Leibniz-Institute of Freshwater Ecology and Inland Fisheries (IGB)

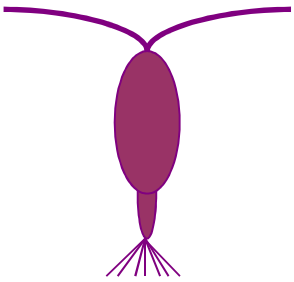
Sampling of Lake Müggelsee (Berlin, Germany) within the long-term ecological research programme of the IGB: Zooplankton Metadata Description

Data storage: IGB Database FRED:

https://fred.igb-berlin.de/Studysites/byType/lake

Uschi Newen, Rita Adrian

Zooplankton sampling and sample processing:



The zooplankton analysis includes rotifer, crustacean zooplankton, planktonic larval stages and some conspicuous ciliate species of the pelagic zone of Lake Müggelsee. A condensed life sample (30µ mesh size) is screened for actual check of species composition in order to guarantee an accurate species determination in the fixed samples.

Sampling protocol: Lake Müggelsee is sampled at weekly intervals during the growing season and at biweekly intervals during periods with ice cover. Between 1979 and 1986, zooplankton samples were sampled biweekly at the deepest point of the lake (M7, Table 1, Figure 1) at 1m intervals from the surface to the bottom. A detailed description of the sampling strategy is given in Driescher et al. (1993). Since 1987, integrated samples were collected weekly at five different lake stations (see description below). We assume that change in the sampling strategy did not cause a significant bias in the plankton series, as analysis of synchronous zooplankton counts in 1987 (n-15) revealed no significant differences (Wilcoxon-Mann-Whitney: $p>0.1$). Moreover, Schellenberger and Stellmacher (1986) found that seston concentrations were quasi homogeneously distributed across the lake.

Coordinates of sampling stations

(A)

Sampling stations	Coordinates North	Coordinates East
M5	52°26.610`	013°39.142`
M3	52°26.308`	013°40.217`
MS3	52°25.953`	013°40.603`

M7	52°26.099`	013°39.539`
M10	52°25.907`	013°37.967`
M8	52°26.541`	013°38.129`

(B)

Sampling stations	**Coordinates North**	**Coordinates East**
MS3 bei Eis	52°25.983`	013°40.566`
MS1 bei Eis	52°25.634`	013°38.633`

Table 1: Locations of the Müggelsee sampling stations during ice free (A) and ice covered (B) periods.

Sampling stations		M5	M3	MS3	MS3 During ice	M7	MS1 During ice	M10	M8
Epilimnion	0.5m	X		X	10l	X	30l	X	X
	1.5m	X	X	X		X		X	X
	2.5m	X				X			X
	3.5m	X				X			X
Hypo-limnion	4.5m	X				X		X	
	5.5m	X				X			
	7.0m					X/**X**			

*Table 2: Depth specific sampling profiles at the different lake stations in Lake Müggelsee depicted by X: During thermal stratification an additional sample is taken at 7m (**X**) for chemical analysis.*

Sampling depths at each sampling station are depicted by (X) in Table 2. At each sampling location 5 liter of lake water are sampled via a transparent Hydro Bios Universal Water Sampler (see picture Figure 2). For accuracy the sampler is lowered via a winch equipped with a depth measurement device.

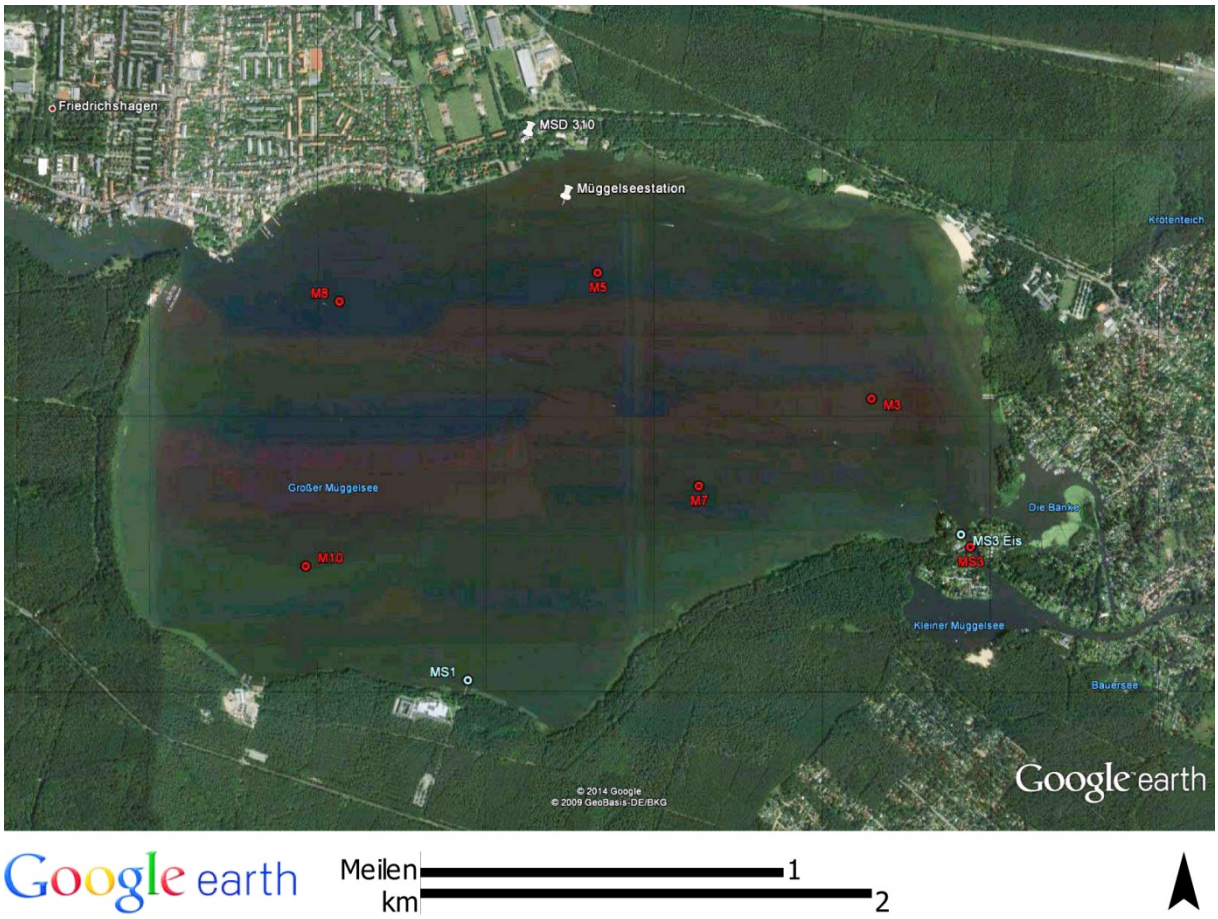


Figure 1: Google Earth Map of Lake Müggelsee: The sampling stations are depicted in red letters. Sample stations during periods of ice cover are depicted in white letters.

Integration of water samples: The integrated water samples derive from samples taken at the differed sampling stations and water depths (Table 2). In Table 3 the sample integration scheme is summarized for ice free and ice covered periods, and for thermally stratified and non- stratified periods. MPO stands for the upper 0-4m; MPU stand for the lower 5-7 m. Sample number in table x is for internal use only. Co-ordinates of the different measuring stations are depicted in table 1. During thermally un-stratified conditions all samples are integrated into one sample (MPS in Table 3). During periods of thermal stratification samples from the upper 0-4 m depths and the lower 5-7 m depth are separated. The 4m water depths basically relates to the location of the thermocline. We consider the lake thermally stratified if oxygen concentrations decline by more than 20% between 2m and 5m water depth. During periods of thermal stratification an additional sample is taken at M7 above the sediment for chemical analysis. Samples at 'MS'3 and 'MS3 Ice' are routinely taken.

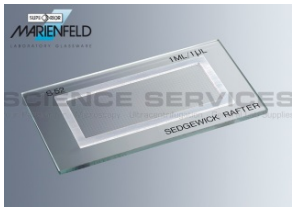
Sample preparation and fixation for zooplankton analysis: Out of the integrated Müggelsee sample (105 L in total; see Table 1 and 2) 20 liters (Total Volume, see calculation below) are screened though a 30µm mesh and the animals are transferred via a wash bottle filled with filtered lake water into a ca. 100mL glass bottle. We slowly add a couple of drops of mineral water (CO_2), in order to prevent strong contractions of the zooplankton prior to fixation. After ca. 10 minutes – when all zooplankton have been narcotized, the sample is fixed with 37% formaldehyde to a final concentration of 4% and stored in a 100mL glass bottle. Work under an exhaust hood- as formaldehyde is harmful to health!

The sample bottle is labelled as follows:

Müggelsee
Date
30 µm 20 L 4% Formol

Prior to counting of the sample all formaldehyde is removed. Therefore the fixed sample is poured into a net bucket with a 30µm mesh size. The formaldehyde is collected – and disposed. The sample is gently rinsed with tab water until all formaldehyde is washed out. The collected zooplankton is transferred to a measuring cylinder (25ml, 50ml, 100ml). The size of the cylinder depends on the density of the zooplankton in the sample. In all processing steps we control that all animals have been transferred from the net bucket. After all animals have been transferred to the measuring cylinder – the cylinder is filled to the respective volume using tap water. The cylinder volume is noted for the final density calculation of the zooplankton (see calculation below).

***Counting and taxonomy*:** Usually several aliquot volumes of the original sample volume are removed and counted. We use a graduated pipette, with a widened pipette tip in order to include small and large sized zooplankton. We take utmost care to gently but thoroughly mix the sample in the cylinder in order to guarantee a homogenous distribution of the zooplankton in the cylinder.



The aliquot of the sample is transferred into a Sedgewick-Rafter counting chamber (see picture). Surface tension is diminished by adding a couple of drops of a detergence in order to prevent that some specimens adhere to the surface. Animals are identified and counted under a microscope at x40 (crustaceans) to x100 (rotifera) magnification. In most cases several parallel chambers are counted until at least 100 individuals of the most prominent species are recorded. The total volume of the processed aliquots is noted (Aliquot Volume; see calculation below).

Used microscopes and binoculars:
Zeiss Axioscope.A1; until 2011 Carl Zeiss Jena, Jenaval

Species are determined according to:

Rotatoria:	Koste (1978), Ruttner-Kolisko (1974);
Cladoceren:	Flössner (2000), Lieder (1996), Korovchinsky (1992);
Copepoden:	Einsle (1993); Kiefer & Fryer (1978), Kiefer (1973).

Rotifera: Some rotifer species are determined to the genus level only. Those include genera such as Collotheca and some Synchaeta; species for which important taxonomic featured are not visible after fixation.

Cladocera: Adult females are determined to the species level. Hybrids are as far as possible determined. Adult males are not determined to the species level. Juveniles which have developed a brood chamber are classified to species level. All others are classified as juveniles. Abundances of large and rare species are counted under a binocular. Here the entire sample is transferred into a Petri dish and the entire area of the Petri dish is screened.

Copepoda: Adult specimens are determined to the species level; males and females are separated. Juvenile stages such as nauplii and copepodites were not determined to the species level till 1987. Since 1988 cyclopoid and calanoid nauplii respectively copepodites are distinguished.

Others: *Dreissena polymorpha* larvae and Difflugia, which are very numerous at times, are quantitatively recorded. We record and count rare specimens such as nematodes, tardigrades, chironomid larvae, ostracodes and chaoborus larvae.

***Calculation of the abundance*:** Abundances are given as Individuals / liter (X)

$$X = \frac{\textbf{Cylinder Volume} \times \text{animal number in the } \textbf{Aliquot Volume}}{\textbf{Aliquot Volume} \times \textbf{Total Volume}}$$

Cylinder Volume = Volume of the measuring cylinder (25ml, 50ml or 100ml) in which the entire condensed water sample (20L) is quantitatively transferred.
Aliquot Volume = Volume of the counted aliquots
Total Volume = Volume of the lake water taken for zooplankton analysis (20L).

Personnel

Names of processors and their taxonomic skills: The following people processed and counted the Müggelsee zooplankton samples:

1979 – 1993:	Maria Krocker
1994 – 2004:	Renate Rusche
2005 – July 2021:	Uschi Newen

All three processors are skilled zooplankton taxonomists. Prior to the change of each processor, the new person was trained for one year by the preceding person. Training of the 'new' processor was considered successful if discrepancies between parallel processing of the same sample by the respective overlapping two processors were in the same range of parallel counting of the same sample by the 'old' processor.

Comments: Uschi Newen assigns a higher number of juvenile Daphnids to the juvenile category compared to Renate Rusche.

References and taxonomic keys

Driescher et al. (1993): Lake Müggelsee and its environment . Natural conditions and anthropogenic impacts. Int. Revue ges. Hydrobiol: 78 (3), 327-343.

Einsle, U. (1993): Crustacea, Copepoda, Calanoida und Cyclopoida. In: J. Schwoerbel & P. Zwick (Hrsg.), Süßwasserfauna von Mitteleuropa Bd.8/4-1, Gustav Fischer Verlag, Stuttgart, Jena, New York: 208 pp.

Flößner, D. (2000): Die Haplopoda und Cladocera (ohne Bosminidae) Mitteleuropas. Backhuys Publishers, Leiden: 428 pp.

Kiefer, F. (1973): Ruderfusskrebse. In: Einführung in die Kleinlebewelt. Kosmos-Verlag Franckh`sche Verlagshandlung, Stuttgart: 99 pp.

Kiefer, F. & Fryer, G. (1978): Freilebende Copepoda. In: Die Binnengewässer Bd. 26, 2.Teil. E. Schweizerbart`sche Verlagsbuchhandlung, Stuttgart: 380 pp.

Korovchinsky, N.M. (1992): Sididae & Holopediidae (Crustacea: Daphniiformes). SPB Academic Publishing bv –III.-, The Hague: 82 pp.

Koste, W. (1978): Rotatoria: Die Rädertiere Mitteleuropas Bd I.(Textband) und Bd.II (Tafelband). Gebrüder Borntraeger, Berlin-Stuttgart: 673 pp. und 234 Tafeln

Lieder, U. (1996): Crustacea, Cladocera/ Bosminidae. In: J. Schwoerbel & P. Zwick (Hrsg.), Süßwasserfauna von Mitteleuropa Bd.8 /2-3. Gustav Fischer Verlag, Stuttgart, Jena, Lübeck, Ulm: 80 pp.

Ruttner-Kolisko, A. (1974): Plankton Rotifers. In: Die Binnengewässer Vol. XXVI/1; Supplement. E. Schweizerbart`sche Verlagsbuchhandlung, Stuttgart: 146 pp. J. Schwoerbel & P. Zwick (Hrsg.),

Pontin, R.M. (1978): A key to the freshwater planktonic and semi-planktonic Rotifera of the British Isles. Freshwater Biological Association Scientific Publication No. 38: 176 pp.

SCHELLENBERGER, G.,ANDR. STELLMACHER. 1986. Zur Frage der Quasihomogenität des Müggelsees. Acta Hydrophysica30:161–173

Stemberger, R.S. (1979) A guide to rotifers of the Laurentian Great Lakes. Publisher: US Environmental Protection Agency, EPA Publ. 600/4-79-021: 186 pp.

Müggelsee - Zooplankton species list

PROTOZOA

Ciliates large
Ciliates small
Codonella cratera
Coleps hirtus
Cothurnia annulata
Epistylis digitalis
Epistylis plicatilis
Epistylis rotans
Peritricha, free
Peritricha, sessile
Stentor spp.
Tintinnidium fluviatile (STEIN, 1863)
Tintinnopsis sp.
Tokophrya sp.
Trichodina sp.
Vorticella sp.
Zoothamnium sp.
Difflugia spp. (LECLERC, 1815)

ROTIFERA

Anuraeopsis fissa (GOSSE, 1851)
Ascomorpha ecaudis (PERTY, 1850)
Ascomorpha ovalis (BERGENDAHL,1892)
Ascomorpha saltans (BARTSCH,1870)
Ascomorpha sp.
Asplanchna girodi/brightwelli Gruppe
Asplanchna priodonta (GOSSE, 1950)
Bdelloida indet.
bentic rotifers ?
Brachionus angularis (GOSSE, 1851)
Brachionus budapestinensis (DADAY)
Brachionus calyciflorus (PALLAS, 1766)
Brachionus diversicornis (DADAY, 1883)
Brachionus quadridentatus (HERMANN, 1783)
Brachionus sp.
Brachionus urceolaris (O.F. MÜLLER, 1773)
Cephalodella sp. (BORY DE ST: VINCENT, 1826)
Collotheca sp. (HARRING, 1913)
Colurella sp. (BORY DE ST. VINCENT, 1824)
Conochilus sp.
Conochilus coenobasis (SKORIKOV, 1914)
Conochilus dossuarius (HUDSON, 1885)

Conochilus natans (SELIGO, 1900)
Conochilus unicornis (ROUSSELET, 1892)
Epiphanes sp.
Euchlanis dilatata (EHRENBERG, 1832)
Euchlanis triquetra (EHRENBERG, 1838)
Euchlanis sp.
Filinia longiseta (EHRENBERG, 1834)
Filinia terminalis (PLATE, 1886)
Gastropus sp.
Gastropus stylifer (IMHOF, 1891)
Hexarthra mira (HUDSON, 1871)
Kellicottia longispina (KELLICOTT, 1879)
Keratella cochlearis (GOSSE, 1851)
Keratella cochlearis var. hispida (LAUTERBORN, 1900)
Keratella cochlearis var. robusta (LAUTERBORN, 1900)
Keratella cochlearis var. tecta (LAUTERBORN, 1900)
Keratella quadrata (O.F. MÜLLER, 1786)
Lecane sp. (NITSCH, 1827)
Lecane / Monostyla sp. (BARTOS, 1959)
Lepadella sp.
Notholca sp.
Notholca acuminata (EHRENBERG, 1832)
Notholca labis (GOSSE, 1887)
Notholca squamula (O.F. MÜLLER, 1786)
Polyarthra sp.
Polyarthra aptera
Polyarthra cf. dolichoptera (IDELSON, 1925)
Polyarthra dolichoptera/vulgaris
Polyarthra major/euryptera
Polyarthra cf. remata (SKORIKOV, 1896)
Polyarthra small
Polyarthra cf.vulgaris (CARLIN, 1943)
Pompholyx complanata (GOSSE, 1851)
Pompholyx sulcata (HUDSON, 1885)
Rotifers indet.
Rotifers hatching
Synchaeta cf. oblonga (EHRENBERG, 1831)
Synchaeta pectinata (EHRENBERG, 1832)
Synchaeta small
Synchaeta stylata (WIERZEJSKI, 1893)
Synchaeta sp.
Trichocerca sp.
Trichocerca bidens (LUCKS, 1912)
Trichocerca capucina (WIERZEJSKI & ZACHARIAS, 1893)
Trichocerca cylindrica (IMHOF, 1891)
Trichocerca pusilla (LAUTERBORN, 1898)
Trichocerca rousseleti (VOIGT, 1902)

Trichocerca similis (WIERZEJSKI, 1893)
Trichocerca stylata (GOSSE, 1851)

CRUSTACEA

Cladocera

Acroperus sp. (BAIRD, 1843)
Alona sp. (BAIRD, 1843)
Eubosmina spp. ♀+ ♂
Eubosmina coregoni coregoni (BAIRD, 1857)
Eubosmina coregoni gibbera (SCHOEDLER, 1863)
Eubosmina coregoni thersites (POPPE, 1887)
Eubosmina coregoni berolinensis (IMHOFF, 1888)
Bosmina longirostris (O.F. MÜLLER, 1785)
Bosmina/Eubosmina juvenile
Bythotrephes longimanus (LEYDIG, 1860)
Ceriodaphnia quadrangula (O.F. MÜLLER, 1785)
Ceriodaphnia sp. (DANA, 1853)
Chydorus sphaericus (O.F. MÜLLER, 1776)
Daphnia juvenile
Daphnia sp. ♀+ ♂
Daphnia cucullata (SARS, 1862)
Daphnia cucullata x galeata (FLÖSSNER, 1993)
Daphnia galeata (SARS, 1863)
Daphnia hyalina (LEYDIG, 1860)
Daphnia hyalina x cucullata (FLÖSSNER, 1993)
Daphnia hyalina x galeata (FLÖSSNER, 1993)
Daphnia longispina (O.F. MÜLLER, 1776)
Diaphanosoma juvenile
Diaphanosoma sp.
Diaphanosoma brachyurum (LIÉVIN, 1848)
Diaphanosoma mongolianum (UENO, 1938)
Diaphanosoma orghidani (NEGREA, 1982)
Eurytemora velox (Lilljeborg, 1853)
Eurytemora sp.
Leptodora Metanauplii
Leptodora Juveniles
Leptodora kindti (FOCKE, 1844)
Leydigia leydigi (SCHOEDLER, 1863)
Monospilus dispar (SARS, 1862)
Pleuroxus truncatus (O.F. MÜLLER, 1785)
Polyphemus pediculus (LINNAEUS, 1761)
Rhynchotalona falcata (SARS, 1861)
Scapholeberis microcephala (SARS, 1890)
Sida crystallina (O.F. MÜLLER, 1776)

Copepoda/Calanoida

Eudiaptomus gracilis (SARS, 1863)
Eudiaptomus graciloides (LILLJEBORG, 1888)

Eurytemora velox (LILLJEBORG, 1853)
Calanoide copepodites
Calanoide nauplii

Copepoda/Cyclopoida

Acanthocyclops robustus (SARS, 1863)
Cyclopoida (s.lat) spp.
Cyclops sp.
Cyclops furcifer (CLAUS, 1857)
Cyclops kolensis (LILLJEBORG, 1901)
Cyclops vicinus (ULJANIN, 1875)
Cyclops strenuus-abyssorum-Gruppe
Diacyclops bicuspidatus (CLAUS, 1857)
Diacyclops sp.
Eucyclops macrurus (SARS, 1863)
Eucyclops serrulatus FISCHER, 1851)
Eucyclops sp.
Megacyclops viridis (JURINE, 1820)
Mesocyclops leuckarti (CLAUS, 1857)
Thermocyclops crassus (FISCHER, 1853)
Thermocyclops oithonoides (SARS, 1863)
Cyclopoid copepodites
Cyclopoid nauplii

OTHERS

Harpacticoida spp. (SARS, 1903)
Chaoborus sp./larvae (LICHTENSTEIN, 1800)
Chironomidae indet.
Dreissena polymorpha/larvae (PALLAS, 1771)
Gastrotricha (Bauchhärlinge)
Hydracarina sp.
Nematoda indet.
Odonata/larvae (Großlibellenlarve) indet.
Oligochaeta indet.
Ostracoda indet.
Tardigrada indet.
Turbellaria indet.