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ORIGINAL RESEARCH ARTICLE

Comparison of methods for nocturnal sampling of predatory zooplankters in shallow waters

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Abstract The aim of the study was to assess the suitability of a plankton net (diameter of 60 cm, mesh size of 500 μm) and a column sampler (length of 200 cm, diameter of 5 cm) for estimating the density of zooplankton predatory species (*Neomysis integer, Leptodora kindtii, Cercopagis pengoi*). Nocturnal sampling was performed once a month (May—November 2018) in the Vistula Lagoon (southern Baltic) in the range depth of 1.3—3.6 m. Statistical analysis indicated no significant differences between the *N. integer* and *C. pengoi* density estimated by the two sampling gears. In the case of *L. kindtii*, the mean density obtained by the column sampler was higher when analyzing all samples together and/or deep-water samples only ($p < 0.02$). However, no such differences were found at shallow stations i.e. up to ca. 2 m in depth. It was assumed that the more suitable sampling equipment for estimating zooplankton abundance in a shallow, well-mixed transitional (brackish) basin is the column sampler. This type of gear, so far used mainly for sampling of micro and mesozooplankton, allows the simultaneous nocturnal collection of the entire zooplankton size spectrum, including representatives of large predatory species. The suitability of light traps for qualitative studies of zooplankton species responding positively to light under the high turbidity of the Vistula Lagoon was also investigated. The traps proved to be most useful for *N. integer* (100% frequency), and much less for *L. kindtii* (46.2%) and *C. pengoi* (27.3%).

1. Introduction

Predatory species of the crustacean zooplankton play an important role in the functioning of the food web of aquatic ecosystems. They are an important food source for organisms at higher trophic levels (Hostens and Mees, 1999; Ojaveer et al., 2004; Søndergaard et al., 2000;

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Vijverberg et al., 1990, 2005; Vogt et al., 2013), and regulate the abundance and species structure of mesozooplankton, thus competing for food with the early developmental stages of fish (Aaser et al., 1995; Branstrator and Lehman, 1991; Herzig, 1995; Herzig and Auer, 1990; Lehtiniemi and Gorokhova, 2008; Naumenko and Telesh, 2019; Ojaveer et al., 2004; Pichlová-Ptáčníková and Vanderploeg, 2009; Pichlová and Brandl, 2003). Indirectly, through the trophic cascade, they also influence the alternative development of primary producers (phytoplankton vs. macrophytes) and water quality (Jeppesen et al., 1994; Moss, 1994).

In fresh and brackish waters, some predatory crustaceans are of particular importance. These are cladocerans *Leptodora kindtii, Cercopagis pengoi* (Branstrator and Lehman, 1991; Golubkov and Litvinchuk, 2015; Herzig and Auer, 1990; Karabin, 1974; Lesutienė et al., 2012; Naumenko, 2018; Naumenko and Telesh, 2019; Pichlová-Ptáčníková and Vanderploeg, 2009; Pichlová and Brandl, 2003) and, optionally, planktonic (necto-benthic) Mysidae — *Neomysis integer* (Aaser et al., 1995; Arndt and Jansen, 1986; Jeppesen et al., 1994). The determination of the abundance and biomass, as well as seasonal variability of all size fractions of the zooplankton in brackish waters (estuaries, lagoons, coastal lakes), including larger predatory species, is quite a challenging task. The methods currently used for mesozooplankton sampling differ in the efficiency and selectivity, so that the results are not always comparable (Gutkowska et al., 2012; Lesutienė et al., 2012; Wojtal et al., 1999). The efficiency of samplers originally developed for sampling from different depths (e.g. Ruttner sampler and similar) is lower for larger predatory species than in case of plankton nets with a larger mesh size (Lesutienė et al., 2012; Wojtal et al., 1999). In contrast, a larger mesh size for adequate filtration prevents sampling of smaller organisms such as rotifers or early larval stages of Copepoda. As a result, for a reliable estimation of the abundance/biomass of all size fractions, it is usually impossible to avoid collecting zooplankton in parallel by different methods (Wojtal et al., 1999).

The column sampler is a simple device that is often used for water sampling, including plankton in shallow basins or mesocosms (Gyllström et al., 2005; Kornijów et al., 2005; Moss et al., 1998). Youngbluth et al. (1983) were the first to demonstrate almost double the efficiency of the column sampler than the plankton net for the collection of copepod nauplii in shallow and well-mixed lagoon waters. Also, Livings et al. (2010) comparing the efficiency of a Wisconsin-type net (inlet diameter 130 mm) and two types of column samplers in terms of the efficiency of determining zooplankton abundance in shallow, polymictic lakes, assessed the column sampler as a more precise equipment. However, this assessment was based on a study of the sampling efficiency of several mesozooplankton taxa, and therefore, did not take into account predatory species, usually of a larger size and potentially greater ability to avoid the sampling gear. The suitability of column samplers for studying the vertical distribution and daily migrations of *L. kindtii* and two predatory species of copepods was found by Chang and Hanazato (2004). They used a column sampler of a similar size to the one that we used (210 $\times$ 5 cm), but equipped with a lower hydraulic valve allowing for sampling at different depths and not only at the surface.

In case of *L. kindtii,* difficulties in estimating the abundance/biomass are additionally linked to the active avoidance of certain sampling gears during daytime surveys (Horppila et al., 2017), and to daily vertical migrations as a way to reduce pressure from predators (Vijverberg, 1991; Vogt et al., 2013). As a consequence, sampling during the day, regardless of the type of sampling gear used, may lead to understated results. However, only in a few cases, zooplankton studies were conducted at night (Alajarvi and Horppila, 2004; Horppila et al., 2017; Vogt et al., 2013; Wojtal et al., 1999).

Daily migrations also create difficulty when estimating the abundance of *N. integer*. Sampling during the day causes that the abundance of crustaceans may be underestimated even several times (2—4 times). An additional difficulty is associated with the necto-benthic occurrence of this species during the daytime (Irvine et al., 1995; Jeppesen et al., 1994). Arndt and Jansen (1986) used various types of nets and hand dredges, as well as floating and submerged light traps for sampling *N. integer* in the Darss-Zingst Bodden chain (western Baltic). In turn, Jeppesen et al. (1994) and Irvine et al. (1995) applied vertical tows using a plankton net with an opening diameter of 50—90 cm for sampling *N. integer*.

In the literature, there is no comparison of the different methods used for plankton sampling including reliable estimation of the abundance of *N. integer* and *L. kindtii*. Therefore we have conducted such studies in the Vistula Lagoon, known for the occurrence of the above mentioned predatory crustaceans, as well as the invasive Ponto-Caspian predatory cladoceran *C. pengoi* (Fadeev and Tarasov, 2001; Kornijów, 2018; Naumenko, 2009, 2018; Polunina, 2005; Ten, 1992). Our aim was to compare two ways of sampling zooplankton under the conditions of a shallow-water transitional basin to determine the optimal gear for estimating the abundance of three predatory crustacean zooplankton representatives (*L. kindtii, N. integer, C. pengoi)*. We have taken into account the two most frequently used quantitative methods of sampling plankton organisms: direct sampling with the plankton net and water collection with the column sampler. Besides, we used light traps to detect the occurrence of predatory crustaceans. The samples were collected from pelagic and littoral zones to determine the impact of the habitat on the effectiveness of sampling equipment.

2. Material and methods

2.1. Research area

Comparative research was conducted in the Polish part of the Vistula Lagoon (southern Baltic). It is a shallow-water basin (mean depth of 2.7 m) with an area of 838 km^2. The exchange of waters between the lagoon and the sea takes place through the Strait of Baltiysk, located in the Russian part of the basin. As a result, the maximum salinity value of about 6 g/kg at the strait gradually decreases to <1 g/kg at the western ends of the basin (Chubarenko and

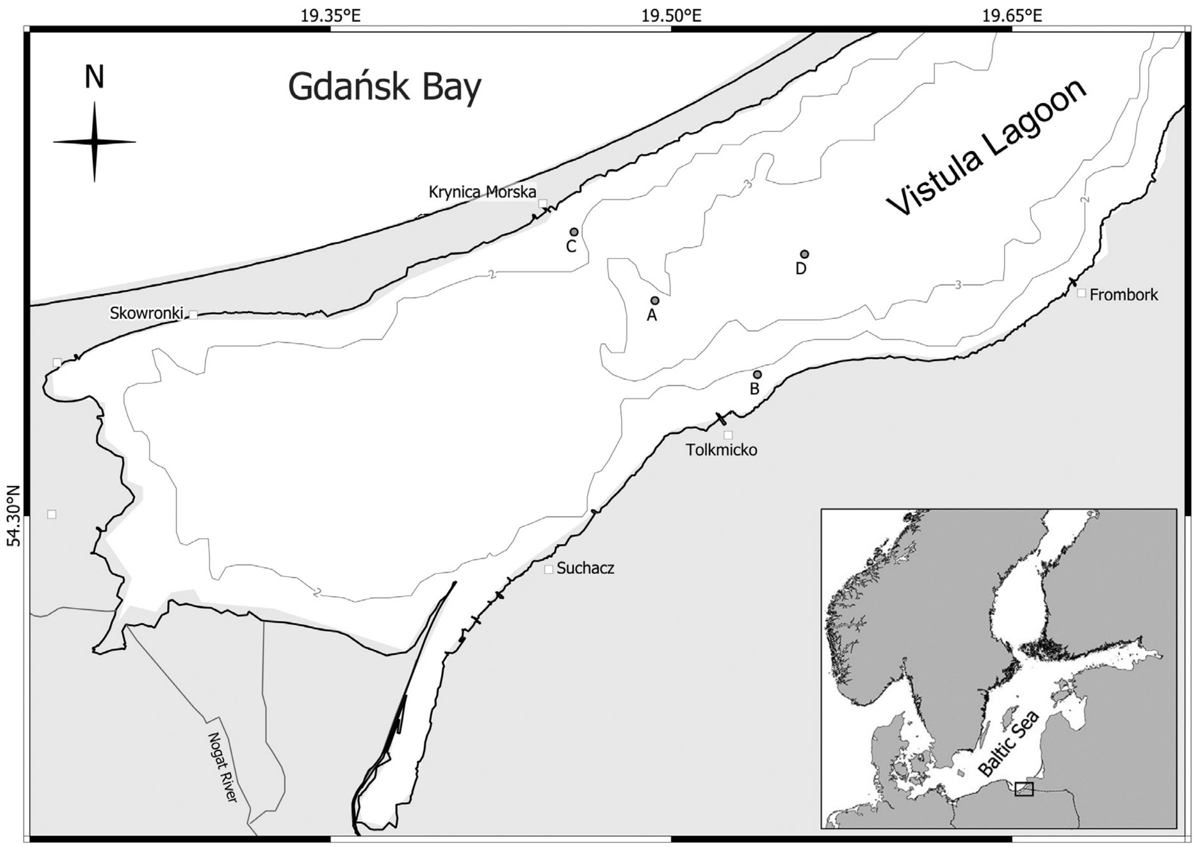

Figure 1 The geographical location of paired samples collected with the plankton net and column sampler in the Polish part of Vistula Lagoon (southern Baltic).

Margoński, 2008). Most of the research was conducted at two stations located approximately on the fairway line between the ports of Tolkmicko and Krynica Morska. Station A: (54,35528°N, 19,49281°E) was located centrally at a depth of about 3 m in the open water zone (pelagic). Station B: (54,3363°N, 19,53793°E) was located in a line of Tolkmicko in the littoral zone at a depth of 1.16—1.88 m, where the bottom was overgrown with the vast patches of *Potamogeton perfoliatus* L. Samples were taken with three sampling gears at least once a month.

Four additional samples, occasionally taken from other locations where light traps were not exposed, were also used for the analyses: Station Ba located near station B (ca. 50 m), and once at two stations in the open water zone of varying depth: station C, depth 2.21 m (included arbitrarily in "shallow stations"); station D, depth 3.64 m. The location of the sampling sites is shown in Figure 1.

2.2. Sampling gear, method of collecting and analyzing zooplankton samples

The column sampler was a polycarbonate pipe 2 m long and 50 mm in internal diameter. When submersed, the upper end of the pipe was closed with a rubber cork to keep the water inside the sampler during recovering it aboard. At every station, 10 liters of water were taken, i.e. 3 to 5 sampler contents, depending on the depth of the station, and then filtered through a 50 μm mesh netting.

For vertical tows, a conical plankton net with an opening diameter of 60 cm, a length of 1 m and a mesh size of 500 μm was used. The circular frame of the plankton net was supported by a 10 cm width collar to prevent contamination of the zooplankton sample by bottom sediments. The net was lowered to the bottom and after approx. 30-60 seconds (depending on the depth and wind force) was lifted at a speed of about 0.5 m s^{-1}. The volume of water filtered through the plankton net was calculated based on the flowmeter indications (General Oceanic) and the net opening area. Sampling performed with the column sampler and with the net were conducted after nightfall. The volume of water filtered in one tow was from 230 to 1610 liters, depending on the station depth and weather conditions. Performing vertical hauls was often not possible due to strong winds and the requirement that the net should stay on the bottom 30—60 seconds to let *Neomysis integer* return to the bottom surface disturbed by the lowered net. A small drift was observed even the boat was always anchored that led to partly oblique rather than 100% vertical hauls and resulted in a larger volume of filtered water than could be expected solely from the water depth and the net opening surface. Light traps usually are used for qualitative research of zooplankton that responds positively to the light attraction (McLeod and Costello, 2017). We used light traps to verify if the analyzed predatory species were present in the environment, as due to their low abundance and/or avoiding the sampling gear could be missing in the

Figure 2 Light trap used in this project: a) overall look; b) light module. The arrow indicates the location of the battery compartment cap of the light module.

samples collected with the plankton net or column sampler. Our light traps were made as described by (Watson et al., 2002) with minor modifications (Figure 2).

The trap consisted of two connected black polyethylene buckets with a capacity of 20 liters each (height 33 cm, bottom diameter 27 cm, top diameter 32 cm), connected by a steel frame. A float was attached to the upper part of the frame, and a rope with an anchor to the lower part. The total height of the device with the frame and float was 138 cm. In the upper part of the trap, 9 funnel-shaped headlights with an area of 45 cm^2 made of transparent polyethylene were mounted. Their larger diameter (78 mm) was integrated with the trap wall, while the smaller (21 mm) was directed to the inside of the trap, constituting at the same time the entrance funnel. White light attracting zooplankters was emitted by light modules made of acrylic cylinders with a diameter of 15 mm and a length of 30 cm (Figure 2b). Each module was equipped with 54 diodes arranged in three rows of 18 pieces and placed in a sealed transparent acrylic sleeve mounted vertically in the center of the upper part of the trap, where there were also light-emitting headlights. Each module was equipped with an energy source in the form of two 9V alkaline cells (type: 6LR61). After a single use, the cells were replaced with new ones to avoid changing the intensity of the emitted light as a result of partial battery depletion. The lower part of the light trap was a sampling container for draining plankton when the whole device was retrieved from the water. For this purpose, six "filtering windows" measuring 5 $\times$ 19 cm each, made of a plankton net with a mesh size of 500 μm, were installed. The light traps were exposed before nightfall and were retrieved the next morning. The location of the light-emitting trap part in the water column depended on the depth at particular stations. At station A it was about 1.5—1.8 m from the surface, at the station in the area of submerged vegetation (B) about 0.7—1.0 m.

Samples were taken between May and November 2018 at approximately monthly intervals from the MIR-2 research boat (Table 1). Altogether a total of 53 zooplankton samples were collected, including 15 samples using light traps, 19 samples using vertical tows with a plankton net, and 19 samples using a column sampler. All collected zooplankton samples were immediately preserved with 40% borax-buffered formalin at a ratio of 1/9 of formalin to sample volume. When analyzing the composition of plankton from the plankton net and light traps sub-samples were taken up to 200 individuals of each species, while in case of samples collected with the column sampler, all collected material was analyzed.

Basic environmental parameters (salinity and temperature) were measured with a CastAway™ CTD probe before collecting zooplankton samples and deploying light traps. Moreover, during the retrieval of light traps, the transparency of water was measured with a Secchi disc. The number of samples collected by particular sampling gears in the

Table 1 Number of zooplankton samples collected by different gears and environmental variables in the Polish part of the Vistula Lagoon, southern Baltic in April—November 2018. Variable values are the means of the sampling occasions.

Month	No. of samples			Environmental variables (mean values)				
	Light traps	Plankton net	Column sampler	Temperature [°C]		Salinity [g/kg]		Secchi depth [m]
				surface	bottom	surface	bottom	
May	3	3	3	17.52	17.76	1.39	1.58	0.40
June	2	2	2	21.48	21.16	1.94	1.91	0.39
July	2	3	3	25.78	25.77	2.32	2.33	0.55
August	2	5	5	21.51	21.33	2.79	2.81	0.73
September	2	2	2	19.17	18.94	3.17	3.16	1.35
October	2	2	2	13.08	12.83	3.76	4.28	1.38
November	2	2	2	8.85	8.85	3.98	3.98	1.55

subsequent months, as well as the environmental parameters are presented in Table 1.

2.3. Statistical methods

Dependent t-test for paired samples was used to compare the effectiveness of predatory crustacean sampling using vertical tows with a plankton net and a column sampler. Statistical calculations were performed with the data analysis software system STATISTICA v. 10 (StatSoft. Inc., 2011).

Due to the different depths at the sampled stations and the different vertical range of impact of the studied gears (column sampler — from the surface to approx. 2 m in depth, plankton net — from the bottom to the surface), the analysis was performed separately for three data sets to exclude the impact of the depth factor on the results: (i) all samples, (ii) samples from deeper stations (bottom depth range 3.08—3.64 m), (iii) samples from shallower stations (1.16—2.21 m). The comparison of sampling efficiency using two studied gears was also performed separately for each of the three predatory species.

3. Results

3.1. Environmental parameters

Basic environmental parameters (Table 1) are presented to draw attention to seasonal changes and characteristics of changes in the water column. The observed changes in water temperature were characteristic of shallow water basins in the temperate zone. In the course of the research period, a clear trend of salinity increase was noted, i.e. from about 1.4 g/kg in May to about 4.0 g/kg and even more in October and November. A seasonal trend also applies to the Secchi depth, i.e. the water transparency. It increased significantly at the end of the growing season (Table 1).

3.2. Comparison of the sampling gears

The comparison of results obtained with three different methods gives an overview of the effectiveness of particular sampling gears for determining the occurrence of predatory crustaceans in the environment (Table 2). The frequency of occurrence of particular species in the gears applied provides some indication of their suitability for sampling the analyzed species. *Neomysis integer* showed the highest susceptibility to light attraction and occurred in all samples (frequency of occurrence = 100%). The frequency of this species in samples from the plankton net and column sampler was significantly lower (84.2% and 36.3%, respectively). The efficiency of light attraction for *Leptodora kindtii* and *Cercopagis pengoi* was significantly lower, amounting to 42.6% and 27.3%, respectively. *L. kindtii* specimens were most often found in samples obtained with the net and sampler rather than with the light traps (Table 2), while *C. pengoi* was most often caught using the plankton net.

The results of the statistical analysis of the density of the three predatory species based on the samples taken with the plankton net and column sampler are shown in Table 3. The efficiency of the column sampler and plankton net applied for *N. integer* and *C. pengoi* sampling, calculated based on all compared samples, as well as separately for materials collected at deep-water and shallow-water stations, did not differ significantly (Table 3). In the case of *L. kindtii,* the mean density obtained by sampling using the column sampler and plankton net differed considerably when analyzing all samples together and deep-water samples ($p < 0.02$). The mean density of *L. kindtii* was significantly higher for the samples taken with the sampler than for those taken with the plankton net. However, no such differences were found at shallow stations (Table 3).

4. Discussion

The efficiency of sampling *Neomysis integer* and *Cercopagis pengoi* using two sampling gears for quantitative studies, i.e. the plankton net and column sampler, proved to be comparable as we found no significant differences in the density of the two species estimated by these gears (Table 2). However, the reason for the lack of significant differences may be due to the low density of these crustaceans or uneven/aggregated distribution (see: Wojtal et al., 1999).

There were no significant differences in the density of *Leptodora kindtii* obtained with the net and column sampler at shallow water stations. This was in the opposition to the deeper stations (> 2.2 m) and all the stations analyzed together. It resulted from the different water column penetration depths of the gears, i.e. from the bottom to the surface (plankton net) vs. from the surface to the depth of 2 m (column sampler). Higher density in samples taken with the column sampler than with the plankton net at deep-water stations may indirectly indicate that this is the effect of uneven distribution of the *L. kindtii* in the water column, implying higher values in the surface layer of 0—2 m in depth.

The results obtained and the assessment of the effectiveness of the samplers could also be influenced by the difference in abundance of the studied crustaceans. The assessment of the density of most numerous *L. kindtii* based on sampling with the column sampler is considered more reliable than based on tows performed with the plankton net. The opposite conclusion can be drawn for *C. pengoi* which was a less abundant species. The small volume of water collected using the column sampler does not allow recommending this gear for surveying not abundant species.

The problem of differences in the volume of water filtered by various gears was also raised by Wojtal et al. (1999). Despite the lack of statistically significant differences between the vertical density of *L. kindtii* determined by using a bongo and a 5 L Bernatowicz's sampler, the authors found that the results from the sampler are not useful for determining the vertical distribution of this predatory cladocerans in a shallow dam reservoir. In their opinion, the large differences in the volume of water filtered by the bongo and taken with the sampler, combined with the aggregated distribution of zooplankton, resulted in very high variability of the results obtained by the sampler (Wojtal et al., 1999). As an additional reason for the unreliable results in a near-surface layer of 1—2 m using Bernatowicz's sampler, the authors recognized the ability of this cladoceran to avoid the sampler, despite the research was performed in the night time.

Table 2 Total number of three predatory zooplankton species caught with a single deployment of light traps (LT), density [spec. L^{-1}] estimated by vertical tows of a plankton net (VPN) and a column sampler (CS). The frequency (F) of occurrence [%] of species in samples collected by each gear is presented at the bottom of the table. x — the gear was not applied on this date and station

Date	Station		*Neomysis integer*			*Leptodora kindtii*			*Cercopagis pengoi*		
	No.	Depth [m]	LT [total number]	VPN [spec. L^{-1}]	CS [spec. L^{-1}]	LT [total number]	VPN [spec. L^{-1}]	CS [spec. L^{-1}]	LT [total number]	VPN [spec. L^{-1}]	CS [spec. L^{-1}]
21/22 May	A	3.24	15	0.003	0	53	0.504	1.5	21	0.0204	0.3
21/22 May	B	1.7	45	0	0	896	0.002	1.4	0	0,0028	0
21/22 May	Ba	1.3	56	0.0024	0	9	1.296	0.7	0	0.0169	0
12/13 Jun	A	3.15	154	0.005	0	38400	22.016	29.4	41	0.0252	0
12/13 Jun	B	1.53	8	0.0041	0	49	12.928	14.5	0	0	0
25/26 Jul	A	3.47	3104	0	0	0	0.113	3.9	0	0	0.4
25/26 Jul	B	1.84	1520	0.0525	0.1	0	0.613	5.8	0	0	0
26 Jul	A	3.49	x	0.007	0.1	x	0.712	3.2	x	0	0
22/23 Aug	A	3.46	1424	0.079	0.9	0	0.388	2.3	0	0.053	0
22/23 Aug	B	1.88	276	0.0731	0	84	2.401	0	13	0.069	0.1
22 Aug	Ba	1.58	x	0.002	0	x	0.319	0.6	x	0	0
22 Aug	D	3.64	x	0.030	0.4	x	0.098	1.3	x	0.019	0
22 Aug	C	2.21	x	0.006	0	x	0.019	0.8	x	0.002	0
20/21 Sep	A	3.4	18944	0.776	0.5	0	0	0.2	0	0.004	0
20/21 Sep	B	1.87	14672	0.166	0	0	0	0	0	0.003	0
18/19 Oct	A	3.52	1576	0.083	0	0	0	0.2	0	0	0
18/19 Oct	B	1.75	11456	0	0.4	0	0	0	0	0	0
7/8 Nov	A	3.4	968	0.007	0.1	0	0	0	0	0	0
7/8 Nov	B	1.73	155082	1.111	0	0	0	0	0	0	0
F [%]			100.0	84.2	36.8	46.2*)	76.5*)	82.4*)	27.3**)1	66.7**)	20.0**)

*) For F calculations, the November results were not included, as *L. kindtii* was found in none of the sampling gears.

**) For F calculations, the October and November results were not included, as *C. pengoi* was found in none of the sampling gears.

Table 3 The quantitative effectiveness of zooplankton sampling with two different gears: the column sampler (CS) and the vertical plankton net (VPN) compared by the dependent t-test for paired samples. The calculations were made separately for all stations, shallow (≤2 m) and deep stations (> 2 m). Statistically significant differences are marked in bold.

	Leptodora kindtii			*Cercopagis pengoi*			*Neomysis integer*		
	All	Shallow	Deep	All	Shallow	Deep	All	Shallow	Deep
CS mean [spec. L^{-1}]	4.387	3.400	5.250	0.080	0.025	0.117	0.139	0.050	0.250
SD mean	7.828	5.267	9.846	0.148	0.050	0.183	0.250	0.127	0.325
VPN mean [spec. L^{-1}]	2.765	2.517	2.982	0.020	0.020	0.021	0.145	0.163	0.124
SD mean	6.245	4.667	7.695	0.023	0.032	0.019	0.304	0.345	0.266
df	14	6	7	9	3	5	17	9	7
t	2.630	1.002	2.682	1.243	0.544	1.221	-0.074	-0.916	0.321
p	**0.020**	0.355	**0.031**	0.245	0.624	0.277	0.942	0.384	1.067

The suitability of column samplers for studying the vertical distribution and daily migrations of *L. kindtii* was found by Chang and Hanazato (2004) while the presented results regarding the possibility of sampling *N. integer* with the column sampler as well as using light traps at the same time as active sampling devices (plankton net and column sampler) are novelties of this paper.

The light traps used in this study, based on the project of Watson et al. (2002) are classified by McLeod and Costello (2017) as cylindrical traps with reflector light emission and entrance funnels located in the center of the headlights. Only raw results of the sampling were presented and no attempt has been made to determine the effectiveness of sampling of particular species. This is due to the fact that several abiotic factors that may potentially influence the effectiveness of light traps have not been studied, e.g. the area of light exposure under different conditions of water transparency, changes in the night time duration in the research cycle, cloudiness and phase of the moon, which may affect the results (McLeod and Costello, 2017).

The light traps were used to obtain additional information on the occurrence of the predatory zooplankters in case of the lack or low effectiveness of the active gears used. *N. integer* was recorded less frequently by the column sampler and plankton net than in the light traps. This trend was particularly noticeable in relation to the results obtained with the column sampler (Table 2), which may be associated with relatively low density of *N. integer* and a small volume of water taken for analyses with this gear. The difference in the frequency of *L. kindtii* in the light traps and active gears are no longer so unambiguous, which may be the result of factors that have a potential impact on attraction by light (e.g. moon phase and cloudiness, degree of water turbidity), as well as a drastic decrease in the density of this species in the environment at the end of observations. A similar limitation on the interpretation of the efficiency of light trap sampling applies also to *C. pengoi*, which was the least abundant species and had the shortest period of occurrence.

The light traps, which are considered to be passive gears for the collection of different groups of aquatic organisms, are most often used in habitats that limit the use of active plankton sampling gears (e.g. coral reefs or mangroves). Light traps are also used to sample organisms which avoid plankton nets (for a review see: McLeod and Costello, 2017). The suitability of light traps for zooplankton sampling in the littoral of inland lakes under dense vegetation conditions has been demonstrated by Szlauer (1971).

The information on the effectiveness of sampling using light traps of the species considered in this study is quite limited. Among others, Arndt and Jansen (1986) listed light traps as one of the sampling gears used in their research focused on *N. integer*. In their opinion, estimating the abundance of this species is difficult due to the occurrence in swarms, as well as vertical and horizontal migrations. A positive response to the light attraction of two species of Mysidacea (*N. integer* and *Mysis mixta*) was also noted in the Puck Bay (Southern Baltic) in the NMFRI project, which used among others the same light traps as in the current studies (Linkowski unpubl.). Szlauer (1971) using a light trap of his own design in freshwater basins, identified *L. kindtii* in a group of cladocerans highly susceptible to being attracted by light.

5. Conclusions

Our study compared the efficiency of nocturnal sampling of three species of predatory zooplankton in a shallow transitional basin with two different gears (plankton net and column sampler), against the background of their occurrence confirmed by the light traps. The obtained results offer the possibility of collecting integrated zooplankton samples (covering all size fractions of organisms occurring in the water column) with one gear, i.e. the column sampler. This conclusion is valid when accepting certain limitations. Firstly, the surveys must be performed at night and, due to the small volume of water collected, the representativeness of the data obtained for the less numerous species, e.g. *Cercopagis pengoi*, will be limited. In case of applying a longer column sampler than the one used in this study, e.g. 4 m long, the range of depths, which can be sampled representatively with this gear, can probably remarkably increase. This creates an opportunity to determine the density of all zooplankton size fractions with a single gear in numerous shallow-water transitional habitats, the depth of which does not exceed the length of the sampler.

The results obtained indicate high effectiveness of light traps as a method to determine the occurrence and possibly seasonal distribution, in particular of *Neomysis integer*, and to a lesser extent also of *Leptodora kindtii* and *C. pengoi*, in a shallow, turbid and well mixed lagoon-type transitional basin.

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