The Genus *Branchiobdella* Odier, 1823 (Annelida, Clitellata, Branchiobdellida): a Review of its European Species

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**Abstract:** The genus *Branchiobdella* Odier, 1823 includes commensals living on surface or in gill cavities of crayfish. This genus is currently represented in Europe by 8 valid species. These are *B. astaci* Odier, 1823, *B. parasita* (Braun, 1805), *B. pentadonta* Whitman, 1882, *B. hexadonta* Gruber, 1883, *B. italica* Canegallo, 1928, *B. balcanica* Moszyński, 1938, *B. kozarovi* Subchev, 1978, and *B. papillosa* Nesemann and Hutter, 2002. A revised synonymy, information about type material, type locality and characteristic morphological features are presented for each of them. In addition, historical notes are given for each species, and the main available data concerning localities on the host, coexistence with other *Branchiobdella* species on the same host, and geographical distribution are reviewed.

**Key words:** *Branchiobdella*, Europe, distribution
which, in most of the cases, the jaws were not oriented dorso-ventrally, thus, any different view of the same jaws was presented as jaws differing by their shape. Furthermore, most of the worms described by the author as new species were juveniles, for which the species identification is very difficult and even not possible in many cases. Pop (1965) made a revision of European branchiobdellids and rejected all the species described by Georgievitch (1955, 1957), showing that all of them were synonyms of the known European species of Branchiobdella. He did not recognise B. italica of Canegallo’s (1928) as a species, as well as the species described by Moszyński (1938): B. balcanica Moszyński, 1938, B. insolita Moszyński, 1938 and Pterodrilus karamani Moszyński, 1938. He proposed demoting ramani Moszyński, 1938. He proposed demoting B. italica to a subspecies of B. pentadonta and described a new subspecies, B. pentadonta orientalis. Actually, as shown later by two other investigators, independently from one another, B. italica is a valid species, while B. p. orientalis is a junior synonym of either B. balcanica, according to Karaman (1970), or B. insolita, according to Kozarov et al. (1972) (for details see below). The latest European species added were those described by Subchev (1978), Branchiobdella kozarovi, and by Neemann, Hutter (2002), Branchiobdella papillosa.

Intensive ultrastructural investigations on B. pentadonta, which will not be a subject of this review, were performed in the University of Padua, Italy, in the second half of the 20th century. The results of these investigations were published in a series of papers (Bondi 1962a, 1962b, 1963, D’Angelo 1965a, 1965b, 1965c, Farnesi et al. 1981, 1982, 1990).

Most European Branchiobdella dwell on a crayfish’s exposed surface but two of them, B. astaci and B. hexadonta, live in the host’s gill cavity. There are no special investigations on the relationship between European branchiobdellids and their hosts (besides those inhabiting gill chamber – see below), but according to Lee et al. (2009), who worked with Asian species, the relationship between crayfish and branchiobdellids living on the host surface can fluctuate between commensalism and mutualism (e.g. cleaning functions). The latter authors proved experimentally that the presence of a complex of branchiobdellids did have significant impact on the host growth rates when cultured under high fouling pressure. Evidence was presented that the European B. astaci and B. hexadonta injure their hosts (Kozarov et al. 1972, Mażyls, Grigelis, 1979, Quaglio et al. 2006).

Branchiobdellids were found on four out of the five indigenous European crayfish species: Astacus astacus (Linnaeus, 1758), Astacus leptodactylus Eschscholtz, 1823, Austropotamobius torrentium (Schrank, 1803) and Austropotamobius pallipes Kessler, 1876. The only exception was Astacus pachypus Rathke, 1837, which has never been recorded as a host of branchiobdellids. In addition, some European Branchiobdella were recorded on the following introduced species: Orconectes limosus (Rafinesque, 1817), Pasifastacus leniusculus (Dana, 1852) and Procambarus (Scapulicambarus) clarkii (Girard, 1852), (see the references below for each Branchiobdella species).

Branchiobdellids were found in almost all parts of Europe, in which crayfish occurs, but none have been reported so far from the peripheral European countries having indigenous crayfish – Norway and Ireland in the north-west and Spain and Portugal in the south-west. However, B. kozarovi reaches Asian Turkey (Subchev 2007, 2008, 2012, Subchev, Gelder 2010), and Iran (Asgharnia 2005, Fard, Gelder 2011) in south-east and Georgia and Kazakhstan in north-east (Subchev 2007, 2008, Subchev, Gelder 2010). B. hexadonta was reported also in Morocco by Neemann, Neubert (1999) and this is the only report on branchiobdellids for Africa.


The present review is focused on the European Branchiobdella species only (for the Asian representatives of the genus, see Gelder, Ohtaka, 2002, and references therein). For a general description of branchiobdellid morphology and anatomy, we refer to Karaman (1967), Holt (1986), Neemann, Neubert (1999) and Gelder (2010). Only a short description of each European species, with its most specific features, will be presented here. For detail descriptions of the species, the reader may refer to the original descriptions in the corresponding articles as well as to the descriptions given in more comprehensive papers (Schmidt 1907, Pierantoni 1912, Moszyński 1938a, 1938b, Pop 1965, Karaman 1970,

One of the confusing features of branchiobdellidians is their size. Due to their growth, both juvenile and adult worms have different body dimensions. At the same time, some authors refer to living worms, while others describe fixed specimens. With regard to the fixed worms, different fixatives lead to different degree of shrinking of the specimens. Nevertheless, we still believe that the division of the European branchiobdellidians in two groups, big ones and small ones (Subchev 1984), is useful, at least for a preliminary identification, especially in dealing with adult worms (or, better to say, worms that have reached their maximal size) from more than one species. In this review, the body shape and dimensions refer to fixed adult specimens. For identification keys to European Branchiobdella spp., we recommend to readers to use articles by Karaman (1967), Boshko (1983), Subchev (1984), Subchev, Stanimirova (1998), Neemann, Neubert (1999).

Corrections to Gelder’s (1996) check list (see below) are given in the list of synonymy for each species. The new and changed species or authority names, as well as any other changes, are marked by asterisks.

**Branchiobdella astaci** Odier, 1823

Synonyms: Astacodella branchiale (Vallot, 1840) Moquin-Tandon, 1846*; Astacodella roesoli (Diesing, 1850) Gelder, 1996; Branchiobdella astaci fluviatilis (Ostroumoff, 1883) Gelder, 1996; Branchiobdella astaci leptodavtyli (Ostroumoff, 1883) Gelder, 1996; Branchiobdella astaci varians var: astaci (Voigt, 1885) Pierantoni, 1912; Hirudo (Microbdella) astaci (Gervais, 1836) Moquin-Tandon, 1846*; Malacobdella (Hirudo) Astaci (Gervais, 1836) Diesing, 1850; Microbdella astaci (Gervais, 1845) Moquin-Tandon, 1846*.

**Type material:** deposited type specimens most probably not available; such were not mentioned by Odier (1823) and not found by us in either the Museum of Natural History in Paris or the other main European museums (Vienna, Berlin and London).

**Type locality:** France, not specified by Odier (1823).

According to Neemann, Neubert (1999), Hirudo astaci is not a branchiobdellidan and should be deleted from Gelder’s (1996) list of synonymy. The first to synonymize *H. (M.) astaci* with *M. astaci* was not Vej dovsky (1884), as specified in Gelder (1996), but Moquin-Tandon (1846). (Here and below the new or modified synonyms are marked by asterisks.)

The main features of *B. astaci* which are sufficient to distinguish it from other European Branchiobdella are: the adults are relatively big (maximum body size more than 4-5 mm), with thick body widened in the middle part, and triangular jaws with clear difference in size – the dorsal jaw being much larger than the ventral jaw (here and in the remaining species the characteristic features are taken from the original descriptions and from Pierantoni 1912, Pop 1965, Kozarov et al. 1972, Neemann, Neubert 1999). This species lives exclusively on crayfish gills (Whitman 1882, Schmidt 1907, Pop 1965, Kozarov et al. 1972, Subchev, Stanimirova 1986). Some authors (Kozarov et al. 1972, Mazylis, Grigelis 1979, Quaglio et al. 2006) in reference to their observations of heavy damages of the gill filaments with melanization and amputation, claimed that *B. astaci* is a parasite.

*B. astaci* is a gill-dwelling species. It was found on the following European crayfish: *A. astacus* (Kozarov et al. 1972, Subchev, Stanimirova 1998, Klobučar et al. 2006, Subchev, Gelder 2010), *A. leptodactylus* (Boshko 2010, Subchev, Gelder 2010), *A. torrentium* (Subchev, Stanimirova 1986, 1998), *A. pallipes* (Klobučar et al. 2006, Gelder et al. 1994, Subchev, Gelder 2010). The only other species that inhabits a host’s gill chambers is *B. hexadonta* and these two species have never been found together on the same host. However, *B. astaci* was found to co-exist with other Branchiobdella species dwelling on exposed surfaces of crayfish: *B. parasita* (Subchev, Stanimirova 1986, 1998), *B. pentadonta* (Subchev, Stanimirova 1986, 1998), *B. italic*ka (Klobučar et al. 2006) and *B. balcanica* (Subchev, Stanimirova 1998).

According to Pop (1965), *B. astaci* was the rarest species among the European branchiobdellidians (*B. kozarovi* and *B. papillo*sa were not known at that time). However, this conclusion might be inferred from the fact that not all investigators of branchiobdellidians examined the gills, the specific host microhabitat of the species. *B. astaci* is distributed throughout almost all European countries (Table 1). Besides the countries where branchiobdellidians were not found (see above), the species has also not been found in Greece and the Scandinavian countries. However, this species was reported for England (Leeke, Price 1965, Rosewarne et al. 2012) as well as for some northern regions of Russia (see Boshko 2010). *B. astaci* on *A. leptodactylus* was recently reported from Yakhshi Lake in northern Kazakhstan (Kolesnykova 2008).

**Branchiobdella parasita** (Braun, 1805)

Incorrect spellings: Branchiobdella parasitica

Synonyms: Astacodella branchialis (Vallot, 1840) Vej dovsky, 1884; Branchiobdella varians var. parasita (Voigt,
Table 1. Geographical distribution of European *Branchiobdella* (only European countries presented; *B. papillosa* not presented in the Table)

<table>
<thead>
<tr>
<th>Country</th>
<th>B. astaci</th>
<th>B. parasita</th>
<th>B. pentadonta</th>
<th>B. hexadonta</th>
<th>B. italic*</th>
<th>B. balcanica</th>
<th>B. kozarovi</th>
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<tr>
<td>Croatia</td>
<td>Klobučar et al., 2006</td>
<td>Klobučar et al., 2006</td>
<td>Klobučar et al., 2006</td>
<td>Klobučar et al., 2006; Subchev, 2009; Subchev, Gelder, 2010</td>
<td>Karaman, 1970</td>
<td>Klobučar et al., 2006</td>
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<td>Czech Republic</td>
<td>Subchev, 2012</td>
<td>Duriš et al., 2006; Subchev &amp; Gelder, 2010</td>
<td>Duriš et al., 2006; Subchev &amp; Gelder, 2010</td>
<td>Duriš et al., 2006; Subchev, Gelder, 2010; Subchev, 2012</td>
<td>Duriš et al., 2006</td>
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<td>England</td>
<td>Leeke, 1965; Rosewarne et al., 2012</td>
<td>Leeke, 1965; Rosewarne et al., 2012</td>
<td>Leeke, 1965; Rosewarne et al., 2012</td>
<td>Leeke, 1965; Rosewarne et al., 2012</td>
<td>Leeke, 1965; Rosewarne et al., 2012</td>
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<td>Finland</td>
<td>Nurminen, 1966a,b</td>
<td>Nurminen, 1966a,b</td>
<td>Nurminen, 1966a,b</td>
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*Note:* The table lists the countries, species of *Branchiobdella*, and the years of publication where the species were reported. The references are included to indicate the sources of the data.
<table>
<thead>
<tr>
<th>Country</th>
<th>B. astaci</th>
<th>B. parasita</th>
<th>B. pentadonta</th>
<th>B. hexadonta</th>
<th>B. italic</th>
<th>B. balcanica</th>
<th>B. kozarovi</th>
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<tr>
<td>Germany</td>
<td>VOkt, 1885a, 1885b, 1886; SCHMIDT, 1907; PIERANTONI, 1912; SUBCHEV, 2007; 2009</td>
<td>VOkt, 1885a, 1885b, 1886; SCHMIDT, 1907; PIERANTONI, 1912; MEIERING, 1975 (as B. parasitica); NESEMANN, 1994; VOGT, 1999; SUBCHEV, 2007</td>
<td>VOkt, 1885a, 1885b, 1886; SCHMIDT, 1907; PIERANTONI, 1912; SUBCHEV, 2007</td>
<td>NESEMANN &amp; NEUBERT, 1999; SUBCHEV et al., 2007; SUBCHEV &amp; GELDER, 2010</td>
<td>NESEMANN &amp; NEUBERT, 1999; SUBCHEV et al., 2007; SUBCHEV &amp; GELDER, 2010</td>
<td>NESEMANN, 1994; Vogt, 1999; SUBCHEV, 2007, 2009</td>
<td>NESEMANN, 1994; Vogt, 1999; SUBCHEV, 2007, 2009</td>
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<td>Italy</td>
<td>PIERANTONI, 1912; QUAGLIO et al., 2006; SUBCHEV &amp; GELDER, 2010; GELDER et al., 1994</td>
<td>QUAGLIO et al., 2006; GELDER et al., 1994; GELDER et al., 2006</td>
<td>PIERANTONI, 1912; QUAGLIO et al., 2006</td>
<td>PIERANTONI, 1912; QUAGLIO et al., 2006</td>
<td>GELDER et al., 1994; GELDER, 1999; GHIRARDI et al., 2002</td>
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<td>GELDER, 1999; GHIRARDI et al., 2002</td>
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Table 1. Continued

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<thead>
<tr>
<th>Country</th>
<th>B. astaci</th>
<th>B. parasita</th>
<th>B. pentadonta</th>
<th>B. hexadonta</th>
<th>B. italic</th>
<th>B. balcanica</th>
<th>B. kozarovi</th>
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</thead>
<tbody>
<tr>
<td><strong>Macedonia</strong></td>
<td>SUBCHEV, 2007</td>
<td>GEORGYEVITCH, 1955 (as B. bidens); GEORGYEVITCH 1957 (as Pterodrilus aliata) KARMA, 1967; SUBCHEV, 2007; SUBCHEV, GELDER, 2010; RMCHESKA et al., 2014</td>
<td>GEORGYEVITCH, 1955 (as Cambarincola doigrantis); GEORGYEVITCH, 1957 (as B. septadonta); KARMA, 1967; RMCHESKA et al., 2014</td>
<td>KARMA, 1967; SUBCHEV, 2007, 2012; RMCHESKA et al., 2014</td>
<td>KARMA, 1967</td>
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<td><strong>Montenegro</strong></td>
<td>SUBCHEV, 2008</td>
<td>GEORGYEVITCH, 1957 (as B. karamani); SUBCHEV, 2009</td>
<td>GELDER, 1999; SUBCHEV, 2009, 2012</td>
<td>KARMA, 1970; SUNDIC et al., 2011</td>
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<td><strong>Netherlands</strong></td>
<td>Stock, 1966</td>
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<td>KOLENSIKOVA et al., 2012</td>
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<td><strong>Slovakia</strong></td>
<td>SUBCHEV, GELDER, 2010</td>
<td>HALGOŚ, 1972</td>
<td>HALGOŚ, 1972</td>
<td>HALGOŚ, 1972 (as B.p.orientalis)</td>
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<td><strong>Sweden</strong></td>
<td>STIJENA-POUTH, 1958; DAIM, 1959; SUBCHEV, 2009</td>
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<td><strong>Switzerland</strong></td>
<td>SUBCHEV, 2007</td>
<td>SUBCHEV, 2007</td>
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**Type material:** deposited type specimens most probably not available: such were not mentioned either by Braun (1805) or by Henle (1835), and were not found by us at the Natural History Museum in Berlin and at the other main European natural history museums (Vienna, Paris and London).

**Type locality:** Germany, not specified by Braun (1805).

As noted above this species was described as *Hirudo parasitana* by Braun (1805). Later Henle (1835) moved the species to the genus *Branchiobdella* and gave much more details on its morphology and biology. After wrong citing of Henle as the author of the species by Pierantoni (1912), this mistake was also made by other authors, e.g. Halgos (1972), Subchev (1984), Gelder (1996), and Wierzbicka, Śmietańa (1999). Some authors included both names: “B. parasitana” (Braun, 1805) Henle, 1835” (Pop 1965; Kozarov et al. 1972, Meike 1999), while others (e.g., Hoffmann 1966) used an incorrect name – *B. parasitica* – for *B. parasitana*. Meijering (1971) reported “*B. parasitica*” on crayfish from the River Fulda, Germany, but based on the picture of that worm, it was actually *B. pentadonta*. In this case there was also a picture of crayfish pincers with branchiobdellidans on them; the pincers are host microhabitats that are usual for *B. pentadonta*, but not for *B. parasitana* (see below). *B. parasitana* is, like *B. astaci*, a relatively big worm (maximum body size more than 4-5 mm) but clearly differed from *B. astaci* by: (1) its more or less cylindrical body and (2) jaws that are triangular but almost equal in size and bear small lateral teeth, while in *B. astaci* the jaws are clearly different in size and bear no teeth.

*B. parasitana* lives on exposed surface of the crayfish: eyestalks, thorax (usually at its edges) and abdomen (Whitman 1882, Henle 1835). Our observations have shown that the most preferable host microhabitat is the ventral side of the abdomen where the relatively big worms are more securely protected. We more often find coconos of *B. parasitana* in the mentioned microhabitat (Subchev, unpublished observations). Halgos (1972) also indicated the ventral and lateral part of the crayfish abdomen as the most preferable host microhabitat for *B. parasitana*. Similarly, Meike (1999) found this species more often on the ventral part of crayfish abdomen and lateral parts of the thorax.


*B. parasitana* is widely distributed in Europe (Table 1) – to Denmark and Sweden in the north, but has not been found in Norway and Finland (see also Subchev 2009), and to Greece and Italy in the south. *B. parasitana* was not reported for Ukraine, in spite of the intensive investigations on branchiobdellidans in that country (Boshko 1983, 2010, Kolesnykova 2007, Kolesnykova et al. 2008). Only a few records are available for Russia (Boshko 2010), which may mean that the main east boundary of the species is Greece-Bulgaria-Romania-Poland.

**Branchiobdella pentadonta** Whitman, 1882

Incorrect spellings: *Branchiobdella pentodonta*


**Type material:** deposited type specimens most probably not available: such were not mentioned by Whitman (1882) and not found by us at the Natural History Museum in Berlin and at the other main European natural history museums (Vienna, Paris and London).
Type locality: Leipzig, Germany (Whitman, 1882).

After the description of the species by Whitman (1882), Pierantoni (1912) was first to change the original name B. pentadonta to B. pentadonta. Consequently, many other authors, among them Pop (1965) in his review and Gelder (1996) in his checklist, also used “pentodonta” instead of “pentadonta”. According to Prof. S. R. Gelder (personal communication), from linguistic point of view, “pentodonta” as used by Pierantoni (1912) is the correct form of the name. However, article 32.5.1 of the International Code of Zoological Nomenclature http://www.nhm.ac.uk/hosted-sites/iczn/code says: “If there is in the original publication itself, without recourse to any external source of information, clear evidence of an inadvertent error, such as a lapsus calami or a copyist’s or printer’s error, it must be corrected. Incorrect transliteration or latinization, or use of an inappropriate connecting vowel, are not to be considered inadvertent errors”. Therefore, the original spelling of B. pentadonta is correct.

As mentioned above, Georgévitch (1955, 1957) described more than 30 new branchiobdellidan species from Lake Dojran located in FYROM and some other sites in the former Yugoslavia. However, those descriptions were made without compliance with the elementary requirements for describing new species (see above). Pop (1965) showed in his revision that none of these species was new and most of them were synonyms of B. pentadonta. Karaman (1967) caused some additional confusion by transferring some of the synonyms of B. pentadonta in Pop (1965) to the synonymic list of B. italica. However, that transfer was not accepted by Gelder (1996). Neither Karaman (1967) argued why he made this move nor Gelder (1996) explained why he did not accept this moving. In fact, the material from the “new species” Branchiobdella cordis and Cambarincola odontias, as described by Georgévitch’s (1955) originated from Lake Dojran where A. pallipes – the specific host of B. italica, does not occur. Thus, those two species should be synonyms of B. pentadonta and moved back to the synonymic list of B. pentadonta proposed by Pop (1965). For the remaining synonyms of B. italica in Karaman (1967), see below.

Characteristic feature for this small size (the maximum body size less than 4-5 mm) species is the flattened body, which is clearly widened in the middle part (leaf-like) (for additional differences from B. balcanica, see below). The jaws bear five well defined teeth, of which the middle and lateral are bigger than the intermediate ones (Whitman 1882). However, the number of the teeth, particularly in the ventral jaw, may vary to seven (Kozarov et al. 1972, Halgös 1972). Thus, the jaws in B. pentadonta clearly distinguished the species from B. astaci, B. parasita, B. hexadonta, and B. papillosa. At the same time, the jaws in this species are similar by shape and dentation to those of B. italica and B. balcanica and by dentation only to those of B. kozarovi.

According to Whitman (1882), B. pentadonta was found “chiefly on the anterior part of ambulatory limbs, on the inner side of the first long joint”. On the other hand, Halgös (1972) stated that this species is located mainly on the head part (pincers and antennae), as well as on the dorsal part of the abdomen. Our observations (Subchev, unpublished) supported the findings of Halgös (1972). It may be noted that in the cases of high infestation the worms and cocoons could be found on the whole body of the host, as observed by us in Greece.


B. pentadonta is widely distributed species in West, Central and in a part of Eastern Europe (Table 1). However, it is not found in France and the Nordic countries besides Finland. The species was not recorded in Romania by Pop (1965). There are only a few records for B. pentadonta in Ukraine and Russia (Boshko, 2010), in which countries the species seems to be replaced by B. kozarovi that dwells on the same host localities, with A. leptodactylus being the predominant crayfish species (see below).

Branchiobdella hexadonta Gruber, 1883

Incorrect spellings: Branchiobdella hexodonta

Type material: deposited type specimens most probably not available: such were not mentioned by Gruber (1883) and not found by us at the Natural History Museum in Berlin or in other main European natural history museums (Vienna, Paris and London).

Type locality: Germany, not specified by Gruber (1883).

Similarly to the case with B. pentadonta, Pierantoni (1912) and many authors after him used the incorrect name B. hexadonta instead of the correct B. hexadonta (see above). The species was described by Gruber (1883) but, as it may be seen from the comparative pictures presented in his paper, Dorner (1865) was the first who found a worm with jaws specific of B. hexadonta. However, Dorner (1865) reported the worms as a known species, B. astaci – most probably because of the location of the worms in the crayfish gill chamber. Georgévitch (1957) described “Branchiobdella pentadonta nov. spec.”, with drawings of its body and jaws, on pp. 11-12 of his paper, but in the list of all the species on p. 7 only B. pentadonta Whitman was included; thus this “new species” was missing. In fact, based upon the drawings of the jaws in the same paper, the “new species” was B. hexadonta, not B. pentadonta. The case was not treated in any of the revision and review papers dealing with European Branchiobdella, e.g., Pop (1965), Karaman (1967, 1970) and Gelder (1996). Only Kozarović et al. (1972) noticed this and proposed this species to be included in the list of synonyms of B. hexadonta, while also noting the homonymy with the species described by Whitman (1882). However, according to article 52.2 of the International Code of Zoological Nomenclature, B. pentadonta in Georgévitch (1957) is not a valid name since it is a junior homonym of the species in Whitman (1882) and cannot be a synonym of B. hexadonta. This “small” European species (maximum body size after fixation less than 4-5 mm) clearly differs from the other Branchiobdella by: (1) the form and dentation of the jaws; (2) its relatively small size with almost cylindrical body; and (3) the division of the head into two parts by an obvious transverse furrow – a feature that is specific only of this species. B. hexadonta is an obligatory dweller in crayfish gill chambers (Schmidt 1907, Pop 1965, Kozarović et al. 1972, Wierzbicka, Šmietana 1999).

Wierzbicka, Šmietana (1999) found fragments of the crayfish gills in the B. hexadonta guts, but only in 6.9% of the individuals, while the gut content in specimens of this species suggested feeding on rotifers, diatoms and filamentous algae.


B. hexadonta was found on the same host together with B. balcanica (Halgós 1972), B. balcanica and B. kozarovi (Šmietana, Wierzbicka 1999), as well as B. parasita and B. pentadonta (Subchev, Stanimirova 1986, 1998, Šmietana, Wierzbicka 1999, Klobučar et al. 2006). The species was found in the same locality together with B. palliposa (Neemann, Hutter 2002).

The range of B. hexadonta covers almost all European countries, but does not reach beyond the line Greece-Bulgaria-Romania-Poland in the east (Table 1). It was not found either in Nordic and Baltic countries or in Russia and Ukraine – the report of this species by Svetlov (1926) for Russia is most probably wrong (Boshko 2010, Subchev 2011). Recently, B. hexadonta was reported for Morocco (Neemann, Neubert 1999), this is the first report of branchiobdellidans for Africa (see a detailed review of B. hexadonta distribution in Subchev, 2011).

Branchiobdella italica Canegallo, 1928


Type material: deposited type specimens most probably not available: such were not mentioned by Canegallo (1928).

Type locality: presumably Italy; the species was described from worms collected on crayfishes from Milano Aquarium (Canegallo 1928).

Karaman (1967) considered as synonyms of B. italica some Georgévitch’s (1957) species, which earlier Pop (1965) had synonymized to B. pentadonta or his newly described subspecies, B. pentadonta orientalis. On the other hand, Gelder (1996) did not accept the changes in the synonymic lists of B. italica as made by Karaman (1967). In fact, as mentioned above, B. cordis and C. odontias should be moved back to the list of synonyms of B. pentadonta (see above) but the remaining six species of
KARAMAN’s (1967) new synonymic list of *B. italicca* could be left there. The argument for this is the fact that the specimens used for the species description were obtained most probably on *A. pallipes*, the specific host of *B. italicca*. According to G. KLOBUČAR (personal communication), in the type localities – rivers Yadro (Jadro) and Cetina in Croatia, at least at the time when GEORGÉVITCH obtained the material for his investigations, *A. pallipes* was either the only crayfish species inhabiting the locality (Yadro) or a member of crayfish species complex inhabiting the locality (Cetina).

According to the description and drawings of the reproductive system in CANEGALLO (1928), the main features that separate this species from *B. pentadonta* (the only species with similar shape and dentation of the jaws, which was known at that time), are: the fusiform body, the spermatheca duct clearly longer than the spermatheca bulb, and the long glandular and non-glandular part of the male reproductive system. KARAMAN (1970), relying on his own material, confirmed these differences. POP (1965) lowered the taxonomic status of *B. italicca* to a subspecies, *B. pentadonta italicca*, and at the same time described a new subspecies, *B. pentadonta orientalis*. These taxonomic changes, however, were corrected by KARAMAN (1970) who restored the species status of all members of his so called “pentadonta” group, *B. pentadonta, B. italicca* and *B. balcanica (= B. pentadonta orientalis, see below). It is worth mentioning that many Italian investigators did not recognize the species described by CANEGALLO (1928), e.g., DEL ROSCIO (1962) and BONDI (1962a), but they did not provide any strong comparative morphological proofs for this. On the other hand, according to the pictures of whole worms presented in the papers of the Italian scientists that worked on the morphology and ultrastructure of Branchiobdella, e.g. BONDI (1962a), FARNESI et al. (1981), it seems that they dealt with *B. italicca*, not with *B. pentadonta* as stated.

CANEGALLO (1928) found *B. italicca* mainly on the lateral/ventral edge of the cephalothorax, proximal segments of the legs, and also on the jaw appendages of the host.

*B. italicca* is the only endemic European species that occurs solely on a single European host, *A. pallipes*. However, it was found also on one introduced species, *P. (S.) clarkii* (GELDER et al. 1999). The other Branchiobdella spp. found to co-exist with *B italicca* are *B. astaci* (KLOBUČAR et al. 2006) and *B. parasita* (GELDER et al. 1999).

The distribution of *B. italicca* is restricted to Italy, Croatia, and parts of Bosnia and Herzegovina, in which countries the species only host *A. pallipes* occurs (Table 1). KARAMAN (1970) indicated several sites, in which he found this species, all of them being in Croatia. However, his illustration of the male reproductive system and spermatheca in *B. italicca* (Fig. 1 in his paper) are of worms from Kesići at B. Grahovo/ Bosnia and Herzegovina. This village is located very close to the border with Croatia and according to the map in SOUTH-CROSSET et al. (2006) fall inside the range of *A. pallipes*. Thus, Bosnia and Herzegovina also should be added to the range of the species. KAHL, WORTAS (1974) reported *B. italicca* from Poland. However, for the identification of their material they relied only on the different number of teeth on jaws which is not a reliable feature to differentiate *B. italicca* from *B. pentadonta*. Moreover, the host was *A. astacus* and not *A. pallipes* (the latter not found in Poland). All this leads to the conclusion that the authors most probably found *B. pentadonta* and not *B. italicca*.

**Branchiobdella balcanica** Moszyński, 1938

**Synonyms:** Branchiobdella insolita (Moszyński, 1938) Karaman, 1967; Xironagion dolichoderos (Georgévitch, 1957) Pop, 1965; Branchiobdella pentodonta orientalis (Pop, 1965) Karaman, 1967

**Type material:** deposited type specimens most probably not available: such were not mentioned by MOSZYŃSKI (1938a).

**Type locality:** the River Ibar, Kosovska Mitrovica, Kosovo (MOSZYŃSKI 1938a).

MOSZYŃSKI (1938a) described two new Branchiobdella species from the former Yugoslavia: *B. balcanica* and *B. insolita*. Almost the same descriptions were presented in MOSZYŃSKI (1938b). Because of different imprint (1937) and actual (1938) date of publication many authors, e.g. POP (1965), KARAMAN (1967, 1970), and SUBCHEV (in all the papers where this species is mentioned), reported a wrong year (1937) of the species description. The original descriptions of these two species are incomplete and difficult to be compared to one another: a drawing of the jaws only (wrongly interpreted by the author because of showing only a lateral view) is presented for *B. balcanica*, while a drawing of the spermatheca and male reproductive system only is presented for *B. insolita*. However, both species have a common morphological feature presented in both descriptions – a sudden expansion of the body starting at the 4th body segment, which differentiates them from all other members of Branchiobdella, including the two close species with similar shape of the jaws, *B. pentadonta* and *B. italicca*. POP (1965) synonymized *B. balcanica* with *B. pentadonta* (his subspecies *B. pentodonta pentodonta*) and *B. in-
The Genus Branchiobdella Odier, 1823 (Annelida: Branchiobdellida): a Review of its European ...
Identification is not excluded), but in the rest of the cases the species was found exclusively on *A. leptodactylus* (Subchev, Stanimirova 1998, Šmietana, Wierzbicka 1999, Boshko 1983, 2010, Kolessnykova et al. 2007, Kolessnykova et al. 2008, Kolessnykova et al. 2012). According to Boshko (2010) this species has Caspian origin and is associated exclusively with *A. leptodactylus*.

*B. kozarovi* was found with the following *Branchiobdella* species on the crayfishes from the same locality: *B. pentadonta* (Subchev, Stanimirova 1998, Šmietana, Wierzbicka 1999), *B. parasita*, *B. hexadonta* and *B. balcanica* (Šmietana, Wierzbicka 1999). Only at eight sites in Ukraine, *B. kozarovi* (six sites) and *B. pentadonta* (two sites) were found separately on *A. leptodactylus* (Kolessnykova 2007).

The distribution of *B. kozarovi* in Europe and the Middle East was described in detail by Fard, Gelder (2011). The most locations for this species are known from Ukraine, which supports the statement of Boshko (2005) that the mentioned country is the center of distribution of *B. kozarovi*. The occurrence of this species in some countries e.g. in Poland (Šmietana, Wierzbicka 1999), may be explained by the introduction of the host species outside its natural range in the 19th and 20th century (Fard, Gelder 2011). The range of this species in the east includes Iran, Turkey, Georgia and Kazakhstan (Fard, Gelder 2011). According to Fard, Gelder (2011), because of the use of *A. leptodactylus* in aquaculture and food production in most of the Euro-Mediterranean countries for many years, *B. kozarovi* should be anticipated to be distributed more widely in this region. The most recent record of the species is from the Netherlands (Kolessnykova et al. 2012).

**Branchiobdella papillosa** Neesemann and Hutter, 2002

No synonyms.

**Type material:** Natural History Museum, Vienna, Austria.

Type locality: the Rhine catchment area, Ill catchment (Walgrau valley), local area of the Giesenbach, small left tributary of the village of Schlins (Eckwald), 530 m a.s.l., Austria (Nesemann, Huter 2002).

This species was described by Neesemann, Huter (2002) but no details of the reproductive system were given. Its later redescription showed that the jaws, male reproductive system and spermatheca are similar to those of *B. parasita*. Features that differentiate *B. papillosa* from *B. parasita* are the presence of four pairs of external papillae and epidermal microfolds (Subchev, Gelder 2010). Nothing is known about location of *B. papillosa* on its host body. This species was found in the same locality together with *B. hexadonta* (Nesemann, Huter 2002).

So far this species was found only at the type locality at Vorarlberg, Austria, on *A. torrentium*. Attempts to collect new material at the same site were not successful (Christian Berger, personal communication).

As a whole, European branchiobdellidan species are well studied from a taxonomic point of view. They are well distinguishable species and, after getting some experience, their identification could be done in most of the cases only by their body size and shape, and structure of jaws.

Now Europe listed 50 countries from which Azerbaijan, Georgia, Kazakhstan, Russia and Turkey are also considered part of Asia (http://simple.wikipedia.org/wiki/List_of_European_countries_in_order_of_geographical_area). There are currently 32 European countries in which branchiobdellidans occur (Table 1). Monaco, San Marino and Vatican, where no branchiobdellidans have been reported so far, are very small states with no or with negligible waters and are not of any importance to the distribution of European branchiobdellidans although, according to Fauna Europaea, Astacus sp. and Austropotamobius sp. are present there. Crayfish occur in Portugal, Spain, Norway, and Ireland, but the investigations carried out so far showed no presence of branchiobdellidans, e.g. the chances they to be found in these countries are not too high. In Iceland and Malta, because of the absence of crayfishes, no branchiobdellidans could occur. In the remaining European countries in which crayfish are found: Andorra, Belgium, Moldova and Serbia, we can expect to find the species already known for their surrounding countries. Much more interesting are the countries of the Middle East, Caucasus (Georgia, Armenia) or Central Asia (Turkmenistan, Kazakhstan), where new records and even new species could be expected.

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