

A re-description of *Leuciscus zrmanjae* (KARAMAN, 1928) and new data on the taxonomy of *Leuciscus illyricus*, *L. svallize* and *L. cephalus* (Pisces: Cyprinidae) in the West Balkans

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Abstract

A group of endemic West Balkan species, *Leuciscus zrmanjae* (KARAMAN), *L. svallize* (HECKEL & KNER) and *L. illyricus* (HECKEL & KNER), is revised and compared to *L. cephalus* (L.). New morphological characters from osteology and sensory canals are critically analyzed together with traditional characters. The study is based upon a wide examination of specimens from both recent and older museum collections (mainly Naturhistorisches Museum Wien). *Leuciscus zrmanjae* is re-described and a neotype designated. The validity of *L. illyricus* and *L. svallize* is confirmed.

Key words: Cyprinidae, *Leuciscus*, taxonomy, endemics, West Balkans.

Zusammenfassung

Die endemischen Arten des West Balkans *Leuciscus zrmanjae* (KARAMAN), *L. svallize* (HECKEL & KNER) und *L. illyricus* (HECKEL & KNER) werden revidiert und mit *L. cephalus* (L.) verglichen. Bisher zur Unterscheidung der Arten benutzte Kriterien werden kritisch analysiert und neue osteologische Merkmale sowie Charakteristika des sensorischen Systems zur Diagnose der Arten eingeführt.

Es wurde Material aus verschiedenen Museen (insbesondere aus dem Naturhistorischen Museums Wien) und aus neuen Aufsammlungen bearbeitet. Im Zuge einer Neubeschreibung von *Leuciscus zrmanjae* wird ein Neotypus festgelegt. Die Gültigkeit von *L. illyricus* und *L. svallize* wird bestätigt.

Introduction.

The taxonomy and ranges of species close to *Leuciscus cephalus* from the West Balkans was poorly known and inconsistent until BIANCO & KNEŽEVIĆ (1987) first revised this group. They confirmed the validity of *Leuciscus svallize* (Neretva and Trebisnjica¹ rivers) and described *Leuciscus* sp. from the Krka River. The latter species was supposed to be identical with *Squalius svallize zrmanjae* originally described by KARAMAN (1928) from Zrmanja river. *Leuciscus* sp. sensu BIANCO & KNEŽEVIĆ (1987) is distinguished by 8 branched dorsal fin rays and 8 or 9 anal ones, 44-48 lateral line scales, a large eye, and a specific pigmentation of scales which forms regularly arranged triangular spots. The validity of *L. illyricus* was considered as doubtful. These authors suggested (p.51) that "it may be better regarded as a subspecies or as a local, cold-water

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¹ BIANCO & KNEŽEVIĆ (1987), BIANCO (1990) and KOTTELAT (1997) give «Trebinje River» but Trebinje is a town in the basin of the Trebisnjica (Trebnica) river.

ecophenotype of *L. cephalus*" and incorrectly limited its range to the Cetina River since the type-locality includes Isonzo² and Krka.

BOGUTSKAYA (1994) considered *L. illyricus* and *L. svallize* as valid species and described differences between *L. cephalus* and *L. illyricus* in the neurocranium width, shape of the supraethmoid and interorbital septum, and configuration of the 4th and 5th infraorbitals.

KOTTELAT (1997) tentatively identified *Leuciscus* sp. of BIANCO & KNEŽEVIĆ (1987) as *L. zrmanjae* and underlined (p. 72) that "once material from Zrmanja becomes available, a neotype designation is desirable to stabilise this use of the name".

Thus, some questions still remain concerning the taxonomy and distribution of *Leuciscus* species of the "*Leuciscus cephalus* complex" sensu BIANCO 1983, or "*L. cephalus* - *L. lepidus* group" sensu BOGUTSKAYA 1994, in Croatia, Bosnia and Herzegovina (Adriatic region): a re-evaluation of the taxonomic status and range of *L. illyricus*, a re-description of *Squalius svallize zrmanjae* KARAMAN and a confirmation of its identity with *Leuciscus* sp. sensu BIANCO & KNEŽEVIĆ from Krka.

While working through specimens in museum collections we found considerable inconsistency in the species identifications. We have re-examined the types of *Squalius illyricus* and *Squalius svallize* and all the *Leuciscus* specimens from the Adriatic West Balkans (from Isonzo to the Skadar Lake), and also report on recent collections by P. Zupančić in the area under consideration. The conclusions of the study presented in this paper are exclusively based upon personally examined material since, in most cases, the data from the literature do not allow exact identification of samples.

Acknowledgements

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Material and methods

In total, over 500 specimens of *L. cephalus*, *L. svallize*, *L. illyricus* and *L. zrmanjae* have been examined from the Naturhistorisches Museum, Wien (NMW), P. Zupančić's private collection (PZC), the Senckenberg Museum, Frankfurt a. Main (SMF); the Zoological Institute, Russian Academy of Sciences, St. Petersburg (ZISP), and the Zoologisches Museum und Institut Universität Hamburg (ZMH). C&S indicates specimens cleared and stained with alizarin red S. Most specimens were radiographed. Methods of skull measuring, counting vertebrae and sensory pores as well as terminology of vertebral regions and subregions follow those given in BOGUTSKAYA (1994) and BOGUTSKAYA & COLLARES-PEREIRA (1997). Two last branched dorsal and anal fin rays are counted as one.

Abbreviations used are: l.l. - number of lateral line scales on the left side of the body, Sl - standard length, D - dorsal fin, A - anal fin, sp. br. - gill rakers, vert. - total vertebrae, abd.

² BIANCO & KNEŽEVIĆ (1987, p. 51) supposed that "two syntypes of *L. illyricus* ... (NMW 49340 and 49341) were wrongly registered" not being collected in Isonzo; however, the authors did not undertake a special investigation and give no comments on the third syntype from Isonzo (NMW 49339).

vert. - abdominal vertebrae, preD vert. - predorsal abdominal vertebrae, caud. vert. - caudal vertebrae.

Cephalic sensory canals: CIO - infraorbital canal, CPM - preopercular-mandibular canal, CSO - supraorbital canal, CST - supratemporal canal.

Skull measurements: H eth - depth of ethmoid region, H soc - depth of occipital region, L bas. n. - length of neurocranial base, L cr. r., length of cranial roof, Lt eth - width of neurocranium between lateral margins of lateral ethmoids, Lt spho - width of neurocranium between lateral margins of sphenotic lateral processes, Lt pto - width of neurocranium between lateral margins of pterotics.

Bones and their elements: aart - anguloarticular, boc - basioccipital, dn - dentary; ectpt - ectopterygoid, entpt - entopterygoid, eoc - exoccipital, epo - epiotic, eth.l. - lateral ethmoid, f - frontal, f. car. - carotid foramen, f. st - subtemporal fossa, hm - hyomandibular, ic - intercalar, io - infraorbitals, iop - interoperculum, iorb - interorbital septum of orbitosphenoid, keth - kinethmoid, meth - mesethmoid, mtpt - metapterygoid, mx - maxilla; op - operculum, orbs - orbitosphenoid, p - parietal, p. m. - masticatory plate of pharyngeal process, pal - palatine, peth - preethmoid, pmx - premaxilla, pr. asc. d. - dorsal ascending process of maxilla, pr. cor. - coronoid process, pr. p.-lat. - postero-lateral process of pterosphenoid, pro - prootic, ps - parasphenoid, pto - pterotic, pts - pterosphenoid, qu - quadrate, s - symplectic, seth - supraethmoid, soc - supraoccipital; sop - suboperculum, spho - sphenotic, spo - supraorbital, rart - retroarticular, v - vomer.

Results

Leuciscus zrmanjae (KARAMAN, 1928)

Squalius svallizze zrmanjae KARAMAN, 1928: p. 159 (Zrmanja near Obrovac)

Squalius svallizze zrmanjae KARAMAN, 1929: p. 172 (Zrmanja near Obrovac)

Leuciscus sp. - BIANCO & KNEŽEVIĆ, 1987: p. 53, fig. 3d (Krka)

Leuciscus zrmanjae - KOTTELAT, 1997: p. 72

Local name: Zrmanjski klen.

Neotype: NMW 94470, Zrmanja R. at Bilisane, Croatia; coll. P. Zupančić, 15.08.1997.

Data for the neotype: SI 140,5 mm; D III 8, A III 9, l.l. 46, sp. br. 9, vert. 43, abd. vert. 24, caud. vert. 19, preD vert. 14, CSO pores 12/10 (7/6 on frontal), CIO 16/19 (5/5 on 1st infraorbital), CPM 17/18 (4/5 on dentary).

Additional material: NMW 94407 (2, Knin), NMW 48926 (6, Obrovadz³, Zrmanja); PZC, 16 (1 C&S SI 123,0 mm), Zrmanja R., Bilisane, Croatia; 15.08.1997, coll. P. Zupančić), PZC, 3 (1 C&S SI 118,4 mm), lower reaches of Krka R., August 1989, coll. P. Zupančić).

Diagnosis

L. zrmanjae is distinguished from all three other species under consideration in having the following combination of characters: dorsal fin commonly with 8 and anal fin with 9 branched rays; number of lateral line pierced scales 44-49; number of gill rakers 8-10; number of CSO pores commonly 10-12 with 6 or 7 openings on the frontal; number of CIO pores 15-19 with commonly 5 openings on the 1st infraorbital; number of CPM

³ Here and below original spelling of localities are given.

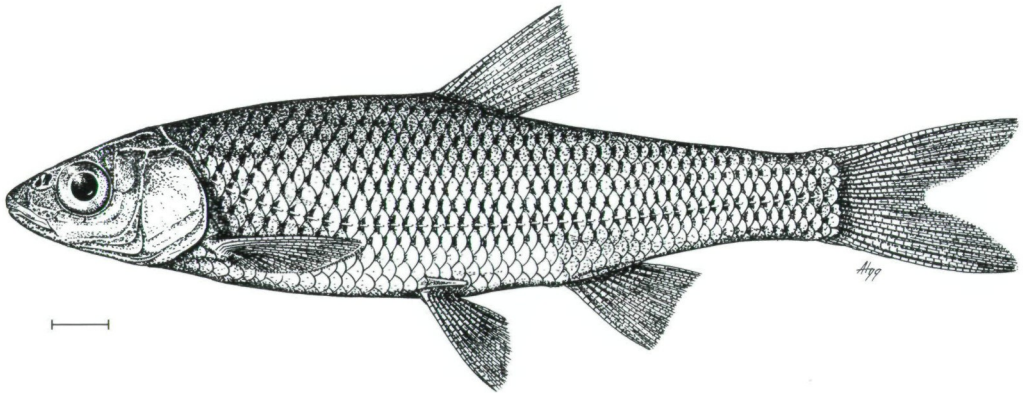


Fig. 1: *Leuciscus zrmanjae*, neotype, NMW 94470, SI 140,5 mm, Zrmanja R. Scale bar = 10 mm. Drawn by A.M. Naseka.

pores 15-19 with 4-6 openings on the dentary; head shallow, conical; snout elongated, slightly rounded; mouth subterminal; lower jaw not long, its length less than operculum depth; eye large, its diameter about 24-28 % lc; free 5th infraorbital commonly absent; black triangular spot on each scale on flanks.

Description

Morphometric data are given in Table 1. The body is elongated, slightly compressed. The head length usually exceeds the maximum body depth. The eye is large, its diameter, 24-28 % lc, only slightly less than the snout length. The postorbital distance averages 50 % lc. The upper head profile is slightly convex, the snout is conical, rounded only at the tip. The mouth is subterminal. The uppermost point of the mouth cleft is about the level of the lower margin of the pupil or slightly below it. The lower jaw-quadrangle junction is about the vertical through the anterior margin of the eye. The interorbital space is moderately wide, its width, averaging 36 % lc, is about equal to the lower jaw length. The operculum is not deep, 35-39 % lc, that correlates with a relatively low head depth at nape, 61-69 % lc. Length of the lower jaw, 34-38 % lc, is usually smaller than the operculum depth.

The dorsal fin has 3 simple and 7 (1), 8 (26) or 9 (1) branched rays. Its outer margin is straight or slightly convex. The dorsal fin origin is slightly behind the vertical through the anterior end of the pelvic fin base. The anal fin has 3 simple and 8 (1), 9 (26) or 10 (1) branched rays. Its outer margin is slightly convex or almost straight.

Number of gill rakers 8 (5), 9 (14) or 10 (9) in total on the left outer side of the first gill arch. Pharyngeal teeth 2.5-5.2, hooked, serrated. Number of lateral line scales is 44 (3), 45 (4), 46 (7), 47 (7), 48 (4) or 49 (3).

All the cephalic sensory canals are complete. CSO has (9)10-12(13), commonly 11, pores. There are (3)4 canal openings on the nasal and 6, 7(8) on the frontal. CIO has 15-18(19), commonly 17, pores with 5, rarely 6, canal openings on the 1st infraorbital. CPM always communicates with CIO and has (15)16, 17(18) pores. There are 5 or 6 (equally frequent), rarely 4, canal openings on the dentary. CST has 6-9, usually 7, pores.

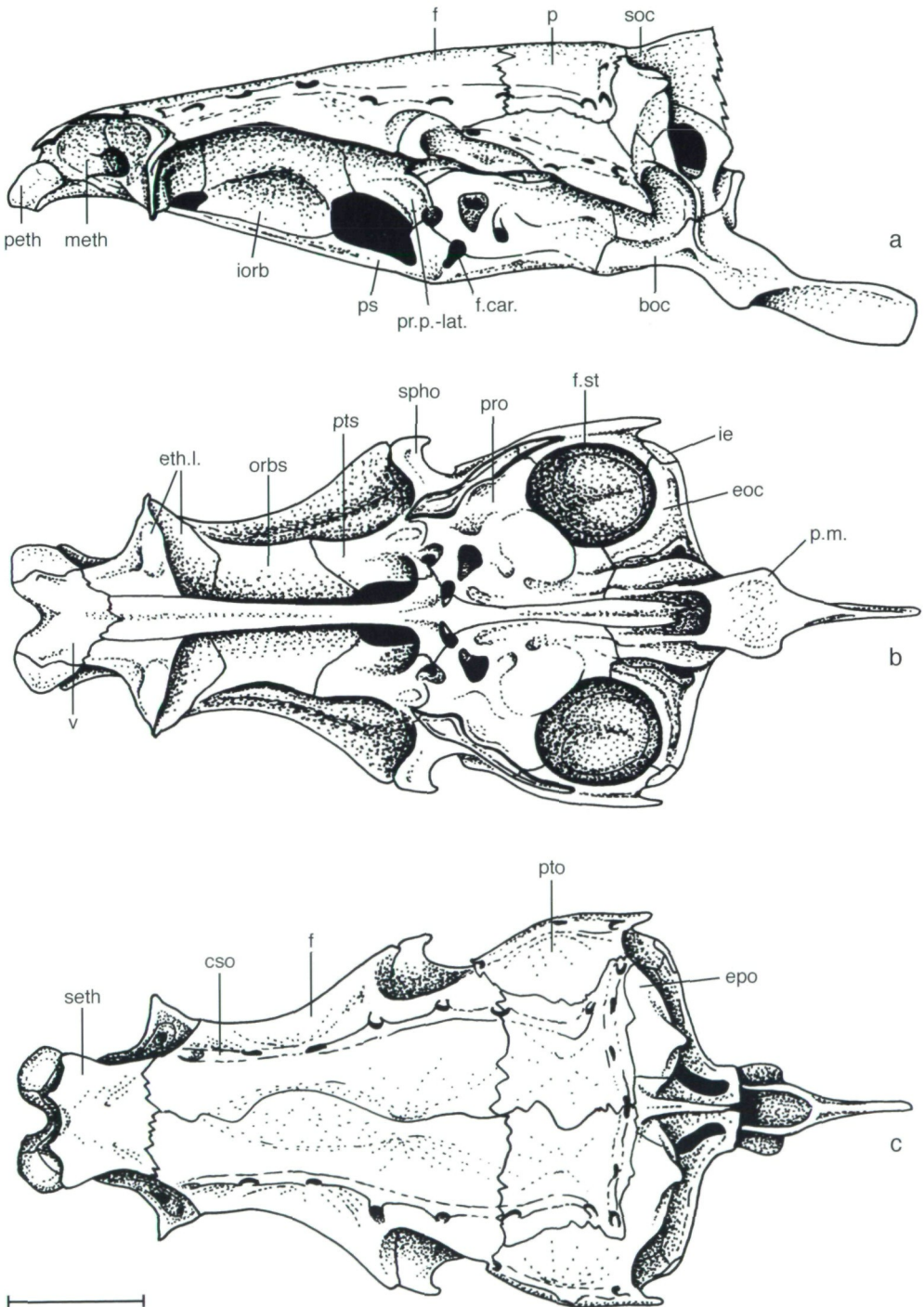


Fig. 2: Neurocranium of *L. zrmanjæ*, PZC, Zrmanja R., SI 123,0 mm, lateral (a), dorsal (b) and ventral (c) views. Scale bar = 5 mm.

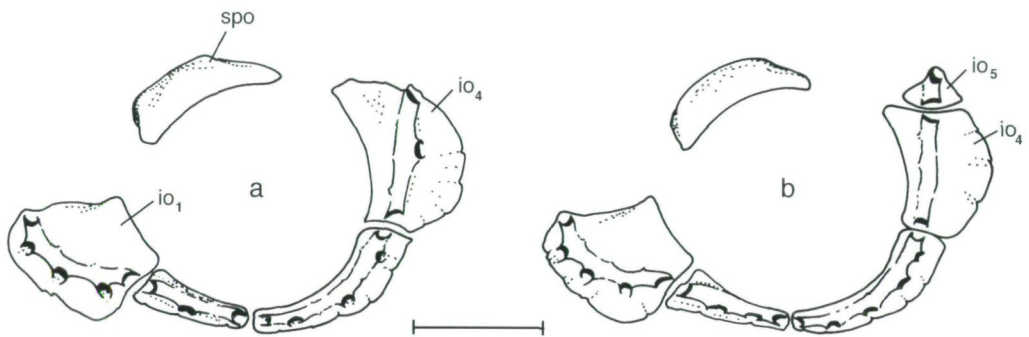


Fig. 3: Circum-orbitals of *L. zrmanjiae*, neotype, NMW 94470, Zrmanja R., SI 140,5 mm (a); PZC, Zrmanja R., SI 123,0 mm (b). Scale bar = 5 mm.

Total number of vertebrae 42 (7) or 43 (14). Number of abdominal vertebrae 24 (15) or 25 (6). Predorsal vertebrae 14 (10) or 15 (11). Intermediate vertebrae 4 (14) or 5 (7). Number of caudal vertebrae 17 (1), 18 (11) or 19 (9). Vertebral formulae 24+19 (9), 24+18 (6), 25+18 (5), 25+17 (1).

The neurocranium (Fig. 2) is moderately deep and broad, its general configuration similar to that in *L. leuciscus* (BOGUTSKAYA, 1994, Fig. 4). Neurocranium measurements (% *L. bas. n.*) are as follows: H eth 13-15 %, H soc 33-34 %, Lt eth 35-36 %, Lt spho 48-50 % and Lt pto 53-56 %. In undissected specimens, maximum depth (Lt pto) is 67-74 % *L. cr. r.*, width of the supraethmoid 28-33 % *Lt pto*.

The preethmoid is entirely cartilaginous. The vomer is shortened, broad. The orbital region is not depressed, the interorbital septum is well pronounced, its depth being 1/3-1/2 of the orbitosphenoid depth. The pterosphenoid bears an extensive postero-lateral process which contacts the upper margin of the parasphenoid ascending process forming the anterior wall of the trigeminal nerve foramen. The paired pterosphenoids widely contact each other forming the entire anterior margin of the orbital-hypophyseal foramen. The sphenotic contributes to the inner wall of the subtemporal fossa forming an extensive anterior apex of the fossa.

The first three infraorbitals have the usual *Leuciscus* configuration. The 4th bone is widened but narrower than that in *L. cephalus*. The 5th infraorbital is absent probably due to fusion with the 4th one (Fig. 3a) or free but not extensive (Fig. 3b).

Opercular bones (Fig. 4a), palato-quadrate complex (Fig. 4b) and bones of the jaws (Fig. 4c) are of the plesiomorphic leuciscine type (BOGUTSKAYA 1994, Fig. 6): the jaws are not long (length of the lower jaw is 43-48 % *L. bas. n.*), the maxillary dorsal ascending process is narrow and deep, the anterior portion of the dentary is not elongated and the coronoid process is vertical.

Coloration. Alcohol preserved specimens are silvery with a darker back and creamy belly. The scales on the flanks, especially those above the lateral line, are pigmented at the base of each scale (pigment dots are mostly located in scale pockets) and, sometimes, along their free margins forming regularly arranged triangular spots (Fig. 1, 5a). The dorsal and caudal fins are slightly pigmented.

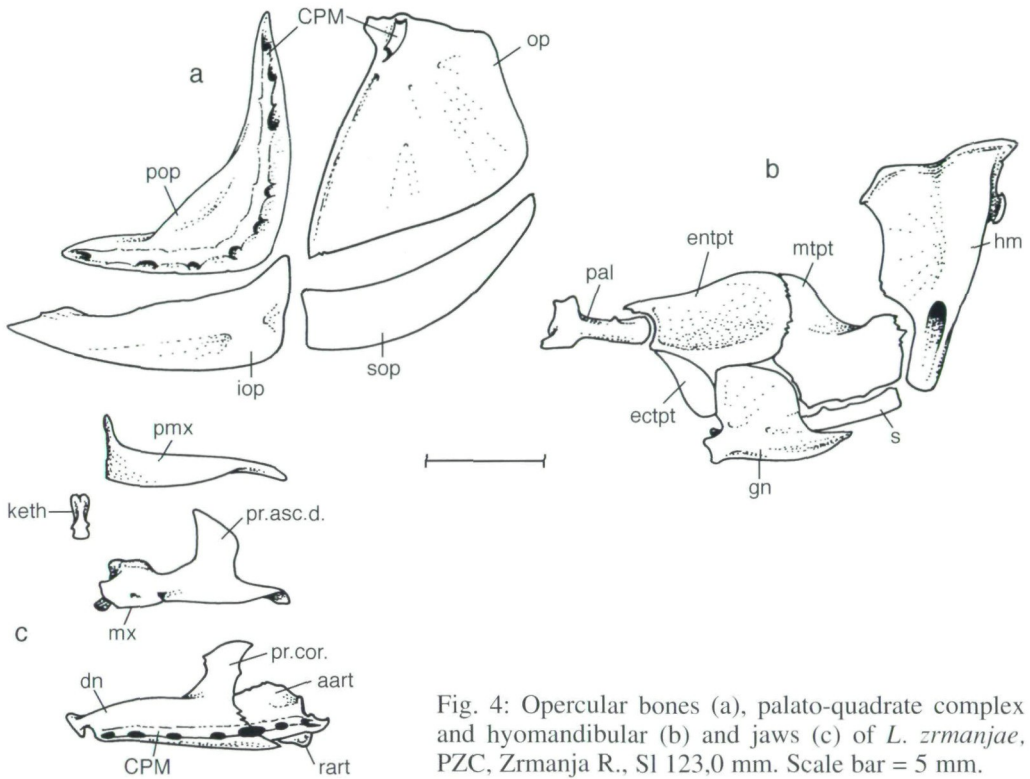


Fig. 4: Opercular bones (a), palato-quadrate complex and hyomandibular (b) and jaws (c) of *L. zrmanjæ*, PZC, Zrmanja R., SI 123,0 mm. Scale bar = 5 mm.

Distribution

Endemic to Croatia. It is quite numerous in the lower and middle course of the Zrmanja River and the lower Krka, also known from the upper Krka at Knin (NMW 94407) but is probably rare there since was not found during the recent collecting trips by P. Zupančić.

In Zrmanja, most probably it is the only *Leuciscus* species which is usually reported under the name *L. svallize* (VUKOVIĆ & IVANOVIĆ 1971, MRAKOVČIĆ & al. 1995) or *L. illyricus* (KOLOMBATOVIĆ 1907, VUKOVIĆ & IVANOVIĆ 1971, VUKOVIĆ, 1982).

In Krka, it occurs sympatrically with *L. cephalus* and *L. illyricus*. The reports of *Leuciscus svallize* from Krka (KATURIC 1887, VUKOVIĆ & IVANOVIĆ 1971, MRAKOVČIĆ & MIŠETIĆ 1989, MRAKOVČIĆ & al. 1995) may refer to *L. zrmanjæ*.

It is questionable if *L. zrmanjæ* is distributed in the Cetina basin. KATURIC (1883) reported *Squalius svallize* from Cetina near Trilj but KARAMAN (1928) supposed that this actually refers to *L. illyricus*. It is not clear what species was mentioned under the name of *L. svallize svallize* from Cetina and tributaries (POVŽ & al. 1990) and as *L. svallize* from the upper Cetina near the village Panj (LEINER & POPOVIĆ 1984). *L. svallize* is absent from Cetina (and Krka as well), so, judging from the number of lateral line scales (48-49) given in the latter paper, the species is *L. illyricus* or *L. zrmanjæ*. The specimens described by LEINER & POPOVIĆ (1984) are also characterized by a large eye (a mean

given is 24,92 % lc) and a short postorbital distance (50,18 % lc). These measurements are characteristic for *L. zrmanjae* in contrast to *L. illyricus* with respectively 16-24 (mean 20,6) % lc and 51-59 (mean 54,2) % lc. Unfortunately, no preserved specimens of "*L. svallize*" from Cetina are available.

LEINER & POPOVIĆ (1984) and LEINER & al. (1995) also reported *L. svallize* from Istrian Peninsula. This could refer to *L. zrmanjae* or to *L. illyricus*. No specimens from Istria are available for examination at the moment to judge the taxonomic status of Istrian populations.

Leuciscus svallize zrmanjae described from Corfu Island and West Greece by STEPHANIDIS (1971) belongs to *L. cephalus* according to BIANCO & KNEŽEVIĆ (1987).

Tab. 1: Morphometric data of *L. zrmanjae* (neotype and material from Zrmanja River), *L. illyricus* (syntypes NMW 49313, 49315, 49322, 49324, 49331, 49339-41) and *L. svallize* (syntypes NMW 49593, 49595, 49597, 49612 and SMF 3398). M = mean value.

	<i>L. zrmanjae</i>			<i>L. illyricus</i>		<i>L. svallize</i>	
	Neotype NMW 94470	Zrmanja R. PZC, n=11, range	M	Syntypes n=17 range	M	Syntypes n=7 range	M
SI (mm)	140,5	92,5-146,2	113,35	85,1-305,3	172,71	139,5-194,1	167,96
% of SI							
lc	26,6	25,2-27,8	26,77	22,9-28,3	26,11	25,1-26,4	25,71
H	26,2	22,2-28,5	24,42	23,3-28,6	25,59	25,1-27,8	26,25
h	9,8	9,4-10,4	9,87	9,9-11,4	10,71	10,3-11,2	10,53
pD	55,7	53,8-57,3	55,53	52,8-58,8	56,10	53,2-57,9	55,97
poD	36,4	34,8-37,3	35,81	32,5-37,2	34,95	34,7-40,4	36,83
lpc	20,1	17,7-20,1	18,69	15,5-19,9	18,31	16,2-21,8	18,55
lD	11,6	11,2-13,0	11,95	10,0-12,6	11,33	11,2-13,3	12,47
hD	17,1	17,1-18,7	17,95	13,9-18,1	16,25	17,4-19,8	18,64
lA	9,6	9,6-10,8	10,10	8,3-11,2	9,77	10,3-11,8	11,22
hA	12,0	12,0-14,9	13,55	9,5-14,7	12,49	13,0-15,2	14,05
lP	19,4	18,8-20,6	19,60	14,4-19,0	16,92	17,2-20,7	18,98
lV	15,9	14,4-16,4	15,51	12,8-15,8	14,43	15,1-16,4	15,71
P-V	27,1	24,9-28,5	26,77	18,8-30,5	27,71	25,1-29,4	27,34
V-A	22,2	19,5-22,2	20,62	15,4-24,1	21,05	19,6-22,9	20,92
% of lc							
prO	28,7	27,3-31,6	28,97	25,3-31,4	28,24	26,1-32,5	28,68
Oh	24,7	23,7-26,6	25,03	16,1-24,5	20,59	19,6-23,5	21,91
poO	50,1	48,1-54,2	49,88	50,6-58,8	54,20	47,6-53,1	50,93
hc	63,0	60,9-68,7	63,90	65,9-80,7	69,66	62,3-65,9	64,20
lac	53,4	50,0-55,3	51,82	45,8-53,3	49,35	47,6-50,3	48,45
io	37,5	32,9-38,8	36,31	29,9-37,8	32,61	33,2-34,8	33,92
lmd	35,7	34,1-38,0	35,43	34,5-39,8	36,44	34,5-38,9	36,26
hop	38,3	34,9-39,1	37,29	38,6-43,6	40,46	35,7-41,1	39,08

Leuciscus illyricus* (HECKEL & KNER, 1858)Squalius illyricus* HECKEL & KNER, 1858: p. 195, fig. 108 (Isonzo; Knin und Sign in Dalmatien)*Leuciscus illyricus* - BIANCO & KNEŽEVIĆ, 1987: p. 49, fig. 1, 3a (? Isonzo; Cetina)*Leuciscus illyricus* - KOTTELAT, 1997: p. 72

Local name: Illirski klen.

Syntypes: NMW 49313 (7, SI 110,2-136,1 mm, Sign, 1843.II.7⁴, Heckel's Reise 1840), 49315 (3, SI 85,1-258,2 mm, Sign, 1856.VII.10⁵, Bellotti), 49322 (1, SI 254,8 mm, Kerka bei Knin, 1843.II.6a⁶, Heckel's Reise 1840), 49324 (1, SI 275,0 mm, Kerka bei Knin, 1843.II.6, Heckel's Reise 1840), 49331 (2, SI 98,2-107,6 mm, Kerka bei Knin, 1843.II.6, Heckel's Reise 1840), 49339 (1, SI 269,2, Isonzo, 1850.IX.8, Nardo), 49340 (1, SI 305,3 mm, Isonzo, 1850.IX.8, Nardo), 49341 (1, SI 294,6 mm, Isonzo, 1850.IX.8, Nardo).

Data for the syntypes: SI 85,1-305,3 mm; D III 8; A III 8 (5), 9 (12) [only 9 given by HECKEL & KNER 1858]; I.1. 46 (1), 48 (3), 49 (3), 50 (4), 52 (3) and approximately 45, 46 and 48 in three because of a partial lack of scales [49-54 given in HECKEL & KNER 1858]; sp. br. 10 (11), 11 (4), 12 (2); vert. 43 (2), 44 (2), abd. vert. 25 (3), 24 (1), caud. vert. 18 (1), 19 (3), preD vert. 14 (1), 15 (3) (NMW 49313:1-4); CSO pores 9-11(12) (5-7 on frontal), CIO 15-19 (4-6 on 1st infraorbital), CPM 15-18 (4-6 on dentary).

Comparative material: NMW 94406 (1, Knin), 49207 (1, Knin), 49309 (3, Sign), 49311 (1, Cettina, Sign), 49312 (18, Cettina, Sign), 49314 (5, Sign), 49316 (7, Sign), 49317 (4, Knin), 49318 (7, Sign), 49319 (5, Knin), 49320 (2, Knin), 49321 (3, Knin), 49327 (4, Knin), 49328 (3, Knin), 49332 (1, Kerka), 49610 (1, Cettina), 84412 (5, Knin); PZC (11, 2 C&S SI 82,5, 108,9 mm, Cetina; 5, 1 C&S SI 134,0 mm, Krka at Roski slap); ZMH 15080 (3, Cetina).

Diagnosis

L. illyricus is distinguished from all three other species in having the following combination of characters: commonly dorsal fin with 8 and anal fin with 8 or 9 branched rays; number of lateral line pierced scales (45)46-54(55); number of gill rakers (9)10-12; number of CSO pores commonly 9-11 with 5-7 openings on the frontal; number of CIO pores 15-19 with 5 (mode) or 6 openings on the 1st infraorbital; number of CPM pores commonly 16-18 with 5 (mode) or 6 openings on the dentary; head deep, snout stout, markedly rounded; mouth subinferior; lower jaw not long, its length always distinctly less than operculum depth; eye comparatively small, its diameter less than snout length; 5th infraorbital triangular-shaped, fused with 4th infraorbital or absent; coloration is intensive, back and fins sometimes blackish, black pigmentation on lateral scales with arch-like spots.

Description

Morphometric data for the syntypes are given in Table 1. The head length is about equal to the maximum body depth. The head (Fig. 6a) is deep, especially (68-80 % lc) in larger specimens. The eye is comparatively small, its diameter negatively correlates with fish size: 18-24 % lc in specimens SI 90-150 mm, and 16-18 % lc (markedly less than the snout length) in specimens SI over 250 mm. The postorbital distance averages 54 % lc. The upper head profile is clearly convex, the snout is stout, markedly rounded. The mouth is subinferior: the uppermost point of the cleft is on or below the level of the

⁴ In the NMW acquisition book, 4 specimens are recorded under this number.

⁵ In the NMW acquisition book, 2 specimens are recorded under this number.

⁶ In the NMW acquisition book, 2 specimens are recorded under this number, and a locality "Kerka bei Scardona" is given.

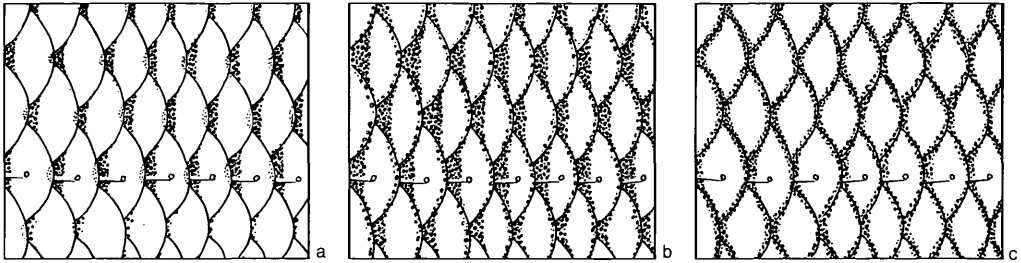


Fig. 5: Pigmentation pattern in (a) *L. zrmanjae*, neotype, NMW 94470, Zrmanja R., SI 140,5 mm; (b) *L. illyricus*, NMW 84412, SI 126,0 mm, Krka R.; (c) *L. cephalus*, PZC, SI 147,1 mm, Krka R.

lower margin of the eye. The lower jaw-quadrates junction is commonly in front of the vertical through the anterior margin of the eye. The interorbital space is narrow; its width, averaging 33 % lc, is markedly less than the lower jaw length. The operculum is comparatively deep, 39-44 % lc. Length of the lower jaw, 34-40 % lc, is always smaller than the operculum depth.

The dorsal fin has 3 simple and 8 branched rays. Its outer margin is slightly convex or almost straight. The dorsal fin origin is about the vertical through the anterior end of the pelvic fin base. The anal fin has 3 simple and 8 (26), 9 (83) or 10 (1) branched rays. Its outer margin is slightly to markedly convex, in smaller specimens almost straight.

Number of gill rakers 9 (4), 10 (56), 11 (37) or 12 (29) in total on the left outer side of the first gill arch. Pharyngeal teeth 2.5-5.2 (3.5-5.2 in two specs), hooked, serrated.

Number of lateral line scales is 45 (2), 46 (4), 47 (8), 48 (22), 49 (17), 50 (18), 51 (12), 52(11), 53 (4), 55(1).

CSO has 9-11(12), commonly 10, pores; the posterior section of the canal is not elongated having on the parietal only one canal segment or just a prolongation of the last frontal segment. There are (3)4 canal openings on the nasal and (5)6, 7(8) on the frontal. CIO has 15-19), commonly 16-18, pores with 5, rarely 4 or 6, canal openings on the 1st infraorbital. CPM has (14,15)16-18(19) pores. There are 5 or 6, rarely 4 or 7, canal openings on the dentary. CST has (6)7(8) pores.

Total number of vertebrae 42 (8), 43 (16) or 44 (7). Number of abdominal vertebrae 24 (13), 25 (16) or 26 (2). Predorsal vertebrae 14 (6) or 15 (25). Intermediate vertebrae 4 (8) or 5 (23). Number of caudal vertebrae 17 (1), 18 (19) or 19 (11). Vertebral formulae 25+18 (10), 24+18 (7), 24+19 (6), 25+19 (5), 26+18 (2), 25+17 (1).

The neurocranium is moderately deep. Its general configuration resembles that in *L. zrmanjae*: measurements (% L. bas. n.) are as follows: H eth 12-14 %, H soc 32-33 %, Lt eth 31-33 %, Lt spho 46-47 % and Lt pto 50-53 %; the orbital region is not depressed, the interorbital septum depth is about 1/2 of the orbitosphenoid depth. In undissected specimens, maximum depth (Lt pto) is 67-77 % L cr. r., width of the supraethmoid 29-34 % Lt pto.

The vomer (Fig. 7a) is slightly elongated. The paired pterosphenoids do not contact along the anterior margin of the orbital-hypophyseal foramen, being separated by the orbitosphenoid. The sphenotic does not contribute to the inner wall of the subtemporal fossa.

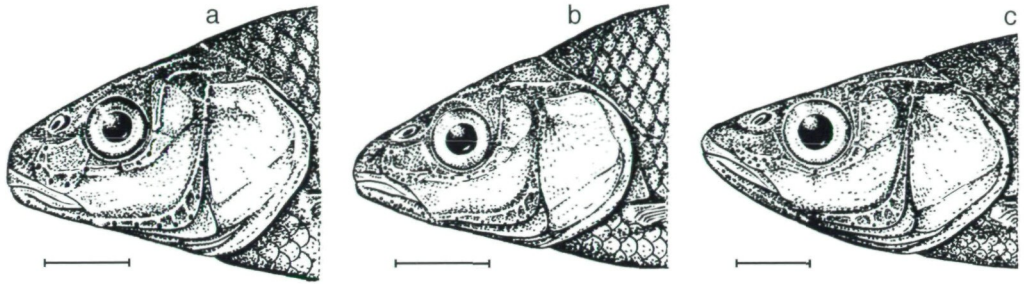


Fig. 6: Head in lateral view of (a) *L. illyricus*, syntype, NMW 49313, SI 136,1 mm, Cetina R.; (b) *L. svallize*, NMW 84412, SI 126,0 mm, Krka R.; (c) *L. cephalus*, PZC, SI 147,1 mm, Krka R. Scale bar = 10 mm. Drawn by A.M. Naseka.

The 4th infraorbital is often fused with the 5th bone or the latter is free but never extensive (Fig. 8a, b). The jaws (Fig. 11a) are not elongated. Length of the lower jaw is 44-46 % L bas. n.

Coloration. Freshly preserved specimens in alcohol are slightly brownish with a darker back. The scales on the flanks are pigmented along their free margins and in the scale pockets forming blackish mesh with regular arch-like spots (Fig. 5b). Some specimens (NMW 49309, 49317, 49327, 49328) are very intensely pigmented with the back and all fins almost black. In freshly caught specimens from Krka at Roski slap the fins were yellow.

Distribution

Croatia, also probably Slovenia and Italy (Soca-Isonzo). *L. illyricus* is originally described from the Cetina basin (town Sign, or Sinj, at Sinjsko Polje), Krka basin (town Knin at Šarena lakes) and Isonzo basin (named Soča in Slovenia). The comparative material examined from the two former basins clearly confirms that this species is distributed in the Cetina basin (including Peruča Lake, Prančevići Lake, Ruda River) where it is a dominant species and in the upper Krka river (including Šarena lakes near Knin and Brljan Lake) down to the Roski slap. MRAKOVČIĆ & MIŠEVIĆ (1989) report *L. illyricus* from Krka having collected fishes in the lower and middle course of the river. MRAKOVČIĆ & al. (1995) mention that *L. illyricus* is a dominant fish in the whole Krka system. According to our examinations of specimens of different *Leuciscus* species from various localities in the Krka basin based on material from NMW and PZC, *L. illyricus* is probably absent from the lower course of Krka.

KOLOMBATOVIĆ (1907) reported *L. illyricus* from the Krupa River, the tributary of Zrmanja. VUKOVIĆ & IVANOVIĆ (1971) and VUKOVIĆ (1982) also gave Zrmanja among the other localities within the range of this species. However, the presence of *L. illyricus* in Zrmanja and Krupa is doubtful. The second author visited Zrmanja and Krupa three times in the last four years and collected no *L. illyricus*. The only species of the genus *Leuciscus* found there was *L. zrmanjae*.

Many authors (GÜNTHER 1868, SEELEY 1886, MUNDA 1926, GRIDELLI 1936, TALER 1953, LADIGES & VOGT 1965, SABIONCELLO 1967, VUKOVIĆ & IVANOVIĆ 1971, RISTIĆ 1977, VUKOVIĆ 1982, SVETINA & al. 1982) reported *L. illyricus* from the Soča (Isonzo) basin

but most probably they just relied on HECKEL & KNER (1858). SKET (1967) doubted an occurrence of *L. illyricus* in Soca, and SVETINA & VERCE (1969), TORTONESE (1970), FORNERIS & al. (1990), POVŽ & SKET (1990), GANDOLFI & al. (1991), MARIANI & BIANCHI (1991) do not report this species from Soca (Isonzo). The question needs further investigation, however, at the present stage of the study, we see no reason to consider the three syntypes (NMW 49339, NMW 49340, NMW 49341) as wrongly registered or confused with *L. cephalus*. The number 1850.IX.8 in the acquisition book indicates 3 specimens received from "Nardo in Venedig", and no other specimens of *Leuciscus* or *Squalius* are recorded at any close date or locality. A comparison with the specimens of *L. cephalus* from Isonzo (NMW 15393, 48923) show a clear difference in characters diagnostic for both species.

DRENSKI (1922, p. 4 and 8) reported *L. illyricus* from Ohrid lake (no taxonomic data given), RAKAJ & FLOKO (1995) - from Albania (no certain locality), and RAKAJ (1995) - from Dalmatia, Macedonia (former Yugoslavian Republic of Macedonia) and the Prespa Lake near Madhe. Most probably, all these reports are based upon misidentifications.

Leuciscus svallize (HECKEL & KNER, 1858)

Squalius svallize HECKEL & KNER, 1858: p. 197, fig. 110 (Seen bei Vergoraz und Narenta in Dalmatien).

Leuciscus svallize - BIANCO & KNEŽEVIĆ, 1987: p. 51, fig. 2, 3b (Neretva and Trebinje river basins).

Leuciscus svallize - KOTTELAT, 1997: p. 72

Local name: Svalic, strugac, sval.

Syntypes: NMW 49593 (1, SI 165,8 mm, Narenta, 1843.II.7a, Heckel's Reise 1840), 49595 (1, SI 154,0 mm, Narenta, 1843.II.7a, Heckel's Reise 1840), 49596 (1, SI 152,5 mm, Narenta, 1843.II.7a, Heckel's Reise 1840), 49597 (1, SI 139,5 mm, Narenta, 1843.II.7a, Heckel's Reise 1840), 49612 (1, SI 194,1 mm, Vergoraz, 1856.VII.5, Kner don.), SMF 3398 (2, SI 185,2 mm, 186,5 mm, W.-Jugoslawien, Dalmatien, Narenta, Wien Museum m. 1882)⁷.

Data for the syntypes: SI 139,5-194,1 mm; D III 8 (2), 9 (5) [only 9 given by HECKEL & KNER, 1858]; A III 10 (7); I.I. 44 (1), 45 (2), 46 (2), 47 (1), 49 (1) [48-49 given in HECKEL & KNER, 1858]; sp. br. 11 (3), 12 (3), 13 (1); vert. 42 (1), 43 (1), 44 (2), abd. vert. 25 (3), 24 (1), caud. vert. 18 (2), 19 (2), preD vert. 15 (4) (NMW 49593, 49595, 49596, 49612); CSO pores 11-15 (7-10 on frontal), CIO 20-25 (5-7 on 1st infraorbital), CPM 16-19 (6, 7 on dentary).

Comparative material: NMW 49218 (6, Narenta-Vergoraz), 49330 (2, Dalmatien), 49576 (3, Trebinje), 49578 (3, Trebinje), 49579 (6, Trebinje), 49580 (5 incl. 1 C&S SI 143,0 mm, Trebinje), 49581 (1, Trebinje), 49582 (2, Trebinje), 49583 (1, Trebinje), 49584 (3, Trebinje), 49585 (1, Trebinje), 49586 (4, Trebinje), 49587 (2, Trebinje), 49588 (3, Trebinje), 49589 (2, Trebinje), 49590 (5, Trebinje), 49591 (3, Trebinje), 49592: 2 (1, Narenta), 49594 (2, Narenta), 49598 (7, Trebinjica bei Tschepelitz), 49599 (2, Metkovitch), 49600 (1, Metkovitch), 49601 (2, Trebinschitz bei Bilek), 49602 (4, Trebinjica bei Tschepelitz), 49603 (4, Metkovitch), 49604 (3, Metkovitch), 49605 (3, Metkovitch), 49606 (7, Metkovitch), 49607 (1, Metkovitch), 49608 (2, Metkovitch), 81127 (1, Metkovitch); ZISP 6854 (3, Narenta).

Diagnosis

L. svallize is distinguished from all three other species in having the following combination of characters: dorsal fin with 8 or 9 and anal fin with 9 or, commonly, 10

⁷ The two specimens in the Senckenberg Museum (Frankfurt am Main) are labelled as syntypes received from the "Wiener Museum" in 1882. KOTTELAT (1997) did not mention them in the type-series of *L. svallize*.

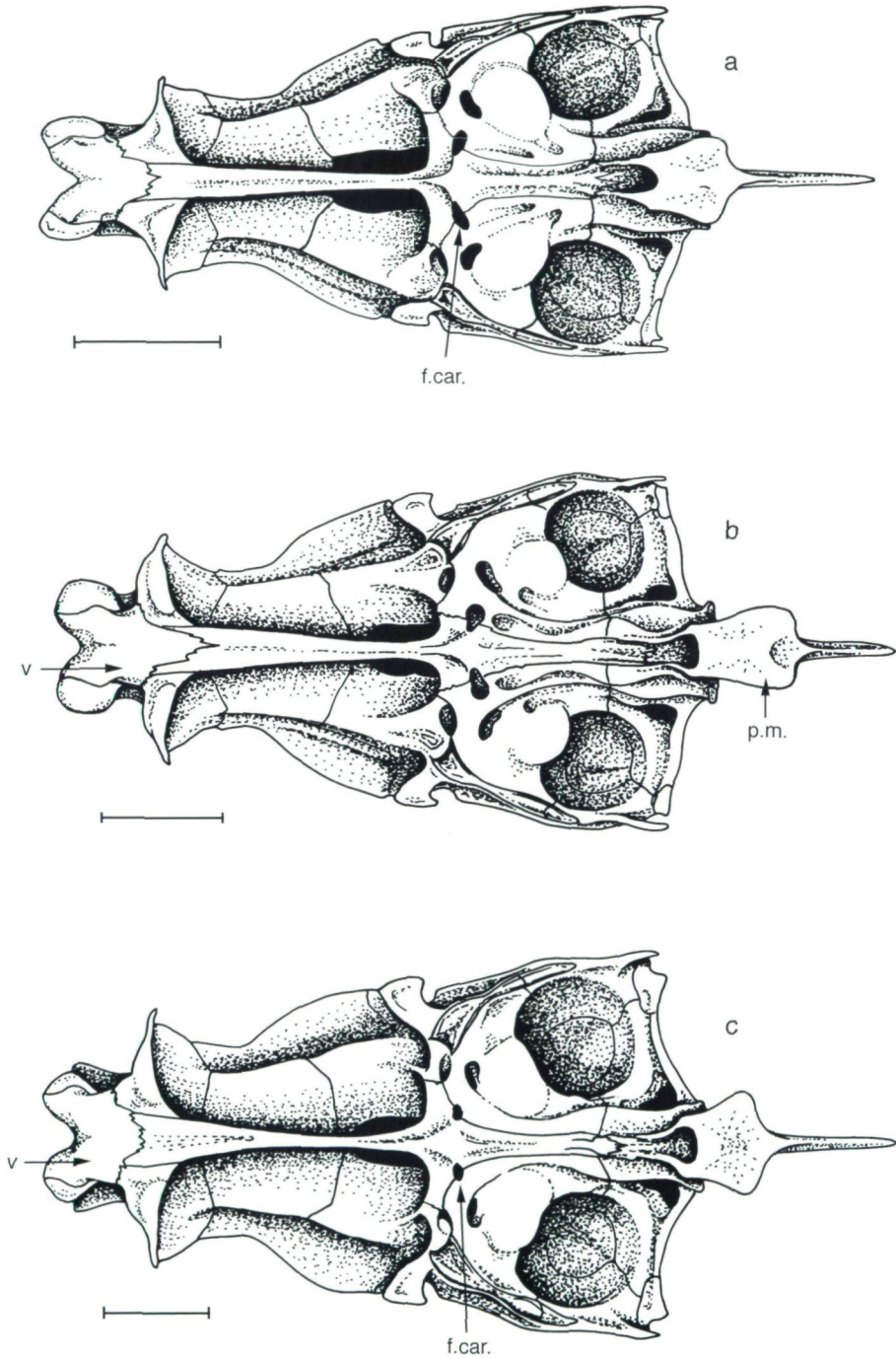


Fig. 7: Neurocranium in ventral view of (a) *L. illyricus*, PZC, SI 134,0 mm, Krka R.; (b) *L. svallize*, NMW 49580, SI 143,0 mm, Trebisnjica R.; (c) *L. cephalus*, PZC, SI 147,1 mm, Krka R. Scale bar = 5 mm.

branched rays; number of lateral line pierced scales 44-51; number of gill rakers 10-13 (14); number of CSO pores commonly 12-14 with 7-9 openings on the frontal; number of CIO pores 20-25 with usually 6 or 7 openings on the 1st infraorbital; number of CPM pores commonly 17-19 with commonly 6 or 7 openings on the dentary; head shallow; snout stout, markedly rounded; mouth subinferior; lower jaw not long, its length always distinctly less than operculum depth; eye comparatively small, its diameter less than snout length; 4th infraorbital not large, free 5th infraorbital commonly absent; coloration intensive, back and fins sometimes blackish, black pigmentation on lateral scales forming a regular mesh.

Description

Morphometric data for the syntypes are given in Table 1. The head length is about equal to the maximum body depth. The head (Fig. 6b) is not deep, its depth at nape is 62-66 % lc. The eye is comparatively small, its diameter 19-23 % lc. The postorbital distance averages 51 % lc. The head is conical, the snout is markedly rounded at the tip. The mouth is subinferior: the uppermost point of the cleft is on or below the level of the lower margin of the eye. The lower jaw-quadrate junction is commonly in front of the vertical through the anterior margin of the eye. The interorbital space is narrow; its width, averaging 3 % lc, is always less than the lower jaw length. Length of the lower jaw, 34-39 % lc, is always smaller than the operculum depth (36-41 % lc).

The dorsal fin has 3 simple and 8 (15) or 9 (87) branched rays. Its outer margin is slightly convex or almost straight. The dorsal fin origin is clearly behind the vertical through the anterior end of the pelvic fin base. The anal fin has 3 simple and 9 (17), 10 (82) or 11 (3) branched rays. Combinations of numbers of branched rays in the dorsal and anal fins are as follows: 8/10 (15), 9/9 (17), 9/10 (67) and 9/11 (3). The anal fin outer margin is almost straight or slightly convex, rarely markedly convex.

Number of gill rakers 10 (5), 11 (51), 12 (41), 13 (4) or 12 (1) in total on the left outer side of the first gill arch. Pharyngeal teeth 2.5-5.2, hooked, serrated.

Number of lateral line scales is 44 (4), 45 (9), 46 (20), 47 (28), 48 (26), 49 (11), 50 (2), 51 (2).

CSO has 11-15, commonly 12-14 pores; the posterior section of the canal is elongated usually having on the parietal two canal segments, rarely three. There are (3)4, 5 canal openings on the nasal and (6)7-9(10) on the frontal. CIO has (18, 19)20-25 pores with 5-7 canal openings on the 1st infraorbital. CPM has (16) 17-19(20) pores. There are rarely 5, commonly 6 or 7 canal openings on the dentary. CST has 7-9 pores.

Total number of vertebrae 42 (1), 43 (4), 44 (5) or 45 (1). Number of abdominal vertebrae 25 (10), rarely 24 (1). Predorsal vertebrae 15 (10), rarely 14 (1). Intermediate vertebrae 5 (11). Number of caudal vertebrae 18 (5), 19 (5), rarely 20 (1). Vertebral formulae 25+19 (5), 25+18 (4), 24+18 (1), 25+20 (1).

The neurocranium is moderately deep, broader than in *L. illyricus* or *L. zrmanjae*: H eth 14 %, H soc 35 %, Lt eth 35 %, Lt spho 48 % and Lt pto 55 % L. bas. n. The orbital region is not depressed, the interorbital septum depth is about 1/2 of the orbitosphenoid depth. In undissected specimens, maximum depth (Lt pto) is 68-79 % L cr. r., width of the supraethmoid 32-37 % Lt pto.

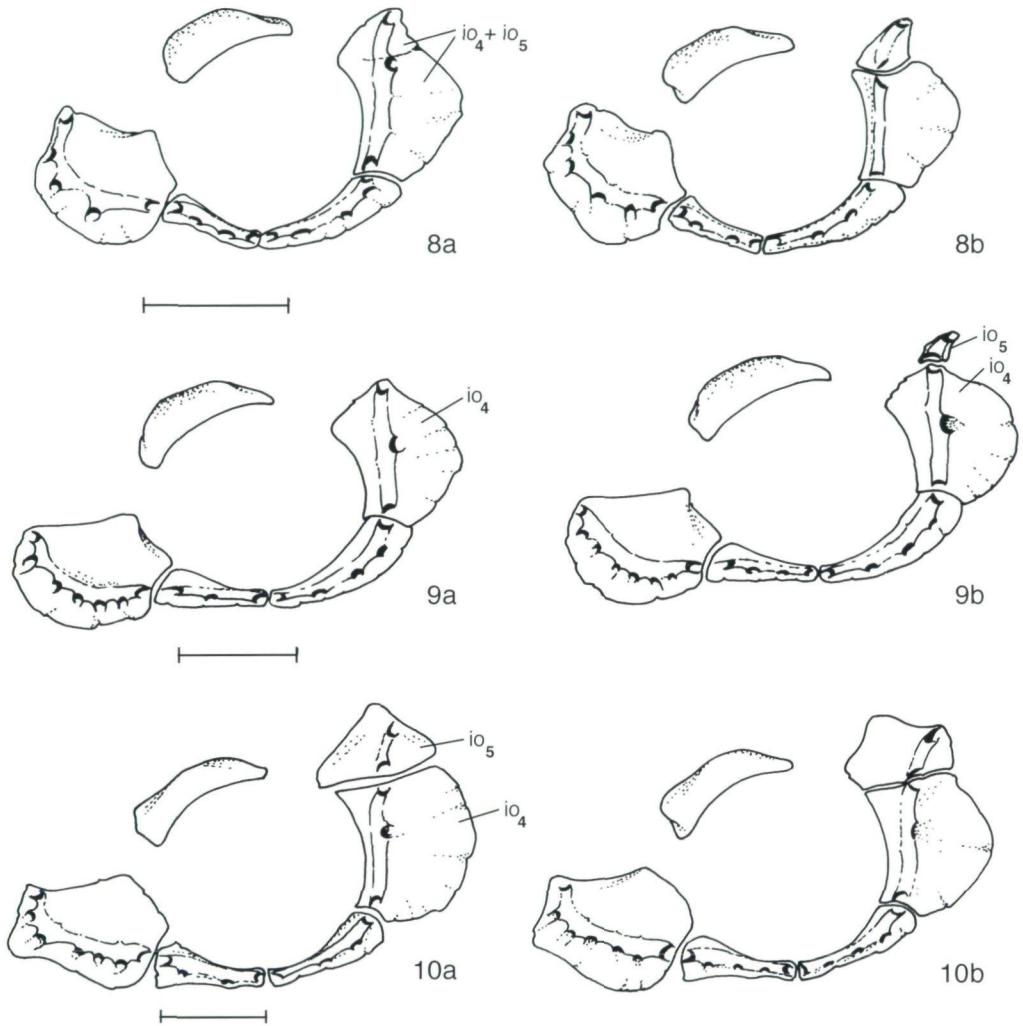


Fig. 8 - 10: Circum-orbitals of (8) *L. illyricus*, (a) PZC, SI 134,0 mm, Krka R.; (b) syntype, NMW 49313, SI 136,1 mm, Cetina R.; (9) *L. svallize*, (a) NMW 49595, syntype, SI 154,0 mm, Neretva R.; (b) NMW 49594, SI 167,3 mm, Neretva R.; (10) *L. cephalus*, (a) PZC, SI 147,1 mm, Krka R.; (b) NMW 49580, SI 150,6 mm, Trebisnjica R. Scale bars = 5 mm.

The vomer (Fig. 7b) is markedly elongated, with a long pointed posterior part. The paired pterosphenoids contact along the anterior margin of the orbital-hypophyseal foramen. The postero-lateral process of the pterosphenoid contacts the margin of the prootic above the upper margin of the parasphenoid ascending process. The sphenotic does not contribute to the inner wall of the subtemporal fossa.

The 5th infraorbital is commonly absent due to probably two reasons: first, a real lack of the 5th bone (Fig. 9a) since a dermal canal segment is present widely separating the 4th bone and the pterotic; second, the 5th infraorbital is fused with the 4th one (sometimes showing

a suture). Rarely, a free 5th infraorbital is present being from a tube-like to a triangular small bone (Fig. 9b). The bones of jaws (Fig. 11b) are short and relatively deep. Maximum depth of the lower jaw is a half its length. Length of the lower jaw is 41 % L bas. n.

Coloration: Alcohol preserved specimens (NMW 49578, 49581, 49582, 49584, 49588, 49590, 49601-605) are intensively pigmented: the most part of the body including the head and all the fins is dark, blackish; scale pigmentation resembles the black net typical for *L. cephalus* (without spots). Some specimens are completely faded.

Distribution

Endemic to Croatia, Bosnia and Herzegovina. *L. svallize* is widely distributed in the Neretva (Narenta) basin up to the Jablanicko Lake, Rama and Buna rivers, waters of the Hutovo blato, and in the Trebisnjica basin including the Bilecko Lake and subterranean waters of the Popovo polje. In Croatia it inhabits the lower Neretva basin and the lower Matica River in the polje Jezero near Vrgorac.

KOSIĆ (1903) reported *Squalius svallize* from Ljuta river (Konavli) near Dubrovnik. No specimens are available for examination from this locality. LEINER & al. (1995) reported *L. svallize* from the Istrian Peninsula (Mirna, Fojba-Pazincica, Rasa, Boljuncica rivers, Letaj and Rakov potok reservoirs). Specific status of this form is questionable (see in the section devoted to *L. zrmanjae*).

Forms described as *Leuciscus svallize* from the Peloponnese (DYBOWSKI 1862), *Leuciscus svallize zrmanjae natio Risae* from lake Risa in Albania (VLADYKOV & PETIT 1930) and *L. svallize zrmanjae* from Corfu (STEPHANIDIS 1971) belong to *L. cephalus* (BIANCO & KNEŽEVIĆ 1987). See also ECONOMIDIS (1991) and KOTTELAT (1997) for discussion of taxonomic status of *L. cf. svallize* from Greece. In our opinion, this form is certainly not *L. svallize* as well as others described (or reported) under the name *L. svallize* from Cetina and Krka.

Leuciscus cephalus (L., 1758)

Cyprinus cephalus L., 1758: p. 322 (Europa meridionali)

Squalius albus - HECKEL & KNER, 1858: p. 198, Fig. 111 (Kerkafluss bei Scardona in Dalmatien)

Leuciscus cephalus var. *albus* - SEELEY, 1886: p. 159, fig. 84 (Krka near Skradin)

Squalius cephalus - STEINDACHNER, 1882: p. 75 (Trebischnitsa, Narenta bei Metkovic, Kerka Oberlauf).

Squalius albus - KOLOMBATOVIĆ, 1886: p. 16 (Krka).

Squalius dobula - ČURČIĆ, 1915: p. 326 (Neretva).

Squalius cephalus cavedanus - KARAMAN, 1928: p. 156 (Neretva near Metkovic).

Leuciscus cephalus - BIANCO & KNEŽEVIĆ, 1987: p. 53, fig. 3c (Central and eastern Balkans; western Balkanic area; absent from Cetina, Trebinje and from waters between Rieka town and Zrmanja river).

Local name: Bijeli klen, klen.

Material from the area where *L. cephalus* is distributed sympatrically with *L. zrmanjae*, *L. illyricus* and/or *L. svallize*: NMW 15393 (1, Isonzo), 43925 (1, Narenta), 48923 (1, Isonzo), 49183 (1, Knin), 49203 (1, Knin), 94471 (2, Trebinje), 94472 (1, Trebinje), 94473 (1, Trebinje), 49611 (1, See bei Gradaz), 94398 (1, Trebinje), 94399 (1, Trebinje), 94400 (1, Trebinjica bei Tschepelitz), 94401 (1, Trebinje), 94402 (1, Trebinje), 94403 (1, Metkovitch), 94404 (1, Trebinschitz bei Bilek), 94405 (1, Trebinje); PZC (1 C&S SI 147,1 mm, lower Krka), PZC (1 C&S SI 128,5 mm, Trebisnjica); ZMH 15094 (1, Narenta).

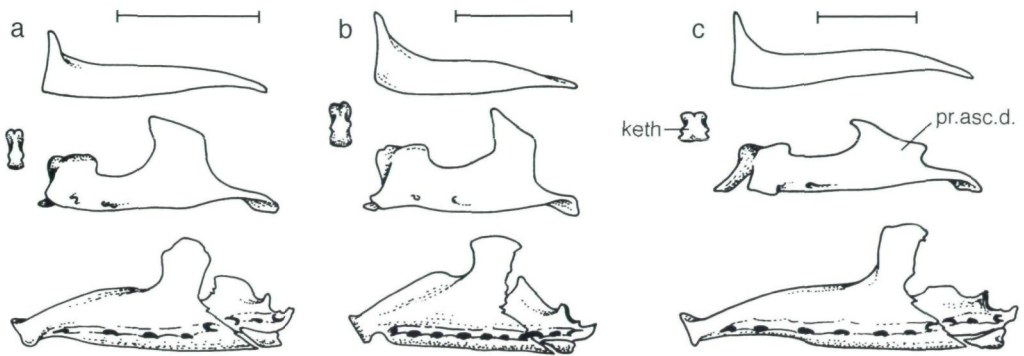


Fig. 11: Jaws of (a) *L. illyricus*, PZC, SI 134,0 mm, Krka R.; (b) *L. svallize*, NMW 49580, SI 143,0 mm; (c) *L. cephalus*, PZC, SI 147,1 mm, Krka R. Scale bar = 5 mm.

Comparative material: NMW 48989 (2, Scutari), 48992 (2, Rieka, Scutari), 48993 (5, Priszren, Drin), 49001 (3, Priszren), 49156 (2, Scutari), 49157 (4, Scutari), 49159 (7, Scutari), 84847 (12, Torino Province), 90569 (1, Zrinos, Albanien); ZMH 796 (2, Ohrid), 1463 (7, Ohrid), 4459 (2, Louros, W Greece), 15039 (1, Rieka, Montenegro), as well as over 200 specimens (NMW, SMF, ZISP, ZMH) from Rhone R., Kuban' R., Kura R., Western Anatolia, Urmia L. and Tigris-Euphrates basin.

Diagnosis

L. cephalus in the area under consideration is distinguished from all three other species in having the following combination of characters: dorsal fin with commonly 8 and anal fin with 8 or 9 branched rays; number of lateral line pierced scales 42-45; number of gill rakers 9-11 with a mode of 10; number of CSO pores commonly 10-13 with 6-8 openings on the frontal; number of CIO pores 17-22 with commonly 6-8 openings on 1st infraorbital; number of CPM pores 15-19 with commonly 6-8 openings on dentary; head dorsally flattened, wide, with straight upper profile; snout pointed; mouth terminal; lower jaw long, its length always exceeds operculum depth; eye comparatively small; 5th infraorbital extensive, together with extremely large 4th infraorbital, covers the most part of the outer surface of the m. dilatatoris operculi; pigmentation on lateral scales like regular black mesh without spots.

Description

The head is not deep, its depth at nape is 56-72 % lc in fishes up to 250-280 mm SI but can attain 81 % in larger specimens. The head width at nape considerably increases with fish size being 50-58 % lc in specimens 52-280 mm SI and up to 63 % in specimens over 300 mm SI. The eye is comparatively small, its diameter negatively correlates with fish size: 18-23 % lc in specimens SI 52-150 mm, and as small as 13-14 % lc in specimens over 280 mm SI. The postorbital distance always exceeds half the head length (attains 62 % lc in specimens over 300 mm SI). The upper head profile is almost straight, the snout is pointed. The mouth is terminal. The uppermost point of the mouth cleft is about the level of the lower margin of the eye (Fig. 6c). The lower jaw-quadrate junction is on the vertical through the anterior margin of the pupil or even behind it. The interorbital space is wide; its width is 36-40 % lc in specimens 52-150 mm SI and 39-44 % in lar-

ger ones. The operculum is comparatively deep, 39-44 % lc. Length of the lower jaw, 40-45 % lc, is always larger than the operculum depth (38-42 % lc).

In the specimens examined from the area under consideration, the dorsal fin has 3 simple and 8 (20), rarely 9 (1), branched rays. The dorsal fin origin is clearly behind the vertical through the anterior end of the pelvic fin base. The anal fin has 3 simple and 8 (20), rarely 9 (1) branched rays. The anal fin outer margin is from almost straight to markedly convex.

Number of gill rakers 9 (5), 10 (15), 11 (1) in total on the left outer side of the first gill arch. Pharyngeal teeth 2.5-5.2, hooked, serrated.

Number of lateral line scales is 42 (1), 43 (5), 44 (12), 45 (3).

CSO has (9)10-13(14) pores; the posterior section of the canal is elongated, downwardly bent passing close to CST, and usually having two canal segments on the parietal. There are (3)4, 5(6) canal openings on the nasal and (6)7-8(9) on the frontal. CIO has (16)17-22 pores with (5)6-8 canal openings on the 1st infraorbital. CPM has 15-19(20) pores. There are (5)6-8 canal openings on the dentary. CST has 7-9 pores.

Total number of vertebrae (in 12 specimens radiographed) 42 (1), 43 (5), 44 (6). Number of abdominal vertebrae 25 (8) or 24 (4). Predorsal vertebrae 14 (5) or 15 (7). Intermediate vertebrae 4 (5) or 5 (7). Number of caudal vertebrae 19 (9) or 18 (3). Vertebral formulae 25+19 (6), 24+19 (3), 25+18 (2), 24+18 (1).

The neurocranium is broad, markedly depressed especially in the orbital region: H eth 10-12 %, H soc 30-32 %, Lt eth 40-42 %, Lt spho 49-50 % and Lt pto 56-58 % L. bas. n. The interorbital septum depth is almost or completely reduced. In undissected specimens, Lt pto is 70-86 %, up to 94 % L cr. r., in the largest specimens, and width of the supraethmoid 40-44 % Lt pto.

The vomer (Fig. 7b) is markedly shortened, much wider than long. The paired pterosphenoids contact along the anterior margin of the orbital-hypophyseal foramen. The sphenotic contributes to the inner wall of the subtemporal fossa. The carotid foramen is small.

The 5th infraorbital is extensive and covers most of or the entire outer surface of the dilatator fossa (Fig. 10a, b). The bones of the jaws (Fig. 11c) are markedly elongated. The maxillary ascending dorsal process is shallow and broad. Length of the lower jaw is 49-56 % L bas. n. The anterior part of the dentary is shallow and relatively long so that the oblique coronoid process is located much closer to the posterior end of the jaw than to its anterior end. The kinethmoid is short.

Coloration. Alcohol preserved specimens usually retain intensive mesh-like color pattern formed by small black pigments dots located along the entire free margins of scales on the back and flanks and resembling a regular net (Fig. 5c).

Distribution in the area under consideration

Leuciscus cephalus is known from Isonzo in Italy, also from the Slovenian part of Soca (Isonzo) basin and Istrian rivers (POVŽ & SKET, 1990; LEINER & al., 1995). It is common in the lower and middle course of Krka (up to Roski slap). Also known from the upper Krka (NMW 49183, 49203, Knin) where it is probably rare. Widely spread in the Neretva basin including the Jablanicko Lake (AGANOVIĆ & al., 1966), Rama, Buna,

Bregava, Krupa rivers including the Hutovo blato and in the Trebisnjica River and Bilecko Lake in the Eastern Herzegovina. *Leuciscus cephalus* was introduced to the Jadova River (P. Zupančić pers. observ.) in the Lika region (Upper Adriatic side between Rieka town and Zrmanja River).

Comparisons

The four species in the *L. cephalus* - *L. lepidus* group sensu Bogutskaya (1994) represent different levels of morphological specialization. *Leuciscus cephalus* is the most derived member of the group and differs from the three other species in having long jaws with a comparatively shallow maxillary ascending dorsal process, depressed ethmoid and orbital neurocranial regions, a reduced interorbital septum, very broad supraethmoid and vomer, exclusively expanded 4th and 5th infraorbitals. It is also clearly different by a wide flattened head (and respectively a wide neurocranium), a pointed snout and a terminal mouth. By these characters it is distinguished from *L. illyricus* as well as by number of lateral line scales (modally 43-44 vs. 47-52 in the latter). These morphological differences together with sympatric distribution of the species (Krka) confirm specific status of *L. illyricus*.

Leuciscus svallize differs from the three other species by higher numbers of dorsal and anal rays (modally 9 and 10 vs. 8 and 9), an elongated vomer, a shortened and deep lower jaw, and an elongated masticatory plate of the pharyngeal process. It shares with *L. cephalus* an increased number of sensory cephalic pores (commonly 7-8 on the frontal, 6-8 on the 1st infraorbital, and 6-8 on the dentary vs. respectively 5-7, 5 and 4-6 in *L. zrmanjae* and *L. illyricus*) but clearly different by, besides the characters mentioned above, a short subterminal mouth and higher numbers of lateral line scales (modally 46-49 vs. 43-44) and gill rakers (modally 11-12 vs. 10).

Leuciscus illyricus and *L. zrmanjae* are closer to each other than to *L. cephalus* or *L. svallize*. From both latter species they differ in having a low number of cephalic canal pores, and also in shape and size of the vomer and jaw bones. The range of lateral line scale count of *L. zrmanjae* (44-49) lies almost entirely within the limits of *L. illyricus* (45-54). The numbers of gill rakers are also quite close (modally 9-10 and 10-11 respectively) as well as the numbers of dorsal and anal fin branched rays (modally 8 dorsal and 9 anal ones in both species). The differences mainly concern relative size of the eye (the eye diameter is usually longer than 24 % lc in *L. zrmanjae* and less than 24 % lc in *L. illyricus*) and length of the postorbital distance (about a half the head length and longer than that respectively), shape of the snout (conical, rather elongated in *L. zrmanjae* and stout, markedly rounded in *L. illyricus*) and pattern of scale pigmentation.

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