Seasonal and Interannual Dynamics of Zooplankton from Lake Kulundinskoye in 2017–2020

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Abstract. The paper presents the findings of studying the influence of main natural environmental factors on interannual (2017–2020) and seasonal (from April to October) dynamics of zooplankton from large hypergaline lake Kulundinskoye located in the Kulunda steppe (Altai Krai, Russia). We studied the relationship of 16 key indicators of zooplankton structure (its abundance and biomass as a whole and in major taxonomic groups, i.e. rotifers, paddleheads, branchipeds and gill-footed crustaceans as well as individual stages of a life cycle and a sex ratio in Artemia population) with 17 hydrophysical and hydrochemical indicators (temperature, density, pH, total salinity, hardness, alkalinity, Cl^-, NO_2^-, NO_3^-, SO_4^{2-}, PO_4^{3-}, NH_4^+, Fe_2^{3+}, Ca^{2+}, Mg^{2+}, $K^+ + Na^+$, permanganate oxidizability). The influence of the studied factors on features of Artemia crustacean population (abundance, biomass, age and sex structure) dominated in zooplankton of this lake was analyzed as well. In different years, hydrophysical and hydrochemical regime of lake Kulundinskoye may vary significantly thus affecting zooplankton indicators. The revealed changes in zooplankton structure are mainly due to the stimulating effect of increased salinity on Artemia population and its depressing influence on other taxa.

Keywords: Zooplankton · Environmental factors · Limnology · Hydrochemistry · Salinity · Brine shrimp · Population · Kulunda

1 Introduction

Lake Kulundinskoye – the largest water body of the Kulunda Plain and Altai Krai, is situated in the south of Western Siberia in the closed Ob-Irtysh interfluve. Its water area in different years and seasons varies from 720 to 728 km^2; the average depth makes up 2.6–3.0 m, the maximum one reaches 3.5–4.0 m. The lake basin is rounded and slightly elongated of about 35 km long; the banks (in places, with salonetz-salonchak complexes) are flat. The lake is drainless with inflowing Rivers Kulunda and Suetka. The water is bitterly salty; its salinity is within 40–131 g/l [1]. Note that Roshydromet

A. Beskopylny et al. (Eds.): INTERAGROMASH 2022, LNNS 575, pp. 189–198, 2023.
https://doi.org/10.1007/978-3-031-21219-2_19

does not implement any hydrological, hydrochemical and hydrobiological observations of the lake.

Similar to some other hypergaline water bodies in this region, lake Kulundinskoye is of economic significance due to intensive extraction of aquatic biological resources, i.e. Artemia gill-footed crustacean cysts used as a starter feedstuff in aquaculture and valuable raw materials for cosmetic and pharmaceutical production [2–4]. However, Artemia productivity and biological resources extraction in the region under study are changeable and hardly predictable.

According to S.V. Gerd biolimnological zoning, the reservoirs of the Kulunda Plain belong to the Barabinsk-Kulunda lake district. A distinctive feature of lakes of this region is shallow basin depth and increased water salinity. Their ecosystems are subject to cyclic successions [5, 6] because climate in the south of Western Siberia is characterized by alternating dry and wet periods with significant fluctuations in water levels and the area of drainless lakes. Strong fluctuations in water levels lead to pronounced changes in hydrochemical and hydrobiological regime of lakes [7, 8].

In a number of works devoted to various invertebrate communities of hypergaline reservoirs, it is noted that the species composition and diversity of zooplankton, abundance, population structure and productivity change under the influence of environmental conditions [9]. In the work of Danni Yuan [10] it is noted that the number and diversity of zooplankton species in the Pearl River estuary decreased as increasing salinity from 0.10 to 21.26 g/l. With increasing salinity, the abundances of rotifers, cladocerans and total zooplankton decreased, while the effect of salinity on the abundances of copepods was minimal. According to María Belén Alfonso et al. [11], the inflow of fresh water into the shallow salt lake La Salado (Argentina) led to an increase in plankton biomass and shaped its composition. Maria Florência Gutierrez et al. [12] in 24 lakes covering a wide salinity gradient (from 0.5 to 115 g l^{-1}) in a semiarid region in northwest China, it was found that that species richness, species diversity, functional diversity, biomass, and size of zooplankton decrease with increasing salinity.

The component, chemical and salt of water is an important hydrochemical characteristic of a salt water body. It plays an important role in shaping the conditions for the ecosystem functioning [13]. Aquatic communities promptly respond to changes in environmental factors affecting lakes; their response time depends on the duration of life cycle of the species [14–16]. For planktonic invertebrates from the south of the West Siberian Plain, life cycles usually last from a few days to several months. Despite rather long investigations of zooplankton from lake Kulundinskoye, the dependences of its dynamics on environmental factors were previously studied mainly in the phenomenological aspect. Our goal was to study the composition, structure and dynamics of zooplankton of lake Kulundinskoye influenced by natural factors using up-to-date computer-based statistics programs.

2 Materials and Methods

The paper deals with analyzing field data obtained during the complex limnological and hydrobiological investigations of lake Kulundinskoye in 2017–2020 data. During this period, samples were collected monthly at the same 48 sampling stations (Fig. 1).

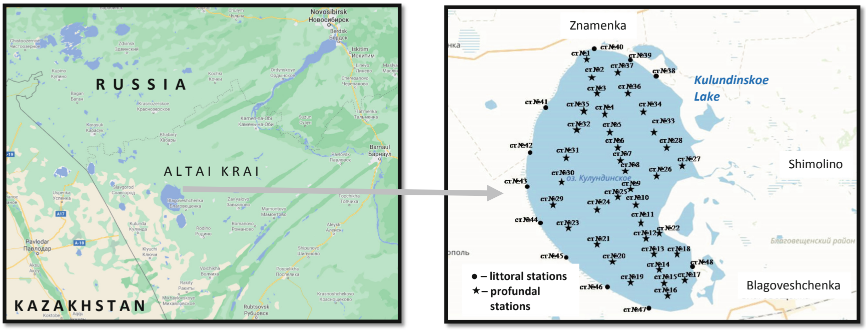

Fig. 1. The schematic map of location of lake Kulundinskoye and sampling stations (No. 1–48)

The selection and processing of zooplankton samples were implemented by means of standard hydrobiological methods. Samples were taken monthly in the period from April (or May) to October using a small Apstein plankton net (with a mesh size of 64 microns), fixed with formalin (up to 4%) and processed using a Bogorov camera and an MBS-10 stereomicroscope. For taxonomic determination, we consulted a number of manuals.

For statistical processing of the obtained data, we used MS Excel-2017 and Statistica 10 software packages. Since the data generally had a normal distribution, the Pearson linear correlation coefficient matrices were constructed to identify the impact of natural factors on zooplankton.

3 Results and Discussion

3.1 Key Parameters of Hydrochemical Regime

Water temperature in the surface layer of lake Kulundinskoye in May 2020 was rather high – 15.0 °C. In summer (July), it reached 29.4 °C and by October fell to 6.4 °C. Similar seasonal dynamics was typical for the average long-term data [1], except for summer temperatures of 2020, which were higher by 3.0–5.0 °C than the average long-term ones.

According to different classification, by salinity, Kulundinskoye refers to a saline/brine lakes, ore hyperhaline lakes. In 2020, water salinity of lake ranged from 87.0 to 94.2 g/l. From long-term observations (2017–2020), it was within 32.0–126.8 g/l (Table 1). An increase in salt concentrations in brine was marked by the end of the growing season. As for main ion composition, the lake water was chloride-sulfate of the sodium group, by pH – slightly alkaline (7.8 to 8.8). The concentration of nitrites ($\leq$0.04 mg/l), nitrates ($\leq$24 mg/l) and phosphates ($\leq$0.7 mg/l) was low, whereas the content of ammonium ions ($\leq$13 mg/l) – increased, and in 2017 they significantly exceeded the MPC Russian standard (0.05 mg/l) for fishery reservoirs. Over the long research period, dissolved oxygen in different months varied as 3.3–13.6 mg/l. Its minimum was recorded in October and the maximum – in April. The permanganate oxidizability of water ranged from 65.6 (in July) to 103.6 mgO_2/l (in April) showing the increased content of organic substances in the water.

3.2 Key Parameters of Zooplankton

Zooplankton of lake Kulundinskoye was represented by 9 species: Rotifera (6), Cladocera (1), Copepoda (2) and Anostraca (1). All detected species are either halobionts (Artemia sp., Cletocamptus retrogressus Schmankevitsch, Brachionus plicatilis (O.F. Müller) or euryhalines (Asplanchna priodonta Gosse, Keratella cochlearis Gosse, K. quadrata (O.F. Müller), Hearthra ohuigis (Zernov), Polyarthra dolichoptera Idelson, Moina macrocopa (Straus)).

We cannot but touch upon the problem of taxonomic identification of Artemia crustacean. According to modern taxonomy, Artemia from the lakes of Western Siberia belongs to the order Anostraca, the family Artemiidae and the genus Artemia Leach, 1819. The specific name of the crustacean (Artemia salina Linnaeus, 1758) is recognized as taxonomically invalid. Six species have been described for bisexual races (consisting of males and females), and populations consisting of only females are conventionally designated as Artemia parthenogenetica. The identification of these species is still incomplete. In this paper, we designate it as Artemia sp. [14, 16].

With increasing water salinity, the number of species decreases, the role of Artemia in the community grows and the share of brackish-water species in the total biomass falls (Table 2). In lake Kulundinskoye, brine salinity of 95–100 g/l is, probably, a barrier to the development of all accompanying Artemia species (Table 3). In 2017–2020, water desalination during the regression phase of water content brought to the loss of a dominant position of this species in the community, as it was noted previously during the periods of high water salinity (105–140 g/l) [1]. In the last four years, the economic significance of the lake decreased because of the lack of bio-raw materials, i.e. commercial accumulations of Artemia cysts.

3.3 Assessment of Natural Factors Effect on Zooplankton Structure

We studied the relationship of 16 key indicators of zooplankton structure (its abundance and biomass as a whole and in major taxonomic groups, i.e. rotifers, paddleheads, branchipeds and gill-footed crustaceans as well as individual stages of a life cycle and a sex ratio in Artemia population) with 17 hydrophysical and hydrochemical indicators (temperature, density, pH, total salinity, hardness, alkalinity, Cl^-, $NO_2{}^-$, $NO_3{}^-$, $SO_4{}^{2-}$, $PO_4{}^{3-}$, $NH_4{}^+$, $Fe_2{}^{3+}$, $Ca_2{}^+$, $Mg_2{}^+$, $K^+ + Na^+$, monthly permanganate oxidizability (2017–2020).

The correlation analysis of monthly values of hydrochemical and hydrobiological indicators (2017–2020) was found to be informative. A total of 22 pairs of reliable (significance level $p < 0.05$ and $p < 0.01$) medium and strong correlations (Pearson correlation coefficient $r = 0.49–0.82$) between the analyzed indicators were revealed (Table 4). Almost half of them were associated with Artemia abundance and at certain stages of its life cycle (naupliuses and cysts). Their abundance positively correlated with water salinity, related concentrations of main salt ions (Cl^- and $SO_4{}^{2-}$) and nitrate ions as well. At the same time, abundance of brackish-water and euryhaline taxa (rotifers and copepods) negatively correlated with water salinity.

Table 1. The main abiotic factors of Kulundinskoe lake (2017–2020).

Year	Month	Temperature of the surface layer of water, ^{o}C (M ± m)	Water transparency, m (M ± m)	Salinity of water, g/l (M ± m)	pH (M ± m)
2017	IV	8.0 ± 0.9	1.3 ± 0.02	126.8 ± 32.18	8.6 ± 0.52
	V	12.0 ± 1.3	0.9 ± 0.24	99.6 ± 3.75	8.9 ± 0.46
	VI	24.0 ± 0.8	0.9 ± 0.18	87.1 ± 2.86	8.5 ± 0.90
	VII	20.8 ± 1.3	0.9 ± 0.09	65.6 ± 1.96	8.7 ± 0.53
	VII	19.4 ± 0.8	0.9 ± 0.12	80.2 ± 2.62	8.9 ± 0.48
	IX	14.8 ± 1.2	0.9 ± 0.68	69.3 ± 3.53	8.8 ± 0.46
	X	6.0 ± 0.9	1.1 ± 0.26	79.9 ± 2.09	8.6 ± 0.51
2018	IV	7.1 ± 0.6	0.5 ± 0.03	93.0 ± 2.54	8.6 ± 0.32
	V	9.1 ± 0.4	0.3 ± 0.01	85.0 ± 0.94	8.9 ± 0.39
	VI	21.0 ± 1.2	0.5 ± 0.02	80.0 ± 1.42	8.8 ± 0.44
	VII	23.6 ± 1,4	0.4 ± 0.22	75.1 ± 1.99	8.6 ± 0.50
	VIII	18.0 ± 0,9	0.6 ± 0.82	76.8 ± 2.05	8.6 ± 0.29
	IX	11.9 ± 0.6	0.6 ± 0.74	83.4 ± 1.16	8.6 ± 0.32
	X	5.5 ± 0.7	0.8 ± 0.68	83.0 ± 1.12	8.6 ± 0.34
2019	IV	0.1 ± 0.01	1.0 ± 0.06	32.0 ± 0.86	8.3 ± 0.80
	V	15.0 ± 1.3	0.1 ± 0.002	71.9 ± 1.06	8.7 ± 0.42
	VI	19.2 ± 0.8	0.4 ± 0.05	59.3 ± 0.73	8.7 ± 0.40
	VII	22.8 ± 0.8	0.7 ± 0.48	82.0 ± 1.28	8.6 ± 0.34
	VIII	28.1 ± 0.9	0.7 ± 0.36	86.7 ± 0.62	8.6 ± 0.32
	IX	13.8 ± 1.0	0.5 ± 0.03	76.0 ± 1.14	8.7 ± 0.39
	X	8.3 ± 0.8	0.4 ± 0.01	88.6 ± 0.98	8.7 ± 0.38
2020	V	15.0 ± 1.2	0.3 ± 0.01	74.0 ± 1.16	8.3 ± 0.78
	VI	24.8 ± 0.8	0.5 ± 0.02	82.3 ± 1.20	8.5 ± 0.64
	VII	29.4 ± 0.9	0.6 ± 0.04	85.9 ± 0.74	7.8 ± 0.80
	VIII	25.6 ± 0.8	0.5 ± 0.09	88.4 ± 1.06	8.6 ± 0.36
	IX	18.5 ± 1.3	0.8 ± 0.04	89.2 ± 1.18	8.8 ± 0.42
	X	6.4 ± 0.7	0.9 ± 0.52	94.2 ± 0.21	8.4 ± 0.30

Obviously, among reliably identified correlation coefficients there are both true dependences of hydrobiological characteristics on hydrochemical factors (e.g. abundance of different taxa of hydrobionts on water salinity) and indirect ones, which depend on the concentration of individual basic ions, which is closely related to the total salinity.

Table 2. Seasonal and inter-annual dynamics of zooplankthon in lake Kulundinskoe (2017–2020).

Month	Abundance, thousands ind./m^3				Biomass, g/m^3			
	Rotifera	Cladocera	Copepoda	Artemia	Rotifera	Cladocera	Copepoda	Artemia
2017								
IV	0	0	0	980 ± 195	0	0	0	167 ± 33.2
V	0	0	0	112 ± 19.0	0	0	0	15.1 ± 2.39
VI	0	0	0	23.0 ± 4.48	0	0	0	13.6 ± 3.66
VII	0	0	0.40 ± 0.32	37.8 ± 4.10	0	0	0.012 ± 0.009	22.3 ± 2.87
VII	0	0	21.02 ± 5.12	5.81 ± 1.13	0	0	0.630 ± 0.150	3.45 ± 0.78
IX	0	0	0.87 ± 0.20	2.12 ± 0.43	0	0	0.026 ± 0.014	1.25 ± 0.27
X	0.17 ± 0.01	0	0.38 ± 0.02	0.07 ± 0.01	0.0003 ± 0.0001	0	0.011 ± 0.002	0.03 ± 0.005
2018								
IV	0	0.006 ± 0.006	2.10 ± 1.58	40.6 ± 11.3	0	0.0003 ± 0.0001	0.07 ± 0.06	6.91 ± 1.93
V	0	0	12.9 ± 6.05	66.0 ± 14.9	0	0	0.71 ± 0.21	5.94 ± 1.34
VI	47.3 ± 17.6	0	15.89 ± 5.93	15.7 ± 5.32	0.19 ± 0.71	0	0.56 ± 0.19	9.28 ± 3.14
VII	373 ± 86.0	93.6 ± 25.8	8.40 ± 2.40	1.10 ± 0.47	1.49 ± 0.34	5.06 ± 1.16	0.29 ± 0.08	0.18 ± 0.08
VIII	384 ± 61.5	86.4 ± 18.8	43.0 ± 24.3	3.21 ± 1.79	1.53 ± 0.25	4.67 ± 1.01	1.51 ± 0.86	1.89 ± 1.06
IX	154.9 ± 25.6	2.92 ± 1.44	16.40 ± 5.19	1.00 ± 0.29	0.62 ± 0.10	0.16 ± 0.07	0.49 ± 0.18	0.59 ± 0.17
X	102 ± 20.3	0.01 ± 0.005	16.3 ± 3.84	0.45 ± 0.22	0.41 ± 0.08	0.001 ± 0.0003	0.57 ± 0.13	0.27 ± 0.13
2019								
IV	0.12 ± 0.06	0.06 ± 0.05	13.9 ± 5.04	0.19 ± 0.07	0.001 ± 0.0002	0.003 ± 0.002	48.47 ± 2.72	3.23 ± 0.01
V	65.7 ± 13.8	0	143.4 ± 42.8	16.1 ± 4.55	0.26 ± 0.06	0	5.02 ± 1.51	2.58 ± 0.73
VI	124 ± 32.5	0.09 ± 0.07	41.2 ± 6.12	18.3 ± 4.85	0.49 ± 0.13	0.005 ± 0.003	1.44 ± 0.21	10.8 ± 2.86
VII	205 ± 19.2	84.4 ± 16.7	29.34 ± 9.59	33.97 ± 7.37	0.82 ± 0.08	4.59 ± 0.92	1.03 ± 0.34	20.0 ± 4.35
VIII	97.7 ± 12.5	430 ± 10.6	0.64 ± 0.12	2.76 ± 0.67	0.39 ± 0.05	1.93 ± 0.48	0.02 ± 0.007	1.63 ± 0.41
IX	236 ± 30.6	12.9 ± 1.95	10.5 ± 3.85	14,1 ± 4.33	0.95 ± 0.12	0.58 ± 0.17	0.37 ± 0.13	8.33 ± 2.55
X	153 ± 24.3	0	1.47 ± 0.51	4.41 ± 0.67	0.61 ± 0.11	0	0.05 ± 0.02	2.60 ± 0.41
2020								
VI	36.2 ± 11.3	6.49 ± 1.72	35.3 ± 6.21	9.01 ± 1.53	0.14 ± 0.001	0.29 ± 0.08	1.24 ± 0.19	5.31 ± 0.90
VII	42.6 ± 2.05	35.3 ± 6.24	14.3 ± 2.68	19.9 ± 5.39	0.17 ± 0.01	1.59 ± 0.28	0.51 ± 0.09	11.7 ± 3.18
VIII	1820 ± 1350	3.54 ± 0.41	14.7 ± 1.89	4.34 ± 0.97	7.29 ± 5.41	0.16 ± 0.02	0.51 ± 0.07	2.56 ± 0.57
IX	180 ± 15.02	0.12 ± 0.07	10.52 ± 1.92	1.86 ± 0.35	0.72 ± 0.06	0.01 ± 0.003	0.37 ± 0.07	1.10 ± 0.21
X	680 ± 53.4	0	89.2 ± 54.2	0.06 ± 0.03	2.72 ± 0.21	0	3.12 ± 1.90	0.35 ± 0.01

Regularities of changes of species number of plankton and benthos along with increase of water mineralization were studied in Canada, Africa, Australia and Russian (Crimean peninsula) [17–21]. The level of water mineralization significantly affects the composition, structure, and abundance of lake biocenoses [22–25]. This is true about the lakes situated at south of the Ob-Irtysh interfluve. These data confirm the regularities about the influence of water salinity on zooplankton, which we identified on the Kulundinskoe lake.

4 Conclusions

Lake Kulundinskoye is a hypergalinic reservoir with predominance of gill-footed crustacean Artemia in zooplankton structure. In different years, hydrophysical, hydrochemical and hydrobiological regime of the lake undergoes significant changes that affects its

Table 3. Seasonal and inter-annual dynamics of *Artemia* (thousands ind./m^3) in lake Kulundinskoe (2017–2020).

Year	Month	Nauplia	Juvenile	Subadults	Adults	Cysts
2017	IV	980 ± 19.5	0	0	0	850 ± 347
	V	86.4 ± 12.6	7.65 ± 2.22	0.19 ± 0.10	0	267 ± 40.9
	VI	5.93 ± 1.98	2.35 ± 0.48	14.6 ± 3.71	0.15 ± 0.03	129 ± 23.6
	VII	22.3 ± 2.83	12.5 ± 1.57	2.31 ± 0.38	0.92 ± 0.10	647 ± 106
	VII	1.89 ± 0.53	2.48 ± 0.61	0.39 ± 0.05	1.08 ± 0.13	336 ± 52.9
	IX	1.76 ± 0.41	0.09 ± 0.02	0.06 ± 0.01	0.21 ± 0.02	432. ± 64.1
	X	0.02 ± 0.003	0.005 ± 0.001	0.001 ± 0.002	0.03 ± 0.004	124 ± 12.5
2018	IV	40.6 ± 11.3	0	0	0	394 ± 55.2
	V	65.5 ± 14.7	0.58 ± 0.15	0	0	66.1 ± 6.18
	VI	2.22 ± 1.36	9.41 ± 2.46	4.09 ± 1.50	0.01 ± 0.004	41.8 ± 8.92
	VII	0.11 ± 0.05	0.03 ± 0.02	0.96 ± 0.40	0	100 ± 25.6
	VIII	0.38 ± 0.10	0.08 ± 0.04	1.02 ± 0.64	1.73 ± 1.01	161 ± 52.1
	IX	0.43 ± 0.12	0.13 ± 0.05	0.03 ± 0.02	0.41 ± 0.10	27.8 ± 2.83
	X	0.02 ± 0.01	0.35 ± 0.17	0.04 ± 0.02	0.04 ± 0.02	35.0 ± 6.01
2019	IV	0.19 ± 0.07	0	0	0	42.6 ± 6.70
	V	8.67 ± 2.39	7.37 ± 2.13	0.07 ± 0.03	0	33.5 ± 2.13
	VI	1.70 ± 1.0	1.40 ± 0.55	15.04 ± 3.27	0.11 ± 0.03	24.9 ± 1.77
	VII	31.2 ± 6.67	1.79 ± 0.52	0.78 ± 0.14	0.25 ± 0.04	21.9 ± 10.4
	VIII	1.43 ± 0.43	0.99 ± 0.17	0.17 ± 0.03	0.17 ± 0.04	20.1 ± 3.54
	IX	13.5 ± 4.18	0.49 ± 0.12	0.01 ± 0.01	0.09 ± 0.02	27.2 ± 2.45
	X	2.41 ± 0.35	0.93 ± 0.16	0.81 ± 0.11	0.26 ± 0.05	71.5 ± 41.3
2020	VI	0.85 ± 0.21	0.52 ± 0.06	7.63 ± 1.25	0.08 ± 0.01	12.2 ± 1.26
	VII	6.86 ± 1.92	8.95 ± 2.64	3.46 ± 0.82	0.58 ± 0.01	26.3 ± 2.84
	VIII	0.25 ± 0.09	2.64 ± 0.59	1.39 ± 0.28	0.06 ± 0.01	37.2 ± 4.68
	IX	0.15 ± 0.01	0.09 ± 0.01	1.39 ± 0.28	0.23 ± 0.05	69.7 ± 9.46
	X	0	0	0.006 ± 0.002	0.05 ± 0.03	42.2 ± 14.8

economic use, i.e. the extraction of crustacean cysts. The statistical analysis of environmental factors having effect on zooplankton structure of lake Kulundinskoye suggests that reliable results are obtained when using monthly hydrophysical and hydrochemical data rather. The revealed variations in zooplankton structure are mainly due to a stimulating effect of increased salinity on Artemia population and its depressing impact on other taxa.

Table 4. Statistically significant correlations of main characteristics of zooplankton with indicators of the aquatic environment of lake Kulundinskoye based on monthly data

Pairs of indicators	*r*	*p*
Artemia abundance (total) – concentration of Cl^-	0.82	<0.01
Artemia abundance (total) – salinity	0.74	<0.01
Artemia abundance (total) – concentration of $NO_3{}^{2-}$	0.57	0.02
Artemia nauplius abundance – concentration of Cl^-	0.82	<0.01
Artemia nauplius abundance – salinity	0.75	<0.01
Artemia nauplius abundance – concentration of $NO_3{}^{2-}$	0.57	0.02
Artemia cysts abundance – concentration of Cl^-	0.64	<0.01
Artemia cysts abundance – concentration of $SO_4{}^{2-}$	0.56	0.02
Artemia cysts abundance – salinity	0.68	<0.01
Artemia cysts abundance – concentration of $NO_3{}^{2-}$	0.58	0.01
Rotifera abundance – Copepoda abundance	0.49	0.05
Rotifera abundance – Cladocera abundance	0.70	<0.01
Rotifera abundance – concentration of $NO_3{}^{2-}$	−0.50	0.04
Rotifera abundance – concentration of $SO_4{}^{2-}$	−0.65	<0.01
Rotifera abundance – salinity	−0.50	0.04
Copepoda abundance – concentration of $SO_4{}^{2-}$	−0.54	0.02
Copepoda abundance – salinity	−0.63	<0.01
Water salinity – concentration of Cl^-	0.73	<0.01
Water salinity – concentration of $SO_4{}^{2-}$	0.63	<0.01
Water salinity – concentration of $NO_3{}^{2-}$	0.76	<0.01
Concentrations of nitrates in water – temperature	−0.60	0.01

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