

TAXONOMIC PROBLEMS IN THE GENUS *Polyarthra* FROM LAKE PEIPSI

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Received 5 May 1999

Abstract. The genus *Polyarthra* is one of the dominant rotifer genera in Lake Peipsi (Estonia). The genus appeared to be quite interesting taxonomically. Two confusing *Polyarthra* morphotaxa, camouflaging each other morphologically and ecologically and coexisting with *P. remata*, were found in the summer rotifer community. Previously these were supposed to be rectangular morphotypes of *P. remata*, but thorough analysis of their morphology and trophi revealed that actually two distinct species were involved: *P. cf. dolichoptera* and *P. cf. vulgaris*. Both are atypical forms without ventral finlets, the latter moreover shows *proloba* variation.

In the present study the range of variation in the external and trophi morphology of these forms is examined to clarify their status.

Key words: *Polyarthra*, taxonomy, morphology.

INTRODUCTION

In general, rotifers are characterized by extensive intraspecific variability, which is the main reason for many taxonomic problems in this group. Identification to species level, so far based mainly on phenotypic characters, may be difficult, particularly in illoricate taxa, as illustrated by the genus *Polyarthra*. Due to the wide variability and presence of transitional forms (e.g. Pejler, 1956), the external morphological features are not always reliable for species discrimination. Calculation of the indices of fin length : body length and fin length : fin width has been recommended (Ruttner-Kolisko, 1972; Koste, 1978; Shiel & Koste, 1993). In some cases biometrical analysis has been used with success (Guiset, 1977; Stemberger, 1979). However, it should be mentioned that

due to an extensive overlap, morphometric criteria are often inadequate to distinguish *Polyarthra* species (Koste & Shiel, 1989; Shiel & Koste, 1993; Virro, 1995). Therefore, analysis of trophi is indispensable to avoid misidentifications. Rotifer trophi appear to be species-specific and are considered extremely valuable taxonomic discriminators (Koste, 1978; Markevich, 1985; Koste & Shiel, 1989; Shiel & Koste, 1993). Sanoamuang (1993) showed that the trophi structure of *Filinia* is not affected by temperature unlike body measurements. Trophi analysis was used successfully by Guiset (1977) to separate *Polyarthra* species.

In my earlier study on the genus *Polyarthra* in L. Peipsi s.s. (Virro, 1995), I found two taxonomically confusing *Polyarthra* forms co-occurring with typical *Polyarthra remata* in summer. Both forms lacked ventral finlets and were quite similar in size to *P. remata*. In contrast with the latter, showing a typical rounded posterior and four nuclei in the vitellarium, the other two forms had an almost rectangular posterior and eight nuclei in the vitellarium. One of these showed a normally positioned mastax; the other had the mastax tilted characteristic of *proloba* variation (Virro, 1995). I supposed them to be rectangular forms of *P. remata* (Virro, 1995).

The aim of the present study is to determine the range of morphological variation of the three forms involved, and to clarify their status by the analysis of their trophi and body morphology.

THE LAKE

Lake Peipsi s.s. (58°22' N–59°00' N, 26°57' E–27°59' E, surface area 2611 km², mean depth 8.3 m, maximum depth 12.9 m) is the northern part of compound L. Peipsi–Pihkva (3555 km²), called also L. Peipus–Pskov in some earlier papers, situated on the eastern border of Estonia. It is eutrophic, with mesotrophic features in the northern region. For a general description of L. Peipsi–Pihkva see, e.g. Nõges et al. (1996), and for the taxonomic composition of rotifers of L. Peipsi s.s., Virro (1996).

MATERIAL AND METHODS

The material dealt with in the present paper is derived from qualitative and quantitative zooplankton samples collected from June 1986 till March 1988 (4 to 6 times a month) from the littoral (depth 0.5–1 m) and pelagial (depth 7 m) stations in the north-western part of L. Peipsi s.s. The qualitative samples were taken with a cone net (80 µm mesh). The quantitative samples were collected with a 1-litre Ruttner sampler and concentrated by the sedimentation method after fixation. The samples were fixed with formaldehyde (3–4%). Water temperature was measured at the moment of sampling.

Measurements of body and fins, and trophi were taken with an ocular microscope at $\times 400$ and $\times 900$ magnification respectively, using a compound microscope. Estimated by the index of sample average determination accuracy (Aarma & Vensel, 1996), the means of morphometric characters are representative, the value of the index varying between 1% and 5%. For trophi analysis, the trophi were isolated using a solution of sodium hypochlorite. Photomicrographs were taken with a Wild MPS 51S camera mounted on a Leitz Laborlux D microscope at $\times 500$ magnification. Drawings were made using a camera lucida.

The rotifer taxa were identified according to Kutikova (1970), Ruttner-Kolisko (1972), Koste (1978), Stemberger (1979), and Shiel & Koste (1993).

RESULTS

Thorough study of the trophi and external morphological features revealed that actually populations of three distinct *Polyarthra* species are involved, causing the seeming and confusing polymorphism of *Polyarthra remata* in L. Peipsi s.s. These are *Polyarthra remata* Skorikov, 1896, and atypical forms of *P. dolichoptera* Idelson, 1925 and *P. vulgaris* Carlin, 1943, here referred to as *P. cf. dolichoptera* and *P. cf. vulgaris*, respectively. Comparative morphometric measurements of these forms and their trophi are presented in Tables 1 and 2, and described below.

Polyarthra remata (Figs. 1a, b)

Typical form with rounded posterior end of body and 4 nuclei in vitellarium. It corresponds in all taxonomically significant features, including trophus morphology (Fig. 2a, b), to the descriptions by, e.g. Kutikova (1970), Koste (1978), and Shiel & Koste (1993).

P. remata occurs in L. Peipsi s.s. from June to October at water temperatures of 6.4–21.9 °C. It has maxima in August or September (Virro, 1995, 1996). Bisexual reproduction, indicated by the presence of haploid eggs, occurs from June to September.

Polyarthra cf. dolichoptera (Figs. 1c, d, e)

Unlike the typical *P. dolichoptera* this form lacks the pair of ventral finlets. It is smaller than the typical form (BL 94–141 μm , FL 105–186 μm) from L. Peipsi s.s. (Virro, 1995). Otherwise it is *dolichoptera*-like in habitus displaying an almost rectangular, sometimes slightly lobed, posterior. Narrow fins longer than body, with distinct median rib; lateral ribs absent or faint (Fig. 1e). Lateral antennae located at posterior corners. Vitellarium with 8 nuclei. Resting eggs

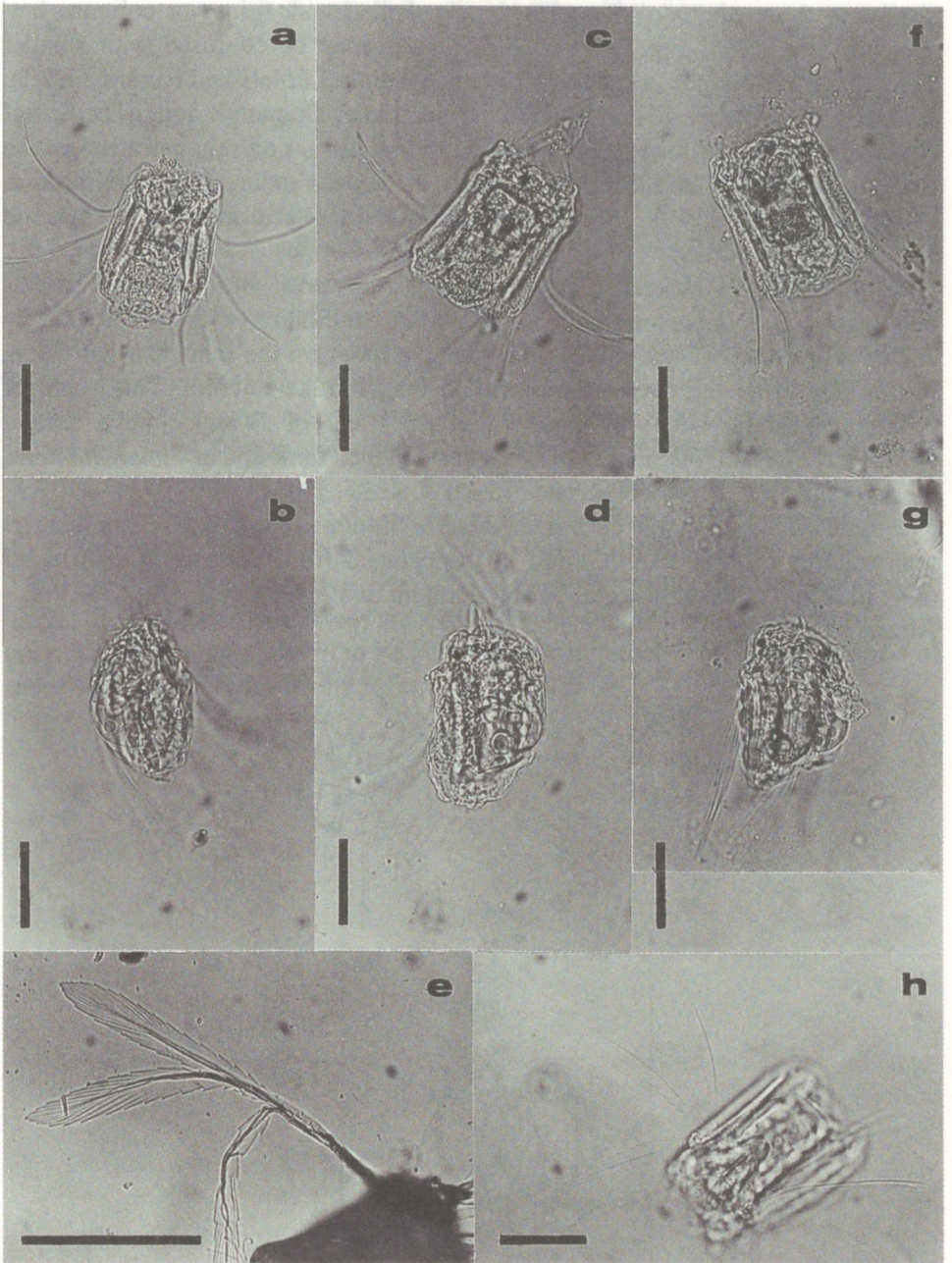


Fig. 1. *Polyarthra remata* (a, b), *P. cf. dolichoptera* (c, d, e), and *P. cf. vulgaris* (f, g, h) from L. Peipsi s.s.; dorsal (a, c), ventral (f), lateral (b, d, g), fin morphology (e, h). Scale bars 50 µm.

similar to those of *P. dolichoptera* (double-shelled with spines or columns between) (Virro, 1995: Fig. 2). *P. cf. dolichoptera* may be confused with smaller individuals of *P. major*, a species also lacking ventral finlets and having 8 nuclei in vitellarium. These two taxa are easily separated by fin morphology. The fins of *P. major* are shorter than the body, wide (15–40 μm), coarsely serrate, leaflike with lateral ribs and stemlike proximal part, median rib fading distally (Kutikova, 1970; Shiel & Koste, 1993; Virro, 1995). In *P. major* lateral antennae are inserted before posterior corners.

Trophi analysis showed (Fig. 2c, d) that this form without ventral finlets belongs to *P. dolichoptera*, having, according to Shiel & Koste (1993), the characteristic hatchet-like ramus with a single tooth on the inner margin fitting into a groove on the opposite ramus, and long rodlike fulcrum. The trophi of *P. major* resemble those of *P. dolichoptera*. Rami of *P. major* have similar opposite rami teeth, but, unlike the knobbed or lobed rami tips in *P. dolichoptera*, the rami tips in *P. major* are serrated (Shiel & Koste, 1993).

P. cf. dolichoptera was encountered in the littoral from July to September at temperatures of 12.6–21.9 $^{\circ}\text{C}$, and in the pelagial from September to October (6.4–14.2 $^{\circ}\text{C}$). It has a bisexual period (haploid and resting eggs found) in July–August.

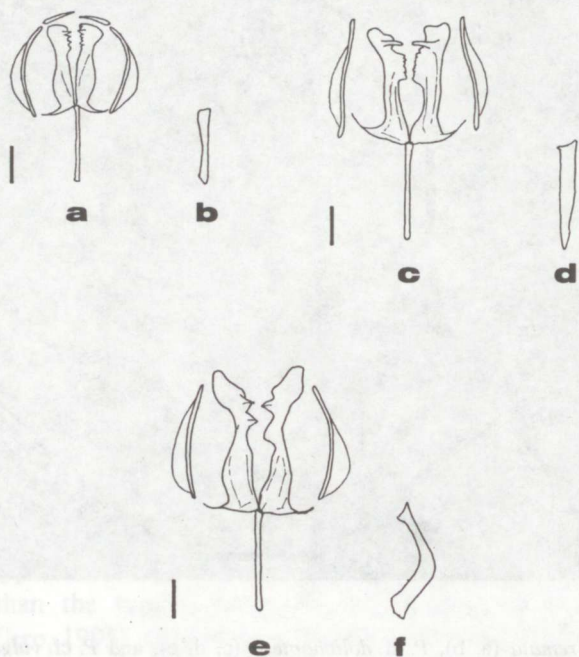


Fig. 2. Trophi of *Polyarthra remata* (a, b), *P. cf. dolichoptera* (c, d), and *P. cf. vulgaris* (e, f); (b, d, f): fulcri, lateral. Scale bars 10 μm .

Polyarthra cf. vulgaris (Figs. 1f, g, h)

This form was different from the typical *P. vulgaris* in two respects. First, the entire population belonged to the *proloba* morphotype with tilted mastax. Second, it was also lacking the pair of ventral finlets. However, having the rectangular habitus similar to *P. vulgaris*, this form is smaller than typical *P. vulgaris* (BL 100–122 μm , FL 107–135 μm) from L. Peipsi s.s. (Virro, 1995). Fins (Fig. 1h) are characteristic of *P. vulgaris*: broader than in *P. dolichoptera*, lanceolate, with medial and lateral ribs and serrate margins. Lateral antennae are near the posterior corners. It also has 8 nuclei in vitellarium.

The trophi of *P. cf. vulgaris* (Fig. 2e, f) are similar to those of typical *P. vulgaris*. In accordance with Koste (1978) and Shiel & Koste (1993), the trophus showed a single tooth on the right ramus, fitting between two large teeth on the left ramus. Unlike the typical *P. vulgaris* the fulcrum of this *proloba* form is curved at an angle of almost 45° , resembling a boomerang in lateral view.

This atypical form of *P. vulgaris* occurred in the littoral only, during August at $16.5\text{--}21.9^\circ\text{C}$.

Because of the extensive overlap in most morphometric criteria (Fig. 3, Tables 1 and 2) the three forms are difficult to distinguish by morphometric data only. Trophi analysis proved to be the most valuable tool in the discrimination of these taxonomically confusing forms of *Polyarthra*.

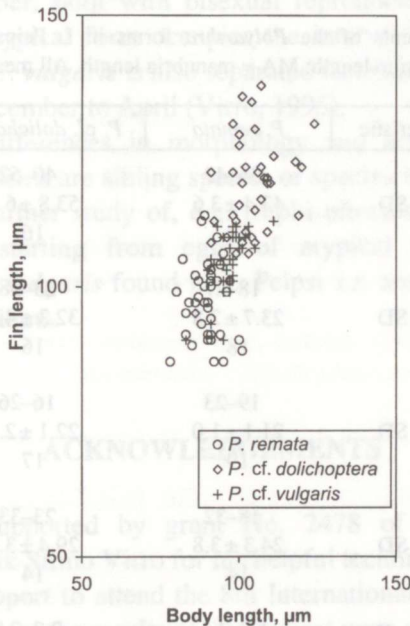


Fig. 3. Relationship between body length and fin length of *Polyarthra remata*, *P. cf. dolichoptera*, and *P. cf. vulgaris*.

Table 1. Morphometric data of the *Polyarthra* forms ($n = 40$, females only) in L. Peipsi s.s. BL = body length; BW = body width; FL = fin length; FW = fin width; NNV = number of nuclei in vitellarium. All measurements in μm

Parameter	Characteristic	<i>P. remata</i>	<i>P. cf. dolichoptera</i>	<i>P. cf. vulgaris</i>
BL	Range	78–101	86–124	83–111
	Mean \pm SD	89.9 \pm 4.9	103.5 \pm 7.9	97.0 \pm 4.5
BW	Range	45–56	55–71	60–69
	Mean \pm SD	50.2 \pm 2.8	65.0 \pm 3.6	64.9 \pm 2.1
FL	Range	86–113	95–137	90–112
	Mean \pm SD	97.4 \pm 6.9	117.2 \pm 9.7	105.0 \pm 5.3
FW	Range	4–7	6–9	9–14
	Mean \pm SD	5.4 \pm 0.8	7.8 \pm 0.9	11.0 \pm 1.3
BL/FL	Range	0.8–1.1	0.7–1.1	0.8–1.1
	Mean \pm SD	0.93 \pm 0.08	0.89 \pm 0.07	0.93 \pm 0.04
FL/FW	Range	13.9–24.5	11.2–21.7	7.6–11.7
	Mean \pm SD	18.32 \pm 2.75	15.36 \pm 2.36	9.62 \pm 0.99
NNV		4	8	8

Table 2. Trophi measurements of the *Polyarthra* forms in L. Peipsi s.s. TR = trophus length; RA = rami length; FU = fulcrum length; MA = manubria length. All measurements in μm

Parameter	Characteristic	<i>P. remata</i>	<i>P. cf. dolichoptera</i>	<i>P. cf. vulgaris</i>
TR	Range	36–49	40–62	45–72
	Mean \pm SD	43.4 \pm 3.6	53.8 \pm 6.1	60.5 \pm 8.7
	n	19	16	14
RA	Range	18–27	23–38	27–44
	Mean \pm SD	23.7 \pm 2.8	32.3 \pm 4.2	36.1 \pm 5.7
	n	18	16	14
FU	Range	19–23	16–26	20–29
	Mean \pm SD	21.1 \pm 1.0	22.1 \pm 2.7	26.0 \pm 2.9
	n	19	17	15
MA	Range	18–32	23–33	27–34
	Mean \pm SD	24.3 \pm 3.8	29.4 \pm 3.4	31.0 \pm 2.3
	n	14	14	9
TR/FU	Range	1.7–2.4	2.2–2.8	1.9–2.8
	Mean \pm SD	2.06 \pm 0.18	2.44 \pm 0.17	2.34 \pm 0.23
	n	19	16	14

DISCUSSION

Considering the above-mentioned results, the supposed polymorphism of *Polyarthra remata* regarding rectangular phenotypic variations, as was described by Wesenberg-Lund (1930) and Virro (1995), should be excluded in our case where two additional morphotaxa are involved. Donner (1978) mentioned *P. dolichoptera* and *P. vulgaris proloba* forms lacking ventral finlets, and coexisting with *P. remata*. He supposed that certain unidentified environmental or internal factors produce similar variations in several *Polyarthra* species along two lines: (1) the disappearance of ventral finlets, and (2) the appearance of *proloba* variation of mastax. Relying on our results, water temperature cannot be this crucial factor, as the temperature ranges of the forms under discussion overlapped. The populations of these species probably include different ecotypes. It is likely that these ecotypes are based on genotypically different demes. This possibility was proposed by Pejler (1957) and Bērziņš & Pejler (1989). It was proved experimentally (King, 1972, 1977) that the rotifer populations consist of temporally restricted, genotypically distinct, and practically discrete demes adapted to different environmental conditions.

The patterns of seasonal development of the two forms of *P. dolichoptera* in L. Peipsi s.s. refer to ecological and reproductive segregation. The typical *P. dolichoptera* has two periods of occurrence: from January to June and from September to November, both with bisexual reproduction (Virro, 1995). The development of the atypical form occupies the interval between these periods. The occurrence of *P. cf. vulgaris* is also separated from the typical form, the latter being present from December to April (Virro, 1995).

Considering the differences in morphology and seasonal occurrence, the possibility that these forms are sibling species or species *in statu nascendi* cannot be excluded either. Further study of, e.g. trophi ultrastructure using SEM, and culture experiments starting from eggs of atypical and typical forms of *P. dolichoptera* and *P. vulgaris* found in L. Peipsi s.s. are necessary to solve the above-mentioned problems.

ACKNOWLEDGEMENTS

This work was supported by grant No. 2478 of the Estonian Science Foundation. I also thank Siimo Virro for his helpful technical assistance and Harri Virro for financial support to attend the 8th International Rotifer Symposium at Collegeville (USA) where the results of this project were presented.

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PEIPSI JÄRVE PEREKOND *Polyarthra* TAKSONOOMILISED PROBLEEMID

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Perekond *Polyarthra* on üks domineerivaid keriloomaperekondi Peipsi järves. Samas on sealsed *Polyarthra* liigid ka taksonoomiliselt üsna huvipakkuvad. Suvises keriloomakoosluses esinevad koos liigiga *P. remata* kaks taksoniliselt kuuluvuselt segast vormi. Morfoloogilise ja ökoloogilise sarnasuse põhjal võis algul oletada, et tegu on *P. remata* kandilise tagakehaga morfotüüpidega. Väliste morfoloogiliste tunnuste ja lõugade põhjalikum analüüs näitas aga, et need vormid kuuluvad tegelikult kahte erinevasse liiki: *P. cf. dolichoptera* ja *P. cf. vulgaris*. Mõlemad vormid on ebatüüpilised, ilma kõhtmiste jätketeta. Lisaks on vormil *P. cf. vulgaris* normaalsest asendist kõrvale kaldunud mastaks (nn. *proloba* teisend).

On uuritud nende kolme vormi morfoloogilise muutlikkuse ulatust ja selgitatud nende staatus väliste morfoloogiliste tunnuste ning lõugade ehituse põhjal.