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The genus *Megacyclops* (Crustacea: Copepoda) in the Netherlands: Distribution and ecology

Martin Soesbergen

Abstract
This paper describes the distribution and ecology of the genus *Megacyclops* in the Netherlands. Three species of this genus are present in the Netherlands: *Megacyclops gigas* (Claus, 1857), *Megacyclops latipes* (Lowndes, 1927), and *Megacyclops viridis* (Jurine, 1820). *M. latipes* is new to the Dutch fauna. The taxonomic position and status of *Megacyclops viridis* var. *pelagica* (De Lint, 1922) is clarified.

Keywords: *Cyclops viridis* var. *pelagica*, *Megacyclops latipes*, *Megacyclops gigas*, distribution, ecology

Introduction
Megacyclops is a small genus in the family *Cyclopidae*. This genus is predatory om mosquito larvae and can play a role in the fight against invasive mosquitos (Dieng *et al*., 2002; Awasthi *et al*., 2012; Blaustein & Margalit, 2013; Früh *et al*., 2019) [1-4]. *Megacyclops* is represented by five species in Europe and eight species worldwide (Einsle, 1993, 1996; Dussart & Defaye, 2006; Błędzki & Rybak, 2016) [5-8].
The checklist of planktonic copepod species of the Netherlands has been updated. *M. viridis* and *M. gigas* were known from the Netherlands (Dresscher, 1976; Dekker & Zwerver, 1997) [9, 10] and a pelagic form of *M. viridis* is described by De Lint (1922) [11]. The status of this taxon is uncertain (Gurney, 1933; Kiefer, 1978; Dussart & Defaye, 2006; Aquo, 2020) [12, 13, 7, 14]. The distribution and ecology of the genus *Megacyclops* was examined in more detail because of this unclear taxonomic position of *C. viridis* var. *pelagica* De Lint, 1922. This article discusses the distribution and ecology of the genus *Megacyclops* in the Netherlands.

Material and Methods
The Netherlands is a country in western Europe, approximately 50% of which is situated below sea level (Fig. 1). Three rivers meet the sea in the Rhine-Muese-Scheldt estuary. Fresh water is almost exclusively found above sea level (Redeke, 1948) [15] at the pleistocene sand bottoms. Oligotrophic acid fens are restricted to the pleistocene parts of the Netherlands. The holocene part consists of clay and peat and the waters are oligo- to mesohaline.

Fig 1: The Netherlands above and below sea level and the main water bodies

A literature review and internet survey were conducted to update the checklists of the Dutch planktonic copepods (Mol, 1984) [16]. Samples from the author's collection were used to check for the recent presence of species in the Netherlands. Special attention was given to *Cyclops viridis* var. *pelagica* De Lint, 1922. The original description (De Lint, 1922) [11] and other publications in which this taxon is mentioned or discussed (Scourfield, 1903; Van Breemen, 1907; De Lint, 1922, 1924; Otto, 1927; Redeke, 1935, 1948) [17-22, 15] were consulted to clarify its position. Most of the literature under study is in Dutch and is made accessible in this article. The records from the literature are brought together in distribution maps and a diagram combining acidity and chlorinity.

Results

The results of the literature search are given in this paper. The literature in which the species are mentioned and the samples in which the species were found are given below.

M. gigas (Claus, 1857)

This species is mentioned in Van Breemen (1907) [15], De Lint (1924) [20], Redeke and De Vos (1932) [23], and Dresscher *et al*. (1952) [24]. It was not found in recent samples.

M. latipes (Lowndes, 1927)

This species is probably described as *M. viridis* in Dresscher *et al*. (1952) [24]. *M. latipes* was found in sample MSO1246 from Drenthe in 2018 (Fig. 2-3).

Fig 2: Habitus *Megacylops latipes* Ven A52, 4 January 2018 (Photo: Martin Soesbergen)

Fig 3: Furca of *Megacylops latipes* Ven A52, 4 January 2018 (Photo: Martin Soesbergen)

***M. viridis* (Jurine, 1820)**

This species is mentioned Havinga (1920) [25], De Lint (1922, 1924) [11, 20], Otto (1927) [21], Vorstman (1939) [26], Nadort 1943 [27], Redeke (1948) [15], De Vos (1949, 1954a, 1954b, 1960) [28-31], Wibout Isebree-Moens (1954) [32], Geelen and Davids (1962) [33], Schroevers (1963) [34], Creuzberg and Leentvaar (1969) [35], Gysels (1972) [36], Heip (1973) [37], Hovius (1973) [38], Dresscher (1976) [9], Smit and Daan (1978) [39], Butter (1981) [40], Gulati (1990) [41], Dekker and Zwerver (1997) [10], and Dekker *et al*. (1998) [42]. *M viridis* was found in samples taken in Vught (2009; MSO0002), Weerterbergen (2019; MSO1631), De Hoort (2020; 1640), and Lelystad (2020; MSO1675).

***M. viridis* var. *pelagica* (De Lint, 1922)**

This variety is described in De Lint (1922) [11] and mentioned in De Lint (1922, 1924) [19, 20], Otto (1927) [21], Redeke (1935, 1948) [22, 15], Bijlmer (1938) [43], and Vorstman (1939) [26].

The distribution of *M. gigas* is given in Fig. 4. It is found along the coast in small ponds in the dunes, and all other records are from diluvial sandy soils. *M. latipes* is found only in the province of Drenthe (Fig. 5), in an area with undisturbed acid fens. *M. viridis* has its centre of distribution along the former Zuiderzee (now Lake IJsselmeer) and in the western provinces (Fig. 6). It is almost completely absent from the diluvial sandy soils in the eastern and southern part of the country. *C. viridis* var. *pelagica* was found in lakes in the peaty meadow area in the west and north of the Netherlands and in ponds along the rivers (Fig. 7).

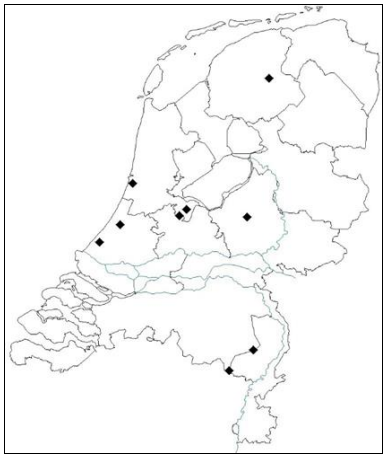

Fig 4: Distribution of *M. gigas*

Fig 5: Distribution of *M. latipes*

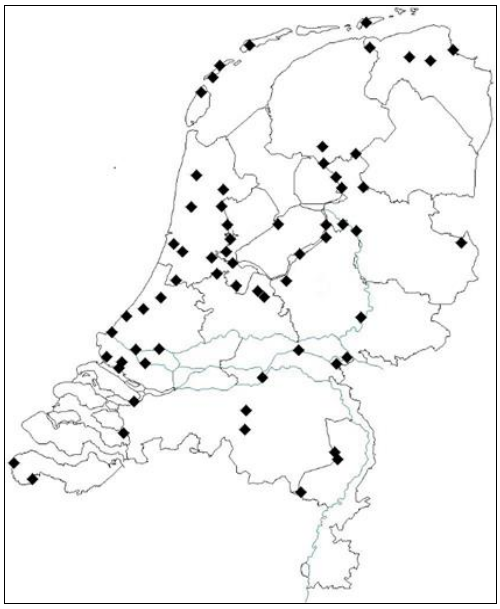

Fig 6: Distribution of *M. viridis*

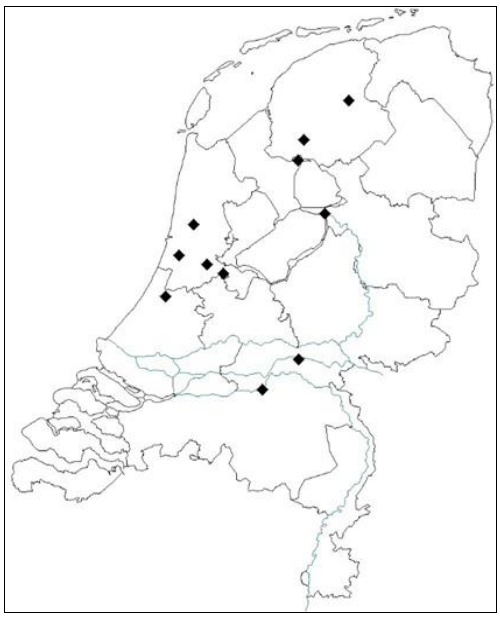

Fig 7: Distribution of *C. viridis* var. *pelagica*

The measurements of acidity and chlorinity mentioned in the literature are merged in figure 8.

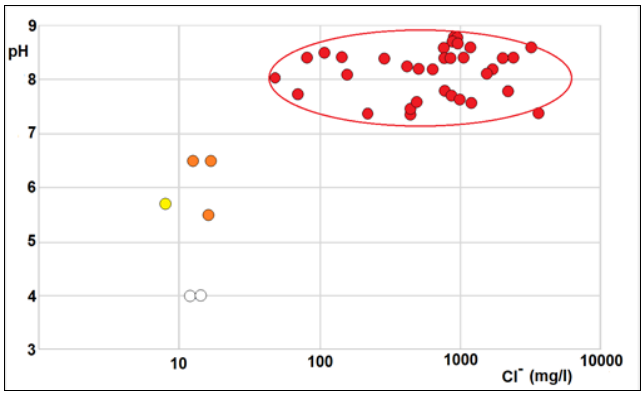

Fig 8: Records of *Megacyclops* according to acidity (pH) and chlorinity (Cl^-), red bullets *M. viridis*, orange bullets *M. gigas*, yellow bullet *M. latipes*, and white bullets '*M. viridis*' from Dresscher *et al*. (1952) [24]

Ecology

The records of *M. gigas* come from small fresh waters (Van Breemen, 1907) [18] and acid oligotrophic fens (Redeke & De Vos, 1932; Dresscher *et al*., 1952) [23, 24]. This species is present in winter and disappears before summer; and it is found between October and April (Van Breemen, 1907; Sars, 1913; De Lint, 1924) [18, 44, 20]. *M. gigas* was found in January 1931 in the Gerritsfles, a slightly acid fen with pH 6.5 and Cl- 16.6 mg/l, together with the copepod *Diaptomus gracilis* and the cladocerans *Acantholeberis curvirostris* and *Coronatella rectangula* (Dresscher *et al*., 1952) [24]. It is a species restricted to pleistocene sandy regions and the dunes where fresh waters are found. There are no recent records of this species in the Netherlands.

Abroad, it is found in small ponds (Sars, 1913; Gaviria, 1998) [44, 45], in the litoral of lakes (Einsle, 1993; Walseng *et al*., 2006) [5, 46], and at considerable depths in the profundal of lakes (Sars, 1913; Kiefer, 1978; Gaviria, 1998) [44, 13, 45].

M. latipes is found in an oligotrophic fen in Drenthe in winter. It was found on 4 January 2018 in turbid water at pH 5.7, with electric conductivity of 38 µS/cm. The fen has a depth of one metre and 50% is covered with peat moss. *M. latipes* was found together with the cladocerans *Acantholeberis curvirostris*, *Acroperus neglectus*, *Chydorus ovalis*, and *Chydorus sphaericus*. The first three are species of oligotrophic waters and have a northern distribution in Europe.

Abroad, *M. latipes* is only found in small puddles and ditches (Gurney, 1933; Cole, 1959; Einsle, 1996) [12, 47, 6] and in the littoral of lakes. In the United States, it is believed to be a species of temporary waters (Cole, 1959; Marten *et al*., 2000; Bruno *et al*., 2001) [47-49]. This species has a northern distribution and prefer cold water (Kiefer, 1939) [50].

M. viridis prefers small ponds and ditches (Otto, 1927; Gurney, 1933; Creutzberg & Leentvaar, 1969; Gysels, 1972; Smit and Daan, 1997) [21, 12, 35, 36, 40] and is also found in the weedy margins of lakes (Havinga, 1920; De Vos, 1954; Stella, 1964; Gaviria, 1998) [25, 29, 51, 45]. *M. viridis* is found in ditches with species-rich submerged vegetation (Smit and Daan 1979) [40]. It is found on holocene clay and peat soils, where oligo- to mesohaline waters are found, but also in fresh waters along the rivers. It is found in eutrophic conditions (Schroevers, 1963; Gulati, 1990) [34, 42] and is absent in oligotrophic peatlands (Schroevers, 1963) [34]. It is present from February until October (Van Breemen, 1907; De Lint, 1924) [18, 20]. *M. viridis* is found together with *Eurytemora velox*, *Macrocyclops fuscus*, *Eucyclops serrulatus*, *E. speratus*, *Acanthocyclops robustus*, and *Macrocyclops albidus*, as well as the cladocerans *Simocephalus vetulis*, *Coronatella rectangula*, and *Pleuroxus truncatus*. These crustaceans are bound to vegetation. The records of *M. viridis* at pH 4 in an oligotrophic fen are questionable. It has been found in vegetation of *Sphagnum subsecundum* and *Eleocharis palustris*, together with the cladocerans *Acantholeberis curvirostris* and *Eubosmina obtusirostris* (Dresscher *et al*., 1952) [24].

Abroad, *M. viridis* is also found in large lakes, where it inhabits the bottom, the profundal, at considerable depths of up to 300 meters (Monakov, 1958; Stella, 1964) [52, 51].

M. viridis is restricted to slightly alkaline to alkaline waters with low (70 mg/l) to high (3650 mg/l) chlorinity (Fig. 8). The few records of *M. gigas* and the one of *M. latipes* are from acid to slightly acid waters with very low (8-16 mg/l)

chlorinity (Fig. 8). The Dutch records show a clear difference between the habitat preference of *M. viridis* and the records of the other two species in the Netherlands.

Discussion

The observed preference of *M. viridis* for alkaline waters with higher conductivity (Fig. 8) is in concordance with the findings of Fryer (1993) [53] in Yorkshire and of Walseng (2016) [54] in Norway. In Norway, *M. viridis* is more common in the south and prefers waters with conductivity above 700 µS/cm (Walseng, 2016) [54]. *M viridis* was found primarily in alkaline waters in Yorkshire (Fryer, 1993) [53]. The range of pH is wider in Yorkshire and Norway (4.5-10.2) than in the Netherlands, but *M. viridis* was never found at a pH lower than 4.5 in Norway (Walseng), 2016) [54] and only three times – out of 124 – at lower than 6.0 in Yorkshire (Fryer, 1993) [53]. The only record of *M. gigas* in England is from Wicken Fen (Harding & Smith, 1974) [55]. *M. gigas* is a common species in Norway. It is found over a broad range of pH and conductivity, but not below pH 4.5. Some Dutch records of '*M. viridis*' at pH 4.0 are lower than observed for both *M. viridis* and *M. gigas* and these are probably records of *M. latipes*. This species was not accepted as valid in 1952.

De Lint describes *Cyclops viridis* var. *pelagica* as a small pelagic taxon, being absent from diluvial sandy soils in the Netherlands (De Lint, 1922a, 1922b, 1924) [11, 19, 20]. It is found in the warmer season and is absent from November until April (De Lint, 1924) [20]. The description (translated from the German) is as follows:

'The size is small. The length of adult females of the variety found by me is between 1.2 and 1.7 mm. The inside of the furcal rami is bold or very minimally occupied with hairs. It is a planktonic species. That is why I call it *Cyclops viridis* var. *pelagica*. It is very common and most abundant in summer. Some animals from De Poel near Amstelveen and Alkmaardermeer have cuticular pits.'

De Lint (1922, 1924) [11, 20] refers in her text to Scourfield (1903) [17], who mentions a pelagic taxon without hairs on the furcal rami. Van Breemen (1907) [18] thought he had found the taxon seen by Scourfield in the river Spaarne. Gurney (1933) [12] states, 'De Lint has recorded a *C. v.* var. *pelagica* as common in Dutch plankton; but there is reason to believe that this is really *C. vemalis americanus'*. Gurney did not substantiate this claim. The Dutch checklist refers to it as *Acanthocyclops viridis pelagica* and thus as part of *Megacyclops viridis*; and later, Kiefer (1978) [13] and Dussart and Defaye (2006) [7] treat it as synonymous with *Megacyclops gigas*. Thus, there are at least three possible names for this taxon. The bold furcal rami are a good reason why this taxon does not belong to the genus *Megacyclops*. *M. gigas* is a species 2.0 to 3.5 mm in length (Einsle, 1996) [6] and the size and hairy inner margin of the furcal rami rule out *M. gigas*. It is not *M. viridis* because De Lint described it as 'variety', and *M. viridis* is not a pelagic species (De Lint, 1922; Otto, Gurney, 1933; De Vos, 1954; Monakov, 1958; Stella, 1964; Harding & Smith, 1974; Dekker *et al*., 1998; Walseng *et al*., 2006) [11, 12, 29, 52, 51, 55, 44, 46] and has a hairy inner margin of the furcal rami (Einsle, 1993 and 1996) [5, 6]. An overlooked remark on *Cyclops viridis* var. *pelagica* comes from Redeke (1948) [15]. He writes (translated), 'Further investigation has shown this taxon to be *Cyclops vernalis americanus* Marsh' (Redeke, 1948) [15], thereby confirming the assumption of Gurney (1933) [12]. *Cyclops vernalis americanus* Marsh is now considered to be a valid species *Acanthocyclops americanus* Marsh, 1893 (Karanovic & Bláha, 2019) [56].

The animals with cuticular pit markings should be regarded as another taxon, because *C. vernalis americanus* has no pit markings (Harding & Smith, 1974) [55]. Cuticular markings are good properties by which to distinguish the species pairs *A. robustus*/*A. americanus* without pits on the genital segment and *A. vernalis*/*A. europensis* with pits (Karanovik & Bláha, 2019) [56]. *A. vernalis* is not found in lakes or open water (Harding & Smith, 1974; Fryer, 1985; Walseng *et al*., 2006) [55, 57, 46], and does not contribute to the species richness of the pelagic in lakes (Walseng *et al*., 2006) [46]. The Dutch animals with cuticular pit markings (De Lint, 1922) [11] might belong to *Acanthocyclops europensis* Karanovik & Bláha, 2019.

Conclusion

Three species of *Megacyclops* are present in the Netherlands: *M. gigas*, *M. latipes*, and *M. viridis*. While there are no records of *M. gigas* after 1952, *M. latipes* is new to the Dutch fauna and *M. viridis* is a common species in the Netherlands.

M. viridis prefers eutrophic, slightly alkaline waters and it is present in fresh, oligo- and mesohaline inland waters. *M. viridis* is found in all kinds of water, including the littoral of the large lakes and small vegetated ditches. *M. gigas* and *M. latipes* are found in small oligotrophic fresh waters, especially in acid fens.

Cyclops viridis var. *pelagica*, as described by De Lint (1922), is not a member of the genus *Megacyclops* but is *Acanthocyclops americanus* Marsh, 1893. The Dutch pelagic animals with cuticular pit markings mentioned by De Lint (1922) [11] might belong to *Acanthocyclops europensis* Karanovik & Bláha, 2019.

References

1. Dieng H, Boots M, Tuno N, Tsuda Y, Takagi M. A laboratory and field evaluation of *Macrocyclops distinctus*, *Megacyclops viridis* and *Mesocyclops pehpeiensis* as control agents of the dengue vector *Aedes albopictus* in a peridomestic area in Nagasaki, Japan. Medical and Veterinary Entomology 2002;16(3):285-291.
2. Awasthi AK, Wu CH, Tsai KH, King CC, Hwang JS. How does the ambush predatory copepod *Megacyclops formosanus* (Harada, 1931) capture mosquito larvae of *Aedes aegypti*? Zoological Studies 2012;51(7):927-936.
3. Blaustein L, Margalit J. Differential vulnerability among mosquito species to predation by the cyclopoid copepod, *Acanthocyclops viridis*. Israel Journal of Zoology 2013;40(1):55-60.
4. Früh L, Kampen H, Schaub G, Werner D. Predation on the invasive mosquito *Aedes japonicus* (Diptera: Culicidae) by native copepod species in Germany. Journal of Vector Ecology 2019;44(2):241-247.
5. Einsle U. Crustacea Copepoda Calanoida und Cyclopoida. - Süβwasserfauna von Mitteleuropa 1993;8/4-1:1-209.
6. Einsle U. Copepoda: Cyclopoida genera *Cyclops*, *Megacyclops*, *Acanthocyclops*. - Guides to the Identification of the Micro invertebrates of the Continental Waters of the World 1996;10:1-83.
7. Dussart B, Defaye D. World directory of Crustacea Copepoda of inland waters II Cyclopiformes. Backhuys

Publishers, Leiden 2006, 1-354.
8. Błędzki LA, Rybak JI. Freshwater crustacean zooplankton of Europe. - Springer International Publishing 2016, 1-918.
9. Dresscher TNG. Index van de namen en vindplaatsen die betrekking hebben op in Nederlandse wateren aangetroffen algen en enige groepen micro-organismen. North-Holland Publishing Company, Amsterdam 1976, 1-808.
10. Dekker P, Zwerver S. Copepoden van het open water handleiding bij de cursusdag. Koeman & Bijkerk, Haren 1997, 1-52.
11. De Lint G. Untersuchungen über Plankton-Copepoden in Niederländischen Gewässern. Internationale Revue der Gesamten Hydrobiologie 1922;10:76-90.
12. Gurney R. British fresh-water Copepoda volume III. Dulau & Co Ltd., London 1933, 1-384.
13. Kiefer F. Freilebende Copepoda. Das Zooplankton der Binnengewässer 1978;26(2):1-380.
14. Aquo. Taxa Waterbeheer Nederland TWN-lijst. https://www.aquo.nl/tools/twn-lijst. 27 December 2020.
15. Redeke HC. Hydrobiologie van Nederland de zoete wateren. Backhuys & Meesters, Amsterdam 1948, 1-580.
16. Mol AWM. Limnofauna Neerlandica een lijst van meercellige ongewervelde dieren aangetroffen in binnenwateren van Nederland. Nieuwsbrief European Invertebrate Survey - Nederland 1984;15:1-124.
17. Scourfield DJ. Synopsis of the known species of the British fresh-water Entomostraca part II Copepoda. Journal of the Quekett Microscopical Club 1903;8:531-544.
18. Van Breemen PJ. Vrijlevende zoetwater-copepoden. Fauna van Nederland 1907;2:-66.
19. De Lint G. Cladoceren en copepoden. In: Redeke, HC. (red.) Flora en fauna der Zuiderzee monografie van een brakwatergebied. De Boer, Den Helder 1922, 289-310.
20. De Lint GM. De copepoden, cladoceren en ostracoden van het zoete en brakke water van Nederland en haar beteekenis als vischvoedsel. RIVON, Ijmuiden 1924, 255-281.
21. Otto JP. Een oecologische studie van de Kagerplassen en omgevende wateren. Proefschrift, Universiteit van Leiden 1927, 1-70.
22. Redeke HC. Synopsis van het Nederlandsche zoet- en brakwater-plankton. Publicatie Hydrobiologische Club 1935;2:1-104.
23. Redeke HC, APC. de Vos Beiträge zur Kenntnis der fauna niederländischer oligotropher Gewässer. Internationale Revue der gesamten Hydrobiologie und Hydrographie 1932;28:1-45.
24. Dresscher TNG, De Graaf F, De Groot AA, Heimans J, Van Heusden GPH, Koster JT *et al*. De Gerritsfles bij Kootwijk. Hydrobiologische Vereniging Publicatie 1952;4:1-22.
25. Havinga B. Studiën over flora en fauna van het Zuidlaarder Meer. Nederlands Kruidkundig Archief 1920;29:9-316.
26. Vorstman AG. Een overzicht over ’t plankton van het Kinselmeer, gedurende het jaar 1938-1939. Verhandelingen van de Hydrobiologische Club Amsterdam 1939;2:12-15.
27. Nadort W. Amsterdam’s planktoncrustacea in het jaar 1941. De Levende Natuur 1943;48(4):45-51.
28. De Vos APC. Enige hydrobiologische waarnemingen op Vlieland. Bijdragen tot de Dierkunde 1949;28:540-542.
29. De Vos APC. De litorale fauna van het IJsselmeer. In: De Beaufort (red.) Veranderingen in de flora en fauna van de Zuiderzee (Thans IJsselmeer) na de afsluiting in 1932. De Boer, Den Helder 1954, 268-276.
30. De Vos APC. Over de oever- en bodemfauna der binnendijkse kolken langs het IJsselmeer. In: De Beaufort (red.) Veranderingen in de flora en fauna van de Zuiderzee (Thans IJsselmeer) na de afsluiting in 1932. De Boer, Den Helder 1954, 270-282.
31. De Vos APC. Crustacea, vermes en insecta verzameld en gedetermineerd. Publicatie van de Hydrobiologische Vereniging Amsterdam 1960;5:79-83.
32. Wibout Isebree-Moens NL. Plankton. In: De Beaufort (red.) Veranderingen in de flora en fauna van de Zuiderzee (Thans IJsselmeer) na de afsluiting in 1932. De Boer, Den Helder 1954, 90-140.
33. Geelen JFM, Davids C. Microfauna van enkele wateren in de Ooypolder. Mededelingen van de Hydrobiologische Vereniging 1992;6:89-99.
34. Schroevers P. Rapport betreffende de micro-organismen en micro-coenosen van Maria- en Helenapeel. RIVON, Bilthoven 1963, 1-23.
35. Creuzberg F, Leentvaar P. Over het voorkomen van copepoden en cladoceren in de Molenpolder 1951-1952. Rivon Verhandelingen 1969;7:61-80.
36. Gysels H. Over de invloed van enkele fysico-chemische faktoren op de faunistische rijkdom van de Noordoost-Vlaamse kreken. Aquatic Ecology 1972;6(4):172-195.
37. Heip C. Een populatie-dynamische studie over de benthale Ostracoda en Copepoda van een brakwaterhabitat. Proefschrift, Rijksuniversiteit Gent 1973, 1-429.
38. Hovius KE. Planktononderzoek D.M.V. in bakken ingesloten koelwater bij de centrale Harculo. KEMA, Arnhem 1973, 1-24.
39. Smit H, Daan R. Een hydrobiologisch onderzoek van de oppervlaktewateren van Voorne-Putten. Openbaar Lichaam Rijnmond 1979, 1-49.
40. Butter ME. Estimation of zooplankton populations in Lake Maarsseveen I: problems, proceedures and results. Hydrobiological Bulletin 1981;15(1-2):51-59.
41. Gulati R. Zooplankton structure in the Loosdrecht lakes in relation to trophic status and recent restoration measures. Hydrobiologia 1990;191:173-188.
42. Dekker P, Dijkers C, Mulder J, Hoyer M, Geene R, Tempelman D *et al*. Hydrobiologisch onderzoek in boezemwateren van Noord-Holland 1998. AquaSense Amsterdam 1999, 1-8.
43. Bijlmer L. Amsterdam´s planktoncrustaceeën. De Levende Natuur 1938;43:87-94.
44. Sars GO. An account of the Crustacea of Norway with short descriptions and figures of all the species vol. VI parts I & II Oithonidae, Cyclopinidae, Cyclopidae (part). Museum of Bergen 1913, 1-225.
45. Gaviria S. Checklist and distribution of the free-living copepods (Arthropoda: Crustacea) from Austria. Annalen des Naturhistorischen Museums in Wien 1998;100:539-594.
46. Walseng B, Hessen DO, Halvorsen G, Schartau AK. Major contribution from littoral crustaceans to zooplankton species richness in lakes. Limnology and

Oceanography 2006;51(6):2600-2606.
47. Cole GA. A summary of our knowledge of Kentucky crustaceans. Transactions of the Kentucky Academy of Science 1959;20(3-4):66-81.
48. Marten GG, Nguyen M, Mason BJ, Ngo G. Natural control of *Culex quinquefasciatu*s larvae in residential ditches by the copepod *Macrocyclops albidus*. Journal of Vector Ecology 2000;25(1):7-15.
49. Bruno MC, Loftus WF, Reid JW, Perry SA. Diapause in copepods (Crustacea) from ephemeral habitats with different hydroperiods in Everglades National Park (Florida, U.S.A.). Hydrobiologia 2001;453:295-308.
50. Kiefer F. Mission scientifique de l'omo Crustacea IV. Copepoda: Diaptomidae, Cyclopoidae. Mémoires du Muséum National d'Histoire Naturelle 1939;9:319-378.
51. Stella S. *Megacyclops viridis* Jurine, abbysal form in Laggo Maggiore. Memorie dell' Istituto Italiano di Idrobiologia 1964;17:57-79.
52. Monakov AV. On the problem of the distribution of *Acanyhocyclops viridis* Jurine in the Rybinsk reservois. FBA Translations 1958;78:1-4.
53. Fryer G. The freshwater Crustacea of Yorkshire a faunistic and ecological survey. Titus Wilson and Son, Kendal 1993, 1-312.
54. Walseng B. Small crustaceans in fresh waters Copepoda. https://www.artsdatabanken.no. 27 December 2020.
55. Harding JP, Smith WA. A key to the British freshwater cyclopid and calanoid copepods. Freshwater Biological Association Scientific Publication 1974;18:1-56.
56. Karanovik T, Bláha M. Taming extreme morphological variability through coupling of molecular phylogeny and quantitative phenotype analysis as a new avenue for taxonomy. Scientific Reports 2019;9(2429):1-15.
57. Fryer G. An ecological validation of a taxonomic distinction: the ecology of *Acanthocyclops vernalis* and *Acanthocyclops robustus* (Crustacea: Copepoda). Zoological Journal of the Linnean Society 1985;84(2);165-180.