for the bottom deposits of lakes (the field methods of biological analysis). — Pp. 383-413 in: *Freshwater Life in USSR* **4(1)**.— Moscow-Leningrad.
- Korschikoff, A. A. 1953: *Protococcineae*. — In: J.V. Roll (ed.), *Viznachnik prisnovod. vodoroslej Ukr. RSR*, **5**. — Kijev.
- Kovalenko, O. V., Nevo, E. & Wasser, S. P. 2002a: New for Israel taxa of blue-green algae (*Cyanoprocaryota*). — *IJA* **4(4)**: 98-110.
- , —, —, Tsarenko, P. M., & Bleich, S. A. 2002b: New data on the diversity of *Cyanoprocaryota* in inland waters of Israel. — *IJA* **4(1)**: 41-50.
- Krammer, K. 1985: Morphologische und lichtmikroskopische Merkmale in Mikrometer bereich. Ein Vergleich. — *Mikrokosmos* **74**: 105-109.

- & Lange-Bertalot, H., 1991a: *Bacillariophyceae*. Teil 1. *Naviculaceae*. — Süßwasserflora von Mitteleuropa 2/1. — Jena; Stuttgart; Lubeck & Ulm.
- & — 1991b: *Bacillariophyceae*. Teil 2. *Bacillariaceae*, *Epithemiaceae*, *Surirellaceae*. — Süßwasserflora von Mitteleuropa 2/2. — Jena; Stuttgart; Lubeck & Ulm.
- & — 1991c: *Bacillariophyceae*. Teil 3. *Centrales*, *Fragilariaceae*, *Eunotiaceae*. — Süßwasserflora von Mitteleuropa 2/3. — Stuttgart & Jena.
- & — 1991d: *Bacillariophyceae*. Teil 4. *Achnantheaceae*, Kritische Ergänzungen zu *Navicula (Lineolatae)* und *Gomphonema* Gesamtliteraturverzeichnis Teil 1-4. — Süßwasserflora von Mitteleuropa 2/4. — Stuttgart & Jena.
- Krause, W. 1997: Charales (*Charophyceae*). — Süßwasserflora von Mitteleuropa. 18. — Jena, Stuttgart, Lubeck & Ulm.
- Kützing, F. T. 1843: *Phycologia generalis*. — Brockhaus **32**: 459.
- 1844: Die kieselschaligen Bacillarien oder Diatomeen. Nordhausen. — Lipsiae.
- 1849: *Species Algarum*. F.A. Brockhaus. — Lipsiae.
- Kuzmin, G. V. 1976: The planktonic algae in the Sheksninsk and the adjacent part of the Rybinsk reservoir. — *The biology, morphology and systematics of aquatic organisms* **31(34)**: 3-60.
- Lemmermann, E. 1910: Beiträge zur Kenntnis der Plankton-algen. — *Arch. Hydrobiol. Planktonk.* **5**: 291-338.
- Masyuk, N. P., Lilitskaya, G. G., Wasser, S. P. & Nevo, E. D. 2001: Green flagellate algae of Israel. New and rare species. — *IJA* **3(1)**: 48-61.
- Mattox, K. R. & Stewart, R. D. 1984: Classification on the green algae: a concept based on comparative cytology. — Pp. 29-72 in: Irvine, D. E. & John, D. M. (eds.), *Systematics of the Green Algae*. Syst. Assoc. Spec. **27**.
- Meister, F. 1912: Beitr. Zur Kryptogamenflora der Schweiz, 4/1. — Bern.
- Meybeck, M. & Helmer, R. 1989: The quality of rivers: from pristine stage to global pollution. — *Palaeogeography, Palaeoclimatology, Palaeoecology (Global and Planetary Change Section)* **75**: 283-309.
- Mihailuk, T. I., Tsarenko, P. M., Wasser, S. P. & Nevo, E. 2001a: New data of aerophytic algae of North Israel. — *Algologia* **11(3)**: 371-390.
- , — , — & — 2001b: Additions to the study of aerophytic algae of Israel. — *IJA* **3(3)**: 19-39.
- Moshkova, N. A. & Gollerbach, M. M. 1986: Green Algae. Chlorophyta: Ulotrichophyceae (1), Ulotrichales. *Opred. Presnovod. Vodor. SSSR*, **10(1)**. — St.-Petersburg.
- Nevo, E. 1994: Biodiversity: The Evolution Canyon at Nahal Oren, Mt Carmel, Israel. — *Isr. J. Plant Sci.* **42**: 83.
- 1995: Asian, African and European biota meet at "Evolution Canyon" Israel: Local tests of global biodiversity and genetic diversity patterns. — *Proc. R. Soc. Biol. London* **262**: 149-155.
- 1997: Evolution in action across phylogeny caused by microclimatic stresses at "Evolution Canyon". — *Theor. Pop. Biol.* **52**: 231-243.
- 2001: Evolution of genome-phenome diversity under environmental stress. — *Proc. Natl. Acad. Sci. USA.* **98**: 6233-6240.
- & Wasser, S. P. 2000: Biodiversity of cyanoprocaryotes, algae and fungi of Israel. *Cyanoprocaryotes and algae of continental Israel*. — Leichtenstein.
- Palamar-Mordvintseva, G. M. 1982: Chlorophyta: Conjugatophyceae. Desmidiaceae. *Opred. Presnovod. Vodor. SSSR*, **11(2)**. — Leningrad.
- Pantle, E. & Buck, H. 1955: Die biologische Überwachung der Gewässer und die Darstellung der Ergebnisse. — *Gas- und Wasserfach* **96(18)**: 604.
- Patrick, R. & Reimer, C. W. 1966: *The diatom of United States*, 1. — Philadelphia.
- Perestenko, L. P. 1994: Red algae of the Far-Eastern seas of Russia. [*Krasnye vodorosli Dalnevostochnyh morej Rossii*]. — St.-Petersburg.

- Popova, T. G. 1966: Euglenophyta. Flora plantarum cryptogamarum URSS. 8(1). — Moskva & Leningrad.
- Printz, H. 1914: Kristianiatrakts Protococcoideer. Vidensk. Skr., I. — Mat.-Naturv. Kl. Kristiania 6: 123.
- Rabenhorst, L. 1883: Kryptogamen flora von Deutschland, Österreich und der Schweiz, 1. — Leipzig.
- Rayss, T. 1951: Les algues des eaux continentales. Matériaux pour la flore algologique de la Palestine. — Pal. J. Bot. 5: 71-95.
- Round, F. E., Crawford, R. M. & Mann, D. G. 1990: The Diatoms. Biology and morphology of the genera. — Cambridge.
- Rumrich, U., Lange-Bertalot H. & Rumrich, M. 2000: Diatoms of the Andes: From Venezuela to Patagonia/ Tierra del Fuego and two additional contributions. — Iconographica diatomologica 9: 672.
- Schmidt, A. & al. 1874-1959: Atlas der Diatomaceen-kunde. Aschersleben-Leipzig. Heft 1-120. — Leipzig.
- Sladeck, V. 1986: Diatoms as indicators of organic pollution. — Acta Hydrochim. Hydrobiol. 14(5): 555-566.
- Starmach, K., 1985: Chrysophyceae und Haptophyceae. — Süßwasserflora von Mitteleuropa 1. — Stuttgart & New York.
- Swift, E. 1967: Cleaning diatom frustules with ultraviolet radiation and peroxide. — Phycologia 6(2-3): 161-163.
- Takhtajan, A. 1978: The floristic regions of the world. — Leningrad.
- Tsarenko, P. M., Vinogradova, O. N., Stupina, V. V., Wasser, S. P. & Nevo, E. D. 2001: Diversity of algae in the continental part of Israel. — Algologia 11(1): 83-99.
- Vinogradova, O. N., Kovalenko, O. V., Wasser, S. P. & Nevo, E. 2001: New representatives of *Chroococcophyceae* (Cyanophyta) from the Mount Carmel National Park and Dead Sea area, Israel. — IJA 3(3): 95-99.
- , Nevo, E. D. & Wasser, S. P. 2000a: Cyanoprocarota (blue-green algae/ cyanobacteria) of Sefunim cave (Israel). — Int. Conf. "Algae and extreme environment. Ecology and physiology" 11-16 September 2000, Trebon, Czech Republic, p. 43.
- , Poem-Finkel, M., Nevo, E. D. & Wasser, S. P. 2000b: Diversity of Cyanoprocarota in Israel. First data about blue-green algae of dry limestones of Upper Galilee. — IJA 2(3): 27-45.
- Wasser, S. P., Nevo, E., Vinogradova, O. N., Navrotskaya, I. L., Ellanskaya, I. A., Volz, P. A., Virchenko, V. M., Tsarenko, P. M. & Kondratyuk, S. Y. 1995: Diversity of cryptogamic plants and fungi in "Evolution Canyon", Nahal Oren, Mount Carmel Natural Preserve, Israel. — Israel J. Plant Sci. 43: 367-383.
- Weber-van Bosse, A. 1921: Liste des algues du Siboga. II. *Rhodophyceae*. Première partie., Nemalionales, Cryptonemiales. — Leiden.
- Zohary, M. & Feinbrun-Dothan, N. 1966: Flora Palaestina. Israel Academy of Sciences and Humanities — Jerusalem.
- 1966: Flora Palaestina, I: Equisetaceae to Moringaceae, Israel Academy of Sciences and Humanities — Jerusalem.

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