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## New records of the centropagid *Boeckella triarticulata* (Thomson, 1883) (Copepoda: Calanoida) in Northern Italy: evidence of a successful invasion?

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### Abstract

In the mid 1980's, the Australasian calanoid copepod *Boeckella triarticulata* was found in fish ponds of Northern Italy, representing the first record of this species for Europe. Its occurrence has not been reported for other Italian localities since 2005, when several specimens were found in the summer zooplankton of the Po River. It seems likely that *B. triarticulata* could be more widespread in the Po River valley than available distributional data suggest, considering both the scarcity of studies on the plankton of the main river channel and its adjacent water bodies as well as the high ecological plasticity of this centropagid species. The occurrence of this non-indigenous species in Italian waters may depend on the establishment of stable populations or on multiple reintroductions. Its threat as an invasive species is discussed on the basis of our preliminary results and from literature review.

Key words: alien species, Calanoida, invasion, Italy, Po River, zooplankton

### Introduction

*Boeckella triarticulata* (Thomson, 1883) is a calanoid species belonging to the family Centropagidae. It shows a typical Gondwana distribution, being reported from Australasia, South America, Eastern Mongolia and Far-Eastern Russia (Bayly 1992, Jamieson 1988, Dussart and Defaye 2002). In the mid 1980's, this species was first recorded in Northern Italy from fish ponds near Massa Finalese and from the "valli" (fish farm) of Ostellato (Figure 1, Annex) (Ferrari et al. 1991). These are the only two locations known so far in European inland waters for the genus *Boeckella* and, except for *Limnocalanus macrurus* which is found in Northern Europe, also for other non-marine centropagid copepods (Dussart and Defaye 2002). Since then, there have been no more records of *B. triarticulata* in Europe. Here we document the reappearance of this non-native

species in samples collected during summer 2005 in the Po River (Northern Italy). The possible vectors of introduction of *B. triarticulata* into Italy and the species' potential as a freshwater invader are discussed.

### Materials and Methods

The sample material for this study was obtained from a station located near Viadana (N 44°54'48", E 10°32'14", 21 m above sea level), in the middle segment of the Po River (Figure 1, Annex). A total of 28 zooplankton samples were collected from early July to early September 2005 at 1 to 13 day intervals, during a period of low river flow (between 355 and 966 m<sup>3</sup> sec<sup>-1</sup>). Samples were gathered by lowering a 15 l bucket into the river; water was then passed through a 50 µm plankton net and poured into another graduated bucket until

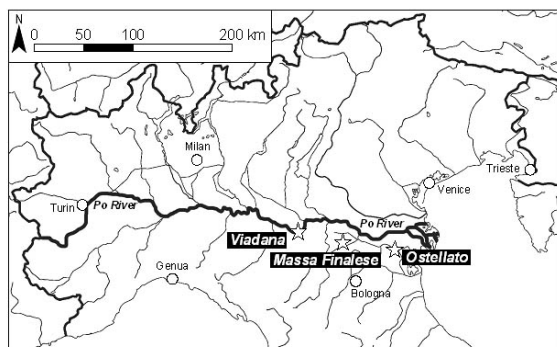


Figure 1. Map of Northern Italy showing the locations in which *Boeckella triarticulata* has been recorded.

reaching a total filtered volume of 60 l. Samples were immediately fixed in a 4% buffered formalin solution. Zooplankton counting was carried out under a compound microscope on subsamples taken by a Hansen-Stempel pipette. For copepods, only adult specimens were identified to species level. Calanoids were identified according to the taxonomic keys of Bayly (1992) and Dussart and Defaye (1995). Appendages were dissected using a binocular microscope and mounted in sealed microscope slides for morphological analysis. Samples are stored at the Department of Environmental Sciences, University of Parma.

## Results and Discussion

Rotifers were overwhelmingly the most abundant and diverse group in the summer zooplankton community of the Po River. Species of the genus *Brachionus* were dominant throughout the study period, with peaks of 1120 ind l<sup>-1</sup> for *B. calyciflorus*, 153 ind l<sup>-1</sup> for *B. urceolaris* and 105 ind l<sup>-1</sup> for *B. quadridentatus*. Other rotifer taxa that occurred in high abundances were *Synchaeta* spp., *Keratella cochlearis tecta* and *Polyarthra* spp., with maxima of 158, 155 and 42 ind l<sup>-1</sup>, respectively. *Moina micrura* was by far the most common and abundant cladoceran species, with densities up to 15 ind l<sup>-1</sup>; also *Bosmina longirostris* and *Daphnia galeata* were found in most of the samples, with density maxima of 3.5 and 0.5 ind l<sup>-1</sup>, respectively. Other cladocerans appeared more sporadically and generally in low abundances. Copepods were mainly represented by immature stages; in particular, cyclopoid nauplii showed a peak of 53 ind l<sup>-1</sup>. *Acanthocyclops* gr. *vernalis-robustus* was the only copepod species in which adults were occasionally present in relatively high numbers

(with a maximum of 4 ind l<sup>-1</sup>). Adults of *Boeckella triarticulata* (Figure 2) were recovered from 5 samples (July 16, August 9 and 11, September 2 and 3), always at densities  $\leq 0.25$  ind l<sup>-1</sup>. Although ovigerous females were found on August 11, it is unlikely that *B. triarticulata* could fully complete its life cycle in lotic environments even at low flow rates. This suggests inoculation from upstream lentic sources with thus a wider distribution than existing records indicate. The occurrence of this species in rivers has been rarely reported in its native geographic distributional area (e.g., Oliver et al. 1999), while it is however able to colonize a wide range of still-water habitats, both permanent and temporary, including lakes (Twombly et al. 1998), ponds (Burns 1984, Jamieson 1998), and depressions that have been weathered out of the surface of granite outcrops (Bayly 1997).

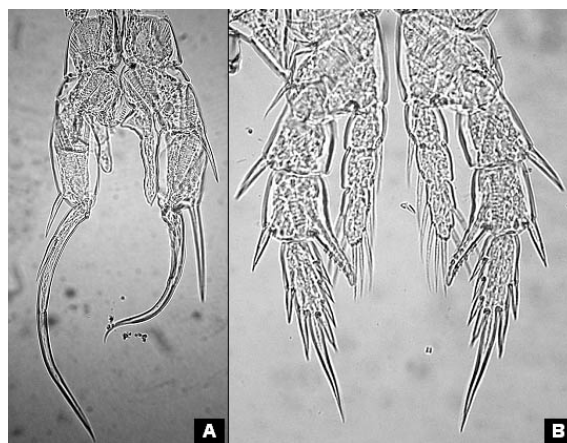


Figure 2. Adult male (A) and adult female (B) fifth thoracic legs of *Boeckella triarticulata*. Specimens collected at the sampling station of Viadana on August 9, 2005 and September 3, 2005, respectively. Not to scale.

The most probable vectors of *Boeckella triarticulata* introduction into Northern Italy are by the stocking of allochthonous fish species (Ferrari et al. 1991) and through the spread of resting eggs associated with imported crop seeds (McKenzie and Moroni 1986), in particular rice, a plant which is traditionally cultivated in this area. The production of diapausing eggs resistant to desiccation and other stresses has been repeatedly demonstrated in *B. triarticulata* (Burns 1984, Couch et al. 2001); in addition, its excellent dispersal capabilities have been researched (Jamieson 1998).

There are also other characteristics which make this species potentially invasive, for example its wide salinity tolerance (Nielsen et al. 2003), the ability to persist during cyanobacterial blooms, and its high reproductive rates (Twombly et al. 1998). The available data cannot determine whether the presence of *Boeckella triarticulata* in the Po River is due to a successful establishment of this species in Northern Italy or is merely a result of multiple occasional reintroductions. It is therefore difficult to assess *B. triarticulata* as an invasive species in this geographic area. However, some tentative considerations can be drawn.

Within the inland waters of the world, the calanoid families Diaptomidae and Centropagidae generally show mutually exclusive distributions, although some exceptions are known (Bayly 1992). The only documented exclusion of an endemic diaptomid species in Northern Italy is that of *Eudiaptomus padanus*, which in recent years has been replaced by the congeneric *E. gracilis* in several water bodies (Rossetti et al. 1996, Riccardi and Rossetti 2005, Riccardi and Giussani 2006). These facts seem to indicate that a large scale invasion of a “diaptomid zone” by *B. triarticulata* is rather improbable. On the other hand, this centropagid species can successfully establish in eutrophic waters, intermittent habitats, and even under strong fish predation pressure, i.e. conditions that may limit the occurrence of diaptomid calanoids (Stella 1984, Dussart and Defaye 1995 and references therein). Freshwater ecosystems with these characteristics are common in the Po River valley, thus representing suitable sites for a rapid expansion of *B. triarticulata*. Unfortunately current knowledge on zooplankton composition in the Po River and its perfluvial wetlands is still inadequate to support such a conclusion.

Existing records demonstrate that in Northern Italy *Boeckella triarticulata* can maintain populations in all seasons; it can also reach very high densities, with a strong impact on the plankton community through the reduction of both phytoplankton biomass and abundance of zooplankton microfilter feeders (Ferrari et al. 1991). Further studies are needed to examine patterns of coexistence or exclusion of *B. triarticulata* with native diaptomid species, as available information is limited to competitive interactions with other centropagids (Jamieson 1988, Maly and Maly 1997), and hence evaluate the ecological consequences of its introduction at the ecosystem level.

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**Annex**

Records of *Boeckella triarticulata* in Italy\*

Location	Record coordinates		Record date	Abundance	Reference/ Collector
	Latitude, °N	Longitude, °E			
Massa Finalese (fish ponds)	44°51'34"	11°14'14"	September 1986 – April 1987	5 – 75 ind l <sup>-1</sup>	Ferrari et al. 1991 / I. Ferrari
Ostellato (fish farm)	44°44'38"	11°58'44"	Late 1980's	unknown	Ferrari et al. 1991 / A. Gnes
Viadana (Po River)	44°54'48"	10°32'14"	July-September 2005	≤ 0.25 ind l <sup>-1</sup>	Ferrari and Rossetti 2006 / I. Ferrari

\*Full reference to the data: Ferrari I and Rossetti G (2006) New records of the centropagid *Boeckella triarticulata* (Thomson, 1883) (Copepoda: Calanoida) in Northern Italy: evidence of a successful invasion? Aquatic Invasions 1(4): 219-222