

Review

Update of “Biodiversity of the Hypersaline Urmia Lake National Park (NW Iran)”

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Abstract: Urmia Lake, an endorheic salt lake in northwestern Iran, was registered in the Ramsar Convention on Wetlands as a wetland of international importance, also a UNESCO biosphere reserve. In this review, we have updated our last checklist in 2014 with available information on the biodiversity of the lake.

Keywords: biodiversity; hypersalinity; Urmia Lake; national park

1. Background

Lake Urmia (37°42' N, 45°19' E) is one of the largest hypersaline lakes in the world and the habitat of a unique bisexual *Artemia urmiana* and some rare species (Figure 1). Our 2014 article in *diversity* entitle *Biodiversity of the hypersaline Urmia Lake National Park (NW Iran)* covered most of the reported species from this national park [1]. This paper updates and extends previous checklist for foraminifers, archaeobacteria and bacteria, microfungi, lichen, phytoplankton, nematodes, apicomplexa, flatworms, arthropods, birds, reptiles and several fossils. In the present update, we have included additional new information on the biodiversity of Urmia Lake which were not included in the previous article due to newly published articles and unavailability of old articles in the web. Urmia Lake has been subject to the drastic ecological and hydrological events which caused a rapid decline of population density of some of the valuable organisms such as brine shrimp *Artemia*. We believe that the current check list would enable us to deeply understand the rich biodiversity of Urmia Lake and subsequently design an integrated environmental guideline to protect living animals against environmental tensions.



Figure 1. Geographical localization of Urmia Lake in the northwestern of Iran.

2. Fossils from Paleozoic Limestone

Microscopical studies of limestone rocks from the island of Shazalan (Shah-saran) revealed remains of foraminifers, including *Endothyra bowmanni* (Endothyridae), *Valvulina bulloides* (Valvulinidae) and *Nodosaria radricula* (Nodosariidae) [2].

3. Archaeobacteria and Bacteria

Urmia Lake harbours a rich collection of archaeobacteria and bacteria. They play a major role in the food chain of Urmia Lake ecosystem. Table 1 includes the updated list of archaeobacterial and bacterial species in the water, soil and mud of Urmia Lake.

Table 1. List of archaeobacteria and bacteria from the National Park of Urmia Lake.

Domain	Phylum	Class	Order	Family	Genus	Species	Ref.
Archaea	Euryarchaeota	Halobacteria	Halobacteriales	Halobacteriaceae	<i>Haloterrigena</i>	sp. ¹	[3]
					<i>Halosiccatus</i>	<i>H. urmianus</i> ²	[4]
					<i>Halovarius</i>	<i>H. luteus</i> ³	[5]
Bacteria	Firmicutes	Bacilli	Bacillales	Bacillaceae Planococcaceae	<i>Ornithinibacillus</i> <i>Planomicrobium</i>	sp. ⁴ sp. ⁴	[6] [6]
	Proteobacteria	Gamma proteobacteria	Pseudomonadales	Moraxellaceae	<i>Psychrobacter</i>	sp. ⁴	[6]

¹ Locality: Shores of Bari, Golmankhaneh Port, Chichest, Rashakan, Kazem Dashi, Gholmankhaneh, Gamichi, Shahi peninsula, Western and Eastern coastlines of Urmia Lake Bridge; Salinity: 24.15%–28.4%; ² Locality: Has not been reported, Salinity: 32%; ³ Locality: Has not been reported, Salinity: Saturated; ⁴ Locality: Seven stations in the Eastern shores of Lake (localities had not been clearly explained); Salinity: 23%–32%.

4. Microfungi

Fungi are cosmopolitan eukaryotic organisms which have worldwide distribution, inhabiting diverse extreme ecotypes from deserts to hypersaline environments. The present update lists 20 species of hyphomycetes fungi explored in soils of the National Park of Urmia Lake (Table 2).

Table 2. List of microfungi harvested from soils of the National Park of Urmia Lake (localities: Kaboudan Island, Espir Island, Golmankhaneh Port, Mahabad Road) [7].

Division	Class	Order	Family	Genus	Species		
Ascomycota	Ascomycetes	Incertae sedis	Incertae sedis	<i>Sarocladium</i>	<i>S. strictum</i>		
		Capnodiales	Davidiellaceae	<i>Cladosporium</i>	<i>C. cladosporioides</i>		
	Dothideomycetes	Pleosporales	Pleosporaceae	<i>Alternaria</i>	<i>A. chlamydospora</i>		
					<i>A. rhizophorae</i>		
				<i>Bipolaris</i>	<i>B. prieskaensis</i>		
	Dothideomycetes	Pleosporales	Pleosporaceae	<i>Embellisia</i>	<i>E. chlamydospora</i>		
					<i>E. tellustris</i>		
				<i>Ulocladium</i>	<i>U. alternariae</i>		
		Eurotiomycetes	Eurotiales	Trichocomaceae	<i>Penicillium</i>	<i>P. expansum</i>	
		Leotiomycetes	Helotiales	Sclerotiniaceae	<i>Botrytis</i>	<i>B. cinerea</i>	
		Sordariomycetes	Hypocreales		<i>Acremonium</i>	<i>A. larvarum</i>	
						<i>A. potronii</i>	
					Hypocreaceae	<i>Acrostalagmus</i>	<i>A. luteoalbus</i>
						<i>Trichoderma</i>	<i>T. atroviride</i>
							<i>T. harzianum</i>
					Incertae sedis	<i>Trichothecium</i>	<i>T. roseum</i>
					Nectriaceae	<i>Fusarium</i>	<i>F. tricinctum</i>
		Stachybotryaceae	<i>Stachybotrys</i>	<i>S. chartarum</i>			
		Incertae sedis	Apiosporaceae	<i>Arthrinium</i>	<i>A. phaeospermum</i>		
		Sordariales	Chaetomiaceae	<i>Chaetomium</i>	<i>C. truncatulum</i>		

5. Lichen

Lichens are composite, symbiotic organisms made up from members of algae or cyanobacteria (or both) living among filaments of a fungus. *Caloplaca ferrugineoides* is a single lichen identified from Urmia Lake National Park (Table 3).

Table 3. List of lichen from the National Park of Urmia Lake (localities: Rahmanloo and Saraydeh) [8].

Phylum	Class	Order	Family	Genus	Species
Ascomycota	Lecanoromycetes	Teloschistales	Teloschistaceae	<i>Caloplaca</i>	<i>C. ferrugineoides</i>

6. Phytoplankton

The main algal flora of Urmia Lake has been listed in our previous checklist in 2014 [1]. Urmia Lake contains a diverse assemblage of phytoplankton, with *Dunaliella* as the dominant alga. It is a green halophilic alga which produces high amounts of β -carotene. This phytoplankton is the major food source for *Artemia* in the Urmia Lake [1]. Recently, four species of *Dunaliella* have been identified using 18S rDNA gene [9]. A current list of *Dunaliella* species in Urmia Lake is given in Table 4.

Table 4. List of phytoplankton from the National Park of Urmia Lake (localities: Western and Eastern coastlines of Urmia Lake Bridge and Gamichi; Salinity: 32.2%–38%) [9].

Phylum	Class	Order	Family	Genus	Species
Chlorophyta	Chlorophyceae	Volvocales	Dunaliellaceae	<i>Dunaliella</i>	<i>D. bardawil</i>
					<i>D. parva</i>
					<i>D. salina</i>
					<i>D. tertiolecta</i>

7. Parasites

The knowledge of parasitic infections in wildlife is necessary for management of protected areas and national parks. Table 5 documents the checklist of parasites of pelicans, wild sheep and yellow deer in the Urmia Lake National Park.

Table 5. List of reported parasites at pelicans and some mammals from the National Park of Urmia Lake.

Phylum	Class	Order	Family	Genus	Species	Host	Locality	Ref.				
Arthropoda	Insecta	Phthiraptera	Menoponidae	<i>Piagetiella</i>	<i>P. titan</i>	pelicans ¹	Nine Islands	[10]				
Apicomplexa	Conoidasida	Eucoccidiorida	Eimeriidae	<i>Eimeria</i>	<i>E. ahsata</i>	wild sheep ²	Kaboudan Island	[11]				
					<i>E. faurei</i>	wild sheep	Kaboudan Island	[11]				
					<i>E. ovinoidalis</i>	wild sheep	Kaboudan Island	[11]				
					<i>E. parva</i>	wild sheep	Kaboudan Island	[11]				
Nematoda	Adenophorea	Trichurida	Trichuridae	<i>Trichuris</i>	spp.	yellow deer ³	Ashk Island	[12]				
					<i>T. discolor</i>	wild sheep	Kaboudan Island	[13]				
					<i>T. georgicus</i>	wild sheep	Kaboudan Island	[13]				
					<i>T. infundibulus</i>	wild sheep	Kaboudan Island	[13]				
					<i>T. ovis</i>	wild sheep	Kaboudan Island	[13]				
					<i>T. skrjabini</i>	wild sheep	Kaboudan Island	[13]				
					<i>T. vondwei</i>	wild sheep	Kaboudan Island	[13]				
Nematoda	Chromadorea	Rhabditida	Molineidae	<i>Nematodirus</i>	<i>N. archari</i> spp.	wild sheep yellow deer	Kaboudan Island Ashk Island	[13] [12]				
			Trichostrongylidae	<i>Ostertagia</i>	<i>O. lyrata</i>	wild sheep	Kaboudan Island	[13]				
					<i>O. ostertagi</i>	wild sheep	Kaboudan Island	[13]				
					<i>O. trifurcata</i>	wild sheep	Kaboudan Island	[13]				
			Nematoda	Secernentea	Strongylida	Ascaridida	Toxocaridae	<i>Toxocara</i>	<i>T. vitulorum</i>	yellow deer	Ashk Island	[12]
						Dictyocaulidae	<i>Dictyocaulus</i>	<i>D. filaria</i>	wild sheep	Kaboudan Island	[14]	
									Protostrongylidae	<i>Muellerius</i> <i>Protostrongylus</i>	spp. <i>P. rufescens</i>	wild sheep wild sheep
Trichostrongylidae	<i>Marshallagia</i>	<i>M. marshalli</i>							wild sheep	Kaboudan Island	[13]	
Platyhelminthes	Cestoda	Cyclophyllidea	Anoplocephalidae	<i>Moniezia</i>	<i>M. benedeni</i>	wild sheep	Kaboudan Island	[13]				
			Taeniidae	<i>Echinococcus</i>	<i>E. granulosus</i>	wild sheep	Kaboudan Island	[14]				
Platyhelminthes	Cestoda	Cyclophyllidea	Taeniidae	<i>Taenia</i>	<i>T. hydatigena</i>	wild sheep	Kaboudan Island	[14]				

¹ *Pelecanus onocrotalus*; ² *Ovis orientalis* Gmilini; ³ *Dama dama mesopotamica*.

8. Insects

A list of uncommon species of insects from surrounding areas of Urmia Lake is presented in Table 6.

Table 6. List of insects in the Western part of National Park of Urmia Lake.

Class	Order	Family	Genus	Species	Ref.			
Insecta	Diptera	Tachinidae	<i>Lespesia</i>	<i>L. frenchii</i> ¹	[15]			
			<i>Nilea</i>	<i>N. anatolica</i>	[16]			
			<i>Bithia</i>	<i>B. glirina</i>	[15]			
	Hemiptera	Reduviidae	<i>Rhynocoris</i>	<i>R. persicus</i>	[17]			
	Hymenoptera	Braconidae	Cotesia	<i>Cotesia</i>	<i>C. ofella</i>	[18]		
					<i>C. vanessae</i>	[18]		
					<i>P. saltans</i>	[19]		
	Lepidoptera	Sesiidae	Chamaesphecia	<i>Chamaesphecia</i>	<i>C. schizoceriformis</i>	[15]		
					Noctuidae	<i>Simyra</i>	<i>S. dentinosa</i>	[20]
					Sphingidae	<i>Hyles</i>	<i>H. euphorbiae</i>	[21]
	Orthoptera	Pamphagidae	<i>Iranotmethis</i>	<i>I. persa</i>	[22]			

¹ Synonym with *Masicera sphingivora*.

9. Crustacea

Temporary aquatic micro-ecosystems i.e. ponds and lagoons, around Urmia Lake provide special habitats for crustaceans. The biodiversity of crustacean is documented in Table 7.

Table 7. List of crustaceans from the National Park of Urmia Lake.

Sub-Phylum	Class	Order	Family	Genus	Species	Ref.
Crustacea	Branchiopoda	Anostraca	Branchinectidae	<i>Branchinecta</i>	<i>B. orientalis</i> ¹	[23]
			Thamnocephalidae	<i>Phallocryptus</i>	<i>P. spinosal</i> ²	[23]
		Notostraca	Triopsidae	<i>Triops</i>	<i>T. cancriformis</i> ³	[23,24]

¹ Locality: Rashakan region; Salinity: 0.1%; ² Locality: Zambil and Chichest regions; Salinity: 1.7%–2%; ³ Locality: The lagoon near the Southern part of Urmia Lake/Rashakan region; Salinity: 0.1%.

10. Reptiles

The surrounding regions of Urmia Lake harbour several species of reptiles. Their communities might be faced with a possible threat of extinction due to unsuitable ecological conditions in Urmia Lake. Special care should be taken to maintain these species at the lake [1]. Table 8 shows the updated list of reptiles in surrounding regions of Urmia Lake National Park.

Table 8. List of reptiles from the National Park of Urmia Lake.

Class	Order	Family	Genus	Species *	Ref.
Reptilia	Squamata	Agamidae	<i>Phrynocephalus</i>	<i>P. belioscopus</i>	[25]
			<i>Darevskia</i>	<i>D. raddei</i>	[26]
		Lacertidae	<i>Eremias</i>	<i>E. pleskei</i>	[25]
				<i>E. velox</i>	[25]
			<i>Lacerta</i>	<i>L. brandti</i>	[25]
				<i>L. strigata</i>	[25]
		<i>L. trilineata</i>	[25]		

* Note: There are no specific localities have been reported for those species.

11. Mid-winter Birds

Our comprehensive bird checklist of Urmia Lake consists of resident breeding species and winter visitors [1]. Table 9 shows new members of mid-winter birds from the National Park of Urmia Lake

Table 9. List of mid-winter birds from the National Park of Urmia Lake [27].

Class	Order	Family	Genus	Species *
Aves	Anseriformes	Anatidae	<i>Branta</i>	<i>B. ruficollis</i>
			<i>Mergus</i>	<i>M. serrator</i>
	Charadriiformes	Scolopacidae	<i>Limosa</i>	<i>L. lapponica</i>
	Gruiformes	Gruidae	<i>Grus</i>	<i>G. virgo</i>
	Pelecaniformes	Ardeidae	<i>Bubulcus</i>	<i>B. ibis</i>

* Note: There are no specific localities have been reported for those species.

12. Fossils

The first and only scientific study of fossils of Urmia Lake goes back to collected samples by Robert T. Gunther (1869–1940) in the late nineteenth century. The list of fossils species from Urmia Lake is presented in Table 10.

Table 10. List of fossils from the National Park of Urmia Lake.

Phylum	Class	Order	Family	Genus	Species	Ref.			
Bryozoa	Gymnolaemata	Cheilostomata	Membraniporidae	<i>Membranipora</i>	<i>M. fenestrata</i> ¹	[28]			
		Cheilostomatida	Celleporidae	<i>Cellepora</i>	<i>C. gracilis</i> ¹	[28]			
	Stenolaemata	Cyclostomata	Cavidae	<i>Polytrema</i> (<i>Ripisoecia</i>)	<i>P. spongiosa</i> ¹	[28]			
			Diastoporidae	<i>Diastopora</i>	<i>D. gemmifera</i> ¹	[28]			
			Cerioporidae	<i>Ceriopora</i>	<i>C. anomala</i> ¹	[28]			
Cnidaria	Anthozoa	Scleractinia	Faviidae	<i>Astrea</i>	<i>A. defrancei</i> ¹	[28]			
				<i>A. ellisiana</i> ¹	[28]				
				<i>A. guettardi</i> ¹	[28]				
				<i>Solenastrea</i>	<i>S. turonensis</i> ²	[29]			
				<i>Thamnaraea</i> (<i>Dendraraea</i>)	<i>T. polymorpha</i> ²	[29]			
			Clypeasteroidea	Clypeasteridae	<i>Clypeaster</i>	Phyllocoeniidae	<i>Phyllocoenia</i>	<i>P. archiaci</i> ²	[28,29]
						Poritidae	<i>Porites</i>	<i>P. dendroidea</i> ¹	[28]
						<i>P. leiophylla</i> ¹	[29]		
						Echinolampadidae	<i>Echinolampas</i>	<i>E. complanatus</i> ¹	[28]
						<i>C. aff. Imperialis</i> ³	[30]		
Clypeasteroidea	Clypeasteridae	<i>Clypeaster</i>	<i>C. altus</i> ¹	[28]					
			<i>C. crassicostatus</i> ¹	[28]					
			<i>C. guentheri</i> ³	[30]					
				<i>C. martini</i> ³	[30]				

Table 10. Cont.

Phylum	Class	Order	Family	Genus	Species	Ref.		
Mollusca	Bivalvia	Carditoida	Carditidae	<i>Cardita</i>	<i>C. martini</i> ³	[30]		
					sp. ¹	[28]		
					<i>O. virleti</i> ¹	[28]		
		Ostreoida	Ostreidae	<i>Ostrea</i>	<i>O. excavate</i> ¹	[28]		
					<i>O. lamellose</i> ¹	[28]		
					<i>O. pseudodigitalina</i> ¹	[28]		
					<i>Chlamys</i>	<i>C. malvinae</i> ¹	[28]	
					<i>P. benedictus</i> ¹	[28]		
			Pectinidae	<i>Pecten</i>	<i>P. burdigalensis</i> ¹	[28]		
					<i>P. convexo-costatus</i> ¹	[28]		
					<i>P. flabelliformis</i> ¹	[28]		
					<i>P. simplex</i> ¹	[28]		
					<i>P. suburmiensis</i> ¹	[28]		
		Veneroida	Veneridae	<i>Meretrix</i>	sp. ¹	[28]		
					<i>Spondylus</i>	<i>S. bifrons</i> ¹	[28]	
					<i>M. incrassate</i> ¹	[28]		
					<i>M. persiensis</i> ¹	[28]		
		Cephalopoda	Ammonitida	Perisphinctidae	<i>Perisphinctes</i>	<i>Venus</i>	<i>V. aglaurae</i> ¹	[28]
						<i>P. curvicosta</i> ¹	[31]	
	Gastropoda	Archaeogastropoda	Haliotidae	<i>Haliotis</i>	<i>H. philberti</i> ¹	[28]		
					Cassidae	<i>Cassis</i>	sp. ¹	[28]
					Ficidae	<i>Pyrula</i>	<i>P. cingulate</i> ¹	[28]
		Mesogastropoda	Strombidae	<i>Strombus</i>	<i>S. bonelli</i> ¹	[28]		
<i>T. archimedis</i> ¹					[28]			
<i>T. gradate</i> ¹					[28]			
<i>T. rotifer</i> ¹					[28]			
Neogastropoda		Conidae	<i>Conus</i>	sp. ¹	[28]			
				Fascioliariidae	<i>Latrius</i>	<i>L. crispus</i> ¹	[28]	

¹ There are no specific localities had been reported for those species; ² Island of Koyun Daghi (Kaboudan);

³ Guvarchin Kala, at the extreme Northern end of Urmia Lake.

The extended and updated list further highlights the high biodiversity of Urmia Lake and surrounding areas. Unfortunately, the desertification and loss of water in Urmia Lake has continued [32] which will further endanger the unique ecosystem and its biodiversity. Urgent measures are required to stop this development.

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