

**TAXONOMIC STATUS OF THE SPECIES  
OF THE GENUS *LEUCISCUS* (PISCES, CYPRINIDAE)  
FROM THE ADRIATIC AND AEGEAN BASINS**

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**ABSTRACT.** The three chub species: *Leuciscus albus*, *L. vardarensis* and *L. macedonicus* are redescribed on the base of morphological features. These species are distinguished mutually and compared with *L. cephalus* by the shape and size of mouth, shape, length and width of snout, width of head, shape and width of interorbital area, relation between depth cutting of mouth and position of the eye, scale rows between lateral line and base of pelvic and anal fins, scale rows between pectoral and pelvic fins and scale rows between pelvic fin and genital papillae origin, and scale rows between the final part of genital papillae and anal fin origin. Besides these, species are distinguished in the some body proportions. In this study *Leuciscus albus* is registered for the lake Kastoria, what is the new finding for the territory of Greece.

**Key words:** taxonomic status, *Leuciscus*, Cyprinidae, Adriatic and Aegean Basins

### INTRODUCTION

The three subspecies of *Leuciscus cephalus* (*L. cephalus albus*, *L. cephalus vardarensis* and *Leuciscus macedonicus*) were in the purpose to determine their status under the Phylogenetic Species Concept (PSC), which is used here.

During the former period the taxonomic status, distribution and some biology characteristics of these fishes were analysed. BIANCO and KNEŽEVIĆ (1987), KOTTELAT (1997) and GEORGIEV (1998) populations of *L. cephalus albus*, *L. cephalus vardarensis* and *Leuciscus cephalus macedonicus* treated as synonyms of *Leuciscus cephalus*. BIANCO and RECCHIAS (1983) considered *L. cephalus albus* as a subspecies of *L. cephalus*, which according to the data seems that *L. cephalus albus* has got distinctive head shape. However, TORTONESE (1970), IVANOVIĆ and SEKULOVIĆ (1971), IVANOVIĆ (1973), ŠORIĆ (1984), RAKAJ and FLLOKO (1995), POVŽ (1995) and MRAKOVČIĆ *et al.* (1995) *L. cephalus albus* registered as a valid subspecies. GRUPČE and DIMOVSKI

(1982) ssp. *vardarensis* and ssp. *macedonicus* recognized as a single subspecies *L. cephalus albus*, while NAUMOVSKI (1995) designate *L. cephalus albus*, *vardarensis* and *macedonicus* were valid subspecies. ECONOMIDIS and SINIS (1988) considered that in Lake Volvi (Greece) the endemic ssp. *macedonicus* exists. Also IMSIRIDOU *et al.*, (1997) conducted the taxonomic investigations using the biochemical genetic method (electroforetic) and conclude that population ssp. *macedonicus* from River Struma, ssp. *vardarensis* from River Vardar (Axios) and ssp. *albus* from lower course of River Vardar, tributary Gumešnica (Greece) are valid subspecies. APOSTOLON and DOBROVALOV (1999) populations of the chub analysed using the equal methods and assumed that *L. cephalus* and *L. macedonicus* are two different species.

Our studies have looked in some details on morphological characteristics.

## MATERIAL AND METHODS

The specimens used in this study are deposited in the collection of the Faculty of Sciences of the University of Kragujevac (FSUK). The material was caught from 5 to 30 June 1984. The analysis totally included 70 specimens from River Beli Drim (Metohija, Serbia), 14 specimens from River Vardar – Lake Dojran (Macedonia, FYROM), 12 specimens from River Strumešnica [tributary of River Strumica (FYROM)] and six specimens from Lake Kastoria (Greece) (Fig. 1).

The data of GRUPČE and DIMOVSKI (1982), obtained on 100 specimens for every population of these species, are used.

The terminology, symbols and material are analyzed by usual methods given by HOLČIK (1998).

From the meristic characters: lateral line scales and transverse rows of scales above and below the lateral line (Squ l.l., Squ. sup, Squ.inf.) were analyzed. In the l.l. only perforated scales were counted. The number of scales between the pectoral fin and the ventral fin was analysed too. Also the number of rows of scales between lateral line and base of anal fin, number of scales between the ventral fin origin and the genital papillae origin, the number of scales between the final part of genital papillae and base of anal-fin origin, circumpeduncular rows, unbranched and branched rays of unpaired and paired fins (Du, Db, Au, Ab, Vu, Vb, Pu, Pb), branchial spines (Sp.br) and pharyngeal teeth (D.ph) were analysed.

Except that, some morphometrics characters were analyzed too: length of snout (measured between nostril and anterior part of the head); width of snout (measured in nostril level); width of mouth (measured in middle part of the opening); Tl - total length; Sl - standard length; length of head; hc - depth of head; lac - head width; hco - head depth (at center of eye); H - maximum of body depth; h - minimum of body depth; lpc - length of caudal peduncle; length unpaired (lD, lA) and paired fins (lV, lP); depth fins (hD, hA); prO - praeorbital distance; poO - postorbital distance; io - interorbital distance; and Oh - diameter oculi. These characters were measured with a slide rule and expressed as percents of standard body length and head length, because of changes of morphometric characters with increase or decrease of body length (the positive and negative allometry). With this in mind, the specimens of approximately the same size were compared in analyzed populations.

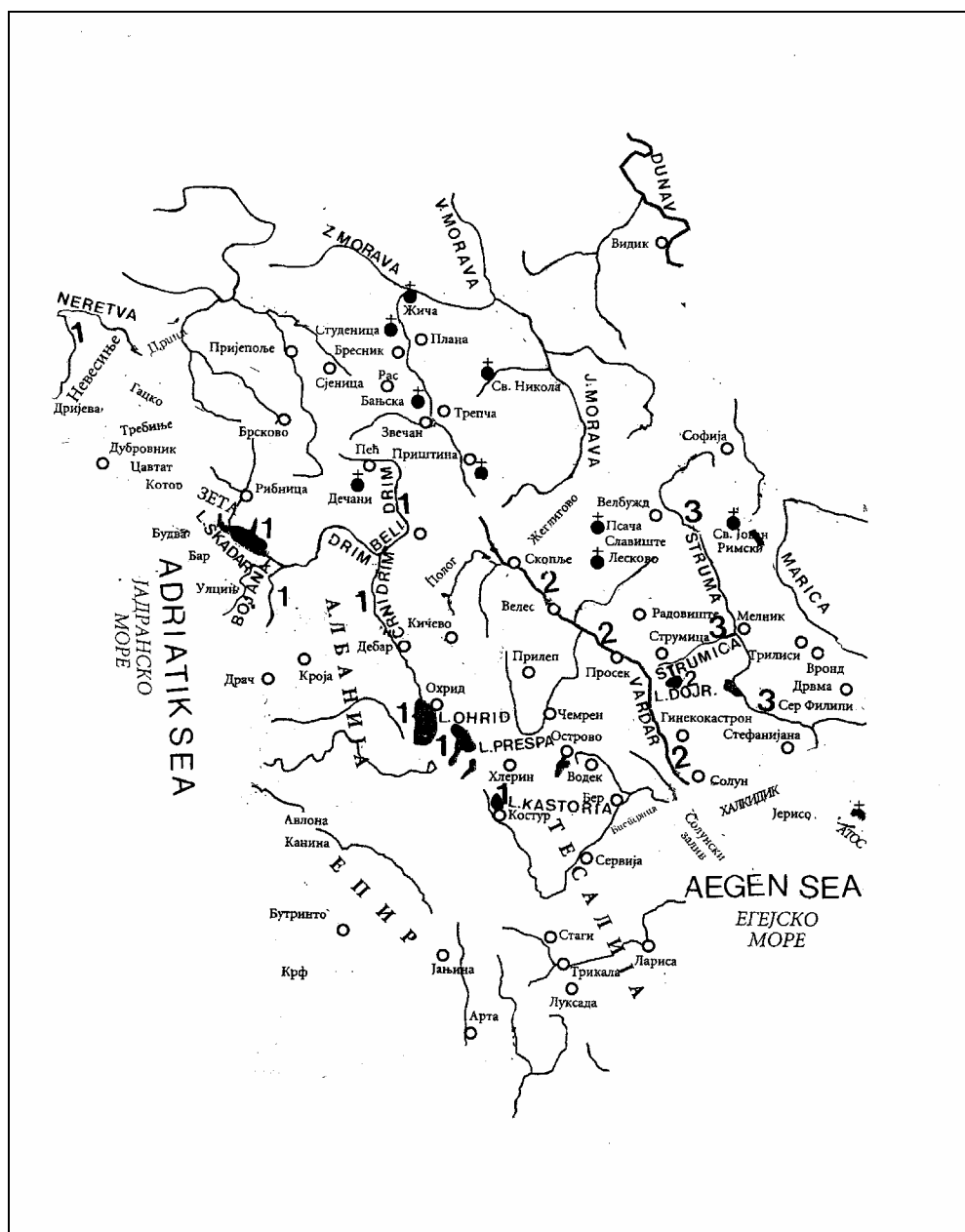


Fig. 1: Distribution of *Leuciscus* species in some localities:  
 1-*Leuciscus albus*, 2-*Leuciscus vardarensis*, 3-*Leuciscus macedonicus*

## RESULTS AND DISCUSSION

The general impression is that taxonomy of *Leuciscus cephalus* was hardly being researched and confusing solved. The earliest taxonomy researches of these species were based on analysis of relatively small number of morphological characteristics. Another reason is that examples of population from different localities were not available in order to be compared. That would be the reason for controversy in conclusion for many authors. Some researchers thought they were valid subspecies, while other found them as synonyms for *Leuciscus cephalus*.

However, IMSIRODOU *et al.* (1997), using the biochemical genetic methods in researching of the population of chubs from the waters of Greece belonging to the Vardar (Axios) and the Struma basin from the region of Macedonia (FYROM), concluded that the population in the Struma basin belongs to *L. cephalus macedonicus*, the population from the main basin of the Vardar belongs to *L. cephalus vardarensis*, and population from the lower basin of the Vardar, from the tributary Gumešnica, in Greece, belongs to *L. cephalus albus*. Using the same methods APOSTOLON and DOBROVOLOV (1999) compared chubs from the Danubian and the Aegean basin and concluded that *L. cephalus* and *L. macedonicus* are two valid species.

All these made provoked us to analyze in details morphological characteristics of these fishes being a more of variability of morphological characters with age, i.e. with increase of body length. In this chubs: lc, hc, pD, PrO, Oh, io, hco exhibit negative allometry, while PoD, Dh, Ah, and P-V exhibit positive allometry. These researches on relatively homogenous samples i. e. the samples, which are of approximate size, were made. Beside the complex analyse, attention to the already described characteristics was paid.

Finally, after all considerations and determinations of analysed populations of chubs no evidence that contraindicate to data to mentioned authors was found. Subspecies are not recognized under the species concept used here.

After this study we found the new geographical data. *L. albus* exists in Lake Kastoria in Greece. We suppose that it came from Prespan Lake (which is close to Lake Kastoria), where *L. albus* exists in large number. Is it autochthones or alohtones, is not known. This species is distinguished from *L. cephalus* by a very different appearance (Fig. 2 and 3).

### ***Leuciscus albus* Bonaparte, 1838**

#### **Synonyms:**

*Leuciscus albus* Bonaparte, 1838 (type locality Lake Transimonto, Italy)

*Squalius cephalus cavedanus* Karaman, 1924, 1928

*Leuciscus cabeda* Vladikov and Petit, 1930

*Leuciscus cephalus albus* Gridelli, 1936

*Leuciscus cephalus albus* Oliva, 1951

*Leuciscus cephalus albus* Grupče and Dimovski, 1982

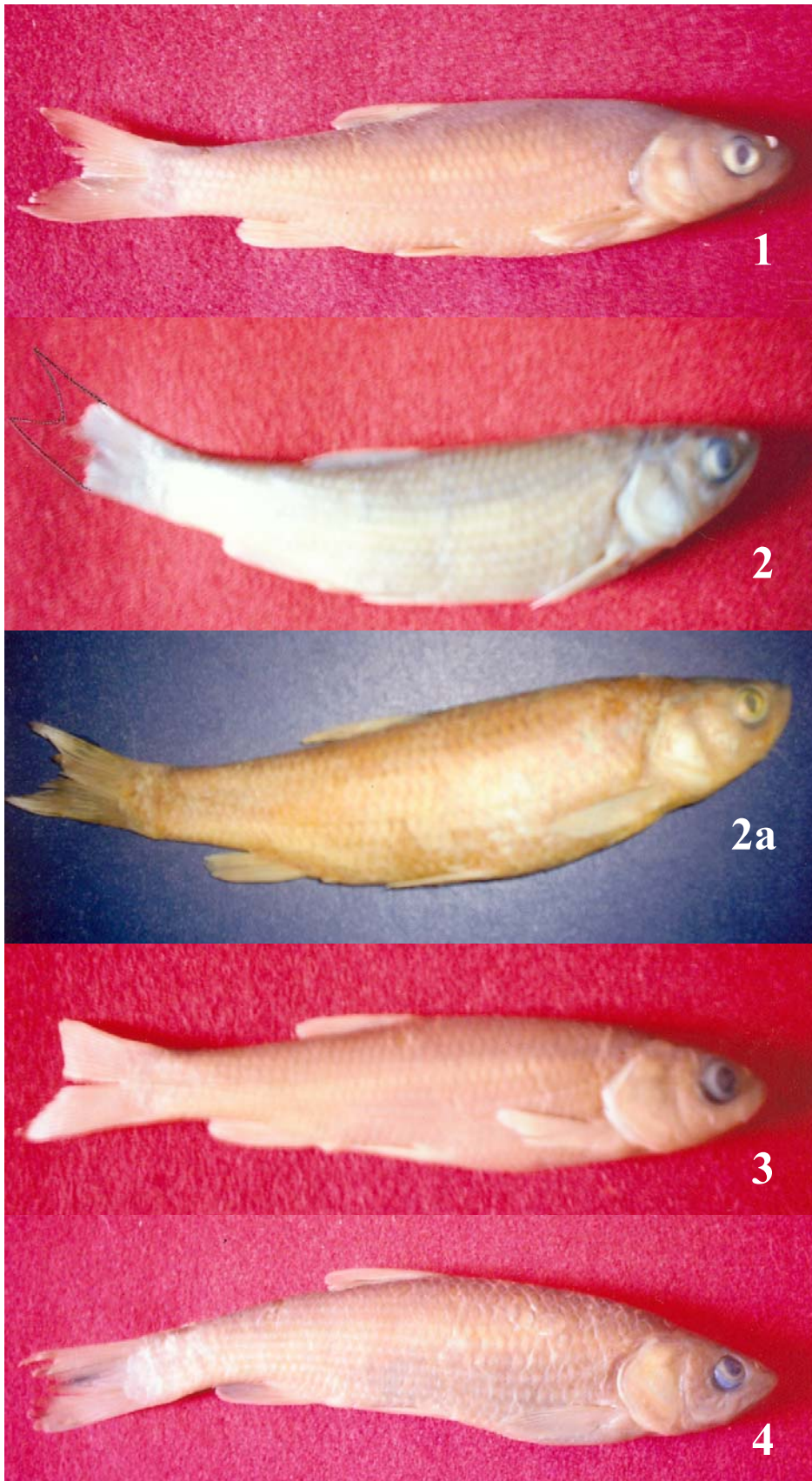
*Leuciscus cephalus* Bianco and Knežević, 1985

*Leuciscus cephalus* Kottelat, 1997

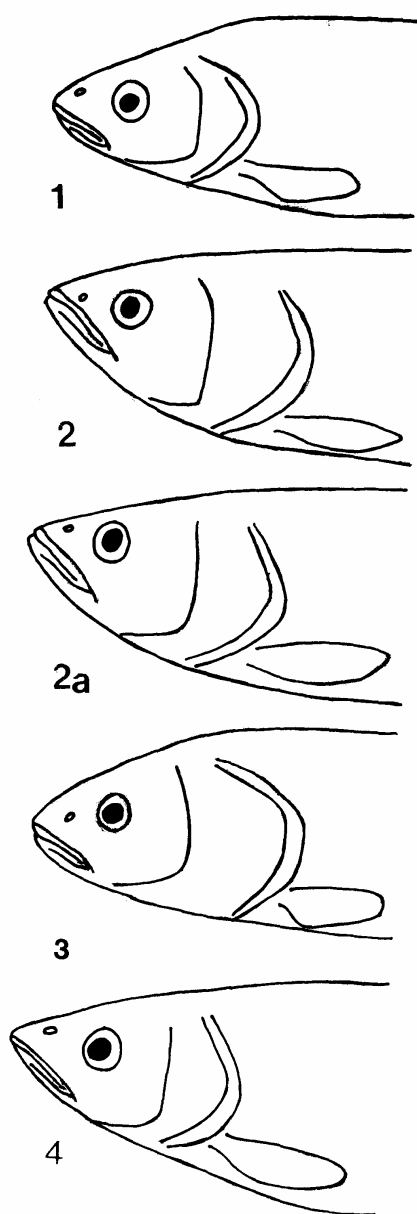
*Leuciscus cephalus albus* Imsiridou *et al.*, 1997

#### **Etymology:**

The name *albus* is derived from the early Italy word “*albus*” which means “white”, and Italy word “*albare*” which means “daybreak”. The lateral surface is silvery-white or ashen color with characteristic splendid.



**Fig. 2:** 1-*L. cephalus*, 2-*L. albus* from Beli Drim River, 2a-from Lake Kastoria, 3-*L. vardarensis* and 4-*L. macedonicus*



**Fig. 3:** Head of chub showing the different position of the mouth:  
 1-*L. cephalus*, 2-*L. albus* from Beli Drim, 2a-from Lake Kastoria,  
 3-*L. vardarensis* and 4-*L. macedonicus*

#### **Description and diagnosis:**

*Leuciscus albus* (Fig. 2 and 2a) is different from *L. cephalus* and other studied species, by the position of mouth. In relation to longitudinal axis of head, the mouth is half-superior, a horizontal line from the top of premaxillare reaches the above upper edge of a pupil. Depth of cutting of mouth reaches vertical in front of a pupil or one third of a pupil. Some rare specimens have mouth which reach frontal edge of the eye.

*L. macedonicus* has half-superior mouth also but less aside while horizontal line passes through the above middle of a pupil. Then *L. albus* has relatively wider mouth, (30.16-32.71 in % cl vs 27.59-32.39 *L. cephalus*; 25.08-29.17 *L. macedonicus* and 28.86-31.02 *L. vardarensis*) shorter and wider snout (length 16.24-19.64, width 33.70-35.83% in cl, vs 19.16-21.58/33.57-34.47 *L. cephalus*; 16.53-23.33/30.08-32.92 *L. macedonicus* and 17.72-21.58/31.72-34.26 *L. vardarensis*), longer, wider and higher back of a head (Tab. 2 and 3). *L. albus* is different from *L. cephalus* because it has bigger pectoral fins and smaller P-V space covered with less number of scales (12-13 vs 11-15 *L. cephalus*). The differences are present even in circumpendicular scales rows (14) 15-16 vs 13-17 *L. cephalus*). V-fins and genital papillae origin is covered with less number of scales too (8-10 vs 7-11 *L. cephalus*). Scales' rows between final part of genital papillae and anal-fin origin having (3-3½, 4 vs 1-2, 2½, 3 *L. cephalus*). The number of rows of scales between lateral line and ventral fin varies (2½), 3-3½, 4 according to other authors 3-4, rarely 2 (vs (3), 3½, 4 *L. cephalus*; 3½ *L. macedonicus*; 3, 3½ *L. vardarensis*); 3, 3½-4 scales rows between lateral line and anal fin origin (vs 4 in *L. cephalus*; (4) 4½ *L. macedonicus*; 3½, 4 *L. vardarensis*). Among measured characteristics the most significant differences are present in number of scales in the lateral line. *L. albus* from the Beli Drim River in set to have the biggest variability (37-39) 41-46 (48) and less scales in lateral line, (in Beli Drim X=47.70, Lake Scadar X=44.11 and Lake Ohrid X=44.14 vs X=45.22 *L. vardarensis* and X=45.86 *L. macedonicus*). It is usual that behind the perforated scales in lateral line there are 1-3 scales, which are not examined. Therefore, *L. albus* has fewer lateral line scales than *L. vardarensis*, *L. macedonicus*. Another important characteristic of *L. albus* is that it has more branchiospines on the first gill arch (8-14). Other data are shown in Tab. 1-3.

#### **Distribution:**

*L. albus* distribution in Lake Trasimento, Lake d'Arsa (the Cental Italy); Krka River (Dalmatia); Neretva River and Trebišnica River (Croatia and Bosnia and Herzegovina); Skadar, Drim, Ohrid system (Montenegro, Albania, Serbia and Macedonia, FYROM); Prespa Lake (FYROM and Greece); Moruos River, Evinos River, Louros River and Janina Lake (Greece). (TORTONESE, 1970; VUKOVIĆ-IVANOVIĆ, 1971; IVANOVIĆ, 1973; GRUPČE and DIMOVSKI, 1982; ŠORIĆ, 1984; BIANCO and KNEŽEVIĆ, 1987; MARIĆ, 1995; MRAKOVČIĆ *et al.*, 1995; POVŽ, 1995)

#### ***Leuciscus vardarensis* (Karaman, 1928)**

##### **Synonyms:**

*Squalius cephalus cephalus* Karaman, 1924 (type locality River Vardar - L. Dojran, FYROM)

*Squalius cephalus vardarensis* Karaman, 1928

*Leuciscus cephalus albus* Grupče and Dimovski, 1982

*Leuciscus cephalus vardarensis* Economidis, 1991, 1995

*Leuciscus cephalus* Kottelat, 1997

*Leuciscus cephalus vardarensis* Imsiridou *et al.*, 1997

*Leuciscus cephalus cephalus* Georgiev, 1998

##### **Etymology:**

The name *vardarensis* is derived from the name of the type locality, Vardar River.

### Description and diagnosis:

This type of a chub (Fig. 2, 3) is different from *L. macedonicus* and *L. albus* for its mouth is terminal like *L. cephalus* but the horizontal line from the top of premaxilare reaches down edge of an eyeball (vs *L. cephalus*, whose horizontal line reaches down edge of a pupil). Depth of cutting mouth reaches vertical in front edge of eyes. The mouth is wider than at *L. macedonicus* but narrower than at other studied species (28.86-31.02 % in cl, vs 25.08-29.17 *L. macedonicus*; 30.16-32.71 *L. albus* and 27.59-32.39 *L. cephalus*). Besides, it has short than *L. macedonicus* and *L. cephalus* and wide snout than *L. macedonicus* (length 17.72-21.58, width 31.72-34.26% in cl vs 16.24-19.64/33.70-35.83 *L. albus*; 16.53-23.33/30.08-32.92 *L. macedonicus* and 19.16-28.00/33.57-34.47 *L. cephalus*). *L. vardarensis* has narrow snout than *L. cephalus* and *L. albus*. In contrast to all analyzed chubs it has a convex top head, which comes in an arch shape toward a mouth hole. Then, it has less P-V distance which is different from in the number of scale rows (12-14 vs 11-15 *L. cephalus*; 12-13 *L. albus* and 13 *L. macedonicus*), smaller preorbital distance, bigger eyes, less depth of caudal peduncle, smaller pectoral fins and D-fin margin is concave. Around 70% of individuals have smaller upper lobe of caudal fin (22.08-25.00 upper lobe, 20.20-20.64 lower lobe). The space of V-fins and genital papillae origin has 8-9 scales; 3-3½ scales between genital papillae final part and anal fin origin and a caudal peduncle is covered with more rows of scales comparing to *L. macedonicus* and less variable in comparing to *L. cephalus* (15-16 vs 14-16 *L. macedonicus*; 13-17 *L. cephalus*). The part of the body between lateral line and the beginning of anal fin is covered with 3½, 4 rows of scales (vs 4 *L. cephalus*; (4) 4½ *L. macedonicus* and 3, 3½, 4 *L. albus*). *L. vardarensis* is different from other species with less variability of rows of scales in lateral line (43-47, X=45.22) and less variability of scales between lateral line-V fins origin than *L. cephalus* and *L. albus* (3, 3½ vs (3), 3½, 4 *L. cephalus*; 2½, 3-3½, 4 *L. albus*) and clear number stability of rays in D-fin (Tab. 1).

### Distribution:

In Macedonia (FYROM) and Greece *L. vardarensis* inhabits River Vardar (Axios) its tributaries Bregalnica, Treska, Crna River (Macedonia, FYROM) and Aaos River, Pinos River, Aliakmon River (Greece); Lake Dojran (FYROM, Greece) (Fig. 1) and probably River Lepenac and River Pčinja (Serbia). (KARAMAN, 1928; VUKOVIĆ-IVANOVIĆ, 1971; ECONOMIDIS *et al.*, 1981; GRUPČE and DIMOVSKI, 1982; ECONOMIDIS, 1991; NAUMOVSKI, 1995; IMSIRIDOU *et al.*, 1997)

### *Leuciscus macedonicus* Karaman, 1955

#### Synonyms:

*Squalius cephalus* Kovačev, 1921 (type locality River Strumica, FYROM)

*Leuciscus cephalus* Šiškov, 1939

*Leuciscus cephalus macedonicus* Karaman, 1955

*Leuciscus cephalus macedonicus* Economidis, 1988

*Leuciscus cephalus albus* Grupče and Dimovski, 1982

*Leuciscus cephalus macedonicus* Imsiridou *et al.*, 1997

*Leuciscus macedonicus* Apostolon and Dobrovolov, 1999



### Etymology:

The specific name *macedonicus* is derived from the name of the area Macedonia.

### Description and diagnosis:

*L. macedonicus* (Fig 2, 4) is different from *L. cephalus* and *L. vardarensis* for its mouth is half-superior (vs terminal in *L. cephalus* and *L. vardarensis*) similar to *L. albus* but less oblique, while horizontal line the top of premaxillare goes through the above middle of a pupil. Depth of cutting of mouth hole is spread to the front edge of an eye. This type is also different since it has narrower mouth (25.08-29.17 % in cl vs 27.59-32.39 *L. cephalus*; 28.86-31.02 *L. vardarensis* and 30.16-32.71 *L. albus*), pointed and narrower snout (length 16.53-23.33, width 30.08-32.92 in % cl vs 16.24-19.64/33.70-35.83 *L. albus*; 17.72-21.58/31.72-34.26 *L. vardarensis*; 19.16-28.00/33.57-34.47 *L. cephalus*), narrower and shorter head in the eye area, less between eye distance and predorsal space, higher D and A fins (Tab. 2-3). In P-V area the number of scale rows is constant-13 which is different from other types (vs 11-15 *L. cephalus*; 12-13 *L. albus* and 12-14 *L. vardarensis*). The area of V-fin and genital papillae origin is covered with 8-9 rows of scales, the most often 8 (vs 7-11 *L. cephalus*) and 2-3, 3½, 4 scales rows between genital papillae final part and anal fin origin. Abdominal fins reach almost genital papillae. Caudal peduncle is covered with 14-16 rows of scales (vs 13-17 *L. cephalus*; 15-16 *L. vardarensis*; (14) 15-16 *L. albus*). In this type it is also found that the area between lateral line and the beginning of V-fins is covered with less number of scales (3½ vs (3), 3½-4 *L. cephalus*; 3, 3½ *L. vardarensis* and (2½), 3-3½, 4 *L. albus*), while the area between lateral line and the beginning of A-fin is covered with relatively the largest number of scale rows ((4)4½ vs 4 *L. cephalus*; 3½, 4 *L. vardarensis*; 3, 3½, 4 *L. albus*). The number of scales in lateral line shows greater variability comparing to *L. vardarensis*, and less variability comparing to *L. albus* (Tab1). According to the studies of GRUPE and DIMOVSKI (1982) and ŠORIĆ (1984), the average value of rows in lateral line among *L. macedonicus* from the Strumešnica River is the biggest X=45.86 while *L. albus* from Ohrid Lake X=44.14, Skadar Lake X=44.11, Beli Drim River X=47.70 and *L. vardarensis* X=45.22.

### Distribution:

*Leuciscus macedonicus* inhabits most of eastwards to the Aegean basin (Fig.1): River Strouma (Struma), Mesta and Maritza (Bulgaria and Greece); River Nestos, Koronia-Lake Volvi (Greece), tributary of River Struma: Strumešnica (Macedonia, FYROM) and probably Dragovištica, Lisinska River and Bankovačka River (south-eastern Serbia). (KARAMAN, 1955; MIHAJLOVA, 1965; ECONOMIDIS, 1988, 1991; NAUMOVSKI, 1995; IMSIRODOU *et al.*, 1997; APOSTOLON and DOBROVOLOV, 1999).

### CONCLUSIONS

The homogenous samples (composed of specimens of approximately the same body length) were analyzed in order to evaluate the taxonomic status of populations of these fishes. No evidence was found that would contraindicate data Imsiridou *et al.*, (1997) and APOSTOLON and DOBROVOLOV (1999), which recognized *L. albus*, *L. vardarensis* and *L. macedonicus* as valid species (subspecies are not recognized under

the species concept usual here). Except the genetical difference, in this investigations author conclude distinguished by a morphology. The fact that the specimens of the chub from different localities are almost of the same size indicates that the proportions of the body are apparently comparable, without any difficulties from allometry. The examination indicate that this species separate in proportions of head: in the position of mouth and snout shape, width of mouth and snout, in relation between depth the cutting of mouth and position of the eye, width and height of head, diameter oculi and shape and width of interorbital space.

There are other characters which separate this species: proportions of the body (length of predorsal and postdorsal distance, length of pectoral and ventral fins, P-V space, depth of dorsal and anal fin, length of caudal peduncle) and meristic characters (lateral line scales, the number of scales between ventral fin and the genital papillae origin, scales between genital papillae final part and anal fin origin, number of scales between pectoral fin and ventral fin, circumpeduncular rows, scale rows between lateral line and pelvic fin, scales rows between lateral line and anal fin, the number of the branched soft rays of unpaired and paired fins). Other meristic characters are relatively stable. Only type of pharyngeal teeth is invariable. The global this species distinguished from *Leuciscus cephalus* and between they're by a very different appearance (Fig. 2 and 3) position of mouth a shape and size of mouth and snout. They further differ by the other morphometrics and meristics characters (Table 1-3).

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Table 1: Meristic characters of *L. albus*, *L. vardarensis* and *L. macedonicus*

<u><i>Leuciscus albus</i></u>								
Character	Du,b	Au,b	Pu,b	Vu,b	Squ.ll.	Squ.sup.	Squ.inf.	Sp.br.
<u>Localites</u>								
B.Drim R. <sup>1)</sup> n=70	III/8(9)	III/(7)8-9(10)	I/15-17	II/(7)8(9)	(37-39)41-46(48)	(7)8-9	(2½), 3-3½,4	9-11
Kastoria L. <sup>2)</sup> n=6	III 7-8	III8	I/15-16	II/8	41-44	7-8	3-3½, 4	8-9
Ohrid L. <sup>3)</sup> n=100	III 8(9)	III/(7)8-9	I/14-16	II/8-9	(43)43-45(46)	7-8	3-4	8-14
Skadar L. <sup>4)</sup> n=72	III/7/8(9)	III/(6)8(9)	I/14-16	II/(7)8(9)	(41-42)43-46(47)	(6)7-8	(2)3-4	8-12
Skadar L. <sup>5)</sup> n=66	III/8	III/8			43-47	7	3	8-13
<sup>1,2)</sup> Šorić (1984) and data of this study <sup>3,4)</sup> Grupče, Dimovski (1982) <sup>5)</sup> Ivanović and Sekulović (1971)								
<u><i>Leuciscus vardarensis</i></u>								
Vardar R Dojran L. <sup>1)</sup> n=14	III/8	III/8	I/14-16	II/(7)8	43-44	(7)8	3-3½	8-9
Ohrid L. <sup>2)</sup> n=100	III/8	III(7)8(9)	I/14-16(17)	II/7-8(9)	44-46(47)	7-8	3-4	(6?)7-10(11)
Vardar syst. <sup>3)</sup> n=?	III/8	III/8	I/15-16	II/8	43-45	7	3	-
<sup>1)</sup> Šorić data of this study <sup>2)</sup> Grupče, Dimovski (1982) <sup>3)</sup> Karaman (1928)								
<u><i>Leuciscus macedonicus</i></u>								
Strumica R. <sup>1)</sup> n=12	III/8	III8-9	I/15-17	II/8	41-46	7-8	3½	8-10
Volvi L. <sup>2)</sup> n=19	7-9	7-8	15-17	7-9	44-48	-	-	7-11
Strumica R. <sup>3)</sup> n=100	III/(7)8(9)	III/(7)8-9	I/14-16(17)	II/(7)8(9)	(43,44)45-49	7-9	3-4	7-11
Korane <sup>4)</sup> , Volvi system (Greece) n=16	III (7)8	III 8	I/15-16	II/8	44-47	8	3-4	8-10
<sup>1)</sup> Šorić data of this study <sup>2)</sup> Economidis and Sinis (1988) <sup>3)</sup> Grupče, Dimovski (1982) <sup>4)</sup> Economidis and Sinis (1982)								

Table 2: Morphometric characteristics of *L. cephalus* and *L. albus*

	<i>L. cephalus</i>		<i>L. albus</i>		<i>L. albus</i>	
Localities	Gruza R. (Danube syst.)		B. Drim R. (Ohrid-Drim-Skadar syst.)		Kastoria L. Altakmon R. system	
Character	Range	X	Range	X	Range	X
Sl	180.0-275 mm		150.0-157.5 mm		185.0-192.5 mm	
In% Sl:						
lc	23.31-25.22	24.30	26.01-26.67	26.34	25.26-27.01	26.32
hc	15.95-16.11	15.93	16.66-18.35	17.35	16.75-18.74	17.87
pD	49.72-51.22	50.93	54.00-55.38	54.51	52.10-55.74	53.78
poD	36.39-39.55	37.24	34.67-39.56	37.88	36.31-37.08	36.62
H	24.72-27.24	26.30	23.33-27.39	24.99	23.57-25.61	24.55
h	10.36-11.39	10.98	10.67-11.08	10.88	10.96-11.30	11.10
lpc	21.56-22.72	22.17	21.33-24.76	22.82	20.00-24.11	22.25
Dh	17.78-20.13	19.06	18.00-19.84	19.01	18.92-21.30	19.93
DI	10.04-11.92	10.47	9.08-10.67	9.91	10.00-12.05	10.95
Ah	15.27-17.66	16.16	13.87-18.83	16.90	14.63-17.30	16.17
Al	9.44-10.01	9.63	9.08-10.67	9.91	8.42-10.00	9.38
IP	16.36-17.43	17.00	17.46-18.74	18.07	19.16-20.78	20.08
IV	13.12-15.67	14.60	15.31-19.96	16.50	15.84-16.54	17.13
P-V	24.77-26.80	25.89	24.12-24.83	24.54	23.40-35.94	24.52
In%cl						
prO	29.81-31.22	30.59	29.89-32.58	31.31	30.57-32.29	31.59
poO	51.48-55.22	53.14	50.00-54.14	52.15	51.22-54.37	53.10
Oh	17.78-22.78	20.25	17.50-21.22	19.98	18.65-20.21	19.50
iO	38.49-40.72	39.92	37.50-40.24	38.72	39.26-40.82	39.89

Table 3: Morphometric characteristics of *L. cephalus*, *L. macedonicus*, *L. albus* and *L. vardarensis*

	<i>L. cephalus</i>		<i>L. macedonicus</i>		<i>L. cephalus</i>	
Localites	Gruza River (Danube syst.)		Strumica R. (Strumica rivet syst.)		Gruza River (Danube syst.)	
Character	Range	X	Range	X	Range	X
Sl	135.0-147.0 mm		125.0-133.0 mm		96.2-118.4 mm	
In% Sl:						
lc	25.55-26.59	26.11	26.46-28.03	27.29	26.69-27.59	27.13
hc	15.99-16.44	16.25	16.96-17.63	17.29	16.70-20.69	18.34
lac	-		13.44-13.66	13.63	14.27-15.07	14.72
pD	52.97-53.41	53.12	52.67-55.64	53.97	53.95-54.74	54.44
poD	36.09-39.26	37.24	36.32-36.87	36.53	36.90-37.93	37.53
H	23.40-24.22	23.90	23.20-23.66	23.39	24.32-25.17	24.63
h	9.39-10.71	10.15	10.53-10.96	10.80	10.29-11.23	10.74
lpc	22.45-23.33	22.89	20.68-21.12	20.88	21.31-32.79	22.21
Dh	15.70-19.38	18.02	19.08-19.22	19.42	16.95-19.26	18.27
Dl	9.52-10.74	10.22	10.40-11.20	10.76	9.60-10.73	10.05
Ah	15.42-17.35	16.53	16.87-17.52	17.09	14.97-15.78	15.40
Al	7.96-10.94	8.99	8.64-9.02	8.79	7.28-10.47	8.76
IP	17.11-17.21	17.14	15.76-18.52	17.43	15.99-18.36	17.17
IV	14.28-15.35	14.94	15.04-15.65	15.30	15.69-17.57	16.66
P-V	25.48-28.50	27.31	22.32-23.89	23.05	22.96-26.89	24.51
In%cl						
lac	-		48.25-50.75	49.65	53.48-55.55	54.43
prO	29.35-30.00	29.64	30.00-32.89	31.49	31.80-32.91	32.51
poO	53.43-56.62	53.60	48.57-52.63	50.76	48.75-50.19	49.33
Oh	19.71-21.45	20.65	20.42-21.59	21.01	24.06-24.52	24.32
iO	36.57-40.26	38.07	35.43-36.58	36.03	43.44-47.13	44.82
hco	-		43.16-45.71	44.33	50.19-57.19	53.83

Table 3 (cont)

	<i>L. albus</i>		<i>L. vardarensis</i>		<i>L. macedonicus</i>	
Localites	Beli Drim R. (Ohrid-Drim-Skadar syst.)		Vardar R.-Lake Dojran syst.		Strumica R. (Strumica rivet syst.)	
Character	Range	X	Range	X	Range	X
Sl	82.5-116.0 mm		87.0-129.5 mm		96.1-125.0 mm	
In% Sl:						
lc	26.72-28.57	27.92	25.64-28.28	26.65	25.94-27.18	26.59
hc	18.10-19.39	18.55	16.36-18.85	17.52	15.71-17.86	17.14
lac	15.69-15.81	15.75	14.05-14.71	14.45	12.80-13.30	13.07
pD	53.31-55.41	54.50	51.58-55.86	53.38	50.08-57.77	54.05
poD	33.88-37.57	36.17	34.86-36.44	35.61	32.04-33.39	32.25
H	23.88-25.00	24.38	24.42-24.71	24.55	22.56-25.53	24.18
h	10.71-11.12	10.94	10.00-10.14	10.05	10.48-10.82	10.70
lpc	21.22-23.27	21.94	18.07-21.15	19.24	18.45-21.12	20.12
Dh	18.06-19.39	18.80	18.07-19.65	18.64	19.45-20.00	19.68
Dl	7.96-9.48	8.80	8.93-10.66	9.79	9.57-10.97	10.31
Ah	15.76-16.76	16.35	13.51-17.24	15.24	15.76-17.08	16.61
Al	8.48-9.08	8.78	8.05-8.57	8.34	7.68-9.42	8.37
IP	15.10-19.63	17.41	16.45-16.56	16.51	17.04-19.03	17.92
IV	14.66-14.79	14.72	14.06-15.44	14.96	14.72-16.70	15.40
P-V	23.28-24.24	23.90	18.37-24.71	20.59	22.56-27.18	25.14
In%cl						
lac	54.89-55.96	55.42	52.84-54.82	52.35	48.93-50.20	49.46
prO	31.49-32.85	32.20	28.45-29.82	28.95	29.64-32.65	30.77
poO	48.39-50.90	49.83	48.98-50.41	49.60	49.64-54.95	51.60
Oh	19.35-25.53	22.78	23.49-28.16	25.89	21.02-23.67	21.92
iO	38.71-42.55	40.68	37.05-40.65	38.96	35.74-38.37	36.85
hco	49.79-51.62	50.70	49.39-52.11	51.04	46.55-48.92	47.74