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Rotifera: Bdelloidea

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INTRODUCTION

The Bdelloidea is a class of rotifers that reproduce through ameiotic parthenogenesis only, and that are very common in several aquatic habitats (Donner 1965; Gilbert 1983; Ricci 1992; Mark Welch and Meselson 2000). Bdelloids have rather uniform morphology and microscopic size (body length between 150–700 μm). Almost all bdelloids are able to undergo a form of dormancy, called anhydrobiosis, to withstand unfavourable periods in their habitat (Gilbert 1974; Ricci 1987, 1998, 2001). Because of dormancy and parthenogenetic reproduction, several species are cosmopolitan.

The class Bdelloidea consists of three orders (Adinetida, Philodinavida and Philodinida), four families, 19 genera and about 350 species recognized on morphology only (Donner 1965; Melone and Ricci 1995).

The name bdelloids is derived from the Greek name for leeches (*bdella*) which they resemble when creeping on a substrate with leech-like movements. Their body consists of three regions: head, trunk and foot (Fig. 1). The head and foot appear segmented (pseudosegments) and are telescopically retractable into the trunk. A retractable rostrum is present on the head, that is clearly visible when the rotifer is creeping. A peculiar structure of bdelloids is the rotatory apparatus, called the corona, that in this class typically consists of two ciliated discs, the trochi, elevated on retractable pedicels. The cilia of each trochus are arranged along two parallel lines, and surround the ventral mouth opening. Bdelloids use their corona to create currents in water to convey food particles toward the mouth; ciliary beating also allows the rotifer to swim. The corona is developed in the order Philodinida, reduced in size and function in the Philodinavida, and transformed into a ventral ciliated field in the Adinetida (Melone and Ricci 1995). A dorsal antenna is present in all bdelloids. Eyes can be present on the rostrum or the head.

A strong muscular pharynx forms the masticatory apparatus and is called the mastax; it consists of hard articulated pieces, trophi (Fig. 2), and the musculature connected to them. In contrast to monogonont rotifers, bdelloids present a unique trophi morphology, called ramate (De Beauchamp 1909; Melone *et al.* 1998). The

trunk is the major region, and contains gonads, nephridia and gut, each connected to the dorsal cloaca. The reproductive apparatus consists of paired gonads (germarium), each embedded into a large gland, the vitellarium. Both germovitellaria are lateral to

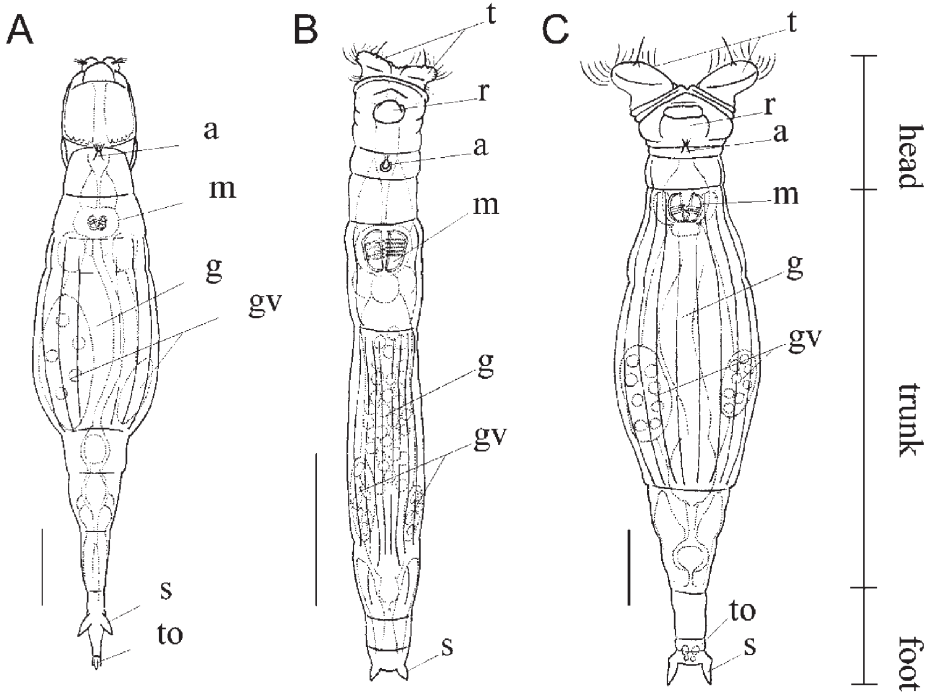


Figure 1. Examples of bdelloid species occurring in Malaysia: A – *Adineta vaga*; B – *Habrotrocha gracilis*; C – *Philodina vorax*. Abbreviations: a, dorsal antenna; g, gut; gv, germovitellaria; m, mastax; r, rostrum; s, spurs; t, trochi; to, toes. Scale bars = 50 μ m. (Sources: A, C, modified from Donner 1965; B, modified from Song and Kim 2000)

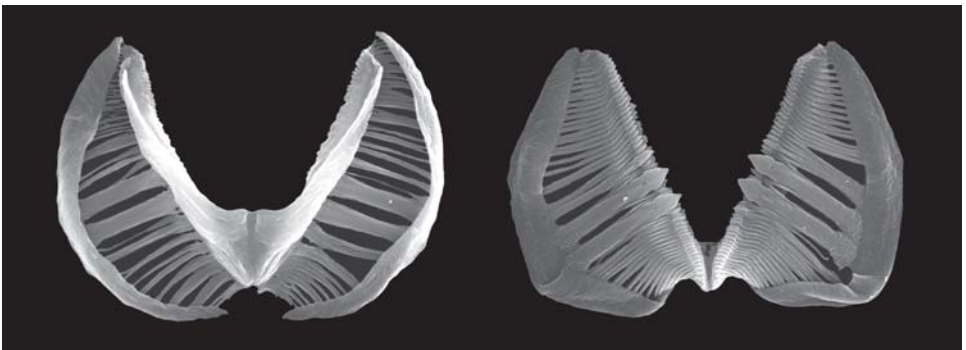


Figure 2. Trophi of *Macrotrachela quadricornifera* from caudal and cephalic view. Scale bar = 10 μ m.

the gut, and eggs or embryos (in viviparous species) can be seen in the trunk. Caudally to it is the foot, with spurs and a number (2–4) of extensible toes, all bearing the openings of pedal glands.

GENERAL BIOLOGY

Except for one species, *Abrochtha carnivora*, which preys upon other rotifers (Ricci *et al.* 2001), bdelloids feed by filtering or scraping or browsing small food items, such as bacteria, unicellular algae, yeasts or particulate organic matter (Ricci 1984).

Bdelloid rotifers dwell on the bottom of lotic and lentic waters, as well as in the thin water film surrounding soil particles, mosses or lichens. Many bdelloids can swim, but in general only occasionally and for short distances, thus some species can be occasionally found in plankton samples (Pejler and Berzinš 1993). Few bdelloids are epizoic and only one, *Zelinkiella synaptae*, is strictly marine.

Physical and chemical requirements are not well known and spatial and temporal distribution of bdelloids is often patchy and probably depends on food sources (Ricci and Balsamo 2000).

Life cycle

Under laboratory conditions, their life cycle is about 30 days, during which they can lay 30–40 eggs (Ricci 1983). Life span in the field is unknown. In response to disturbance (e.g. evaporation of environmental water) bdelloids enter anhydrobiosis, and will resume activity when the habitat conditions become suitable again. The rate of recovery depends upon species (Ricci 1998), length of desiccation period (Caprioli and Ricci 2001) and rotifer age (Ricci 1987; Örstan 1995; Orsenigo *et al.* 1998). In any case, dormancy represents a blind period in the bdelloid life, because they will resume their life without considering the time spent dormant. It seems that some species do really need to become dormant from time to time: constantly stable conditions seem to drive laboratory cultures to decline (Ricci 2001).

REGIONAL TAXA

More than 100 bdelloid species from 15 genera are reported for the oriental region (Song and Kim 2000; Segers 2001). In Peninsular Malaysia, Singapore and Borneo, about 30 species are recorded that belong to 10 genera: *Adineta*, *Dissotrocha*, *Habrotrocha*, *Henoceros*, *Macrotrachela*, *Otostephanos*, *Philodina*, *Pleuretra*, *Rotaria* and *Scepanotrocha* (Karunakaran and Johnson 1978; Fernando and Zankai 1981; Sudzuki 1989). The few studies carried out in this region make the list far from being exhaustive. More efforts are necessary to have a more reliable picture of bdelloid distribution in this area as well as in other regions. Given the broad distribution of bdelloid rotifers, we can expect that more genera are actually present in Malaysia.

KEY TO BDELLOIDEA FAMILIES AND GENERA

Only careful observation of living specimens allows appropriate identification of bdelloid species. Most of the taxonomically important features are poorly detectable, or not visible, in contracted specimens and can only be seen in active animals. Thus the use of preserved samples for listing bdelloid species is useless. Two keys to species are available (Bartoš 1951; Donner 1965); other keys relate to generic identification, and among them a useful pictorial key has been produced recently (Ricci and Melone 2000). There are no keys devoted to oriental bdelloids, although the one of Shiel (1995) covers Australian bdelloids.

Because of obligate parthenogenesis, the species of bdelloids are strictly ‘morphospecies’. In contrast to monogonont rotifers, trophi morphology of bdelloids is rather uniform and cannot be used for species identification. No extensive revision of the established bdelloid taxonomy has been done so far.

The following taxonomic key is not limited to the taxa already reported in Malaysia, but considers all bdelloid families and genera known in freshwater habitats.

1. Trophi (jaws) close to mouth opening; can be extruded when the animal is feeding PHILODINAVIDAE .. 2
- Trophi deep in the oesophagus, not extruded when feeding 4
2. Corona with trochi (ciliated discs) elevated on pedicels *Abrochtha*
- Corona reduced to small ciliated field, no trochi visible 3
3. Foot with 2 short spurs *Philodinavus*
- Foot with 1 spur and 4 big toes *Henoceros*
4. Corona modified to a ventral ciliated field with no trochi ADINETIDAE .. 5
- Corona with trochi elevated on pedicels 6
5. Foot long and extensible, with 3 toes and 2 spurs *Adineta*
- Foot short with several papillae on the posterior border of the penultimate pseudo-segment *Bradyscela*
6. Stomach without visible lumen and with round pellets within its wall. Pedicels of trochi are often very close to each other HABROTROCHIDAE .. 7
- Stomach with thick walls, with a lumen and not completely filled with round pellets PHILODINIDAE .. 9
7. Upper lip with remarkably large lobe, that partially covers the trochi *Scepanotrocha*
- Upper lip normally developed, trochi visible 8
8. Each trochus has a transversal cuticular ring, ventrally and dorsally incomplete... *Otostephanos*
- Trochi without cuticular ring *Habrotrocha*
9. Foot without toes 10
- Foot with toes 11

- 10. Foot shorter than one half of trunk length *Mniobia*
 - Foot longer than one half of trunk length; often epizoic *Anomopus*
- 11. Foot with 2 toes *Didymodactylos*
 - Foot with 3 or 4 toes 12
- 12. Foot with 3 toes 13
 - Foot with 4 toes 15
- 13. Corona with horn-shaped lateral projections *Ceratotrocha*
 - Corona otherwise 14
- 14. Viviparous, often eye-spots on rostrum; rostrum extended also when swimming *Rotaria*
 - Oviparous, eye-spots commonly absent *Macrotrachela*
- 15. Viviparous 16
 - Oviparous 17
- 16. Integument sculptured *Dissotrocha*
 - Integument smooth *Embata*
- 17. Integument thick and sculptured; eye-spots not evident *Pleuretra*
 - Integument thin and smooth; eye-spots, when visible, on brain *Philodina*

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