

Intraguild (IARPG) and Interguild (IERPG) Zooplankton Predation in Lake Kinneret (Israel)

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Abstract

Statistical evaluation of the long-term (1969-2001) record of zooplankton density (No./L) (including life cycle stages of Cyclopoid Copepods, Cladocera, and egg-carrying Rotifers) in Lake Kinneret involved weekly sampling at 7 stations and 7 - 10 discrete depths, which confirmed a significant decline over time. A hypothesis was proposed that this decline was mainly caused by the predator Cyclopoid, referred to as “Intraguild Predation” (IARPG). It was determined through correlation analysis between Cyclopoid Copepods, Cladocera life cycle stages and Cladocera species that the primary cause is fish predation, specifically “Interguild Predation” (IERPG). The effect of temperature was also examined.

Keywords

Cyclopoid Copepods, Cladocera, Rotifera, Predation, Kinneret

1. Introduction

Freshwater lake communities naturally consist of inter- and intra-action relations between consumers (predators) and their utilized (preyed-upon) zooplankton. The zooplankton community structure includes a wide range of taxonomic components, from high levels (phylum, class, order, family) to low levels (genus, species). Vardit *et al.* [1] carried out a modeling-based study of zooplankton predation by Cyclopoid copepods. Regarding the case of zooplankton predator/prey interactions, a definition was accepted [1] for Cyclopoid predation within the context of intraguild relation predation (IARPG), namely “Intraguild” (IARGP), referring to relations within a single entity. Predator-prey relations between two or more separate entities are defined as “Interguild” (IARPG) predatory relations,

including interactions between fish and zooplankton, referred to as “Interguild” (IERGP). Earlier studies on the role of fish (Interguild) and Cyclopoid predation (Intraguilid) of zooplankton in Lake Kinneret identified the top-down ecological influence of fish predation on zooplankton populations, controlling their size and composition [1]. It was concluded that Cyclopoid predation (Intraguilid) is not less effective than fish predation (IERPG). The evidence for intraguilid predation on zooplankton was based on a modeling structure where details about zooplankton and fish taxa and species varieties were not considered [1]. Nonetheless, differences in consumption rates and preferences among species within groups (Copepoda, Cladocera) were experimentally documented. The predatory habits of Cyclopoida feeding were documented by Gophen [2]-[4], and the significant impact of Kinneret fishes on zooplankton communities—and consequently water quality and management—has been widely studied [3]-[16]. In this paper, a comparative analysis of the predation pressure and efficiency impacts of fish and Cyclopoids is presented.

2. Materials and Methods

Zooplankton was sampled weekly. One liter was sampled at discrete depths in the Epilimnion (surface to Bottom thermocline limit) and combined and mixed. From this, one liter was subsampled and preserved with 10 ml of 40% formaldehyde solution. Eight ml were sampled under well mixing and filtered through a 0.45 μm Millipore filter paper. All matters assembled on the filter paper were flushed into the Counting chamber and sorted. Counting was carried out under M5 Wild Binocular. Biomass (Biovolume converted to $\mu\text{g}(\text{ww})/\text{Individual}$), feeding and swimming features were taken from earlier studies. Zooplankton items are given in **Table 1**.

Table 1. Species and life cycle stages biomass (converted Biovolume to Biomass [$10^6 \mu^3 = 1 \mu\text{g}(\text{ww})$]), size (S = small; L = Large) and feature classification: Feeding: H = Herbivore; P = Predator; Swimming speed: LL = slow, MM = medium, HH = high, refer to High, Medium and Low swimming speed indicating high, medium and low level of vulnerability respectively.

Biomass: $\mu\text{g}(\text{ww})/\text{Individual}$	Feeding behavior	Size Class	Swimming Behavior	Name
0.6	H	S	MM	Small Nauplius
1.2	H	S	MM	Large Nauplius
3	H	S	MM	Copepodite 1
3.9	H	S	MM	Copepodite 2
5.9	H	S	HH	Copepodite 3
7.6	HP	S	HH	Copepodite 4
10.3	P	L	HH	Copepodite 5
24	P	L	HH	<i>Mesocyclops ogunnus</i> Female
13.6	P	L	HH	<i>Mesocyclops ogunnus</i> Male
8.2	H	L	HH	<i>Thermocyclops dybowskii</i> Male

Continued

8.2	H	L	HH	<i>Thermocyclops dybowskii</i> Female
15	P	L	HH	<i>Eucyclops serrulatus</i> Male
20	P	L	HH	<i>Eucyclops serrulatus</i> Female
1	H	S	MM	<i>Diaptomus dreishi</i> Nauplii
9	H	M	HH	<i>Diaptomus dreishi</i> Copepodites
30	H	L	HH	<i>Diaptomus dreishi</i> Female
25	H	L	HH	<i>Diaptomus dreishi</i> Male
28	H	S	HH	Small <i>Diaphanosoma brachyurum</i>
56	H	L	HH	Large <i>Diaphanosoma brachyurum</i>
9.2	H	S	LL	Small <i>Bosmina longirostris</i>
18.3	H	L	LL	Large <i>Bosmina longirostris</i>
8.6	H	S	LL	Small <i>Bosmina longirostris</i> Var., <i>cornuta</i>
17.2	H	L	LL	Large <i>Bosmina longirostris</i> Var., <i>cornuta</i>
15.1	H	S	LL	Small <i>Ceriodaphnia reticulata</i>
30.2	H	L	LL	Large <i>Ceriodaphnia reticulata</i>
12	H	S	LL	Small <i>Ceriodaphnia rigaudi</i>
24	H	L	LL	Large <i>Ceriodaphnia rigaudi</i>
0.1 - 4.5	H	S	MM-HH	Rotifera All species (<i>Asplanchna</i> sp. Excluded)

Nauplius and Copepodite (5th exclude) of the Copepod life cycle stages body length sorted as “Small” and 5th Copepodite and adults as “Large”.

1 - 2 Cladoceran neonates are sorted as “Small” and >3 neonates as “Large”.

All rotifer species except *Asplanchna* spp were sorted as small organisms.

Feeding and swimming behavior (Vulnerability) and feeding habits as based on experimental study [7] [9] and gut content analysis [6] [14] [15] Information about food resources and feeding habits of fish were obtained from published earlier experimental studies, and gut content analysis [3]-[9] [13]-[17].

Kinneret epilimnetic temperatures were obtained from the Kinneret Limnological Laboratory, IOLR, annual reports.

The following regression method plots are presented (STATA 17): 1) Fractional polynomial regression of continuous covariates, a form of parsimonious parametric modeling (Published in Applied Statistics 43: 429 - 467); 2) Linear regression with confidence interval percentage (95%) (STATA17); 3) LOWESS Smoother (0.8 Bandwidth), which provides weighted scatterplot smoothing.

The routine monitor program relies on microscopic observations of animal identification, sorting and counting. The gut content of adult Cyclopoids and Cladocerans [2] [18] was carried out on freshly sampled individual identified animals. Residual fragments of Copepodite and Nauplius stages and *Diaphanosoma* sp. and *Ceriodaphnia* spp. were documented in adult cyclopoid gut content. Residual fragments of *Bosnina* spp. were not detected [2]. Microscopical observations on living animals were carried out and video-taped, where adult Cyclopoid prey *Diaphanosoma*.

3. Results

Temporal changes of Copepoda, Cladocera and Rotifera all species and life cycle stages, all sampled depths, sampling stations and dates, densities in Lake Kinneret during 1969-2001 are shown in **Figures 1-3**.

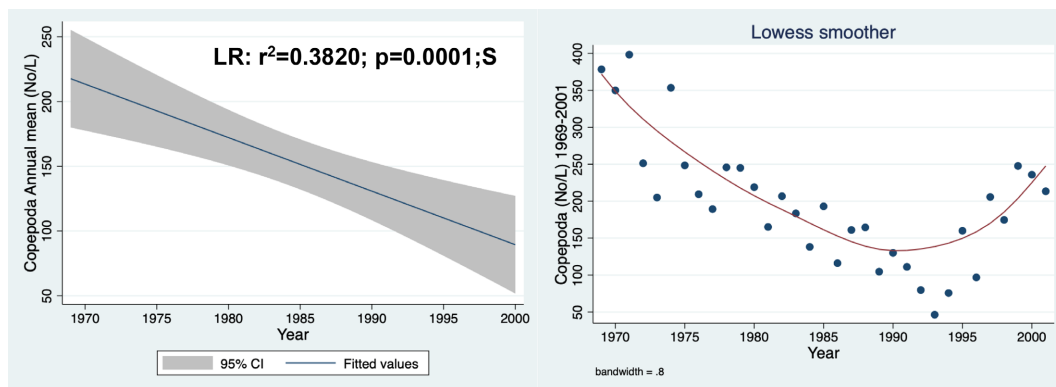


Figure 1. Linear regression (left) and lowess smoother (bandwidth 0.8) (right) plots of the temporal (1969-2000) changes of distribution of all life cycle stages of copepoda and years (LR parameters are shown; S = Significant) (annual means: no/L).

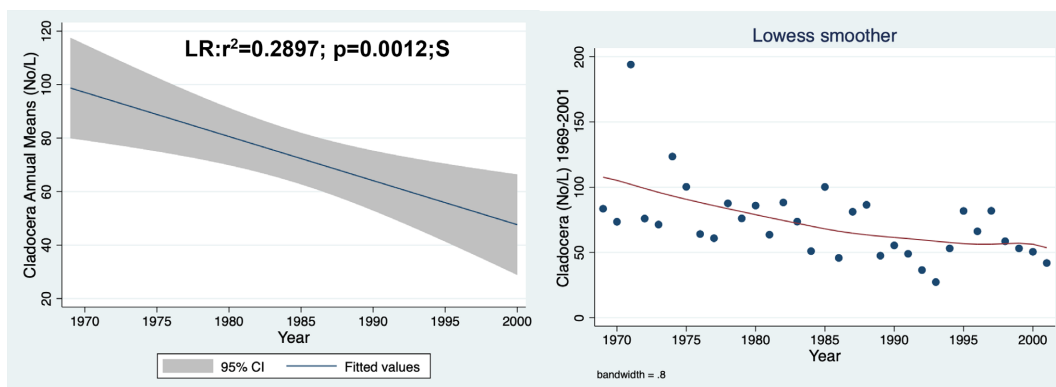


Figure 2. Linear regression (left) and Lowess Smoother (bandwidth 0.8) (right) plots of temporal (1969-2001) changes of annual mean density distribution (No/L) of *Cladocera organisms* (S = Significant).

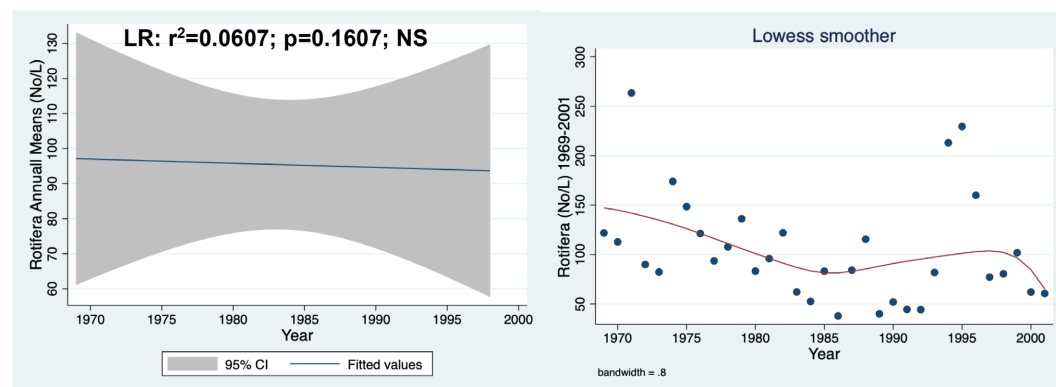


Figure 3. Linear regression (left) and lowess smoother (bandwidth 0.8) (right) plots of the temporal (1969-2001) correlation (LR parameters are shown; S = Significant) and distribution between all Rotifera (all species, excluding *Asplanchna spp.*) (annual means: no/L).

Results shown in **Figures 1-3** indicate a significant temporal (1969-2001) decline in the density (No./L) of Copepoda and Cladocera, whereas no significant changes in the Rotifer's density. The trend of density decline similarity of Cladocera and Copepoda reflects, probably, a mutual predator. It is suggested that such a component might be the Zooplanktivorous fish, the Bleaks *Acanthobrama lissneri* and *Mirogrex terraesanctae*. Those two are endemic species, Palearctic affinities, winter spawners [5] [6] [10] [13] [18]-[22]. Moreover, all other adult fish species of which the food composition was studied indicated non-selective consumption, whilst larval and young of the Year (YOY) stages selectively preyed on large body size copepods and cladocerans.

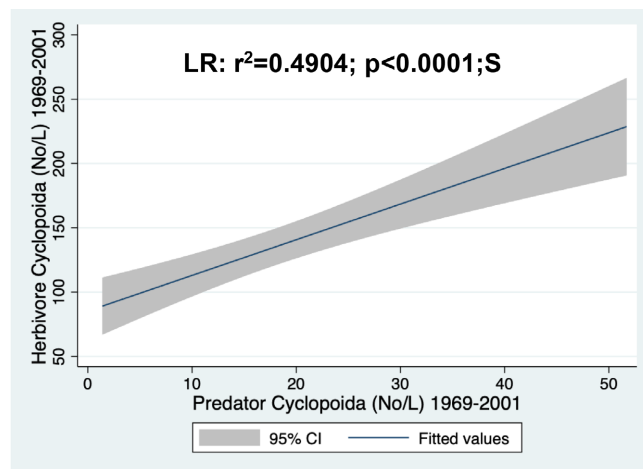


Figure 4. Linear regression (prediction) plots (LR parameters are shown; S = Significant) of the total number of herbivorous and predator life cycle stages (annual means; No/l) during 1969-2001.

Figure 4 represents the key issue describing predator-prey zooplankton inter-relationships, which clearly indicates non-intra (predator Cyclopoid copepods) and distinct inter (external factor) impact.

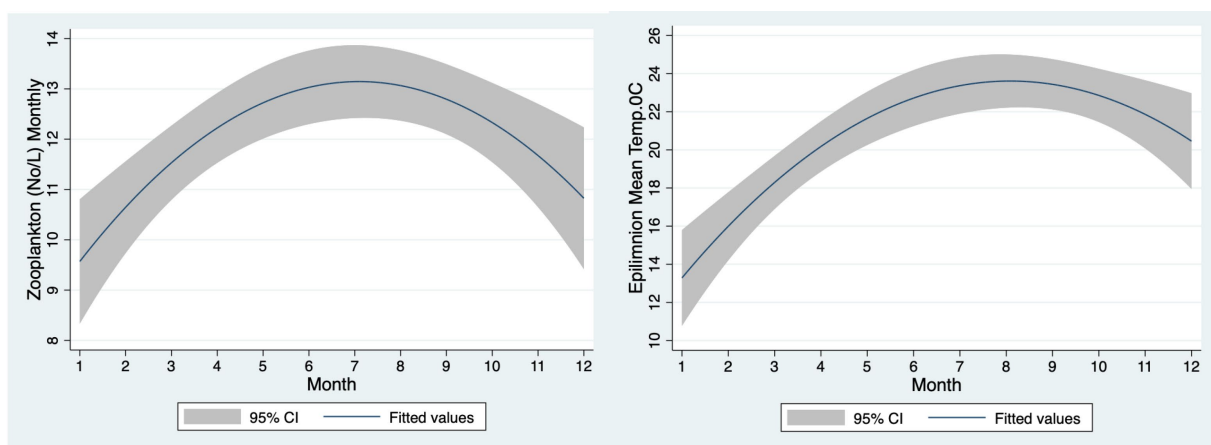


Figure 5. Fractional polynomial (w/95%CI) plots of multi-annual means of seasonal (monthly) density (No./L) distribution of total zooplankton community (left) and temperatures (right) in the Epilimnion during 1969-2001.

The results shown in **Figure 5** indicate the close relationship between seasonal (monthly) fluctuations in zooplankton population densities (No/L) and water temperatures, confirming the strong link between zooplankton metabolism and temperature. Temperature elevation also enhances fish metabolism and consequently the rate of their feeding activity, which includes zooplankton predation.

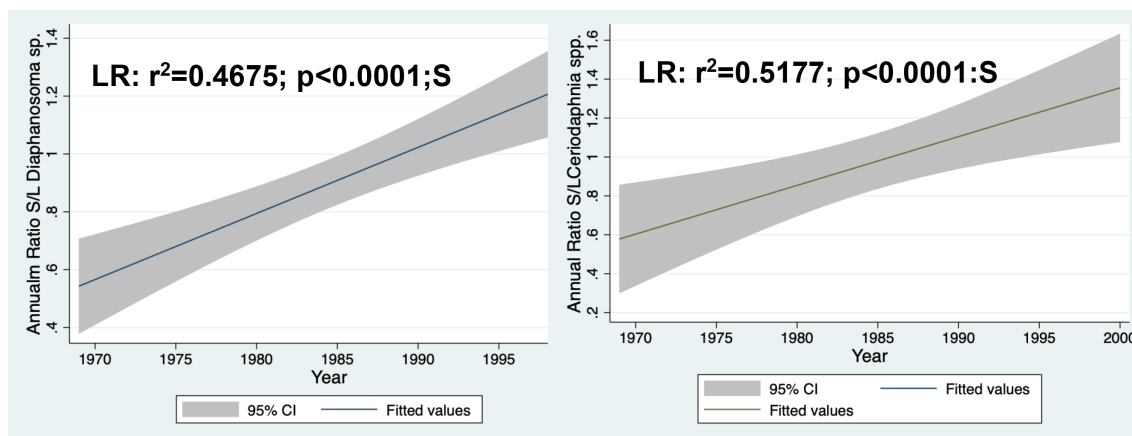


Figure 6. Linear regression (prediction) (w/95%CI) plots of temporal changes of annual means (1969-2001) of the numerical density (No/L) ratio between small (1 - 3 neonate stages) and large (adults) *Diaphanosoma sp.* (left) and *Ceriodaphnia spp.* (right) (LR parameters are shown; S = Significant).

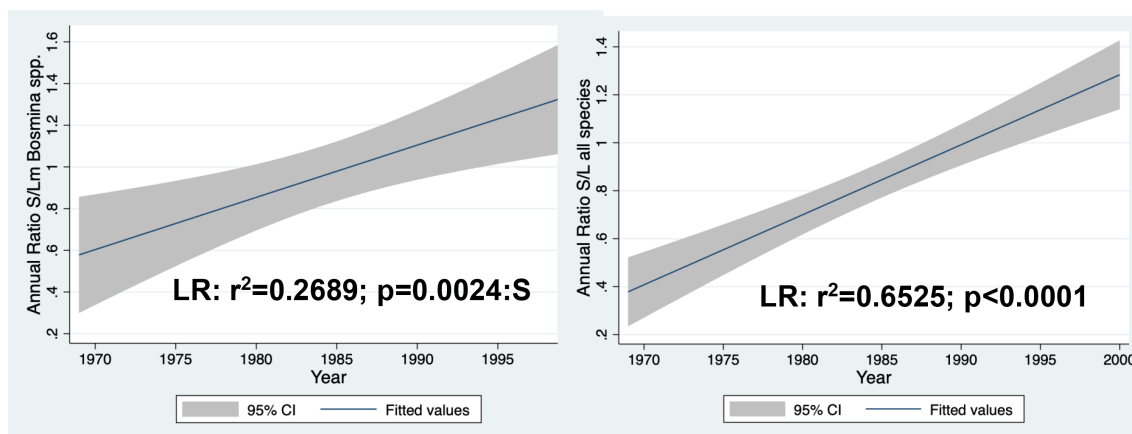


Figure 7. Linear regression (Prediction) (w/95%CI) plots of temporal changes of annual means (1969-2001) of the numerical density (No/L) ratio between small (1 - 3 neonate stages) and large (adults) *Bosmina spp.* (left) and all Cladocera species (right) (LR parameters are shown; S = Significant).

Figure 6 and **Figure 7** evidently emphasize the mutual IERPG impact (*i.e.*, fish predation) on zooplankton density. The temporal (1969-2001) changes of the ratio between small and large body zooplankters confirm fish's selective higher predation pressure on large body animals, which consequently enhances the relative density of the small organisms. Body size selective preference by carnivorous Cyclopoid copepods was not confirmed.

The dominant factor controlling the ecophysiological features of aquatic animals (zooplankton, fish) in Lake Kinneret is temperature. The seasonal (monthly)

mean (1969-2001) epilimnetic (surface-bottom boundary of the thermocline) temperature is given in **Table 2**.

Table 2. Monthly mean (1969-2001) epilimnetic (0 - 20 m depth) temperature (°C) in lake Kinneret: Max - Min range and Mean. LR: Mean monthly Temp. vs Month: $r^2 = 0.4422$; $p = 0.0183$; significant.

Month	Herb (No./L)	Pred (No./L)	Mean Temp. (°C)	Max - Min (°C)
1	13	7	15.6	15.6 - 15.6
2	14	8	14.8	14.7 - 14.9
3	8	8	17.1	14.9 - 19.3
4	11	9	19.4	16.1 - 22.7
5	13	8	21.4	17.1 - 25.7
6	17	11	21.9	18.1 - 25.7
7	23	9	23.3	19.3 - 27.2
8	23	10	24.2	20.3 - 28.0
9	9	9	24.7	21.7 - 27.7
10	13	8	24.7	23.3 - 26.1
11	17	7	22.4	22.2 - 22.5
12	16	7	18.2	18.1 - 18.3

The Role of Thermal Conditions

Previous studies about eco-physiological features of *Cyclopoid copepods* (*Mesocyclops ogunnus*) in Lake Kinneret confirmed temperature as the limiting environmental factor controlling its population dynamics. Sufficient food availability throughout the entire year cycle and growth rate dependence correlation with temperature was confirmed. Despite of optimal environmental conditions zooplankton in Lake Kinneret is significantly exposed to fish predation pressure during 9 months a year. Increased water temperature above 16°C - 17°C during spring-summer-autumn months induce metabolic activity and feeding rate of both fish and zooplankton. The correlation between zooplankton density and water temperature is therefore critical for the analysis Cyclopoid copepods long-term record of density changes.

Results given in **Table 2** indicate a significant correlation between water temperature and month, as an obvious characteristic of a sub-tropical climate. A consequent reflection of the reproduction of Cyclopoid Herbivore and Predator stage populations: mean (No./l/month) increase from 12.5 to 17 and from 7.8 to 9 of Herbivores and Predators, respectively. The changes between predator and herbivore densities are distinct. A distinct similarity of seasonal density distribution between herbivore and predator zooplankters was indicated (**Figure 4**). Distinct enhancement of zooplankton density during April-August was probably resulted by growth rate increase affected by temperature elevation. Nevertheless, zooplankton density declined later on (September-October) probably resulted by intensification of fish predation (**Figure 5**). The respected predator Cyclopoid control of the Herbivore population size can not be confirmed.

Aimed at the indication of optional Intraguild or Interguild predation effect on zooplankton (Copepoda, Cladocera, Rotifera), the following evaluation was carried out: Linear regressions were evaluated for any adjacent life cycle stages concluded by considering significant results, indicating Interguild, an external factor impact similarly on both and Intraguild impact if insignificance was concluded, indicating intra-group predation was affected. The paired components that were analyzed and the statistical r-test results of r^2 , p value and Significance (S) and Not Significance (NS) indication are given in **Table 3**.

Table 3. Results of linear regression analysis between Pairs of adjacent zooplankton life cycle stages (r^2 , p value and Significance (S) and Not Significance (NS) indication are given): Cyclopoid Copepods: Nauplius, Copepodite (Copt, 1 - 5 stages) and adult (Mes—Mesocyclops; Ther.—Thermocyclops; EU—Eucyclops; male and females Cyclopoid and Calanoid (Cal) Copepod; Small and Large Cladocerans small *Keratella cochlearis*, *K. valga tropica* and *Brachionus angularis*, carried (CE) and non-carried (NCE) egg rotifers.

Name	r^2	p
Copepoda		
Small/Large Nauplius	0.2059	0.0080
Large Nauplius/Copt1	0.3733	0.0002
Copt1/Copt2	0.7711	<0.000
Copt2/Copt3	0.6680	<0.0001
Copt3/Copt4	0.2454	<0.0001
Copt4/Copt5	0.5537	<0.0001
Copt5/Mes female	0.5493	<0.0001
Mes Female/Mes Male	0.2160	0.0064
Copt 5/Mes male	0.7766	<0.0001
Cal Nauplius/Cal Copt	0.3554	0.0003
Cal Copt/Cal Adult	0.4172	<0.0001
Cladocera		
Small/Large <i>Diaphanosoma</i>	0.5925	<0.0001
Small/Large <i>Bosmina longirostris</i>	0.2783	0.0016
Small /Large <i>Bosmina longirostris</i> var. <i>Cornuta</i>	0.6259	<0.0001
Small/Large <i>Ceriodaphnia reticulata</i>	0.3171	0.0006
Small/Large <i>Ceriodaphnia rigaudi</i>	0.7303	<0.0001
Small/Large <i>Chydorus sphaericus</i>	0.8336	<0.0001
Small/Large <i>Moina rectirostris</i>	0.7584	<0.0001
Rotifera		
<i>Keratella cochlearis</i> : CE/NCE	0.2828	0.0014
<i>Keratella valga tropica</i> : CE/NCE	0.2262	0.0052
<i>Brachionus angularis</i> : CE/NCE	0.2568	0.0026

Results given in **Table 3** confirm that all correlations between copepods and cladoceran sequencing life cycle stages and rotifers with (CE) and without eggs

(NCE) are all positively significant and correlated. Appropriate interpretation of these data is the similarity between external (Inter) predation impact on adjacent aged sequencing organisms, *i.e.* no IARPG significant impact.

4. Discussion

Vardit *et al.* [1] carried out a modeling-based study of zooplankton predation by Cyclopoid copepods, which concluded as IARPG type. The present paper is an empirical re-evaluation of the trophic relations between zooplankton and fish. Vardit *et al.* [1] claimed that the food composition of the predatory Intraguild (IARPG) zooplankton (Cyclopoida) consists of micro-zooplankton, herbivorous zooplankton, and Cyclopoida early stages of predatory zooplankton, *i.e.*, self-limiting or cannibalism consumed with preferences of 0.5, 0.35, 0.15, respectively. Cladoceran herbivorous zooplankton consists of five major genera: *Diaphanosoma*, *Ceriodaphnia*, *Moina*, *Chydorus* and *Bosmina*. Experimental study of the gut content of Cyclopoid copepod [2] confirmed zero preference for *Bosmina* [2] and vulnerability estimated locomotion capabilities of the other two (*Diaphanosoma*, *Ceriodaphnia*) are strictly different, high and low, respectively. The usage of one simple value of preference (0.35) for the estimation of the four genera's predation is inappropriate and misleading. Despite dissimilarity in Cyclopoid prey capture preference of herbivorous zooplankton, statistical correlation analysis of long-term records, including documented density data of all components, is more suitable than modeling usage of "smoothed" parameters. The dietary source of herbivorous zooplankton is phytoplanktonic algae, detritus particles, protozoans and bacteria [2] [18]-[20]. Solid sampling and experimental values, as presented in the present paper, are a crucial requirement for the verification of the modelling ecosystem dynamic structure. The basic premise of the Intraguild model [1] validation exists as long as it is not denied by solid field and experimental, even partial data that deny it. Cyclopoid cannibalism and predation of *Diaphanosoma*, *Ceriodaphnia*, as well as visual attack and filter-feeding strategies by fish were confirmed and incorporated into ecosystem structure evaluation here.

Water Level Fluctuations (WLF) in freshwater lakes might be a significant impact factor in the ecosystem, but it was not so in Lake Kinneret [21] [22]. Not like nutrient balances, WLF impact on the limnological trait, and during temporal (1933-2025), recorded 6 meters amplitude as of today, since 1933 when dam implementation on the Jordan river outlet was activated, significant long-term changes in water quality were not confirmed [21] [22]. Nevertheless, an indirect impact of WLF influence on zooplankton population size through Bleak community enhancement was indicated. The specific impact of WLF on the enhancement of predator Cyclopoids was not confirmed. Spawning season of the Bleak fishes continues from late December to early April when mixed-sex schools migrate to the shallow waters (0.1 - 1.0 m depth) at certain sites where the bottom is covered by smooth surface pebbles. Display within a school occurs under moonlight, characterized by stormy splashing water and noisy sound. Female eggs and sperm are

spread freely in the water, and fertilization occurs in open water, and prompt sticky substance covers all around the fertilized zygote. The heavily fertilized sticky zygote settled down, adhered and stuck to the pebble's surface. Nevertheless, if the pebble surface is covered by Epipelon, Epipsammon, and Epiphyton organisms (bacteria, algae and invertebrates) mixed with detritus particles, the eggs stuck to the surface are impossible and suspended fertilized eggs promptly covered by fungi, and embryo development fails. The newborn Bleaks start feeding at a ten-day age and feed on small-sized zooplankters [19] [20]. YOY fingerlings and adults feed on all body sizes of copepods, cladocerans and Rotifers. The increase in water level occurs during the winter rainfall season. If rainfall capacity and rate are high and water level increase is not slower than 2 cm per day, the pebble surface stays smooth and exposed accompanied by successful Bleak eggs sticking and efficient Bleak reproduction, followed by fish population enhancement and intensification of zooplankton predation pressure. Conclusively, the impact of WLF on zooplankton is independently carried out indirectly through the rate of water level (WL) elevation, but not the total rain capacity and point WL altitude, respectively. The dominant factor that controls the eco-physiological traits of zooplankters and fishes is temperature. The statistical plot similarity between the seasonal density distribution of zooplankton population size and temperature changes is demonstrated in **Figure 5**.

Figure 4 confirms a significant ($r^2 = 0.4904$; $p < 0.0001$) positive correlation between population size within dynamic changes (No./l) of herbivore younger stages and older stages and adult predator Cyclopoid copepods, which does not represent classical predator/prey of irreversible relationships. Temperature elevation accelerates reproduction and consequently relative increase in herbivore organisms (**Figure 5, Table 2**). Later on, the density enrichment of herbivores might induce predators increase and feedback predation intensification response whereas this is not the case. Such dynamic fluctuations are denied (**Figure 4**) and temporal (1969-2001) fluctuations of Copepoda and Cladocera densities (No/L) indicated a significant decline: Copepoda: $r^2 = 0.3820$, $p = 0.0001$; Cladocera: $r^2 = 0.2897$, $p = 0.0012$. These are suggested-supporting data confirming continuous pressure intensification of fish predation either by visual attack or by filter-feeding strategies [7] [9] [14] [15]. Moreover, the principal impact of predator Cyclopoid copepods creating long-term decline of zooplankton is unacceptable, supported by documented results about the feeding habits of Cyclopoid copepods [2] [8] [18]. The relatively stable densities of Rotifera are probably due to the permanent, unchanged filter feeding pressure from other than Bleaks, specified predators of larger body size zooplankters.

4.1. Intraguild (IARPG) or Interguild (IERPG)

Three major environmental components within the freshwater lake ecosystem, complex interactions are significantly involved in structuring the zooplankton community: temperature, food resources availability and predation. Earlier stud-

ies confirmed that food resources for herbivore zooplankton (Cyclopoid young stages and Calanoids; Cladocera and Rotifera) are unlimited [18] [23]-[25] and sources of utilization are often exchanged (phytoplankton, protozoa, bacteria and detritus). The impact of temperature is presented here (Figure 5; [2] [4]). This paper is focused on the predation factor. As is commonly known in ecological events, several factors are mixed and therefore combined. Zooplankton predation may be affected by several factors. Nevertheless, temperature impact covered the entire period and not specifically one or other factors and food limitation was not recorded for the predator-herbivore. The Intraguild and IERPG predation pressure are analyzed here solely. The temporal (1969-2001) decline of zooplankton density (Figure 1, Figure 2) is therefore attributed to fish (mostly Bleaks) predation. The stable density of Rotifers (Figure 3) is probably due to their small size, which improves their vulnerability against visual attack by fish feeders. Numerical density (No/L) of total Zooplankton, indiscriminated herbivore and predator (Intraguild and Interguild) density (Figure 1, Figure 2), as well as specific sorted herbivore and predator (Figure 4, Figure 6, Figure 7) confirm IERPG and IARPG rejection as a significant factor in assembled composition constructor and Cyclopoid's cannibalism was experimentally confirmed. The absence of residual fragments of *Bosmina* and the presence of those of *Diaphanosoma* and *Ceriodaphnia* in the Cyclopoid gut content resulted from the carapace structure. The two ventral edges of the carapace valves of *Diaphanosoma* and *Ceriodaphnia* are structured freely separated, whilst in *Bosmina*-closely attached. The predator Cyclopoid is unable to penetrate by inserting the Mandible and Maxillar mouth parts to chew and crush the soft body parts of the prey. Moreover, the chitinous chemical composition of the *Bosmina*'s carapace is more crush-resistant than that of *Diaphanosoma*, *Ceriodaphnia* and Copepods Nauplius and Copepodites. Data given in Table 3 indicate simultaneous rates of density (No/L) changes of life cycle stages of Cyclopoid copepods, and Cladocera and egg bearing Rotifera. It is therefore suggested that population dynamics of those animals are dependent on one or more external factors which affect entirely. Those factors might be non-selective food resources fish, temperature or any other environmental component, which is affecting total zooplankton entirely. The influence of one factor leads to an individual effect causing correlation disruption which is absent in Table 3. Data shown in Table 3 justify conclusion of non-selective zooplankton consumption. Despite specimen presentation in Table 3 differ significantly by body size, locomotion mobility and vulnerability their density fluctuation pattern is similar as defined by predation IERPG type. In case predation would be IARPG type preferential feeding would consequently carry out but absent in the given data (Table 3).

4.2. Conclusion

A comprehensive view on the role of various kinds of zooplankton predators where the most critical status is attributed to invertebrates, such as cyclopoid copepods, and fish was documented [26]. Particular consideration was attributed to

the role of prey body size vulnerability to invertebrate and fish carnivores was widely documented (among others) [27]-[29]. What is more effective in controlling the population size of herbivore zooplankters? Ecological meaning attribution to IARPG and IERPG considers the indication of the zooplanktonic predator compartment as internal (IARPG), which is more effective than the fish external (IERPG) factor [1]. The focus of this paper is on identifying which of these is more relevant and appropriate for the Kinneret ecosystem. Results given in **Table 3** imply confirmation of the dominant IERPG predation impact. The minority of the IARPG predation effect is not denied, but the major control of zooplankton population size is attributed to fish IERPG over IAPRG predation. The correlative relations between life cycle stages (**Table 3, Figure 6, Figure 7**) and predator-herbivore relations (**Figure 4**) indicate that IERPG predation is a significant control effect, whereas the absence of significance is noted for IARPG.

The close relation defined between bleak population size and Water Level Fluctuations (WLF) and consequently with zooplankton density conclusively indicate the relevance of fishery management design implications. Reduction of bleak stock biomass might be considered by market conditions improvement to enhance its fishery or subsidized removal.

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Data Availability

There is no restriction on the availability of data from the author on request.

Contributions

The author is responsible for the scientific structuring, computerized evaluations, design and writing of the paper.

Conflicts of Interest

The author has no conflict of interest that may affect this article.

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