

DESCRIPTION OF TWO NEW SPECIES,  
*PHOXINELLUS KRBAVENSIS* AND *P. JADO-*  
*VENSIS*, RE-DESCRIPTION OF *P. FONTINALIS*  
KARAMAN, 1972, AND DISCUSSION OF THE  
DISTRIBUTION OF *PHOXINELLUS* SPECIES  
(TELEOSTEI: CYPRINIDAE) IN CROATIA AND  
IN BOSNIA AND HERZEGOVINA

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Including description of two new species, ten *Phoxinellus* species are reported from Croatia and Bosnia-Herzegovina. *Phoxinellus krbavensis*, new species, and *Phoxinellus jadovensis*, new species, together with *P. adspersus* and *P. ghetaldii*, constitute a group which is characterized by an irregular spotted color pattern, an elongate caudal peduncle, a large postcleithrum, an increased number of precaudal anal-fin pterygiophores, and the presence of a large genital papilla in females. *P. krbavensis* also differs from all congeners in having a short, highly interrupted lateral line formed from small, separated poorly ossified scales, commonly 20–40, extremely reduced body scales, a very short V-A distance, and the highest number of gill rakers (usually 11). *P. jadovensis* is distinguished from the other species of the group in having a conical slightly pointed snout, a terminal mouth, body scales embedded, poorly ossified, and spaced, and a long lateral line, commonly 51–60 total scales. *P. pstrossii*, described from the Trebišnjica River is tentatively considered to be a synonym for *P. ghetaldii*.

*P. fontinalis*, a poorly-known striped *Phoxinellus*, differs from all other species of the genus in particular by having a strongly laterally compressed, humped body with a straightened ventral profile and a short caudal peduncle, well developed scales, an incomplete interrupted lateral line with (17)23–37(56) total scales, terminating in the area between the pectoral and anal fins, and a rel-

actively elongate abdominal vertebral region, total count usually 23+16 or 23+17 with numerous both predorsal (15) and intermediate (5) vertebrae.

**Key words:** *Phoxinellus*, taxonomy, new species, redescription, Croatia, Bosnia and Herzegovina

**Zupančič, P. & Bogutskaja, N. G.: Opis dviju novih vrsta, *Phoxinellus krbavensis* i *P. jadovensis*, rediskripcija vrste *P. fontinalis* Karaman, 1972 i rasprava o rasprostranjenju vrsta roda *Phoxinellus* (Teleostei: Cyprinidae) u Hrvatskoj i u Bosni i Hercegovini. Nat. Croat., Vol. 11, No. 4, 411–437, 2002, Zagreb.**

Zajedno s opisom dviju novih vrsta poznato je deset opisanih vrsta roda *Phoxinellus* iz Hrvatske i Bosne i Hercegovine. Dvije nove vrste, *P. krbavensis* i *P. jadovensis* zajedno s *P. adspersus* i *P. ghetaldii* tvore skupinu koju karakteriziraju: nepravilne točkaste šare, izduženi korijen repa, veliki postkleitrum, povećani broj pterigiofora u podrepnoj peraji, te povećana genitalna kvržica kod ženki. *P. krbavensis* se od srodnih vrsta razlikuje po kratkoj i vrlo isprekidanoj bočnoj pruzi, koju čini najčešće 20 do 40 sitnih razdvojenih i slabo okoštalih ljsaka, veoma kratkoj A–V udaljenosti, te najvećem broju škržnih lukova (najčešće 11). *P. jadovensis* se razlikuje od drugih vrsta iz skupine po koničnom, blago zašiljenom rostrumu, terminalnim ustima, slabo osificiranim uralim ljskama i dugoj neprekinutoj bočnoj pruzi s najčešće ukupno 51 do 60 ljsaka. *P. pstrossii* opisan iz rijeke Trebišnjice je najvjerojatnije sinonim *P. ghetaldii*.

*P. fontinalis* je dosad slabo poznata *Phoxinellus* vrsta koja se razlikuje od ostalih vrsta roda po izrazito bočno spljoštenom grbavom tijelu s izravnatim trbušnim profilom i kratkim korijenom repa, dobro razvijenim ljskama, nepotpunom i isprekidanom bočnom prugom s ukupno (17)23–37(56) ljsaka koja završava između prsne i podrepne peraje, relativno produženim abdominalnim dijelom kralježnice (najčešće 23+16 ili 23+17) s brojnim predleđnim (15) i središnjim (5) kralješcima.

**Ključne riječi:** *Phoxinellus*, taksonomija, nove vrste, dopunjeni opis, Hrvatska, Bosna i Hercegovina

## INTRODUCTION

Seven *Phoxinellus* species – *P. adspersus* (Heckel, 1843), *P. alepidotus* Heckel, 1843, *P. croaticus* Steindachner, 1865, *P. fontinalis* Karaman, 1972, *P. ghetaldii* (Steindachner, 1882), *P. metohiensis* Steindachner, 1901, and *P. pstrossii* (Steindachner, 1882) – had been commonly reported from the isolated drainages and in river systems of the Adriatic basin in the territory of Croatia and Bosnia-Herzegovina (HECKEL & KNER, 1858; VUKOVIĆ & IVANOVIĆ, 1971; KOTTELAT, 1997; and many others) by the time of a recent description of *P. dalmaticus* (ZUPANČIČ & BOGUTSKAYA, 2000). The latter study revealed that some other, previously undescribed, species occur in the region.

A wide morphological study based on the examination of 1145 specimens from different museums as well as from the private collection of the first author (PZC) provided new data for an understanding of the distribution patterns of *Phoxinellus* species in the north-western Balkans. It was shown that the genus has a disjunct distribution area, and there are only four regions of reliable sympatric occurrence of different species – the Neretva River drainage, Dabarsko Polje, the Jadova River and Krbavsko Polje. Here, we describe new species from two areas of sympatry, one from the Jadova and one from Krbavsko Polje.

The definition of *Phoxinellus* Heckel, 1843 (type-species *Phoxinellus alepidotus* Heckel, 1843; synonym *Paraphoxinus* Bleeker, 1863 – for details see TREWAVAS (1971) and its difference from *Pseudophoxinus* Bleeker, 1860 (type-species *Phoxinellus zeregi*

Heckel, 1843) has already been briefly discussed (BOGUTSKAYA, 1999). Both genera include small-sized leuciscines characterized by disconnected infraorbital and preoperculo-mandibular cephalic sensory canals and the lack of a parietal supraorbital canal segment. *Phoxinellus* is easily distinguished by having reduced scales (they are small, irregularly located, non-overlapping, often widely spaced or missing on certain body parts, poorly ossified, embedded in the skin vs. well developed, regularly set, overlapping in *Pseudophoxinus*) and higher vertebral counts (average total numbers 39–40 with 21–23 abdominal vertebrae and 17–19 caudal vs. 35–37 with 18–21 abdominal and 15–17 caudal in *Pseudophoxinus*).

## METHODS AND MATERIAL

Most specimens were radiographed. The two last branched dorsal and anal fin rays are counted as 1½. Methods of counting vertebrae and sensory pores as well as terminology and abbreviations of vertebral regions and subregions follow those given in BOGUTSKAYA (1997). Number of lateral line scales (l.l.) includes all pored scales. Number of scales in the lateral series (=number of transverse rows of scales, sq.l.) contains all scales including those on the base of the caudal peduncle. Standard length (SL) is measured from the tip of the upper jaw to the posterior margin of hypurals. Head length (HL) is measured from the anteriormost point of the upper jaw to the posterior margin of the gill cover. Total number of gill rakers (sp. br.) is counted on the outer side of the first left gill arch. C&S indicates specimens cleared and stained with alizarin red S following JAKUBOWSKI (1970).

The examined material is deposited in the following collections: CNHM, fish collection of the Croatian Natural History Museum, Zagreb; LU, fish collection of Ljubljana University; NMW, Naturhistorisches Museum, Vienna; PZC, personal collection of the first author (will be deposited in CNHM); SMF, Senckenberg Museum, Frankfurt a. Main; ZISP, Zoological Institute, Russian Academy of Sciences, St. Petersburg; ZMH, Zoologisches Museum und Institut Universität Hamburg; ZU, fish collection of Faculty of Science, Zagreb University.

Besides type-specimens for the species described below, the following material was examined: *P. adspersus*: NMW 51070 (7; Sipovaca Quelle, Imotski – here and below spellings of localities are those on the original museum labels); 51073 (6), 51074 (4), 51075 (8), 51076 (6), 51078 (2), 51079 (2), 51080 (7), 51081 (5), 51082 (5), 51095 (16) – all from Duovica Quelle, Imotski; SMF uncat. (10; Vrljika R., Croatia); PZC (9; Proložac, Imotsko Polje); PZC (16; Krenice source at Medvidovića Draga, Vrljika R. system); PZC (7; Krenice source at Vinjani Donji, Vrljika R. system); PZC (8; Vrljika R. at Glavina Donja); PZC (15; Nezdavica source at Tihaljina, Tihaljina R., Neretva system); PZC (9; Nezdavica source at Tihaljina, Tihaljina R., Neretva system); PZC (10; Studena source, Matica R., Neretva system); PZC (12; Studena source, Matica R., Neretva system); ZU uncat. (10; Lukavac at Vrgorac, Neretva system); ZU, uncat. (2; Izvor Norin, R., Neretva system); ZU, uncat. (5; Kuti Lake, Lower Neretva system); six specimens (58.5–88.0 mm SL) C&S; *P. alepidotus*: NMW 51106 (?syntypes, 2; Sign, Cettina n.v. Split); NMW 51061 (?syntypes, 3; Sign, Cettina n.v.

Split); SMF 802 (1 syntype, Livno); NMW 12970–971 (2; Sign); NMW 51047 (3; Sign); NMW 51048 (3; Livno); NMW 51049 (4; Livno); NMW 51050 (4; Livno); NMW 51051 (5; Sign); NMW 51052 (4; Sign); NMW 51054 (9; Sign); NMW 51055 (3; Bosnien); NMW 51056 (4; Livno); NMW 51057 (11; Livno); NMW 51058 (3; Livno); 51059 (6; Livno); NMW 51060 (4; Livno); NMW 51062 (6; Sign); NMW 51107 (3; Sign); NMW 51108 (5; Sign); NMW 51109 (2; Sign); NMW 51110 (2; Sign); NMW 51111 (4; Sign); NMW 51113 (2; Cettina bei Sign); ZISP 6855 (3; Dalmatien); ZISP 12947 (2; Livno); ZISP 39490 (2; Livno); ZMH 15136 (5; Livno); SMF 807 (2; Livno); LU 185 (3; Glamočko polje); PZC (15; Glamočko polje); PZC (5; Miloševo Jezero at Hrvace, Cetina River system); PZC (8; Jaruga, Glamočko polje); PZC (9; Korana at Bosansko Grahovo); LU 190 (12; Livno); PZC (5; Vrba, Glamočko polje); five specimens (SL 69.7–102.8) C&S; *P. croaticus*: NMW 51063 (5 syntypes; Ottucha Fluss bei Grachacz), NMW 51064 (9 syntypes; Richicza Fluss bei Stikada), NMW 51115 (2 syntypes; Novcica Fluss bei Gospic), NMW 51116 (1 syntype; Novcica Fluss bei Gospic), NMW 51167 (45 syntypes; Licca bei Gospic); NMW 51114 (6; St. Roch, Kroatien), NMW 51118 (9; Szluin); PZC (32, Jadova at Vrebac); PZC (4; Ričica at Ričice); LU 188 (8, Gračac, Lika); LU 189 (18; Gatsko Polje); two specimens (SL 57.0 and 76.4) C&S; *P. dalmaticus*: CNHM 5387 (holotype), CNHM 5495–5505 (11 paratypes), PZC (46) (all from Vrba and Čikola at Kljake); one specimen (SL 52.3 mm) C&S; *P. ghetaldii*: NMW 51158 (2 syntypes of *P. ghetaldii*), 51159 (2 syntypes of *P. ghetaldii*), 51161 (2 syntypes of *P. ghetaldii*), 51162 (2 syntypes of *P. ghetaldii*), 51164 (2 syntypes of *P. ghetaldii*), 51165 (syntypes of *P. ghetaldii*), all from »Höhlen v. Popovo«; NMW 51177 (2 syntypes of *P. pstrossii*, Trebinschitzfluss Trebinje); NMW 10802–03 (2; Rasovac), 12991–4 (4; Popovo Polje); 51065 (2; Trebinje); 16946–8 (3; Popovo Polje); 51066 (1; Trebinje); 51084 (9; Trebinsica bei Bilek); 51085 (4; Trebinsica bei Bilek); 51086 (3; Trebinsica bei Bilek); 51156 (5; Höhlen v. Popovo); 51157 (5; Höhlen v. Popovo); 51160 (3; Höhlen v. Popovo); 51163 (5; Höhlen v. Popovo); 51178 (3; Rasovac); 51179 (3; Trebinje); 90640 (6; Gaovice Quelle bei Trebinje); SMF 806 (1; Stolac); ZISP 12948 (2; Stolac); LU 184 (2; Baba Pečina, Popovo Polje); CNHM 5483 (1; Kaverna izvora Omble, near Dubrovnik, Croatia); PZC (15; a pond near Belenići, Trebišnjica R.); PZC (20; Ljubomir potok, Ljubomirsko polje); PZC (7; a pond near Stravča village at Cavtat, Croatia); PZC (20, a channel from Ljelješnica cave, Dabarsko polje); PZC (5; source in Blaca, a small karstic field, near Neum); four specimens (54.5–82.5 SL) C&S, ten partly dissected; *P. metohiensis*: NMW 12972–75 (4 syntypes), 51172–76 (10 syntypes) (all Musica bei Smolski); NMW 51171 (3 syntypes?), 51173 (1 syntype?) (all Ljutaflusse bei Gruda); NMW 9368–9372 (5), 51088–94 (51) (all Zalomska Nevesinsko Polje as *P. affinis* nomen museale); SMF 805 (2; Gacko, Metohia; labelled as syntypes but erroneously since according to the label, the specimens were received from F. Werner, 1903), ZISP 12949 (2; Gacko); ZMH 15137 (7; Gacko, Metohia); NMW 51169 (15; Bach Ljuta bei Gruda); 51170 (4; Bach Ljuta bei Gruda); PZC (3; Batuša., Nevesinsko Polje); PZC (18; Batuša., Nevesinsko Polje); PZC (19; source Ljeskovik at Odžak, Zalomska R. system, Nevesinsko Polje); PZC (3; Opačica R. at Potkom, Dabarsko Polje); PZC (14; Opačica R. at Potkom, Dabarsko Polje); PZC (4; a spring near Vilina Pečina, Cerničko Polje); PZC (16; a spring near Vilina Pečina, Cerničko Polje); PZC (7; a spring at Ključ, Cerničko Polje); PZC (4; a spring at Ključ,

Cerničko Polje); PZC (5; Vrijeka R., Dabarsko Polje); PZC (8; Vrijeka R., Dabarsko Polje); PZC (32; Vrijeka R., Dabarsko Polje); LU 183 (6, Gacko); *Phoxinellus* sp.: NMW 51087 (20), 51096-99 (34), 51100-105 (65), 51116 (4) (all Mostarsko Blato); NMW 51112 (1; Narenta); PZC uncat. (14, Ljuti Dolac, Mostarsko blato); five specimens (SL 74.5–87.6) C&S.

## RESULTS AND DISCUSSION

All regions and localities in Croatia (Lika and Dalmatia) and Bosnia-Herzegovina discussed below are situated in Dinaric karst area (Fig. 1.)

**Isolated karstic plains (»poljes«) in eastern Herzegovina (Bosnia and Herzegovina), and coastal drainages in south-eastern Dalmatia (Croatia).** Only *P. ghetaldii* (commonly recorded as »*Paraphoxinus ghetaldii*«) is known from Popovo Polje (Trebišnjica river system – mostly as a part of coastal drainage through a subterranean

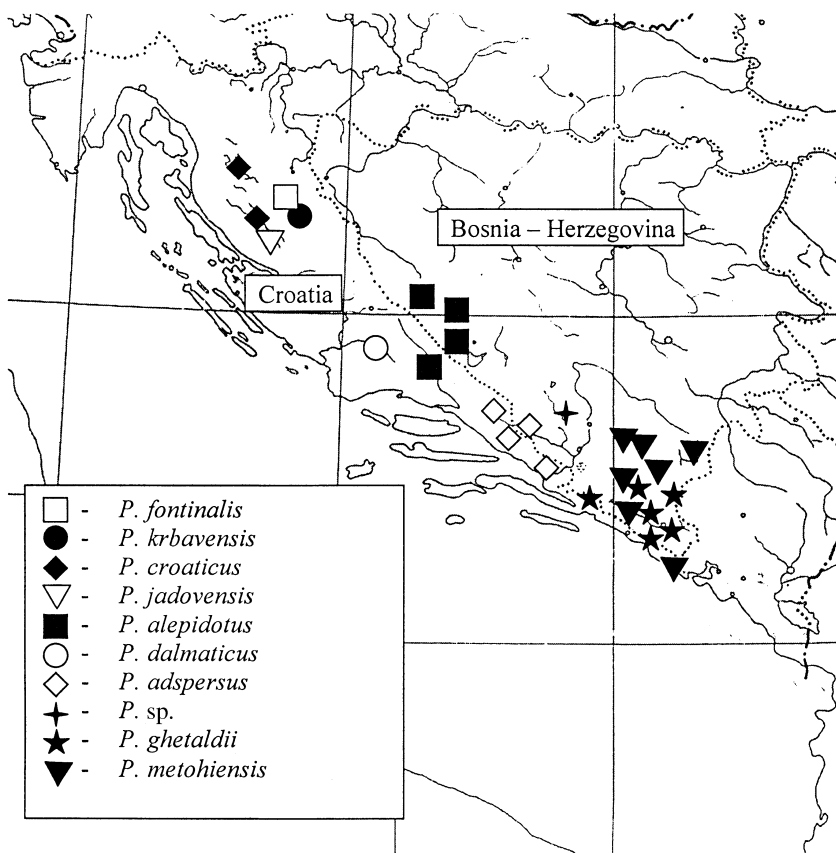


Fig. 1. Distribution of *Phoxinellus* species in Croatia and Bosnia-Herzegovina.

connection; only east of the Neretva River); STEINDACHNER (1882 a, c), KOSIĆ (1903), TRGOVČEVIĆ (1905, 1932), ČURČIĆ (1913, 1915 a, b), TALER (1952, 1953 a), RISTIĆ (1977), VUKOVIĆ (1982). ČURČIĆ (1915 a) found *P. ghetaldii* at Blaca, a small karstic polje north-east of Neum. Occurrence of this species there was recently confirmed by PZ samplings (PZC). Besides, *P. ghetaldii* was found by B. Jalžić and N. Tvrtković for the first time in a cave part of the source of Rijeka Dubrovačka (Ombla) near Dubrovnik and in an isolated spring pool in Stravča near Cavtat (both localities in Dalmatia) (CNHM and PZC holdings).

*Phoxinellus metohiensis* (a part of the NMW syntypes) was recorded from the same region, in the Ljuta River (Konavle, Dalmatia, Croatia). All 16 *P. metohiensis* syntypes from the Ljuta have 8½ branched rays in the anal fin (*vs.* usually 7½ in most other localities). No other reliable records exist for the presence of this species in the Ljuta or adjacent rivers. KOLOMBATOVIĆ (1902) and KOSIĆ (1903) reported *P. pstrossii* from the Ljuta River but this may be a misidentification of *P. metohiensis*. The possible reason for the extirpation of the species from the Ljuta drainage is the introduction of *Oncorhynchus mykiss* (Mrakovčić pers. observ.) which may have been detrimental to the population of *P. metohiensis* as well as *Leuciscus svallize*.

According to ČURČIĆ (1915 a, b) and materials in NMW and PZC, *P. ghetaldii* is present north of Popovo polje, in Ljubomirsko and Fatničko Polje (eastern Herzegovina, all coastal drainage).

A special comment should be made on the taxonomy of *P. ghetaldii* – *P. pstrossii*. According to our data, both series of syntypes share a set of characters unique within the genus: increased numbers of lateral line scales (l.l. 80–91, *vs.* 0–70), and scales in the lateral series (sq.l. 90–105, *vs.* up to 77), the upper lip interrupted in the middle and the upper jaw immobile (*vs.* the upper lip complete and the upper jaw protrusible), both cleithrum and coracoid strong and enlarged, the pectoral girdles contacting each other at mid-line by the anteriormost cleithral extremity and a long anterior margin of the coracoid which is comparatively very deep (*vs.* considerably less developed both cleithrum and coracoid as it can be seen, for example, in ZUPANČIĆ & BOGUTSKAYA, 2000, Fig. 5). *Phoxinellus pstrossii* (two syntypes, NMW 51177, SL 86.3 and 78.5 mm) is characterized by STEINDACHNER (1882b, 1883) as a species resembling *P. ghetaldii* but different in having well visible, overlapping scales covered by a thin skin on the flanks that makes it possible to count them here without difficulties, which is completely impossible in all specimens of *Paraph. Ghetaldii* examined because of the thick skin (STEINDACHNER, 1883, p. 74–75). Other differences of *P. pstrossii* syntypes from *P. ghetaldii* syntypes are the presence of a dark lateral stripe and 8½ branched anal-fin rays (STEINDACHNER, 1882 a–c; 1883). As far as the scale pattern is concerned, many specimens of *P. ghetaldii* examined by us, juveniles (SL up to 60–70 mm) and some adults probably caught during spawning season (in late summer), have a comparatively thin skin and clearly distinct scales (syntypes NMW 51158, 51162; NMW 51084, 90640; LU 184; CNHM uncat. and all PZC specimens mentioned in the list of the material given above). The lateral line scales are located close to each other and are slightly larger than the remaining body scales; the body scales are oval or roundish, narrowly to widely spaced and cover the entire body though they may be very rare on the pre-pectoral area and on

the very upper part of the back. Syntypes of both species are most probably ethanol-fixed, so they are now rather pale. However, irregular spots are seen in both series. »A lead gray, rather broad stripe« described by Steindachner for *P. pstrossii* and seen in his figure 3 (STEINDACHNER, 1883) is inconspicuous now. We suppose that the stripe was an immediate result of the ethanol fixation when the stripe, which is silvery in live specimens, may become much darker.  $8\frac{1}{2}$  branched rays are found among the specimens of *P. ghetaldii* examined though rather rare (in 6 specimens out of 145). We consider that the syntypes of *P. ghetaldii* and *P. pstrossii* are conspecific and thus the names are synonyms. Both names are available from 1882 but *P. ghetaldii* has priority. The original description of *P. ghetaldii* appeared in »Anzeiger der Kaiserlichen Akademie der Wissenschaften«, volume 19, fascicle 5, reporting a meeting held on 9 February 1882, while that of *P. pstrossii* was published in volume 19, fascicle 16 of the same journal reporting a meeting held on 22 June 1882.

Many authors reported *Phoxinellus* (or *Paraphoxinus*) *pstrossii* from the Trebišnjica River near Trebinje, Herzegovina and Dalmatia region, or just the Adriatic basin in Yugoslavia: KIŠPATIĆ (1893); TALER (1952, 1953 a, b); SKET (1967); VUKOVIĆ & IVANOVIĆ (1971); RISTIĆ (1977); VUKOVIĆ (1977 a, 1982); POČRNJIĆ *et al.* (1979); POVŽ *et al.* (1990); MIKAVICA (1998). VUKOVIĆ & MILADINOVIĆ (1969), BERBEROVIĆ *et al.* (1969), AGANOVIĆ & KAPETANOVIĆ (1971) and VUKOVIĆ (1977 a) reported *P. pstrossii* from Ljubomirsko Polje. SOFRADŽIJA & BERBEROVIĆ (1972) reported *P. pstrossii* from Dabarsko and Ljubomirsko polje, and PAVLOVIĆ & BERBEROVIĆ (1978) from Dabarsko Polje. These records correspond well to the known range of *P. ghetaldii*.

Dabarsko Polje (eastern Herzegovina) is separated from Popovo Polje (underground connection to the Bregava River, a left-hand tributary of the Neretva River) and lies further to the north. *Phoxinellus ghetaldii* was first recorded there (Sušica and Ljelješnica caves) by ČURČIĆ (1915 a) and recently confirmed by PZ's findings of juveniles of the species in a channel flowing from Ljelješnica Cave. In Dabarsko Polje, in the Vrijeka and Opačica rivers, another species was also present, tentatively identified here as *P. metohiensis*. However, specimens from Dabarsko Polje differ from *P. metohiensis* from localities other than the Ljuta River in having more anal-fin branched rays ( $7\frac{1}{2}$  in only 5 of 52 specimens,  $8\frac{1}{2}$  in 46 specimens,  $9\frac{1}{2}$  in 1 *vs.*  $7\frac{1}{2}$  in 57 of 79 specimens,  $8\frac{1}{2}$  in 22), earlier definitive development of the lateral line canals on the head and body (in specimens from 43 mm SL *vs.* 70 mm), and overlapping scales (*vs.* non-overlapping, narrowly to widely spaced). The taxonomic status of this population needs a special study.

ČURČIĆ (1915 a, b), TALER (1953 a, b), SABIONCELLO (1967) and VUKOVIĆ (1977 a, 1982) reported *P. metohiensis* from Lukavačko Polje, north of Dabarsko Polje and from Fatničko Polje lying eastwards close to the Dabarsko polje. However, no collection materials are known from these regions. In 1998–2001, PZ found only juveniles of *P. ghetaldii* in Fatničko Polje.

Further to the north, only *P. metohiensis* is distributed in isolated systems of Gatačko Polje (underground connection to Fatničko Polje and the Trebišnjica River, too) and Nevesinjsko Polje (underground connection to the Buna River, a left-hand tributary of the Neretva River). It is known from the Mušica (Mušnica) River at Gacko, small streams and sources in Cerničko Polje (south from Gatačko Polje) and

in the Zalomka River system. STEINDACHNER (1901), TRGOVČEVIĆ (1905), ČURČIĆ (1915 a, b), BERBEROVIĆ *et al.* (1969), AGANOVIĆ & KAPETANOVIĆ (1971), and POVŽ *et al.* (1990) reported *P. metohiensis* from the Gračanica River near Gacko, but in 1998–2000 PZ found only *Phoxinus phoxinus*.

**The Neretva River estuary drainage** – right coast tributary (central Dalmatia and western Herzegovina). *Phoxinellus* species are absent from the main stream of the Neretva. In Imotsko Polje (Crveno Jezero and the Vrljika River drainage) and near Vrgorac in the Matica River system only *P. adspersus* is distributed: SEELEY (1886); KIŠPATIĆ (1893); KOLOMBATOVIĆ (1886, 1896); SKET (1967), SABIONCELLO (1967); BERBEROVIĆ *et al.* (1971); KARAMAN (1972); SOFRADŽIJA & BERBEROVIĆ (1972); RISTIĆ (1977); PAVLOVIĆ & BERBEROVIĆ (1978); VUKOVIĆ (1982); MRAKOVČIĆ *et al.* (1996). These systems all belong to the right-hand tributary of Neretva drainage. PZ also collected *P. adspersus* in the Draga brook which belongs to the Trebižat River system, a right-hand tributary of the lower Neretva in western Herzegovina. Most probably, this species is also present in the Tihaljina River, which is fed by underground waters from Imotsko Polje and is connected to the Trebižat River via the Mlada river. *Phoxinellus adspersus* was found in the source of the Norin River, a right-hand tributary of the lower Neretva at Metković, Croatia, and Kuti Lake, the left-hand tributary of the lower Neretva system (ZU material).

Further upstream, an undescribed species close to *P. alepidotus* (hereinafter referred to as »*Phoxinellus* sp.«) occurs in Mostarsko blato (a periodical wetland adjacent to Mostar) in the Neretva drainage (ZUPANČIĆ & BOGUTSKAYA (2000); BOGUTSKAYA & ZUPANČIĆ (2002). It probably occurs also in the Neretva itself as suggested by NMW 51112, which is labeled as collected in the »Narenta« (an old name for the Neretva). Besides this, HECKEL & KNER (1858), SEELEY (1886), KOLOMBATOVIĆ (1886), KIŠPATIĆ (1893), TRGOVČEVIĆ (1905), POVŽ *et al.* (1990), SABIONCELLO (1967), VUKOVIĆ & IVANOVIĆ (1971), and VUKOVIĆ (1977 a) reported a species identified as *P. alepidotus* from the Neretva river. According to TALER (1964) cited by KOSORIĆ & VUKOVIĆ (1967), »*P. alepidotus*« was found in an oxbow near Kula Norinska which belongs to the Neretva system. PZ visited the Kula Norinska region several times in 1995–2001 and found no *Phoxinellus alepidotus*-like species there. ČURČIĆ (1913) reported *Paraphoxinus adspersus*, *P. ghetaldii* and »*P. alepidotus*« from the upper part of the Trebižat River in Western Herzegovina. Very probably, large males of *P. adspersus* were misidentified as *P. ghetaldii*. Thus the Neretva drainage represents another area of sympatric distribution of two *Phoxinellus* species, *Phoxinellus* sp. and *P. adspersus*.

It is uncertain where *P. ghetaldii* is distributed in the Neretva system. KOSORIĆ & VUKOVIĆ (1967) reported the species from the Buna River, a left hand tributary of the Neretva. This identification might be questionable (see below, discussion of Kasindolka specimens). We have examined 3 specimens of *P. ghetaldii* (SMF 806 and ZISP 12948) labeled as »from Stolac«, a town on the Bregava River, a left hand tributary of the lower Neretva, close to Dabarsko Polje where *P. ghetaldii* is present. It is possible that the specimens were collected in karstic springs near Stolac but outside of the Bregava drainage. There are no recent field observations to confirm this.

**Duvanjsko Polje.** *Phoxinellus* species are probably absent from Duvanjsko Polje and Blidinje Lake (western Bosnia and Herzegovina). Intensive samplings by PZ



during the last few years revealed only *Chondrostoma phoxinus* and *Aulopyge huegelii* sympatrically distributed in Duvanjsko Polje. ČURČIĆ (1916) reported *P. alepidotus* from Šuica, the main stream in Duvanjsko Polje. TALER (1953 a, b), SABIONCELLO (1967), VUKOVIĆ & IVANOVIĆ (1971), VUKOVIĆ (1977 a, 1982) also included Duvanjsko Polje in the range of *P. alepidotus*. The presence of this species in Blidinje Lake: TALER (1953 a, b); SABIONCELLO (1967); VUKOVIĆ & IVANOVIĆ (1971); VUKOVIĆ (1977 a, 1982); POVŽ *et al.* (1990) needs to be confirmed. ČURČIĆ (1916), using the vernacular name »podbila«, reported a *Phoxinellus* species from Blidinje Lake together with *Aulopyge huegelii*, *Leuciscus microlepis* and *Leuciscus tenellus* which all were introduced into the lake. We do not know any *Phoxinellus* specimen from this region.

**The Cetina River drainage** (Croatia and Bosnia-Herzegovina). Sign (Sinj, a town on a Cetina tributary) in Sinjsko Polje (Croatia) is given as a locality for *P. alepidotus* specimens in NMW (syntypes 51161, 51106; non-type 12970-71, 51047, 51051-52, 51054-55, 51-62, 51107-11): the exact source of the material is not known. In 1999, PZ found the species only in Miloševo Jezero at Hrvace near Sinj (two small lakes a hundred meters long) but he has not observed it in the remaining localities throughout the entire drainage of the Cetina River. In Miloševo Jezero, it is found together with the native *Aulopyge huegelii* and the introduced *Cyprinus carpio* and *Pseudorasbora parva*. No other locations are known within the Cetina drainage.

**Karstic plains in western Bosnia-Herzegovina.** Livno (a town in the south-eastern part of Livanjsko Polje, western Bosnia, Cetina river drainage) is also given as a locality for *P. alepidotus* specimens in SMF (syntype 802; 807), NMW (51048-50, 51056-60), ZMH (15136) and ZISP (12947, 39490), again without exact source. There are no recent field observations available for Livanjsko Polje. In 1997, PZ confirmed the presence of *P. alepidotus* in Glamočko Polje (the Jaruga stream at Glamoč), north-west of Livanjsko Polje. MARIĆ (1980) reported *P. alepidotus* from the Struga River near Bosansko Grahovo in Grahovsko Polje (north-west from Livanjsko Polje). VUKOVIĆ (1977 b) reported *P. alepidotus* from the Korana River near Bosansko Grahovo, which was confirmed by PZ in 1999. This river drains to the Danube River system through a subterranean connection.

**The Krka River drainage** (Croatia). The only *Phoxinellus* species reliably known to be present in the Krka drainage is *P. dalmaticus* ZUPANČIĆ & BOGUTSKAYA (2000). KARAMAN (1972) wrongly reported »*Ph. alepidotus*« from Kninsko Polje (Resanovci Spring, Struga bei Knin) – this locality is near Bosansko Grahovo (B. Sket leg.; see above). MRAKOVČIĆ & MIŠETIĆ (1989) and POVŽ *et al.* (1990) reported »*P. pstrossi*« from the Krka River, Dalmatia, but this can not be confirmed by voucher specimens.

**Lika and Zrmanja region (the Gacka River drainage, the Lika River drainage, the Ričica and Otuča Rivers as a part of the Zrmanja River drainage, the Zrmanja River, Krbavsko Polje as a border area between the Danube and the Adriatic basin – the Zrmanja and Gacka River drainage; all Croatia).** In the Lika region, STEINDACHNER (1895), TRGOVČEVIĆ (1905), TALER (1953 b), REDENŠEK (1955), SABIONCELLO (1967), VUKOVIĆ & IVANOVIĆ (1971), VUKOVIĆ (1982), and POVŽ *et al.* (1990) reported *P. croaticus* from the Lika, Jadova and Novčica rivers, and from the Ričica and Otuča rivers. The presence of *P. croaticus* in the Zrmanja River (MRAKOVČIĆ *et al.*, 1995) needs confirmation. We do not know of any voucher specimens from the

drainage. Another *Phoxinellus* species, a new one, is distributed here sympatrically with *P. croaticus*. TRGOVČEVIĆ (1905) gave a good description of the species under the name »*Paraphoxinus adspersus*« from the Balatin and Japoga streams in the Lika River drainage. This species was later reported again as *P. adspersus* from the Balatin and Japoga streams in the Lika region by TRGOVČEVIĆ (1932), TALER (1953 b), SABIONCELLO (1967), RISTIĆ (1977), VUKOVIĆ & IVANOVIĆ (1971), and VUKOVIĆ (1982). There is also a report on »*Paraphoxinus ghetaldii*« caught together with *P. croaticus* from the Ričica (HABEKOVIĆ *et al.*, 1992). Most probably, these findings refer to a species described below as *P. jadovensis* sp.n.

TRGOVČEVIĆ (1905) identified a species found in Zelena Špilja (Green Cave, both the Gacka River and the Danube River drainage) in Krbavsko polje and the Krbavica River close to it as *P. croaticus*. No material is available from these locations but present knowledge suggests that this refers to *P. fontinalis*, a species endemic to karstic streams and springs in Krbavsko Polje (Croatia). PZ has not collected this species at the type locality (Hrnjakova pećina Cave) despite two annual visits in each of the last six years. The waters of this part of Krbavsko Polje drain to the Danube system through subterranean connection via Una River basin (ŠENOVA, 1900). The other species found in sources of springs in caves on the southern border of Krbavsko Polje was first well described by TRGOVČEVIĆ (1905) as *P. ghetaldii* from the Suvaja cave and brook near Mekinjar, and most other publications followed this author: TRGOVČEVIĆ (1932); TALER (1953 a, b); SKET (1967); VUKOVIĆ (1967); SABIONCELLO (1967); VUKOVIĆ & IVANOVIĆ (1971); RISTIĆ (1977). This species is described below as *P. krbavensis* sp.n.

Only *P. croaticus* is present in the Gacka River system, in Gacko Polje (LU material) in the northernmost area of the genus distribution range, but the exact locality is unknown. BRUSINA (1892) and TALER (1951) also reported *Phoxinellus* specimens from Konjsko jezero (Konjsko Lake, now dried out) near Otočac in the Gacka drainage under the local name »pior« (»pijor«), which is commonly applied in Croatia to any *Phoxinellus* species or *Phoxinus phoxinus*.

Outside the area of distribution discussed above, VUKOVIĆ (1967) gave a brief description of 11 specimens from the Kasindolka brook (a tributary of the Željeznica River in the upper reaches of the Bosna River, Bosnia-Herzegovina, the Danube drainage), which he identified as *P. ghetaldii*. The listed character states (*e.g.* 56–62 lateral line scales, 5–5 pharyngeal teeth) disagree with those of *P. ghetaldii* (80–99 lateral line scales, 5–4 pharyngeal teeth). We do not have access to material from this locality and are presently unable to clarify the identity of this population.

### ***Phoxinellus fontinalis* Karaman, 1972**

*Phoxinellus adspersus fontinalis* Karaman, 1972: 134, fig. 5 (loc. typ.: Krbavsko polje in Lika, a source in the Hrnjakova Pećina cave)

The original description was based upon 6 specimens (syntypes) collected by B. Sket.

Existence of the type material is unknown.

**Material examined:** ZISP 52611, 5, Ribničko Jezero at Krbava, Croatia; coll. P. Zupančič, 13.07.1998; PZC, 3 (the same data); PZC, 2, Izvor Močilo, Krbavsko Polje, Croatia; coll. P. Zupančič, 17.08.1998; PZC, 2, Ribničko Jezero at Krbava, Croatia; coll. P. Zupančič, 05.07.2001. (12 specimens altogether). One specimen (SL 98.0 mm) C&S and dissected.

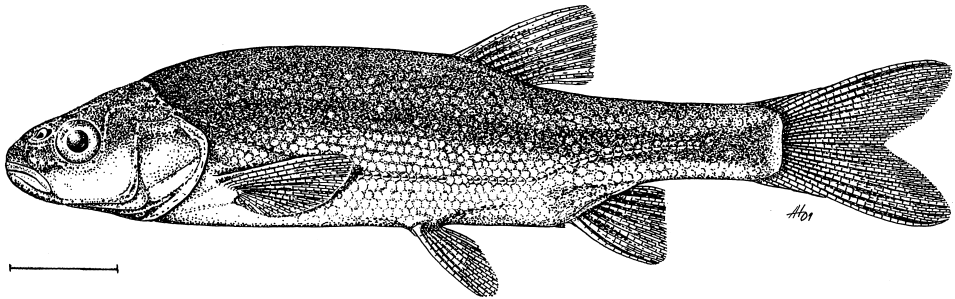


Fig. 2. *Phoxinellus fontinalis*, PZC, female, 73.0 mm SL, Vukova pećina cave. Scale bar 1 mm. Drawn by A. M. Naseka.

**Supplementary diagnosis.** *Phoxinellus fontinalis* is distinguished from the other species of the genus in having a strongly laterally compressed body, a humped back, body with a straight ventral profile and a short caudal peduncle (16–18% SL, length on average 1.7 times its depth), a stout snout, a subterminal mouth, a long lower jaw (37–42% HL, larger than the operculum depth, 33–36% HL), slightly serrate pharyngeal teeth (5–5), a thin skin and well developed distinct scales, a short lateral line which is incomplete and interrupted, with (17)23–37(56) total scales, terminating in the area between pectoral and anal fins, and an elongate abdominal vertebral region, total vertebrae modally 23+16 or 23+17 with numerous both predorsal (15) and intermediate (5) vertebrae.

**Re-description.** Morphometric data are given in Tab. 1.

Body elongate, markedly laterally compressed. Weak scaled ventral keel in front of pelvic. Back behind head rising in a conspicuous hump, ventral profile almost straight. Head narrow, long, its length considerably exceeds maximum body depth. Caudal peduncle 1.7 times longer than deep.

Eye small, its diameter markedly smaller than snout length. Snout stout, considerably rounded. Mouth subterminal, low, almost horizontal. Uppermost point of mouth cleft below level of lower margin of eye. Lower jaw-quadrangle junction about vertical through middle of eye. Postorbital region elongate. Head rather shallow. Lower jaw long, its length markedly greater than operculum depth.

Dorsal fin with 3 simple and 7½ branched rays; outer margin straight or slightly convex; origin about vertical through posterior end of pelvic-fin base. Anal fin with 3 simple and 7½ branched rays (two syntypes have 8½); KARAMAN (1972); outer margin straight; origin not far behind vertical through posterior end of dorsal-fin

**Tab. 1.** Morphometric data of *Phoxinellus fontinalis*.

| SL (mm)                  | 90.0<br>female | 89.4<br>female | 83.5<br>male | 73.0<br>female | 65.6<br>male | 56.0<br>female |
|--------------------------|----------------|----------------|--------------|----------------|--------------|----------------|
| Percents of SL           |                |                |              |                |              |                |
| Head length              | 28.0           | 27.2           | 26.9         | 27.9           | 28.5         | 27.9           |
| Maximum body depth       | 26.2           | 26.3           | 24.0         | 22.6           | 24.7         | 21.6           |
| Depth of caudal peduncle | 9.9            | 8.9            | 10.2         | 10.8           | 11.3         | 9.1            |
| Predorsal distance       | 59.3           | 58.1           | 57.2         | 58.9           | 58.4         | 57.1           |
| Postdorsal distance      | 35.6           | 34.8           | 34.0         | 35.6           | 34.5         | 36.4           |
| Caudal peduncle length   | 18.0           | 16.1           | 16.6         | 17.5           | 18.4         | 16.5           |
| Dorsal fin length        | 10.6           | 11.2           | 11.0         | 10.5           | 11.4         | 8.4            |
| Dorsal fin depth         | 19.1           | 19.5           | 18.8         | 17.9           | 20.4         | 18.2           |
| Anal fin length          | 9.9            | 9.7            | 10.4         | 10.3           | 10.8         | 9.3            |
| Anal fin depth           | 13.4           | 13.9           | 15.6         | 14.1           | 15.5         | 15.7           |
| Pectoral fin length      | 19.8           | 19.2           | 21.3         | 19.5           | 22.9         | 18.9           |
| Pelvic fin length        | 12.7           | 13.8           | 15.6         | 13.4           | 15.5         | 13.3           |
| P-V distance             | 28.9           | 27.6           | 28.0         | 29.6           | 29.1         | 27.0           |
| V-A distance             | 19.4           | 17.2           | 18.9         | 17.8           | 18.0         | 19.1           |
| Percents of head length  |                |                |              |                |              |                |
| Snout length             | 28.6           | 30.3           | 32.0         | 32.4           | 31.0         | 28.8           |
| Eye diameter             | 21.0           | 22.2           | 23.1         | 25.0           | 24.6         | 25.0           |
| Postorbital distance     | 57.1           | 55.6           | 57.6         | 53.9           | 54.5         | 56.1           |
| Head depth at nape       | 65.5           | 65.8           | 65.8         | 59.8           | 65.2         | 58.7           |
| Head width at nape       | 47.2           | 49.0           | 50.2         | 50.0           | 50.8         | 48.2           |
| Interorbital distance    | 33.7           | 35.5           | 34.6         | 36.3           | 35.8         | 34.1           |
| Lower jaw length         | 40.7           | 38.9           | 38.2         | 39.2           | 37.4         | 41.7           |
| Operculum depth          | 36.1           | 35.9           | 35.0         | 35.3           | 36.4         | 34.1           |

base; V-A distance relatively short, averaging 64% of P-V. Caudal fin markedly forked, lobes pointed or slightly rounded.

Total gill rakers 9 (8) or 10 (5). Gill rakers short. Pharyngeal teeth 5–5, hooked, slightly serrated (plicate).

Body entirely covered by scales; on most of body, scales more or less regularly set and overlapping. Scales smaller, more widely set and inconspicuous in pre-pectoral and pre-pelvic areas. Skin not thickened. Scales visible on most of flanks, though weakly ossified (judging from intensity of staining) and deeply embedded. Scales small, roundish. Number of scales between dorsal-fin origin and lateral line not countable with accuracy since scales on back proper small, spaced and irregularly set. In C&S specimen, about 17½.

Lateral line highly incomplete, often interrupted at its very end, terminating above pelvic or sometimes anal fin; rarely with a few segments on caudal peduncle. Total number of lateral line scales (17)23–37(56).

Supraorbital canal (CSO) complete with 8 or 9, rarely 10, pores. Infraorbital canal (CIO) complete with 15–17 pores (4 or 5 openings on 1st infraorbital). Preoperculo-

mandibular canal (CPM) not communicating with CIO, terminating just above upper margin of opercular antedorsal process; CPM incomplete, interrupted between lower jaw (angulo-articular) and preoperculum. Commonly 6 pores on lower jaw with 5 openings on dentary. Supraorbital canal (CST) narrowly interrupted, 4+4 pores.

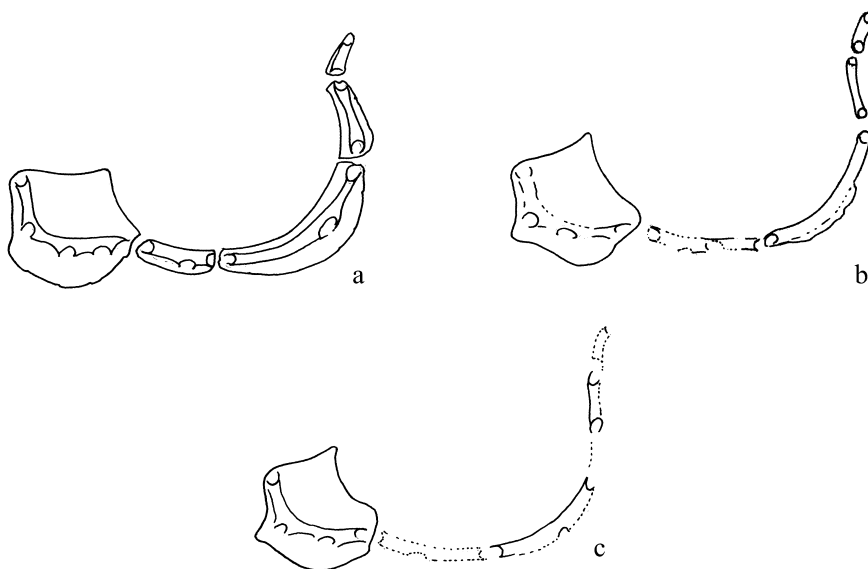
Total number of vertebrae 39 (7), 40 (3) or 38 (1). Number of abdominal vertebrae 23 (9) or 22 (2). Predorsal vertebrae 15 (9) or 14 (2). Intermediate vertebrae 5. Number of caudal vertebrae 16 (7) or 17 (4). Vertebral formulae 23+16 (7), 23+17 (3), 22+17 (1) or 22+16 (1).

Infraorbitals (Fig. 3a) comparatively well ossified, lamellate parts normally developed except for tube-like 5th one. Infraorbital 5 and pterotic never disconnected.

Postcleithrum is thin, short (Fig. 4a).

**Coloration.** In both live and ethanol preserved specimens, overall coloration of back and sides dark, blackish. Wide lateral stripe from behind head to end of caudal peduncle. Pigmented area without marked border from below – pigment dots spreading down to level of upper margin of pectoral. No dark irregular spots. Sometimes small light round spots on scales on upper flanks. Peritoneum intensively pigmented, black.

**Sexual dimorphism.** Genital papilla absent in both males and females. Pectoral fins longer in males (21–23% SL) than in females (13–16% SL) though in both not reaching pelvic-fin origin. Pelvic fin reaching anus in males (15–16% SL), shorter in females, 13–14% SL. Small weak breeding tubercles on upper head and back and markedly larger tubercles over entire operculum in males.



**Fig. 3.** Infraorbitals of *Phoxinellus fontinalis*, 98.0 mm SL, PZC, Ribničko Jezero (a), *P. krbavensis* sp. n., 83.0 mm SL, PZC, Vukova Pečina (b), *P. jadovensis* sp. n., 77.0 mm SL, PZC, Jadova River at Ploča (c)

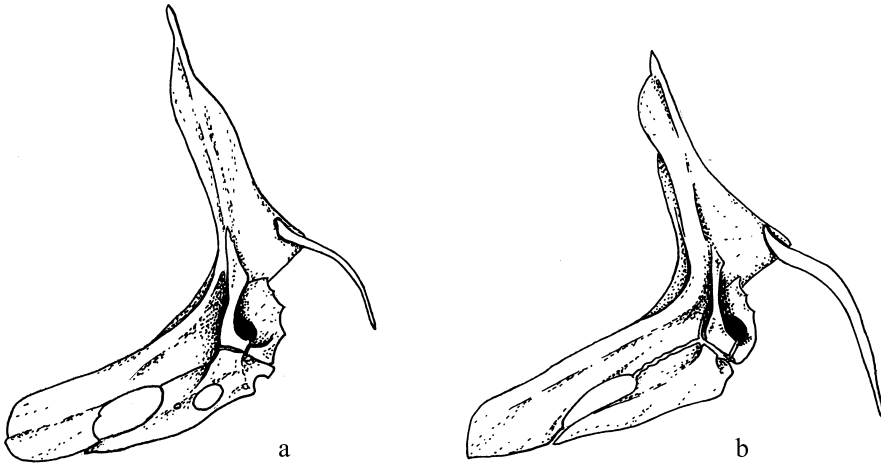


Fig. 4. Pectoral girdle of *Phoxinellus fontinalis*, 98.0 mm SL, PZC, Ribničko Jezero (a) and *P. krbavensis* sp. n., 83.0 mm SL, PZC, Vukova Pečina (b).

**Distribution:** Only known from karstic streams and springs in Krbavsko Polje (Croatia) (Fig.1), but before the introduction of *Oncorhynchus mykiss* and *Salmo trutta* (in 1979) in Krbavica polje streams, too (Tvrtković, pers. comm.).

**Comments and comparisons.** Together with *P. croaticus* and *P. metohiensis*, *P. fontinalis* belongs to the group of *Phoxinellus* species with unspotted coloration, usual presence of a stripe from the head to the caudal fin, and scales on the whole body. *P. fontinalis* differs from *P. croaticus* and *P. metohiensis* in having a short lateral line (vs. commonly 51–70 and 56–68, respectively). The body shape and vertebral structure are unique within the species examined (BOGUTSKAYA & ZUPANČIČ, 2002).

**Habitat.** In streams and springs. Enters subterranean waters during winter or summer droughts.

### *Phoxinellus krbavensis*, sp. n.

*Paraphoxinus ghetaldii* (non Steindachner) – TRGOVČEVIĆ, 1905: 14 (Suvaja at Mekinjar)

**Holotype:** CNHM 5484, a source in Vukova Pečina cave, at Krbava, Croatia; leg. P. Zupančič, 29.05.1998

**Paratypes:** ZISP 52613, 8, a source in Vukova Pečina cave, at Krbava, Croatia; leg. P. Zupančič, 29.05.1998; PZC, 9, the same data; PZC, 13, same locality, at Krbava, Croatia; leg. P. Zupančič, 17.04.2000; PZC, 1, Ribničko Jezero at Krbava, Krbavsko Polje, leg. P. Zupančič, 13.07.1998; PZC, 1, same locality and collector, 05.07.2001; CNHM 5485–90, 6, a source in Suvaja Cave at Mekinjar, Krbavsko Polje, leg. Ž. Ludvig, 1.08.2000; CNHM 5491–92, 2, same locality and date, but 40 m deep in the water passage in the cave, leg. B. Jalžić; CNHM 5493, 1, same locality and date, leg. N. Tvrtković (41 specimens altogether).

Two specimens (SL 55.2 and 83.0 mm) C&S and dissected.

Data for the holotype: female, SL 76.3 mm; D III 7  $\frac{1}{2}$ , A III 7  $\frac{1}{2}$ , l. 1. 36, highly interrupted and fragmented into segments in posterior section (49 pores in total), incomplete, terminating at about  $\frac{3}{4}$  of caudal peduncle length, sp. br. 11, vert. 39, abd. vert. 21, caud. vert. 18, preD vert. 14.

**Diagnosis.** *Phoxinellus krbavensis* (Fig. 5, 6) is distinguished from congeners in having irregular spotted color pattern, a humped back with an elongate shallow caudal peduncle (length on average 2.3 times its depth), a very short V-A distance which averages 57% of P-V distance, a subterminal mouth, numerous gill rakers ((10)11– 12), usually smooth pharyngeal teeth (5–4), a thickened skin, scales small,

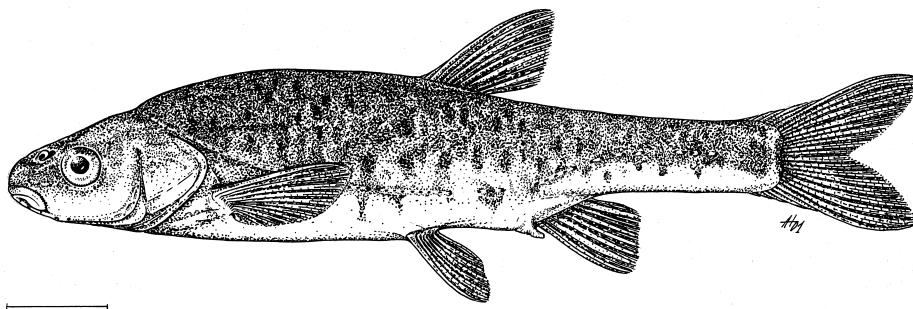


Fig. 5. *Phoxinellus krbavensis* sp. n., holotype, female, CNHM 5484, SL 76.3 mm SL. Scale bar 1 mm. Drawn by A. M. Naseka.



Fig. 6. *Phoxinellus krbavensis* sp. n., paratype, female, from Suvaja spring Cave near Mekinjar, Krbavsko polje (before sampling). Photo: B. Jalžić.

poorly ossified, considerably distant from each other, deeply embedded in skin, a very interrupted incomplete lateral line with usually 20–40 scales, a thick and long postcleithrum, and a large genital papilla in females.

**Description.** Morphometric data (for specimens 57 mm SL and larger) are given in Tab. 2.

Body elongate, markedly compressed. Dorsal body profile comparatively convex, back behind head rising in a conspicuous hump, ventral profile almost straight or slightly convex. Caudal peduncle elongate and shallow, length 2.3 times its minimum depth; maximum caudal peduncle depth (12.3 % SL on average) only very slightly exceeds its minimum depth (10.5% SL).

**Tab. 2.** Morphometric data of *Phoxinellus krbavensis* sp. n.

|                          | Holotype | Paratypes, n=12 |       |
|--------------------------|----------|-----------------|-------|
|                          |          | min.–max.       | M     |
| SL (mm)                  | 76.3     | 57.3–94.0       |       |
| Percents of SL           |          |                 |       |
| Head length              | 27.5     | 27.0–30.0       | 28.80 |
| Maximum body depth       | 22.9     | 22.8–26.6       | 24.57 |
| Depth of caudal peduncle | 9.5      | 9.5–11.0        | 10.08 |
| Predorsal distance       | 56.7     | 55.4–61.1       | 57.5  |
| Postdorsal distance      | 35.9     | 34.8–39.2       | 37.65 |
| Caudal peduncle length   | 23.7     | 20.4–24.0       | 22.93 |
| Dorsal fin length        | 8.9      | 8.2–11.0        | 9.41  |
| Dorsal fin depth         | 17.7     | 16.7–21.3       | 19.32 |
| Anal fin length          | 10.3     | 7.8–10.4        | 8.87  |
| Anal fin depth           | 13.5     | 13.9–18.9       | 16.01 |
| Pectoral fin length      |          |                 |       |
| males                    |          | 20.0–23.1       |       |
| females                  | 18.3     | 17.5–19.2       |       |
| Pelvic fin length        |          |                 |       |
| males                    |          | 14.5–17.4       |       |
| females                  | 13.1     | 12.2–13.6       |       |
| P-V distance             | 27.1     | 25.7–31.4       | 27.9  |
| V-A distance             | 19.6     | 14.4–17.5       | 15.77 |
| Percents of head length  |          |                 |       |
| Snout length             | 29.3     | 27.0–31.3       | 28.53 |
| Eye diameter             | 21.1     | 20.9–23.9       | 22.53 |
| Postorbital distance     | 51.2     | 50.8–55.2       | 53.25 |
| Head depth at nape       | 58.8     | 58.1–65.5       | 61.0  |
| Head width at nape       | 49.7     | 47.7–51.8       | 49.34 |
| Interorbital distance    | 34.1     | 32.4–36.5       | 32.20 |
| Lower jaw length         | 34.1     | 31.4–36.0       | 34.06 |
| Operculum depth          | 31.6     | 23.8–28.4       | 25.99 |





**Fig. 7.** Photo of *Phoxinellus krbavensis* sp. n., SL 69.1 mm, Vukova pećina (a), *P. jadovensis* sp. n., SL 72.0 mm, Jadova River at Ploča (b), *P. adspersus*, SL 72.4 mm, Vrljika River, Imotsko Polje (c).

Head relatively long, its length considerably greater than caudal peduncle depth. Eye small, its diameter markedly smaller than snout length. Snout stout, markedly rounded. Mouth subterminal (Fig. 7a). Uppermost point of mouth cleft below level of lower margin of eye. Lower jaw-quadrate junction slightly behind vertical through anterior margin of eye. Postorbital region length averages 53% HL. Head shallow, elongate, its depth and width at nape average 61 and 49% HL, respectively. Operculum very shallow, depth smaller than lower jaw length, though lower jaw relatively short.

Dorsal fin with 3 simple and  $7\frac{1}{2}$  ( $6\frac{1}{2}$  in 1 specimen) branched rays; outer margin straight or convex; origin above pelvic-fin base. Anal-fin with 3 simple and  $7\frac{1}{2}$  ( $6\frac{1}{2}$  in 3 specimens and  $8\frac{1}{2}$  in 1) branched rays; outer margin slightly convex or almost straight; origin comparatively close to vertical through posterior end of dorsal-fin base. V-A distance markedly smaller than P-V distance and averages about 57% of the latter. Caudal fin moderately forked, lobes slightly pointed.

Total gill rakers (in 25 specimens examined) 11 (20), rarely 12 (4) or 10 (1). Pharyngeal teeth 5–4, narrow, hooked, smooth or sometimes central one or two teeth very slightly serrated. No correlation found between teeth serration and size of fish.

All scales deeply embedded in skin. Skin markedly thickened and plicate in adults especially during spawning season; most scales not visible without dissec-

tion and staining, including lateral line scales. Lateral line scales somewhat irregular in shape, more or less distant from each other and larger than body scales; body scales roundish or somewhat irregular, relatively small, widely spaced and absent from pre-pelvic area and just behind cleithrum. All scales poorly ossified, lacking radii and only weakly stained by alizarin red S or not stained at all.

Lateral line interrupted, separated into segments so that number of lateral line scales commonly much less than number of pores. Lateral line terminates from just behind pectoral fin to above anal-fin base, sometimes on caudal peduncle, but only a few segments present on caudal peduncle; number of lateral line scales variable, 12–48, usually 20–40.

CSO complete with 8 or 9 pores or interrupted between nasal and frontal, commonly 3+6 pores. CIO commonly interrupted in more than two places, often between all infraorbitals and in front of pterotic. Number of CIO pores highly variable, 13–19 (4 or 5 on the 1st infraorbital). CPM terminates above opercular antedorsal process area but never fused to opercular process if opercular segment present, or on preoperculum. CPM interrupted between angulo-articular and preoperculum, (6+9 or 6+10 pores), sometimes also between dentary and angulo-articular. CST interrupted, 3+3 or 4+4 pores, or fragmented. Sometimes one of lateral CST branches absent.

Total number of vertebrae (in 15 specimens examined) 38 (4) or 39 (11). Number of abdominal vertebrae 20 (1), 21 (11) or 22 (3). Predorsal vertebrae 13 (7) or 14 (8). Intermediate vertebrae 4. Number of caudal vertebrae 17 (6) or 18 (9). Most frequent vertebral formula 21+18 (9). Number of anal-fin pterygiophores in front of first caudal hemal spine 2 (1), 3 (10) or 4 (4).

All cephalic canals on neurocranial bones poorly ossified from above, weakly embedded and often not fused to underlying bone in anterior frontal CSO portion and in parietal CST portion. CST not fused or weakly fused to posttemporal and supracleithrum as well.

Infraorbitals (Fig. 3b) except for 1st intraorbital poorly ossified and narrow, their lamellate parts considerably or completely reduced. Second to 5th infraorbitals are often fragmented, last bones sometimes absent, and infraorbital ring in general incomplete and interrupted.

Postcleithrum very strong, thickened, long; lower end reaching much below pectoral-fin base (Fig. 4b).

**Coloration.** Whole dorsal surface and flank covered by numerous small dark brown or blackish spots of irregular shape and size, rather dense on the very back, and may be fused to form larger irregularly-shaped spots. Peritoneum intensively pigmented, black.

**Sexual dimorphism.** Genital papilla absent in males, present in females, a thickened triangular fold with anus at its base on ventral surface and genital orifice located in about middle of dorsal surface (never on very top of fold). Papilla already developed in juvenile females (up to 50 mm SL) though narrow and elongate; in adult females (over about 53 mm SL) relatively much larger, with wide base,

overlapping lowermost part of first anal-fin rays. Very well developed in a female 94.0 mm SL.

Pectoral and pelvic fins longer in males than in females (Tab. 2). Pectoral fin reaching about  $\frac{1}{2}$  of P-V distance in females, about  $\frac{3}{4}$  in males (but never right up to pelvic-fin origin). Pelvic fin not reaching anus in females, reaching behind anal-fin origin in males (Fig. 8).



Fig. 8. Photo of *P. krbavensis*, male, SL 81.0 mm, Vukova pećina cave.

Ripe males with breeding tubercles very weak, small and sparse, only on upper surface of head and inner surface of pectoral fin along uppermost rays; tubercles on operculum not larger than others.

**Distribution.** Only known from karstic streams and springs in Krbavsko polje (Croatia), mostly on their southern edge.

**Comments and comparisons.** Together with *P. adspersus*, *P. ghetaldii*, and *P. jadovensis* sp. n., *P. krbavensis* belongs to the group of *Phoxinellus* species with irregular spotted color pattern, a large postcleithrum, an increased number of precaudal anal-fin pterygiophores (in contrast to commonly 1, rarely 2, typical for most leuciscins), and the presence of a large genital papilla in females. The species clearly differs from *P. adspersus*, *P. ghetaldii*, and *P. jadovensis* sp. n. in having a short very interrupted lateral line formed from small, separated poorly ossified scales (usually 20–40 vs. 50–99), extremely reduced body scales, and a very short V-A distance

(averages 57% of P-V distance vs. 64–68%). It is distinguished from *P. adpersus* by a smaller eye diameter (21–24% HL vs. 26–29), and from *P. jadovensis* by a subterminal mouth (vs. terminal).

**Ecology.** The specimens described were caught in places with slow current and clear water. The smallest mature female, 53.9 mm SL, with ripe eggs, was collected on April, 17, in Vukova Pečina cave together with the smallest mature male, 54.7 mm SL. Judging on size and state of the gonads, the specimens collected in May are caught at the very spawning period. Most probably, the females can lay more than one portion of eggs.

**Etymology.** The name refers to the type-locality, Krbavsko Polje.

***Phoxinellus jadovensis*, sp. n.**

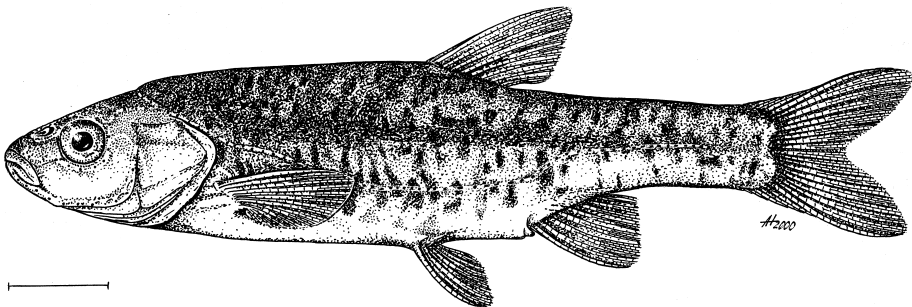
*Paraphoxinus adpersus* (non Heckel et Kner) – Trgovčević, 1905: 12 (Balatin, Japoga)

**Holotype:** CNHM 5494, Jadova River at Ploča, Croatia; leg. P. Zupančič, 21.05.1997

**Paratypes:** ZISP, 4, Jadova River at Ploča, Croatia; leg. P. Zupančič, 29.05.1998; PZC, 8, same locality and collector, 21.05.1997; PZC, 4, same locality and collector, 06.06.1997; PZC, 9, same locality and collector, 16.06.1998; PZC, 3, same locality and collector, 19.05.1999; two specimens (SL 50.2 and 77.0 mm) C&S and dissected.

Data for the holotype: female, SL 74.6 mm; D III 7½, A III 7½, l. l. 55 (non-interrupted, incomplete, terminating at about ¾ of caudal peduncle length), sp. br. 11, vert. 38, abd. vert. 21, caud. vert. 17, preD vert. 13.

**Diagnosis.** *Phoxinellus jadovensis* (Fig. 9) is distinguished from the other species of the genus in having an irregular spotted color pattern, an elongate caudal peduncle (length 2.1 times its depth), a conical slightly pointed snout, a terminal mouth, smooth pharyngeal teeth 5–4, a thickened skin, body scales embedded, poorly ossified, distant from each other, a lateral line complete or interrupted, usually terminating on caudal peduncle, with (30–50)51–60 total pored scales, vertebral formulae 21+17 or 21+18 with modally 13 predorsal vertebrae, a large postcleithrum, and a large genital papilla in females.



**Fig. 9.** *Phoxinellus jadovensis* sp. n., holotype, female, CNHM 5494, SL 74.6 mm SL, Jadova River at Ploča. Scale bar 1 mm. Drawn by A. M. Naseka.

**Tab. 3.** Morphometric data of *Phoxinellus jadovensis* sp. n.

|                          | Holotype | Paratypes, n=16 |       |
|--------------------------|----------|-----------------|-------|
|                          |          | min.–max.       | M     |
| SL (mm)                  | 74.6     | 58.3–93.0       |       |
| Percents of SL           |          |                 |       |
| Head length              | 28.7     | 27.9–31.4       | 29.16 |
| Maximum body depth       | 22.8     | 20.8–26.9       | 23.45 |
| Depth of caudal peduncle | 10.7     | 9.5–11.7        | 10.53 |
| Predorsal distance       | 56.7     | 54.3–57.6       | 56.04 |
| Postdorsal distance      | 35.9     | 34.6–39.5       | 37.28 |
| Caudal peduncle length   | 21.6     | 20.2–23.6       | 22.02 |
| Dorsal fin length        | 8.9      | 8.3–11.1        | 9.85  |
| Dorsal fin depth         | 19.2     | 16.4–23.5       | 19.86 |
| Anal fin length          | 10.3     | 7.9–10.8        | 9.19  |
| Anal fin depth           | 13.4     | 12.1–19.8       | 16.79 |
| Pectoral fin length      |          |                 |       |
| males                    |          | 18.0–20.1       |       |
| females                  | 18.5     | 20.1–22.9       |       |
| Pelvic fin length        |          |                 |       |
| males                    |          | 17.1–18.6       |       |
| females                  | 13.2     | 12.7–16.9       |       |
| P-V distance             | 26.1     | 23.9–30.3       | 26.14 |
| V-A distance             | 16.6     | 14.3–17.7       | 16.26 |
| Percents of head length  |          |                 |       |
| Snout length             | 29.3     | 26.7–33.0       | 30.01 |
| Eye diameter             | 20.1     | 19.7–23.7       | 21.62 |
| Postorbital distance     | 52.3     | 51.4–56.7       | 53.99 |
| Head depth at nape       | 59.8     | 58.2–66.7       | 61.9  |
| Head width at nape       | 48.8     | 46.1–53.4       | 48.64 |
| Interorbital distance    | 33.3     | 29.6–35.8       | 33.03 |
| Lower jaw length         | 34.5     | 32.7–37.2       | 34.85 |
| Operculum depth          | 31.6     | 29.9–35.1       | 32.06 |

**Description.** Morphometric data (for specimens 58 mm SL and larger) are given in Tab. 3.

Body elongate, markedly compressed. Caudal peduncle relatively elongate, length 2.1 times its depth. Head long, its length considerably greater than maximum body depth. Eye small, its diameter markedly smaller than snout length. Snout moderately conical, slightly rounded at very tip. Mouth terminal (Fig. 7b). Uppermost point of mouth cleft about level of lower margin of pupil. Lower jaw-quadrangle junction about vertical through anterior margin of eye. Postorbital region elongate, its length averaging 55% HL. Head shallow, elongate, its depth and width at nape av-

erage 62 and 49% HL, respectively. Lower jaw long, its length equal to or exceeding operculum depth.

Dorsal fin with 3 simple and 7½ branched rays; outer margin straight or convex; origin above pelvic-fin base. Anal fin with 3 simple and 7½ (8½ in 1 specimen) branched rays; outer margin slightly convex or almost straight; origin comparatively close to vertical through posterior end of dorsal-fin base. V-A distance averages 62% of P-V distance. Caudal fin moderately forked, lobes slightly rounded.

Total gill rakers 10 (10), 11 (17) or 12 (1). Pharyngeal teeth 5–4, hooked, smooth (unserrated).

All scales deeply embedded in skin. Skin markedly thickened in adults especially during spawning season; most scales including lateral line scales are not visible without special dissection and staining; lateral line scales set close to each other and larger than remaining body scales; body scales oval or roundish, relatively small, widely spaced especially on dorsal and ventral surfaces proper but present over whole body (sometimes absent from pre-pectoral area). Scales poorly ossified, lacking radii and weakly stained with alizarin red S.

Lateral line non-interrupted or interrupted but interruptions usually not very wide, usually terminating on caudal peduncle, often on the last third; number of lateral line scales (30–50)51–60.

CSO complete with 8 or 9 pores. CIO with 15–17 pores (4 or 5 openings on 1st infraorbital), complete, interrupted in usually one place (between last infraorbital and pterotic). CPM interrupted between angulo-articular and preoperculum, 6+9 or 6+10 pores. CST 3+3 or 4+4 pores, or fragmented. CST parietal segments often not fused to underlying bone.

Total number of vertebrae (in 24 specimens examined) 37 (1), 38 (10) or 39 (13). Number of abdominal vertebrae 20 (5), 21 (16) or 22 (3). Predorsal vertebrae 12 (1), 13 (22) or 14 (1). Intermediate vertebrae 4. Number of caudal vertebrae 16 (1), 17 (8) or 18 (15), so, usual vertebral formulae 21+18 (11) or 21+17 (5). Number of anal-fin pterygiophores in front of the first caudal hemal spine 2 (3), 3 (14) or 4 (7).

Infraorbitals (Fig. 3c) except for 1st intraorbital poorly ossified and narrow, their lamellate parts considerably or completely reduced.

Postcleithrum very strong, thickened, long; lower end reaching much below pectoral-fin base.

**Coloration.** Whole dorsal surface and flanks covered by numerous dark spots of irregular shape and of slightly different sizes, rather dense on very back. Spots sometimes fused together into larger irregularly-shaped blotches. During spawning season, females with small red spots on belly and red bases of pelvic and anal fins TRGOVČEVIĆ (1905). Peritoneum is intensively pigmented, black.

**Sexual dimorphism.** Genital papilla absent in males and present in females. It resembles that in *P. krbavensis*. Genital orifice located in about middle of its dorsal surface. Papilla already developed in juvenile females (39–58 mm SL) though narrow and elongate; in adult females (from about 58 mm SL) relatively much larger, with wide base, overlapping the lowermost part of first anal-fin rays.

Pectoral and pelvic fins longer in males than in females (Tab. 3), pelvic fin reaching up to 2/3 of V-A distance in females and behind anal-fin origin in males. No males or females with breeding tubercles have been found among specimens studied.

**Distribution.** Probably endemic to the Lika and Jadova drainages. Nowadays, only found in the Jadova near Ploča and Vrebac villages (Croatia).

**Comments and discussion.** Together with *P. adspersus*, *P. ghetaldii*, and *P. krbavensis* sp. n., *P. jadovensis* belongs to the group of *Phoxinellus* species with irregular spotty coloration, an elongated caudal peduncle, a large postcleithrum, 2–4 precaudal anal-fin pterygiophores, and the presence of a large genital papilla in females. All these characters makes the species clearly different from sympatric *P. croaticus* which has a plain dark back and a lateral stripe below it, a thin shortened postcleithrum, no or one precaudal pterygiophore, no genital papilla. *Phoxinellus jadovensis* is distinguished from the other species of the group by the following combination of characters: a conical slightly pointed snout, a terminal mouth, body scales embedded, poorly ossified, and distant from each other, and 51–60 lateral line scales.

**Ecology.** The specimens described were caught in places with slow current and clear water. The ovaries of a 58.3 mm SL female collected on 16 June contain ripe eggs though obviously she already had laid a portion of eggs.

**Etymology.** The name refers to the type locality, the Jadova River.

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## S A Ž E T A K

**Opis dviju novih vrsta, *Phoxinellus krbavensis* i *P. jadovensis*, rediskripcija vrste *P. fontinalis* Karaman, 1972 i rasprava o rasprostranjenju vrsta roda *Phoxinellus* (Teleostei: Cyprinidae) u Hrvatskoj i u Bosni i Hercegovini**

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O broju i taksonomskom statusu endemičnih svojti pijora i gaovica unutar unutar roda *Phoxinellus* Heckel, 1843 postoje oprečna mišljenja, od priznavanja samo jedne vrste s brojnim podvrstama (KARAMAN, 1972), do priznavanja statusa vrsta kod svih opisanih svojti (KOTTELAT, 1997). Dosad je opisano ukupno 8 svojti s područja Dinarskog krša Hrvatske te Bosne i Hercegovine: *alepidotus*, *adspersus* (HECKEL, 1843), *croaticus* (STEINDACHNER, 1865), *ghetaldii*, *pstrossi* (STEINDACHNER, 1882), *metohiensis* (STEINDACHNER, 1901), *fontinalis* (M. KARAMAN, 1972), te *dalmaticus* (ZUPANČIĆ & BOGUTSKAYA, 2000).

Na temelju pregleda svih sačuvanih muzejskih primjeraka, terenskog prikupljanja nove građe, te morfološke analize, izvršena je prva kritička revizija taksonomskog statusa i rasprostranjenja. Tragom podataka TRGOVČEVIĆA (1905) i dodatnih istraživanja opisuju se dvije nove vrste, *P. krbavensis* n. sp. s Krbavskog polja (razvodnica Dunavskog i Jadranskog bazena), te *P. jadovensis* n. sp. iz Jadove, pritoke rijeke Like, obje stenoendemične za manje lokalitete u Hrvatskoj. Uz to se daje i prošireni opis *P. fontinalis* s područja Krbavskog polja. Utvrđeno je da većina opisanih svojti ima alopatričko rasprostranjenje u pojedinim slivovima rijeka Jadranskog bazena i izvorištima Dunavskog sliva, ali je simpatrija potvrđena na Krbavskom polju (*fontinalis* i *krbavensis*), u rijeci Jadovi (*croaticus* i *jadovensis*), te u slivu Neretve (*ghetaldii* i *metohiensis*). Slučajevi simpatrije i stupanj morfološke diferenciranosti uvjerali su autore da se priklone mišljenju da su pojedine svojte zasebne vrste. Obradom pregledanih primjeraka zaključuje se da je *P. pstrossii* iz rijeke Trebišnjice sinonim *P. ghetaldii*, ali da postoji još najmanje jedna neopisana vrsta u okolini Mostara. Ukupno bi do sada poznatih vrsta bilo 10, od toga 9 u Hrvatskoj, a samo 5 u Bosni i Hercegovini. Potvrđuje se nestanak *P. metohiensis* iz sliva rijeke Ljute na Konavlima, te *P. fontinalis* na tipskom lokalitetu (Hrnjakova pećina) na Krbavskom polju i na polju Krbavici, u oba slučaja zbog unošenja alohtonih predatorskih vrsta pastrva.