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The Ein El Balad Charophyte Locality in the Mount Carmel Biosphere Reserve, Israel

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Abstract: *New charophytes locality the Ein El Balad in the territory of the Mount Carmel Biosphere Reserve in Northern Israel was studied firstly with implementation bio-indication methods for revealing of algal diversity and ecological assessment of the water object environment. Altogether forty seven species of cyanobacteria and algae including one of them macro-algae Chara vulgaris Linnaeus were revealed. Chara was found in massive growth in two ancient pools. Bio-indication and chemical variables characterize the pools environment as eutrophic, moderate organic polluted, Class III-V of water quality. Water was fresh, temperate, low alkaline, and well saturated by oxygen. Succession of algal community shows increasing of organic pollution from dry to wet season as a result of groundwater impact which has nitrates concentration increasing after rainy period. Bio-indication demonstrated high self-purification capacity of the pools ecosystem. We can recommend the Ein El Balad pools for monitoring of natural aquatic object in the Mount Carmel Biosphere Reserve as reference site, and Chara vulgaris as climatic and successional indicator.*

Keywords: *algae, charophytes, ecology, bio-indication, Mount Carmel Biosphere Reserve, Israel*

1. INTRODUCTION

Study of diversity in the Biosphere reserves is the important part of screening and protection of regional natural environment and gene pool of the species. Only one Biosphere Reserve – Mount Carmel, is represented the Eastern Mediterranean diversity and environment. While studies of vascular plants and animals here have some history, aquatic organisms, especially algal communities stay in initial stage. Earlier we investigated the Oren River basin in the Mount Carmel Biosphere Reserve springs and pools of which were inhabited by not only more than two hundred species of microalgae but also macroalgae, including charophytes [1-3].

Diversity of the charophytes (Charales, Streptophyta) in the Eastern Mediterranean is studied in initial stage [3,4]. But these macroscopic autotrophic algae may be very important components of vegetation in several types of water bodies and can be used along with microalgae as a bio-indicator of ecosystem state, water quality, and ecosystem recovery and waterbodies management efficiency.

Charophytes is very interesting part of the regional diversity. They are easily colonized habitats in new water bodies as well as ones formed as result of disturbance. They are well-known as pioneer plants i.e. key species in first stages of succession subsequently replaced by angiosperms or filamentous algae especially as a result of eutrophication. In temporal water bodies charophytes are ephemeral or in other words meteoric in appearance. Several species mostly largest ones are perennial and may form communities which are the most stable in clear deep stratifying lakes [5] and in the protected areas such as Biosphere reserves.

The charophytes prefer alkaline water environment which forms on the carbonates that are very distributed in studied region. During last year's we find new, unstudied aquatic objects in which were identified charophyte algae [4]. They are apparently absent in single Israeli large lake (Lake Kinneret) for a long time as might be concluded from published data and our observations. Nearby regions, such as Turkey, also give us charophyte algae new localities that we studied in respect of species diversity and bio-indication of its environment [6,7]. It is especially important to reveal the charophytes diversity in the Natural Reserves with saving diversity programs.

The aim of present study is to identify of charophyte and microscopic algal diversity that studied firstly for the Isifya locality Ein El Balad in the Mount Carmel Biosphere Reserve, and to assess the pools environment by bio-indication methods on the base of revealed algae and water chemistry.

2. MATERIAL AND METHODS

2.1. Sampling and Laboratory Studies

Algological samples were collected during the field course of Haifa University trips in 9 September 2011, 6 and 13 March 2012. Eighteen periphytonic and planktonic samples were taken by scratching and scooping, placed in 15 ml plastic tubes, and partly fixed with 3% neutral formaldehyde solution, as well as partly not fixed and transported to the laboratory in the ice box. We also studied 21 living and 14 dry samples of charophytes that were collected in parallel with algal samples.

Charophytes were treated with 2-3% HCl to remove calcium carbonate. After washing several times with distilled water the material was studied with Nikon stereomicroscope with distilled water. The structure elements of Charophytes were observed with a Carl Zeiss Stereo Discovery V12 stereomicroscope equipped with an AxioCam MRs–5 digital camera and Axiovision 4.8 software, and DinoLight Professional camera.

The oospores were treated with acetic acid to remove any lime–shell, washed with distilled water and cleaned from spiral cells by adding 10% Triton X100, then stored at 60 °C for at least 10 hours. Finally, they were washed with distilled water and sonicated to remove spiral cells completely. The cleaned oospores were stored in 95% alcohol. They were coated with zinc and studied with a scanning electron microscope ZEISS EVO 40 (Carl Zeiss) at 17.54 kV.

Algae and cyanobacteria were observed with Nikon Eclipse Ci and SWIFT dissecting microscopes (LM) under magnifications 740x–1850x from three repetitions of each sample and were photographed with a DC (OMAX A35100U) and Leica 520 DC. The diatoms were prepared by the peroxide technique [8] modified for glass slides [9] and were placed in the Naphrax® resin from two repetitions of each sample. Charophyte and microscopic algae abundance were assessed as abundance scores according 6-score scale [10]. Algal diversity was studied in the Institute of Evolution, University of Haifa, and the Central Siberian Botanical Garden with help of international handbooks [11-16].

Temperature, Electrical conductivity (EC), Acidity (pH), and TDS were measured with HANNA HI 9813-0. The concentration of $N\text{-}NO_3$ was measured with HANNA HI 93728.

Index saprobity s was calculated according to Sládeček [17]. Index of aquatic ecosystem sustainable was calculated according to Barinova et al. [10] and Barinova [3] as (1):

$$WESI = Rank\ S / Rank\ N\text{-}NO_3. \quad (1)$$

Where: Rank S – rank of water quality on the Sladeček's indices of saprobity; Rank $N\text{-}NO_3$ – rank of water quality on the nitric-nitrogen concentration (Table 1).

If WESI is equal to or larger than 1, the photosynthetic level is positively correlated with the level of nitrate concentration. If the WESI is less than 1, the photosynthesis is suppressed presumably according to toxic disturbance [10].

2.2. Description of Study Site

The Ein El Balad pools are located in the basin of the Qishon River in the northern slope of the Mount Carmel, Northern Israel, on the 450 m above sea level near the Isfiya Village, and represent one of the water bodies of the Mount Carmel Biosphere Reserve (Fig. 1). The spring was discovered on the village over 500 years ago and attracted the first Druze residents from Lebanon and Syria that established the Isfiya Village where are ancient olive oil extraction plant which is situated inside a cave and heritage center of the Druze community in northern Israel. Isfiya is located on Mount Carmel as a part of the Haifa district. Isfiya was built on the ruins of a Byzantine settlement and crusader remnants with a mosaic floor have been found in the village [18]. The pools are used as an attraction for visitors as well as a small source of water for local people's agriculture. The water system included two polls: upper (32º43'09.93'' N; 35º04'18.35'' E), and lower (32º43'10.71'' N; 35º04'17.68'' E). Water rich the first pool and come from groundwater spring of Carmel, then follow to lower pool, and then formed some stream that exist only in rainy winter. Both pools are small (Figs. 2-6), about 10 m length and wide and watered year-round. The climate is warm and temperate in Isfiya. In winter there is much more rainfall in Isfiya than in summer. The average annual temperature is 18.4 °C. About 709 mm of precipitation falls annually. The driest month is August with 0 mm.

Most precipitation falls in January, with an average of 188 mm. The warmest month of the year is August with an average temperature of 25.3 °C. In January, the average temperature is 11.1 °C. It is the lowest average temperature of the whole year. The average temperatures vary during the year by 14.2 °C [19].

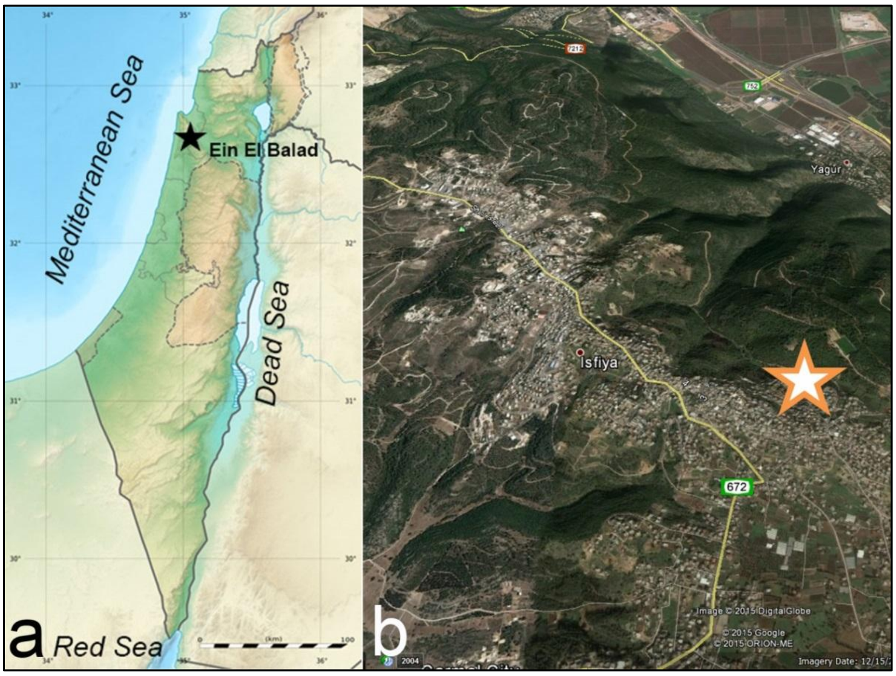

Fig.1. *The Ein El Balad pools on the map of Israel (a, black star), and in the Carmel Mountain Biosphere Reserve (b, white star).*

Fig.2. *The Ein El Balad pool view in the Carmel Mountain Biosphere Reserve (a), and the Haifa University students field trip on the pool (b).*

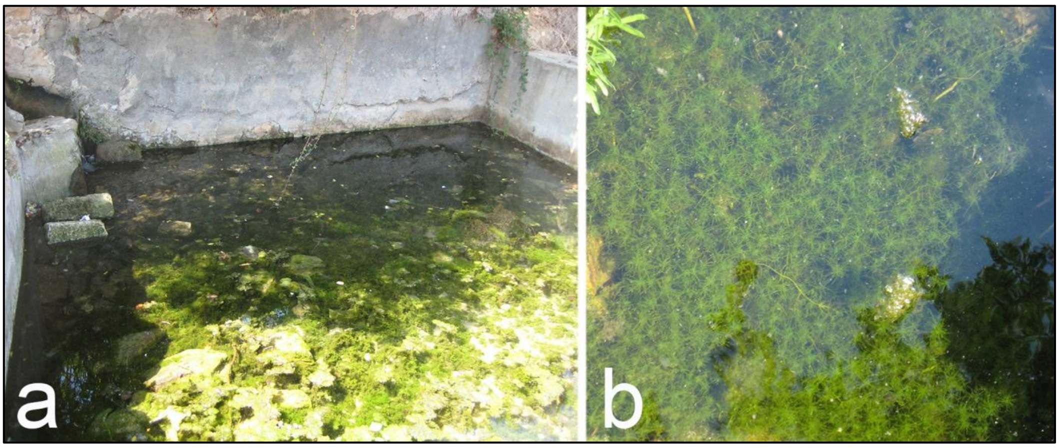

Fig.3. *The Ein El Balad Upper pool view (a), and the charophyte community (b) in September 2011*

Fig.4. *The Ein El Balad Upper pool view (a), and the charophyte community (b) in March 2012*

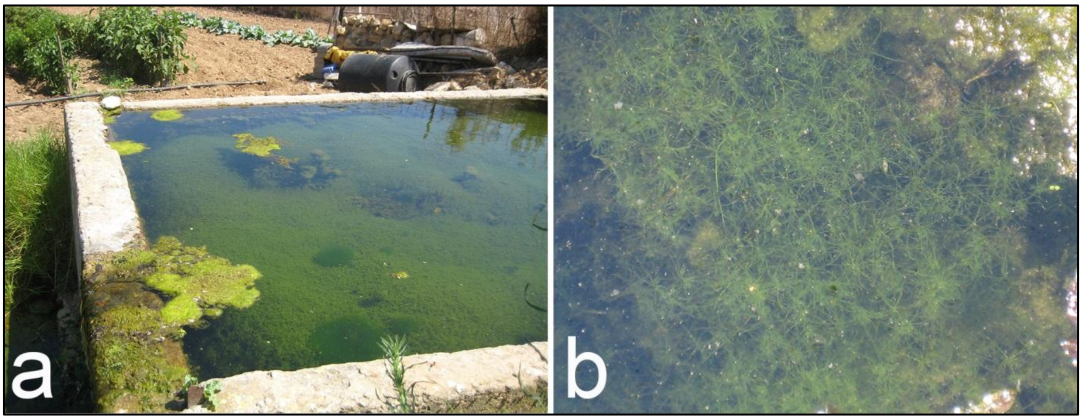

Fig.5. *The Ein El Balad Lower pool view (a), and the charophyte community (b) in September 2011*

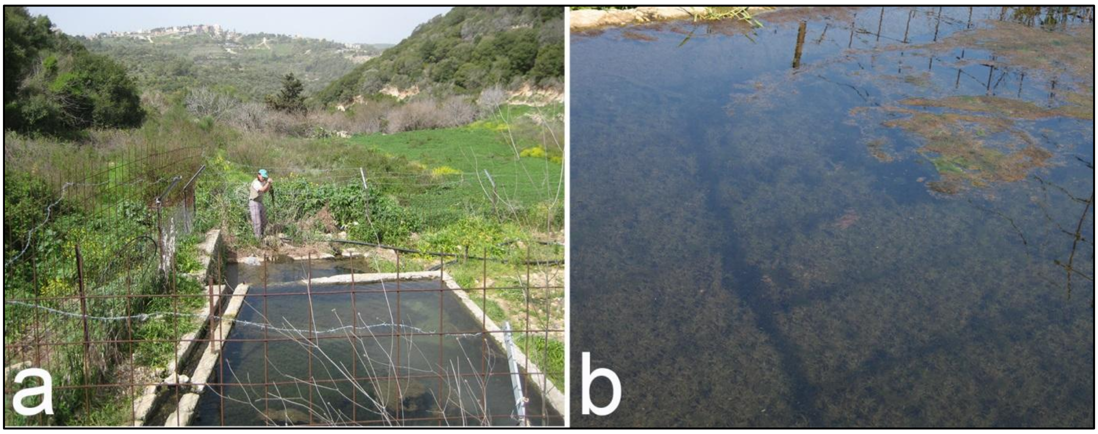

Fig.6. *The Ein El Balad Lower pool view (a), and the charophyte community (b) in March 2012*

3. Results and Discussion

3.1. Environmental variables

Water level (Figs. 3-6) and measured water variables in the Ein El Balad pools were very stable in the both pools and in wet and dry seasons. Table 1 show that Water temperature was about 20 C°, water conductivity also fluctuated in small range about 1.1 ms cm^{-1}, and also Total Dissolved Solids (TDS) were as 800 mg l^{-1}. Water pH was higher in the dry period with 8.1 and decreased in wet period up to 7.2. Especially attention we can give to the nitric-nitrogen concentration as one of variables that strongly related with organic pollution. As can be seen in Table 1, the lowermost concentration of N-NO_3 was at the end of the summer season, 5.30 mg l^{-1}. But it was rapidly increased with the wet period starting up to 5.7 mg l^{-1}, and then up to 10.15 mg l^{-1} when the rain is falls in 2012. The Water Quality Class V assessed on the concentration of N-NO_3 that reflects much polluted waters [10] during study period in dry and wet seasons. Nitrates dynamics together with changing of pH and TDS let us to assume that ground waters became organic pollution with the rainy waters that the ground waters obtains organic pollution when rainwater washes away the surface accumulations and penetrates into the lower lying horizons of rocks.

Table1. *Averaged chemical and biological variables of the Ein El Balad pools with charophytes in 2011-2012*

No.	Pool	Season	Date	Temperature, C°	pH	Conductivity, ms cm^{-1}	TDS, mg l^{-1}	N-NO_3 mg l^{-1}
1	Upper	Dry	9 September 2011	21.70	8.10	1.14	900.00	5.30
2	Upper	Wet	6 March 2012	17.80	7.20	1.03	733.00	5.70
3	Upper	Wet	13 March 2012	19.15	7.65	1.15	818.00	10.15
4	Lower	Wet	13 March 2012	19.90	7.55	1.02	729.00	8.50

3.2. Diversity and Ecology of Algae and Cyanobacteria

Altogether forty seven species of algae and cyanobacteria from six taxonomic Divisions were found in 18 samples of plankton and periphyton, and 35 samples of charophytes (Table 2). Most diverse and abundant from them were diatoms with 33 taxa. Next follow green algae and cyanobacteria with nine taxa of each. Charophytes represents by three taxa, and three were flagellates from *Glenodinium* and Euglenophyta.

The most abundant species around which was formed algal community was *Chara vulgaris* L. f. *longibracteata* (Kützing) H.Groves & J.Groves in the both studied pools. Total view of the *Chara* plants (Fig. 7) and its structural elements (Figs. 8, 9) are confirm that fended species is *C. vulgaris* in good condition and abundantly fructified. Interesting that reproduction process was found in dry and wet season, but cortex structure was significantly different in winter with irregularly diplostichous obviously tylacanthous cortex and in summer with diplostichous aulocanthous cortex typical for *C. vulgaris*. The oospore ornamentation (Fig. 9) varied from pustular to granulate which is in a good agreement with reported data for Israel and many other regions [20-25]. The charophyte mass was so large that basal parts of thalluses were lost its chlorophyll and decayed (Fig. 7a). This suggests a long-term process of forming mass of perennial *Chara* plants under conditions of constant and high enough water level as in pools of the Neot Zmadar [26], and opposed to the Ein Qinia pool [27] under periodical desiccation. The same type of growth was described for *Chara hispida* L. [28] and it seems to be characteristic for perennial populations of charophytes. *Chara vulgaris* was revealed before present study in the Oren River basin the pools and spring of which are on the territory of the Mount Carmel Biosphere Reserve [1-3]. This charophyte species is well indicator of environmental changes [29]. When we found the new locality in the territory of the natural reserve with *Chara vulgaris* community it confirms that diversity of the area is well protected.

Table 2 show changes in community during study period. So, in the late summer community was diverse with abundant after *Chara* of cyanobacteria *Phormidium breve*, diatoms *Navicula rhynchocephala* and *Nitzschia frustulum*, as well as greens *Cladophora glomerata* and *Oedogonium*. In winter can be seen changes with microalgae dominants to diatom *Ulnaria ulna*, the same greens and *Chlamydomonas* sp. In winter communities cyanobacteria have not preferences but present. Comparison of Figs. 3b and 4b for the upper pool as well as Figs. 5b and 6b for lower pool show that the charophyte plants were change its color from green in summer to brown in winter. The reason of coloring changes was in massive development of periphyton, consisting mainly of diatoms, such as *Ulnaria ulna*. Community of *Chara vulgaris* in the opposite slope of Mount Carmel in the Oren River also contain more green filamentous algae that show seasonality of species dominance with changing it from *Spirogyra* (or in last year's, *Cladophora*) to *Chara vulgaris* [30] as we can see on the Ein El Balad pools.

Fig.7. *Chara vulgaris in the Ein El Balad pool in March 2012: a – total view of thalluses, b – upper branchlets, Scale bar: b – 5 mm*

Fig.8. *Chara vulgaris morphology: axial cortex, stipulodes and base of whorl (a – wet period; c – dry period), b – whorl of branchlets with antheridia and oogonia, d – axial cortex cross section. Scale bar: 500 um.*

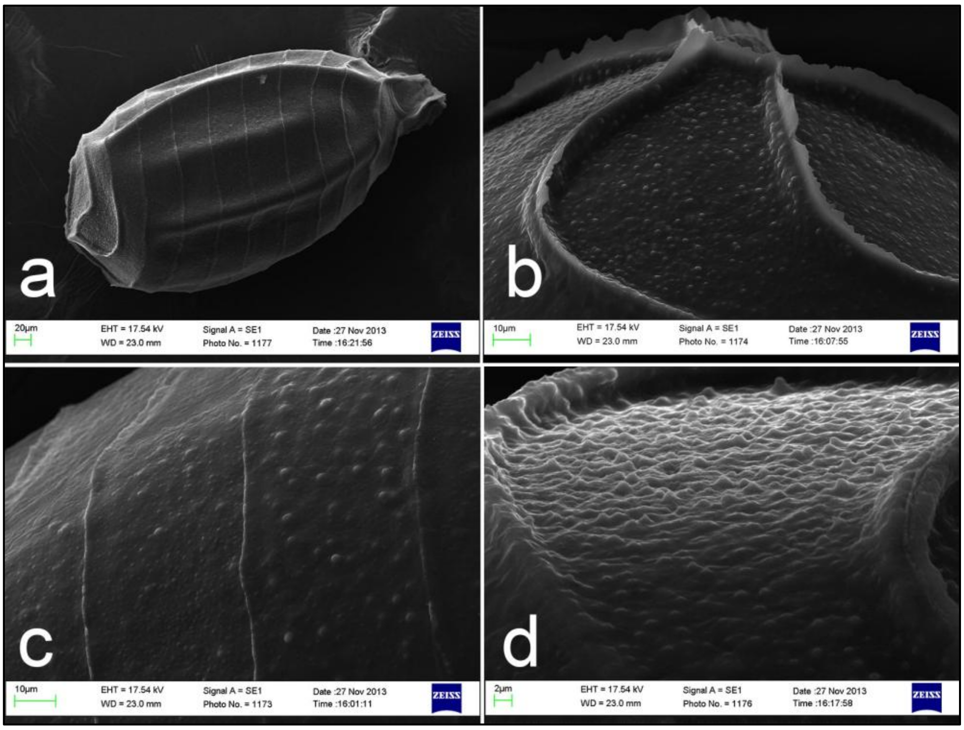

Fig.9. *The oospores of Chara vulgaris, SEM: a – total view; b, d – apical parts; c – lateral part.*

Table2. *Diversity of algae and cyanobacteria in the charophyte community of the Ein El Balad pools in autumn, 2011 and spring, 2012 with abundance scores and species autecology according to Barinova et al. [10] and Van Dam et al. [31]. Abundance scores are given for the sampling dates as in Table 1.*

Taxa	1	2	3	4	Hab	T	Oxy	pH	Sal	Sap	D	Aut-Het	Tro	pH range	S
Cyanobacteria															
Chroococcus turgidus (Kützing) Nägeli	3	0	0	0	P-B	-	aer	alf	hl	o	-	-	-	-	1.3
Limnococcus limneticus (Lemmermann) Komárková, Jezberová, O.Komárek & Zapomelová	3	0	0	0	P	-	-	-	-	o-b	-	-	o-m	-	1.4
Lyngbya sp.	4	0	0	1		-	-	-	-	-	-	-	-	-	-
Merismopedia minima G.Beck	2	0	0	0	B,S	-	aer	-	-	-	-	-	o	-	-
Microcoleus amoenus (Gomont) Strunecky, Komárek & J.R.Johansen	0	0	0	3	P-B	-	st-str	-	-	x	-	-	-	-	2.7
Microcoleus autumnalis (Gomont) Strunecky, Komárek & J.R.Johansen	3	0	0	0	B,S	-	st-str	-	-	b	-	-	-	-	2.3
Microcystis smithii Komárek & Anagnostidis	1	0	0	0	P	-	-	-	-	-	-	-	-	-	-
Phormidium breve (Kützing ex Gomont) Anagnostidis & Komárek	6	0	0	3	P-B	-	st	-	-	b-p	-	-	-	-	3.1
Phormidium retzii Kützing ex Gomont	2	0	0	0	B,S	-	st-str	-	-	o	-	-	o	-	1.0
Bacillariophyta															
Achnanthidium minutissimum (Kützing) Czarnecki	0	0	2-3	2	B	eterm	st-str	alf	i	b	es	ate	o-e	4.3-9.2	1.2
Amphora ovalis (Kützing) Kützing	1	1	1	2	B	temp	st-str	alf	i	a-b	sx	ate	e	6.2-9	1.5
*Amphora pediculus (*Kützing) Grunow ex A.Schmidt	1	1	0	3	B	temp	st	alf	i	o-a	sx	ate	e	8.0	1.7
Cocconeis placentula Ehrenberg	2	3	3	5	P-B	temp	st-str	alf	i	o-b	es	ate	e	5.5-9	1.3
Cyclotella meneghiniana Kützing	1	0	0	0	P-B	temp	st	alf	hl	o-a	sp	hne	e	5.5-9	2.8
Gomphonema parvulum (Kützing) Kützing	4	2	1	2	B	temp	str	ind	i	x	es	hne	e	4,5	2.3
Hantzschia amphilepta (Grunow) Lange-Bertalot	1	1	0	1	B	temp	st-str	neu	i	b-o	es	ate	o-e	-	1.9
Navicula exigua Gregory	0	0	1-3	2	B	-	str	alf	i	x-o	es	ats	e	-	1.4
Navicula microcephala Grunow	0	1	0	1	B	-	-	-	i	o	sx	-	-	-	
Navicula recens (Lange-Bertalot) Lange-Bertalot	0	3	2	0	P-B	-	-	alf	i	o-b	es	-	e	-	2.5
Navicula rhynchocephala Kützing	6	0	0	3	B	-	-	alf	hl	b	-	ate	o-e	6.5-9	1.3
Nitzschia dissipata	0	0	1	0	B	-	st-str	alf	i	x	sx	ate	me	6.55-7.85	1.7

(Kützing) Rabenhorst															
Nitzschia filiformis (W.Smith) Hustedt	0	0	1	0	B	-	st-str	alf	hl	x	es	hne	e	-	2.5
Nitzschia fonticola (Grunow) Grunow	0	2	1-3	3	B	-	st-str	alf	oh	o-b		ate	me	7.7-7.95	1.5
Nitzschia frustulum (Kützing) Grunow	6	3	3-4	2	B	temp	st-str	alf	hl	b	sp	hce	e	-	2.3
Nitzschia palea (Kützing) W.Smith	3	0	1	0	P-B	temp		ind	i	o-x	sp	hce	he	7-9	2.8
Nitzschia tryblionella Hantzsch	1	0	0	0	B	-	st-str	alf	hl	o		ate	e	-	2.6
Nitzschia umbonata (Ehrenberg) Lange-Bertalot	1	0	0	0	P	-	st-str	-	-	b-o	es	-	-	-	2.8
Nitzschia vermicularis (Kützing) Hantzsch	0	1	1	0	B	-	str	alf	i	o	-	-	o-e	-	2.2
Rhoicosphenia abbreviata (C.Agardh) Lange-Bertalot	4	2	2-3	3	P-B	-	st-str	alf	i	x-o	es	ate	e	6.7	1.9
Surirella ovalis Brébisson	0	0	1	0	P-B	-	st-str	alf	mh	o	es	ate	e	-	1.9
Tryblionella hungarica var. *linearis* (Grunow) M.Aboal	0	1	1	0	P-B	-	-	alf	mh	a-b	sp	ate	e	-	2.9
Ulnaria ulna (Nitzsch) P.Compère	1	6	5-6	5	P-B	temp	st-str	alf	i	b-o	es	ate	o-e	5-9.2	2.4
Euglenophyta															
Discoplastis spathirhyncha (Skuja) Triemer	1	0	0	0	P	-	st-str	-	i	a-p	-	-	-	-	2.7
Euglena texta (Dujardin) Hübner	1	0	0	0	P	eterm	st-str	ind	-	b	-	-	-	-	2.3
Miozoa															
Glenodinium pulvisculus (Ehrenberg) Stein	1	0	0	0	-	-	-	-	-	-	-	-	-	-	-
Chlorophyta															
Chlamydomonas sp.	0	0	2-5	2	-	-	-	-	-	-	-	-	-	-	-
Cladophora glomerata (Linnaeus) Kützing	6	0	2	6	P-B	-	st-str	alf	i	b-o	-	-	-	7.5-8.5	1.7
Cosmarium granatum Brébisson ex Ralfs	1	0	0	0	B	-	st-str	ind	i	o	-	-	me	-	1.2
Oedogonium sp.	6	0	1	0	-	-	-	-	-	-	-	-	-	-	-
Oocystis submarina Lagerheim	0	0	0	1	P-B	-	st	-	i	-	-	-	-	-	-
Scenedesmus apiculatus (West & G.S.West) Chodat	1	0	0	0	P	-	st-str	-	-	-	-	-	-	-	-
Scenedesmus obliquus (Turpin) Kützing	1	0	0	0	P-B	-	st-str	-	i	b	-	-	-	-	2.0
Scenedesmus obtusus Meyen	1	0	0	0	P-B	-	st-str	-	-	b	-	-	-	-	2.0
Scenedesmus parvus (G.M.Smith) Bourrelly	1	0	0	0	P-B	-	st-str	-	-	-	-	-	-	-	-
Charophyta															
Chara vulgaris L.	6	6	6	6	B	-	st-str	-	-	o	-	-	-	-	1.1
Spirogyra sp.	0	4	2	2	-	-	-	-	-	-	-	-	-	-	-
Zygnema sp.	0	0	1	0	-	-	-	-	-	-	-	-	-	-	-

Note: Substrate (Sub) – substrate preferences (P – planktonic, P-B – plankto-benthic, B – benthic); Temperature (T) – temperature preferences (temp – temperate, eterm – eurythermic); Oxygenation (Oxy) – streaming and oxygenation (st – standing water, str – streaming water, st-str – low streaming water); Salinity (Hal) – halobity degree on the [32] – (i – oligohalobes-indifferent, mh – mesohalobes, hl – halophiles; oh – undifferent oligihalobes); Acidity (pH) – pH degree on the [33] – (alf – alkaliphiles, ind – indifferents; neu – neutrophiles as a part of indifferents); Saprobity DAIpo (D) – degree of saprobity according Watanabe et al. [34] – (sx – saproxenes, es – eurysaprobes, sp – saprophiles); Autotrophy-Heterotrophy (Het) – nitrogen uptake metabolism [31] – (ats – nitrogen-autotrophic taxa, tolerating very small concentrations of organically bound nitrogen; ate – nitrogen-autotrophic taxa, tolerating elevated concentrations of organically bound nitrogen, hne – facultatively nitrogen-heterotrophic taxa, needing periodically elevated concentrations of organically bound nitrogen; hce – nitrogen-heterotrophic taxa, needing elevated concentrations of organically bound nitrogen); Trophy (Tro) – trophic state [31] – (o – oligotraphentic; o-m – oligo-mesotraphentic; e – eutraphentic; me – meso-eutraphentic; e – eutraphentic; he – hypereutraphentic); o-e – oligo- to eutraphentic (hypereutraphentic). Saprobity S (Sap) – degree of saprobity [35] – (x – xenosaprobes, x-o – xeno-oligosaprobes, o-x – oligo-xenosaprobes, o-a – oligo-alphamesosaprobes, o – oligosaprobes, a-b – alpha-netamesosaprobes, o-b – oligo-betamesosaprobes, b – betamesosaprobes, b-o – beta-oligosaprobes, b-p – beta-polysaprobes, a-p – alpha-polysaprobes); s – species-specific saprobity index [10].

3.3. Bio-Indication of the Ein El Balad Pools Environment

We use bio-indication methods on the base of algal species ecological preferences in purpose to characterize of the pools water quality in which *Chara vulgaris* is formed most massive biomass. Table 2 represent species abundance and ecology over sampling dates. Algal community can characterize Ein El Balad pools environment as a whole as temperate, low alkaline, with middle oxygenated fresh waters of moderate organic pollution. As can be seen in Table 2 and Fig. 10, algal species survived mostly as benthic forms, but plankto-benthic life still also presented. The pools water was Class of Water Quality II and III, and eutrophic status inhabited of community species of which are preferred autotrophic type of nutrition whereas mixotrophic species are also presents.

Calculated index of saprobity S according to Sládeček [17] was fluctuated in small range as an average from 1.75 to 1.92 (Table 3). That reflects of Water Quality Class II, which shows slightly clearer water than after our bio-indication results (Fig. 10). Bio-indication can help us to assess trophic stat of the pools (Table 2) and shows that they have an oligotrophic state. Lacoul & Freedman [36] are characterizing the major algal species *C. vulgaris* as oligotraphentic species which have species optimum in oligotrophic lakes environment that slightly different from our algal community bio-indication.

Because our estimates based on the ecological preferences of species and saprobic indices are slightly different, we calculated the index of the state of the ecosystem (WESI) in order to identify the cause of these differences. Table 3 show that WESI were below 1.0 which reflect low-toxic environment during all studied period. Significantly that lowermost WESI (0.33) was in the middle of rainy period when we revealed so many nitrates input to the pools water. In contrary, WESI increased (0.57) (the stress decreased) in the dry period when nitrates also decreased. It let us to assume that groundwater play important role in algal community functionality because brings some substances that suppressed algal community photosynthetic activity in the rainy period especially.

Therefore, bio-indication show that the Ein El Balad pools have mainly eutrophic state, and fresh low alkaline water with low to moderate organic pollution Class III of water quality.

Table3. *Biological variables in the Ein El Balad pools in 2011-2012*

No.	Pool	Date	No of Species	Index S	Class of Water Quality	WESI
1	Upper	9/8/2011	31±22.5	1.92±0.17	III	0.50±0.07
2	Upper	3/6/2012	14±9.5	1.90±0.11	III	0.57±0.07
3	Upper	13/03/2012	22±12.5	1.75±0.13	III	0.33±0.07
4	Lower	13/03/2012	20±11.5	1.75±0.13	III	0.44±0.07

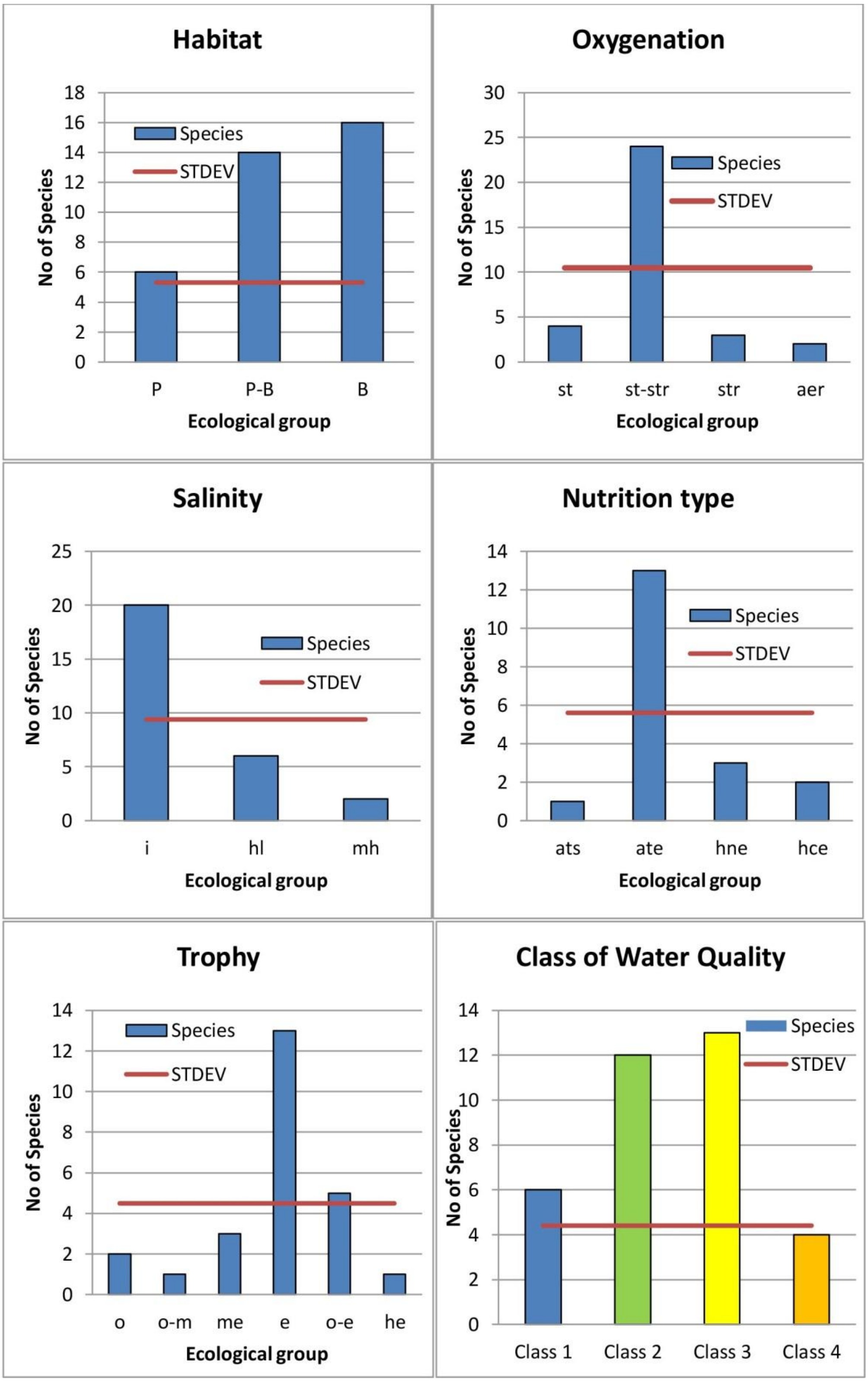

Fig.10. *Bio-indication plots of the Ein El Balad pools environment on the base of algal community. Ecological groups are arranged in order of parameter increasing, abbreviation given as in Table 2. Water Quality Classes indicators are under EU color standards.*

4. Conclusion

The Ein El Balad pools represent one of the rare aquatic communities on the territory of the Mount Carmel Biosphere reserve. We studied it in first time and revealed forty seven taxa of algae and cyanobacteria from six taxonomic Divisions with prevailing of diatoms in species richness and *Chara vulgaris* L. in biomass. Chemistry of water was stable enough in dry and wet periods as well as in both pools. The source of groundwater was organically enriched by nitrates, and assessed as Class V of Water Quality. In contrary, bio-indication results let us to assess the pools water as Class III on the base of species richness and abundance as well as Index saprobity S. In this case we implemented ecosystem state index WESI calculation and confirm that studied aquatic ecosystem of the Ein El Balad pools was under stress of photosynthetic activity that come with groundwater especially in rainy period. Index saprobity S as well as nitrates dynamic show that self-purification process in the pools is rather strong and can be seeing even from upper to lower pools in most impacted period. Nevertheless, the *Chara vulgaris* large biomass in both pools reflects that their aquatic communities have good condition in the protected object of the Mount Carmel Biosphere Reserve. In this case we recommended the Ein El Balad pools for including to the net of regularly monitoring of chemical and biological variables and watershed protection.

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