

An update on the inland cladoceran and copepod fauna of Belgium, with a note on the importance of temporary waters

László Forró¹, Luc De Meester², Karl Cottenie² and Henri J. Dumont³

¹Department of Zoology, Hungarian Natural History Museum, Baross u. 13, H-1088 Budapest, Hungary

²Laboratory of Aquatic Ecology, Katholieke Universiteit Leuven, Ch. De Beriotstraat 32, B-3000 Leuven, Belgium

³Laboratory of Animal Ecology, University of Ghent, K.L. Ledeganckstraat 35, B-9000 Gent, Belgium

ABSTRACT. A field survey of mostly small and shallow inland water bodies in Flanders yielded three cladoceran and two copepod species new to the fauna of Belgium. These new records involve two *Moina* species (*M. micrura*, *M. weismanni*), *Simocephalus serrulatus*, the calanoid copepod *Mixodiaptomus kupelwieseri* and the cyclopoid copepod *Metacyclops minutus*. Special attention was paid to the fauna of temporary pools and wheel tracks. In the pools sampled in spring, the zooplankton was dominated by *Daphnia obtusa*, *Eucyclops serrulatus* and/or *Diacyclops bicuspidatus*. The crustacean fauna of the pools sampled in summer was dominated by *Moina macrocopa* and *Metacyclops gracilis*, whereas *Metacyclops minutus* was dominant in the pools sampled in autumn. Even though species diversity was generally found to be low in the wheel tracks and pools sampled, the taxa were found to be rather typical.

KEY WORDS : Cladocera, Copepoda, new records, temporary waters, vernal pools, Belgium.

INTRODUCTION

Temporary waters bodies are common on all continents, but biological and ecological research on these habitats lags behind the studies on permanent lentic and lotic waters (e.g. SCHWARTZ & JENKINS, 2000). This lack of attention probably stems from the small size of many of these habitats, the fact that they contain no fish, and their transient nature. As such, these habitats have been considered of limited economic value. From an ecological point of view, however, these habitats have considerable added value, because they contain taxa that are absent from more permanent water bodies (EDER & HÖDL, 1996; MAIER et al., 1998). Although biodiversity in these habitats is often not spectacularly high, many taxa inhabiting temporary water bodies have special adaptations to the ephemeral nature of the habitat and can be considered ecological specialists (BRENDONCK, 1996; WILLIAMS, 2000). Since temporary waters often lack fish, they also function as a refuge for taxa that are not able to coexist with fish because of their large body size (KERFOOT & LYNCH, 1987). The best representatives of this strategy are the large branchiopods, that, in the course of evolution, were excluded from many habitats by smaller-sized zooplankton species that were less vulnerable to fish predation (KERFOOT & LYNCH, 1987), but managed to survive in all kinds of, mostly temporary, water bodies that lack fish. Large branchiopods can thus be considered "flagship" species of small temporary waters (EDER & HÖDL, 1996). Temporary ponds are threatened all over the world, not only because of deteriorating water quality, but also because their number is decreasing dramatically, largely due to human impact such as draining, agriculture, and urban

development (BROWN, 1998). Temporary waters are under threat all over Europe, but their status is more dramatic in Western than in Central Europe (e.g. MURA, 1993). In areas such as Flanders (Belgium), most temporary pools and ponds have disappeared, and the large branchiopods have disappeared for about a century (BRENDONCK, 1989). Of the two records of large branchiopods in Belgium in the last decades (*Leptestheria dahalacensis* (RÜPPEL, 1837), BRENDONCK et al., 1989; *Chirocephalus diaphanus* (Prévost, 1803), LONEUX (WALRAVENS, 1998), the conchostracan *Leptestheria dahalacensis* recorded from the region of Brussels no doubt was accidentally introduced.

There is virtually no knowledge on the biota in the remaining temporary ponds in Flanders, such that a comparison with ponds in less impacted areas is impossible. The purpose of the present paper is to present the results of a survey of a limited number of temporary pools in Flanders, in an effort to gain insight on whether these water bodies contain typical crustacean zooplankton taxa, even though the large branchiopods have disappeared. In addition, we report on the occurrence of *Moina* species in Flanders. *Moina* species are often an important component of the zooplankton in temporary waters (GOULDEN, 1968), but virtually no data have been reported on the occurrence of *Moina* species in Flanders. We have observed *Moina* species in both temporary and more permanent water bodies. Finally, we also report on an additional new record for the cladoceran fauna of Belgium.

MATERIAL AND METHODS

The field surveys consisted of two parts. First, we conducted a survey of the microcrustacean taxon composition

in a set of 30 temporary pools and wheel tracks. We sampled ten temporary waters in spring 2000 (March-April), 13 in summer 2000 (July) and seven in autumn 2000 (November) (Table 1). All samples were taken with a plankton net of 85 µm mesh size. The samples were immediately preserved with 4% formaldehyde.

In addition to this survey of the zooplankton composition of a limited set of temporary waters, we also carried out several field surveys directed at the documentation of the occurrence of representatives of *Moina* in Flanders. Between 1988 and 2000, numerous water bodies were sampled and screened for the presence of *Moina* species.

Finally, we also report another new record for the Belgian cladoceran fauna. This species was observed during field surveys of the pond complex of De Maten (COTTENIE et al., 2001 ; COTTENIE & DE MEESTER, in press). The pond complex consists of 35 shallow and interconnected ponds ranging in size from <1 ha to approx. 10 ha. In summer (July) 1996, 14 of these ponds were intensively sampled with a dip net with mesh size 200 µm and analysed in detail for their taxon composition in microcrustacean zooplankton, screening a minimum of 300 individuals. As the earlier work on these samples focused on patterns of similarities in species composition among ponds (COTTENIE et al., 2001) and on patterns of species diversity (COTTENIE & DE MEESTER, in press) without providing a species list, we here report on the new records.

RESULTS

New records

Moina micrura Kurz, 1874

Material : several egg-bearing parthenogenetic and ephippial females and two males.

Locality : pond near Lake Donkmeer (Overmere, Eastern Flanders ; August 1988)

M. micrura was originally described from Central Europe, and considered as a highly variable, cosmopolitan species (GOULDEN, 1968). In Europe, this species has a circummediterranean-pontic distribution, with the northernmost occurrence at Hamburg (FLÖSSNER, 2000). It is also known from The Netherlands (NOTENBOOM-RAM, 1981). Its occurrence in Belgium was anticipated by DUMONT (1989a). The species can be easily differentiated from the two *Moina* species that have previously been reported from Belgium (*M. brachiata* and *M. macrocopa* : DUMONT, 1989a) by its small size, large eye, deep supra-ocular depression, and the structure of its postabdomen and claw.

Moina weismanni Ishikawa, 1896

Material : seven parthenogenetic females, two ephippial females and two males.

Locality : dead arm of the River Schelde near Melle (Eastern Flanders ; August 1988).

M. weismanni was earlier known from the Far East (GOULDEN, 1968). MARGARITORA et al. (1987) have recorded this species for the first time in Europe in Italy. HUDEC (1990) reported the occurrence of this species from Czechoslovakia, Hungary and Yugoslavia, and PETKOVSKI

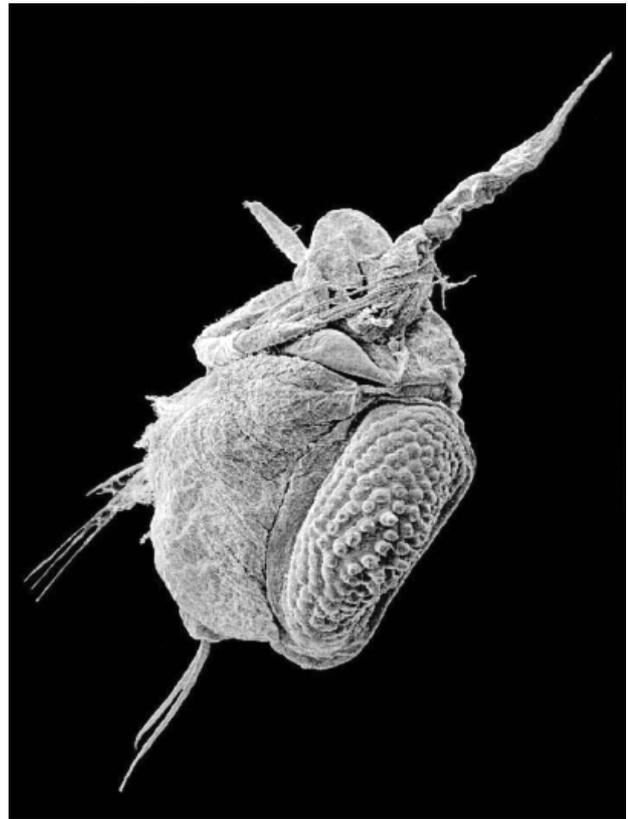


Fig. 1. – *Moina weismanni*, female showing ornamentation of ephippia.

(1991) reported the species from SW Yugoslavia (Macedonia), proving that the species inhabited the Balkan Peninsula too. The present record is the first from Western Europe. *M. weismanni* is very similar to *M. micrura* : the parthenogenetic females of the two species are very difficult to separate. The sexual females can, however, easily be recognized, because of the unique surface ornamentation of the ephippium of *M. weismanni* (Fig. 1). The central and dorsal part of the ephippium of *M. weismanni* is characterized by raised knobs, which can be easily seen in lateral view. In addition to the ephippium, the female's distinctive features are the short and thick antennules and the 15-21 fine, long spicules of the pecten on the postabdominal claw (HUDEC, 1990). In the Central European *M. micrura*, the antennules are long and spindle-like, and the pecten has 10-15 short, thick horns that are nearly triangular-shaped. The distinctive characters of *M. weismanni* males are the long antennules that are thick near the base and show four short, thick hooks at the tip. *M. micrura* males have long and thin antennules, with three long and thin hooks on the tip (HUDEC, 1990). The ventro-anterior part of the carapace has fine, long hairs in *M. weismanni*, while it is entirely naked in *M. micrura*.

Simocephalus serrulatus (Koch, 1841)

Material : 62 parthenogenetic females.

Locality : five different ponds in the pond complex of De Maten (July 1996).

Simocephalus serrulatus has a world-wide distribution, but has never been recorded from Belgium. It has been found all over Europe, except the Iberian peninsula, Ire-

land and the Arctic region (FLÖSSNER, 2000) and was anticipated to occur in Belgium in the review by DUMONT (1989a). This species is very characteristic, and easy to recognize thanks to the large prominence of the dorso-posterior valve separated from the rest of the valves by deep embayment. Further characteristic features are the denticles on the frons and on the ventral, posterior and on about one third of the dorsal margins of the valves. It seems to be quite widespread in the pond complex of De Maten, although it proved much less abundant than the two other *Simocephalus* species (*S. vetulus* and *S. expinosus*), which were both represented by several hundreds of individuals in the same samples.

Mixodiaptomus kupelwieseri (Brehm, 1907)

Material : several females and males.

Locality : a vernal pool in Bourgoyen Nature Reserve (Gent, Eastern Flanders ; March 2000).

Mixodiaptomus kupelwieseri was the only calanoid copepod in our samples from temporary pools, and was abundant in the one pond in which it was found. This record greatly extends the known distribution area, since previously it was known from Central and Southern Europe (Austria, Moravia, Hungary, Italy, Greece) and from the Camargue (DUSSART, 1967 ; EINSLE, 1993). It is a typical inhabitant of temporary waters. It is found in autumn and winter in Southern Europe (DUSSART, 1967) and in spring in Central Europe (BRTEK, 1954).

DUMONT (1989b) listed seven calanoids from Belgium, four of them belonging to Diaptomidae. *Mixodiaptomus kupelwieseri*, the fifth diaptomid species, but the only member of the genus *Mixodiaptomus* in Belgium, can be easily differentiated from the other diaptomids, particularly based on the structure of the fifth legs of the female and male (EINSLE, 1993).

Metacyclops minutus (Claus, 1863)

Material : several females and males.

Locality : seven temporary pools located near Leuven, Erps-Kwerps, Nederokkerzele and Kampenhout (November 2000).

M. minutus is a typical species of temporary pools (MAIER, 1992a), its occurrence in our material was limited to temporary pools sampled in autumn. With the exception of at one site it occurred in very low numbers. However, in six of the seven pools it was the only species found.

This is the third species of the genus *Metacyclops* found in Belgium. Based on the antennule containing 11 segments it can be separated from *M. problematicus* (which is only known from one locality). *Metacyclops gracilis* has two apical spines on the endopod of the 4th leg, while there is only one seta on the endopod of the 4th leg of *M. minutus* and a further distinctive character is the absence of the inner seta on the basis of the 1st leg in the latter species. It is cosmopolitan (EINSLE, 1993), distributed all over Europe, though mostly rare; in Germany it is listed in the red data book (MAIER et al., 1998).

The occurrence of *Moina* in Flanders

Altogether four species of *Moina* are presently known from Belgium. In addition to the two new species reported to occur in Belgium (see above, *M. micrura* and *M. weismanni*), *M. brachiata* and *M. macrocopa* have already been reported (DUMONT, 1989a). During our survey, we did not detect *M. brachiata*, while *M. macrocopa* was found in several wheel tracks near Willebringen and Tielrode in July 2000.

Community composition of crustacean zooplankton in temporary pools and wheel tracks

Table 1 lists the taxa observed in a total of 30 temporary pools and wheel tracks. In total, seven cladocerans and nine copepods were recorded. In spring, only three cladoceran species were observed, all of which were widespread and common. The dominance of *Daphnia obtusa* as the only daphnid in all but one of the pools sampled in spring is striking. Copepods were prominent members of the zooplankton in the pools sampled in spring, with a total of three cyclopoid species and one calanoid species. The calanoid *Mixodiaptomus kupelwieseri* has been discussed above. There was only little overlap in the occurrence of the different cyclopoid copepods, which tended all to be very common. In summer, six cladocerans and six copepods were observed. The two larger temporary pools sampled (Haasrode) were dominated by *Simocephalus* species, *Daphnia curvirostris* (one pond) and three cyclopoid copepods (*Macrocyclus albidus*, *Eucyclops serrulatus* and *Acanthocyclops robustus*). *Moina macrocopa* reached very high densities in most of the small wheel tracks sampled at Willebringen, whereas *Daphnia obtusa* dominated the larger wheel tracks at the Doode Beemde. In most of the small wheel tracks at Willebringen, *Metacyclops gracilis* was the only copepod. In two of these wheel tracks, this species was accompanied by *Paracyclops fimbriatus* (Table 1). In autumn, most ponds sampled only harboured *Metacyclops minutus*. In one of the ponds, this species was accompanied by *Daphnia pulex* and *Cyclops strenuus*.

DISCUSSION

DUMONT (1989a) summarized the faunistical knowledge on the non-marine Cladocera of Belgium and listed 74 species. Since then, BELADJAL et al. (1992) reported the occurrence of *Alona rustica* Scott, 1895, DE MEESTER & BOSMANS (1994) reported on the occurrence of *Eurycercus glacialis* Lilljeborg, 1887 in a pond that had been restored by dredging (thus potentially representing a case of the recovery of a species that occurred in the pristine habitat and hatched from an old resting egg bank), and KETELAARS & GILLE (1994) reported on the occurrence of *Bythotrephes longimanus* Leydig, 1860 from Belgium. The present paper adds three new records to this list (*Moina micrura*, *M. weismanni* and *Simocephalus serrulatus*). As a result, the current number of cladocerans recorded from Belgium has increased to 80. Several of the species were anticipated to be discovered based on their known geographic area (DUMONT, 1989a). The most surprising and unexpected finding is *M. weismanni*. The previous records from Central and Southern Europe were attributed to an introduction

wheel tracks studied was dominated by *Moina macrocopa*, *Daphnia obtusa* only being found in relatively large wheel tracks. The copepod fauna in summer was dominated by *Metacyclops gracilis*, whereas the only species occurring in the autumn samples was *M. minutus*, and *Mixodiaptomus kupelwieseri* is a typical spring species. As we sampled different ponds in the different seasons, it is obvious that one should be careful in interpreting these patterns as merely reflecting seasonal changes. Yet, the patterns discussed are in concordance with literature data (FRYER, 1985a; MAIER et al., 1998). MAIER (1992b, 1993) describes a replacement of *Daphnia obtusa* by *Moina brachiata* in vernal pools in Germany, whereas FRYER (1985a) reported on the occurrence of both *Daphnia obtusa* and *Moina brachiata* in temporary waters in the U.K. It is striking that we observed only *Moina macrocopa* in our samples, whereas both these earlier reports refer to *M. brachiata*.

Overall, our study underlines the importance of temporary water bodies for the aquatic invertebrate fauna. The fact that an albeit limited sampling effort has resulted in four (two cladocerans and two copepod) taxa new to the Belgian fauna suggests that wheel tracks, temporary waters and wetlands in general deserve more detailed study, and should be incorporated in standard monitoring schemes on nature value.

ACKNOWLEDGEMENTS

This study was made possible thanks to project BIL99/17, a project of Bilateral scientific cooperation between Hungary and the Flemish government. KC is a research assistant with the National Fund for Scientific Research - Flanders (FWO). Sandra Enis carried out some of the species determinations of the samples from De Maten, and Koen De Gelas and Eddy Holsters helped with field work.

REFERENCES

- ALEKSEEV, V., E. FEFILOVA & H.J. DUMONT (2002). Some noteworthy free-living copepods from surface freshwater in Belgium. *Belg. J. Zool.*, 132 : 133-139.
- BACHIORRI, A., V. ROSSI, C. BONACINA & P. MENOZZI (1991). Enzymatic variability of a colonizing population of *Daphnia obtusa* Kurz (Crustacea, Cladocera) in Lake Orta (Italy). *Verh. Internat. Verein. Limnol.*, 24 : 2813-2815.
- BELADJAL, L., J. MERTENS & H.J. DUMONT (1992). A simple basket trap for estimating relative abundances of some components of hyporheic faunas : application to the Cladocera. *Stygologia*, 7 : 193-195.
- BRENDONCK, L. (1989). A review of the phyllopod (Crustacea : Anostraca, Notostraca, Conchostraca) of the Belgian fauna. In : WOUTERS, K. & BAERT, L. (eds), *Invertébrés de Belgique*. C. R. Sc. Nat. Belgique : 129-135.
- BRENDONCK, L. (1996). Diapause, quiescence, hatching requirements : what we can learn from large freshwater branchiopods (Crustacea : Branchiopoda : Anostraca, Notostraca, Conchostraca). *Hydrobiologia*, 320 : 85-97.
- BRENDONCK, L., B. GODDEERIS & K. MARTENS (1989). *Leptesteria dahalacensis* (Rüppell, 1837), a conchostracan new for the Belgian fauna. *Bull. Inst. r. Sci. Nat. Belgique, Biologie*, 59 : 59-62.
- BROWN, K.S. (1998). Vanishing pools taking species with them. *Science*, 281 : 626.
- BRTEK, J. (1954). Beitrag zur Kenntnis des *Mixodiaptomus kupelwieseri* (Brehm) in der Slowakei. *Biologia (Bratislava)*, 9 : 60-64.
- COTTENIE, K., N. NUYTTEN, E. MICHELS & L. DE MEESTER (2001). Zooplankton community structure and environmental conditions in a set of interconnected ponds. *Hydrobiologia*, 442 : 339-350.
- COTTENIE, K. & L. DE MEESTER (in press). Connectivity and cladoceran species richness in a small interconnected pond system. *Freshwater Biology*.
- DE MEESTER, L. & R. BOSMANS (1993). *Eurycerus glacialis* (Crustacea, Anomopoda) : a chydorid cladoceran new to the Belgian fauna. *Biol. Jb. Dodonaea*, 61 : 80-83.
- DUMONT, H.J. (1989a). The non-marine Cladocera of Belgium. In : WOUTERS, K. & BAERT, L. (eds), *Invertébrés de Belgique*. C. R. Sc. Nat. Belgique : 137-142.
- DUMONT, H.J. (1989b). The free-living fresh- and brackish water copepods of Belgium. In : WOUTERS, K. & BAERT, L. (eds), *Invertébrés de Belgique*. C. R. Sc. Nat. Belgique : 147-151.
- DUSSART, B.H. (1967). *Les Copépodes des eaux continentales d'Europe occidentale. Vol. I. Calanoides et Harpacticoides*. N. Boubé & Cie, Paris, 500 pp.
- EDER, E. & W. HÖDL (1996). Wozu "Urzeitkrebse"? Praktische Bedeutung der Grossbranchiopoden für Wirtschaft, Naturschutz und Wissenschaft. *Stapfia*, 42 : 149-159.
- EINSLER, U. (1993). Crustacea Copepoda Calanoida und Cyclopoidea. In : SCHWOERBEL, J. & ZWICK, P. (Eds), *Süßwasserfauna von Mitteleuropa* 8(4) (1) : 1-209. Gustav Fischer Verlag, Stuttgart-Jena-New York.
- ELBOURN, C.A. (1966). *Daphnia obtusa* (Crustacea : Cladocera) in small ponds. *Ann. Mag. Nat. Hist.*, 9 : 297-308.
- FIERS, F. & V. GHENNE (2000). Cryptozoic copepods from Belgium : diversity and biogeographic implications. *Belg. J. Zool.*, 130 : 11-19.
- FLÖSSNER, D. (2000). *Die Haplopoda und Cladocera (ohne Bosminidae) Mitteleuropas*. Backhuys Publishers, Leiden, 428 pp.
- FRYER, G. (1985a). Crustacean diversity in relation to the size of water bodies : some facts and problems. *Freshwat. Biol.*, 15 : 347-361.
- FRYER, G. (1985b). The ecology and distribution of the genus *Daphnia* (Crustacea : Cladocera) in restricted areas : the pattern in Yorkshire. *J. nat. Hist.*, 19 : 97-128.
- GOULDEN, C.E. (1968). The systematics and evolution of the Moinidae. *Trans. am. phil. Soc.*, 58 : 1-101.
- HUDEC, I. (1990). *Moina weismanni* Ishikawa, 1896 (Cladocera, Moinidae) in Central Europe. *Hydrobiologia*, 190 : 33-42.
- KERFOOT, W.C. & M. LYNCH (1987). Branchiopod communities : associations with planktivorous fish in space and time. In : KERFOOT, W.C. & A. SIH (eds.), *Predation, direct and indirect impacts on aquatic communities*. University Press of New England, Hanover (N.H.), pp. 367-378.
- KETELAARS, H.A.M. & L. GILLE (1994). Range extension of the predatory cladoceran *Bythotrephes longimanus* Leydig 1860 (Crustacea, Onychopoda) in Western Europe. *Neth. J. Aquat. Ecol.*, 28 : 175-180.
- LONEUX, M. & E. WALRAVENS (1998). Observation recente de *Chirocephalus diaphanus* (Prevost in Jurin, 1820) en Belgique : appel aux naturalistes. *Les Naturalistes belges*, 79 : 9-14.
- MAIER, G. (1992a). *Metacyclops minutus* (Claus, 1863) – population dynamics and life history characteristics of a rapidly developing copepod. *Int. Revue ges. Hydrobiol.*, 77 : 455-466.
- MAIER, G. (1992b). Development, reproduction and growth pattern of two coexisting pond dwelling cladocerans. *Int. Revue ges. Hydrobiol.*, 77 : 621-632.

- MAIER, G. (1993). The life histories of two temporarily coexisting, pond dwelling cladocerans. *Int. Revue ges. Hydrobiol.*, 78 : 83-93.
- MAIER, G., HÖSSLER, J. (U. TESSENOW. (1998). Succession of physical and chemical conditions and of crustacean communities in some small, man made water bodies. *Internat. Rev. Hydrobiol.*, 83 : 405-418.
- MARGARITORA, F.G., I. FERRARI & D. CROSETTI (1987). A Far East *Moina*, *M. weismanni* Ishikawa, 1896 found in an Italian ricefield. *Hydrobiologia*, 145 : 93-103.
- MURA, G. (1993). Italian Anostraca : distribution and status. *Anostraca News*, 1 : 3.
- NOTENBOOM-RAM, E. (1981). *Verspreiding en Ecologie van de Branchiopoda in Nederland*. RIN-rapport, Arnhem. 95 pp.
- PETKOVSKI, S.T. (1991). *Moina weismanni* Ishikawa, 1896, a rare East Palearctic faunistic element from S.W. Yugoslavia. *Spixiana*, 14 : 1-7.
- SCHWARTZ, S.S. & D.G. JENKINS (2000). Temporary aquatic habitats : constraints and opportunities. *Aquat. Ecol.*, 34 : 3-8.
- WILLIAMS, W.D. (2000). Biodiversity in temporary wetlands of dryland regions. *Verh. Internat. Verein. Limnol.*, 27 : 141-144.

Received: March 6, 2002

Accepted: September 25, 2002