A review of the *Clarias* species (Pisces; Siluriformes) from the Lower Congo and the Pool Malebo

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ABSTRACT

HANSSENS, M. 2009. A review of the *Clarias* species (Pisces; Siluriformes) from the Lower Congo and the Pool Malebo. *J. Afrotrop. Zool.* 5: 27-40.
A review is made of the *Clarias* species known from the Lower Congo and from the Pool Malebo (Congo Basin). Six valid species are recognized for the Lower Congo and the Pool Malebo; these are *C. gariepinus*, *C. platycephalus*, *C. camerunensis*, *C. gabonensis*, *C. buthupogon* and *C. angolensis*. Diagnostics and species descriptions were updated with redefined or corrected diagnostic characters, and a key to the *Clarias* in the area was made. A revised synonymy for *C. ngola* and *C. Lualae* is proposed.

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Keywords: *Clarias*, Lower Congo, Pool Malebo, identification key, diagnostics

INTRODUCTION

A pan-African revision of the genus *Clarias* Scopoli, 1777 was made by Teugels (1986). In this review, six subgenera within the genus *Clarias* were recognised (*Dinotopteroides*, *Clarias*, *Platycephaloides*, *Clarioides*, *Anguilloclarias* and *Brevicephaloides*). Identification keys to these subgenera and to the species groups in each of these subgenera were given. Nevertheless, the identification of certain *Clarias* species (particularly of those belonging to the same subgenus) remained difficult. Identification problems were mainly due to ill-defined diagnostic characters (such as the form of the frontal fontanelle and the presence and strength of the serration on the inside and outside of the pectoral spine, see discussion below) or to the misinterpretation of certain diagnostic characters (such as the pattern of the secondary sensory pores, see discussion below).
For the Lower Congo and Pool Malebo, seven species from four subgenera were reported (Teugels 1982b; 1986). These are *Clarias gariepinus* (Burchell, 1822) (subgenus *Clarias* Scopoli, 1777), *C. platycephalus* Boulenger, 1902 (subgenus *Platycephaloides* Teugels, 1982b), *C. dumerilii* Steindachner, 1866 and *C. camerunensis* Lönnberg, 1895 (subgenus *Brevicephaloides* Teugels, 1982b) and *C. gabonensis* Günther, 1867, *C. buthupogon* Sauvage, 1879 and *C. angolensis* Steindachner, 1866 [subgenus *Clarioides* David (in David & Poll, 1937)].
In this manuscript, a revision of the *Clarias* species from the study area is made and revised or new diagnostic characters are presented that allow easier identification of these species. A revised synonymy of *Clarias ngola* and *C. lualae* is presented.

MATERIAL AND METHODS

All counts and measurements follow Teugels (1986), except for the length of the cleithrum. This is the longitudinal distance measured where the paired cleithra are fused (Fig. 1).
The sizes of the premaxillary and vomerine toothplates are often used as a diagnostic character to distinguish *Clarias* species (Teugels 1986; 2003; Teugels *et al.* 2007). In Teugels (1986; 2003) these measurements are illustrated, but this illustration has unfortunately

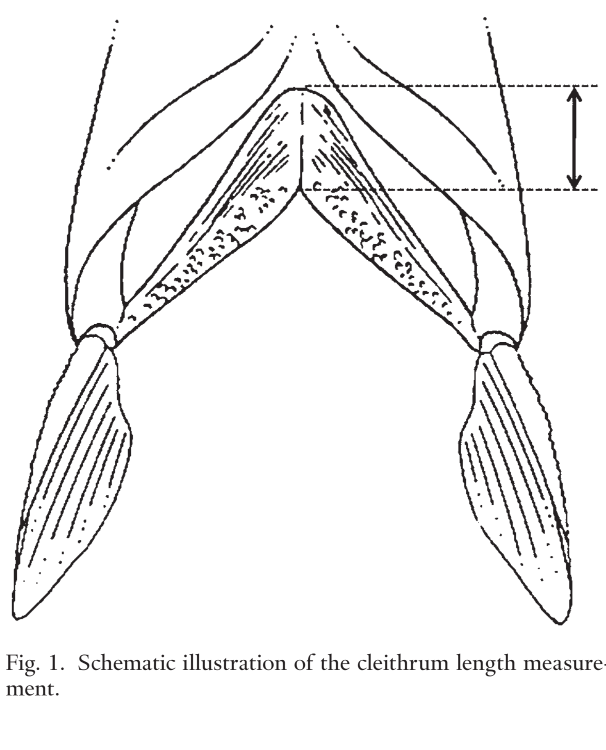

Fig. 1. Schematic illustration of the cleithrum length measurement.

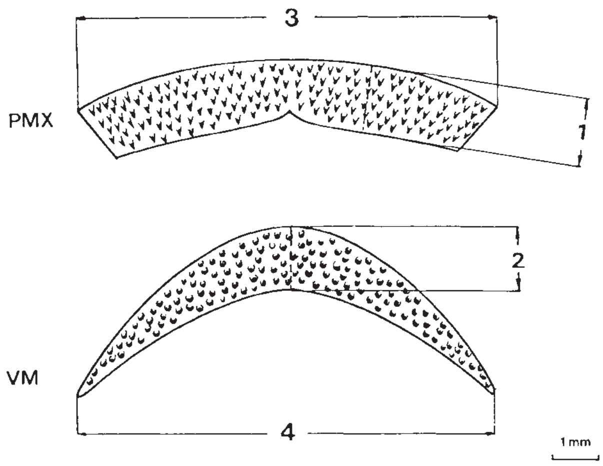

Fig. 2. Schematic illustration of the toothplate measurements. 1: length of the premaxillary (PMX) toothplate; 2: length of the vomerine (VM) toothplate; 3: width of the premaxillary toothplate; 4: width of the vomerine toothplate.

been omitted in Teugels *et al.* (2007). Since the terms he used for the different dimensions or measurements may lead to confusion, we illustrate them here as well (Fig. 2). Intuitively, for any rectangular object, the term 'length' is used for the distance between its ends (longest dimension), while the 'width' generally indicates the distance from side to side, often measured at right angles to the length. Using these terms accordingly will result in confusion on the dimensions given for the toothplates. Teugels (1986; 2003) uses the term length for the measurement of the toothplates in the longitudinal axis (Fig. 2), which is the shortest measurement. He uses the term width for the longest measurement of the two: the size of the toothplate taken perpendicular to the longitudinal body axis. Although this may be counterintuitive at first, this terminology is consistent with usual anatomical terminology (e.g., toothplate measurement in cichlids), and we have adopted the term length for the longitidunal measurement of the cleithrum 'depth' as well.

Clarias gariepinus (Burchell, 1822)
Figure 3

Diagnosis In *C. gariepinus* the posterior margin of the pectoral spine is smooth, while strongly serrated in *C. gabonensis*, *C. buthupogon* and *C. angolensis*. It has 27 or more gill rakers on the first arch, while *C. platycephalus*, *C. dumerilii* and *C. camerunensis* have 14 or fewer. Most *C. gariepinus* can easily be distinguished from the other *Clarias* in the area by the presence of a band of pigment on either side of the lower head (Fig. 4). It furthermore has a larger head than *C. camerunensis* (26.6-35.0 vs. 21.0-26.1 % SL) and, on average, a shorter dorsal fin than *C. angolensis*, *C. gabonensis* and *C. buthupogon* (53.6-67.4 vs. 65.1 % SL or more).

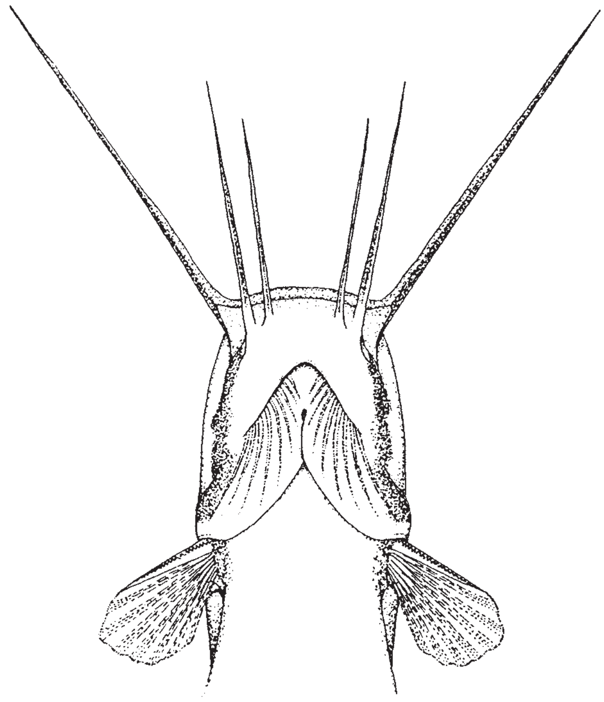

Fig. 4. Pigmentation bands on the lower head of *Clarias gariepinus* (after Teugels, 1982a).

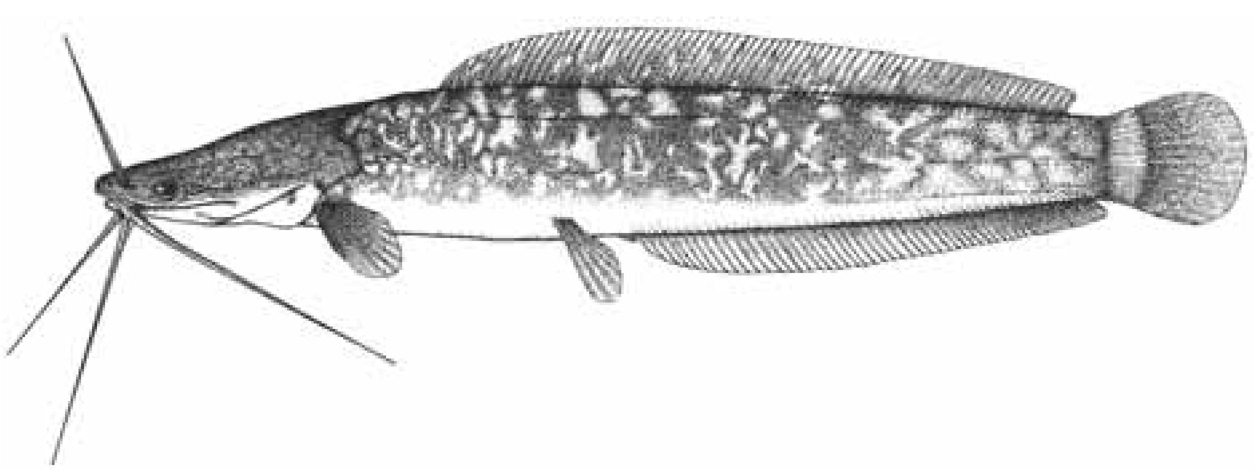

Fig. 3. *Clarias gariepinus*, Ruzizi River, 202.0 mm TL (after Teugels, 1986).

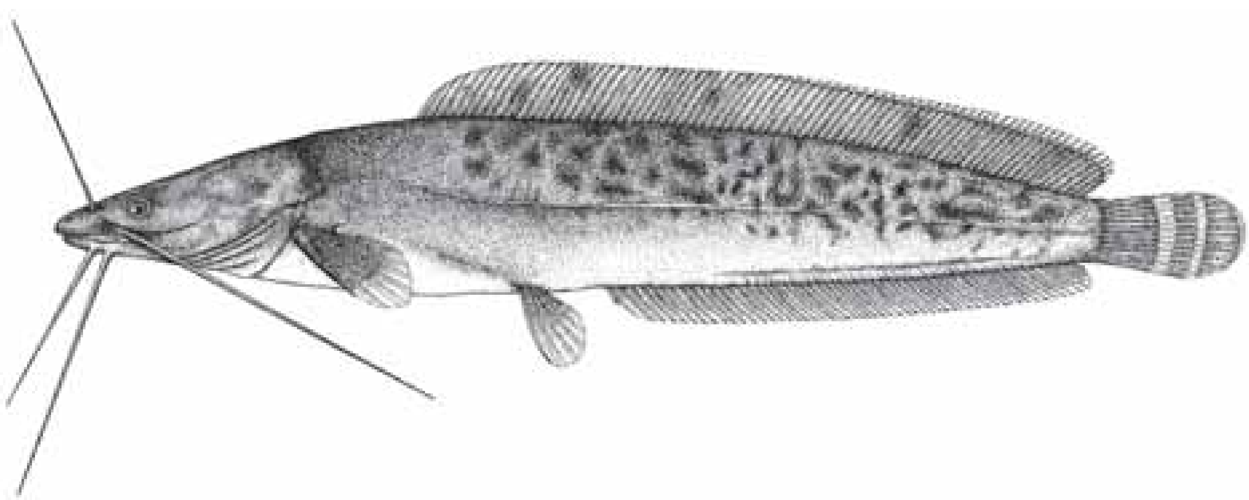

Fig. 5. *Clarias platycephalus*, Luita River, Angola, 151.0 mm TL (after Teugels, 1986).

Description See Table 1.
Maximum size 700 mm TL [but specimens of up to 1,500 mm have been reported (Teugels *et al.*, 2007)].
Coloration: Preserved specimens exhibit two colour types: one is marbled and the other uniform. In the former, irregular black blotches overlie a pale base colour on the back and flanks, the ventrum is creamy white. In the second, the back and flanks are dark grey or blackish, the ventrum is creamy white. The two colour types appear to correlate with water turbidity and substrate type. Although Teugels *et al.* (2007) reported that in both colour forms a band of pigment is present on either side of the lower head (Fig. 3), we have collected pale coloured *C. gariepinus* in the Inkisi Basin (Lower Congo) that lack these pigment bands. In some specimens the anterior part of the caudal fin is clearer than the posterior part, and there may be series of irregular black spots on the caudal fin.
Distribution Reported from the Lower Congo and Pool Malebo (Teugels 1986). Virtually pan-African in distribution.

Clarias platycephalus Boulenger, 1902
Figure 5

Diagnosis In *C. platycephalus* the posterior margin of the pectoral spine is smooth, while strongly serrated in *C. gabonensis*, *C. buthupogon* and *C. angolensis*. It has fewer gill rakers on the first arch (13 or fewer vs. 27 or more), and a smaller head (24.5-28.4 vs. 26.6-35.0 % SL) than *C. gariepinus*. Its premaxillary toothplate width is larger (32.4-40.0 % HL) than in *C. gariepinus* (23.2-32.1 % HL), *C. angolensis* (24.3-30.7 % HL) and *C. gabonenesis* (21.3-28.2 % HL). It has a shorter dorsal fin base (60.4-65.6 % SL) than *C. angolensis* (65.1-73.8 % SL), *C. gabonensis* (65.7-75.0 % SL) and *C. buthupogon* (65.1-73.0 % SL). It has a striking marbled colouration pattern, while *C. camerunensis* and *C. angolensis* have a uniform body colouration
Description See Table 1.
Maximum size 376 mm TL.
Coloration: Both in life and in preservation coloration is marbled. Large black blotches on a pale brown base are present on the back, flanks, dorsal and anal fins, and on the posterior parts of the paired fins. Ventrum and lower parts of paired fins are beige, as are the distal parts of unpaired fins. The caudal fin bears a series of pale and dark bands.
Distribution Only reported from the Pool Malebo (Teugels 1986). Elsewhere known from the Lower Guinea (Teugels *et al.* 2007) and from the Central Congo Basin.

Clarias camerunensis Lönnberg, 1895
Figure 6

Diagnosis *Clarias camerunensis* can easily be distinguished from *C. gariepinus* by its low number of gill rakers (14 or less vs 27 or more) and smaller head (21.0-26.1 vs. 26.6-35.0 % SL). It can be distinguished from *C. gabonensis*, *C. buthupogon* and *C. angolensis* by the absence of serration on the inner side of the pectoral spine. It has a generally larger premaxillary toothplate width (30.4-38.9 HL) than *C. gariepinus* (23.2-32.1 % HL), *C. angolensis* (24.3-30.7 % HL) and *C. gabonensis* (21.3-28.2 % HL). On average, it has a shorter dorsal fin base (59.5-67.9 % SL) than *C. angolensis* (65.1-73.8 % SL), *C. gabonensis* (65.7-75.0 % SL) and *C. buthupogon* (65.1-73.0 % SL). It furthermore differs from *C. platycephalus* in its colouration pattern (uniform vs. strikingly marbled).

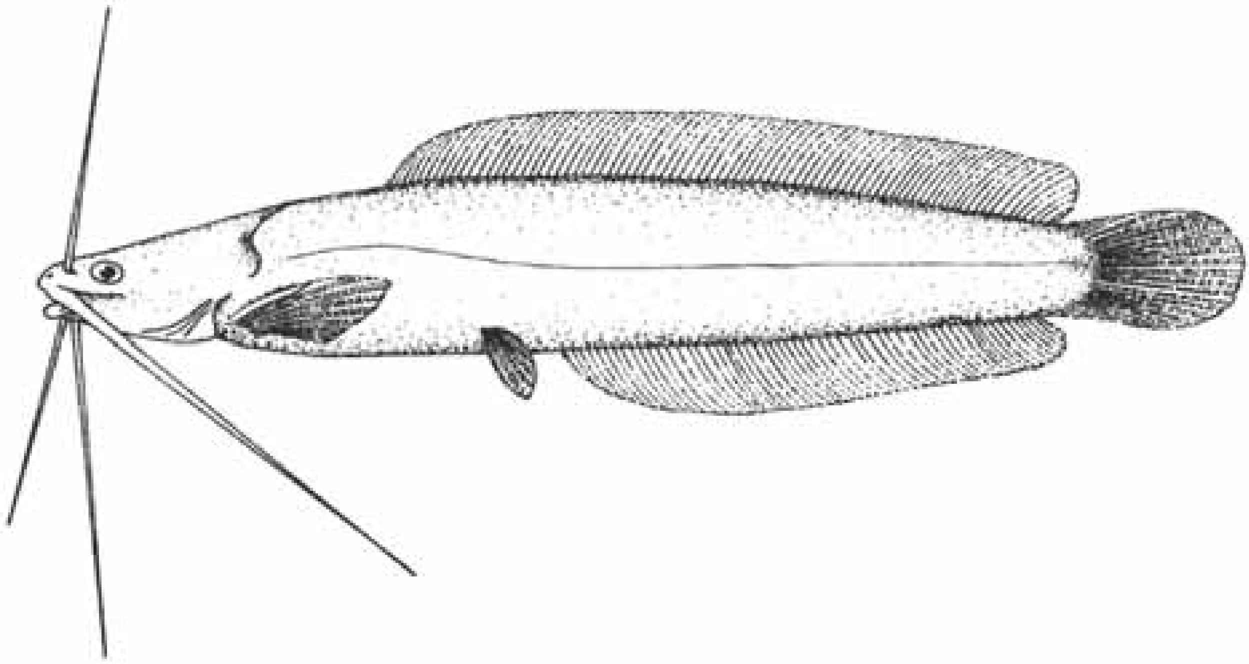

Fig. 6. *Clarias camerunensis*, Cameroon, 87.7 mm TL (after Teugels, 1986).

Description See Table 1.
Maximum size 466 mm TL.
Coloration: No information on live coloration available. Preserved specimens are dark brown on the back and flanks, while the ventrum is pale brown or beige. Pectoral and pelvic fins sometimes with a clear distal band. Caudal fin may have a series of alternating clear and dark vertical bands.
Distribution Only reported from the Lower Congo. Elsewhere present in most Lower Guinea Basins (Teugels *et al.* 2007) and from the middle Congo (Teugels 1986).

Clarias gabonensis Günther, 1867
Figure 7

Diagnosis *Clarias gabonensis* has a pectoral spine that is strongly serrated on both sides, while the inner side of the pectoral spine is smooth in *C. gariepinus* and *C. camerunensis*, and slightly serrated on the upward section of the posterior side in *C. platycephalus*. Compared to the other species in the *Clarioides* subgenus, a large part of the bony surface of its cleithrum is exposed trough the skin (cleithrum length 21.5-26.0 % HL, Fig. 8A). In *C. angolensis*, a

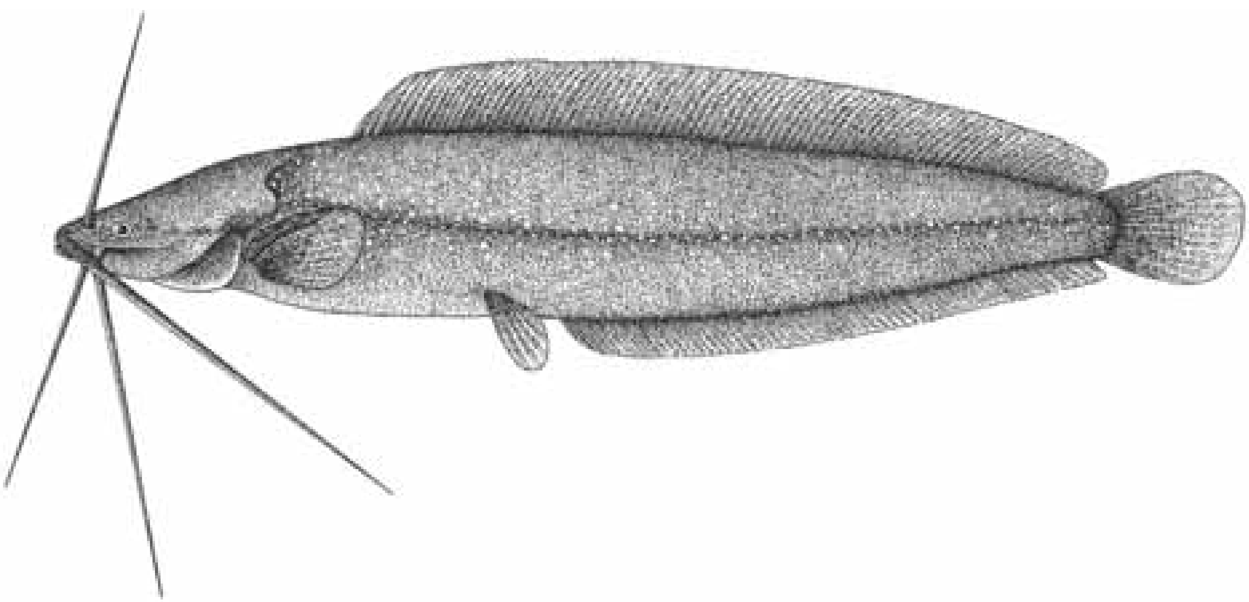

Fig. 7. *Clarias gabonensis*, Ezanga River, Gabon, 221.0 mm TL (after Teugels, 1982a).

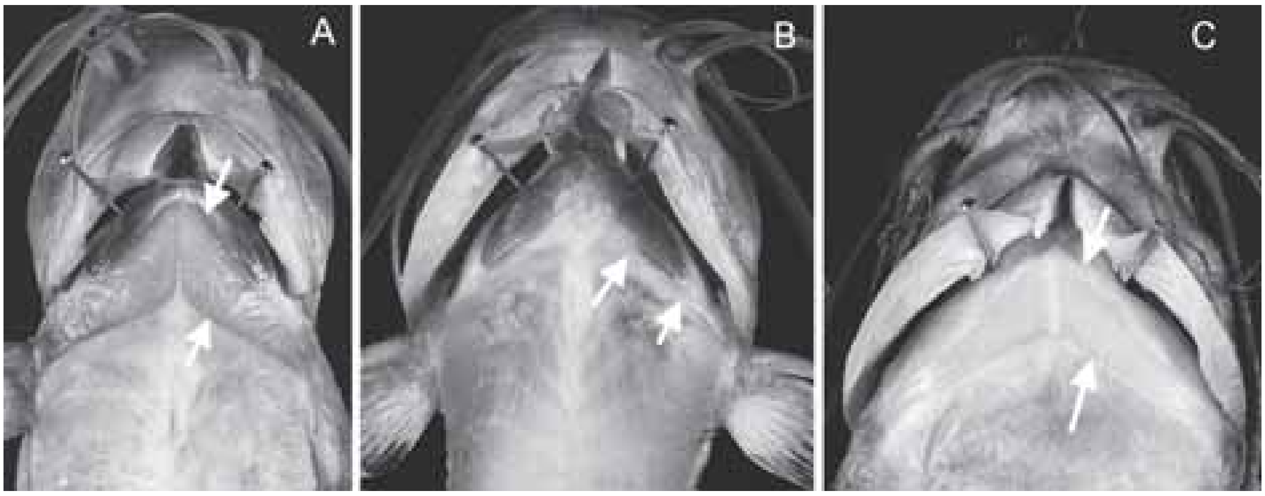

Fig. 8. Illustration of the morphology of the cleithrum in the three speciers of the subgenus *Clarioides*. A: *Clarias gabonensis*; B: *C. buthupogon*; C: *C. angolensis*. Arrows indicate anterior and posterior border of cleithrum in *C. gabonensis* and *C. angolensis*, position of cleithrum in *C. buthupogon*.

much smaller part of the bony surface is exposed trough the skin (13.0-18.6 % HL, Fig. 8C), while in *C. buthupogon*, the cleithrum is deeply embedded in soft tissue and only a narrow bony ridge is exposed trough the skin (Fig. 8B). The width of its premaxillary toothplate is smaller (21.3-28.2 % HL) than in *C. platycephalus* (32.4-40.0 % HL) or in *C. camerunensis* (30.4-38.9 % HL). Its dorsal fin base is generally larger (65.7-75.0 % SL) than in *C. gariepinus* (53.6-67.4 % SL), *C. platycephalus* (60.4-65.6 % SL) or in *C. camerunensis* (59.5-67.9 % SL).

Description See Table 1.

Maximum size 317 mm SL (Teugels 1986).

Coloration: ln life, brownish yellow. Pigmentation may be uniform but is more often marbled, with many, small yellowish spots. The distal quarter of the caudal fin is clearer than the anterior portion.

Distribution Found in the Lower Congo and the Pool Malebo (Teugels, 1986). Elsewhere known from the Ogowe, Noya, Kouilou, and Chiloango rivers (Lower Guinea) (Teugels *et al.* 2007) and from the Central Congo Basin (Teugels 1986).

Clarias buthupogon **Sauvage, 1879**

Figure 9

Diagnosis *Clarias buthupogon* has a pectoral spine that is strongly serrated on both sides, while

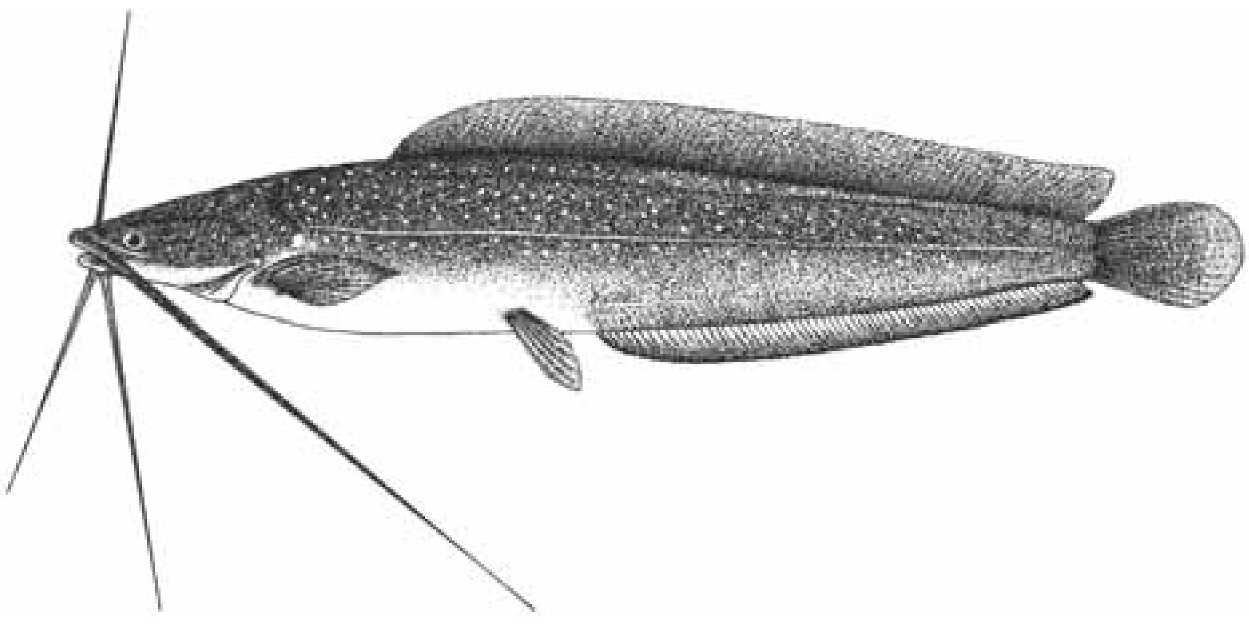

Fig. 9. *Clarias buthupogon*, Ogowe River, Gabon, 188.0 mm TL (after Teugels, 1986).

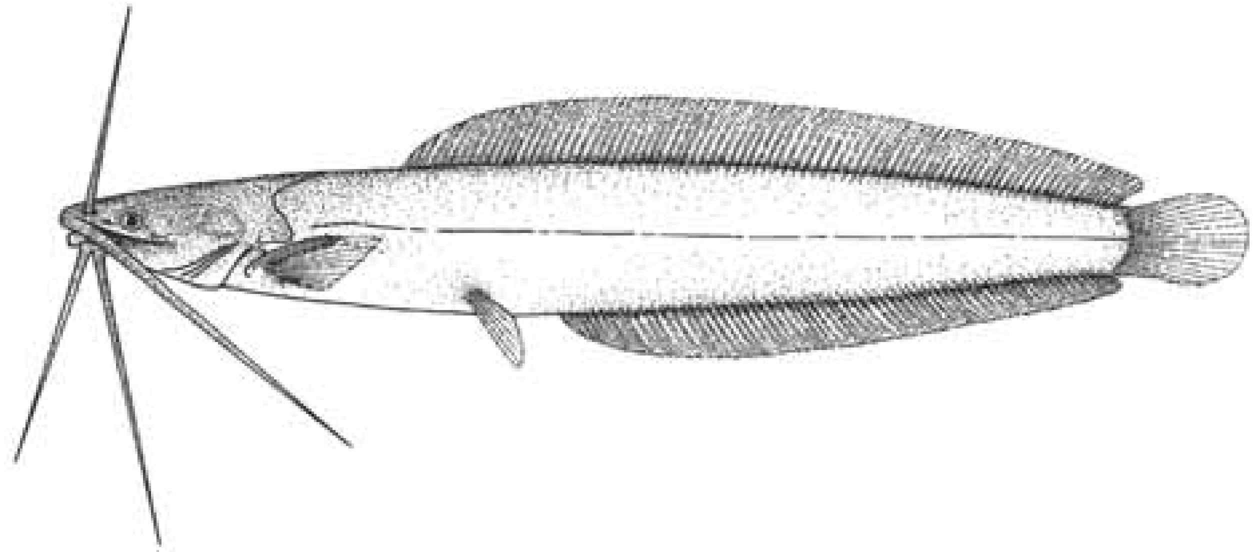

Fig. 10. *Clarias angolensis*, Angola, 157.0 mm TL (after Teugels, 1986).

the inner side of the pectoral spine is smooth in *C. gariepinus* and *C. camerunensis*, and slightly serrated on the upward section of the inner side in *C. platycephalus*. Compared to the other species in the *Clarioides* subgenus, its cleithrum is mostly inbedded in soft tissue, only a thin bony ridge is exposed trough the skin, while a larger part of the bony surface of the cleithrum is exposed trough the skin (length more than 13.0 % HL) in *C. angolensis* and *C. gabonensis* (Fig. 8A,C). Its dorsal fin base is generally larger (65.1-73.0 % SL) than in *C. gariepinus* (53.6-67.4 % SL), *C. platycephalus* (60.4-65.6 % SL) or in *C. camerunensis* (59.5-67.9 % SL).
Description See Table 1.
Maximum size 266 mm SL (Teugels 1986).
Coloration: Both in life and preservation colour is generally dark. Both uniform and marbled coloration is observed. When uniform the dorsum and flanks are brownish black while the ventrum is paler. When marbled there are numerous small dark brown spots on a paler background over the dorsum and flanks, the ventrum is creamy. In marbled individuals the unpaired fins are very dark. On the caudal fin are a series of vertical bands, a clear, median band is flanked by dark bands.
Distribution Reported from the Lower Congo and the Pool Malebo (Teugels, 1986). Elsewhere, its distribution ranges up to the coastal rivers of Benin and Nigeria, it is present in the Lower Guinea and the Central and Upper Congo basin (Teugels 1986; Teugels *et al.* 2007).

Clarias angolensis Steindachner, 1866
Figure 10

Diagnosis *Clarias angolensis* has a pectoral spine that is strongly serrated on both sides, while the inner side of the pectoral spine is smooth in *C. gariepinus* and *C. camerunensis*, and slightly serrated on the upward section of the posterior side in *C. platycephalus*. Compared to the other species in the *Clarioides* subgenus, the surface of its cleithrum that is exposed trough the skin is intermediate (length 13.0-18.6 % HL) (Fig. 8C), while much larger in *C. gabonensis* (length 21.5-26.0 % HL) (Fig. 8A), and reduced to a narrow bony ridge in *C. buthupogon* (Fig. 8B). Its premaxillary toothplate width is smaller (24.3-30.7 % HL) than in *C. platycephalus* (32.4-40.0 % SL) or *C. camerunensis* (30.4-38.9 % HL). Its dorsal fin base is generally larger (65.1-73.8 % SL) than in *C. gariepinus* (53.6-67.4 % SL), *C. platycephalus* (60.4-65.6 % SL) or in *C. camerunensis* (59.5-67.9 % SL). It has a uniform body colouration, while marbled in *C. platycephalus*.
Description See Table 1.
Maximum size 282 mm SL (Teugels 1986).
Coloration: Preserved specimens with a uniform coloration. Dorsum, flanks and dorsal parts of the paired fins are dark brown, while the ventrum and ventral parts of the paired fins are pale brown to grey.
Distribution Reported from the Lower Congo and the Pool Malebo (Teugels, 1986). Elsewhere it is found in the Lower Guinea (Teugels *et al.* 2007) and the Central Congo Basin.

Table 1. Ranges in Standard Length, relative measurements and meristics for the *Clarias* species from the Lower Congo and the Pool Malebo (after Teugels, 1986). Abbreviations: SL standard length; HL head length; HW head width; HD head depth; SnL snout length; IOW interorbital width; ED eye diameter; NaBL nasal barbel length; MaBL maxillary barbel length; IMBL inner mandibulary barbel length; OMBL outer mandibulary barbel length; PmW premaxillary toothplate width; PmL premaxillary toothplate length; VoW vomerine toothplate width; VoL vomerine toothplate length; PD predorsal distance; PA preanal distance; PV preventral distance; PP prepectoral distance; DFL length dorsal fin base; AFL length anal fin base; VFL ventral fin length; PFL pectoral fin length; PSL pectoral spine length; CFL caudal fine length; DC distance dorsal fin to caudal fin; OPD distance occipital process to dorsal fin; CPD caudal peduncle depth; BDA; body depth at anus; GR gill rakers on first branchial arch; AFR anal fin rays; DFR dorsal fin rays; VFR ventral fin rays; PFR pectoral fin rays; BSR branchiostegal rays; V vertebral count.

	C. gariepinus	*C. platycephalus*	*C. angolensis*	*C. gabonensis*	*C. buthupogon*	*C. camerunensis*
SL (mm)	27.7 - 701.0	28.2 - 334.0	31.2 - 282.0	39.4 - 317.0	29.0 - 266.0	22.9 - 417.0
HL % SL	26.6 - 35.0	24.5 - 28.4	22.3 - 27.1	24.4 - 27.7	21.0 - 27.9	21.0 - 26.1
HW % SL	15.7 - 23.1	17.4 - 21.9	14.1 - 19.4	15.8 - 19.0	14.2 - 20.9	15.7 - 21.9
HD % SL	9.1 - 16.0	8.8 - 12.4	9.4 - 13.2	7.1 - 11.4	7.0 - 11.9	7.3 - 12.8
SnL % HL	17.4 - 26.8	23.1 - 28.1	20.8 - 26.8	20.2 - 24.0	21.3 - 29.4	22.4 - 28.6
IOW % HL	36.4 - 45.7	42.6 - 51.8	41.4 - 48.6	41.1 - 45.4	41.3 - 51.8	45.5 - 54.3
ED % HL	5.2 - 13.1	6.1 - 10.6	6.5 - 8.7	6.4 - 10.3	7.1 - 12.1	6.1 - 11.0
NaBL % HL	18.6 - 90.6	45.5 - 98.4	72.1 - 130.2	78.3 - 110.0	77.8 - 187.5	49.0 - 114.1
MaBL % HL	57.4 - 173.7	76.7 - 174.0	105.1 - 195.3	106.6 - 235.5	142.9 - 305.8	85.9 - 176.8
IMBL % HL	30.0 - 78.3	30.1 - 80.3	72.4 - 108.9	63.0 - 94.0	58.9 - 128.7	17.1 - 100.0
OMBL %HL	42.5 - 121.9	68.0 - 127.5	95.0 - 134.5	58.0 - 142.0	104.3 - 211.2	73.2 - 137.9
PmW % HL	23.2 - 32.1	32.4 - 40.0	24.3 - 30.7	21.3 - 28.2	25.9 - 37.2	30.4 - 38.9
PmL % HL	2.4 - 6.9	5.4 - 7.3	4.9 - 6.8	3.8 - 5.8	3.7 - 6.4	5.2 - 7.1
VoW % HL	18.8 - 26.8	26.4 - 36.2	20.9 - 27.5	18.6 - 25.9	21.0 - 31.2	26.1 - 33.9
VoL % HL	2.0 - 7.7	3.6 - 5.8	3.2 - 8.1	3.3 - 5.2	2.7 - 8.3	3.6 - 7.1
PD % SL	31.3 - 40.0	33.7 - 38.6	28.3 - 35.0	27.6 - 35.6	27.0 - 35.0	31.5 - 38.2
PA % SL	48.7 - 59.5	48.1 - 56.3	45.8 - 53.4	45.8 - 52.7	45.7 - 52.0	47.5 - 53.9
PV % SL	42.2 - 51.1	42.0 - 48.1	38.2 - 46.2	38.1 - 46.5	38.1 - 44.0	38.8 - 45.5
PP % SL	21.5 - 27.7	19.4 - 25.4	16.2 - 22.6	18.0 - 22.4	16.6 - 23.0	18.0 - 24.7
DFL % SL	53.6 - 67.4	60.4 - 65.6	65.1 - 73.8	65.7 - 75.0	65.1 - 73.0	59.5 - 67.9
AFL % SL	37.0 - 47.6	43.7 - 48.0	47.7 - 54.9	47.3 - 53.6	46.3 - 55.2	45.0 - 52.9
VFL % SL	7.8 - 12.2	7.5 - 12.1	7.2 - 10.1	7.8 - 9.5	7.4 - 15.2	5.9 - 9.9
PFL % SL	9.5 - 16.3	10.4 - 15.6	10.6 - 14.9	12.3 - 15.1	11.2 - 16.2	10.3 - 15.3
PSL % SL	4.4 - 12.1	6.5 - 11.3	6.5 - 11.4	8.7 - 12.5	7.1 - 13.0	5.6 - 10.0
CFL % SL		10.7 - 16.3		9.4 - 15.9	9.8 - 17.2	11.1 - 15.6
DC % SL	0.0 - 7.6	1.6 - 3.7	0.9 - 2.7	0.0 - 2.5	- 1.4 - 2.1	1.2 - 4.3
OPD % SL	2.7 - 8.6	6.4 - 14.9	4.3 - 9.8	3.0 - 8.6	3.3 - 8.6	8.4 - 13.8
CPD % SL	6.2 - 10.1	6.1 - 7.3	5.5 - 7.2	4.7 - 6.8	5.0 - 7.6	5.8 - 7.9
BDA % SL	10.7 - 18.1	12.2 - 17.1	14.0 - 18.6	13.9 - 17.9	11.3 - 18.7	11.9 - 16.4
GR	24 - 110	8 - 13	10 - 23	16 - 28	12 - 22	7 - 14
AFR	45 - 60	56 - 65	55 - 69	56 - 71	55 - 68	52 - 70
DFR	61 - 79	72 - 83	67 - 84	72 - 88	75 - 88	69 - 87
VFR	6	6	6	6	6	6 - 7
PFR	I 9 - I 12	I 8 - I 11	I 8 - I 9	I 8 - I 10	I 8 - I 10	I 8 - I 10
BSR	8 - 12	8 - 10	8 - 9	7 - 9	7 - 10	7 - 10
V	56 - 63	59 - 63		55 - 60	56 - 63	56 - 61

Key to the *Clarias* species from the Lower Congo and the Pool Malebo

1a. Pectoral spine with strong serration on the outside, sometimes weak serration towards the tip on the inside of the pectoral spine. Dorsal fin base length varies between 53.6 to 67.9 % SL. Never an irregular pattern of small white spots on the body . . 2
1b. Pectoral spine with strong serration on the outside and the inside. Dorsal fin base varies between 65.1 to 75.0 % SL. Some specimens may show an irregular pattern of small white spots on the body 4

2a. 27 or more gill rakers . . . . *C. gariepinus*
2b. 14 or fewer gill rakers 3

3a. Head length 24.5-28.4 % SL, striking marbled colour pattern on lateral and upper body parts, caudal with three dark vertical bands, separated by narrower light bands . . . . *C. platycephalus*
3b. Head length 21.0-26.1 % SL, colour pattern uniform, dark brown lateral and upper body parts . . . . *C. camerunensis*

4a. Interorbital distance 41.1-45.4 % HL; Cleithrum length 21.5-26.0 % HL; Nasal barbel 78.3-110 % HL; Outer mandibular barbel 58.0-142 % HL; Gill rakers 16-28 . . . . *C. gabonensis*
4b. Interorbital distance 41.3-51.8 % HL; Cleithrum length ≤ 18.6 % HL; Nasal Barbel 72.1-187.5 % HL; Outer mandibular barbel 95.0-211.2 % HL; Gill rakers 10-23 5

5a. Premaxillary toothplate width 25.9-37.2 % HL; Vomerine toothplate width 21.0-31.2 % HL; Cleithrum only visible as thin line through ventral skin; Maxillary barbel length 142.9-305.8 % HL; Outer mandibular barbel length 104.3-211.2 % HL; Preserved specimens darkly coloured . . *C. buthupogon*
5b. Premaxillary toothplate width 24.3-30.7 HL; Vomerine toothplate width 20.9-27.5 % HL; Cleithrum length 13.0-18.6 % HL; Maxillary barbel length 105.1-195.3 % HL; Outer mandibular barbel length 95.0-134.5 % HL; preserved specimens not obviously dark coloured . . . . *C. angolensis*

DISCUSSION

The subgenera in the genus *Clarias*

The six *Clarias* species from the Lower Congo and the Pool Malebo belong to four different subgenera as defined by Teugels (1986). Three of these (*Clarias*, *Brevicephaloides* and *Platycephaloides*) are represented by a single species, one (*Clarioides*) by three different species. These subgenera were described on the basis of derived morphological traits (Teugels, 1982b; 1986). Several phylogenies of the Clariidae have since been proposed (Teugels & Adriaens, 2003; Agnese & Teugels, 2005; Devaere *et al.*, 2007). The morphology-based phylogeny by Teugels & Adriaens (2003) only deals with the interrelationships of the genera and subgenera in the clariids. The other two are species-based, but due to the fact that the species numbers for each subgenus are generally limited (single species in some cases), the exact composition, validity or interrelationships of the *Clarias* subgenera cannot be fully assessed. Nevertheless, in view of the taxonomic discussions below, we will briefly discuss some topics that are relevant to the subgenera concerned.

Teugels & Adriaens (2003) clearly demonstrated that the genus *Clarias* is paraphyletic but were unable to resolve the position of several genera and subgenera. The monophyly of a clade incorporating the subgenus *Clarioides* and the genera *Channalabes* and *Dolichallabes* was based on a single apomorphic character; the irregular pattern of the secondary neuromasts. This is in contradiction with our findings of a regular pattern of secondary neuromasts in *Clarioides* (see discussion below). A review of several *Channalabes* species and *Dolichallabes microphthalmus* demonstrated that they also possess a regular pattern of neuromasts (pers. obs.). Based on these observations, it seems that there are strong affinities between the subgenera *Clarioides* and *Anguilloclarias*. Indeed, when the derived character 'neuromasts placed in irregular pattern' is deleted from the cladogram, there is no character left to separate the subgenera *Clarioides* and *Anguilloclarias*. Interestingly, most representatives of both subgenera were considered by David (1935) to belong to the same subgenus *Clarioides*. In the cladogram of Teugels & Adriaens (2003), the strong serration on both sides of the pectoral spine is the derived character that defines the monophyletic assemblage including, amongst others, the subgenera *Clarioides* and *Anguilloclarias*. This observation, however, is in contrast to the statement in Teugels (1986) where "not strongly marked" outer serrations are reported for the genus *Anguilloclarias*. Our observations demonstrated that this character shows a high inter- and intraspecific variability in *Anguilloclarias*; the serration on the oustide varies from completely absent to strongly-developed on the basal half of the pectoral spine (pers. obs.). Also in the genus *Channalabes*, which is found in the same clade defined by the strong pectoral spine serration, the outer serration shows a similar variability, from strongly developed to entirely absent (Devaere, 2005).

Based on a molecular phylogeny, Agnese & Teugels (2005) suggested that the subgenus *Clarioides* probably represents a monophyletic group (all four

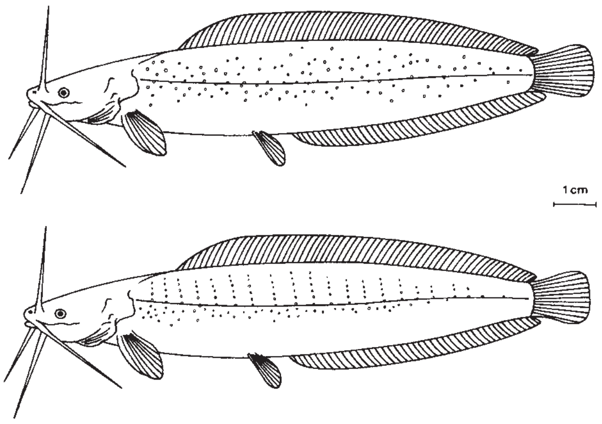

Fig. 11. Schematic illustration of the two patterns of the secondary sensory pores as suggested by Teugels (1986). A: Subgenus *Clariodes*. B: All *Clarias* subgenera except *Clarioides*.

Clariodes species formed a monophyletic assemblage, near but distinct from the *Anguilloclarias* species), while the validity of the other genera remains to be tested.

In the combined morphological and molecular phylogeny by Devaere *et al.* (2007), representatives of *Anguilloclarias* and *Clarioides* are found in the same monophyletic clade, with the sole representative of *Clarioides* together with *Channalabes* representing a clade within the paraphyletic *Anguilloclarias*. Based on these phylogenies and our observations, it seems clear that the validity of these subgenera needs to be re-addressed. However, even if both subgenera turn out to be synonymous, as the subgenus *Clarioides* has priority over *Anguilloclarias*, the nomenclature and taxonomic status of the three Congo species considered here would remain unchanged.

Identification and diagnostics of the subgenus *Clarioides*

The subgenus *Clarioides* was defined on the basis of two characters (Teugels 1982b; 1986). The inside of the pectoral spine has strong serration over most of its length, a character missing in all but one (*Anguilloclarias*) of the other *Clarias* subgenera, and the irregular random pattern of the secondary openings of the sensory system (Fig. 11A), which are arranged in vertical bands in all other *Clarias* subgenera (Fig. 11B) (Teugels 1982b; 1986).

The serration of the pectoral spine however isn't a totally unambiguous character to distinguish the six subgenera. The differences between 'strong', 'not strongly marked' or 'weak' serration is not always clear-cut. There is quite a bit of variation in what Teugels (1986) considered as 'strong' serration (compare Fig. 12A outside spine, B inside spine and D inside spine with C inside spine which are all considered as 'strong'). Teugels' 'not strongly marked' serration (Fig. 12C outside spine) and 'strong' serration (Fig. 12C inside spine) seem more similar to each other than to the 'strong' serration as illustrated elsewhere (Fig. 12A outside spine and 12D outside spine). In addition it is difficult to draw an objective

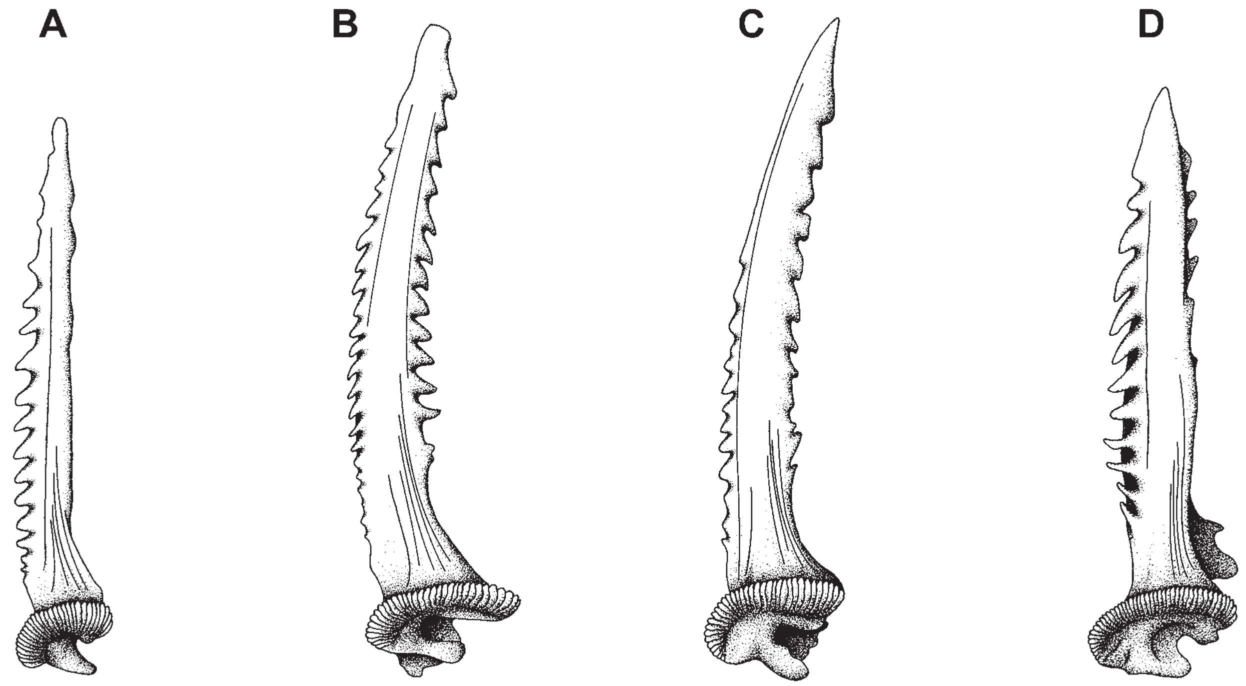

Fig. 12. Schematic illustration of the different types of pectoral spine serration. A: Strong serration only on outside, subgenera *Dinotopteroides*, *Clarias* and *Platycephaloides*. B: Strong serration on both sides, subgenus *Clarioides*. C: Serration not strongly marked on outside, strong serration on inside, subgenus *Anguilloclarias*. D: Strong serration on outside, weak serration on distal part inside, subgenera *Brevicephaloides* and *Platycephaloides*.

line between these supposedly different character states as all species probably show some intraspecific variability in the strength of the serration on the pectoral spine. This further complicates the assignment of certain specimens to one of these categories or subgenera. Fortunately, however, since the subgenus *Anguilloclarias* is absent from the Lower Congo and the Pool Malebo, the serration of the inner side of the pectoral spine remains a good character to distinguish the subgenus *Clarioides* (strong inner serration, Fig. 12B) from the other subgenera present [*Clarias* and *Brevicephaloides* (no inner serration, Fig. 12A) and *Platycephaloides* (weak inner serration on distal part, Fig. 12D)].

The pattern of the secondary sensory pores, the second character used as diagnostic for the subgenus *Clarioides* (Fig. 11), seems to be a misinterpretation of what is simply a pigmentation pattern. Close examination of several specimens belonging to different species of the subgenus *Clarioides* showed that the arrangement of the secondary pores does not differ from the other *Clarias* subgenera. The very small pores of the sensory system (mostly invisible to the naked eye) differ in size from the larger white spots (which are small, but visible by the naked eye) on the body. In all *Claroides* specimens examined these secondary pores are clearly arranged in vertical lines. Although Teugels (1986), in the colour description of *C. albopunctatus* (a species belonging to the *Clariodes* subgenus), stated that 'it should be noted that the small white spots on the body form part of the sensory system and are not at all a colouration character', our observations on several *C. albopunctatus* specimens showed that the opposite is true. The irregular small white spots that are clearly visible on the body of some *Clarioides* species are nothing but a pigmentation character. While *C. angolensis* clearly belongs to the subgenus *Clarioides* (based on the strong inner serration of the pectoral spine), its pigmentation lacks the irregular pattern of small white spots on the body and unpaired fins.

Diagnostics of the species in the *Clarioides* subgenus

The frontal fontanelle shape was used as an important diagnostic character to distinguish *Clarias gabonenis* from *C. buthupogon* and *C. angolensis* in the subgenus *Clarioides* (Teugels 1986). It was described to be short and squat in *C. gabonensis* ('sole'-shaped or less than twice as long as wide), while long and small ('knife'-shaped or more than twice as long as wide) in *C. buthupogon* and *C. angolensis*. Since the frontal fontanelle shape can be highly variable, and these two 'types' fall in a continuous range of shape variation, the clear-cut distinction between the two shapes is arbitrary. Our data taken on *C. gabonensis* and *C. angolensis* indeed confirm that it is shorter on average in *C. gabonensis* (1.4-2.7 times as long as wide, average 2.1, n=5) than in *C. angolensis* (2.1-3.2 times as long as wide, average 2.8, n=9), but there is considerable overlap between both species, and the range observed in *C. gabonensis* does not correspond to the definition of the short 'sole'-shaped fontanelle used by Teugels (1986).

Further examination and comparison of *C. gabonensis*, *C. buthupogon*, *C. angolensis* specimens however showed that the external visibility of the cleithrum is clearly different in these three species. In *C. buthupogon*, the cleithrum is embedded in soft tissue, and only a narrow bony ridge is exposed trough the skin; in *C. angolensis* and *C. gabonensis*, a larger part of the bony surface of the cleithrum is exposed trough the skin (Fig. 8). The length of the visible part of the cleithrum, measured along the longitudinal axis as a percentage of head length, is much higher in *C. gabonenis* than in *C. angolensis* (21.5-26.0 % HL, average 23,6 % HL, n=19 *vs.* 13.0-18.6 % HL, average 15,9 % HL, n= 11). Consequently, the inner angle formed by both paired bones is clearly sharper in *C. angolensis* than in *C. gabonensis*, where the posterior border of the visible part of the cleithrum sometimes forms an almost straight line. No overlap in this character was observed between *C. angolensis* and *C. gabonensis*, both species can relatively easily be distinguished, even without the necessity of taking the cleithrum length measurement.

Identification, diagnostics, synonyms and distribution of *C. camerunensis* and *C. dumerilii* (subgenus *Brevicephaloides*)

A brief note on the *C. dumerilii* neotype. Because the type of *C. dumerilii* was lost, Teugels (1986) designated a neotype for this species. The *C. dumerilii* neotype was selected from a series of five specimens, catalog number BMNH 7.13:42-46 [the neotype is listed as BMNH 7.13:42 in Teugels (1986), while the remaining four specimens BMNH 7.13:43-46 are listed as study material]. The indicated neotype has however never been set apart and all five specimens are still contained in one single sample BMNH 7.13:42-46. Since the three largest specimens all approach the reported size of the neotype (151.1 mm total length), it is impossible to determine which of these was intended to be the neotype of *C. dumerilii*.

Teugels (1986) synonymised two species, *C. ngola* Lönnberg & Rendahl, 1920 and *C. lualae* Lönnberg & Rendahl, 1922, with *C. dumerilii*. Both species were only known from their types (holotype of *C. ngola* and two syntypes of *C. lualae*), and both originated from the Luala Basin, a northern tributary from the Lower Congo River, DRC. Their synonymy with *C. dumerilii* was based on the morphology of the lateral head bones, their relative measurements and meristics and the presence of a long frontal fontanelle, all characters observed in *C. dumerilii*. The fact that their type localities are fairly distant from the known distribution range of *C. dumerilii* was not discussed, and the observed difference in the development of the suprabranchial organ was considered unimportant, as this character was reported to be highly variable and ecophenotypic in *C. dumerilii*. *Clarias dumerilii* and *C. camerunensis* both belong to the subgenus *Brevicephaloides* and are morphologically extremely similar. They were mainly distinguished on the basis of the morphology of the lateral head bones (Teugels 1986). In *C. dumerilii* the dermosphenotic and supraorbital are always separated and may even be somewhat reduced (Fig. 13). In *C. camerunensis* the dermosphenotic and supraorbital bones become joined in specimens longer than 200 mm SL, although some larger specimens were found lacking the joined structure. [There appears to be an error in the key: in the option leading, amongst others, to *C. dumerilii*, it is stated that 'the lateral bones "dermosphenotic" and supraorbital become joined between 80 and 150 mm standard length (depending on the species), they are never reduced'. This option in the key equally leads to two other species, *C. laeviceps* (for which it is stated in the description that the lateral head bones become joined between 80-100 mm) and *C. liocephalus* (bones are separated to about 150 mm)]. Since the lateral head bones in *C. camerunensis* become joined in specimens larger than 200 mm SL, specimens smaller than 200 mm standard length cannot unambiguously be identified as

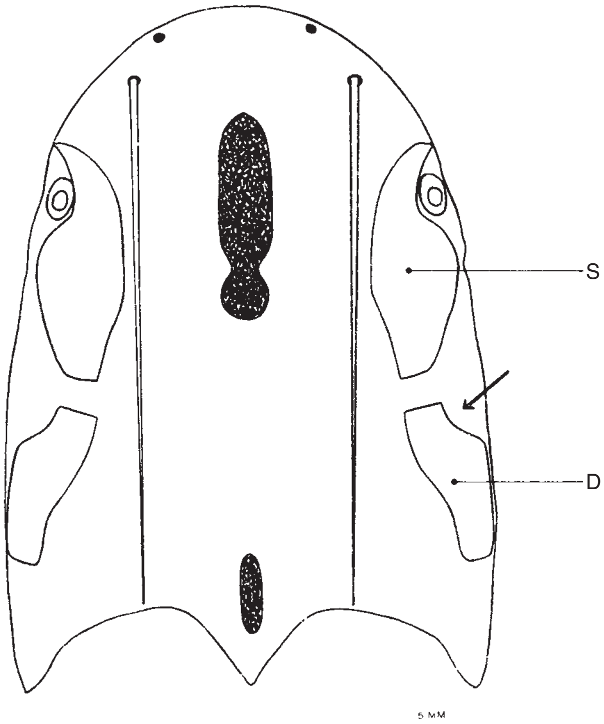

Fig. 13. Morphology of the supraorbital and dermosphenotic bones in *Clarias dumerilii*. After Teugels (1986).

either *C. dumerilii* or *C. camerunensis*. The types of *C. ngola* (158 mm SL) and *C. lualae* (174 and 175 mm SL) are much smaller than 200 mm SL, thus their separated head bones do not allow them to be identified as either *C. dumerilii* or *C. camerunensis*. Moreover, following Teugels (1986) the dermosphenotic bone of *C. ngola* shows the presence of a notch, a character he reported to be typical for *C. dumerilii*. We have compared the *C. ngola* and *C. lualae* types with *C. dumerilii* specimens (including the types). The dermospenotic in *C. ngola* indeed shows the presence of a notch (Fig. 13) [the illustration of this character in Teugels (1986) is based on the *C. ngola* holotype], but in the *C. lualae* types and most of the *C. dumerilii* specimens no notch was observed at all. Due to the variability in the morphology of the dermospenotic, and the fact that the notch observed in the *C. ngola* type is not particularly characteristic for most other *C. dumerilii* examined, the presence (or absence) of a notch in the dermosphenotic is not diagnostic.

Comparing Teugels' (1986) measurements and meristics for *C. ngola* and *C. lualae* with *C. camerunensis* shows that both equally fit in the range observed for *C. camerunensis*. Therefore, these measurements do not allow them to be identified as either *C. dumerilii* or *C. camerunensis*.

Our observations furthermore showed that the frontal fontanelle length in the *C. ngola* and *C. lualae* types equally fitted in the range we observed in *C. camerunensis*. Therefore, this character does not allow them to be identified as either *C. dumerilii* or *C. camerunensis*.

The types of *C. ngola* and *C. lualae* originated from the Luala River at Kingoyi and near Kinkenge respectively (Fig. 14). When considered as junior synonyms of *C. dumerilii*, these type specimens represent the only records of *C. dumerilii* in the Lower Congo, which is otherwise only known from localities in the Kasaï, the Aruwimi Basin and the Upper Congo (Fig. 15), all of which fairly distant from the Lower Congo. These type localities fall entirely within the distribution range of *C. camerunensis*, which includes part of West Africa, the Lower Guinea and most of the Congo Basin, including the Lower Congo.

One single difference between *C. ngola* and *C. dumerilii* however was reported (Teugels, 1986): a difference in the development of the suprabranchial organ, but it was argued that this character shows high intraspecific variation in *C. dumerilii* and may be ecophenotypic. As a consequence, the difference in the development of the suprabranchial organ was considered unimportant for species identification. The description of the development of the suprabranchial organ in *C. dumerilii* and *C. camerunensis* however clearly indicates that both species differ significantly in this

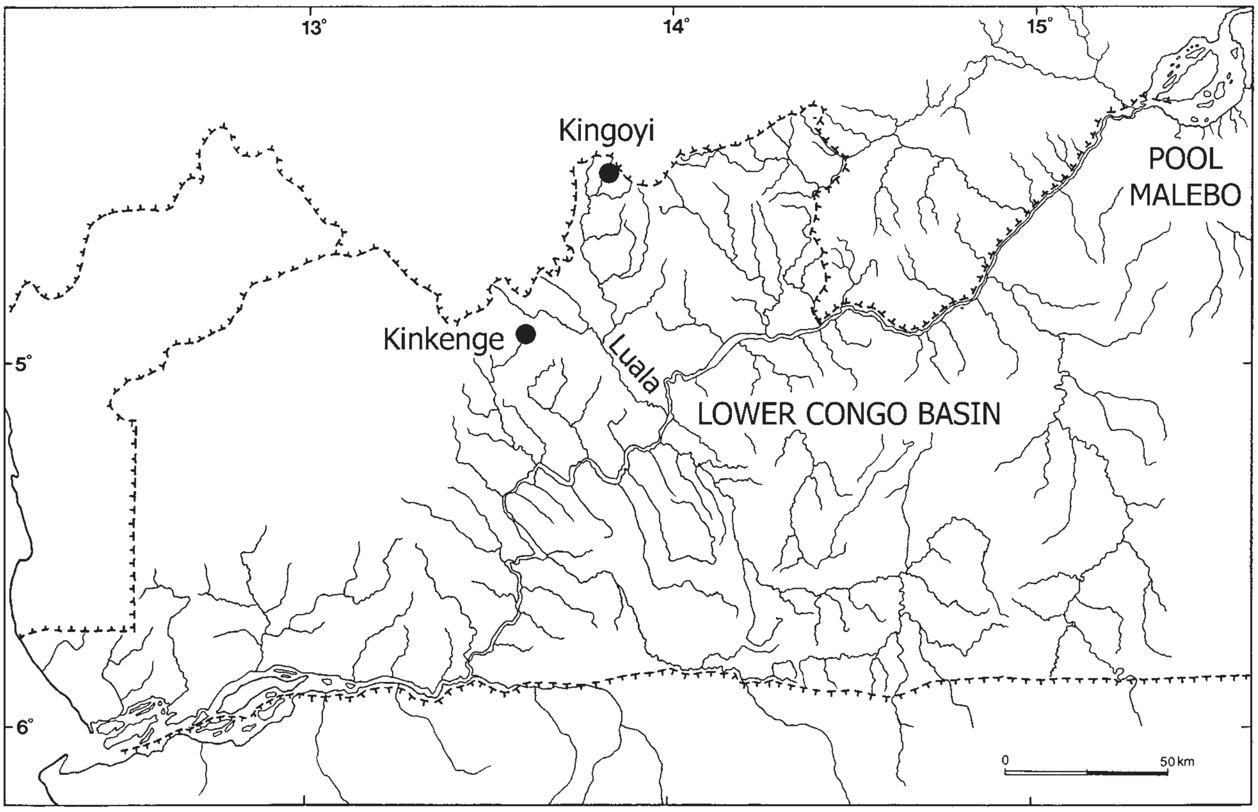

Fig. 14. Type localities of *Clarias ngola* and *C. lualae* in the Luala basin, Lower Congo.

respect. In *C. dumerilii* the suprabranchial organ is either virtually absent, present as a small fold on the fourth branchial arch or present as a small fold on the second and fourth branchial arch. All *C. dumerilii* are characterised by a reduced branchial organ. In *C. camerunensis* the suprabranchial is well developed; folds on the second and fourth branchial arch are well diverticulated; the suprabranchial chamber is nearly completely filled. The suprabranchial organ in the *C. ngola* type is reported to be well-developed (Teugels, 1986). The development of the suprabranchial organ in *C. lualae* was not mentioned by Teugels (1986), but examination of one of the syntypes (the head of only one of the syntypes was dissected far enough to observe the suprabranchial organ) showed it to be well developed in *C. lualae* as well. The *C. ngola* and *C. lualae* types, with their well-developed suprabranchial organ, therefore are more similar to *C. camerunensis* than to *C. dumerilii*.

Based on these observations, it seems inappropriate to leave *C. ngola* and *C. lualae* as synonyms of *C. dumerilii*. The diagnostic characters (lateral head bones, measurements and meristics, frontal fontanelle size) discussed by Teugels (1986) fit the description of both *C. dumerilii* and *C. camerunensis*, while the geographic origin of the *C. ngola* and *C. lualae* types and their well developed suprabranchial organ are characteristic of *C. camerunensis*, not *C. dumerilii*. We therefore propose a revised synonymy for *C. ngola* and *C. lualae*, and consider them to be junior synonyms of *C. camerunensis*. As a consequence, the distribution of *C. dumerilii* is restricted to the eastern Kasaï, the Aruwimi Basin and the Upper Congo.

ACKNOWLEDGEMENTS

Sven Kullander and Erik Åhlander (NRM) are thanked for the loan of the *C. ngola* and *C. lualae* types. Jos Snoeks (RMCA) is thanked for commenting on the manuscript. Heok Hee Ng and an anonymous reviewer are thanked for their comments on the manuscript.

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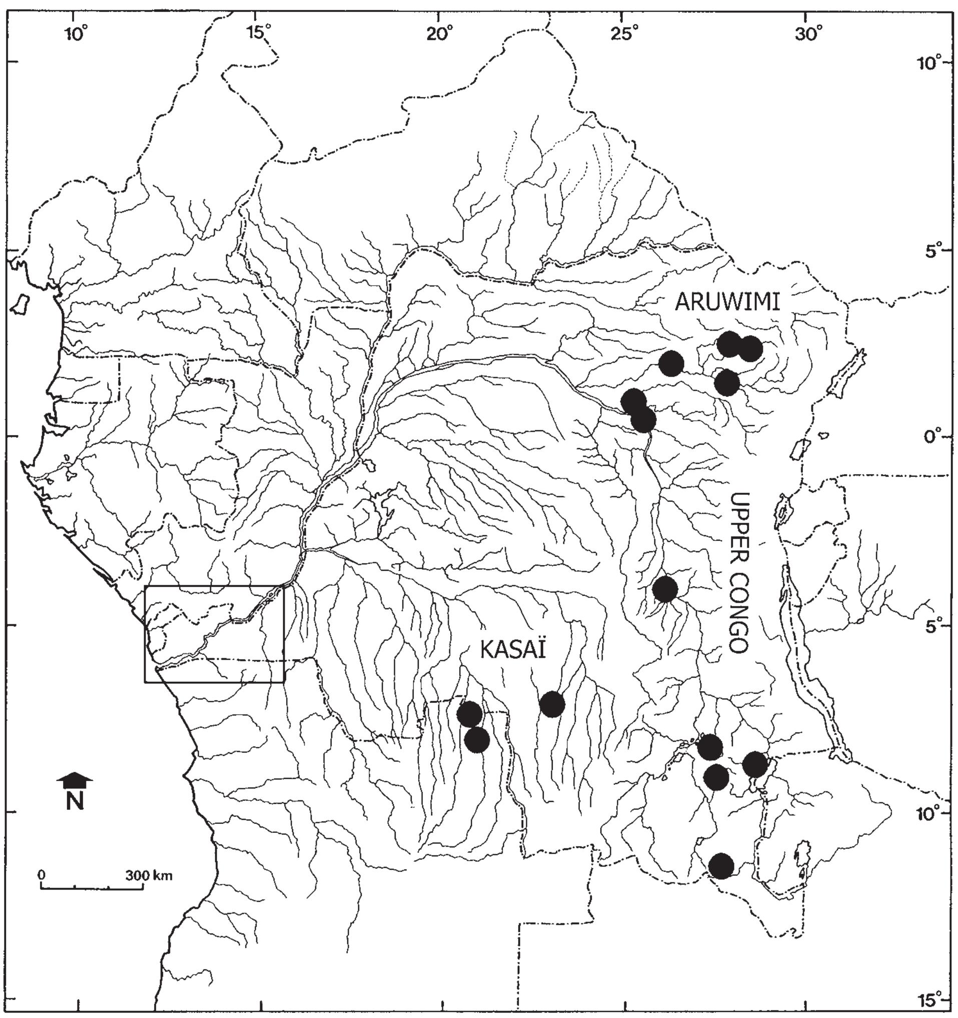

Fig. 15. Distribution of *Clarias dumerilii* (after Teugels, 1986). Box marks area including the Lower Congo and Pool Malebo enlarged in Fig. 14.

Specimens examined

Clarias camerunensis / dumerilii complex

NRM 9908. Kingoye, Bas Zaïre. Holotype *Clarias ngola.*
NRM 39931. Luala River, Lower Congo. Syntypes *Clarias lualae.*
MRAC 29819-823. Stanleyville. Coll. Dr. Richard. (1)
MRAC 79-1-P-4466-476. Kankunda, afflt. gauche de la riv. Lupiala et s/afflt. droit de la riv. Lufira, alt. 1300 m. Coll. Expl. P.N.U. G.F. De Witte. 11-19.XI.1947. (2)
MRAC 31884-897. Kansenia. Coll. G.F. De Witte. 15.IX-15.X.1930. (1)
MRAC 79-1-P-4564-578. Pelenge, afflt. droit de la riv. Lufira, alt. 1140-1150 m. Coll. Expl. P.N.U. G.F. De Witte. 30.VI.1947. (6)
MRAC 79-1-P-4634-640. Ganza, salines, près de la riv. Kamandula, afflt. De la riv. Lufira, alt. 860 m. Coll. Expl. P.N.U. G.F. De Witte. 4-5.VII.1949. (1)
MRAC 88-31-P-18. Kisangani, riv. Libuku. Coll. M. Katembo. III.1988.
MRAC 89-43-P-2624. Riv. Edoro (=Itoro), route Ituri-Epulu, 461 km de Kisangani, Zaïre. Coll. M. Katembo-Sikubwabo. 8.XI.1988.
A7-09-P-731-733. Riv. M'Soni, village Yanama, RDC. Coll. S. Wamuini. 12.II.2007. (3)
A7-09-P-735. Riv. Wungu, village Kiyanga, RDC. Coll. S. Wamuini. 4.IX.2006.
A7-09-P-736. Riv. M'Soni, village Yanama, RDC. Coll. S. Wamuini. 11.II.2007.
BMNH 1864.7.13:42-46. "Angola". (3)
MRAC 20858-862. Medje. Coll. H. Schouteden. (2)
MRAC 161939-945. Riv. Tchimenji, Angola. Coll. Museo do Dundo. 9.I.1963. (2)
MRAC 86-21-P-118-119. Lemfu, Riv. Inkisi, Zaïre. Coll. Mutambwe Shango. XI.1985. (1)
MRAC 170465. Ganda Sundi, Mayumbe, Congo. Coll. A. Fain. 27.III.1964.
MRAC 37550. Thysville, grotte no. 2, Congo Belge. Coll. P. Golenvaux. VIII.1931. Holotype *Clarias submarginatus thysvillensis.*
MRAC 173797-801. Région de Mabuba, Terr. de Tshela, Congo Belge. Coll. R. Laurent. 16-17.VI.1958. (1)
MRAC 19143-45. Temvo, Congo Belge. Coll. H. Schouteden. (3)

Clarias gabonensis

MRAC 1647. Mayumbe, Kuka Muno, DRC. Coll. W. Ansorge. 1912.
MRAC 47471. Boma-Banana, DRC. Coll. Y. Schwetz. 1936.
MRAC 55626. Boma, Congo Belge. Coll. E. Dartevelle. 1.VIII.1937.
MRAC 57759. Lac Tumba, DRC. Coll. Gonze de Loneux. 1938.
MRAC 73-22-P-3271. Stanley Pool, DRC. Coll. J. Mandeville. 09.IV.1958.
MRAC 179015-017. Kingabwe, Stanley Pool, Congo Belge. Coll. Brien, Poll & Bouillon. 4.VIII.1958. (3)
MRAC 86-21-P-125. Inkisi, riv. Inkisi. Coll. Mutambwe Shango. XII.1985.
MRAC 91-13-P-711. Riv. N'Sele (Benzale), affl. fleuve Zaïre près de Kinshasa. Coll. M. Tshibwabwa. 1985.
MRAC A6-07-P-610-611. riv. Nkenge, afflt. Yambi, vill. Kimbimbi, Bas Congo, RDC. Coll. Exp. Bas-Congo 2005. 14.IX.2005.
MRAC A6-07-P-612. riv. Lukunga, au pont, village Lukunga, Bas-Congo, RDC. Coll. Exp. Bas-Congo 2005. 28.IX.2005.
MRAC A6-07-P-613. Riv. Luki River, Réserve forestière de Luki, Bas-Congo, RDC. Coll. Exp. Bas-Congo 2005. 26.IX.2005.
MRAC A6-07-P615-517. riv. Lukunga, au pont, village Lukunga, Bas-Congo, RDC. Coll. Exp. Bas-Congo 2005. 29.IX.2005.
MRAC A6-07-P-618-620. riv. Lukunga, au pont, village Lukunga, Bas-Congo, RDC. Coll. Exp. Bas-Congo 2005. 30.IX.2005.
MRAC A6-07-P-621. riv. Luki, en amont du pont, dans la réserve forestière de Luki, Bas-Congo, RDC. Coll. Exp. Bas-Congo 2005. 26.IX.2005.

Clarias angolensis

MRAC 179001-014. Kingabwe, Stanley Pool, Congo Belge. Coll. Brien, Poll & Bouillon. 4.VIII.1958. (10)
MRAC 62527. Kunungu, Congo Belge. Coll. H. Schouteden. 1.I-27.VII.1939. Alizarin prepared specimen.