

## 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* Neesemann 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

The genus *Branchiobdella* Odier, 1823 belongs to the family Branchiobdellidae Grube, 1851, which most earlier authors, following STEPHENSON'S (1930) classification, had considered as a member of the order Oligochaeta (Annelida: Clitellata). HOLT (1965) raised this family to the ordinal rank, as Branchiobdellida within the class Clitellata, in order to separate it from the Oligochaeta and Hirudinea. Later, he (HOLT 1986) raised its five groups of genera to the rank of families. Recently, some authors (BRINKHURST 1999, BRINKHURST, GELDER 2001) suppressed HOLT'S families to the subfamily rank, resulting into a single family in the order containing four subfamilies (GELDER 2010). For more historical details, see GELDER (1996).

RÖSEL VON ROSENHOFF (1755) was the first to describe a branchiobdellidan living on a crayfish body (detailed story in GELDER 1996). Later, BRAUN (1805) was the first to name a crayfish worm, *Hirudo parasita*. ODIER (1823) described *Branchiobdella astaci* and mentioned that this new species has similarities with RÖSEL VON ROSENHOFF'S (1755) crayfish worms. HENLE (1835) described *Branchiobdella parasita* and explicitly noted that this was not a

new species but the species described by BRAUN (1805) as *Hirudo parasita*. The next species described were *Branchiobdella pentadonta* Whitman, 1882 and *Branchiobdella hexadonta* Gruber, 1883. Later, VOIGT (1885a, 1885b, 1888) recognized the four known species as infraspecific variants of a single species, *Branchiobdella varians*, which was generally not accepted by the other researchers. The first review of branchiobdellidans was PIERANTONI'S (1912) "Monografia dei Discodrillidae". In the first half of the 20<sup>th</sup> century, CANEGALLO (1928) described *Branchiobdella italica* in Italy and MOSZYŃSKI (1938a, 1938b) reported three new branchiobdellidans in the former Yugoslavia, of which only one, *Branchiobdella balcanica*, is currently recognized as valid. GEORGÉVITCH (1955, 1957) caused great confusion when describing 33 new species, including several affiliated to four American genera, from the former Yugoslavia. All these descriptions were based only on the external morphology of the body (peristomium, general form of the body) and the shape and dentation of the jaws but without any details of the reproductive system. In addition, he made descriptions from the whole body mounts, in

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 branchiobdellidans and rejected all the species described by GEORGÉVITCH (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 *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 NESEMANN, 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 20<sup>th</sup> 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 branchiobdellidans 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 branchiobdellidans 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 branchiobdellidans 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, MAŻYLIS, GRIGELIS, 1979, QUAGLIO *et al.* 2006).

Branchiobdellidans were found on four out of the five indigenous European crayfish species:

*Astacus astacus* (Linnaeus, 1758), *Astacus leptodactylus* Eschscholtz, 1823, *Austropotamobius torrentium* (Schränk, 1803) and *Austropotamobius palipes* 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).

Branchiobdellidans 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 NESEMANN, NEUBERT (1999) and this is the only report on branchiobdellidans for Africa.

Today the genus *Branchiobdella* consists of 17 valid species divided in two groups: one that occurs allopatrically in Europe and some adjacent regions in Middle East and another in the Far East. The European species 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, *B. papillosa* Nesemann and Hutter, 2002. The Asian species are *B. digitata* Pierantoni, 1906, *B. minuta* Pierantoni, 1912, *B. orientalis* Jamaguchi, 1934, *B. cheni* Liu, 1964, *B. monodontus* Liu, 1983, *B. macropersistomium* Liu & Zhang, 1983, *B. teresae* Subchev, 1986 and *B. domina* Timm, 1991.

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 branchiobdellidan morphology and anatomy, we refer to KARAMAN (1967), HOLT (1986), NESEMANN, 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,

KOZAROV *et al.* 1972, NESEMANN 1994, NESEMANN, NEUBERT 1999).

One of the confusing features of branchiobdellidans 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 branchiobdellidans 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), NESEMANN, 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: *Astacobdelle branchiale* (Vallot, 1840) Moquin-Tandon, 1846\*; *Astacobdella roesoli* (Diesing, 1850) Gelder, 1996; *Branchiobdella astaci fluviatilis* (Ostroumoff, 1883) Gelder, 1996; *Branchiobdella astaci leptodavtyli* (Ostroumoff, 1883) Gelder, 1996; *Branchiobdella 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 NESEMANN, 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 VEJDOVSKÝ (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, NESEMANN, 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, MAŽYLIS, 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. italica* (KLOBUČAR *et al.* 2006) and *B. balcanica* (SUBCHEV, STANIMIROVA 1998).

According to POP (1965), *B. astaci* was the rarest species among the European branchiobdellidans (*B. kozarovi* and *B. papillosa* were not known at that time). However, this conclusion might be inferred from the fact that not all investigators of branchiobdellidans 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 branchiobdellidans 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 Yakshchi Lake in northern Kazakhstan (KOLESNYKOVA 2008).

### ***Branchiobdella parasita* (BRAUN, 1805)**

**Incorrect spellings:** *Branchiobdella parasitica*

Synonyms: *Astacobdella branchialis* (Vallot, 1840) Vejdovský, 1884; *Branchiobdella varians* var. *parasita* (Voigt,

Table 1. Geographical distribution of European *Branchiobdella* (only European countries presented; *B. papillosa* not presented in the Table)

Country	<i>B. astaci</i>	<i>B. parasita</i>	<i>B. pentadonta</i>	<i>B. hexadonta</i>	<i>B. italica</i>	<i>B. balcanica</i>	<i>B. kozarovi</i>
Albania				Subchev, 2011			
Austria	SUBCHEV & GELDER, 2010, SUBCHEV, 2012	NESEMANN, 1994 FÜREDER <i>et al.</i> , 2009 SUBCHEV & GELDER, 2010	NESEMANN, 1994 FÜREDER <i>et al.</i> , 2009	NESEMANN, 1994; NESEMANN, HEUTER, 2002; FÜREDER <i>et al.</i> , 2009; SUBCHEV, GELDER, 2010		NESEMANN, 1994 FÜREDER <i>et al.</i> , 2009	
Belarus							SUBCHEV, 2013
Bosnia and Herzegovina	MOSZYŃSKI, 1938a	MOSZYŃSKI, 1938a; KARAMAN, 1967	MOSZYŃSKI, 1938; GEORGÉVITCH, 1957 <sup>7</sup> (as <i>Branchiobdella cordis</i> ) KARAMAN, 1967	GEORGÉVITCH, 1957 (as <i>B. pentadonta</i> ); MOSZYŃSKI, 1938a; KARAMAN, 1967; SUBCHEV, GELDER, 2010	KARAMAN, 1970	MOSZYŃSKI, 1938a	
Bulgaria	KOZAROV <i>et al.</i> , 1972; SUBCHEV, STANIMIROVA, 1986, 1998	KOZAROV <i>et al.</i> , 1972; SUBCHEV, STANIMIROVA, 1986, 1998	KOZAROV <i>et al.</i> , 1972; SUBCHEV, STANIMIROVA, 1986, 1998	KOZAROV <i>et al.</i> , 1972; SUBCHEV, STANIMIROVA, 1986, 1998		KOZAROV <i>et al.</i> , 1972 (as <i>B. insolitata</i> ); SUBCHEV, STANIMIROVA, 1998	SUBCHEV, 1978; SUBCHEV, STANIMIROVA, 1986, 1998
Croatia	KLOBUČAR <i>et al.</i> , 2006	KLOBUČAR <i>et al.</i> , 2006	KLOBUČAR <i>et al.</i> , 2006	KLOBUČAR <i>et al.</i> , 2006; SUBCHEV, 2009; SUBCHEV, GELDER, 2010	KARAMAN, 1970 KLOBUČAR <i>et al.</i> , 2006	KLOBUČAR <i>et al.</i> , 2006; SUBCHEV, GELDER, 2010	
Czech Republic	SUBCHEV, 2012	ĎURIS <i>et al.</i> , 2006 ; SUBCHEV & GELDER, 2010	ĎURIS <i>et al.</i> , 2006; SUBCHEV, 2012	STRÁŠKRABA, 1956; ĎURIS <i>et al.</i> , 2006; SUBCHEV, GELDER, 2010; SUBCHEV, 2012		ĎURIS <i>et al.</i> , 2006	
Denmark		SUBCHEV, 2009, 2012, 2013	SUBCHEV, 2009, 2013				
England	LEEKE, 1965; ROSEWARNE <i>et al.</i> , 2012						
Estonia	JÄRVEKÜLG, 1957	JÄRVEKÜLG, 1957	JÄRVEKÜLG, 1957				
Finland			Nurminen, 1966 a.b				
France	RÖSEL VON ROSENHOF, 1775; ODIER, 1823; SUBCHEV, 2008, 2012, 2013	PIERANTONI, 1912		Subchev, 2008			

Table 1. Continued

Country	<i>B. astaci</i>	<i>B. parasita</i>	<i>B. pentadonta</i>	<i>B. hexadonta</i>	<i>B. italica</i>	<i>B. balcanica</i>	<i>B. kozarovi</i>
<b>Germany</b>	VOIGT, 1885a, 1885b, 1886; SCHMIDT, 1907; PIERANTONI, 1912; SUBCHEV, 2007; 2009	VOIGT, 1885a, 1885b, 1886; SCHMIDT, 1907; PIERANTONI, 1912; NAGEL, 1978; NESEMANN, 1994; MEIKE, 1999; VOGT, 1999; SUBCHEV, 2007]; 2009	VOIGT, 1885a, 1885b, 1886; SCHMIDT, 1907; PIERANTONI, 1912; MEIJERING, 1975 (as <i>B. parasitica</i> ); NESEMANN, 1994; VOGT, 1999; SUBCHEV, 2007	VOIGT, 1885a, 1885b, 1886; SCHMIDT, 1907; PIERANTONI, 1912; SUBCHEV, 2009; SUBCHEV & GELDER, 2010		Nesemann, 1994; Vogt, 1999;	
<b>Greece</b>		NESEMANN & NEUBERT, 1999; SUBCHEV <i>et al.</i> , 2007; SUBCHEV, 2008 ; 2009	SUBCHEV <i>et al.</i> , 2007; SUBCHEV & GELDER, 2010	NESEMANN & NEUBERT, 1999; SUBCHEV <i>et al.</i> , 2007; SUBCHEV, 2008 ; SUBCHEV, 2009; SUBCHEV & GELDER, 2010			
<b>Hungary</b>	ANDRÁSSY, 1955; FERENCZ, 1979; POP, 1965; FERENCZ, 1979; POP, 1965;	ANDRÁSSY, 1955; FERENCZ, 1979; POP, 1965; KOVASZ, JUHÁSZ, 2007; SUBCHEV, 2012	SUBCHEV, 1984; KOVASZ & JUHÁSZ, 2007; SUBCHEV, 2007; SUBCHEV, 2012	SUBCHEV, 1984; KOVASZ, JUHÁSZ, 2007; SUBCHEV, 2012		Subchev, 1984; Kovasz, Juhász, 2007	
<b>Italy</b>	PIERANTONI, 1912; QUAGLIO <i>et al.</i> , 2006; SUBCHEV & GELDER, 2010; GELDER <i>et al.</i> , 1994	QUAGLIO <i>et al.</i> , 2006; GELDER <i>et al.</i> , 1994; GELDER <i>et al.</i> , 1999	PIERANTONI, 1912; QUAGLIO <i>et al.</i> , 2006	GELDER <i>et al.</i> , 1994; GELDER, 1999; GHERARDI <i>et al.</i> , 2002; OBERKOFLER <i>et al.</i> , 2002; QUAGLIO <i>et al.</i> , 2006; FÜREDER <i>et al.</i> , 2009; SUBCHEV, 2012	CANEVALLO, 1932; QUAGLIO <i>et al.</i> , 2006; OBERKOFLER <i>et al.</i> , 2002; GHERARDI <i>et al.</i> , 2002; GELDER <i>et al.</i> , 1994; 1999; SCALICI <i>et al.</i> , 2010; SUBCHEV, 2012		
<b>Kosovo</b>	MOSZYŃSKI, 1938a;	MOSZYŃSKI, 1938a; KARAMAN, 1967	MOSZYŃSKI, 1938a; KARAMAN, 1967	MOSZYŃSKI, 1938a; KARAMAN, 1967		MOSZYŃSKI, 1938a; KARAMAN, 1967	
<b>Liechtenstein</b>			Bohl, 1997				
<b>Lithuania</b>	MAŽYLIS, GRIGELIS, 1979; MAŽEIKA <i>et al.</i> , 1999	MAŽEIKA <i>et al.</i> , 1999	MAŽYLIS, GRIGELIS, 1979				
<b>Luxembourg</b>		Hoffman					

Table 1. Continued

Country	<i>B. astaci</i>	<i>B. parasita</i>	<i>B. pentadonta</i>	<i>B. hexadonta</i>	<i>B. italica</i>	<i>B. balcanica</i>	<i>B. kozarovi</i>
<b>Macedonia</b>	SUBCHEV, 2007	GEORGÉVITCH, 1955 (as <i>B. bidens</i> ); GEORGÉVITCH 1957 (as <i>Pterodrilus alata</i> ) KARAMAN, 1967; SUBCHEV, 2007; SUBCHEV, GELDER, 2010; RIMCHESKA <i>et al.</i> , 2014	GEORGÉVITCH, 1955 (as <i>Cambarincola dojranensis</i> ); GEORGÉVITCH, 1957 (as <i>B. septadonta</i> ); KARAMAN, 1967; RIMCHESKA <i>et al.</i> , 2014	KARAMAN, 1967; SUBCHEV, 2007, 2012; RIMCHESKA <i>et al.</i> , 2014		KARAMAN, 1967	
<b>Montenegro</b>	SUBCHEV, 2008		GEORGÉVITCH, 1957 (as <i>B. karamani</i> ); SUBCHEV, 2009	GELDER, 1999; SUBCHEV, 2009, 2012		KARAMAN, 1970; ŠUNDIĆ <i>et al.</i> , 2011	
<b>Netherlands</b>		Stock, 1966					KOLESNIKOVA <i>et al.</i> , 2012
<b>Poland</b>	WOJTAS, 1964; KAHL, WOJTAS, 1974	MOSZYŃSKI & MOSZYŃSKA, 1957; MOSZYŃSKA, 1962 (PO WOJTAS, 1964); WOJTAS, 1964; KAHL, WOJTAS, 1974; ŚMIETANA, WIERZBICKA, 1999; WIERZBICKA ŚMIETANA, 1999	WOJTAS, 1964; KAHL, WOJTAS, 1974; ŚMIETANA, WIERZBICKA, 1999	WOJTAS, 1964; GRABDA, WIERZBICKA, 1969; KAHL, WOJTAS, 1974; KASPRZAK, 1981; ŚMIETANA, WIERZBICKA, 1999; WIERZBICKA ŚMIETANA, 1999	KAHL, WOJTAS, 1974	ŚMIETANA, WIERZBICKA, 1999; WIERZBICKA ŚMIETANA, 1999	ŚMIETANA, WIERZBICKA, 1999; WIERZBICKA ŚMIETANA, 1999
<b>Roumania</b>	Pop (1965)	Pop (1965)		Pop, 1965		Pop, 1965 (as <i>B. pentadonta orientalis</i> )	SUBCHEV, 2013
<b>Russia</b>	OSTROUMOFF, 1883; CHEKANOVSKAYA, 1962; SUBCHEV, 2007, 2009; SUBCHEV & GELDER, 2010; BOSHKO, 2010	CHEKANOVSKAYA, 1962; BOSHKO, 2010	CHEKANOVSKAYA, 1962; BOSHKO, 2010	SVETLOV, 1926*; CHEKANOVSKAYA, 1962			BOSHKO, 2010
<b>Slovakia</b>	SUBCHEV, GELDER, 2010	HALGOŚ, 1972	HALGOŚ, 1972	HALGOŚ, 1972		HALGOŚ, 1972 (as <i>B. p. orientalis</i> )	
<b>Slovenia</b>	SUBCHEV, GELDER, 2010	KARAMAN, 1967	KARAMAN, 1967	KARAMAN, 1967		KARAMAN, 1967	
<b>Sweden</b>		Stijerna-Pooth, 1958); Dahm, 1959; Subchev, 2009					
<b>Switzerland</b>		Subchev, 2007		Subchev, 2007			
<b>Ukraine</b>	SUBCHEV, 2008	BOSHKO, 2010	BOSHKO, 1983, 2010] KOLESNYKOVA, 2007			BOSHKO, 1983, 2010;	BOSHKO, 1983, 2005; 2010; KOLESNIKOVA, 2006, 2007; KOLESNYKOVA <i>et al.</i> , 2008

1885) Pierantoni, 1912; *Branchiobdella anatis* (Pierantoni, 1912) Pop, 1965; *Branchiobdella bidens* (Pierantoni, 1912) Pop, 1965; *Branchiobdella decidonta* (Pierantoni, 1912) Pop, 1965; *Branchiobdella tridens* (Pierantoni, 1912) Pop, 1965; *Cambarincola cylindrica* (Georgévitch, 1957) Pop, 1965; *Cambarincola odontias* (Georgévitch, 1955) Pop, 1965; *Pterodrilus aliata* (Georgévitch, 1957) Pop, 1965; *Pterodrilus bidens* (Georgévitch, 1955) Pop, 1965; *Pterodrilus dentata* (Georgévitch, 1957) Pop, 1965; *Pterodrilus karamani* (Moszyński, 1938) Pop, 1965; *Pterodrilus megas* (Georgévitch, 1955) Pop, 1965; *Pterodrilus megodont* (Georgévitch, 1955) Pop, 1965; *Pterodrilus prion* (Georgévitch, 1955) Pop, 1965; *Xironogiton bidens* (Georgévitch, 1955) Pop, 1965

**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 parasita* 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. HALGOŠ (1972), SUBCHEV (1984), GELDER (1996), and WIERZBICKA, ŠMIETANA (1999). Some authors included both names: “*B. parasita* (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. parasita*. 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. parasita* (see below). *B. parasita* 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. parasita* 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 cocoons of *B. parasita* in the mentioned microhabitat (SUBCHEV, unpublished observations). HALGOŠ (1972) also indicated

the ventral and lateral part of the crayfish abdomen as the most preferable host microhabitat for *B. parasita*. Similarly, MEIKE (1999) found this species more often on the ventral part of crayfish abdomen and lateral parts of the thorax.

*B. parasita* was found on the European indigenous crayfish species *A. astacus* (HALGOŠ 1972, KOZAROV *et al.* 1972, SUBCHEV, STANIMIROVA 1986, 1998, KLOBUČAR *et al.* 2006, KOVÁCS, JUHÁSZ 2007, FÜREDER *et al.* 2009), *A. leptodactylus* (SUBCHEV, STANIMIROVA 1998, BOSHKO 2010), *A. torrentium* (HALGOŠ 1972, SUBCHEV, STANIMIROVA 1986, 1998, KLOBUČAR *et al.* 2006, FÜREDER *et al.* 2009), *A. pallipes* (GELDER *et al.* 1994, GELDER *et al.* 1999, QUAGLIO *et al.* 2006), and also on the alien crayfishes *O. limosus* (NAGEL 1978, ĎURIŠ *et al.* 2006), *P. leniusculus* (KOVÁCS, JUHÁSZ 2007) and *P. (S.) clarkii* (GELDER *et al.* 1999).

*B. parasita* was found to co-exist with *B. astaci* (SUBCHEV, STANIMIROVA 1986, 1998), *B. pentadonta* and *B. hexadonta* (SUBCHEV, STANIMIROVA 1986, 1998, ŠMIETANA, WIERZBICKA 1999, KLOBUČAR *et al.* 2006), *B. balcanica* (HALGOŠ 1972, KLOBUČAR *et al.* 2006) and *B. kozarovi* (ŠMIETANA, WIERZBICKA 1999).

*B. parasita* 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. parasita* 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*

**Synonyms:** *Branchiobdella varians* var. *pentadonta* (Voigt, 1885) Pierantoni, 1912; *Branchiobdella capito* (Georgévitch, 1955) Pop, 1965; *Branchiobdella cordis* (Georgévitch, 1955) Pop\*, 1965; *Branchiobdella segmentata* (Georgévitch, 1957) Pop, 1965; *Branchiobdella septadonta* (Georgévitch, 1957) Pop, 1965; *Cambarincola dojrjanensis* (Georgévitch, 1955) Pop, 1965; *Cambarincola gastrax* (Georgévitch, 1955) Pop, 1965; *Cambarincola odontias* (Georgévitch, 1955) Pop\*, 1965; *Xironodrilus crassus* (Georgévitch, 1955) Pop, 1965; *Xironogiton dilatatus* (Georgévitch, 1955) Pop, 1965; *Xironogiton dolicoberos* (Georgévitch, 1955) Pop, 1965; *Xironogiton latus* (Georgévitch, 1957) Pop, 1965

**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. pentodonta*. 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, HALGOŠ 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 join”. On the other hand, HALGOŠ (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 HALGOŠ (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* was found on: *A. astacus* (KOZAROV *et al.* 1972, HALGOŠ 1972, SUBCHEV, STANIMIROVA 1986, 1998, KLOBUČAR *et al.* 2006, KOVÁCS, JUHÁSZ 2007, FÜREDER *et al.* 2009, BOSHKO 2010), *A. leptodactylus* (SUBCHEV, STANIMIROVA 1998, BOSHKO 2010), *A. torrentium* (SUBCHEV, STANIMIROVA 1986, 1998, KLOBUČAR *et al.* 2006, KOVÁCS, JUHÁSZ 2007, FÜREDER *et al.* 2009) and *A. pallipes* (FÜREDER *et al.* 2009), and on the alien species *O. limosus* (ĐURIŠ *et al.* 2006).

It is known that *B. pentadonta* co-exists with the following *Branchiobdella* spp.: *B. astaci* (SUBCHEV, STANIMIROVA 1986, 1998), *B. parasita* and *B. hexadonta* (SUBCHEV, STANIMIROVA 1986, 1998, ŠMIETANA, WIERZBICKA 1999, KLOBUČAR *et al.* 2006); *B. kozarovi* (SUBCHEV, STANIMIROVA 1998) and *B. balcanica* (ŠMIETANA, WIERZBICKA 1999, KLOBUČAR *et al.* 2006).

*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*

Synonyms: *Branchiobdella dubia* (Pierantoni, 1912) Pop, 1965; *Branchiobdella ochridensis* (Georgévitch, 1957) Pop, 1965; *Branchiobdella varians* var. *parasita* (Voigt, 1885) Pierantoni, 1912; *Branchiobdella pentadonta* (Georgévitch, 1957), new synonymy, a homonym of *B. pentadonta* Whitman, 1882; *Cambarincola pluridentata* (Georgévitch, 1957) Pop, 1965

**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 drawing 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 KOZAROV *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, KOZAROV *et al.* 1972, WIERZBICKA, ŚMIETANA 1999).

WIERZBICKA, ŚMIETANA (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: *A. astacus* (KOZAROV *et al.* 1972, HALGOŚ 1972, SUBCHEV, STANIMIROVA 1998, KLOBUČAR *et al.* 2006, KOVÁCS, JUHÁSZ 2007, BOSHKO 2010, FÜREDER *et al.* 2009), *A. leptodactylus* (BOSHKO 2010), *A. torrentium* (SUBCHEV, STANIMIROVA 1986, 1998, KLOBUČAR *et al.* 2006, KOVÁCS, JUHÁSZ 2007, FÜREDER *et al.* 2009), *A. pallipes* (e.g., KLOBUČAR *et al.* 2006, FÜREDER *et al.* 2009), and the introduced species *O. limosus* (ĐURIŠ *et al.* 2006).

*B. hexadonta* was found on the same host together with *B. balcanica* (HALGOŚ 1972), *B. balcanica* and *B. kozarovi* (ŚMIETANA, WIERZBICKA 1999), as well as *B. parasita* and *B. pentadonta* (SUBCHEV, STANIMIROVA 1986, 1998, ŚMIETANA, WIERZBICKA 1999, KLOBUČAR *et al.* 2006). The species was found in the same locality together with *B. papillosa* (NESEMANN, 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 (NESEMANN, 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**

Synonyms: *Branchiobdella pentadonta italica* (Pop, 1965) Karaman, 1967; *Bdellodrilus hexadonta* (Georgévitch, 1957) Karaman, 1967; *Branchiobdella karamani* (Georgévitch, 1957) Karaman, 1967; *Branchiobdella unidonta* (Georgévitch, 1957) Karaman, 1967; *Cambarincola hamata* (Georgévitch, 1957) Karaman, 1967; *Xirondrilus tetradonta* (Georgévitch, 1955) Karaman, 1967; *Xironogiton tridens* (Georgévitch, 1955) Karaman, 1967; *Branchiobdella pentadonta* (Georgévitch, 1957) Kozarov *et al.* (1972)

**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. italica* 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. italica*. 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. italica* to a subspecies, *B. pentadonta italica*, 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. italica* 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. italica*, not with *B. pentadonta* as stated.

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

*B. italica* 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. italica* are *B. astaci* (KLOBUČAR *et al.* 2006) and *B. parasita* (GELDER *et al.* 1999).

The distribution of *B. italica* 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. italica* (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 SOUTY-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, WOJTAS (1974) reported *B. italica* 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. italica* 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. italica*.

### ***Branchiobdella balcanica* Moszyński, 1938**

Synonyms: *Branchiobdella insolita* (Moszyński, 1938) Karaman, 1967; *Xironogiton dolicoberos* (Georgévitch, 1957) Pop, 1965; *Branchiobdella pentadonta 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 4<sup>th</sup> 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. italica*. POP (1965) synonymized *B. balcanica* with *B. pentadonta* (his subspecies *B. pentadonta pentadonta*) and *B. in-*

*solita* with *B. italica* (his subspecies *B. pentadonta italica*). However, he did not note the very important peculiarity shared by these two species in MOSZYŃSKI (1938a) – their body shape as mentioned above. This distinct morphological feature that distinguishes these worms from both *Branchiobdella* species (*B. pentadonta* and *B. italica*) with similar jaws in the “*pentadonta* group” of KARAMAN (1970), was the reason for their validation proposed independently by KARAMAN (1967, 1970) and KOZAROV *et al.* (1972). KARAMAN (1967, 1970) restored *B. balcanica* based on the original description and noted that the species is a junior synonym of *B. insolita*, while KOZAROV *et al.* (1972) restored *B. insolita* with referring to the expansion of the 4<sup>th</sup> body segment and the shape of the spermatheca and male reproductive system, which were drawn by MOSZYŃSKI (1938a, 1938b). KOZAROV *et al.* (1972), relying on their own material, demonstrated by drawings that the spermatheca of *B. balcanica* (their *B. insolita*) is clearly distinguished from the spermatheca of *B. pentadonta* by having a duct similar in length to the spermatheca bulb, while in *B. pentadonta* this duct is shorter and connects with the spermatheca bulb end laterally. In addition, the glandular part of the male reproductive system in *B. balcanica* is clearly shorter than the non-glandular part of that system, while the opposite is valid in *B. pentadonta*. In fact, the spermatheca and male reproductive system of *B. balcanica* is more similar to those in *B. italica* than in *B. pentadonta*. However, the differences in body shapes of the two species: a flatten body with a sudden expansion from the 4<sup>th</sup> body segment in *B. balcanica* and a fusiform body in *B. italica* gives no possibility for misidentification. The subspecies, *B. pentadonta orientalis*, described as a new by POP (1965), is actually a junior synonym of *B. balcanica* (KARAMAN 1970). KARAMAN (1967) also described a new *B. balcanica* subspecies – *B. balcanica sketi*. However, he indicated the bigger spermatheca and penis (actually penis bursa) in the new subspecies as the only features that differentiate the subspecies from the nominal one, without giving data about variations, which is not enough for identification. Recent investigations on worms from the same locality provided no proofs of the existence of enough differences to separate the local *B. balcanica* population as a new subspecies (Maria Kolesnikova, personal communication).

According to BOSHKO (1983), *B. balcanica* is located on the thoracic and abdominal limbs of the host.

The following species have been reported as hosts of *B. balcanica*: *A. astacus* (KOZAROV *et al.* 1972, HALGOŚ 1972, SUBCHEV, STANIMIROVA 1998,

KLOBUČAR *et al.* 2006, KOVÁCS, JUHÁSZ 2007, FÜREDER *et al.* 2009, BOSHKO 2010), *A. leptodactylus* (BOSHKO 2010), *A. torrentium* (HALGOŚ 1972, KOVÁCS, JUHÁSZ 2007) and *O. limosus* (ĐURIŠ *et al.* 2006).

*B. balcanica* was found to co-exist with *B. astaci* (SUBCHEV, STANIMIROVA (1998) as well as *B. parasita* and *B. hexadonta* (HALGOŚ 1972; KLOBUČAR *et al.* 2006)

*B. balcanica* has been found from Germany and Austria through the Czech Republic and Poland and almost all Balkan countries to Ukraine (not reported for Russia, but seem to be absent from the Nordic and Baltic countries as well as in the southern countries such as France, Italy and Greece (Table 1).

### ***Branchiobdella kozarovi* Subchev, 1978**

No synonyms.

**Type specimen and paratypes:** in the National Museum of Natural History, Sofia, Bulgaria. Paratypes are also available at museums of natural history in Paris, Berlin and London.

**Type locality:** man-made ponds near the village of Razdelna, Varna district, Bulgaria (SUBCHEV 1978).

This species differs from all other European species by its body shape and the form of the male reproductive system and spermatheca. The species with similar jaws, *B. pentadonta* and *B. balcanica*, have bodies more or less dorso-ventrally flattened, in contrast to the cylindrical body of *B. kozarovi*. In the mentioned two species and in *B. italica*, another species with similar jaws, the width of the jaws is clearly bigger than their height, while in *B. kozarovi* these dimensions are similar in size. *B. hexadonta* resembles *B. kozarovi* by body size and shape, but the former species may be very well distinguished externally by a presence of a transverse head furrow (see above), which is absent in all other *Branchiobdella* species. No synonyms are available although, according to BOSHKO (2010), in some of the records from Russia and Ukraine identified as *B. pentadonta* before the description *B. kozarovi*, such a transverse head furrow has been described. Most probably the worms from Saratov, reported as *B. hexadonta* by SVETLOV (1923), were also *B. kozarovi* (see above).

The usual location on the host are the pincers and thoracic legs of the host (SUBCHEV 1978) but, according to some authors (BOSHKO 1983, KOLESNYKOVA *et al.* 2008), worms of this species could also be found in other locations on the crayfish surface and even in the gill chamber (BOSHKO 1983, KOLESNYKOVA *et al.* 2008).

*B. kozarovi* was found on crayfish identified at the time as *A. astacus* (SUBCHEV 1972) (a mis-

dentification 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, KOLESNYKOVA 2007, KOLESNYKOVA *et al.* 2008, KOLESNYKOVA *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* (KOLESNYKOVA 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 19<sup>th</sup> and 20<sup>th</sup> 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 (KOLESNYKOVA *et al.* 2012).

### ***Branchiobdella papillosa* Nesemann and Hutter, 2002**

No synonyms.

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

**Type locality:** the Rhine catchment area, Ill catchment (Walgau 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 NESEMANN, HUTER (2002) but no details of the reproductive system were given. Its later redescription showed that the jaws, male reproductive system and spermatheca are simi-

lar 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, HUTTER 2002).

So far this species was found only at the type locality at Voralberg, 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](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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