



<https://doi.org/10.11646/zootaxa.4433.3.9>

<http://zoobank.org/urn:lsid:zoobank.org:pub:AD2CD33C-1E75-46C5-9EAF-2A1EC854E6E1>

## *Luciobarbus lanigarensis* and *L. numidiensis*, two new species of barbels from the Mediterranean Sea basin in North Africa (Teostei: Cyprinidae)

AMINA BRAHIMI<sup>1,5</sup>, ROLAND LIBOIS<sup>1</sup>, ARNAUD HENRARD<sup>2,3</sup> & JÖRG FREYHOF<sup>4</sup>

<sup>1</sup>Zoogeography Research Unit, Department of Biology, Ecology and Evolution, University of Liège, Chemin de la vallée 4 (Bât. B22) 4000 Sart Tilman, Belgium. E-mail: [minagro005@yahoo.fr](mailto:minagro005@yahoo.fr); [roland.libois@uliege.be](mailto:roland.libois@uliege.be)

<sup>2</sup>Earth and life Institute, Biodiversity research Center, UCL-17. 07. 04, Bâtiment Carnoy, Croix du Sud, 5, B-1348, Louvain-la-Neuve, Belgium.

<sup>3</sup>Royal Museum for Central Africa, Leuvensesteenweg 13, 3080 Tervuren, Belgium. E-mail: [arnaud.henrard@africamuseum.be](mailto:arnaud.henrard@africamuseum.be)

<sup>4</sup>Leibniz-Institute of Freshwater Ecology and Inland Fisheries (IGB), Müggelseedamm 310, 12587 Berlin, Germany.

E-mail: [j.freyhof@igb-berlin.de](mailto:j.freyhof@igb-berlin.de)

<sup>5</sup>Corresponding author. E-mail: [minagro005@yahoo.fr](mailto:minagro005@yahoo.fr)

### Abstract

Two new species of *Luciobarbus* are described from the Mediterranean Sea basin in Morocco and Algeria. Their monophyly and phylogenetic placement are resolved by molecular analyses using two mitochondrial markers (cyt b and D-loop). *Luciobarbus lanigarensis*, new species, from the Tafna River drainage in Algeria and Morocco, is distinguished by having orange fins, a great predorsal length (52–59% SL) and a very long pectoral fin (79–90% HL). *Luciobarbus numidiensis*, new species, from the El-Kébir River drainage in Algeria, is distinguished by having a golden pectoral-fin margin, 43–47+1–3 lateral line scales and a very long anal-fin (19–23%).

**Key words:** North Africa, Mediterranean biodiversity hotspot, news species, Morphology, Cytochrome b, D-loop control

### Introduction

The diversity of *Luciobarbus* species occurring in the Mediterranean biodiversity hotspot in North Africa has recently received considerable attention. Geiger *et al.* (2014) presented a comprehensive set of molecular data and treated *L. leptopogon* as a valid species. Casal-Lopez *et al.* (2015) described the long-known but unnamed species from northern-most Morocco as *L. rifensis*. Doadrio *et al.* (2016b) described the species until then known as *L. nasus* from the Moulouya River drainage as *L. guercifensis*. Doadrio *et al.* (2016a) stated that *L. moulouyensis* from the Moulouya River drainage is a synonym of *Carasobarbus fritschii* and described the *Luciobarbus* previously known as *L. moulouyensis* as *L. yahyaoui*. Finally, Brahimi *et al.* (2017) presented an identification key of all *Luciobarbus* species found in the African Mediterranean Sea basin, a new set of molecular data and described two additional new species from Algeria (*L. chelifensis* & *L. mascarensis*).

These studies increased remarkably the number of *Luciobarbus* species known from the African Mediterranean Sea basin from four (*L. callensis*, *L. nasus*, *L. moulouyensis*, *L. setivimensis*) to eight. However, there are still several small- and medium-sized rivers flowing to the African Mediterranean Sea inhabited by unstudied populations of *Luciobarbus*. Here, we provide the description of two additional new species from those rivers, which had passed unnoticed in previous studies.

### Material and methods

**Morphology.** Fish were caught with hand nets and by electrofishing. After anaesthesia, fishes were either fixed in 5% formaldehyde and stored in 70% ethanol or directly fixed in 99% ethanol. Measurements were made point-to-

point, with a dial caliper and recorded to 0.1 mm. Two measurements were taken over projections to the body axis: pre-dorsal length and pre-pelvic length. Other methods for measurements and all counts follow Kottelat & Freyhof (2007). Standard length (SL) is measured from the tip of the snout to the posterior extremity of the hypural complex. The length of the caudal peduncle is measured from behind the base of the last anal-fin ray to the posterior extremity of the hypural complex, at mid-height of the caudal-fin base. The length of anal-fin is given together for males and females, as it was not found to be sexually dimorphic. The first unbranched dorsal and anal-fins rays are hidden in the skin and unbranched rays were counted from X-ray pictures. The position of the dorsal-fin origin was determined from x-ray pictures. The last two branched rays articulating on a single pterygiophore in the dorsal and anal fins are counted as "1½". Scales in lateral series are counted along the midlateral line from the first one to touch the shoulder girdle to the last scale at the posterior extremity of the hypural complex. The scales on the caudal-fin base are separated by +. The holotype is included in the calculation of ranges, means and SD.

**Abbreviations used.** BI, bayesian inference; cyt b, cytochrome b; d, cyt b genetic distance; D-loop, displacement loop; HL, lateral head length; ML, maximum likelihood analysis; SL, standard length.

**Collection codes.** FSJF, Fischsammlung J. Freyhof, Berlin; RMCA, Royal Museum for Central Africa, Tervuren; ZFMK, Zoologisches Forschungsmuseum A. Koenig, Bonn.

**Molecular analysis.** To evaluate the phylogenetic relationships between the *Luciobarbus* species from the African Mediterranean Sea basin, we were able to generate 42 new mitochondrial sequences (cyt b and D-loop) for three *Luciobarbus* species (*L. guercifensis*, *L. lanigarensis* and *L. numidiensis*). From NCBI Genbank, 103 additional cyt b sequences and 48 D-loop sequences from *Luciobarbus* from the African Mediterranean Sea basin were downloaded. *Barbus barbatus* was used as outgroup (Table 1). Polymerase chain reaction (PCR) amplification and sequencing were applied to two fragments of the mitochondrial genome: cytochrome b (cyt b) and D-loop control region. We used GLUDGL (Palumbi 1996) and H16460 primers (Perdices & Doadrio 2001) to amplify cyt b, while the D-loop was amplified using L15923 (Iguchi *et al.* 1997) and H16500 primers (Nishida *et al.* 1998). All sequences were visualized and edited in SEQUENCHER v.5.2.4 (Gene Codes, USA) and then compared with other GenBank sequences in order to identify any undesirable contamination. The sequences were then aligned using MAFFT v.7 (Kato & Standley 2013) with default parameters. Alignment refinement was performed using Gblocks v.0.90b available on the Gblocks Server in order to eliminate poorly aligned positions and divergent regions (Talavera & Castresana 2007). A combined Cyt b–D-loop alignment was created with seaview v.4.5.4 (Gouy *et al.* 2010) by concatenating the MAFFT-Gblocks curated alignments of the two markers into a single matrix. For the analyses, datasets were partitioned to account for the differences in evolutionary dynamics among sites and genes. The protein-coding gene (Cyt b) was partitioned into single codon positions. By consequence the combined alignment dataset was subdivided into four partitions: the 1st, 2nd and 3rd codon positions of the cyt b and the D-loop. Both markers and the concatenated alignments were analysed in PartitionFinder v.2 (Lanfear *et al.* 2017) in order to select the best models per partitions: K80+I (Kimura 1980), F81 (Felsenstein 1981), GTR+G (Lanave *et al.* 1984; Tavaré 1986; Rodriguez *et al.* 1990) and HKY+G (Hasegawa *et al.* 1985) for cyt b 1st, 2nd and 3rd codons positions and D-loop, respectively.

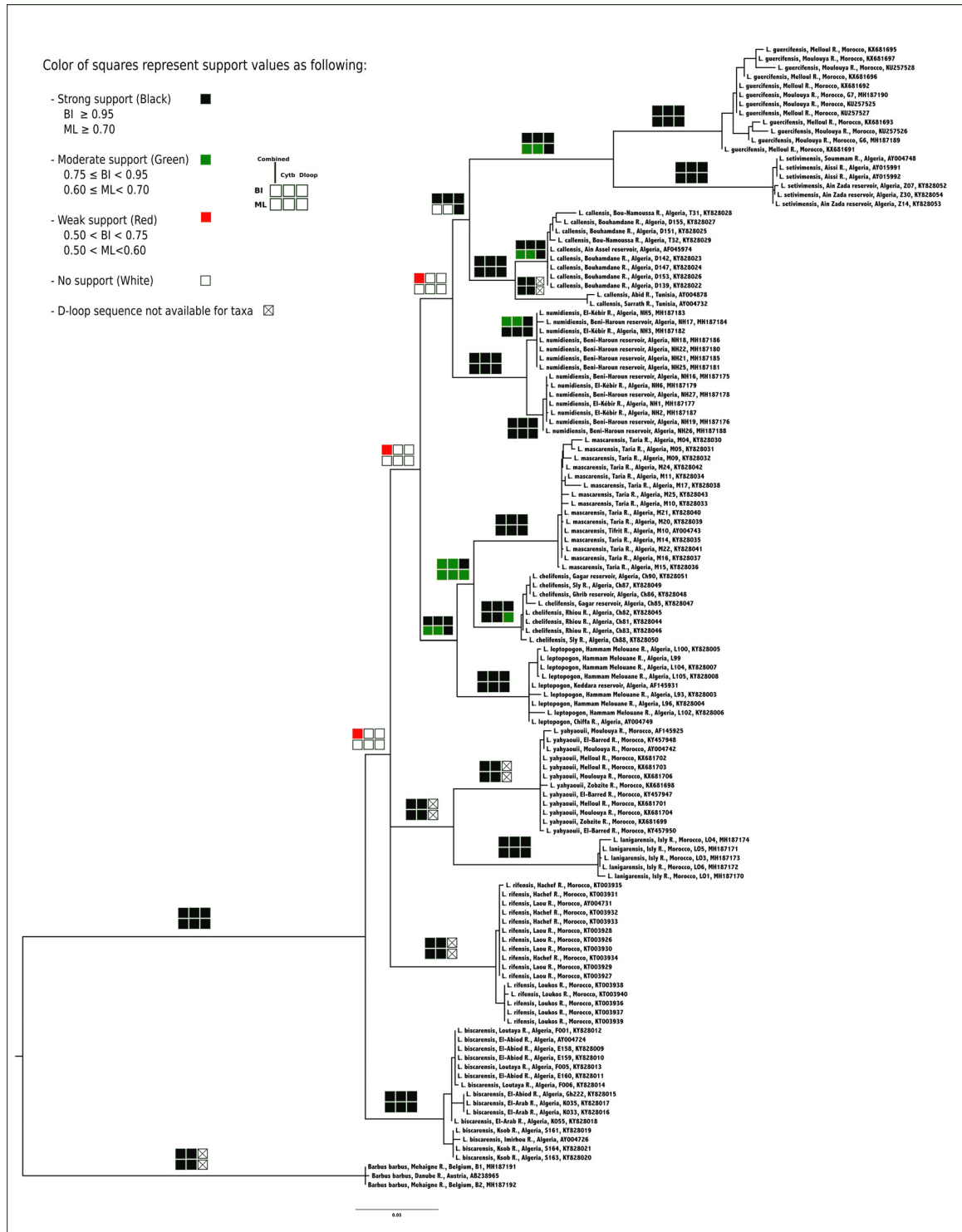
Phylogenetic analyses were inferred using statistical approaches (ML and BI). The phylogenetic analyses were inferred from each marker independently: Cyt b (1140 bp) and D-loop (470 bp) and on the combined alignment (with a total of 1610 sites). Maximum likelihood analyses (ML) (Felsenstein 1981) were implemented in GARLI v.2.1 (Bazin *et al.* 2014) using the models suggested by PartitionFinder. In total, 1000 bootstraps (BT) were obtained in four independent runs, each including 250 repetitions. BT values were then summarized on the best maximum likelihood tree using SumTree (Sukumaran & Holder 2015) (run on DendroPy v.4.0.0; Sukumaran & Holder 2010). Bayesian inference (BI), was implemented in the Mr.Bayes program v.3.2.5 (Ronquist *et al.* 2012), using four runs of Metropolis-coupled Markov Chain Monte Carlo (MCMC) sampling and with default model parameters as starting values. The analysis was proceeded up to 10 000 000 generations, checking that the standard deviation of split frequencies decreased below 0.01. Best-fit models were applied to each partition. The trees were first edited using Figtree v.1.4.2 (Rambaut 2009) then drawn with Inkscape v.0.91 (<http://inkscape.org>) for publication. The average uncorrected p-distances among *Luciobarbus* species from the African Mediterranean Sea basin were calculated for the cyt b gene using MEGA v.6.0 (Tamura *et al.* 2013).

**TABLE 1.** Sequences from GenBank used in this study. Species, localities, the number of sequenced specimens and GenBank accession numbers (cyt b) are given.

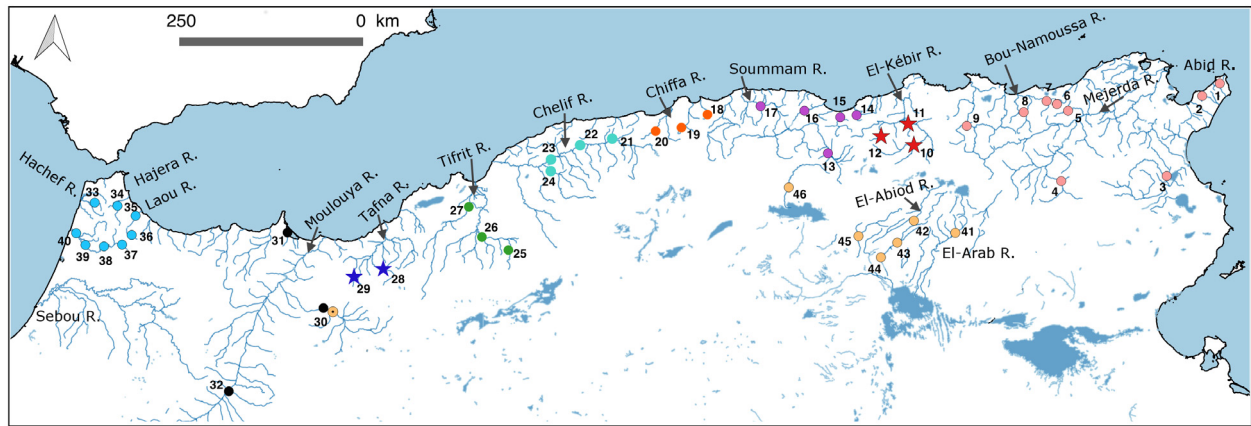
Species	Locality	Coordinates	GenBank Nr.
<i>Luciobarbus biscarensis</i>	Illizi, Algeria		AY004724
<i>Luciobarbus biscarensis</i>	El-Abiod River, Biskra, Algeria	35.867736°N, 5.926079°E (42)	AY004726
<i>Luciobarbus biscarensis</i>	El-Abiod River, Biskra, Algeria	35.052039°N, 6.166728°E (43)	KY828015
<i>Luciobarbus biscarensis</i>	Foum-El-Gherza reservoir, Biskra, Algeria	34.870207°N, 5.925388°E (44)	KY828009-11
<i>Luciobarbus biscarensis</i>	Loutaya River at Manbae, Biskra, Algeria	35.094477°N, 5.586152°E (45)	KY828012-14
<i>Luciobarbus biscarensis</i>	Ksob River, M'sila, Algeria	35.840216°N, 4.572089°E (46)	KY828019-21
<i>Luciobarbus biscarensis</i>	El-Arab River, Khenchela, Algeria	35.166192°N, 7.020921°E (41)	KY828016-18
<i>Luciobarbus callensis</i>	Abid River, Cap Bon, Tunisia	36.867286°N, 10.724574°E (2)	AY004878
<i>Luciobarbus callensis</i>	Sarrath River, Djerissa, Tunisia	35.807531°N, 8.563658°E (4)	AY004732
<i>Luciobarbus callensis</i>	Ain Assel reservoir, El-Taref, Algeria	36.747037°N, 8.400955°E (7)	AF045974
<i>Luciobarbus callensis</i>	Bou-Namoussa River, El-Taref, Algeria	36.621504°N, 8.057990°E (8)	KY828028-29
<i>Luciobarbus callensis</i>	Bouhamdane River, Guelma, Algeria	36.468478°N, 7.229560°E (9)	KY828022-27
<i>Luciobarbus chelifensis</i>	Rhiou River, Relizane, Algeria	36.009889°N, 0.992520°E (23)	KY828044-46
<i>Luciobarbus chelifensis</i>	Gagar reservoir, Relizane, Algeria	35.908391°N, 1.008624°E (24)	KY828047 KY828051
<i>Luciobarbus chelifensis</i>	Sly River, Chelif, Algeria	36.026609°N, 1.266014°E (22)	KY828049-50
<i>Luciobarbus chelifensis</i>	Ghrib reservoir, Ain Defla, Algeria	36.140553°N, 2.563226°E (21)	KY828048
<i>Luciobarbus guercifensis</i>	Melloul River, Guercif, Morocco	34.218000°N, 3.346700°W	KU257527 KX681691-93 KX681695-96
<i>Luciobarbus guercifensis</i>	Moulouya River, Ghafoula, Morocco	34.145000°N, 3.388000°W	KU257525-26 KU257528 KX681697
<i>Luciobarbus leptopogon</i>	Keddara reservoir, Boumrdèse, Algeria	36.647275°N, 3.424412°E (18)	AF145931
<i>Luciobarbus leptopogon</i>	Chiffa River, Blida, Algeria	36.445279°N, 2.756340°E (19)	AY004749
<i>Luciobarbus leptopogon</i>	Hammam Melouane River, Blida, Algeria	36.482900°N, 3.041400°E (20)	KY828003-08
<i>Luciobarbus mascarensis</i>	Tifrit River, Balloul, Algeria	34.987064°N, 0.408772°E (25)	AY004743
<i>Luciobarbus mascarensis</i>	Taria River, Mascara, Algeria	35.109848°N, 0.067300°E (26)	KY828030-43
<i>Luciobarbus rifensis</i>	Laou River, Chefchaouen, Morocco		AY004731
<i>Luciobarbus rifensis</i>	Laou River, Dardara, Morocco	35.118986°N, 5.288900°W (37)	KT003926-30
<i>Luciobarbus rifensis</i>	Hachef River, Dar Chaoui, Morocco	35.526763°N, 5.713771°W (33)	KT003931-35
<i>Luciobarbus rifensis</i>	Loukos River, Souk Had Laghdir, Morocco	35.026240°N, 5.404660°W (38)	KT003936-40
<i>Luciobarbus setivimensis</i>	Soummam River, Algeria	36.632246°N, 4.74745°E (16)	AY004748
<i>Luciobarbus setivimensis</i>	Aissi River, Tizi Ouzou, Algeria	36.668968° N, 4.124125°E (17)	AY015991-92
<i>Luciobarbus setivimensis</i>	Ain Zada Reservoir, Bordj-Bou-Arreidj, Algeria	36.668968° N, 4.124125°E (13)	KY828052-54
<i>Luciobarbus yahyaouii</i>	Moulouya River, Boumia, Morocco	32.801789°N, 4.791778°W (31)	AY004742
<i>Luciobarbus yahyaouii</i>	Moulouya River, Morocco	34.226706°N, 2.392343°W (30)	AF145925
<i>Luciobarbus yahyaouii</i>	Moulouya River, Ghafoula, Morocco	34.145000°N, 3.388000°W	KX681704-06
<i>Luciobarbus yahyaouii</i>	Melloul River, Guercif, Morocco	34.218000°N, 3.346700°W	KX681701-03
<i>Luciobarbus yahyaouii</i>	Zobzite River, Moulouya Basin, Berkine, Morocco		KX681698-99
<i>Luciobarbus yahyaouii</i>	El Barred River at Asrire, Morocco		KY457947-48 KY457950
<i>Barbus barbus</i>	Danube River, Austria		AB238965

## Results

Phylogenetic inferences (ML and BI) were carried out on each alignment including GenBank sequences and support values from the different analyses are summarized here on the majority rule consensus ML tree obtained from the combined alignment (Fig. 1). The tree topologies obtained from both BI and ML did not differ in the clades recovered, but it differed in the support values for the recovered groups with, in general, BI provided higher support values than the ML analysis.



**FIGURE 1.** Phylogenetic relationships from DNAmT (Cyt b and D-loop) of *Luciobarbus* species from the African Mediterranean Sea basin, using Bayesian inference (BI) and Maximum Likelihood (ML). Support values from the different analyses run on the combined alignment and on each marker are summarized here on the majority rule consensus.



**FIGURE 2.** Records of *Luciobarbus* species examined in this study. Numbers correspond to materials examined.

Cyt b and D-loop analyses also showed generally similar topologies, congruent with the combined analyses. Indeed, all clades corresponding to species were recovered with high support values in all analyses. Only deeper nodes were not supported, except the monophyly of *Luciobarbus*. Some species groups are however well supported. Among African Mediterranean *Luciobarbus*, *L. setivimensis*, and *L. guercifensis* are sister group and showed a high genetic divergence compared to all the other taxa analyzed from this area.

Our analyses also reveal that *L. mascarensis*, *L. chelifensis* and *L. leptopogon* form a well-supported Algerian group. *Luciobarbus callensis* is basal to the clade formed by the two species *L. setivimensis* and *L. guercifensis* but is mainly supported by D-loop. It is also the case for *L. yahyaouii* and *L. lanigarensis*, but for which mainly the cyt b gives support to the clade. The genetic distance (Cyt b) between *L. lanigarensis* and *L. yahyaouii* is relatively large ( $d = 4.6\%$ ). Individuals of *L. numidiensis* included in the molecular analysis form one well-supported monophyletic clade. This clade is further separated into two well-supported sub-groups, which are however faintly genetically differentiated ( $d = 0.28\%$ ), indicating a restricted gene-flow between the populations. The relationships of and affinities between *Luciobarbus* species of African Mediterranean Sea basin remain unclear.

### Key to species of *Luciobarbus* in the African Mediterranean Sea basin

The key is developed based on materials examined listed at the end of the text.

- 1a Barbels thick, rostral-barbel origin close to tip of snout. . . . . *L. guercifensis*
- 1b Barbels thin, rostral-barbel origin clearly behind tip of snout. . . . . 2
- 2a Last unbranched dorsal-fin ray serrated along 2/3 of its length. . . . . 3
- 2b Last unbranched dorsal-fin ray serrated along almost its entire length. . . . . 8
- 3a Caudal peduncle 1.2–1.3 times longer than deep . . . . . 4
- 3b Caudal peduncle 1.3–1.5 times longer than deep . . . . . 6
- 4a Predorsal length 46–52% SL; interorbital distance 40–44% HL; 43–47+1–3 lateral line scales . . . . . *Luciobarbus setivimensis*
- 4b Predorsal length 52–59% SL; interorbital distance 36–46% HL; 41–45+1–3 lateral line scales . . . . . 5
- 5a Pectoral-fin length 17–21% SL, 60–79% HL; usually 41+1–2 lateral line scales . . . . . *Luciobarbus mascarensis*
- 5b Pectoral-fin length 21–24% SL, 79–90% HL; 43–45+1–3 lateral line scales . . . . . *Luciobarbus lanigarensis*
- 6a Caudal peduncle depth 13–14% SL; 43–47+1–2 lateral line scales . . . . . *Luciobarbus numidiensis*
- 6b Caudal peduncle depth 10–13% SL; 41–45+1–2 lateral line scales . . . . . 7
- 7a Predorsal length 46–52% SL; Interorbital distance 36–39% HL; 41–43+1–2 lateral line scales; 4 unbranched dorsal-fin rays . . . . . *Luciobarbus leptopogon*
- 7b Predorsal length 52–56% SL; Interorbital distance 33–40% HL; 42–45+1–2 lateral line scales; usually 5, very rarely 4 unbranched dorsal-fin rays . . . . . *Luciobarbus yahyaouii*
- 8a Anal-fin length 19–23% SL . . . . . *Luciobarbus numidiensis*
- 8b Anal-fin length 16–19% SL . . . . . 9
- 9a Anal-fin base length 8–10% SL; 41–43+1–2 lateral line scales. . . . . *Luciobarbus chelifensis*
- 9b Anal-fin base length 6–8% SL; 43–47+1–3 lateral line scales . . . . . *Luciobarbus callensis* / *Luciobarbus rifensis*

## *Luciobarbus lanigarensis*, new species

(Figs. 3–5)

**Holotype.** RMCA 2017-022-P-0024, 134 mm SL; Morocco: Guenfouda prov.: Oued Isly, 34.5118°N, 2.05826°W.

**Paratypes.** RMCA 2017-022-P-0019-0042, 21, 71–150 mm SL; ZFMK ICH-105602-105603, 2, 115–123 mm SL; same data as holotype.

**Material for molecular analyses.** RMCA DNA-2017-022-P-LO1-LO6; same data as holotype (GenBank accession numbers: Cyt b: MH187170, MH187171, MH187172, MH187173, MH187174; D-loop: MH187193, MH187194, MH187195, MH187196, MH187197).

**Diagnosis.** *Luciobarbus lanigarensis* is distinguished from other *Luciobarbus* species from the African Mediterranean Sea basin by a combination of characters, none of them unique. *Luciobarbus lanigarensis* is distributed adjacent to *L. mascarensis* in the east and *L. yahyaouii* and *L. guercifensis* in the west.

It is distinguished from *L. guercifensis* by having thin barbels (vs. thick), the rostral-barbel origin placed clearly behind the tip of the snout (vs. rostral-barbel origin at the extreme anterior of the snout) and from *L. mascarensis*, *L. yahyaouii* and *L. leptopogon*, by having a wider interorbital distance (38–47% HL vs. 36–40 in *L. mascarensis*, 33–40 in *L. yahyaouii*, 36–39 in *L. leptopogon*) and a longer pectoral-fin (21–24% SL vs. 16–21 in *L. mascarensis*, 18–21 in *L. yahyaouii*). It is further distinguished from *L. chelifensis*, *L. leptopogon* and *L. mascarensis* by having 43–45+1–3 lateral line scales (vs. 41–43+1–2 in *L. chelifensis* and *L. leptopogon*, usually 41+1–2 in *L. mascarensis*) (Table 8).

**TABLE 2.** Morphometric data of *Luciobarbus lanigarensis* (holotype RMCA 2017-022-P-0024; paratypes RMCA 2017-022-P-0019-0042, n=21; ZFMK ICH-105602-105603, n=2; non-preserved individuals, n=23). The holotype and paratypes are included in the calculation of ranges, means and SD.

	holotype	holotype & paratypes		
		range	mean	SD
Standard length (mm)	134	71–150		
In percent of standard length				
Body depth at dorsal-fin origin	24.2	24.2–29.6	26.4	1.6
Head length	26.2	25.5–29.0	27.1	1.1
Pre-dorsal length	53.7	53.6–59.2	56.1	1.7
Pre-pelvic length	55.2	55.2–60.6	57.7	1.4
Pre-anal length	78.4	76.3–84.5	79.5	2.1
Dorsal fin base length	13.8	13.5–16.0	14.7	0.7
Anal fin base length	7.4	6.6–8.8	7.7	0.6
Anal fin length	21.5	20.2–23.0	21.5	0.8
Pelvic fin length	18.3	17.0–20.4	18.7	1.0
Pectoral fin length	21.3	21.3–23.9	22.4	0.7
Caudal peduncle length	17.4	15.4–18.8	17.4	0.9
Caudal peduncle depth	13.1	12.1–13.7	12.9	0.5
Distance between dorsal and anal-fin origins	31.6	30.3–35.4	33.0	1.3
Distance between pectoral and pelvic-fin origins	28.2	27.6–31.9	29.6	1.3
Distance between pelvic and anal-fin origins	24.6	21.1–24.6	22.8	1.1
In percent of head length				
Snout length	32	29–37	33.2	2.2
Eye diameter	19	19–26	21.9	2.1
Post-orbital length	48	42–49	44.9	1.8
Interorbital distance	43	38–46	41.5	2.7
Pectoral-fin length	81	79–89	83.0	2.7
Caudal peduncle depth	50	43–51	47.8	2.4

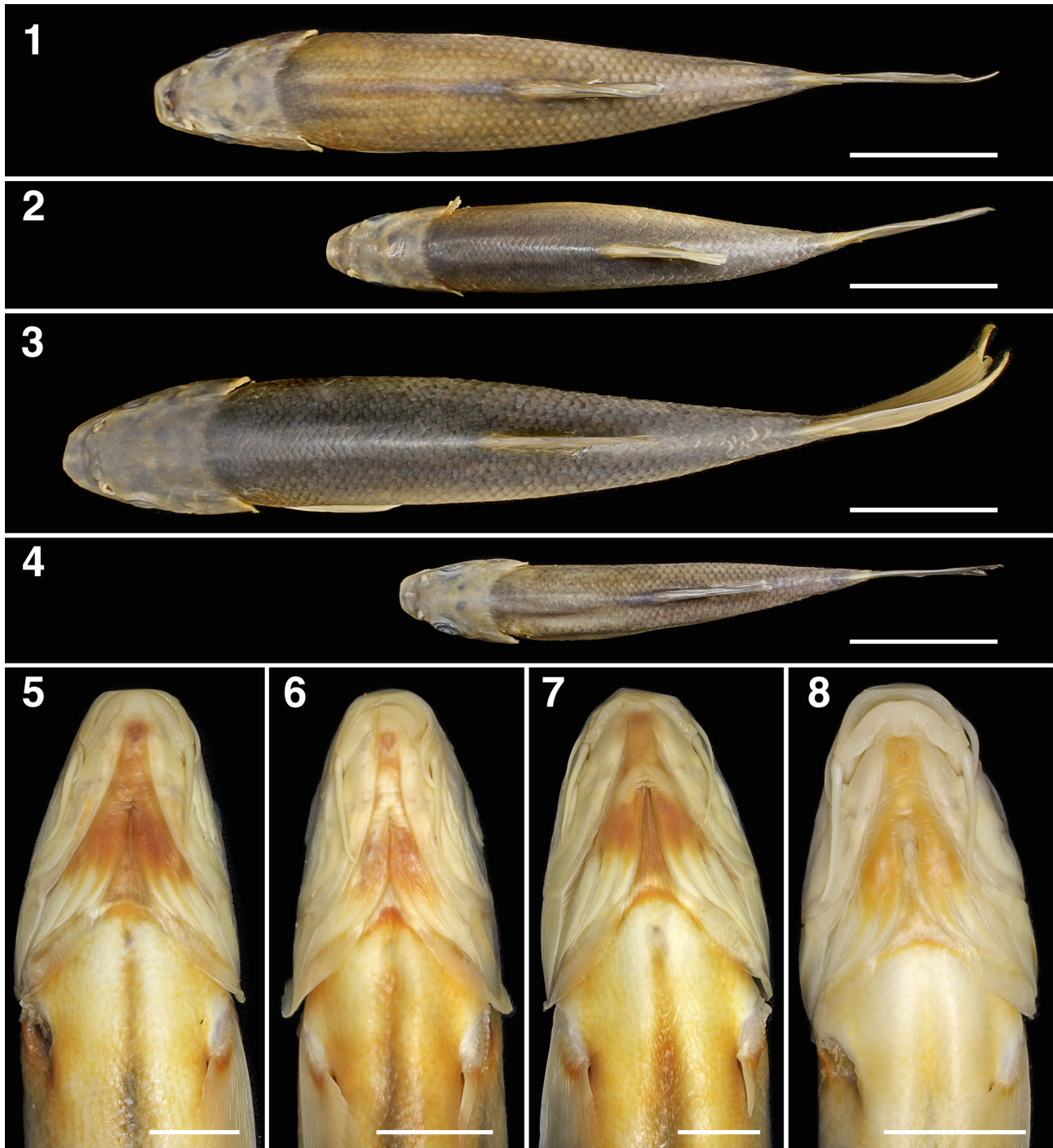


**FIGURE 3.** *Luciobarbus lanigarensis*, RMCA 2017-022-P-0020, paratype, 102 mm SL; Morocco: Oued Isly.



**FIGURE 4.** *Luciobarbus lanigarensis*, 1, RMCA 2017-022-P-0024, holotype, 134 mm SL; 2, RMCA 2017-022-P-0020, paratype, 102 mm SL; 3, RMCA 2017-022-P-0021, paratype, 150 mm SL; 4, RMCA 2017-022-P-0032, paratype, 93 mm SL; Morocco: Oued Isly. Scale bars = 30 mm.

The new species is distinguished from *L. callensis*, *L. chelifensis* and *L. rifensis* by having the last unbranched dorsal-fin ray serrated along 2/3 of its length (vs. last unbranched dorsal-fin ray serrated along almost its entire length) and a longer anal-fin (19–23% SL vs. 17–19 in *L. callensis* and *L. chelifensis*, 16–19 in *L. rifensis*). The new species is distinguished from *L. leptopogon* and *L. setivimensis* by having a greater pre-dorsal distance (53–59% SL vs. 49–52 in *L. leptopogon*, 47–52 in *L. setivimensis*).



**FIGURE 5.** *Luciobarbus lanigarensis*, 1+5, RMCA 2017-022-P-0024, holotype, 134 mm SL; 2+6, RMCA 2017-022-P-0020, paratype, 102 mm SL; 3+7, RMCA 2017-022-P-0021, paratype, 150 mm SL; 4+8, RMCA 2018-022-P-0032, paratype, 93 mm SL; Morocco: Oued Isly. Scale bars: 1–4 = 30 mm; 5–8 = 10 mm.

**Description.** See Figures 3–5 for general appearance. Morphometric data are given in Table 2 and meristic data in Tables 7 and 8. Middle sized and stout species, with a moderately long head. Body deepest at dorsal-fin origin. Depth decreasing continuously towards caudal-fin base. Greatest body width between pectoral and dorsal-



fin origins. Caudal peduncle compressed, 1.3–1.5 times longer than deep. Section of head roundish, flattened on ventral surface. Snout rounded. Mouth inferior. Dorsal-fin origin situated above pelvic-fin origin. Anal-fin origin at vertical of 50–60% of distance between dorsal and caudal-fin origins. Anal fin reaching to caudal-fin base. Pectoral fin reaching 70–80% of distance between pectoral-fin and pelvic-fin origins. Pelvic fin not reaching vertical of tip of last dorsal-fin ray when folded down. Pelvic fin reaching to about 70–90% of distance between pelvic and anal-fin origins. Posterior dorsal-fin margin slightly concave. Posterior pectoral- and anal-fin margins convex. Caudal fin forked with rounded lobes of equal length. Largest known specimen 150 mm SL, but expected to grow larger.

Dorsal fin with 4 unbranched and 8½ branched rays, last unbranched ray ossified and serrated at 2/3 of its length. Anal fin with 3 unbranched and 5½ branched rays. Pectoral-fin with 14–17 (mode 16) and pelvic fin with 8 rays. Lateral line with 43–45 scales on flank and 1–3 scales on caudal-fin base. Between dorsal-fin origin and lateral line 8½–9½ (mode 8½) scale rows, and 5½–6½ (mode 5½) scale rows between pelvic-fin origin and lateral line. Pharyngeal teeth in three rows: 4+3+2. On first gill arch, 3-4 gill rakers on the on the upper and 8 on lower limb.

**TABLE 3.** Morphometric data of *Luciobarbus numidiensis* (holotype RMCA 2017-022-P-0004; paratypes RMCA 2017-022-P-0001-0018, n=13; ZFMK ICH-105604-105605, n=2; non-preserved individuals, n=15). The holotype is included in the calculation of ranges, means and SD.

	holotype	holotype & paratypes		
		range	mean	SD
Standard length (mm)	140	75–430		
In percent of standard length				
Body depth at dorsal-fin origin	25.5	21.6–28.3	25.1	1.7
Head length	26.1	23.1–27.2	25.5	0.9
Pre-dorsal length	52.1	48.8–55.2	52.2	1.7
Pre-pelvic length	51.4	49.7–55.4	52.8	1.7
Pre-anal length	77.1	69.7–80.0	77.6	2.3
Dorsal fin base length	14.5	12.7–16.0	14.3	0.9
Anal fin base length	7	6.5–10.0	7.9	0.7
Anal fin length	21.6	19.1–21.9	20.0	0.9
Pelvic fin length	18.2	14.9–20.1	17.1	1.7
Pectoral fin length	23	18.5–23.3	20.8	1.4
Caudal peduncle length	18.8	16.3–18.8	17.7	0.5
Caudal peduncle depth	13.2	12.1–14.0	12.9	0.4
Distance between dorsal and anal-fin origins	33.8	30.1–36.0	33.6	1.2
Distance between pectoral and pelvic-fin origins	29.4	27.2–30.6	29.2	0.6
Distance between pelvic and anal-fin origins	25.8	22.5–26.2	25.3	1.1
In percent of head length				
Snout length	34	29–38	34.5	2.4
Eye diameter	17	11–22	16.1	3.6
Post-orbital length	48	46–52	49.4	1.6
Interorbital distance	40	37–43	39.4	1.5
Pectoral-fin length	88	74–94	81.7	6.1
Caudal peduncle depth	50	46–54	50.7	1.9

**Coloration.** Brown yellowish-golden in life and preserved individuals without colour pattern. Head golden, cheeks and ventral side of head and body whitish. In life, fins orange.

**Etymology.** *Luciobarbus lanigarensis* is named for Lanigar, the old name of Ouajda province, given by *Claudius Ptolemaeus* (100-170). An adjective.

**Distribution.** *Luciobarbus lanigarensis* was found in the Isly River in northeastern Morocco, which is a headwater stream of the Tafna River. The Tafna River drainage is situated in the border area between Algeria and Morocco, having its estuary in Algeria close to the city of Tlemcen. Therefore, we expect *L. lanigarensis* to be found in Algeria also. See Figure 2 (*L. lanigarensis* are Nr. 28–29) for the distribution of *Luciobarbus* species from the African Mediterranean Sea basin.

**TABLE 4.** Morphometric data of *L. biscarensis* (FSJF 3286, n=31; FSJF 3279, n=9; non-preserved individuals, n=24); *L. callensis* (FSJF 3014, n=6; FSJF 3011, n=4; FSJF 3017, n=20; FSJF 3008, n=9; non-preserved individuals, n=21); *L. leptopogon* (FSJF 3284, n=9; RMCA-2016-024-P-0001-0009: n=9; non-preserved individuals, n=21).

	<i>L. biscarensis</i>			<i>L. callensis</i>			<i>L. leptopogon</i>		
	range	mean	SD	range	mean	SD	range	mean	SD
Standard length (mm)	50–305			44–334			76–175		
In percent of standard length									
Body depth at dorsal–fin origin	21.1–28.8	25.3	2.0	22.0–30.9	26.5	2.3	20.2–27.0	24.4	2.0
Head length	25.5–28.8	26.8	0.7	24.3–29.8	26.4	1.2	23.9–28.3	25.9	0.7
Pre–dorsal length	51.9–57.4	54.4	1.2	49.4–55.2	52.0	1.3	48.8–52.6	51.1	0.9
Pre–pelvic length	50.0–56.5	54.3	1.4	50.6–56.9	53.0	1.3	51.1–57.1	54.1	1.4
Pre–anal length	73.0–81.2	77.2	1.9	73.5–81.4	77.1	1.7	73.6–81.6	78.1	2.2
Dorsal fin base length	11.3–15.4	13.3	1.0	12.1–15.8	13.9	0.9	13.9–15.8	14.6	0.6
Anal fin base length	6.0–8.6	7.5	0.5	6.5–8.4	7.3	0.5	6.8–10.2	8.4	1.0
Anal fin length	17.3–20.0	18.7	0.6	16.9–19.0	17.9	0.4	19.3–21.9	20.5	0.6
Pelvic fin length	12.3–17.8	15.3	1.3	13.9–20.5	16.4	1.5	16.3–20.0	17.8	1.1
Pectoral fin length	16.1–21.2	18.3	1.1	17.7–23.1	20.4	1.2	17.9–22.9	20.2	1.3
Caudal peduncle length	16.5–19.3	17.6	0.7	15.1–20.5	17.3	0.9	15.0–19.5	17.3	1.0
Caudal peduncle depth	11.0–13.3	11.8	0.7	11.0–14.1	12.6	0.5	10.5–12.9	11.8	0.5
Distance between dorsal and anal–fin origins	27.3–36.4	31.3	2.0	29.7–39.3	34.4	1.7	30.1–38.2	33.7	1.7
Distance between pectoral and pelvic–fin origins	21.8–30.2	27.4	1.6	22.5–29.3	26.6	1.4	25.6–31.2	28.2	1.6
Distance between pelvic and anal–fin origins	19.0–27.1	23.0	1.7	20.4–27.7	24.1	1.7	20.6–26.9	24.0	1.6
In percent of head length									
Snout length	30–39	34.5	2.2	24–41	33.8	4.8	29–34	32.1	1.2
Eye diameter	9–21	15.6	4.0	11–28	16.6	5.0	17–24	20.6	1.5
Post–orbital length	44–53	49.9	2.7	44–50	47.6	1.0	45–50	47.4	0.9
Interorbital distance	31–39	35.5	1.9	32–42	36.9	1.9	36–39	38.0	0.9
Pectoral–fin length	61–78	68.2	4.1	69–84	77.2	3.3	63–90	78.0	5.7
Caudal peduncle depth	41–47	43.8	1.7	40–53	47.8	2.8	41–59	45.7	2.1

### *Luciobarbus numidiensis*, new species

(Figs. 6–8)

**Holotype.** RMCA 2017-022-P-0004, 140 mm SL; Algeria: Mila prov.: Oued El-Kébir at Hammam Beni Haroun, 36.6053°N, 6.2783°E.

**Paratypes.** RMCA 2017-022-P-0001-0007, 6, 99–162 mm SL; same data as holotype.—RMCA 2017-022-P-0008-0011, 4, 45–78 mm SL; Algeria: Jijel prov.: Oued Saleh at Borj Bou Akkaz, 36.4915°N, 5.8894°E.—RMCA 2017-022-P-0012-0018, 5, 73–150 mm SL; ZFMK ICH-105604-105605, 2, 100–109 mm SL; Algeria: Mila prov.: Oued El-Kébir at Hammam Beni Haroun, 36.6053°N, 6.2783°E.

**Material for molecular analyses.** RMCA DNA-2017-022-P-NH1-NH6, same data as holotype (GenBank accession numbers: Cyt b: MH187177, MH187179, MH187182, MH187183, MH187187; D-loop: MH187200,

MH187203, MH187205, MH187206, MH187210).—RMCA DNA-2017-022-P-NH16-NH27, Algeria: Mila prov.: Beni-Haroun reservoir at Oued El-Kébir, 36.3319, 6.1611 (GenBank accession numbers: Cyt b: MH187175, MH187176, MH187178, MH187180, MH187181, MH187184, MH187185, MH187186, MH187188; D-loop: MH187198, MH187199, MH187201, MH187202, MH187204, MH187207, MH187208, MH187209, MH187211).

**Diagnosis.** *Luciobarbus numidiensis* is distinguished from other *Luciobarbus* species from the African Mediterranean Sea basin, by a combination of characters, none of them unique. *Luciobarbus numidiensis* is distributed adjacent to *L. callensis* in the east and *L. setivimensis* in the west.

It is distinguished from *L. callensis* by having a longer anal-fin (19–23% SL vs. 16–19%), a wider anal-fin base (6.5–10% SL vs. 6.5–8) and a longer distance between the pectoral and pelvic-fin origins (27–30% SL vs. 22–29). The new species is distinguished from *L. setivimensis* by the having a longer pectoral-fin (74–94% HL vs. 69–84), a longer pre-dorsal length (49–55% SL vs. 46–52), a wider caudal peduncle depth (12–14% SL vs. 11–13) and a smaller eye diameter (11–22% HL vs. 11–28%).



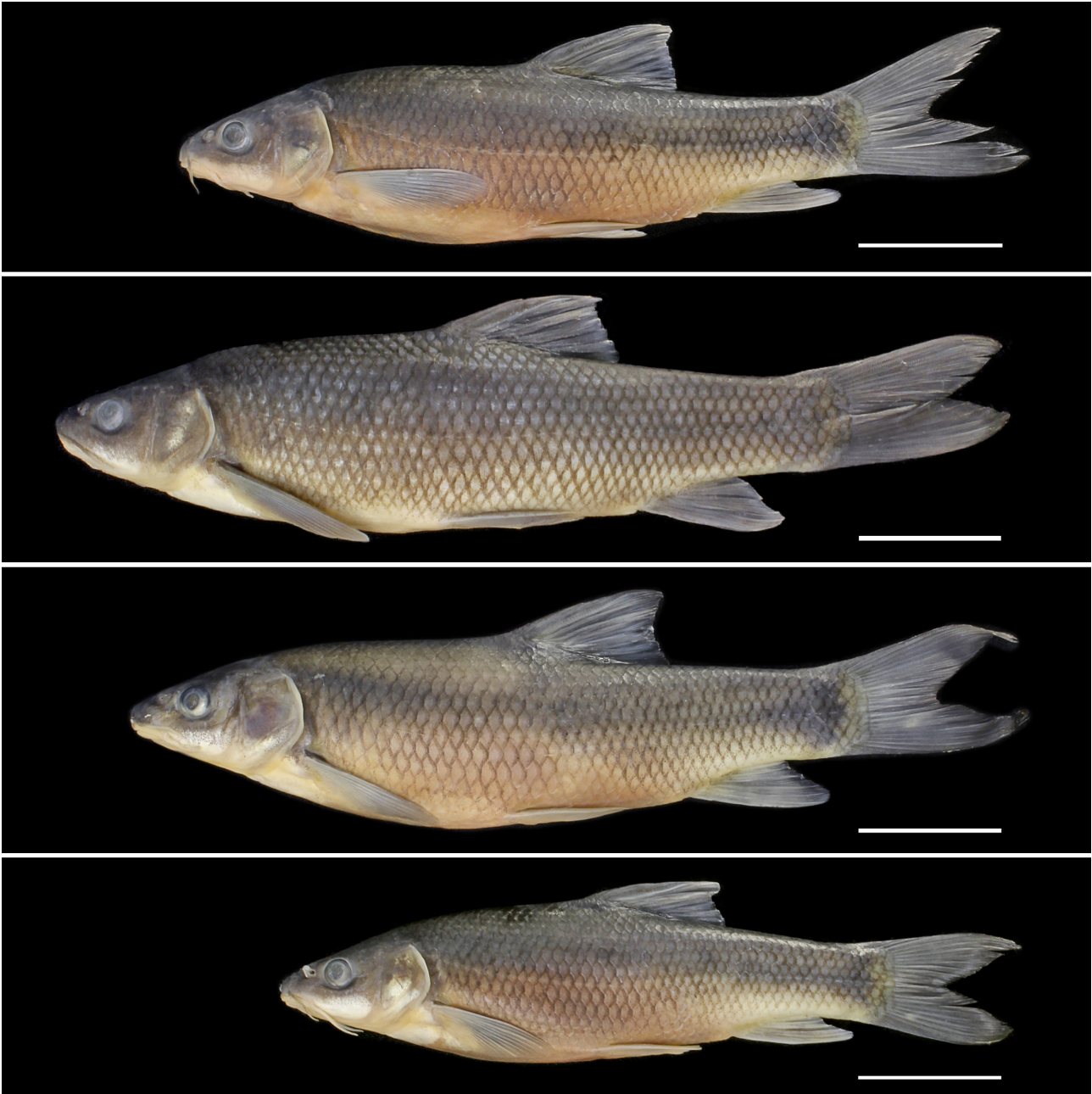
**FIGURE 6.** *Luciobarbus numidiensis*, RMCA 2017-022-P-0004, holotype, 140 mm SL; Algeria: Oued El-Kébir.

The new species is distinguished from *L. guercifensis* by having thin barbels (vs. thick), the rostral-barbel origin placed clearly behind the tip of the snout (vs. rostral-barbel origin at the extreme anterior of the snout). It is distinguished from *L. chelifensis*, *L. mascarensis* and *L. leptopogon* by having 43–47+1–2 lateral line scales (vs. 41–43+1–2 in *L. chelifensis* and *L. leptopogon*, usually 41+1–2 in *L. mascarensis*) (Table 8).

*Luciobarbus numidiensis* is further distinguished from *L. chelifensis* and *L. rifensis* by having a longer anal fin (19–22% SL vs. 17–19 in *L. chelifensis*, 16–19 in *L. rifensis*). The new species is distinguished from *L. leptopogon* by having a greater caudal peduncle depth (12–14% SL vs. 10–13) and from *L. yahyaouii* by having a longer distance between the pelvic and anal-fin origins (23–26% SL vs. 20–24).

It is also distinguished from *L. mascarensis*, *L. lanigarensis* and *L. yahyaouii* by having a shorter pre-dorsal length (48–55% SL vs. 53–58 in *L. mascarensis*, 54–59 in *L. lanigarensis*, 53–57 in *L. yahyaouii*). The new species is also distinguished from *L. lanigarensis* by having a smaller pre-pelvic length (49–56% SL vs. 55–60%), a greater post-orbital length (46–52% HL vs. 42–48) and the last unbranched dorsal-fin ray ossified and serrated at 2/3 of its length (vs. last unbranched dorsal-fin ray serrated along almost its entire length).

**Description.** See Figures 6–8 for general appearance. Morphometric data are given in Table 3 and meristic data in Table 7 and 8. A large-sized species with a moderately long head. Body deepest at dorsal-fin origin or about midline between nape and dorsal-fin origin. Depth decreasing continuously towards caudal-fin base. Greatest body width in front of dorsal-fin origin. Caudal peduncle compressed, 1.2–1.5 times longer than deep. Section of head roundish, flattened on ventral surface. Snout rounded. Mouth inferior. Dorsal-fin origin situated above pelvic-fin origin. Anal-fin origin slightly behind vertical of middle between dorsal and caudal-fin origins. Anal-fin origin slightly behind vertical of middle of distance between dorsal and caudal-fin origins. Anal fin reaching to caudal-fin base. Pectoral fin reaching 60–80% of distance between pectoral- and pelvic-fin origin. Pelvic fin not reaching vertical of tip of last dorsal-fin ray when folded down. Pelvic fin reaching to 60–90% of distance between pelvic and anal-fin origins. Posterior dorsal-fin margin straight or slightly concave. Posterior pectoral and anal-fin margins convex. Caudal fin forked with rounded lobes of equal length. Largest known specimen 430 mm SL.



**FIGURE 7.** *Luciobarbus numidiensis*, 1, RMCA 2017-022-P-0004, holotype, 140 mm SL; 2, RMCA 2017-022-P-0002, paratype, 162 mm SL; 3, RMCA 2017-022-P-0006, paratype, 148 mm SL; 4, RMCA 2017-022-P-0007, paratype, 121 mm SL; Algeria: Oued El-Kébir. Scale bars = 30 mm.

Dorsal fin with 4 or 5 unbranched and  $8\frac{1}{2}$  branched rays, last unbranched ray serrated along almost its entire length. Anal fin with 3 unbranched and  $5\frac{1}{2}$  branched rays. Pectoral-fin with 13–18 rays (mode 17) and pelvic fin with 8 rays. Lateral line with 43–47 scales on flank and 1–2 scales on caudal-fin base. Between dorsal-fin origin and lateral line  $8\frac{1}{2}$ – $9\frac{1}{2}$  (mode  $9\frac{1}{2}$ ) scale rows and  $5\frac{1}{2}$ – $6\frac{1}{2}$  (mode  $5\frac{1}{2}$ ) scale rows between pelvic-fin origin and lateral line. Pharyngeal teeth in three rows: 4+3+2. On first gill arch, 3-4 gill rakers on upper and 8-10 on lower limb.

**Coloration.** In life, whitish-golden on belly, silvery-grey on flank and dark-grey on back. Head golden-grey and cheeks greenish-golden. All fins grey. Pectoral fin with a golden distal edge.

**Etymology.** *Luciobarbus numidiensis* is named for Numidia, an ancient Berber kingdom, located in Algeria. The capital of Numidia was Cirta, the present city of Constantine. The El-Kebir River, the habitat of *L. numidiensis*, flows through Constantine. An adjective.



**FIGURE 8.** *Luciobarbus numidiensis*, 1+5, RMCA 2017-022-P-0004, holotype, 140 mm SL; 2+6, RMCA 2017-022-P-0002, paratype, 162 mm SL; 3+7, RMCA 2017-022-P-0006, paratype, 148 mm SL; 4+8, RMCA 2017-022-P-0007, paratype, 121 mm SL; Algeria: Oued El-Kébir. Scale bars: 1–4 = 30 mm; 5–8 = 10 mm.

**Distribution.** *Luciobarbus numidiensis* was found in the El-Kébir River and in the Beni Haroun reservoir, both belonging to the El-Kébir River drainage in northeastern Algeria. See Figure 2 (*L. numidiensis* are Nr. 10–12) for the distribution of *Luciobarbus* species in the African Mediterranean Sea basin.

**Remarks.** *Luciobarbus numidiensis* occurs north of the range of *L. biscarensis*, which is found in the rivers of the Algerian Sahara. It is distinguished from this species by having 43–47+1–2 lateral line scales (vs. 49–51+1–2), 5½–6½ scale rows between the lateral line and the pelvic-fin origin (vs. 7½–8½), 4 at 5 unbranched dorsal-fin rays (vs. 5), the dorsal-fin origin situated above the pelvic-fin origin (vs. behind), a longer anal fin (19–22% SL vs. 17–19) and a more wider interorbital distance (37–43% HL vs. 31–39).

**TABLE 5.** Morphometric data of *L. rifensis* (FSJF 3335, n=19); *L. setivimensis* (FSJF 3289, n=15; FSJF 3297, n=13; FSJF 3292, n=19; non-preserved individuals, n=10); *L. yahyaouii* (FSJF 3331, n=10; FSJF 3313, n=19).

	<i>L. rifensis</i>			<i>L. setivimensis</i>			<i>L. yahyaouii</i>		
	range	mean	SD	range	mean	SD	range	mean	SD
Standard length (mm)	80–208			61–363			67–181		
In percent of standard length									
Body depth at dorsal–fin origin	25.5–32.6	29.3	1.8	21.0–31.5	26.6	2.5	24.5–32.1	28.3	1.9
Head length	23.7–27.8	25.6	0.9	22.4–28.4	25.0	1.7	24.6–30.7	27.0	1.5
Pre–dorsal length	50.5–54.5	52.3	1.2	46.7–52.2	50.3	1.3	52.7–56.9	54.0	1.1
Pre–pelvic length	50.5–56.4	53.1	1.6	48.4–54.8	51.7	1.4	52.7–57.0	54.5	1.2
Pre–anal length	74.6–81.8	76.9	1.6	73.3–79.5	76.1	1.6	75.4–80.6	77.2	1.3
Dorsal fin base length	12.1–14.9	13.4	0.9	11.5–16.3	14.1	1.1	12.9–15.2	13.9	0.6
Anal fin base length	6.7–8.2	7.3	0.5	6.4–9.4	8.3	0.7	7.8–9.0	8.5	0.3
Anal fin length	15.9–18.9	17.7	0.8	19.0–21.6	19.8	0.4	19.1–21.3	20.1	0.7
Pelvic fin length	11.7–17.7	16.1	1.4	13.5–19.2	16.8	1.5	15.9–18.6	17.3	0.7
Pectoral fin length	17.2–20.6	19.4	0.9	16.8–22.3	19.7	1.2	18.4–21.3	19.9	0.7
Caudal peduncle length	16.1–19.6	17.8	1.2	14.4–18.4	17.1	0.8	16.1–19.4	17.5	0.8
Caudal peduncle depth	11.6–13.4	12.2	0.4	11.1–13.5	12.3	0.7	11.0–12.8	12.2	0.5
Distance between dorsal and anal–fin origins	30.5–39.5	35.3	2.1	32.2–39.0	35.4	1.6	31.3–38.3	35.1	1.8
Distance between pectoral and pelvic–fin origins	25.1–32.4	27.5	1.8	22.1–30.4	26.7	1.8	24.0–30.8	27.6	1.5
Distance between pelvic and anal–fin origins	20.7–27	23.8	1.5	19.2–28.9	24.4	1.9	20.8–24.0	22.7	1.0
In percent of head length									
Snout length	26–40	32.5	4.1	27–38	32.9	2.6	28–37	32.0	2.1
Eye diameter	14–24	20.6	2.6	11–28	16.6	5.0	15–26	20.9	2.8
Post–orbital length	42–51	47.0	2.4	45–50	47.6	1.0	45–50	47.1	1.5
Interorbital distance	34–41	37.5	1.8	40–44	41.5	1.9	33–40	38.0	1.8
Pectoral–fin length	66–84	75.9	4.1	69–84	77.2	3.3	65–79	74.0	3.6
Caudal peduncle depth	45–52	47.8	2.2	40–53	47.8	2.8	40–52	45.3	3.1

*Luciobarbus numidiensis* is quite variable in the serration of the last unbranched dorsal-fin ray. Specimens collected from the Beni-Haroun reservoir have the last unbranched dorsal-fin ray serrated along 2/3 of its length with sparsely set denticulations while fish collected from the El-Kébir River have the last unbranched dorsal-fin ray serrated along almost its entire length with densely set denticulations.

## Discussion

This study follows Casal-Lopez *et al.* (2015), Doadrio *et al.* (2016a, 2016b) and Brahim *et al.* (2017) in describing new species of African *Luciobarbus* based largely on molecular distances. We further made considerable efforts to detect external morphological characters usable for an univocal identification of the different *Luciobarbus* species from the African Mediterranean Sea basin. However, this exercise was found to be frustrating. Most species are very similar in their morphometric and meristic characters and almost all morphometric and meristic ranges overlap; larger overlaps are expected if larger series of specimens are examined. This is especially the case for *L. callensis*, *L. numidiensis* and *L. setivimensis*. However, all these allopatric species are well differentiated genetically and show substantial molecular distances (*L. callensis* / *L. numidiensis* = 4.3%; *L. setivimensis* / *L. numidiensis* = 8.8%).

**TABLE 6.** Morphometric data of *L. chelifensis* (RMCA 2016-024-P-0010-0016, n=7; non-preserved individuals, n=19); *L. mascarensis* (RMCA 2016-024-P-0017-0026, n=10; non-preserved individuals, n=15).

	<i>L. chelifensis</i>			<i>L. mascarensis</i>		
	range	mean	SD	range	mean	SD
Standard length (mm)	102–296			63.5–185		
In percent of standard length						
Body depth at dorsal-fin origin	24.8–31.3	27.6	1.3	26.2–30.6	28.6	1.1
Head length	22.4–26.4	24.2	1.2	24.4–28.0	26.1	0.8
Pre-dorsal length	49–54.2	51.6	1.1	52.5–58.3	54.6	1.4
Pre-pelvic length	50.3–56	53.4	1.6	50.0–58.3	54.4	1.7
Pre-anal length	73.8–79.3	77.3	1.6	73.3–85.1	79.9	1.9
Dorsal fin base length	12.8–15.2	13.6	0.6	12.1–15.3	13.8	0.8
Anal fin base length	8.5–9.9	9.0	0.4	6.6–9.6	7.9	0.6
Anal fin length	17.6–18.5	18.1	0.3	19.1–21.7	20.1	0.7
Pelvic fin length	14.1–16.2	15.2	0.6	14.3–19.4	15.8	1.2
Pectoral fin length	17.4–20.7	19.0	0.9	16.4–21.3	18.5	1.3
Caudal peduncle length	14.0–18.3	15.7	1.3	15.2–17.1	16.3	0.5
Caudal peduncle depth	11.2–12.7	11.9	0.5	11.8–13.3	12.6	0.4
Distance between dorsal and anal-fin origins	32.9–38.3	35.6	1.3	32.8–38.1	34.9	1.3
Distance between pectoral and pelvic-fin origins	25.5–31.3	29.2	1.5	25.8–31.4	28.3	1.4
Distance between pelvic and anal-fin origins	20.6–27.6	23.9	1.2	24.1–28.2	25.6	1.2
In percent of head length						
Snout length	27–37	32.2	2.9	26–38	32.3	2.8
Eye diameter	14–18	16.3	1.0	15–28	21.8	2.7
Post-orbital length	47–55	51.5	2.6	44–48	45.9	0.7
Interorbital distance	36–40	37.9	0.8	36–40	38.8	0.8
Pectoral-fin length	70–85	78.7	4.2	61–80	70.8	5.2
Caudal peduncle depth	46–52	49.2	1.2	46–53	48.5	1.2

**TABLE 7.** Frequencies of meristic characters: unbranched dorsal-fin rays and branched fin rays of *Luciobarbus* species examined for this study.

Species	N	unbranched dorsal-fin rays			N	branched dorsal-fin rays			branched pelvic-fin rays	
		3	4	5		7½	8½	9½	7	8
<i>L. biscarensis</i>	26			26	64	5	59		22	42
<i>L. callensis</i>	23		19	4	60		60			60
<i>L. chelifensis</i>	15		15		26		26		2	24
<i>L. leptopogon</i>	18		18		39	4	35		1	38
<i>L. mascarensis</i>	13		13		29		29		5	24
<i>L. lanigarensis</i>	10		10		23		23			23
<i>L. numidiensis</i>	11		6	5	15		15			15
<i>L. rifensis</i>	19		13	6	19		19			19
<i>L. setivimensis</i>	30	8	22		57		57		4	53
<i>L. yahyaouii</i>	19		1	18	29		27	2	4	25

**TABLE 8.** Frequencies of lateral-line scales on flank in *Luciobarbus* species examined for this study.

Species	N	Scales along the lateral line										
		41	42	43	44	45	46	47	48	49	50	51
<i>L. biscarensis</i>	26									8	2	16
<i>L. callensis</i>	34			2	5	16	9	2				
<i>L. chelifensis</i>	15	4	9	2								
<i>L. leptopogon</i>	18	5	8	5								
<i>L. mascarensis</i>	15	14		1								
<i>L. lanigarensis</i>	18			13	2	3						
<i>L. numidiensis</i>	29			3	2	6	1	17				
<i>L. rifensis</i>	19			10	6	3						
<i>L. setivimensis</i>	30			6	9	5	8	2				
<i>L. yahyaouii</i>	19		6	7	4	2						

Recently, Clavero *et al.* (2017:10) showed stunning examples of how head and body shape might be variable in African *Luciobarbus* species. They speculate that this substantial morphological variability might correspond to the very high ecological plasticity of these barbels, which indeed inhabit almost all kinds of waterbodies. With regard to the paucity of diagnostic morphological characters, the inclusion of molecular genetic characters into standard taxonomic works in *Luciobarbus* is of great value but makes it very difficult to identify species in the field.

### Comparative material.

Numbers in brackets correspond to Figure 2.

*Luciobarbus biscarensis*: FSJF 3286, 31, 69–190 mm SL; Algeria: Biskra prov.: Oued el Abiod above damlake at Oued Lahbal, 34.896365°N 5.91696°E (43)—FSJF 3279, 9, 50–122 mm SL; Algeria: Biskra prov.: Oued Loutaya at Manbae, 35.094477°N 5.586152°E (45).

*Luciobarbus callensis*. FSJF 3014, 6, 35–97 mm SL; Tunisia: Oued el Abid about 2 km west of Erritiba, 36.867286°N 10.724574°E (2).—FSJF 3011, 4, 36–94 mm SL; Tunisia: Oued Ghezala 1 km south of Fernana, 36.643868°N 8.699214°E (5).—FSJF 3017, 20, 60–210 mm SL; Tunisia: Kébir River below Zouitina reservoir, 36.732208°N 8.529498°E (6).—FSJF 3008, 9, 71–145 mm SL; Tunisia: Oued Zahzah 2 km south of Bechechema, 35.821259°N 10.159296°E (3).

*Luciobarbus chelifensis*: RMCA 2016-024-P-0010-0016, 7, 102–152 mm SL; Algeria: Chelif prov.: Oued Sly west of Ouled Ben Abdelkader village, 36.026609°N 1.266014°E (22). ZFMK ICH-105597-105601, 5, 82–122 mm SL; Algeria: Ain Defla prov.: Ghrib reservoir at Oued Chorffa, 36.140553°N 2.563226°E (21).

*Luciobarbus guercifensis*: ZFMK ICH-105305, 1, 115 mm SL; Morocco: Oued Za near Guefait, Moulouya, 34.226706°N 2.392343°W (30).

*Luciobarbus leptopogon*: FSJF 3284, 9, 97–128 mm SL; Algeria: stream Meliji at Hammam Melouane, 36.4829°N, 3.0414°E (20).—RMCA-2016-024-P-0001-0009: 9, 76–133 mm SL; Algeria: Blida prov.: Oued Hammam Melouane, 36.4829°N, 3.0414°E (20).

*Luciobarbus mascarensis*: FSJF 3283, 4, 75–121 mm SL; Algeria: Mascara prov.: Oued El Hammam upriver of Hocine, 35.444265°N, 0.035043°E (27).—RMCA 2016-024-P-0017-0026, 10, 66–188 mm SL; Algeria: Mascara prov.: Oued Taria north of Meftah Sidi Boubekeur, 35.109848°N, 0.0673°E (26).

*Luciobarbus rifensis*: FSJF 3335, 19, 80–208 mm SL; Morocco: Laou River near Chefchaouene, 35.168483°N 5.314508°W (36).

*Luciobarbus setivimensis*: FSJF 3289, 15, 66–156 mm SL; Algeria: Oued Zitouna at Tala Khaled, 36.634327°N 5.216879°E (15).—FSJF 3297, 13, 132–225 mm SL; Algeria: Oued Boughzazene at Boughzazene, 36.614407°N 5.361913°E (14).—FSJF 3292, 19, 66–156 mm SL; Algeria: Oued Remila at inflow into Oued Soummam, 36.632246°N 4.74745°E (16).

*Luciobarbus yahyaouii*: FSJF 3331, 10, 75–166 mm SL; Morocco, Mar chica, Small wadi on road to Kariat



Arkmane, 35.052146°N 2.876565°W (32).—FSJF 3313, 19, 67–187 mm SL; Morocco: Oued Za near Guefait, Moulouya, 34.226706°N 2.392343°W (30).

Material used for molecular analyses

*Barbus barbus*. B1, B2, Belgium: Moha prov.: Mehaigne River, Meuse Basin, 50.5451°N 5.1164°E. River drainage (GenBank accession number: Cyt b: MH187191, MH187192).

*Luciobarbus guercifensis*. G6, G7, Morocco: Oued Za near Guefait, Moulouya, 34.226706°N 2.392343°W (GenBank accession number: Cyt b: MH187189, MH187190; D-loop: MH187212, MH187213).

Materials examined but not preserved (used for osteological study).

*Luciobarbus biscarensis*: 24, 242–308 mm SL; Algeria: Khenchela prov.: Oued el Arab at Babar, 35.166192°N 7.020921°E (41).

*Luciobarbus callensis*: 2, 313–334 mm SL; Algeria: El-Taref prov.: Oued Bou-Namoussa in Seybouse drainage, 36.621504°N 8.057990°E (8).—19, 205–292 mm SL; Algeria: Guelma prov.: Oued Bouhamdane at Hammam Debagh drainage, 36.468478°N 7.229560°E (9).

*Luciobarbus chelifensis*: 3, 242–262 mm SL; Algeria: Relizane prov.: Oued Rhiou at Sidi Abed village, 36.009889°N 0.992520°E (23).—6, 252–300 mm SL; Algeria: Relizane prov.: Gagar Dam at Ouled Taieb village, 35.908391°N 1.008624°E (24).—9, 111–165 mm SL; Algeria: Chelif prov.: Oued Sly west of Ouled Ben Abdelkader village, 36.026609°N 1.266014°E (22).—1, 267 mm SL; Algeria: Ain Defla prov.: Ghrib reservoir at Oued Chorffa, 36.140553°N 2.563226°E (21).

*Luciobarbus leptopogon*: 21, 82–175 mm SL; Algeria: Blida prov.: Oued Hammam Melouane, 36.4829°N, 3.0414°E (20).

*Luciobarbus mascarensis*: 15, 67–158 mm SL; Algeria: Mascara prov.: Oued Taria north of Meftah Sidi Boubekour, 35.109848°N, 0.0673°E (26).

*Luciobarbus lanigarensis*: 23, 61–210 mm SL; Morocco: Guenfouda prov.: Oued Isly, 34.5118°N 2.05826°W (29).

*Luciobarbus numidiensis*: 15, 217–430 mm SL; Algeria: Mila prov.: Beni-Haroun reservoir, 36.3319°N, 6.1611°E (11).

*Luciobarbus setivimensis*: 10, 187–363 mm SL; Algeria: Bordj-Bou-Arredj prov.: Ain Zada Dam at Ain Taghrout, 36.151209°N 5.159443°E (13).

## Acknowledgements

We are grateful to Serkan Wesel and Fabian Herder (ZFMK) for their assistance and for allowing us to examine material under their care. Emmanuel Vreven, Miguel Parrent, Tobias Musschoot (RMCA) are thanked for their time and providing pictures. This study is a part of the training session on FishBase and fish taxonomy at RMCA, Tervuren (Belgium). Photographs of some fishes are visible on the digital collections of the RMCA at <http://digit03.africamuseum.be/home>. It is publication number BRC 422 of the Biodiversity Research Center, Université Catholique de Louvain, Belgium. This study was supported by the FREDIE project, supported by the Leibniz Association Joint Initiative for Research and Innovation (SAW).

## Literature cited

- Bazinet, A.L., Zwickl, D.J. & Cummings, M.P. (2014) A gateway for phylogenetic analysis powered by grid computing featuring GARLI 2.0. *Systematic Biology*, 63, 812–818.  
<https://doi.org/10.1093/sysbio/syu031>
- Brahimi, A., Freyhof, J., Henrard, A. & Libois, R. (2017) *Luciobarbus mascarensis* and *Luciobarbus chelifensis* (Cyprinidae): two new species in Algeria. *Zootaxa*, 4277 (1), 32–50.  
<https://doi.org/10.11646/zootaxa.4277.1.3>
- Casal-Lopez, M., Perea, S., Yahyaoui, A. & Doadrio, I. (2015) Taxonomic review of the genus *Luciobarbus* Heckel, 1843 (Actinopterygii, Cyprinidae) from northwestern Morocco with the description of three new species. *Graellsia*, 71, 1–24  
<https://doi.org/10.3989/graellsia.2015.v71.135>
- Clavero, M., Qninba, A., Riesco, M., Esquivias, J., Calzada, J. & Delibes, M. (2017) Fish in Moroccan desert rives: the arid extreme of Mediterranean streams. *Fishes in Mediterranean Environments*, 003, 1–21.  
<https://doi.org/10.29094/FiSHMED.2017.003>

- Doadrio, I., Casal-López, M. & Perea, S. (2016a) Taxonomic remarks on *Barbus moulouyensis* Pellegrin, 1924 (Actinopterygii, Cyprinidae) with the description of a new species of *Luciobarbus* Heckel, 1843 from Morocco. *Graellsia*, 72, 1–24.  
<https://doi.org/10.3989/graellsia.2016.v72.174>
- Doadrio, I., Casal-López, L. Perea, S. & Yahyaoui, A. (2016b) Taxonomy of rheophilic *Luciobarbus* Heckel, 1842 (Actinopterygii, Cyprinidae) from Morocco with the description of two new species. *Graellsia*, 72, 1–17.  
<https://doi.org/10.3989/graellsia.2015.v71.135>
- Felsenstein, J. (1981) Evolutionary tree from DNA sequences, a maximum likelihood approach, *Journal of Molecular Evolution*, 17, 368–376.  
<https://doi.org/10.1007/BF01734359>
- Geiger, M.F., Herder, F., Monaghan, M.T., Almada, V., Barbieri, R., Bariche, M., Berrebi, P., Bohlen, J., Casal-Lopez, M., Delmastro, G.B. Denys, G.P., Dettai, A., Doadrio, I., Kalogianni, E., Kärst, H., Kottelat, M., Kovačić, M., Laporte, M., Lorenzoni, M., Marčić, Z., Özuluğ, M., Perdices, A., Perea, S., Persat, H., Porcelotti, S., Puzzi, C., Robalo, J., Šanda, R., Schneider, M., Šlechtová, V., Stoumboudi, M., Walter, S. & Freyhof, J. (2014) Spatial heterogeneity in the Mediterranean Biodiversity Hotspot affects barcoding accuracy of its freshwater fishes. *Molecular Ecology Resources*, 14, 1210–1221.  
<https://doi.org/10.1111/1755-0998.12257>
- Gouy, M., Guindon, S. & Gascuel, O. (2010) SeaView Version 4: A multiplatform graphical user interface for sequence alignment and phylogenetic tree building. *Molecular Biology and Evolution*, 27, 221–224.  
<https://doi.org/10.1093/molbev/msp259>
- Hasegawa, M., Kishino, H. & Yano, T. (1985) Dating of the human-ape split by a molecular clock by mitochondrial DNA. *Journal of Molecular Evolution*, 22, 160–174.  
<https://doi.org/10.1007/BF02101694>
- Iguchi, K., Tanimura, Y. & Nishida, M. (1997) Sequence divergence in the mtDNA control region of amphidromous and landlocked forms of ayu. *Fish Sciences*, 63, 901–905.  
<https://doi.org/10.2331/fishsci.63.901>
- Katoh, K. & Standley, D.M. (2013) MAFFT Multiple sequence alignment Software Version 7. Improvements in performance and usability. *Molecular Biology and Evolution*, 30, 772–780.  
<https://doi.org/10.1093/molbev/mst010>
- Kimura, M. (1980) Estimation of evolutionary distances between homologous nucleotide sequences. *Proceedings of the National Academy of Sciences*, 78, 454–458.  
<https://doi.org/10.1073/pnas.78.1.454>
- Kottelat, M. & Freyhof, J. (2007). *Handbook of European Freshwater Fishes*. Cornol, Suisse, xiv + 646 pp.
- Lanave, C., Preparata, G., Saccone, C. & Serio, G. (1984) A new method for calculating evolutionary substitution rates. *Journal of Molecular Evolution*, 20, 86–93.  
<https://doi.org/10.1007/BF02101990>
- Lanfear, R., Frandsen, P.B., Wright, A.M., Senfeld, T. & Calcott, B. (2017) PartitionFinder 2: new methods for selecting partitioned models of evolution for molecular and morphological phylogenetic analyses. *Molecular Biology and Evolution*, 34, 772–773.  
<https://doi.org/10.1093/molbev/msw260>
- Nishida, M., Ohkawa, T. & Iwata, H. (1998) Methods of analysis of genetic population structure with mitochondrial DNA markers. *Fish Genetics and Breeding Science*, 26, 81–100.  
<https://doi.org/10.1371/journal.pone.0179706>
- Palumbi, S.R. (1996) Nucleic acids II: The polymerase chain reaction. In: Hillis, D.M., Moritz, C. & Mable, B.K. (Eds.), *Molecular Systematic. 2<sup>nd</sup> Edition*. Sinauer, Sunderland, MA, pp. 5–247.
- Perdices, A. & Doadrio, I. (2001) The molecular systematics and biogeography of the European cobitids based on mitochondrial DNA sequences. *Molecular Phylogenetics and Evolution*, 19, 468–478.  
<https://doi.org/10.1006/mpev.2000.0900>
- Rambaut, A. (2009) FigTree. Version 1.4.2. Available from: <http://tree.bio.ed.ac.uk/software/figtree/> (accessed 2 May 2017)
- Rodríguez, F., Oliver, J.L., Marín, A. & Medina, J.R. (1990) The general stochastic model of nucleotide substitution. *Journal of Theoretical Biology*, 142 (4), 485–501.  
[https://doi.org/10.1016/S0022-5193\(05\)80104-3](https://doi.org/10.1016/S0022-5193(05)80104-3)
- Ronquist, F., Teslenko, M., Mark, P., Ayres, D.L., Darling, A., Höhna, S., Larget, B., Liu, L., Suchard, M.A. & Huelsenbeck, J.P. (2012) MrBayes 3.2. Efficient Bayesian phylogenetic inference and model choice across a large, model space. *Systematic Biology*, 61, 539–542.  
<https://doi.org/10.1093/sysbio/sys029>
- Sukumaran, J. & Holder, M.T. (2010) DendroPy, a Python library for phylogenetic computing. *Bioinformatics*, 26, 1569–1571.  
<https://doi.org/10.1093/bioinformatics/btq228>
- Sukumaran, J. & Holder, M.T. (2015) SumTrees. Phylogenetic tree Summarization, 4.0.0 Available from: <https://github.com/jeetsukumaran/DendroPy> (accessed 2 May 2017)
- Talavera, G. & Castresana, J. (2007) Improvement of phylogenies after removing divergent and ambiguously aligned blocks from protein sequence alignments. *Systematic Biology*, 56, 564–577.  
<https://doi.org/10.1080/10635150701472164>

- Tamura, K., Stecher, G., Peterson, D., Filipski, A. & Kumar, S. (2013) Molecular Evolutionary Genetics Analysis: MEGA version 6.0. *Molecular Biology and Evolution* 30, 2725–2729.  
<https://doi.org/10.1093/molbev/mst197>
- Tavaré, S. (1986) Some probabilistic and statistical problems in the analysis of DNA sequences. *Lectures on Mathematics in the Life Sciences (American Mathematical Society)*, 17, 5786.