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Distribution and Identification key for species of freshwater leech genus *Erpobdella* Blainville, 1818 (Hirudinida: Arhynchobdellida: Erpobdelliformes: Erpobdellidae)

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ABSTRACT

Genus *Erpobdella* (Family Erpobdellidae) comprises of freshwater predatory leeches, characterized by the presence of multiple testis sacs per somite, eyes arranged in two groups, presence of preatrial loops, location of gonopores in somite XII and lacking pharyngeal stylets. Despite being subjected to phylogentic analysis many a times, its taxonomic position is still not clear as some taxonomists still follow the old traditional method involving subdivision of annuli to distinguish between different genera within erpobdellidae. Some authors however, agree with the suppression of all old generic names (*Dina, Trocheta, Nephelopsis, Mooreobdella, Motobdella, and Croatobranchus*) with genus *Erpobdella* as sole valid genus for all the species within the family. In the present paper, an attempt has been made to gather all the data regarding description of all species within this genus (after synonymization) which otherwise is not available in an organised way. A detailed procedure regarding method of study of this group and distributional data is also presented. Further, a dichotomous identification key for about 45 species of genus *Erpobdella* has been proposed with an aim that it would ease the identification process in future studies.

Keywords: Hirudinida, Leech, Erpobdellidae and *Erpobdella*

Introduction

Arhynchobdellids as defined by Harding and Moore (1927) includes freshwater and terrestrial leeches that lack a protrusible proboscis. They may be sanguivorous parasite or non sanguivourous predators of small aquatic worms or invertebrate larvae (Toman and Dall, 1997). Order Arhynchobdellida is divided into two suborders-Hirudiniformes and Erpobdelliformes (Sawyer, 1986). The former group is strictly sanguivorous, proboscis less, characterized by the modification of pharynx into muscular jaws. The Erpobdelliformes however, are predatory with pseudognaths and a strepsilamatous pharynx (Nesemann and Neubert, 1999), and further subdivided into two families-Erpobdellidae and Salifidae (Sawyer, 1986). Family Erpobdellidae according to Harding and Moore (1927) comprised of members having eyes not arranged in parabolic arch, annuli of complete somite tends to divide further from basic annulations formula (b1, b2, a_2, b5, b6); lack jaws, proboscis and gastric caeca. Earlier this family was believed to be comprised of three subfamilies – Erpobdellinae (homonomously quinquannulated); Trochetinae (five to nine annulate somites) and Mooreobdellinae

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(heteronomous five to six annulate somite and lack preatrial loops) (Nesemann and Wien, 1993).

Historically, it was believed that this family contains genera – *Erpobdella* Blainville (1818), *Dina* Blanchard (1892), *Trocheta* Dutrochet (1817), *Nephelopsis* Verrill (1972), *Motobdella* Govedich *et al*. (1998) and *Mooreobdella* Pawlowski (1955). For years, these different genera were classified on the basis of two characters: subdivision of annuli and male reproductive system particularly presence or absence of preatrial loops. The basic annulation structure of an erpobdellid is a five annulate somite as in traditional *Erpobdella* (Figure 1A), annulus b6 is either broader than other annuli or is subdivided into c11 and c12 in *Dina* species (Figure 1B). Further, subdivision of b1 into c1 and c2 together with subdivision of c12 into d23 and d24 results in a somite being octoannulate, a characteristic of genus *Trocheta* (Figure 1C). The remaining genera *viz. Mooreobdella* lack preatrial loops; *Motobdella* has paired post-caeca and *Nephelopsis* is characterized by the presence of highly coiled atrial horns. A new genus of cave dwelling leeches *Croatobranchus* was raised by Kerovec *et al.* (1999) within the family characterized by the presence of peculiar set of somatic appendages which are lacking in any other group within Erpobdellidae.

Grouping of genera into family Erpobdellidae has always been confusing as some eminent leech taxonomists (Harding and Moore, 1927; Klemm, 1982; Nesemann and Wien, 1993; Neubert and Nesemann, 1995; Grosser *et al.* 2014 and Ahmed *et al.* 2008), believed that three genera *Erpobdella*, *Dina* and *Trocheta* be incorporated in this family, considering the pattern of division of annuli to be the prime differentiating feature. On the other hand some workers consider this particular character to be unreliable in order to authenticate the differentiation between different genera in the family (Trontlej and Sket, 2000; Siddall, 2002; Borda and Siddall, 2004). This ambiguity however, was resolved to some extent by Trontlej and Sket (2000) when they established that the degree of subdivision of annuli is an inappropriate feature to differentiate *Dina* and *Trocheta*. They found strong evidence of a close phylogenetical relationship between *Trocheta bykowskii krasense, Dina punctata* and *Dina lineata* and based on this observation suggested to annule the subfamily Trochetinae and inclusion of *T. b. krasense* into *Dina* as *Dina krasense.* Siddall (2002), based on phylogenetic review synonymised not only *Dina* and *Trocheta,* but also other genera (*Nephelopsis*, *Mooreobdella* and *Croatobranchus*) which were neither found monophyletic, nor rendering the genus *Erpobdella* paraphyletic. This classification was relied upon by many leech taxonomists from time to time (Oceguora-Figueroa *et al.*, 2010; Cichocka *et al.*, 2015; Tessler *et al.*, 2018; and Anderson *et al.*, 2020).

Since description of many species under *Erpobdella* is available by their old names and so are their identification keys, which therefore, accounts for major discrepancies in their identification. The aim of this review paper is to compile the entire information available with respect to the diagnostic characters and distributional records of about 45 species within genus *Erpobdella* and to propose identification keys based on the data on record.

Materials and Methods

1. Collection, Narcotization, Fixation and Preservation: Erpobdellids can be directly handpicked using tweezers from underside of stones, leaves of submerged or floating plants, cracks (mostly) or by sieving the dredged out sediments (few). Accuracy of identification is dependent on suitable preservation. Direct dropping of the live specimen in 70-80% alcohol or 5-10% formalin results in strong contraction of body and even distortion of some important taxonomic characters (body shapes, genital pores, annulations pattern and eyes). Narcotization can be done by adding few drops of chloroform to the water containing leeches. This method is the fastest, and most efficient that hardly takes 5 minutes to relax the leeches. Some other methods of narcotisation include use of carbonated water, 1 % propylene phenoxetol, 1% sodium nembutal and 4% ether solution. Relaxed leeches should be passed between fingers or wiped with brush to remove excess of oozing out mucous. Photography of leech specimen

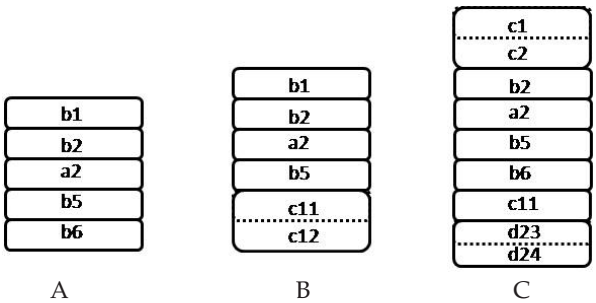

Fig. 1. Homonomous (A) and Heteronomous (B, C) annulations in *Erpobdella species*

as a whole and noting down the colour of leech before proceeding for fixation is necessary as skipping this step may result in disappearance of colour which is of utmost taxonomic value. Fixation and straightening of leech is done by placing the relaxed leech in straight position in a dissection tray and is then covered by a filter paper following by the addition of 10% formalin in the tray. After about 12 hours leeches should be taken out, washed in distilled water and then preserved in 70% alcohol or 5% buffered formalin (Klemm, 1982).

2. Dissection of Reproductive organs: To obtain better transparency, preserved specimen should be given a glycerine treatment for about 12 hours (depending upon the size of leech) before dissection. Animal should be pinned ventrally and then a rectangular area of body wall be removed from clitellar region, beginning from about 6 annuli anterior to ♂ gonopore and about 6 annuli behind ♀ gonopore. Removal of connective tissue in that area results in exposure of ejaculatory ducts, preatrial loops and genital atrium.

3. Formulation of Keys: Descriptions of species were gathered from various taxonomic reviews, monographs, identification keys and handbooks such as Soos (1963). Klemm (1982). Neubert and Nesemann (1995), Nesemann and Neubert (1999), Thorp and Lovell (2016 and 2019).

Results and Discussion

The new definition of *Erpobdella* adopted here is that of Siddall (2002) where according to him *Erpobdella,* should be defined as leeches with multiple clusters of testis sacs per somite, absence of pharyngeal stylets (a feature of family Salifidae), presence of apomorphic condition of two pairs of labial eyes (when present) and either one or two more pairs of eyes in buccal group. In the original document, he enlisted about 37 species to be included in this genus. Apart from suppressing the generic names, he also suggested some other nomenclatural changes to avoid homonymy between North American *E. punctata* Leidy, 1870 and European *E. punctata* Johansson, 1927 (earlier *Dina*) by proposing a new name, *E. johanssoni* for the latter species. Some species like *E. mauchi* (old name- *Dina punctata mauchi*) and *E. coastalis* (old name- *E. punctata coastalis*) were lifted from subspecies to species level. Later on, some more new species were added to this genus such as *E.bhatiai* Nesemann (2007), *E. borisi* Cichocka (2015) and *E. adani* Tessler (2018). *E. montezuma* Davis and Singhal (1985) earlier known by the name *Motobdella montezuma* was included in the studied genus by Oceguroa-Figueroa *et al*. (2010). A new genus *Erpobdellopsis* within subfamily Erpobdellinae was proposed by Jueg and Grosser (2017) following traditional classification based on subdivision of annuli and lack of preatrial loops. On the other hand, *E. ochoterenai and E. adani* , found to be closely related to *Erpobdella* by Tessler (2018) also like *Erpobdellopsis* lack preatrial loops and are homonomously five annulated. So here the confusion arises as to whether *Erpobdellopsis* should be considered a separate genera or not and need to be solved by further molecular evidences. Many species of *Erpobdella* are not included in the present key due to lack of proper evidence of their being related to *Erpobdella.* To cite an example, *Barbronia wuttkei* Kutschera, 2004 was originally described as a species of *Erpobdella*, but Grosser and Trontlej (2008) recovered the presence of accessory pores and pharyngeal stylets in this species and hence assigned this species to genus *Barbronia* Johansson, 1918 within family Salifidae. Accessory pores are also present in *Erpobdella haskonis*, but it lacks pharyngeal stylets, hence its inclusion in *Erpobdella*, and thus in Erpobdellidae is justified.

Use of Key: Description of some terms used in the key is given below.

Annulation pattern: It is the pattern of subdivision of annuli within a somite. A fully developed somite is present in middle of body. The annulations pattern suggested by Moore (1898) is followed here in the key (Table 1). Basic annulation pattern is that of a triannulate somite where a single somite divides primarily into three annuli a1, a2 and a3. Of these three basic/primary annuli, sensory annulus is the middle one (a2) that contains nerve cord ganglia. The distance between sensory annulus of one somite to sensory annulus of succeeding somite is called a neurosomite (ns). Each primary annulus further subdivides into secondary, tertiary and then into quaternary annuli as depicted in the Table 1. Each annulus is separated from the next by forming a narrow groove called 'furrow' designated by a slash '/' between the annulus names. For instance, a furrow between annulus b1 and b2 of XIIth somite is designated as 'XII b1/b2'. If the width of every annulus in a somite is equal then it is said to be 'homonomous'. If any one of the annulus in a somite

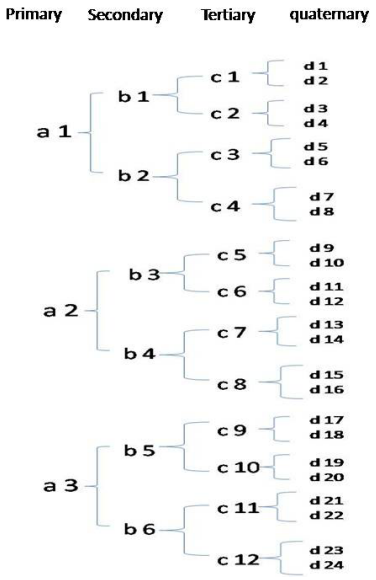

Table 1. Theoretical table showing pattern of subdivision of annuli after Moore (1898)

is wider than the other annuli, it is said to be 'heteronomous' (Figure 1).

Eyes: in general *Erpobdella* has 1-4 pairs of eyes (may be absent in some) arranged in two groups - first group are eyes directed anteriorly (labial group) and the second group is of eyes directed laterally or dorsolaterally (buccal group) as shown in (Figure 2A).

Longitudinal stripes: pigmented lines extending from anterior to posterior part in dorsum.

Papillae: are sensory structures protruding from dorsal side of leech may be coloured and appear as pale or coloured spots on body. (Figure 2B)

Gonopores: Opening of ♂ and ♀ reproductive organs located ventrally on the clitellum. ♂ gonopore is always large than ♀ gonopore. (Figure 2C)

Atrium: It is ♂ reproductive organ which has a median glandular chamber and a pair of atrial horns (cornua). It opens to exterior via ♂ gonopore. (Figure 2D)

Preatrial loops: Ejaculatory ducts arising from epididymis might extend anteriorly to ganglion XI before meeting with atrial horns, resulting in formation of loops called preatrial loops. Cornua might be simply curved (*E. bhatiai*) or spirally coiled (*E. obscura*).

Identification keys for species of genus *Erpobdella*: The key proposed here is a dichotomous key, presenting two sets of contrasting characters in

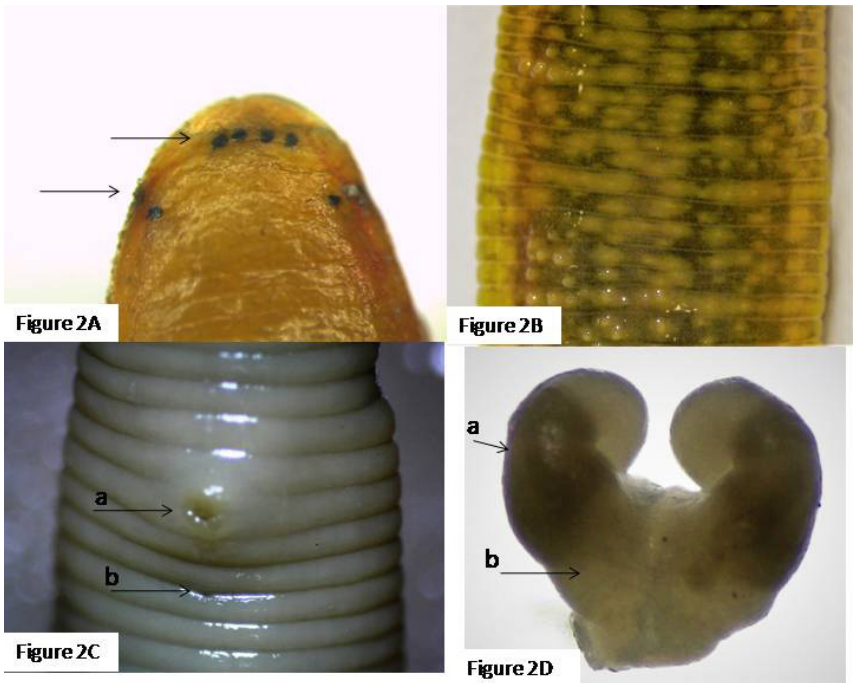

Fig. 2A. Anterior region of an erpobdellid showing presence of two groups of eyes (denoted by arrow). Figure 2B. Dorsum of an Erpobdella species showing the presence of spots and papillae. Figure 2C. Ventral region of clitellum showing male gonopore (a) at annulus and female gonopore (b) in furrow, both separated by 2.5 annuli. Figure 2D. Male genital atrium showing two parts (a) atrial body and (b) atrial cornua curved ventro medially.

each pair of statements.

1. Mid-body somite (in post clitellar region) homonomously annulated.....(2)
1′ Mid-body somite heteronomously annulated..... (18)
2(1) Eyes present and conspicuous ..... (3)
2′ Eyes inconspicuous; adult 25-40 mm, milky white to pale yellow, elongated moderately and slightly dorsoventrally depressed; gonopores separated by 2.5 annuli, ♂ gonopore on XII a2 and ♀ gonopore on XII b6/XIII b1; 4 pairs of tentacles around oral sucker (disappears when sucker attaches to substrate); 10 or more conspicuous lateral processes in postclitellar region.....*E. mestrovi* (*Croatobranchus mestrovi* Kerovec *et al.*, 1999)
3(2) Eyes more than four/ more than four pairs..... (4)
3′ Eyes less than four pairs..... (10)
4(3) Eyes four pairs ..... (5)
4′ Eyes six pairs (may be 7 pairs or 4/5 pairs), Body 32-104 mm, third ring of a complete somite greyish white dorsally, venter lack spots, gonopores separated by 2.5-3 annuli .....*E. luguensis* Liu, 1984
5(4) Gonopore separated by 2/2.5/3 annuli..... (6)
5′ Gonopores separated by 4/5 annuli..... (8)
6(5) Longitudinal paramedian or mid dorsal stripes present ..... (7)
6′ Longitudinal stripes absent; large leeches attaining length of clitellate leech upto 100mm, greenish brown dorsum, irregularly arranged spots present; gonopores located in furrows and separated by 2 annuli; atrial horns spirally coiled like ram's horn with preatrial loops.....*E. obscura* (*Nephelopsis obscura* Verrill, 1872)
7(6) Two and one-half annuli between gonopores..... (9)
7′ Three annuli between gonopores, ♂ gonopore in XII b1/b2 and ♀ gonopore in XII b5/b6; adult about 45 mm, cylindrical, dark reddish brown-black, one pair of dark longitudinal stripes dorsally, transverse row of spots on each annulus; papillae present both dorsally and ventrally .....*E. vilnensis* Liskiewicz, 1925
8(5) Four annuli between gonopores, ♂ gonopore in XIIb1/b2 and ♀ gonopore in XII b6/XIII b1; adult maximum 40 mm long, cylindrical, dark brown; papillae present on body dorsally; two pairs of longitudinal stripes present.....*E.testacea* Savigny, 1820
8′ Five annuli between gonopores, ♂ gonopore prominent in XII b1/b2 and ♀ gonopore inconspicuous in XIII b1/b2; adult about 30 mm, elongated, dorsal colour dark gray with light gray spots, one faint mid dorsal line present, body papillate; four pair of eyes, first pair of cephalic eyes larger, second pair moderate and last two pairs of buccal eyes smaller in size; pre atrial loops are present.....*E. lahontana* Hovingh and Klemm, 2000
9(7) Right angle between atrial horns and atrial body, preatrial loops present; ♂ gonopore on annulus XII b2 and ♀ gonopore in XII b5/b6; adult 30-70 mm; greenish yellow to red brown dorsum; one pair of light longitudinal stripes present in venter, bright spots present on each annulus; papillae present.....*E. octoculata* Linnaeus, 1758
9′ Acute angle between atrial horns and atrial body, pre-atrial loops extending to ganglion XI; ♂ gonopore on annulus XII b2 and ♀ gonopore in furrow XII b5/b6; adult 20-50 mm; olive green dorsum; one pair of longitudinal stripes present, 15-20 spots on each annulus dorsally; sensillary papillae present.....*E. bhatiai* Nesemann, 2007
10(3) ♂ paired ducts do not form preatrial loops..... (11)
10′ ♂ paired ducts extending upto ganglion XI to form preatrial loops…..... (12)
11(10) Three dark longitudinal lines present on dorsum; adult 35-64 mm; dorsoventrally flattened, vermiform, dark gray dorsum, lighter ventral surface; papillae inconspicuous; clitellum thick; ♂ gonopore enlarge in XII b2/a2 (in some cases occupy entire length of b2 and half of a2 in XII) and ♀ gonopore in XII b6/XIII b1, gonopores separated by three annuli..

..... *E. adani*, Tessler, 2018

11′ A black mid-dorsal longitudinal line present on dorsum, additional marginal lines also visible in some; average about 51mm; anterior 2/3rd of body terete, remaining 1/3rd of body dorsoventrally flattened; ♂ gonopore in XII b2/a2 might be displaced to b2 in some, ♀ gonopore in XII b6/ XIII b1, gonopores separated by three (in first case) or three and one half annuli (in second case) .....*E. ochoterenai* Caballero, 1932

12(10) Two annuli between gonopores..... (13)

12′ More than two annuli between gonopore..... (15)

13(12) Testicular follicles absent..... (14)

13′ Six pairs of large testicular follicles present along with small bunches of testicular follicles; adult about 71 mm; 3 pairs of unequal eyes (1st pair closer and smaller); two dark pigmented paramedian lines present from neck to anal region; both genital pores present on raised areas, separated by two annuli, ♂ gonopore at XII b2/a2 and ♀ gonopore is very small in b4/b5 of XII..... *E. montezuma* (*Motobdella montezuma* Davis and Singhal, 1985)

14(13) Preatrial loops of male paired ducts simply curved, not coiled; atrium longer than wide; adult gonopores in furrows, ♂ gonopore very large, separated by two annuli; adult about 100mm, two to four rows of black pigment forming longitudinal stripes or irregular spots, mid dorsal pair much prominent.....*E. punctata* Leidy, 1870

14′ Preatrial loops spirally coiled like ram-horn before entering atrium; ♂ gonopore on somite XII b2/a2, ♀ gonopore on XII b5/b6; gonopores separated by two annuli; one pair of black paramedian longitudinal lines dorsally.....*E. mexicana*, Duges 1872

15(12) Dorsal side without longitudinal stripes..... (16)

15′ Dorsal side with longitudinal stripes..... (17)

16(15) Adult large sized, about 100mm, uniform gray; sensillae absent; gonopores separated by 2½ annuli, ♂ gonopore in furrow and ♀ gonopore on the annulus; atrium longer than wide, atrial cornua simple curved..... .....*E. coastalis* (*E. punctata coastalis* Sawyer and Shelley, 1976)

16ˆ Adult small-medium sized, about 50mm, cylindrical, ambent translucent or brownish gray; head blunt with dark neck band, preclitellar region with reticulated dark pattern, postclitellar region uniformly coloured; gonopores separated by 4 annuli (rarely 3[1/2]-5); ♂ gonopore in XII b1/b2 and ♀ gonopore in XII b6/ XIII b1.....*E. nigricollis* Brandes, 1900

17(15) Three annuli between gonopores, ♂ pore on XII b1/b2 and ♀ pore on XII b5/b6; one pair of dorsal dark paramedian longitudinal stripe present.....*E. triannulata* Moore, 1908

17′ Four annuli between gonopores, ♂ gonopore in XII b1/b2 and ♀ gonopore in XII b6/XIII b1; adult small, about 30mm long; bright yellow to brown; anterior portion cylindrical, posterior part flattened; one dark longitudinal stripe present throughout the entire length of body without interruption; venter uncoloured and brighter than dorsum; papillae absent;.....*E. monostriata* Lindenfeld and Pietruszynski, 1890

18(1) Somite either quniquannulate with a broad annuli b6 or 6-annulate or more than 6-annulate..... (19)

18′ Somite in preclitellar region 6 annulate (b1,b2,a2,b5,b6(c11,c12)) and in post clitellar region more than 6 annulate (c1, c2, b2 (c3,c4), a2 (b3,b4), c9, c10, c11, d23 and d24); large leech 8-12cm , dorsum black-brown, yellow spots present transversally on each somite; ♂ gonopore in XII a2, ♀ porus in XII b5/b6 or XII b5/ c11.....*E. mauchi* (*Dina punctata mauchi* Nesemann, 1995)

19(18) Somite with broad b6 or in some divided b6

annuli..... (20)

19′ Somite more than six annulate..... (42)

20 Pre atrial loops of male paired ducts absent..... (21)

20′ Pre atrial loops of male paired ducts present..... (25)

21 Gonopores separated by two annuli..... (22)

21′ Gonopores separated by three/four and one half annuli; atrium wider than long..... (24)

22 Dorsum lacking scattered black pigment concentrations, uniform gray/black..... (23)

22′ Dorsum having scattered black pigment concentrations, adult medium sized about 55mm, body whitish; atrium large, cornua projects anterio-medially and not coiled ....*E. melanostoma* (*Mooreobdella melanostoma* Sawyer and Shelley, 1976)

23 Atrium longer than wide, atrial horns of ♀ atrium projecting anteriorly; eyes 3 pairs (may be 4 pairs); dark and light longitudinal stripes present over dorsum, length 20-50mm.....*E. fervida* (*M. fervida* Verrill, 1871)

23′ Atrial body globoid, atrial horns projecting laterally with ejaculatory ducts; eyes 3 pairs; cbody uniform smoky gray, live specimen appear red due to cutaneous blood vessels; small to medium sized 10-30 mm .....*E. bucera* (*M. bucera* Moore, 1949)

24(21) Gonopores located in furrows and separated by three annuli; ellipsoidal atrium, horns project anteriorly; eyes 3 pairs; length 30-50mm..... .....*E. microstoma* (*M. microstoma* Moore 1901)

24′ Gonopores located on annulus and separated by 4-4.5 annuli; atrial horns project anteriorly or anteriolaterally; eyes 3 pairs; length 40mm..... .....*E. tetragon* (*M. tetragon* Sawyer and Shelley, 1976)

25(19) Eyes absent..... .....(26)

25′ Eyes present..... .....

(29)

26(25) Gonopores separated by 2 annuli, ♂ gonopore in XI b6/XII b1 and ♀ gonopore in XII b2/a2; 3 post anal annuli; leech with four gray/dull black coloured longitudinal stripes..... *E. anoculata* (*Dina anoculata* Moore, 1898)

26ˆ Gonopores separated by 2/2.5/ 3 annuli; troglobiont..... (27)

27(26) Colour uniform white..... (28)

27′ Colour of living specimen light gray, adult upto 26mm, dark irregular spots on dorsum, venter much lighter and has few spots; lateral keels in post-clitellar region; ♂ gonopore in XII b1/b2 (in some XII b2), ♀ gonopore in XII b5/c11 (may be in XII c11), atrial cornua oblique and curved towards the ventral side, preatrial loops present.....*E. borisi* Cichocka *et al.* 2015

28(27) Ovisacs about 8-9ns long; ♂ gonopore opens in XII b1/b2, ♀ gonopore in XII b5/b6, preatrial loops present; atrial cornua coiled in transition zone to the vasa differentia; leech lack pigment, papillae; pre-clitellar region is cylindrical; caudal sucker broad..... *E. absoloni* (*Dina absoloni* Johansson, 1913)

28′ Ovisacs short extending only to next ganglion; ♂ gonopore onb2/a2 of XII, ♀ gonopore in XII b6/ XIII b1, gonopores separated by 3 annuli, atrium slender, longer and less coiled cornua.....*E. ratschaensis* (*D. ratschaensis* Kobakhidze, 1958)

29(25) Eyes 1-3 pairs..... (30)

29′ Eyes 4 pairs..... (34)

30(29) Eyes 1-3 pairs mostly invisible; adult 35mm, translucent, pinkish, sometimes with a brown tint along neck; ♂ gonopore in XII b2/a2, ♀ gonopore in XII b6/b1, ovisacs about 4ns long.....*E. svilesta* (*D. svilesta* Sket, 1989)

30′ Eyes always 3 pairs..... (31)

31(30) Keels present..... .... (32)

31′ Keels absent, animal dark red, slightly brownish; lightly pigmented eyes; ♂ gonopore in b2/a2 of XII and ♀ gonopore in b1/b2 of XIII, ♂ atrium as long as wide or curved in dorsoventral direction, atrial cornua form obtuse angle with atrial body and converge distally..... *E. eturpshem* (*D. eturpshem* Sket, 1989)

32(31) Paramedian longitudinal stripe present..... (33)

32′ Paramedian longitudinal stripe absent; adult 35mm, width/length ratio- 0.13, dark red anteriorly and brownish posteriorly; eyes weekly pigmented; smooth surface; ♂ gonopore less prominent in XII b2/a2, ♀ gonopore less visible, somewhere in b6/b2.....*E. krilata* (*D. krilata* Sket, 1989)

33(32); Complete somite 5 annulate, annulus b6 slightly broad, but not subdivided further; adult 33-55 mm, live colour dark brown, reddish brown or yellowish brown; one pair of dark longitudinal paramedian stripe present; keels present in postclitellar region; 11-14 light spots transversally on each annulus; ♂ gonopore on annulus XII b2, ♀ gonopore in furrow XII b5/b6, gonopores separated by 2.5 annuli; vasa differentia and ovisacs extend to 5th ganglion posterior to gonopore.....*E. japonica* Pawlowski, 1962

33′ Complete somite having b6 divided to c11 and c12 and tendency to divide further; adult upto 50mm, dorsum grayish black or dark reddish, ventrally pale or grayish, papillae present; one pair of dark paramedian stripe present; yellowish spots arranged transversally on annulus a2; gonopores separated by 1.5/2 annuli..... .....*E. johanssoni* (*D. punctata* Johansson, 1927)

34(29) ♂ gonopore always inside annulus..... (35)

34′ ♂ gonopore always in furrow.....(37)

35(34) Gonopores separated by 3.5 annuli..... (36)

35′ Gonopores separated by 1.5 annuli, ♂ opening prominent on broad papilla at annulus XII a2, ♀ gonopore inconspicuous at furrow XII b5/b6; adult large sized upto 90 mm (extended); papillae absent; suckers small ……*E. maoriana* (*D. maoriana* Mason, 1976)

36(35) Brown or black mid dorsal stripe in anterior part, faded in posterior part; adult 20-60mm; eyes unequal; dorsum greenish, spots present irregularly; ♂ gonopore in XII a2, ♀ gonopore in XIII b1/b2; atrial cornua directed anteriorly and curved ventrally..... *E. dubia* (*D. dubia* Moore and Meyer, 1951)

36′ Mid dorsal stripe absent; adult 25-30mm; unpigmented dorsum; colour uniform gray, atrium with simply curved cornua; preatrial loops present..... ..... *E. parva* (*D. parva* Moore, 1912)

37(34) ♂ gonopore in XII b1/b2, genital pores separated by more than 3 annuli..... (38)

37′ ♂ gonopore in XIIb2/a2, genital pores separated by less than 3 annuli..... (39)

38(37) Gonopores separated by 3 annuli; ♂ gonopore in XII b1/b2, ♀ gonopore in XII b5/b6,; small and rounded atrium, horns have broad insertion into atrial body; adult upto 60 mm, flat ventrally, yellow, cream white to buff, two broad pigmented stripes present, spots present more prominent on a2 and b5; all annuli have faint furrow, b6 splits into c11 and c12;.....*E. latestriata* (*D. latestriata* Neubert and Nesemann, 1995)

38ˆ Gonopores separated by 4/5 annuli, ♂ gonopore at XII b1/b2 (or b1 rarely), ♀ gonopore at XII/XIII to XIII b1/b2; adult 18-29 mm, dorsum pale yellowish gray/light clay; equal sized eyes.....*E. quaternaria* (*D. quaternaria* Moore, 1930)

39(37) Gonopores separated by 2 annuli..... (40)

39ˆ Gonopores separated by 2-2.5 annuli..... (41)

40(39) Ground colour dark greenish or reddish black, yellow spots arranged in a row transversally on each annulus (two rows on

Table 2. Data regarding distribution of different species of genus *Erpobdella* (Arhynchobdellida: Erpobdelliformes: Erpobdellidae)

S.No.	Name of Species	Biogeographical zone	Countries
1	*E. absoloni*	Palaeractic	Europe: Bosnia, Herzegowina and Georgia (Nesemann and Wien, 1993)
2	*E. adani*	Neo tropical	South of North America: Chiapas, Mexico (Tessler *et al.* 2018)
3	*E. anoculata*	Nearctic	North America: San Digo County, California (Moore, 1898)
4	*E. apathyi*	Palaearctic	Central to Eastern Europe- Poland, Ukraine, Romania, Hungary and Austria (Nesemann and Neubert, 1999)
5	*E. bhatiai*	Oriental	Asia: India, Pakistan (Nesemann *et al.* 2007)
6	*E. borisi*	Palaeractic	Azerbaijan: Sahoolan cave; Iran (Cichocka *et al.* 2015)
7	*E. bucera*	Nearctic	North America: Southeastern Michigan (Sawyer, 1972) Canada: Ontario (Anderson *et al.* 2020)
8	*E. bykowskii*	Palaearctic	Central Europe: In Alps and Carpathians, Northern adjacent areas of South west Germany and South East Poland; Italy: Apennines (Nesemann and Neubert, 1999)
9	*E. coastalis*	Nearctic	North America: Carolinas (Sawyer and Shelley, 1976)
10	*E. concolor*	Palaearctic	Iran, Turkey, Syria, Iraq, Israel, Jordan and the north of Saudi Arabia (Nesemann and Neubert, 1999)Greece (Groser and Pesic, 2013)
11	*E. dubia*	Nearctic	North America: Alaska and Canada (Klemm, 1982); Michigan (Apakupakul *et al.* 1999)
12	*E. eturpshem*	Palaearctic	Europe: Ohrid basin, Lake ohrid (Neubert and Nesemann, 1995)
13	*E. fervida*	Nearctic	North America: Canada (Klemm,1982)
14	*E. haskonis*	Palaearctic	Europe: Germany (Pfeiffer *et al.* 2005)
15	*E. japonica*	Palaearctic	Asia: Korea (Apakupakul *et al.* 1999)
16	*E. johanssoni*	Palaearctic	West EuropeanMiddle East: Northern Iraq: Lesser Zab river (Bilal *et al.* 2017)
17	*E. krasensis*	Palaearctic	Europe : Slovenia and Croatia (Nesemann and Neubert, 1999)
18	*E. krilata*	Palaearctic	Europe: Ohrid basin (Neubert and Nesemann, 1995)
19	*E. lahontana*	Nearctic	North America: California and Nevada (Hovingh and Klemm, 2000)
20	*E. latestriata*	Palaearctic	Europe: Greece and Macedonia: Lake Prespa (Neubert and Nesemann, 1995)
21	*E. lineata*	Palaearctic	Europe: Poland: Olsztyn, Baltic coast, Pomeranian lake, Masurian Lake, Wielkopolsko-Kujawska lowland, Bialowieza forest, Lower and upper Silesia, Trzebnickie hills, Malopolska upland (Ropelewska *et al.* 2013)
22	*E. luguensis*	Palaearctic	China: Lake Luguhu, between Sichuan and Yunnan Province (Liu, 1984)
23	*E. maoriana*	Australasian	New Zealand (Neubert and Nesemann, 1995)
24	*E. mauchi*	Palaearctic	Western Europe: Signold north of Bobingen, Bavaria, Germany (Nesemann and Neubert, 1999)
25	*E. melanostoma*	Nearctic	North America: Carolinas (Sawyer and Shelley, 1976); Canada: Quebec: Louisiana, Massachusetts, North Caolina (Klemm,1982)
26	*E. mestrovi*	Palaearctic	Europe: Croatia: Northern Velebit (Sket *et al.*, 2001)
27	*E. mexicana*	Nearctic	North America: Mexico: Guanajuato, Tlaxcala (Oceguera-Figueroa *et. al.*, 2005); Hidalgo (Armenta and Oceguora-Figueroa, 2019)
28	*E. microstoma*	Nearctic	North America: Canada: Saskatchewan (Anderson *et al*., 2020)
29	*E. monostriata*	Palaearctic	Europe: Carpathian baisn (Lukin, 1976); Germany: Magdeburg (Pfeiffer *et al.* 2005), Pomerania (Trajanovski *et al.*, 2010) European Russia: lake Ugolnoe, Voronezh Oblast (Utevsky *et al.*, 2015)
30	*E. montezuma*	Neotropical, Nearctic	Northern America : Arizona (Davis *et al.*, 1985)
31	*E. nigricollis*	Palaearctic	Central-East Europe
32	*E. obscura*	Nearctic	North America: Alaska and Canada (Klemm, 1982)

Table 2. *Contiued ...*

S.No.	Name of Species	Biogeographical zone	Countries
33	*E. ochoterenai*	Nearctic, Neotropical	Mexico: Hidalgo, Mexico city (Armenta and Figueroa, 2019)
34	*E. octoculata*	Palaearctic Oriental	Asia: China(Moore, 1930); India: Jammu and Kashmir (Chandra, 1983, 1991) Middle East: Iraq: Al-Hindyia river/ Babil province (AL-Ameen and Jawair, 2019)
35	*E. parva*	Nearctic	Northern United States and Canada (Klemm, 1982)
36	*E. punctata*	Nearctic	Iraq: Al-Hindyia river/ Babil province (AL-Ameen and Jawair, 2019)
37	*E. quaternaria*	Palaearctic	Asia: China (Moore, 1930)
38	*E. ratschaensis*	Palaearctic	Western Asia: Georgia cave at Ratscha, Schartali (Neubert and Nesemann, 1995)
39	*E. stschegolewi*	Palaearctic	Cremean Peninsula, Azerbaijan, Georgia, Ukraine, South Caucasus and Israel, Lebanon, Iran, Syria and Turkey (Khomenko *et al.* 2018)
40	*E. subviridis*	Palaearctic	Northern Europe: Italy, Ireland; Western Europe : France, Luxem bourg and England (Nesemann and Neubert, 1999)
41	*E. svilesta*	Palaearctic	Europe: Ohrid basin (Neubert and Nesemann, 1995)
42	*E. testacea*	Palaearctic	Northern Italy and GreeceCroatia, Montenegro, Bosnia and Herzegovina (Sket, 1968)Tunisia (Ahmed *et al.* 2008)
43	*E. tetragon*	Nearctic	North America: Atlantic coast and Gulf states of USA, Massachu setts, New Jersey, Carolina, Georgia, Albama and Florida (Klemm, 1982)
44	*E. triannulata*	Neotropical	North America: Chiapas, Mexico (Tessler *et al.* 2018)Central America: Costa Rica, Guatemala, and Honduras (Oceguora-Figueroa and Chaves, 2012; Cornejo *et al.* 2015)
45	*E. vilnensis*	Palaearctic	Europe: Germany (Pfeiffer *et al.* 2005)

b6), ♂ gonopore in XII b2/a2, ♀ gonopore in XII b5/b6, atrium long and horns simply coiled; large sized leeches upto 80 mm. .....*E. apathyi* (*D. apathyi* Gedroyc, 1916)

40′ lack dorsal paramedian stripes and spots; leech is uncoloured; ♂ gonopore in furrow XII b2/a2 and ♀ gonopore in XII b5/c1....*E. concolor* (*D. lineata concolor* Annandale, 1913)

41(39) One or two pairs of dark paramedian stripes, keels present posterior-laterally, adult medium sized, upto 50 mm, red-brown, ventral side brighter; ♂ gonopore in XII b2/a2 and ♀ genital pore in XII c11/ c12.....*E. lineata* (*D. lineata* Muller, 1774)

41′ Medium sized leech upto 50 mm, reddish brown dorsally, venter pale white or yellowish white, yellow spots arranged in transverse rows on each annulus, lack paramedian stripe, 4 pairs of reduced eyes.....*E. stschegolewi* (*D. stschegolewi* Lukin and Epshtein, 1960)

42(19) Lack longitudinal Stripe and spots on dorsum..... (43)

42′ longitudinal dorsal stripe present..... (44)

43(42) Accessory pores present, gonopores separated by 2.5 or 3 annuli, papillae present, grayish or brownish gray dorsum.....*E. haskonis* (*Trocheta haskonis* Grosser, 2000)

43′ Accessory pores absent; very large leeches 80-140mm,whitish gray or reddish transparent, rarely pink; Accessory pseudognaths and folds in pharynx; ♂ gonopore in XII b2/a2 and ♀ gonopore in XII b5/c11 annulations formula c1,c2,b2,a2,b5,c11,d23 and d24; oral sucker long and rostelloid;.....*E. bykowskii* (*T. bykowskii* Gedryoc, 1913)

44(42) Gonopores separated by 2 annuli, ♂ gonopore in XII b2/a2, ♀ gonopore in XII b5/ c11Olive-green leech, one pair of paramedian stripes present, annulations formula is c 1 , c 2 , b 2 , a 2 , b 5 , c 1 1 , c 1 2 (d 2 3 , d24).....*E. krasense* (*T. b. krasense* Sket, 1968)

4 4 ˆ Gonopores separated by 6-9 annuli, ♂ gonopore in XII c2/c3, ♀ gonopore in XII d24/ XIII c1; leeches upto 140mm, dorsum brown, 2 longitudinal paramedian stripes present, spots absent; annulations formula of somite b1, b2, b3(c3,c4), a2(b3,b4), b5(c9,c10), c11, d23 and d24; paragnaths larger.....*E. subviridis* (*T. subviridis* Dutrochet, 1817)

The key is designed in a way to aid those in identification as well who still follow old concept of generic differentiation, as old names have also been mentioned in the bracket along with their new names after synonymization. The distributional data of all the species is given in Table 2.

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References

Ahmed, R.B., Tekeya, S. and Harrath, H. 2008. Preliminary study of the leeches in Tunisia: Description and systematic (Clitellata, Hirudinea). *Bulletin de la Societe Zoologique de France*. 133(1-3): 85-95.

AL-Ameen, N.I. and Jawair, H.J. 2019. New record of three speies of leeches (Annelida: Hirudinea) in Al-Hindyia River/ Babil Province/ Iraq. *Baghdad Science Journal*. 16(3): 677-681.

Anderson, K., Braoudakis, G. and Kvist, S. 2020. Genetic variation, pseudocryptic diversity, and phylogeny of Erpobdella (Annelida: Hirudinida: Erpobdelliformes), with emphasis on Canadian species. *Molecular Phylogenetics and Evolution*. 143: 1-11.

Apakupakul, K., Siddall, M. E. and Burreson, E. M. 1999. Higher level relationships of leeches (Annelida: Clitellata: Euhirudinea) based on morphology and gene sequences. *Molecular Phylogenetics and Evolution*. 12: 350-359.

Armenta, J.J. and Oceguora-Figueroa, A. 2019. Leeches from Mexico City, remnants of the ancient lake. *Mitochondrial DNA Part A*. 30(4): 632-642.

Bilal, S.J., Ali, L.A., Abdullah, L.Y., Khailany, R.A., Dhahir, F. and Abdullah, M.A. 2017. First record of Leech Dina punctata (Annelida: Erpobdellidae) from Lesser Zab River in Northern Iraq: Morphological and molecular Investigation. *Jordan Journal of Biological Sciences*. 10(2): 69-72.

Borda, E. and Siddall, M.E. 2004. Review of the evolution of life history strategies and phylogeny of the Hirudinida (Annelida: Oligochaeta). *Lauterbornia*. 52: 5-25.

Chandra, M. 1983. The leech fauna of Jammu region of Jammu and Kashmir state, India. *Records of Zoological Survey of India*. 81: 289-298.

Chandra, M. 1991. *The leeches of India-a handbook*. Zoological survey of India, Solan.

Cichocka, J.M., Bielecki, A., Kur, J. and Pikula, D. 2015. A new leech species (Hirudinida: Erpobdellidae: Erpobdella) from a cave in the West Azerbaijan province of Iran. *Zootaxa*. 4013(3): 413-427.

Cornejo, A.A., Oceguera-Figueroa, A. and Bernal-Vega, J. 2015. Sanguijuelas (Annelida: Clitellata) de agua dulce de Panamá: comparación con la riqueza de especies de Centro América. *Puente Biológico* 1: 1-13.

Davies, R.W., Singhal, R.N. and Blinn, D.W. 1985. *Erpobdella montezuma* (Hirudinioidea: Erpobdellidae), a new species of freshwater leech from North America. *Can. J. Zool.* 63:965-969.

Grosser, C. and Pešiæ, V. 2013. First record of *Erpobdella concolor* (Annandale, 1913) (Hirudinida: Erpobdellidae) from Greece. *Biologica Nyssana*. 4 (1-2): 91-92.

Grosser, C. and Trontlej, P. 2008. On the taxonomic status of *Barbronia wuttkei* (Kutschera, 2004) n. comb. - a leech species (Hirudinea: Salifidae) from a German aquarium. *Lauterbornia*. 65: 69-75.

Grosser, C., Pesic, V. and Lazarevic, P. 2014. A checklist of the leeches (Annelida: Hirudinida) of Serbia, with new records. *Fauna Balkana*. 3: 71-86.

Harding, W.A. and Moore, J.P. 1927. *The Fauna of British India including Ceylon and Burma: Hirudinea*. Taylor & Francis, London. I-XXXXIII & 1-302.

Hovingh, P. and Klemm, D.J. 2000. *Erpobdella lahontana* (Annelida: Hirudinea: Arhynchobdellida: Erpobdellidae), a new species of freshwater leech from North America. *Proceedings of the Biological Society of Washington*. 113(1): 151-161.

Jueg, U. and Grosser, C. 2017. *Erpobdellopsis graacki* n.gen., n. sp.- a peculiar leech from Spain (Annelida, Hirudinida: Erpobdellidae). *Lauterbornia*. 84: 69-87.

Kerovec, M., Kucinid, M. and Jalzid, B. 1999. *Croatobranchus mestrovi* sp. n. -predstavnik nove endemske podzemne vrste pijavica (Hirudinea, Erpobdellidae). *Speleolog*. 44–45, 35–36.

Khomenko, A., Utevsky, S., Palatov, D., Huseynov, M., Farzali, S., Dadashova, L., Darestani, K.D. and Utevsky, A. 2018. On the distribution of *Dina stschegolewi* (Hirudinida: Erpobdellidae) in the South Caucasus. *Zoology in the Middle East*. 64(1): 88-90.

Klemm, D.J. 1982. *Leeches (Annelida: Hirudinea) of North America*. United States Environmental Protection Agency, EPA-600/3-82-025.

Liu, L. 1984. A new species of the leech Genus *Erpobdella* (Hirudinea: Erpobdellidae). *Geography. Proceedings*.

Lukin, E.I. 1976. *Leeches of fresh and brackish waters (Fauna*

of the USSR Leeches). Leeches, Vol. 1. Acad. Sci, USSR.
Moore, J.P. 1898. The leeches of the U.S. National Museum. *Proc. U.S. Nat. Mus*. 21: 543-563.
Moore, J.P. 1930. Leeches from China with Descriptions of New species. *Proceedings of the Academy of Natural Sciences of Philadelphia.* 82: 169-192.
Nesemann, H. and Neubert, E. 1999. Annelida, Clitellata. Branchiobdellida, Acanthobdellida, Hirudinea. In: Subwasserfauna von Mitteleuropa, 6/2. Hiedelberg, Berlin.
Nesemann, H. and Wien. 1993. Identification key to the Hungarian leeches of the subfamily Trochetinae Pawlowski, 1954, with notes on systematic of the subfamily Erpobdellinae Blanchard, 1894 (Hirudinea). *Annales Historico-Nationalis Hungarici*. 85: 19-35.
Nesemann, H., Sharma, S. and Sharma, G. 2007. "Order" Hirudinida, p- 170-193. In: H. Nesemann, S. Sharma, G. Sharma, S.N. Khanal, B.P.N. Shah, R.D.T. Shah (ed.). *Aquatic Invertebrates of the Ganga River System (Mollusca, Annelida, Crustacea [in part])*. Chandi Media Pvt. Ltd.
Neubert, E. and Nesemann, H. 1995. Contribution to the knowledge of the genus Dina Blanchard, 1892 (Hirudinea: Erpobdellidae). *Hydrobiologia*. 315: 89-94.
Oceguera-Figueroa, A. and Pacheco-Chaves. 2012. Registros de sanguijuelas de Costa Rica y clave para la identificación de las especies con redescripción de *Cylicobdella costaricae*. *Revista Mexicana de Biodiversidad*. 83 : 946–957.
Oceguera-Figueroa, A., Leon-Regagnon, V. and Siddall, M. E. 2005. Phylogeny and revision of Erpobdelliformes (Annelida, Arhynchobdellida) from Mexico based on nuclear and mitochondrial gene sequences. *Revista Mexicana de Biodiversidad*. 76(2): 191-198.
Oceguora-Figueroa, A., Phillips, A.J., Chaves, B.P., Reeves, W.K. and Siddall, M.E. 2010. Phylogeny of macrophagous leeches (Hirudinea, Clitellata) based on molecular data and evaluation of the barcoding locus. *Zoologica Scripta*. 1-10.
Pfeiffer, I., Brenig, B. and Kutschera, U. 2005. Molecular phylogeny of selected predaceous leeches with reference to evolution of body size and terrestrialism. *Theory in Biosccience*s. 124: 55-64.
Ropelwska, E., Bielecki, A., Czachorowski, S., Ropelewski, M. and Dziejowski, J. 2013. *Dina lineata* (O.F. Muller, 1774)- an interesting species of leech in Asiatic reservoirs of the city of Olsztyn and its surroundings. *Ecological Questions*. 18: 69-72.
Sawyer, R. T. 1986. *Leech Biology and Behavior*. Clarendon Press, Oxford.
Sawyer, R.T. 1972. North American freshwater leeches, exclusive of the Piscicolidae with a key to all the species. *Illinois Biol. Monogr*. 46 : 1-155.
Sawyer, R.T. and Shelley, R.M. 1976. New records and species of leeches (Annelida: Hirudinea) from North and South Carolina. *J. Nat. Hist*. 10 : 65-97.
Siddall, M.E. 2002. Phylogeny of the leech family Erpobdellidae (Hirudinida: Oligochaeta). *Invertebrate Systematics*. 16: 1-6.
Sket, B. 1968. K poznavanju faune pijavk (Hirudinea) v Jugoslaviji (Zur Kenntnis der Egel-Fauna Jugoslawiens). *Razprave SAZU, Cl. IV*. 11: 127-197.
Sket, B., Dovc, P., Jazic, B., Kerovec, M., Kucinic, M. and Trontlej, P. 2001. A cave leech (Hirudinea, Erpobdellidae) from Croatia with unique morphological features. *Zoologica Scripta*. 30 : 223-339.
Soos, A. 1963. Identification key to the species of of genus Dina R. Blanchard. 1892 (emend. Mann, 1952) (Hirudinea: Erpobdellidae). *Acta Univ. Szegediensis, Acta Boil. (new species)*. 9 : 253-261.
Tessler, M., Siddall, M.E. and Oceguera-Figueroa, A. 2018. Leeches from Chiapas, Mexico, with a new species of *Erpobdella* (Hirudinida: Erpobdellidae). *American Museum Novitates*. 3895 : 1-15.
Thorp, J.H. and Lovell, L.L. 2016. Phylum Annelida, p-223-263. In: J.H. Thorp and D.C. Rogers (Eds.). *Keys to Nearctic Fauna, Thorp and Covich's Freshwater Invertebrates*, Vol. II, 4th Edition, Elsevier: Academic Press, New York.
Thorp, J.H. and Lovell, L.L. 2019. Introduction to Annelida, p- 360-518. In: D.C. Rogers and J.H Thorp (Eds.). *Keys to Palaearctic Fauna, Thorp and Covich's Freshwater Invertebrates*, Vol. IV, 4th Edition, Elsevier: Academic Press, New York.
Toman, M.J. and Dall, P.C. 1997. The diet of *Erpobdella octoculata* (Hirudinea: Erpobdellidae) in two Danish lowland streams**.** *Archiv fur Hydrobiologie*. 140 : 549-563.
Trajanovski, S., Albrecht, C., Schreiber, K., Schultheib, R., Stadler, T. and Wilke, T.B.M. 2010. Testing the spatial and temporal framework of speciation in ancient lake species flock: the leech genus *Dina* (Hirudinea: Erpobdellidae) in Lake Ohrid. *Biogeosciences Discussions*. 7: 5011-5045.
Trontlej, P. and Sket, B. 2000. Molecular reassessment of some phylogenetic, taxonomic and biogeographic relationships between the leech genera *Dina* and *Troheta* (Hirudinia: Erpobdellidae). *Hydrobiologia*. 438: 227-235.
Utevsky, S., Dubov, P.G. and Prokin, A.A. 2015. First Russian record of *Erpobdella monostriata*: DNA barcoding and geographical distribution (Annelida, Hirudinida, Erpobdellinae). *Spixiana.* 38(2): 161-168.