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An overview of labeonin relationships and the phylogenetic placement of the Afro-Asian genus *Garra* Hamilton, 1922 (Teleostei: Cyprinidae), with the description of five new species of *Garra* from Ethiopia, and a key to all African species

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A clarification of the morphological character data supporting the hypothesis of labeonin monophyly, and also for one of its subgroups, the Garraina, is presented. As an aid to ongoing studies, a full listing of putative labeonin genera is provided. Included in the Garraina is the widespread and taxonomically problematical Afro-Asian genus *Garra*. Getahun (2000) in an unpublished thesis clarified much of the taxonomic confusion surrounding the African members of this genus, and we summarize many of his conclusions in the form of an artificial identification key for all 17 valid species of *Garra* on the African continent. The diversity of *Garra* in Ethiopia, the geographical centre of species diversity for the genus in Africa, is resolved and redescriptions of the six species previously recognized in Ethiopian inland waters are provided, along with formal taxonomic descriptions of an additional five new species from that country. Four of the new species are endemic to Ethiopia: ***Garra regressus* sp. nov.**, ***Garra duobarbis* sp. nov.**, ***Garra geba* sp. nov.**, and ***Garra tana* sp. nov.**, whereas the fifth, ***Garra dembecha* sp. nov.**, is more widespread and found also in Eritrea, Kenya, and Tanzania in eastern Africa. *Zoological Journal of the Linnean Society*, 2007, **150**, 41–83.

ADDITIONAL KEYWORDS: cyprinid morphology – Garraina – Labeonini – Labeoina –phylogenetics – taxonomy.

INTRODUCTION

Cyprinid phylogenetics are notoriously problematical and a well-corroborated scheme of intrafamilial relationships remains an elusive goal (see e.g. Chen, Yue & Lin, 1984; Howes, 1991; Cavender & Coburn, 1992; Briolay *et al*., 1998; Zardoya & Doadrio, 1999; Gilles *et al*., 2001; Cunha *et al*., 2002; Liu & Chen, 2003). Nonetheless, the morphological works of Reid (1982, 1985) provide character data in support of a large clade within a monophyletic Cyprininae (Howes, 1991; Cavender & Coburn, 1992). Reid (1982, 1985) informally referred to this assemblage as the 'labeine cyprinids' and included the following taxa within his concept of labeines (Labeonini herein), further grouping them into *Labeo* + *Labeo*-like cyprinids (Labeoina herein) and *Garra* + *Garra*-like cyprinids (Garraina herein). Reid's *Labeo* + *Labeo*-like cyprinids included the following genera: *Labeo* Cuvier, 1817, *Osteochilus* Günther, 1868; *Labiobarbus* Hasselt, 1823; *Tylognathus* Heckel, 1843; and *Cirrhinus* Oken (ex. Cuvier), 1817. His *Garra* + *Garra*-like cyprinids included the genera: *Garra* Hamilton, 1822; *Semilabeo* Peters, 1880; *Crossocheilus* Hasselt, 1823; *Paracrossocheilus* Popta, 1904; *Typhlogarra* Trewavas (1955); *Mekongina* Fowler, 1937; *Iranocypris* Bruun & Kaiser, 1944; and *Epalzeorhynchos* Bleeker, 1855. He suggested,

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pending further study, that *Barbichthys* Bleeker, 1860 should probably also be included among labeines, and this placement is tentatively confirmed by our examination of *Barbichthys laevis* (Valenciennes, 1842), which is included here in the Labeoina (Table 1). Since the ground-breaking studies of Reid there has been little subsequent study of the limits and relationships of the Labeonini, and the task of simply trying to assemble a full listing of putative labeonin genera is challenging. However, Rainboth (1991) and Zhang & Chen (2004) provide up-to-date summaries for South-East Asia and China (see Table 1).

As Siebert & Tjakrawidjaja (1998) note, the systematics and general taxonomy of the Labeonini are in a 'state-of-flux' with little consensus regarding either the limits of the group or at what rank it, or proposed subgroups, should be recognized. Similar uncertainties pertain to the other cyprinine subgroups, and whereas Zhang & Chen (2004) chose to restrict Chen *et al*.'s (1984) subfamily Labeoninae (equivalent to the Cyprininae of most authors) to include only the 'labeine cyprinids' of Reid (1982, 1985), we prefer the more conservative approach of Siebert & Tjakrawidjaja (1998) in adhering to the nomenclature of Rainboth (1991). Therefore the labeine cyprinids (*sensu* Reid) are maintained in the Cyprininae and are assigned the rank of tribe (Labeonini) with two putatively monophyletic subtribes, the Labeoina and Garraina (the former collectively termed Labeoins and the later termed Garrains herein). Based on details of oromandibular anatomy, Zhang & Chen (2004) have recently proposed a third labeine subgroup (Banganina) comprised of *Lobocheilos*, *Bangana*, and *Qianlabeo,* which they posit represent 'an intermediate form' between the Labeoins (Labeonini) and Garrains (Garrini). We have been unable to examine specimens of these taxa and, like Zhang & Chen (2004), we recognize that a thorough cladistic analysis including representative sampling of all putative members of the Labeonini will be necessary to satisfactorily and fully resolve the phylogenetic structure of this complex cyprinine tribe.

In this paper we aim to lay the foundation for a comprehensive phylogenetic analysis of the inter- and intrarelationships of Labeonini, by providing a clarification of the morphological character data supporting the hypothesis of labeonin monophyly, and also for one of its subgroups, the Garraina. Included in the Garraina is the widespread and taxonomically problematical Afro-Asian genus *Garra*. Getahun (2000) in an unpublished thesis clarified much of the taxonomic confusion surrounding the African members of this genus, and we summarize many of his conclusions in the form of an artificial identification key for all valid species of African *Garra*. Finally, in a taxonomic section of the paper, we clarify the diversity of *Garra* in

Table 1. Preliminary list of genera considered here as Labeonini, with subdivision into two putatively monophyletic subtribes [Labeoina and Garraina (data compiled from Reid, 1982, 1985; Howes, 1991; Rainboth, 1991, 1996; Siebert & Tjakrawidjaja, 1998; Jayaram, 1999; Zhang *et al*., 2000; Zhang & Chen, 2004)]. Genera preceded by a parenthetical question mark indicate those we have been unable to examine and cannot confirm as labeonins based on data available in the literature

Labeoina	Garraina
Bangana Hamilton, 1822	*Crossocheilus* van Hasselt, 1823
Barbichthys Bleeker, 1860	*Discocheilus* Zhang, 1997
Cirrhinus Oken (ex. Cuvier), 1817	*Discogobio* Lin, 1931
Henicorhynchus Smith, 1945	*Epalzeorhynchos* Bleeker, 1855
Labeo Cuvier, 1816	*Garra* Hamilton, 1822
Labiobarbus van Hasselt, 1823 (= ? *Dangila* Valenciennes, 1842)	(?) *Horalabiosa* Silas, 1954
Lobocheilos Bleeker, 1853	(?) *Iranocypris* Bruun & Kaiser, 1944
Nukta Hora, 1942	*Mekongina* Fowler, 1937
Osteochilus Günther, 1868	*Paracrossocheilus* Popta, 1904
Qianlabeo Zhang & Chen, 2004	*Parasinilabeo* Wu, 1939
Schismatorhynchos Bleeker, 1855	*Placocheilus* Wu, 1977
Sinilabeo Rendahl, 1932	*Pseudocrossocheilus* Zhang & Chen, 1997
Tylognathus Heckel, 1843	*Pseudogyrinocheilus* Fang, 1933
	Ptychidio Myers, 1930
	Rectoris Lin, 1933
	Semilabeo Peters, 1880
	Sinocrossocheilus Wu, 1977
	Typhlogarra Trewavas, 1955

Ethiopia, the geographical centre of species diversity for this genus on the African continent, and provide redescriptions of six species previously recognized in Ethiopian inland waters, and present formal taxonomic descriptions of an additional five new species from that country.

MATERIAL AND METHODS

Materials of labeonin and other cyprinid and cyprinoid taxa examined in this study are listed in the Appendix. For osteological observations, specimens were cleared and stained following the procedures of Taylor & Van Dyke (1985). For the taxonomic reappraisal of Ethiopian *Garra*, most character definitions follow Menon (1964), and those of particular use in facilitating the identification of African species are detailed below.

Position of eye: The distance from the tip of the snout to the middle of the eyeball relative to head length. If the former is half of the length of the head, the position is described as 'median'. If it is less than half the head length, then it is considered 'anterior', and if it is more than half it is considered 'posterior'.

Vent distance: The distance between the origin of the anal fin and the vent (expressed as a percentage of the distance between the origin of the anal fin and the pelvic-fin insertion).

Relative gas bladder length: Measured by dividing the standard length by the length of the posterior chamber of the gas bladder.

Predorsal scales: Scales counted from the origin of the dorsal fin to the occiput.

Disc development (Fig. 1): Varies markedly among, and to some extent ontogenetically within, *Garra* species. As an aid for identification, three disc types are, somewhat arbitrarily, recognized here. Type A (Fig. 1A) is a weakly developed disc without free posterior or lateral margins, and often consisting only of a central cushion-like callus. Type C (Fig. 1C) is well developed with free lateral and posterior margins; type-C discs are heavily papillate with batteries of fleshy papillae arrayed around the periphery of the whole disc. Type B (Fig. 1B) is intermediate in development, the disc may be conspicuous but usually has only partially free lateral margins and a narrow free posterior margin, and is lacking fields of conspicuous papillae around the periphery.

All measurements were recorded to the nearest 0.2 mm using either digital or dial calipers. Total vertebral count sums Weberian (four) + abdominal + caudal + fused PU1 (last preural) and U1 (first ural) centra. Visualization of scale rows and canal-bearing scales was aided by directing a fine jet of compressed air onto scales. In the taxonomic section of this contribution, non-type materials examined are arranged by institutional collection with the values after each catalogue number indicating the number of specimens examined, and these do not necessarily correspond to the total number of specimens in each lot. Specimens examined are listed as the total number examined, followed by the number that are cleared and stained (C&S). Institutional abbreviations follow those of Leviton *et al*. (1985). The following abbreviations are also used in the text and key: ex., examples; HL, head length; Int.L, intestine length; m., mean; SD, standard deviation; SL, standard length.

LABEONIN MONOPHYLY, CHARACTER SURVEY, AND THE PHYLOGENETIC PLACEMENT OF *GARRA*

In a recent mitochondrial DNA (mtDNA) based phylogeny of East-Asian cyprinids, Liu & Chen (2003) suggest that within a monophyletic Cyprininae, labeonins are the sister group to the remaining cyprinines. However, taxon sampling of cyprinines was extremely limited in that study, and labeonins were represented by a single taxon, *Discogobio tetrabarbatus* Lin, 1931. Although we have not undertaken a comprehensive analysis of all putative labeonin taxa (see the Appendix), because of the paucity of synthetic data on this large assemblage of Afro-Asian cyprinines, we believe that it is useful to briefly clarify some of the morphological character data supporting the hypothesis of labeonin monophyly, and to clarify the phylogenetic placement of *Garra* within that assemblage.

CHARACTER 1: PRESENCE OF A VOMERO-PALATINE ORGAN

Reid (1982) noted that the presence of a vomero-palatine organ characterizes a large grouping of cyprinid fishes. The organ is situated in a navicular depression of the buccal epithelium covering the mouth roof, and in most labeonins includes a paired longitudinal series of transverse fleshy folds or lamellae (e.g. Fig. 2A). The size, shape, number, and degree of lamellar development vary markedly, both ontogenetically and between species. Reid (1982: 502) notes that the organ may be regressed 'almost to the point of absence' in adult *Garra*, but that in early ontogeny a generalized number of lamellar pairs (seven ± two) is evident. Although we are able to confirm the presence of a lamellar organ in *Semilabeo* (the presence of the organ in this taxon was queried by Reid, 1982), we have not been able to recognize an unambiguous vomero-palatine organ in *Garra*. A review of oral

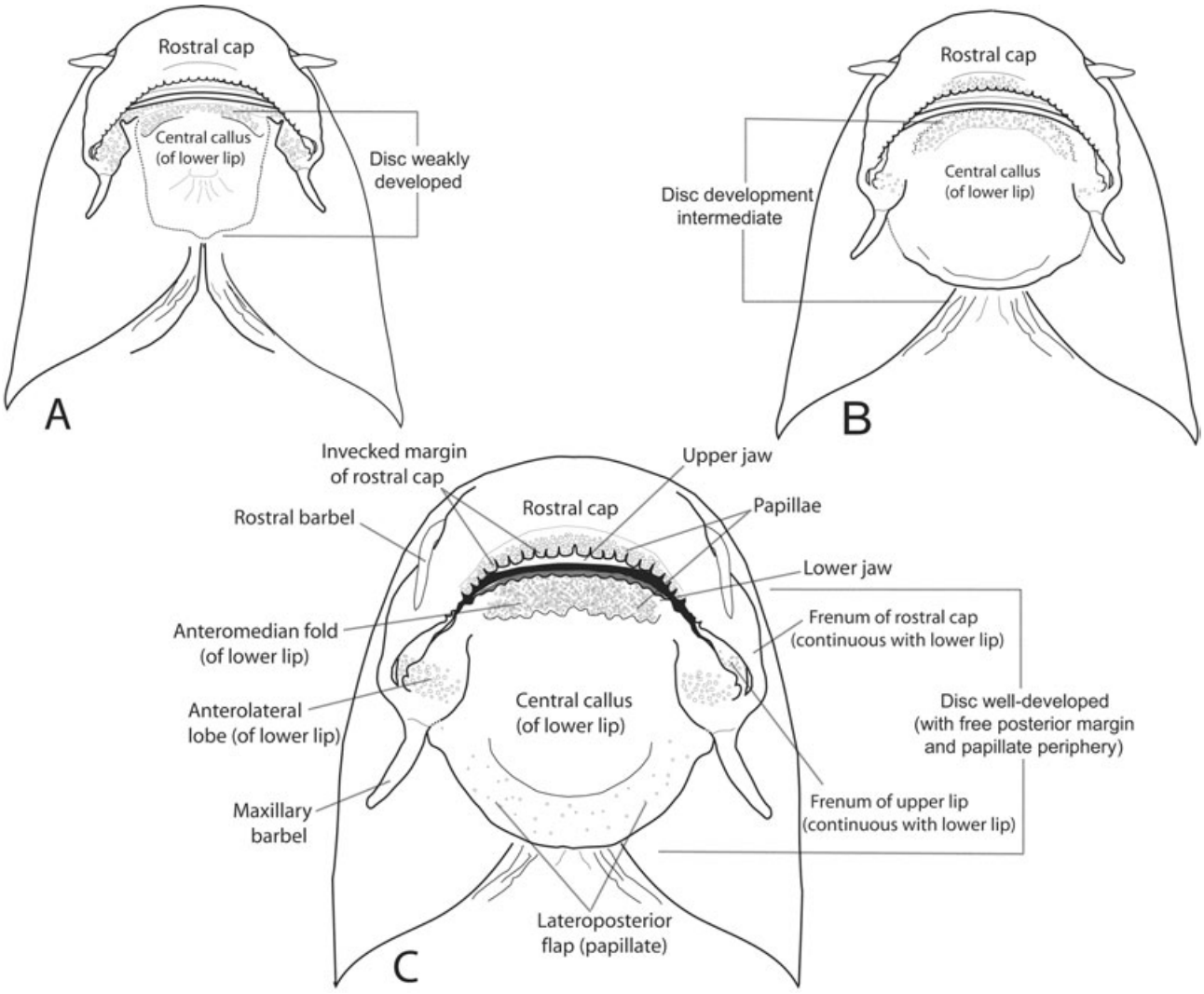

Figure 1. Range of variation in disc type among African *Garra*: (A) type-A disc, weakly developed; (B) type-B disc, intermediate development; (C) type-C disc, well-developed.

anatomy of a series of juvenile and adult *Garra* did not reveal an ontogenetic transformation from lamellar to regressed organs in any of the species surveyed. However, in adult *Garra aethiopica* (a relatively deep-bodied and presumably non-rheophilic species) the mouth roof is folded along the longitudinal axis with a central depression that may represent a vestigial vomero-palatine organ (Fig. 2B). In juvenile *G. aethiopica* the mouth roof is covered with more-or-less uniformly arrayed fleshy papillae with no trace of either a central depression or lamellae. In light of other character data discussed below, we concur with Reid (1982) that the absence (or regression) of a vomero-palatine organ in *Garra* is most reasonably interpreted as a secondary 'loss', rather than a primitive absence.

CHARACTER 2: CONTACT OF NEURAL COMPLEX OF THE WEBERIAN APPARATUS WITH THE NEUROCRANIUM

Reid (1982, 1985) noted that the neural complex of the Weberian apparatus of labeonins is in direct (or close) contact with the occipital region of the skull. In *Garra,* contact is mediated through an expanded anterior supraneural element that abuts the exoccipital of the neurocranium (Fig. 3A). A similar configuration is found in the other garrain taxa examined (e.g. Fig. 3B), whereas in labeoins (e.g. Fig. 3C, D) contact is mediated via an abutment of the posterior supraneural with the supraoccipital of the neurocranium. Both conditions are interpreted here as derived relative to the widespread condition found in the cyprinins, barbins, and leuciscines examined, where the

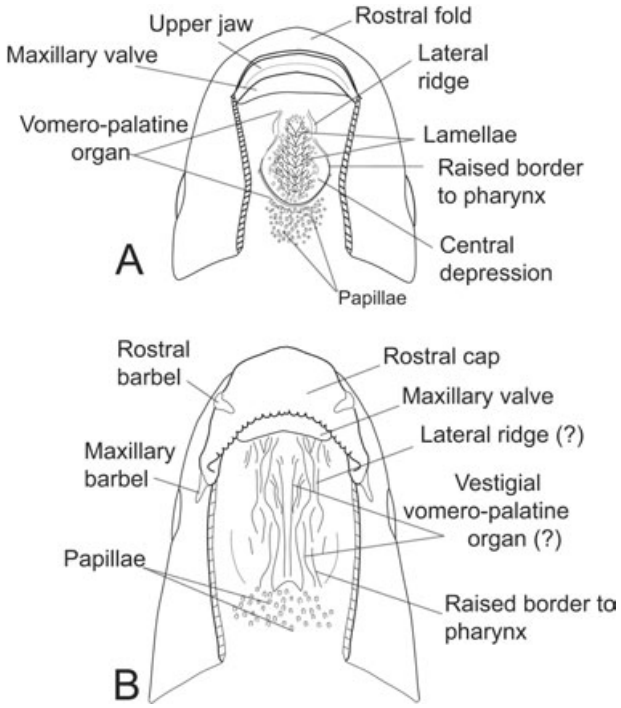

Figure 2. Ventral surface of mouth roof (lower jaw and branchial apparatus removed) in (A) *Henicorhynchus siamensis*, and (B) *Garra aethiopica*.

anterior supraneural is a small element separated from the neurocranium by the claustrum and scaphium, and the posterior supraneural, which typically retains a large dorsal process, is also located distant from the occiput (e.g. Fig. 3E, F).

Character 3: terete basioccipital process

Reid (1982) regarded the presence of an elongate and terete basioccipital process as further evidence of labeonin monophyly, and this derived state of the basioccipital process is present in *Garra* (Fig. 3A) and other labeonins examined. The distinction between terete and non-terete basioccipital processes is not evident in lateral view, but is clearly evident in cross section (compare Fig. 3A–D with Fig. 3E, F).

Although we have not undertaken an exhaustive investigation of Weberian anatomy in cyprinids, it is clear that this complex holds considerable potential as a source of phylogenetically informative character variation (see also Chen *et al*., 1984; Cavender & Coburn, 1992). For example, in *Garra* and other labeonin taxa surveyed, the transverse process of vertebra 4 is short and stout with an expanded distal tip. The os suspensorium is also short and stout and is often concealed from lateral view by the transverse processes of vertebra 4, whereas the parapophysis of vertebra 1 is elongate and anteriorly orientated over the body of the basioccipital process. Based on our preliminary observations, these features appear to be consistently present in labeonins, and are contrasted with those in, for example, barbins (e.g. Fig. 3E), leuciscines (e.g. Fig. 3F), and most other cyprinids examined.

Character 4: double fenestration of dilatator fossa

Howes (1987, 1991) observed that the Cyprininae may be subdivided on the basis of whether the dilatator fossa is either fenestrated or intact. In *Garra* (Fig. 4A) and other labeonins (e.g. Fig. 4B) the dilatator fossa is always fenestrated, and, in addition to a fenestrated frontal lamella (frequently with two foramina), the sphenotic is also fenestrated. The presence of a double (or multiple) fenestration of the dilatator fossa is interpreted here as additional evidence of labeonin monophyly.

Character 5: incised border of first anal-fin pterygiophore

In the generalized cyprinid condition, the leading pterygiophore of the anal fin is elongate with narrow anterior and posterior flanges (e.g. Fig. 5A). In contrast, labeonins, as exemplified by *Garra* (Fig. 5B), have a leading edge of the anterior flange of the first anal-fin pterygiophore that is deeply incised and terminates well below the apical tip of the central rod of the element (Getahun, 2000). Among cyprinids, the first anal-fin pterygiophore morphology of gobionines is also deeply incised along its anterior border (e.g. Fig. 5C) and is broadly similar to that of labeonins. However, given the absence of the other labeonin (and cyprinine) synapomorphies in gobionines this feature is interpreted as independently derived in the two groups. Additionally, the first anal-fin pterygiophore of gobionines bears a broad lateral flange on its central rod that lends a dimensionality to the fin that is not observed elsewhere among cyprinoids. Finally, a deeply incised first anal-fin pterygiophore is found also in gyrinocheilids, but this too, in the absence of a phylogenetic analysis, is tentatively interpreted here as convergent with the labeonin condition.

Character 6: ventrally expanded rostral fold

In most cyprinids a simple transverse crease of the skin covering the snout and maxillary bones forms a truncated fold or flap (e.g. Fig. 6A, D). In labeonins this fold of skin is hypertrophied and expanded ventrally forming a fleshy rostral cap or fold that extends over the upper lip and premaxillae (Roberts, 1980;

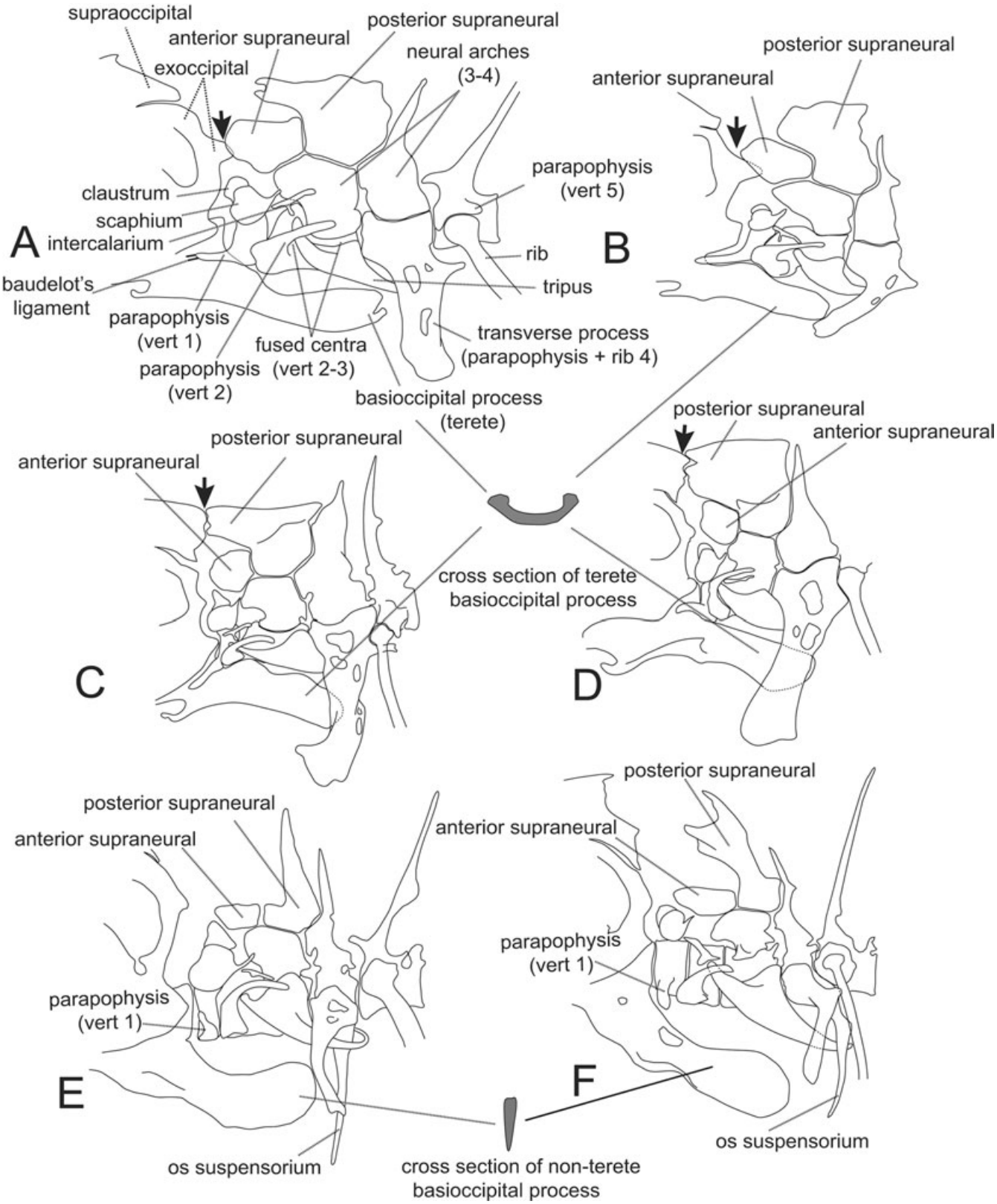

Figure 3. Weberian apparatus and posterior neurocranium: lateral view of (A) *Garra dembeensis*, (B) *Paracrossocheilus acerus*, (C) *Labeo cylindricus*, (D) *Osteochilus salsburyi*, (E) *Prolabeops melanhypopterus*, and (F) *Leuciscus leuciscus*. The cross section of the basioccipital process is shaded grey; arrows indicate point of contact between neural complex and neurocranium.

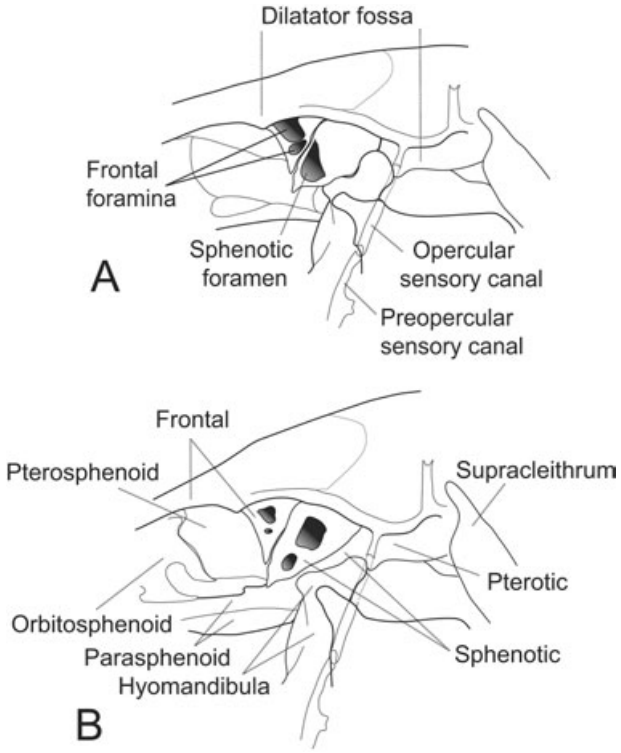

Figure 4. Posterior neurocranium region of dilatator fossa of (A) *Garra dembeensis* and (B) *Osteochilus salsburyi*.

Reid, 1985). A hypertrophied rostral cap is present in *Garra* (Fig. 6C, F) and most other labeonins (e.g. Fig. 6B, E). Although there is considerable variation in the degree of hypertrophy of the cap among labeonins, a qualitative difference between the labeonin condition and that of other cyprinines is, if hard to quantify, generally discernible.

CHARACTER 7: PRESENCE OF A SUPERFICIAL POSTERIOR LABIAL FOLD

Reid (1982, 1985) regarded the presence of a labial fold developed posterior to the lower jaw as further evidence of labeonin monophyly. The labeonin labial fold is a modification of the lower lip whereby it is separated from the lower jaw by a deep groove, as illustrated here for *Garra* (Fig. 6F) and *Labeo* (Fig. 6E). The derived labeonin condition contrasts with the more generalized cyprinid condition, in which the lips are formed by a corium, or fleshy covering of the jaws, and no groove separating a labial fold (lower lip) from the lower jaw is present (e.g. Fig. 6D). Among labeonins the degree of development of the lower labial fold varies considerably, but, as far as we are able to determine, a fold separating the lower lip from the keratinized lower jaw is present to some degree in all labeonins.

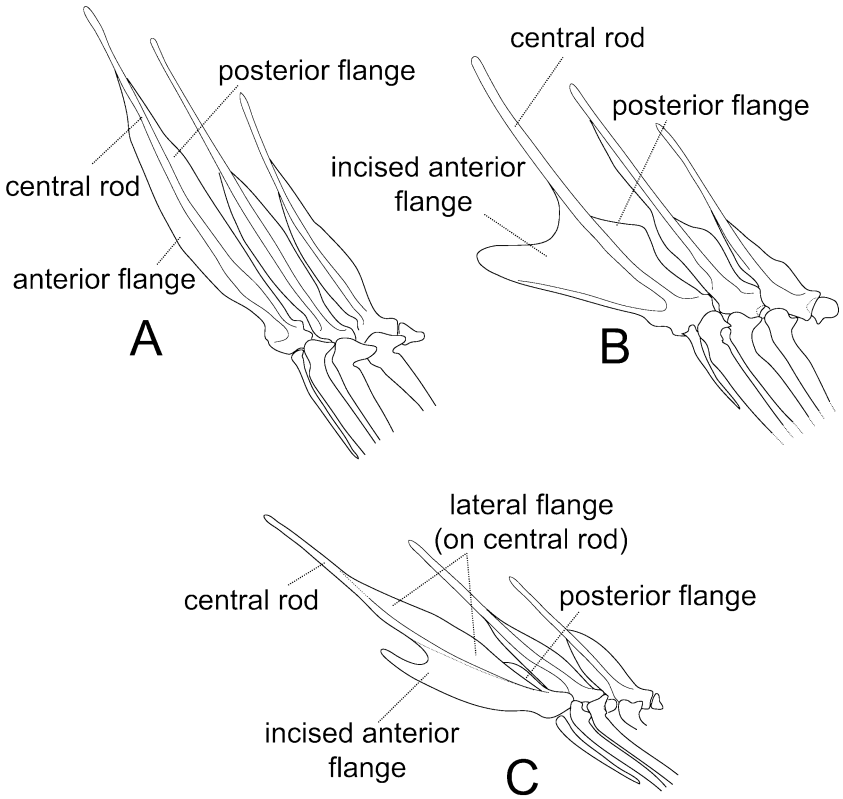

Figure 5. Anterior anal fin elements of (A) *Barbus radiatus*, (B) *Garra dembeensis,* and (C) *Gobio gobio*.

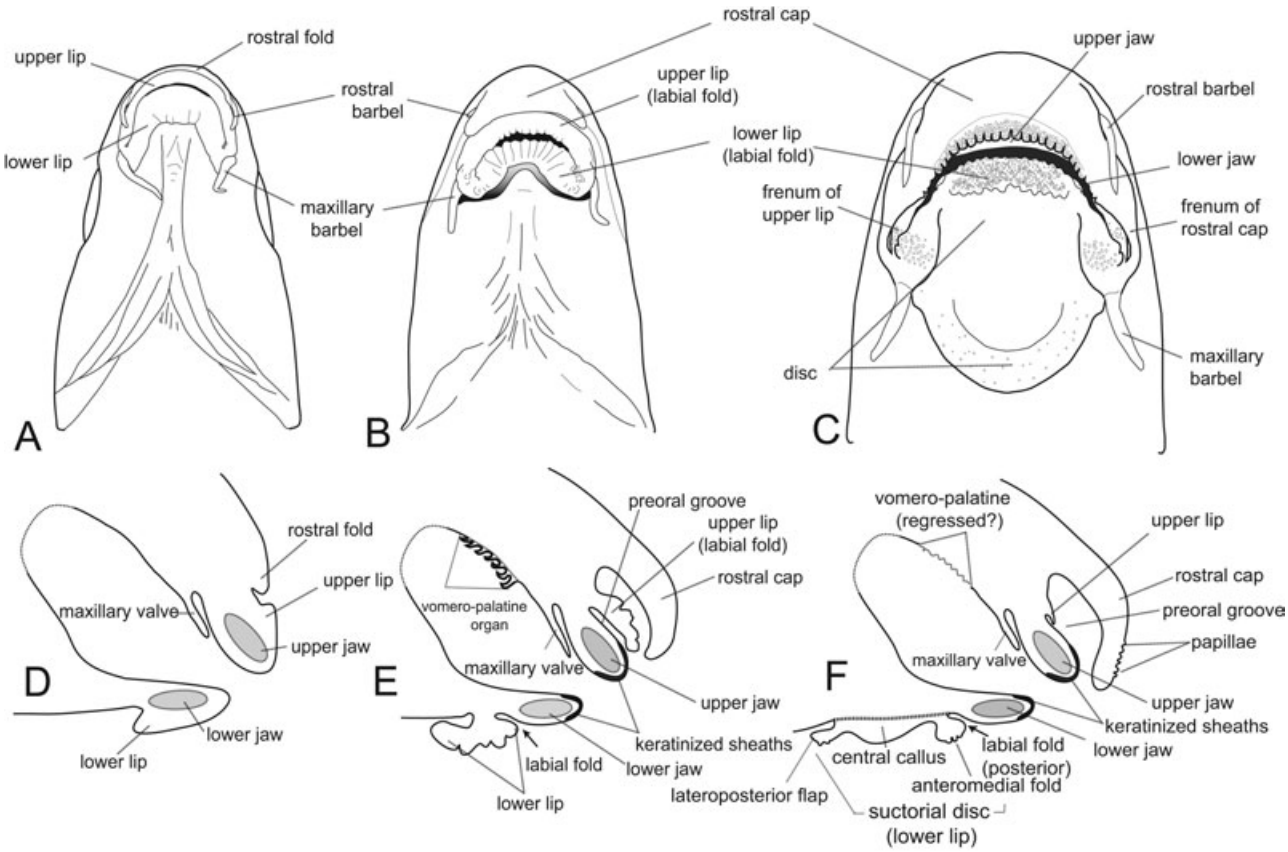

Figure 6. Head (ventral view) of (A) *Labeobarbus caudovittatus*, (B) *Labeo nasus*, and (C) *Garra dembeensis*, and in cross-sectional schematic view (D) *Labeobarbus*, (E) *Labeo*, and (F) *Garra*.

CHARACTER SUPPORT FOR MONOPHYLETIC GARRAINA

CHARACTERS 8, 9: MEDIATION OF CONTACT OF NEURAL COMPLEX WITH THE NEUROCRANIUM

As noted above in *Garra* (Fig. 3A) and other garrains (e.g. Fig. 3B), contact between the neurocranium and the neural complex of the Weberian apparatus is mediated through an expanded anterior supraneural element that abuts the exoccipital of the neurocranium. This condition is interpreted here as a synapomorphy of garrains, and is contrasted with the alternate synapomorphic condition in labeoins where contact with the supraoccipital is mediated via the posterior supraneural element of the complex, and a plesiomorphic condition of 'no contact', as exemplified by other cyprinids.

CHARACTER 10: INVECKED VENTRAL MARGIN OF ROSTRAL CAP

Reid (1985) noted that the free ventral margin of the rostral cap is smooth without an invecked margin in most cyprinids (e.g. Fig. 6A) and labeoins examined (e.g. Fig. 6B) [see also Siebert & Tjakrawidjaja (1998: fig. 1) for *Schismatorhynchos*, *Lobocheilos*, and *Tylognathus* (= *Bangana*?); Zhang, Yue & Chen (2000: fig. 112) for *Sinilabeo*; Zhang & Chen (2004: fig. 1) for *Bangana* and *Qianlabeo*]. In contrast, most *Garra* (e.g. Fig. 6C) and other garrains have a ventral margin of the rostral cap that is clearly either invecked or fimbriate (Figs 7A–D and 8B–D, F) [see also Zhang & Chen (2004: fig. 1) for *Pseudocrossocheilus, Parasinilabeo*, and *Sinocrossocheilus*]. Although this is not the case in either *Discocheilus* (Fig. 8A) or *Semilabeo* (Fig. 8E), and although this feature is somewhat variable among *Garra,* most do have an invecked rostral cap. In light of the distribution of other characters discussed here, the absence of either an invecked or a fimbriate ventral margin of the rostral cap in these few garrains is reasonably interpreted as a secondary loss rather than a primitive absence (Fig. 9), but this assessment is of course contingent on a comprehensive phylogenetic analysis.

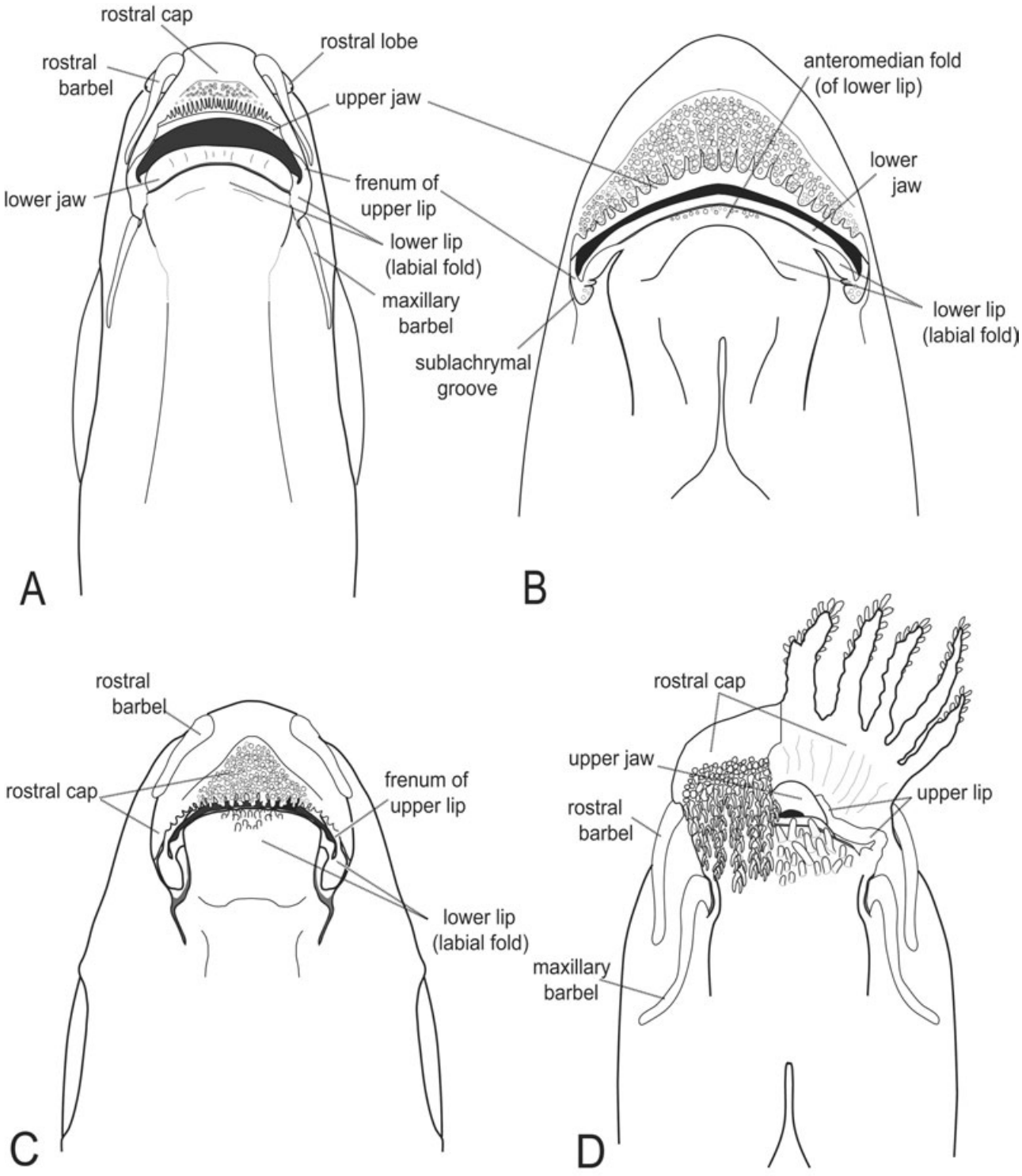

Figure 7. Head (ventral view) of (A) *Epalzeorhynchus kalopterus*, (B) *Mekongina erythrospila*, (C) *Crossocheilus siamensis*, and (D) *Ptychidio jordani*.

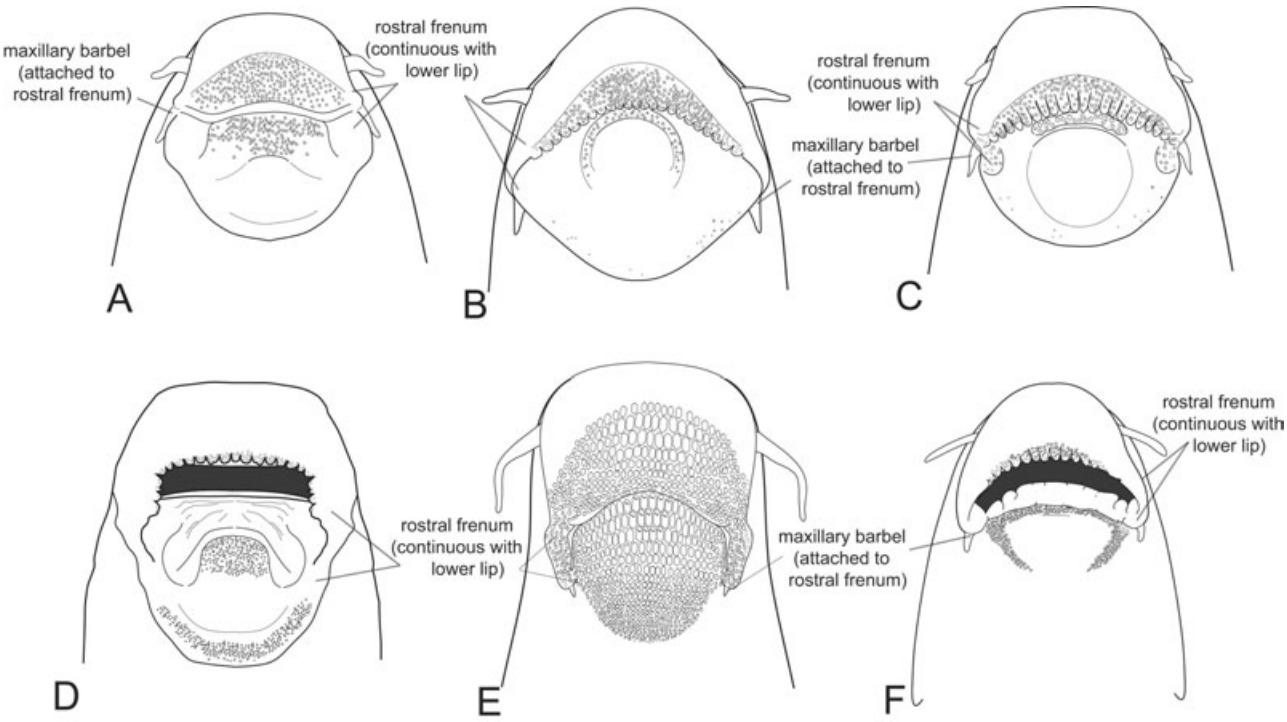

Figure 8. Head (ventral view) of (A) *Discocheilus wui*, (B) *Discogobio yunnanensis*, (C) *Placocheilus robustus* (after Zhang et al., 2002), (D) *Pseudogyrinocheilus prochilus*, (E) *Semilabeo obscurus*, and (F) *Rectoris luxiensis* (after Zhang et al., 2000).

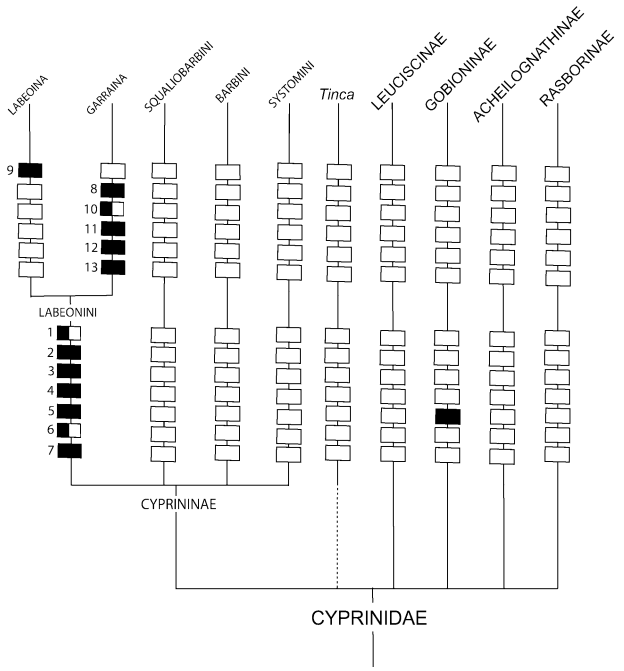

Figure 9. Character distributions among labeonins and related taxa. Character numbers correspond with those used in the text. Black bars indicate putatively derived character states, white bars indicate putatively generalized states, and black/white bars indicate some level of polymorphism within the group denoted.

CHARACTER 11: ANTERO-ROSTRAL POSITION OF ROSTRAL BARBELS

Reid (1985) catalogs considerable variation in barbel implantation and orientation among labeonins. The rostral barbels of *Garra* (Fig. 6C) and other garrains (Figs 7 and 8) are positioned at the anterior of the ventrally expanded rostral cap (antero-rostral in the terminology used by Reid, 1985), and they grow out through, and project ventral to, the rostral cap. In most other barbeled cyprinids the rostral barbels originate below the rostral fold and lie exposed on either side of the snout, whereas in most labeoins the rostral barbels are inserted on the ventro-lateral face of the rostral cap (Reid, 1985).

CHARACTER 12: PAPILLAE DENSELY SCATTERED OVER VENTRAL MARGIN OF ROSTRAL CAP AND LOWER LIP

Roberts (1980) documented considerable diversity in the degree and development of horny projections, or unculi, found scattered on the labial papillae of many cyprinoids. Uniquely in *Garra* (Fig. 6C) and other garrains (e.g. Figs 7 and 8), unculiferous papillae are densely arrayed over the fimbrate ventral margin on the outer face of the rostral cap and over the lower lip (see also Reid, 1985; Banarescu, 1986; Roberts, 1989; Zhang & Chen, 1997, 2004; Yang & Winterbottom, 1998; Su, Yang & Cui, 2001, 2003).

CHARACTER 13: UPPER LIP (LABIAL FOLD)

Zhang & Chen (2004) follow Reid (1985) in noting that the rostral cap (or fold) of garrains is more developed than the upper lip, functionally replacing it, at least in adults. Zhang & Chen (2004) further observe that in garrains the pendulous rostral cap completely covers the upper jaw and is separated from it by a deep preoral groove, as illustrated here in *Garra* (Fig. 6F), whereas in most labeoins the rostral cap is separated from the upper jaw by the upper lip (see e.g. Fig. 6E). The degree of regression of the upper lip varies among garrains (and among labeoins, see e.g. Siebert & Tjakrawidjaja, 1998 for a discussion of the ontogenetic regression of the upper lip in *Schismatorhynchos*), but in all garrains the upper lip is greatly reduced in size and seemingly without trophic function. In all garrains the upper lip is reduced to a very thin membranous fold that may either be fully adnate to the proximal margin of the keratinized upper jaw in adults, or hangs ventrally as a short membranous fringe fully overlain by the rostral cap. Even in those taxa in which the upper lip is fully regressed and absent medially, an upper lip frenum attaching to the lower lip and/or rostral cap is usually retained at the lateral margin of the lower jaw (e.g. Figs 7A–D and 8C).

These character data are summarized in Figure 9, with character distributions plotted among the selected cyprinine and cyprinid outgroups examined. Although this diagram is a helpful visualization of character distributions, there clearly remains much need for a matrix-based phylogenetic analysis including representative sampling of all putative members of the Labeonini and additional outgroups. The current morphological investigation presented here aims at providing a useful starting point for that enterprise.

It has been proposed that the immediate relationships of *Garra* lie with the other disc-bearing garrains, a putative clade consisting of *Garra*, *Discocheilus*, *Placocheilus*, and *Discogobio* (Getahun, 2000; Zhang, He & Chen, 2002). In these taxa, and also in *Semilabeo* (Fig. 8E), *Pseudogryrinocheilus* (Fig. 8D), *Pseudocrossocheilus*, *Parasinilabeo*, *Rectoris* (Fig. 8C), and possibly also *Sinocrossocheilus* and *Qianlabeo* (see below), the rostral cap is fully expanded ventrally and a well-developed rostral frenum connects the cap directly with the lower lip at its anterolateral corners. Unfortunately we have been unable to obtain material of *Sinocrossocheilus* for examination, and information in the literature is contradictory regarding the state of this feature in that taxon. For example, Su *et al*. (2003: 420) in a taxonomic review of the genus state that the rostral cap covers the lower jaw and is '…connecting directly with the lower lip', whereas Zhang & Chen (2004) remark that the rostral fold (or cap) and lower lip are 'disconnected' in *Sinocrossocheilus*. The newly described *Qianlabeo* has, according to Zhang & Chen (2004), a ventrally expanded rostral frenum that is directly connected with the lower lip. In all of these taxa the maxillary barbels (if present) are situated at, and connected to, the base of the rostral frenum at its junction with the lower lip. Although in other barbeled garrains (e.g. Fig. 7A, C), labeoins, and other cyprinids, the maxillary barbel is positioned distant from, and unconnected with, the rostral cap or fold.

In his account of *Garra* from western Borneo Roberts (1989: 40) expressed the opinion that 'It seems likely that all species of African and Asian Labeoninae with a mental adhesive disc probably belong to this one genus', and although we do not claim to have undertaken an exhaustive study, based on the foregoing, we cannot agree with Robert's assessment. As was noted by Zhang *et al*. (2002), there are distinct, if subtle, differences in disc morphology among the disc-bearing genera (compare e.g. *Garra* Fig. 6C, *Discocheilus* Fig. 8A, *Discogobio* Fig. 8B, and *Placocheilus* Fig. 8C). Furthermore, *Garra* usually have three rows of pharyngeal teeth, whereas *Placocheilus* (as reported in Zhang *et al*., 2002), *Discocheilus*, and *Discogobio*, invariably have two rows. Additionally, Getahun (2000), following the original observations of Gosline (1978), noted an anterior elongation of the cleithrum in *Garra* (Fig. 10A), a feature that is contrasted with the generalized condition found in other garrains (e.g. Fig. 10B), labeoins, and most cyprinids. Another feature worth mention in this context is that in *Garra* the first two pectoral-fin rays are prominent, fleshy, and are frequently unbranched (Lundberg & Marsh, 1976; Getahun, 2000). Although the presence of more than one unbranched pectoral ray occurs in many balitorids, and in the enigmatic *Psilorhynchus*, it is, as far as we are aware, unique to *Garra* among cyprinids, in which, apart from *Garra,* only the leading pectoral ray is unbranched.

TAXONOMIC REVISION

The following section is in large-part based on the unpublished PhD dissertation of Getahun (2000). The names of the new species described here appeared in that work, but are not available for zoological nomenclature as the dissertation does not qualify as a publication in the sense of the Code (art. 11.1), as it does not satisfy articles 8.1.1, 8.1.2, and 8.1.3 of the Code. The authorship for the new species descriptions provided below is Getahun and Stiassny.

GARRA HAMILTON, 1822

Type species: Cyprinus (Garra) lamta Hamilton, 1822 by subsequent designation of Bleeker (1863: 192).

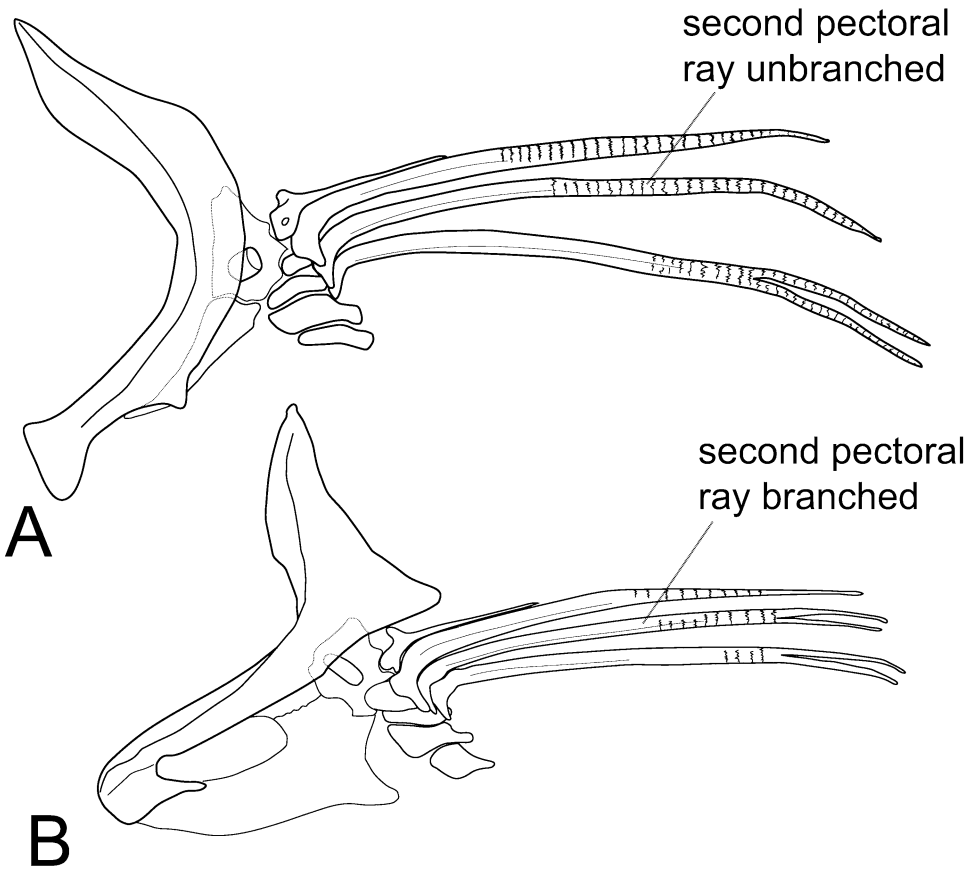

Figure 10. Pectoral girdle and upper fin rays of (A) *Garra dembeensis*, and (B) *Epalzeorhynchus munense*.

Type locality: Behar Province and Rapti River, Gorakhpur District, Uttar Pradesh, India.

Diagnosis: Among cyprinids *Garra* is phylogenetically diagnosed by the following combination of apomorphic features: lower lip expanded posteriorly to form either an ovoid or circular callous pad or suctorial disc; vomero-palatine organ either vestigial or fully regressed; pectoral fins with the first two or more rays prominent and often unbranched; supraethmoid wider than long in dorsal aspect; cleithrum narrow and anteriorly elongate.

In addition, the following combination of features distinguish *Garra* from other members of the labeonin subtribe Garraina: pharyngeal teeth in three rows, 2,4,5–5,4,2; dorsal fin with either ten or 11 rays, inserted slightly in advance of pelvic fins; anal fin with either eight or nine rays, situated well behind pelvic fins; diploid chromosome number 50.

Remarks: Garra are generally benthic omnivores, feeding on attached algae, phytoplankton, and small invertebrates. Food is typically scraped off the substrate with sharp, keratinized jaw margins, and then sucked into the mouth by alternating dilation and contraction of the buccopharynx. *Garra* have no stomach and the oesophagus leads directly to the intestine, from which it is separated by a sphincter. The length of the intestine varies according to dominant food type, being longer in those species feeding predominantly on plant material. The intestinal length (Int.L) shows marked variation between species and is a useful feature for species identification. Little confirmed sexual dimorphism or dichromatism has been reported. When ripe, more than 75% of the body cavity may be occupied by the gonads. Ripe females carry between 400 and 1000 ovarian eggs (average diameter 1.77 mm; Getahun, 2000). Breeding behaviour is poorly known but spawning migration of lacustrine species to rivers is presumed to occur.

Although African species were poorly represented in Menon's (1964) revision of *Garra*, that study provides a useful comparative taxonomic framework and a starting point for further investigation of the genus. Probably in reflection of limited sampling, Menon (1964) recognized only eight species of *Garra* from the African continent. Not included in that study, or described since, are *Garra allostoma* Roberts, 1990, *Garra congoensis* Poll, 1959, and *Garra*

lancrenonensis Blache & Miton, 1960. Getahun (2000), in a taxonomic review of African *Garra*, resurrected *G. aethiopica* (Pellegrin, 1927), *Garra blanfordii* (Boulenger, 1901), and *Garra hindii* (Boulenger, 1905), and synonomized *Garra trewavasae* Monod, 1950, and *Garra tibanica* Trewavas, 1941, with *Garra ornata* (Nichols & Griscom, 1917) and *Garra quadrimaculata* (Ruppell, 1931), respectively. Including the five new species described herein, we recognize a total of 17 valid African species and an artificial key for their identification is provided here.

GARRA REGRESSUS SP. NOV. (FIG. 11; TABLE 2)

Garra microstoma Getahun, 2000, *nomen nudum* [p. 92, unpubl. PhD thesis, preoccupied by *Garra microstoma* Mai (1978) and valid as *Discogobio microstoma* (Mai, 1978) (Kottelat, 2001)]

Diagnosis: Unique among African *Garra* in possession of a small, acutely pointed head, narrow mouth, regressed rostral cap, and a fully exposed upper jaw.

Description: Morphometric and meristic data for holotype and two paratypes given in Table 2. Maximum size: 121.8 mm SL (holotype, AMNH 228487). Currently known only from type series. All specimens relatively slender (body depth 19.8–20.6, m. 20.1% SL) and elongate, greatest body depth located at level of dorsal-fin origin. Head relatively short (19.7–21.0, m. 20.5% SL), snout acutely pointed and often studded with small tubercles, mouth narrow. Eye positioned a little posterior on head. Dorsal head profile rising steeply over snout, dorsum of head more-or-less flattened, dorsal body profile smoothly convex to dorsal-fin origin. Disc type A, weakly developed and inconspicuous, without free posterior margin. Rostral cap thin and regressed leaving upper jaw exposed. Two pairs of small barbels, maxillary pair usually

Table 2. Morphometric and meristic data for ***Garra regressus sp. nov.*** Proportional measurements (mm) in either the percentage of standard length (SL) or the percentage of head length (HL), unless noted otherwise. When range of values, meristics of holotype are given in parenthesis

Character	*n*	holotype	range	mean	SD
Standard length (SL)	3	121.8	94.7–121.8		
% SL					
Body depth	3	20.1	19.8–20.6	20.1	0.44
Head length	3	19.6	19.7–21.0	20.5	0.72
Predorsal length	3	46.2	44.0–46.3	45.0	1.18
Pectoral fin length	3	19.6	17.5–21.0	19.6	1.83
Caudal peduncle length	3	18.1	18.2–18.9	18.6	0.35
Caudal peduncle depth	3	10.2	9.9–11.1	10.7	0.67
Dorsal fin length	3	18.7	18.7–24.1	20.7	2.90
Anal fin length	3	16.9	16.8–18.7	17.5	1.08
Pelvic fin length	3	16.8	16.8–20.8	19.0	2.04
% HL					
Head width	3	64.6	62.7–71.2	66.8	4.26
Head depth	3	59.4	57.5–61.0	59.8	1.97
Snout length	3	44.5	38.9–44.7	41.5	2.96
Orbit diameter	3	16.5	16.3–21.7	19.3	2.75
Interorbital width	3	44.3	41.0–44.3	42.7	1.65
% Orbit diameter					
Rostral barbel length	3	56.2	44.0–66.0	54.0	11.14
Maxillary barbel length	3	57.1	35.6–68.4	54.0	16.74
Dorsal fin rays		III + 7			
Anal fin rays		III + 5			
Pectoral fin rays		IV + 11			
Pelvic fin rays		II + 6			
Lateral line scales		39			
Scale rows lateral line–dorsal fin		4–5 (H, 5)			
Scale rows lateral line–pelvic fin		3–4 (H, 4)			
Scale rows lateral line–anal fin		4.5			
Predorsal scales		8–9 (H, 8)			

ARTIFICIAL KEY TO *GARRA* OF THE AFRICAN CONTINENT

1. Two pairs of barbels (maxillary and rostral) 2
   Single pair of (maxillary) barbels ..... *Garra duobarbis* (Ethiopia)
2. Rostral fold ventrally expanded and covering upper jaw; mouth broad 3
   Rostral fold not ventrally expanded and upper jaw exposed; mouth narrow ..... *Garra regressus* (Ethiopia, Lake Tana)
3. Mental disc moderately to very well developed, with free lateral and posterior margins (Fig. 1B, C) 4
   Mental disc reduced to a central callus, sometimes with a narrow free posterior margin, but entirely lacking free lateral margins and papillate periphery (Fig. 1A) 14
4. Chest with either many, or some scattered scales 5
   Chest asquamate 6
5. Lateral line scales 34–35; vent located close to anal fin (vent distance 8.6–19.1% of distance between anterior end of anal- and pelvic-fin insertions); eye median ..... *Garra quadrimaculata* (Ethiopia, Eritrea, Somalia)
   Lateral line scales 40–42; vent located relatively far from anal fin (vent distance 29.3–30.2% of distance between anterior end of anal- and pelvic-fin insertions); eye posterior .... *Garra hindii* (Cameroon, Congo*, Kenya, Uganda)
6. Post-pelvic region asquamate 7
   Post-pelvic region scaled 9
7. Body either with distinct midlateral band, or darker dorsally than ventrally; black spots in basal membrane of dorsal fin; predorsal region only partially scaled; region between vent and anal fin scaled 8
   Uniformly pale body coloration; no markings in dorsal fin; fully scaled predorsal region; no scales between vent and anal fin ..... *Garra blanfordii* (Ethiopia, Eritrea, Sudan)
8. Between five and nine scales in predorsal region; body depth 14.9–16.8, m. 16.0% SL; intestine short (SL 95.0–102.0% Int.L) ..... *Garra geba* (Ethiopia)
   Between zero and three scales in predorsal region; body depth 15.6–23.9, m. 20.4% SL; intestine moderately long (SL 39.0–42.0% Int.L) ..... *Garra dembeensis* (Cameroon, Chad, Egypt, Ethiopia, Kenya, Nigeria,Tanzania)
9. Predorsal region either naked or only partially scaled 10
   Predorsal region fully scaled 11
10. Body and head markedly dorso-ventrally flattened (body depth 10.6–15.0, m. 11.9% SL); gas bladder extremely reduced, posterior chamber 3.1–3.8% SL ..... *Garra congoensis* (Angola, Congo*)
    Body depth 15.8–22.3, m. 17.8% SL; posterior chamber of gas bladder 6.2–10.0% SL ..... *Garra ornata* (Cameroon, Central African Republic, Congo*, Gabon, Guinea, Nigeria)
11. Either 29 or 30 scales on the lateral line; body depth 29.1–30.9, m. 30.0% SL; 27–28 vertebrae ..... *Garra ethelwynnae* (Eritrea)
    More than 34 scales on the lateral line; body depth less than 28.0% SL; more than 30 vertebrae 12
12. Disc moderately developed (type B); dark ash-grey midlateral band to base of caudal peduncle; belly scaled; no tubercles on snout ..... *Garra aethiopica* (Ethiopia)
    Disc well developed (type C); body more-or-less uniformly dark on flanks; belly either asquamate or with only a few embedded scales; tubercles on snout 13
13. Some scales on belly; distance from vent to anal fin 10.3–16.9, m. 13.6% of distance between anal- and pelvic-fin insertions; eye either median, or posterior in large specimens ..... *Garra makiensis* (Ethiopia)
    Belly asquamate; distance from vent to anal fin 19.2–29.5, m. 18.2% of distance of anal- and pelvic-fin insertions; eye median ..... *Garra ignestii* (Ethiopia)
14. Post-pelvic region asquamate, Ethiopian distribution 15
    Post-pelvic region scaled, found in Cameroon and Tchad 16
15. Length of caudal peduncle 20.4–22.3, m. 20.2% SL; either 39 or 40 scales in lateral line; intestine short (SL 62.7–79% Int.L); spots in basal membrane of dorsal fin either absent or small and faint ..... *Garra tana* (Ethiopia, Lake Tana)
    Length of caudal peduncle 13.3–20.7, m. 16.8% SL; 37–38 scales in lateral line; intestine longer (SL 40–56% Int.L); either four or five elongate black spots in basal membrane of dorsal fin ..... *Garra dembecha* (Ethiopia, Eritrea, Kenya, Tanzania)
16. Vent close to anal fin (vent distance 13.3–17.4% of distance between pelvic- and anal-fin insertions) ..... *Garra lancrenonensis* (Tchad)
    Vent situated relatively far from anal fin (vent distance 28.5–30.6% of distance between pelvic- and anal-fin insertions) ..... *Garra allostoma* (Cameroon)

*Congo River basin.

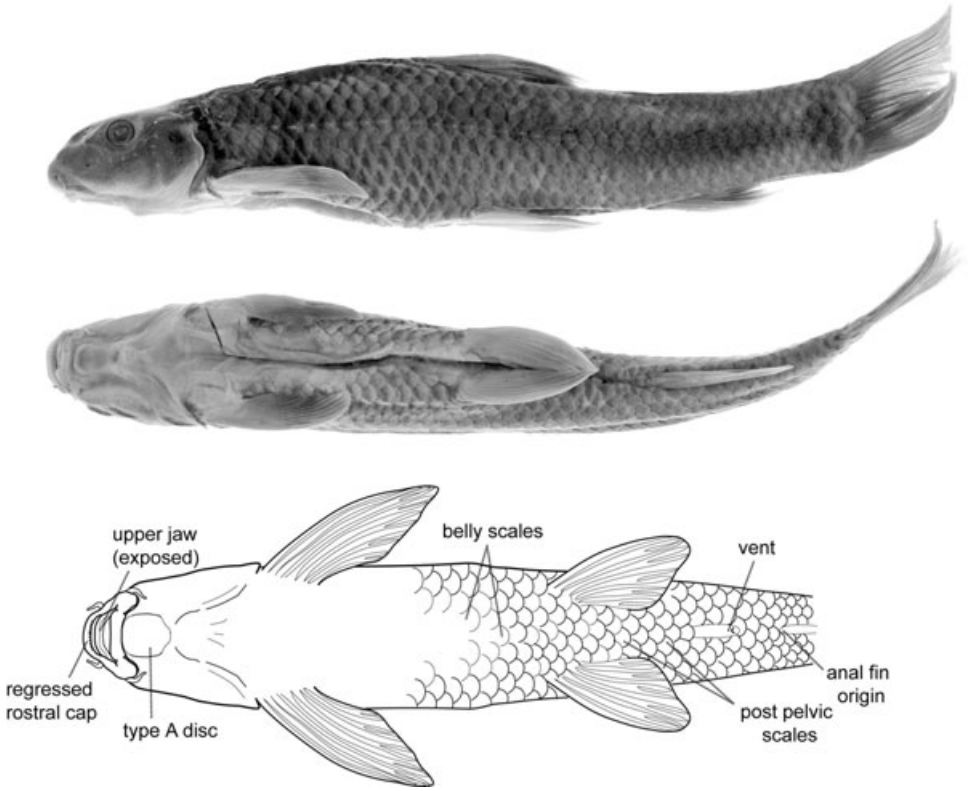

Figure 11. *Garra regressus*, holotype, AMNH 228487, 121.8 mm standard length.

longest. Thirty-nine pored scales along lateral line; either eight or nine predorsal scales anterior to dorsal fin; either three or four scales from lateral line to origin of pelvic fin; either four or five scales from lateral line to origin of dorsal fin. Chest asquamate, belly with a few deeply embedded scales, and postpelvic region fully scaled. Dorsal-fin rays iii, seven, inserted well anterior to pelvic fin, with short subacuminate tip, first and second branched rays longest, extending slightly beyond last ray; posterior margin straight, posteriormost ray not extending to tip of pelvic fin. Predorsal length (distance between dorsal-fin origin and tip of snout) 44.0–46.3% SL. Anal-fin rays iii, five, with short subacuminate tip; posterior margin straight. Pectoral-fin rays iv, 11; pectoral length 17.5–21.0% SL. Vent located relatively close to anal fin (vent distance 19.3–23.8, mean 21.9%). Intestine very short (SL 108–116% Int.L). Gas bladder well developed and large (posterior chamber 21.7–24.9% SL).

Colour in preservation: Body dark brown dorsally, somewhat lighter brown below lateral line but not markedly so. In largest specimen (Fig. 11) traces of a dark midlateral band evident. Head, snout, cheek, and opercle: dark brown. Lips, lower cheek, gular region, and branchiostegal membranes: pale yellow brown. Dorsal and anal fins dark brown distally, paler proximally, with pale, creamy subacuminate tips. Either four or five discrete black spots between rays in basal membrane of dorsal fin. Caudal fin uniformly dark brown. Pelvic and pectoral fins light brown with pale leading edges.

Distribution and habitat: Currently known from region of Gerima in southern part of Lake Tana, Ethiopia. Specimens were collected by trawl in papyrus beds close to shore (25–30 m) in water *c*. 2.5 m in depth.

Etymology: Regressus, from the Latin regress, meaning to go back, in reference to the regressed rostral cap characteristic of the species.

Material examined – type material: Holotype of *G. regressus,* AMNH 228487, 121.8 mm SL, Lake Tana, Gerima, *c*. 30 m off shore (11°35′N, 37°24′E); paratypes of *G. regressus,* AMNH 228487, two ex., one ex. C & S, 94.7–115.6 mm SL, same data as holotype.

GARRA DUOBARBIS SP. NOV. (FIG. 12; TABLE 3)

Garra duobarbis Getahun, 2000, *nomen nudum* (p. 62 unpubl. PhD thesis)

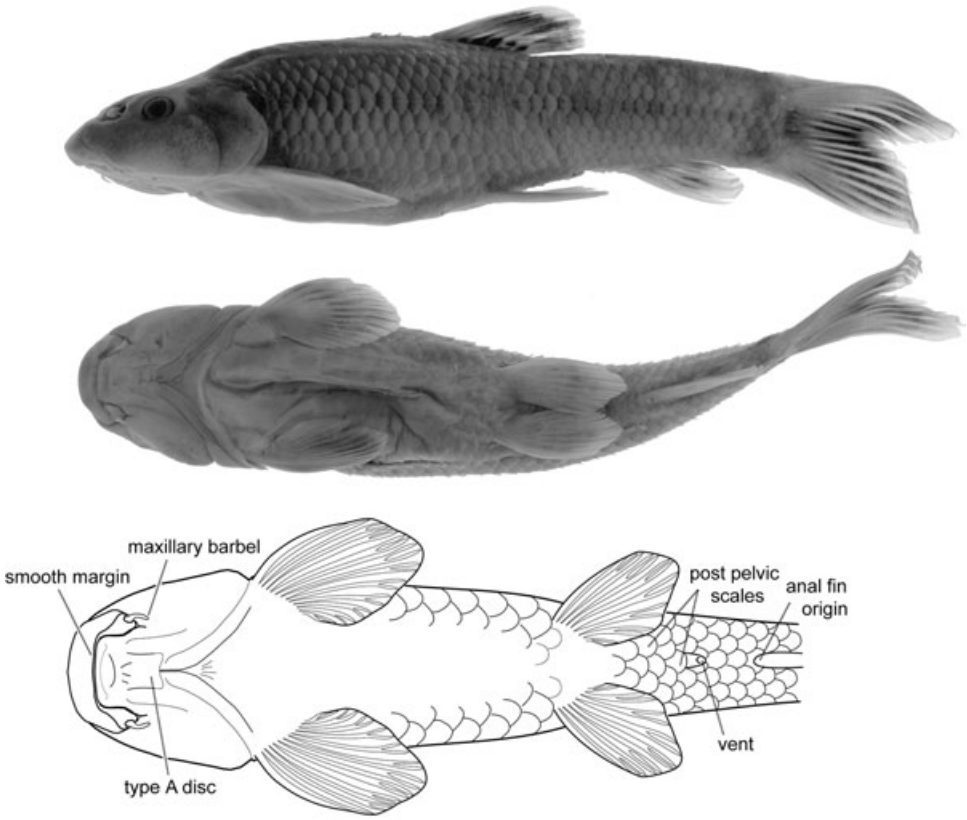

Figure 12. *Garra duobarbis*, holotype, AMNH 228484, 66.8 mm standard length.

Diagnosis: Unique among African *Garra* in possessing a single (maxillary) pair of barbels.

Description: Morphometric and meristic data for holotype and nine paratypes given in Table 3. Maximum size: 66.8 mm SL (holotype, AMNH 228484). Currently known only from type series. All are robust, and relatively deep-bodied (body depth 18.8–24.3, m. 23.4% SL); greatest body depth located well anterior to dorsal-fin origin, at level of pectoral-fin tips. Head depressed and flattened (length 24.6–28.4, m. 25.9% SL), snout short and bluntly rounded, with no tubercles. Eyes positioned a little anterior on head. Dorsal head profile rises smoothly over snout and head; dorsal body profile steeply convex to dorsal-fin origin, often with a sharp demarcation between dorsal head profile and dorsal body profile. Disc type A, extremely weakly developed and inconspicuous without either free posterior edge or distinct lateral margins. Rostral cap well developed with smooth ventral margin extended ventrally over upper jaw. Rostral barbels absent; single pair of maxillary barbels, relatively long and conspicuous. Between 34 and 36 scales along lateral line; 4.5 scales from lateral line to origin of pelvic fin; 5.5 scales from lateral line to origin of dorsal fin. No predorsal scales anterior to dorsal fin, chest and belly asquamate, postpelvic region scaled. Dorsal-fin rays iv, seven, inserted just anterior to pelvic fin, with rounded tip, second branched ray longest, not reaching last ray; posterior margin straight. Predorsal length 50.6–54.0% SL. Anal-fin rays iv, five, with short subacuminate tip; posterior margin straight. Pectoral-fin rays iv, 12; pectoral fin rounded and paddle-shaped, length 12.9–21.4% SL. Vent located relatively close to anal fin (vent distance 18.8–28.2, m. 22.0%). Intestine short (SL 72.0–79.0% Int.L). Gas bladder small (posterior chamber 15.1–19.6% SL).

Colour in preservation: Base body colour pale creamy brown, slightly darker dorsally, pale cream below lateral line and ventrally. Snout, dorsum of head, and anterior opercle: brownish-grey. Lips, cheek, gular region and branchiostegal membranes: pale creamy yellow. Posterior border of opercle also pale cream. Pale coloration extends postero-dorsally to eye. Dorsal-fin membrane pale cream distally, broad submarginal band of black pigment in membrane between rays, and pale cream proximally. Either five or six small black spots between rays in basal membrane of dorsal fin. Anal fin cream in smaller specimens, and

Table 3. Morphometric and meristic data for ***Garra duobarbis sp. nov.*** Proportional measurements (mm) are given in either percentage standard length (SL) or percentage head length (HL), unless noted otherwise. When range of values, meristics of holotype are given in parenthesis

Character	*n*	holotype	range	mean	SD
Standard length (SL)	10	66.8	46.1–66.8		
% SL					
Body depth	10	22.4	18.8–24.3	22.4	1.82
Head length	10	27.2	24.6–28.4	25.9	1.05
Predorsal length	10	52.7	50.6–54.0	51.6	0.97
Pectoral fin length	10	19.5	12.9–21.4	18.6	2.47
Caudal peduncle length	10	14.7	12.7–16.7	14.9	1.43
Caudal peduncle depth	10	11.4	10.6–12.2	11.6	0.47
Dorsal fin length	10	22.6	20.5–23.9	21.8	1.01
Anal fin length	10	18.1	17.4–18.6	17.9	0.42
Pelvic fin length	10	17.9	16.1–18.3	17.7	0.62
% HL					
Head width	10	73.3	66.8–77.5	72.1	2.94
Head depth	10	54.3	51.2–63.9	55.4	3.48
Snout length	10	43.1	30.5–43.1	37.4	3.78
Orbit diameter	10	19.2	16.6–21.0	18.4	1.51
Interorbital width	10	44.6	38.6–46.3	42.2	2.54
% Orbit diameter					
Rostral barbel length	10	absent	absent		
Maxillary barbel length	10	91.4	60.3–98.2	88.0	1.24
Dorsal fin rays		IV + 7			
Anal fin rays		IV + 5			
Pectoral fin rays		IV + 12			
Pelvic fin rays		II + 6			
Lateral line scales		34–36 (H, 36)			
Scale rows lateral line–dorsal fin		5.5			
Scale rows lateral line–pelvic fin		4.5			
Scale rows lateral line–anal fin		5.5			
Predorsal scales		0			

with broad submarginal band of black pigment in larger specimens (Fig. 12). Distinct black spot in fin membrane at base of caudal fin. Medial caudal-fin rays, dark brown and membranes pale cream; whole fin with a pale distal margin. Pelvic and pectoral fins pale creamy brown with pale leading edges.

Distribution and habitat: Currently known only from type locality (Koladiba, about 80 km south of Gondar, in Dirma River, Ethiopia) from where the species was collected some 200 m west of a highway bridge in muddy water. Habitat largely disturbed with some fringing vegetation (*Eucalyptus*) along riverbank.

Etymology: Duobarbis, from the Greek *duo*, meaning two, and the Latin *barba*, meaning beard, in reference to the single pair of barbels that are characteristic of the species.

Material examined – type material: Holotype of *G. duobarbis* AMNH 228484, 66.8 mm SL, Koladiba, about 80 km south of Gondar, Dirma River, Ethiopia (12°25′N, 37°20′E); paratypes of *G. duobarbis* AMNH 223736, nine ex., two ex. C & S, 46.1–64.8 mm SL, same data as holotype.

GARRA GEBA SP. NOV. (FIG. 13; TABLE 4)

Garra geba Getahun, 2000, *nomen nudum* (p. 68 unpubl. PhD thesis)

Diagnosis: Distinguished from African congeners by the following combination of features: intermediate disc development; depressed head and gracile body; between five and nine predorsal scales anterior to dorsal fin; asquamate chest, belly, and postpelvic region; posterior chamber of gas bladder small (13.9–16.2% SL); and intestine short (SL 95.0–102.0% Int.L).

Description: Morphometric and meristic data for holotype and seven paratypes given in Table 4. Maximum

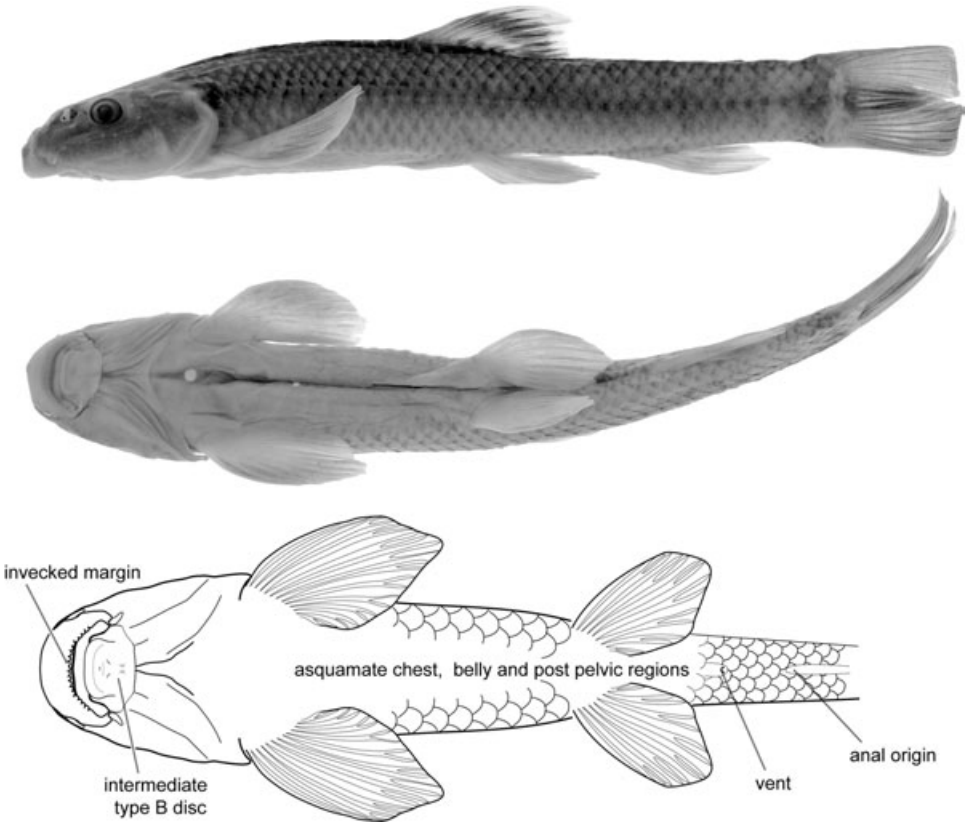

Figure 13. *Garra geba*, holotype, AMNH 228485, 86.4 mm standard length.

size: 86.4 mm SL (holotype, AMNH 228485). Currently known only from type series. All specimens extremely gracile (body depth 14.9–16.8, m. 16.0% SL) and elongate, greatest body depth located well anterior to dorsal fin, midway between dorsal-fin origin and snout. Head gracile and depressed, often with small circular tubercles in front of nostrils, becoming tubular beneath eyes. Eyes positioned medially on head. Dorsal head profile rises steeply over snout, dorsum of head more-or-less flattened, dorsal body profile smoothly convex to dorsal-fin origin. Disc variously developed; only weakly so in smaller specimens, becoming quite well-developed (type B) with a narrow free posterior edge and partially free lateral margins in adult specimens, but never broadly papillate (as in type C). Disc in adults markedly wider than deep. Rostral cap well developed, extending ventrally over upper jaw and with invecked ventral margin. Two pairs of barbels: maxillary barbels usually slightly longer than rostral pair. Between 37 and 39 scales along lateral line; between five and nine predorsal scales anterior to dorsal fin; 2.5–3.5 scales from lateral line to origin of pelvic fin; 4.5–5.5 scales from lateral line to dorsal-fin origin. Chest, belly, and postpelvic regions asquamate. Dorsal-fin rays iv, seven, inserted well anterior to pelvic fin, with short subacuminate tip, first and second unbranched rays longest, extending slightly beyond last ray; posterior margin weakly concave, posterior rays extending almost to pelvic-fin tip. Predorsal length 46.9–50.0% SL. Anal-fin rays iv, five, with short subacuminate tip; posterior margin weakly concave. Pectoral rays iv, 11; pectoral length 19.1–22.6% SL, with somewhat pointed tips. Vent located relatively distant from anal fin (vent distance 18.4–29.1, m. 24.6%). Intestine short (SL 95.0–102.0% Int.L). Gas bladder small (posterior chamber 13.9–16.2% SL).

Colour in preservation: Body dark dorsally, lighter brown below lateral line and ventrally. Head, snout, and most of cheek and opercle: dark brown. Lips, gular region, posterior margin of opercle, and branchiostegal membranes: creamy yellow-brown. Pale coloration extends postero-dorsally around eye. Dorsal-fin membrane pale cream distally, faint submarginal band of black pigment in membrane between rays, and pale cream proximally. Either four or five small black spots between rays in basal membrane of dorsal fin. Anal fin uniformly pale creamy brown. Caudal fin pale dusky brown, with median rays a darker

Table 4. Morphometric and meristic data for ***Garra geba sp. nov.*** Proportional measurements (mm) are given in either percentage standard length (SL) or percentage head length (HL), unless noted otherwise. When range of values, meristics of holotype are given in parenthesis

Character	*n*	holotype	range	mean	SD
Standard length (SL)	8	86.4	40.3–86.4		
% SL					
Body depth	8	14.9	14.8–16.8	16.0	0.62
Head length	8	23.1	23.2–25.7	24.3	0.83
Predorsal length	8	47.9	46.9–50.0	48.5	0.89
Pectoral fin length	8	20.7	19.1–22.6	21.1	0.92
Caudal peduncle length	8	16.5	14.4–19.9	16.9	1.64
Caudal peduncle depth	8	10.0	8.3–10.6	9.6	0.66
Dorsal fin length	8	20.6	19.4–22.1	20.8	0.98
Anal fin length	8	15.9	12.2–18.5	16.4	1.80
Pelvic fin length	8	16.8	16.2–17.6	16.9	0.57
% HL					
Head width	8	71.1	61.5–76.1	70.4	4.10
Head depth	8	54.5	47.6–59.4	53.7	4.01
Snout length	8	45.0	31.6–45.7	37.4	4.22
Orbit diameter	8	20.2	14.2–23.1	19.9	2.50
Interorbital width	8	40.4	34.5–42.5	38.7	2.84
% Orbit diameter					
Rostral barbel length	8	65.9	35.0–73.0	54.8	11.50
Maxillary barbel length	8	67.4	32.0–82.8	57.7	15.66
Dorsal fin rays		IV + 7			
Anal fin rays		IV + 5			
Pectoral fin rays		IV + 11			
Pelvic fin rays		II + 6			
Lateral line scales		37–39 (H, 39)			
Scale rows lateral line–dorsal fin		4.5–5.5 (H, 5.5)			
Scale rows lateral line–pelvic fin		2.5–3.5 (H, 3.5)			
Scale rows lateral line–anal fin		3.5–4 (H, 4)			
Predorsal scales		5–9 (H, 7)			

brown. Pelvic and pectoral fins uniformly pale creamy brown.

Distribution and habitat: Currently known only from type locality on Geba River about 2 km south of Hagere Selam town, Tigray, Ethiopia. In this region the Geba River flows through highly degraded farmland with sparse vegetation and little cover. Type-series was collected some 100 m east of a highway bridge in slowly flowing water over mud and sand, with some fringing grasses along riverbanks.

Etymology: Geba, in reference to the river system in which the type series was collected.

Remarks: In some features (absence of chest, belly, and postpelvic scales, high number of lateral line scales, and median position of the eye) *G. geba* is similar to *G. dembeensis*. However, *G. geba* is readily distinguished from *G. dembeensis* in having a partially scaled predoral region, a less well-developed disc that lacks prominent papillation, a much shorter intestine (SL 95.0–102.0 vs. 39.0–42.0% Int.L), and a smaller posterior gas bladder chamber (13.9–16.2 vs. 20.9–21.9% SL).

Material examined – type material: Holotype of *G. geba,* AMNH 228485, 86.4 mm SL, Geba River, about 2 km south of Hagere Selam town, Tigray, Ethiopia (13°35′N, 39°25′E); paratypes of *G. geba,* AMNH 223747, seven ex., two ex. C & S, 55.4–69.6 mm SL, same data as holotype.

GARRA TANA SP. NOV. (FIG. 14; TABLE 5)

Garra tana Getahun, 2000, *nomen nudum*, (p. 108, unpublished PhD thesis)

Diagnosis: Distinguished from African congeners by the following combination of features: very weakly developed disc; between three and five predorsal

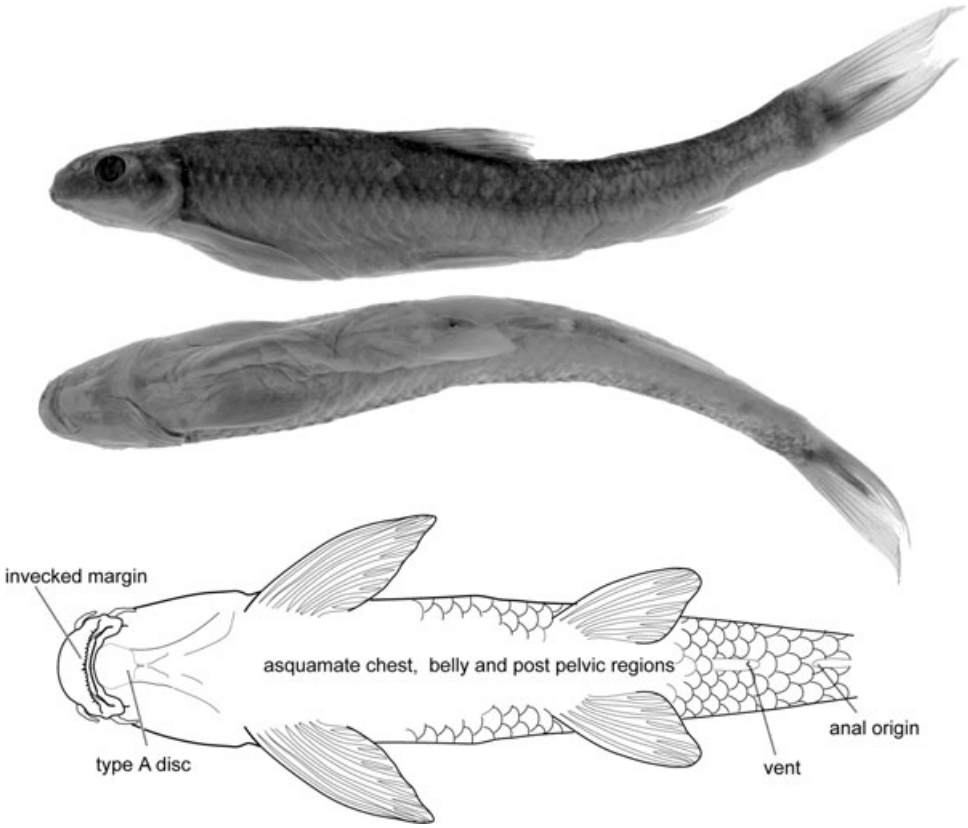

Figure 14. *Garra tana*, holotype, AMNH 223824, 108.3 mm standard length.

scales anterior to dorsal fin; chest, belly, and postpelvic region asquamate; elongate, narrow caudal peduncle (length 20.4–22.3%, m. 20.2% SL; depth 7.2–10.0, m. 8.4% SL); and short intestine (SL 62.0–79.0% Int.L).

Description: Morphometric and meristic data for holotype and 30 paratypes given in Table 5. Maximum size: 108.3 mm SL (holotype, AMNH 223824). Currently known only from type series. All specimens are slender and gracile (body depth 13.4–18.8, m. 16.6% SL), greatest body depth located well anterior to dorsal-fin origin, at level of pectoral-fin tip. Caudal peduncle: elongate and narrow. Head short (18.9–25.6%, m. 21.5% SL), snout prominent, with no tubercles, mouth wide. Eyes positioned medially on head, and relatively large (diameter 15.3–27.9% HL, m. 21.5%). Dorsal head profile rises steeply over snout, then more-or-less smoothly convex to dorsal-fin origin. Type-A disc: very weakly developed and inconspicuous without free posterior margin. Rostral cap well-developed, ventrally expanded covering upper jaw and with clearly invecked ventral margin. Two pairs of small barbels: rostral pair frequently conspicuous and often longest. Either 39 or 40 scales along lateral line; between three and five predorsal scales anterior to dorsal fin; either three or four scales from lateral line to origin of pelvic fin; 4–4.5 scales from lateral line to dorsal-fin origin. Chest, belly, and postpelvic regions asquamate. Dorsal-fin rays iii, seven, inserted well anterior to pelvic fin, with subacuminate tip, third branched ray longest, extending well beyond last ray; posterior margin concave. Predorsal length: 39.8–50.0% SL. Anal-fin rays iii, five, with subacuminate tip; posterior margin concave. Pectoral-fin rays iv, 11; pectoral length 16.6–20.2% SL, with somewhat pointed tips. Vent located distant from anal fin (vent distance 17.9–53.0, m. 27.8%). Intestine short (SL 62.0–79.0% Int.L). Gas bladder well developed and large (posterior chamber 22.1–25.4% SL).

Colour in preservation: Body dark dorsally, lighter brown below lateral line and ventrally. Head, snout, and most of cheek and opercle: dark brown. Lips, gular region, posterior opercle, and branchiostegal membranes: pale yellow-brown. Dorsal fin membrane with pale cream tip, faint submarginal band of black pigment in membrane between rays, and pale cream

Table 5 . Morphometric and meristic data for ***Garra tana sp. nov.*** Proportional measurements (mm) are given in either percentage standard length (SL) or percentage head length (HL), unless noted otherwise. When range of values, meristics of holotype are given in parenthesis

Character	*n*	holotype	range	mean	SD
Standard length (SL)	31	108.3	26.4–108.3		
% SL					
Body depth	31	18.0	13.4–18.8	16.6	1.47
Head length	31	18.9	18.9–25.6	21.5	1.79
Predorsal length	31	45.6	39.8–50.0	43.0	3.02
Pectoral fin length	31	19.0	16.6–20.2	18.4	1.04
Caudal peduncle length	31	20.1	20.4–22.3	20.2	1.74
Caudal peduncle depth	31	7.9	7.2–10.0	8.4	0.77
Dorsal fin length	31	24.7	22.0–26.0	23.6	1.07
Anal fin length	31	17.7	17.1–19.3	18.3	0.49
Pelvic fin length	31	16.9	16.4–19.7	18.0	0.78
% HL					
Head width	31	61.0	56.7–66.3	60.5	2.68
Head depth	31	54.7	45.2–61.1	53.1	3.05
Snout length	31	44.0	33.9–44.1	38.4	3.08
Orbit diameter	31	23.4	15.3–27.9	21.5	3.14
Interorbital width	31	42.1	29.4–59.4	36.4	5.30
% Orbit diameter					
Rostral barbel length	31	96.2	43.0–127.0	81.8	0.51
Maxillary barbel length	31	90.3	41.0–102.9	77.4	18.07
Dorsal fin rays		III + 7			
Anal fin rays		III + 5			
Pectoral fin rays		IV + 11			
Pelvic fin rays		II + 6			
Lateral line scales		39–40 (H, 39)			
Scale rows lateral line–dorsal fin		4–4.5 (H, 4.5)			
Scale rows lateral line–pelvic fin		3–4 (H, 4)			
Scale rows lateral line–anal fin		4–4.5 (H, 4)			
Predorsal scales		3–5 (H, 5)			

proximally. Some specimens with faint trace of either five or six very small black spots between rays in basal membrane of dorsal fin, but in most specimens dorsal-fin spots absent. Anal fin uniformly pale creamy yellow. Caudal fin pale creamy brown, with median rays a contrasting darker brown. Pelvic and pectoral fins uniformly pale creamy brown.

Distribution and habitat: Currently known only from south of Lake Tana, Ethiopia. All specimens were collected by trawl close to shore (25–2000 m) in water ranging from 2 to 14 m in depth, over mud, sand, and rocks.

Remarks: G. tana occurs in sympatry with *G. regressus* and *G. dembeensis*. It is readily distinguished from *G. regressus* by the possession of a well-developed rostral cap with invecked ventral margin that covers the upper jaw (vs. regressed rostral cap with smooth margin and upper jaw exposed in *G. regressus*), and from *G. dembeensis* by a weakly developed, type-A mental disc that lacks a free posterior margin (vs. well-developed disc with free posterior and lateral margins in *G. dembeensis*). *G. tana* is further differentiated from both species by an elongate caudal peduncle (length 20.4–22.3% SL vs. 18.2–18.8% SL and 12.7–19.4% SL, respectively).

Etymology: Tana, in reference to the lake in which the type series was collected.

Material examined – type material: Holotype of *G. tana,* AMNH 223824, 108.3 mm SL, Kenbefami, Lake Tana, Ethiopia (11°40′N, 37°20′E); paratypes, AMNH 227687, eight ex., two ex. C & S, 26.4–102 mm SL, north-west of Dek Island, Lake Tana, Ethiopia (11°56′N, 37°11′E); paratypes, AMNH 227688, three ex., 88.1–94.6 mm SL, Kibran shore, Lake Tana, Ethiopia (11°39′N, 37°23′E); paratype, AMNH 227689, one ex., 104.4 mm SL, Entos Island, Lake Tana, Ethiopia

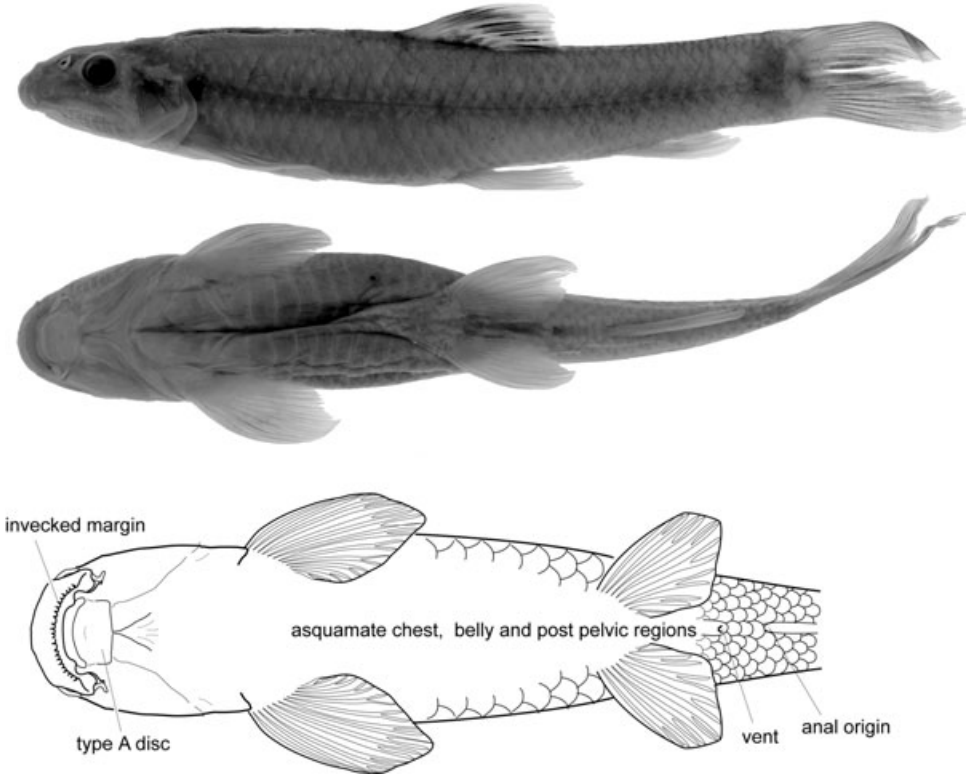

Figure 15. *Garra dembecha*, holotype, AMNH 228483, 78.8 mm standard length.

(11°37′N, 37°24′E); paratypes, AMNH 227690, five ex., 49.4–100.3 mm SL, north of mid-Gulf, Lake Tana, Ethiopia (11°46′N, 37°22′E); paratypes, AMNH 227691, seven ex., 35.5–99.3 mm SL, same data as AMNH 227691; paratypes, AMNH 227693, three ex., 61.6–100.8 mm SL, Bet Menzo Island, *c*. 500 m offshore, Lake Tana, Ethiopia (11°44′N, 37°25′E); paratypes, AMNH 22695, three ex., 89.9–106.5 mm SL, 25 m off Entos Island, Lake Tana, Ethiopia (11°37′N, 37°24′E).

GARRA DEMBECHA SP. NOV. (FIG. 15; TABLE 6)

Garra dembecha Getahun, 2000, *nomen nudum*, (p. 45 unpublished PhD thesis)
Gobio quadrimaculatus (non-Rüppell, 1836): Boulenger, 1903, *Proc. Zool. Soc. Lond.*, p. 330; Boulenger, 1907, *The fishes of the Nile*, p. 186; Boulenger, 1909, *Catalogue of the freshwater fishes of Africa*, Vol. 1, p. 351
Discognathus quadrimaculatus (non-Rüppell, 1836): Boulenger, 1903, *Proc. Zool. Soc. Lond.*, p. 330; Boulenger, 1907, *The fishes of the Nile*, p. 186; Boulenger, 1909, *Catalogue of the freshwater fishes of Africa*, Vol. 1, p. 351.
Crossocheilus quadrimaculatus: Boulenger, 1902; *Ann. Mag. N.H.* (7), p. 422; Boulenger, 1907, *The fishes of the Nile*, p. 186; Boulenger, 1909, *Catalogue of the freshwater fishes of Africa*, Vol. 1, p. 351

Diagnosis: Distinguished from African congeners by the following combination of features: weakly developed disc; predorsal region partially scaled anterior to dorsal fin; chest, belly, and postpelvic region asquamate; moderately elongate intestine (SL 40.0–56.0% Int.L); large gas bladder (posterior chamber 21.7–22.4% SL); and vent situated distant from anal fin (vent distance 24.3–43.2, m. 32.0%).

Description: Morphometric and meristic data for holotype and 27 paratypes given in Table 6. Maximum size: 129.7 mm SL (MSNM 2162). Body relatively gracile (depth 16.7–23.0, m. 19.5% SL), greatest body depth located midway between dorsal-fin origin and snout. Head gracile and depressed (depth 50.0–65.2, m. 56.9% HL), without tubercles on snout. Eyes positioned medially on head. Dorsal head profile rises steeply over snout, dorsum of head more-or-less flattened, dorsal body profile weakly convex, almost flat to dorsal-fin origin in most specimens, although in some larger individuals dorsal body profile rises steeply

Table 6. Morphometric and meristic data for ***Garra dembecha sp. nov.*** Proportional measurements (mm) are given in either percentage standard length (SL) or percentage head length (HL), unless noted otherwise. When range of values, meristics of holotype are given in parenthesis

Character	*n*	holotype	range	mean	SD
Standard length (SL)	28	78.8	23.5–82.1		
% SL					
Body depth	28	19.2	16.7–23.0	19.5	1.85
Head length	28	24.1	19.8–28.2	24.7	1.93
Predorsal length	28	47.0	45.3–54.4	50.0	1.48
Pectoral fin length	28	19.3	16.6–22.3	20.1	1.38
Caudal peduncle length	28	15.9	13.3–20.7	16.8	1.57
Caudal peduncle depth	28	9.8	8.8–12.0	10.3	0.91
Dorsal fin length	28	21.5	19.5–22.6	21.0	0.87
Anal fin length	28	16.4	16.1–17.0	16.6	0.26
Pelvic fin length	28	16.9	16.1–18.9	17.6	0.77
% HL					
Head width	28	65.3	57.5–80.9	67.2	5.74
Head depth	28	55.4	50.0–65.2	56.9	3.80
Snout length	28	30.9	25.2–50.0	35.5	6.15
Orbit diameter	28	22.1	15.8–27.3	20.7	3.13
Interorbital width	28	39.7	33.3–49.5	39.3	3.77
% Orbit diameter					
Rostral barbel length	28	65.0	42.0–91.0	60.7	15.61
Maxillary barbel length	28	60.2	38.0–86.5	60.0	16.10
Dorsal fin rays		IV + 7			
Anal fin rays		IV + 5			
Pectoral fin rays		IV + 12			
Pelvic fin rays		III + 7			
Lateral line scales		37–38 (H, 37)			
Scale rows lateral line–dorsal fin		5.5			
Scale rows lateral line–pelvic fin		3.5			
Scale rows lateral line–anal fin		4.5			
Predorsal scales		5–6 (H, 6)			

behind head and is smoothly covex to dorsal fin. Disc weakly developed (type A), but often with narrow free posterior edge in large specimens, and usually wider than long. Rostral cap well developed, extending ventrally over upper jaw and with invecked ventral margin. Two pairs of barbels: maxillary barbels usually about same length as rostral pair. Either 37 or 38 scales along lateral line; either five or six predorsal scales anterior to dorsal fin; 3.5 scales from lateral line to origin of pelvic fins; 5.5 scales from lateral line to dorsal-fin origin. Chest, belly, and postpelvic region asquamate. Dorsal-fin rays iv, seven, inserted well in advance of pelvic fin, with a slightly rounded tip, first and second unbranched rays longest, but not extending to last ray; posterior margin straight, posterior rays not extending to pelvic-fin tip. Predorsal length 45.3–43.2% SL. Anal-fin rays iv, five, with subacuminate tip; posterior margin concave. Pectoral rays iv, 12; pectoral length 16.6–22.3% SL, with somewhat pointed tips. Vent distant from anal fin (vent distance 24.3–43.2, m. 32.0%). Intestine moderate in length (SL 40.0–56.0% Int.L). Gas bladder well developed and large (posterior chamber 21.7–22.4% SL).

Colour in preservation: Body brown dorsally, slightly lighter brown below lateral line and ventrally. Trace of midlateral band of variable width often present on flanks and caudal peduncle. Distinct bar spanning depth of caudal peduncle, just anterior to caudal fin. Dorsum of head, snout, and most of opercle: dark brown. Lips, gular region, posterior margin of opercle, and branchiostegal membranes: creamy yellow-brown. Entire cheek often pale creamy brown, with pale coloration extending around entire eye. Characteristically well-developed, small black spot present just behind opercle, in region of first lateral line scale.

Dorsal-fin membrane pale cream distally, with strongly pigmented, wide black submarginal band in membrane between rays, and narrow pale cream band proximally. Either four or five elongate black spots extend dorsally between rays in basal membrane of dorsal fin, often reaching into basal third of dorsal fin. Anal fin uniformly pale creamy brown. Caudal fin pale dusky brown, with median rays a slightly darker brown. Pelvic and pectoral fins uniformly pale creamy brown.

Distribution and habitat: Recorded from river basins in Eritrea, Ethiopia, and Kenya. Type locality, Bula River, is in the Abbay drainage basin in northern Ethiopia.

Remarks: G. dembecha includes many specimens previously identified as *G. quadrimaculata* (non-Rüppell) following the descriptions of Boulenger (1903, 1907, 1909); however, Boulenger's *D. quadrimaculatus* differs trenchantly from *G. quadrimaculatus* (Rüppell, 1836). Notable differences include the presence of a weakly developed type-A disc in *G. dembecha* (vs. a well-developed disc in *G. quadrimaculata*) and an asquamate belly and chest (vs. scaled in *G. quadrimaculata*).

Etymology: Dembecha, in reference to the town near which the type series was collected.

Material examined – type material: Holotype of *G. dembecha,* AMNH 228483, 78.8 mm SL, Bula River, crossing southern part of Dembecha, Gojam, Ethiopia; paratypes, AMNH 223693, 27 ex., three ex.C & S, 23.5–82.1 mm SL, Bula River, crossing southern part of Dembecha, Gojam, Ethiopia.

Material examined – non-type material: BMNH 1908.1.20:59–68, ten ex., 46.0–108.3 mm SL, Lake Zurui, Kenya (misidentified as *D. quadrimaculatus*); BMNH 1902.12.13.424–433/392–399, 18 ex., 29.7–86.4 mm SL, Lake Tana, Ethiopia (misidentified as *D. quadrimaculatus*); BMNH 1933.9.30.1–3, three ex., 67.1–77.6 mm SL, small Abbay River, Lake Tsana (misidentified as *D. quadrimaculatus*); BMNH 1948.1.14.153–156, four ex., 27.3–31.8 mm SL, Mai Toccor, Eritrea (misidentified as *G. quadrimaculatus*); BMNH 1908.1.20.69, one ex., 59.6 mm SL, Akaki River, Ethiopia (misidentified as *G. quadrimaculata*); BMNH 1937.4.20.14–21, eight ex., 52.6–85.5 mm SL, Lake Ziway, Ethiopia (misidentified as *G. quadrimaculata*); BMNH 1902.12.13.400–409, ten ex., 23.9–95.2 mm SL, Chaffe-Donsa high plateau, Abyssinia (misidentified as *G. quadrimaculata*); BMNH 1903.11.16.13.14, two ex., 45.28–67.3 mm SL, Suksuk River, Lake Ziway, Ethiopia (misidentified as *D. quadrimaculatus*); MNHN 85-93-54-7, four ex., 41.9–56.8 mm SL, Lake Tana, Ethiopia (misidentified as *G. quadrimaculatus*); MNHN 85-93-54-2, three ex., 36.2–62.1 mm SL, Afrique orientale (misidentified as *G. quadrimaculatus*); MNHN 85.93.54.3, seven ex., 22.2–30.6 mm SL, Abyssinia (misidentified as *G. quadrimaculatus*); MNHN 85-93-54-6, one ex., 18.9 mm SL, Abyssinia (misidentified as *G. quadrimaculatus*); MNHN 85-93-54-1, three ex., 25.5–35.6 mm SL, Lake Victoria, Nyanza (misidentified as *G. quadrimaculatus*); MNHN 85-93-54-5, one ex., 25.6 mm SL, Abyssinia (misidentified as *G. quadrimaculatus*); MHNG 1446.99, one ex., 90.9 mm SL, affluent of River Athi, environs of Nairobi (near Masai Lodge), Kenya (misidentified as *G. dembeensis*); MHNG 2030.23, one ex., 88.9 mm SL, Kilimanjaro, Tanzania (misidentified as *G. dembeensis*); MSNM 2138 (ex 4322), one ex., 69.40 mm SL, Lake Tana, Bahirdar, Ethiopia (misidentified as *D. quadrimaculatus*); MSNM 2162 (ex 4314), six ex., 84.7–129.7 mm SL, 'Fiume Caha', Gondar, Ethiopia (misidentified as *D. quadrimaculatus*); AMNH 223702, four ex., 34.0–64.1 mm SL, Lah River, south of Finote Selam town, Gojam, Ethiopia (10°50′N, 37°15′E); AMNH 223665, six ex., 44.7–84.6 mm SL, Mesha River, north of Butajira town, Rift Valley, Ethiopia (8°10′N, 38°30′E); AMNH 223689, one ex., 100.5 mm SL, Gedeb River, about 20 km north of Debremarkos town, Gojam, Ethiopia (10°30′N, 37°40′E); AMNH 223700, 12 ex., 55.7–97.3 mm SL, Kechen River, 30 km south of Finote Selam town, Gojam, Ethiopia (10°45′N, 37°20′E); AMNH 223724, five ex., 112.7–124 mm SL, Gumara River, northern end of Maksegnit town, about 30 km south of Gondar town, Ethiopia (12°40′N, 37°40′E); AMNH 223735, three ex., 54.2–64.0 mm SL, Dirma River, in Kola Diba town, about 80 km south of Gondar town, on the way to Gorgora, Gondar, Ethiopia (12°25′N, 37°20′E); AMNH 223796, 19 ex., 17.9–81.5 mm SL, Wenchet creek, on Gondar-Bahirdar road, about 5 km south of Wereta village, Ethiopia (11°45′N, 37°30′E); AMNH 223805, nine ex., 18.4–61.2 mm SL, Idiyemo creek, *c*. 20 km north of Bahir Dar on Gondar road, Ethiopia (11°40′N, 37°30′E); AMNH 223699, eight ex., 58.7–95.1 mm SL, Kechen river, about 30 km south of Finote Selam town, Gojam, Ethiopia (10°45′N, 37°20′E); AMNH 223745, seven ex., 55.4–69.7 mm SL, Elala River, crossing northern part of Makale town, Tigrai, Ethiopia (13°30′N, 39°30′E); AMNH 223677, 33 ex., 21.9–32.8 mm SL, Angordgood creek, 4 km north-east of Bahirdar town, Gojam, Ethiopia (11°35′N, 37°30′E); AMNH 223833, 76 ex., 31.0–91.2 mm SL, Kela River, 1 km east of Welenkomi town, on the way from Addis Ababa to Nekempte, Shoa, Ethiopia (9°5′N, 38°10′E); AMNH 227303, five ex., 40.9–88.6 mm SL, Arer River, *c*. 30 km north-east of Jima town, on the road to Addis Ababa, Kefa, Ethiopia (7°50′N, 37°10′E); AMNH 227261, 42 ex., 40.2–101.6 mm SL, Dabena River,

2 km south-west of Bedele town, Illubabor, Ethiopia (8°20′N, 36°15′E); AMNH 223694, two ex., 63.1–84.6 mm SL, Chereka River, *c*. 10 km north of Dembecha town, Gojam, Ethiopia (10°40′N, 37°25′E); AMNH 223773, one ex., 42.38 mm SL, Worka River, Wondo Genet, Small stream near the hot spring, Shoa, Ethiopia (7°10′N, 38°40′E); AMNH 223702, four ex., 33.9–64.1 mm SL, Lah River, south of Finote Selam town, Gojam, Ethiopia (10°50′N, 37°15′E); AMNH 223704, 14 ex., 40.7–102.0 mm SL, Kakist River, near Tilili town, *c*. 50 km north of Finote Selam town, Gojam, Ethiopia (10°55′N, 37°5′E); AMNH 227694, three ex., 90.9–140.2 mm SL, Lake Tana, Gerima, *c*. 25 meters off shore (11°35′N, 37°24′E); AMNH 236097, three ex., 96.4–105.7 mm SL, Bula River, crossing southern part of Dembecha town, Gojam, Ethiopia.

GARRA QUADRIMACULATA (RÜPPELL, 1836) (FIG. 16 A, B; TABLE 7)

Gobio quadrimaculatus Rüppell, 1836, *Mus. Senckenberg. Abhandl. Beschr. Naturg.* Vol. 2, p. 22, Plate 3 (original description, type locality: Ethiopia)

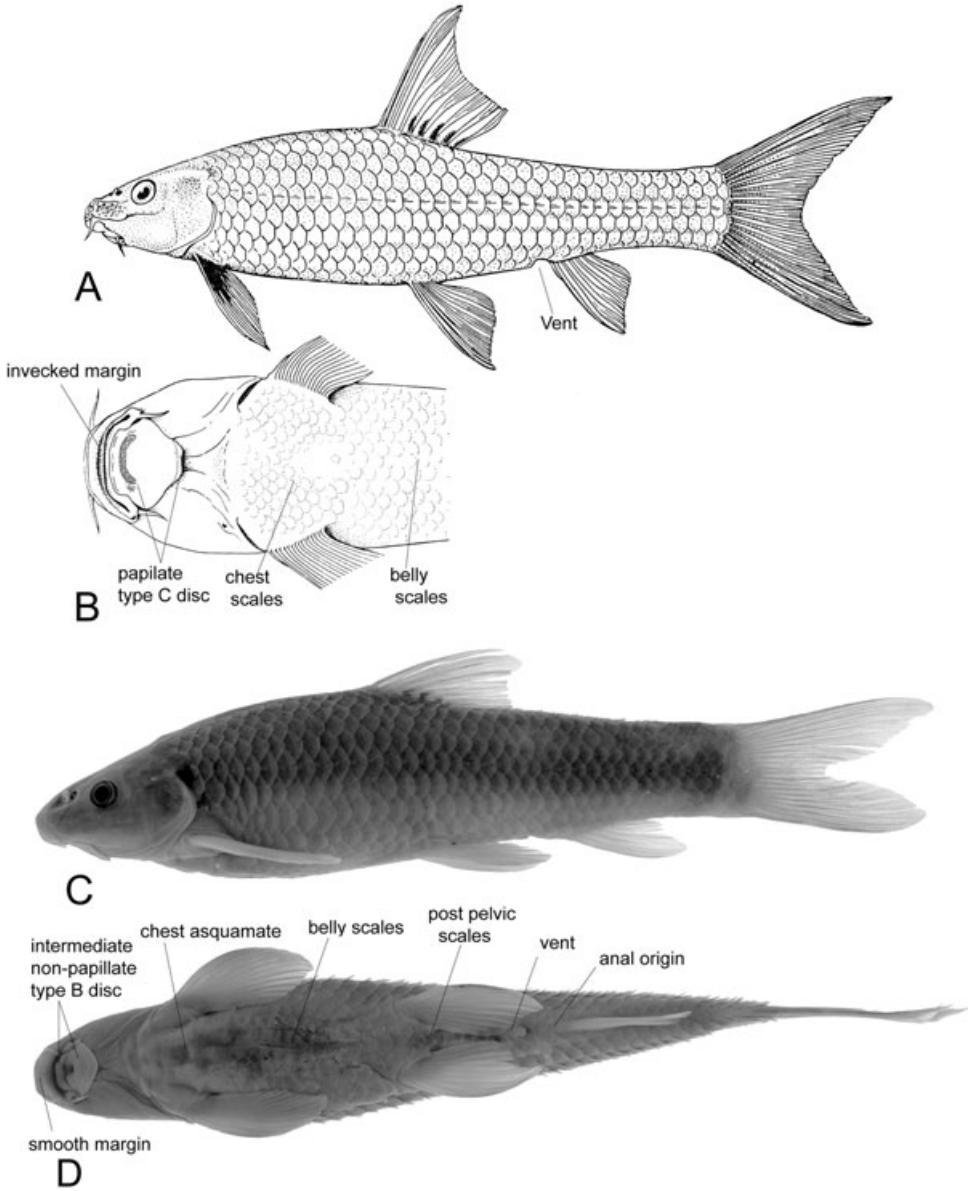

Figure 16. (A) and (B) *Garra quadrimaculata* (type of *Garra tibanica* modified after Trewavas, 1941). (C) and (D) *Garra aethiopicus*, AMNH 223649, 84.8 mm standard length.

Table 7. Morphometric and meristic data for *Garra quadrimaculata* (Rüppell, 1836). Proportional measurements (mm) are given in either percentage standard length (SL) or percentage head length (HL), unless noted otherwise

Character	*n*	range	mean	SD
Standard length (SL)	12	28.9–100.8		
% SL				
Body depth	12	16.0–20.7	18.4	3.32
Head length	12	21.5–22.5	22.0	0.71
Predorsal length	12	47.4–49.7	48.6	1.63
Pectoral fin length	12	19.0–19.6	19.3	0.42
Caudal peduncle length	12	17.6–17.9	17.8	0.21
Caudal peduncle depth	12	10.1–11.3	10.7	0.85
Dorsal fin length	12	20.5–25.9	23.2	3.81
Anal fin length	12	16.5–18.5	17.5	1.39
Pelvic fin length	12	17.5–19.3	18.4	1.22
% HL				
Head width	12	66.8–83.5	75.2	11.81
Head depth	12	58.9–67.5	63.2	6.08
Snout length	12	40.5–42.9	41.7	1.70
Orbit diameter	12	16.1–19.1	17.6	2.12
Interorbital width	12	42.0–42.3	42.2	0.21
% Orbit diameter				
Rostral barbel length	12	93.0–94.0	93.5	0.71
Maxillary barbel length	12	60.2–60.4	60.3	0.16
Dorsal fin rays		III + 7		
Anal fin rays		III + 5		
Pectoral fin rays		IV + 11		
Pelvic fin rays		II + 6		
Lateral line scales		34		
Scale rows lateral line–dorsal fin		4.5		
Scale rows lateral line–pelvic fin		3.5		
Scale rows lateral line–anal fin		3.5–4		
Predorsal scales		13		

Gobio hirticeps Rüppell, 1836, *Mus. Senckenberg. Abhandl. Beschr. Naturg.* Vol. 2, p. 23, Plates 3 and 4 (original description, type locality: Ethiopia)
Garra tibanica Trewavas, 1941, British Museum (Natural History) expedition to South-west Arabia 1937–38, 3. Freshwater fishes, Vol. 1, p. 8. (original description, type locality: Pool at Usaifira, 1 mile north of Ta'izz, Yemen)
Garra brittoni Trewavas, 1941, British Museum (Natural History) expedition to South-west Arabia 1937–38, 3. Freshwater fishes, Vol. 1, p. 11. (original description, type locality: Migyal al Alaf, in a cistern 8 miles south of San'a, Yemen)

Diagnosis: Distinguished from African congeners by the following combination of features: well developed papillate disc; fully scaled predorsum, chest, belly, and postpelvic regions; vent positioned very close to anal fin (vent distance 8.6–19.1, mean 12.3%); and long intestine (SL 20.9–24.2% Int.L).

Description: Morphometric and meristic data presented in Table 7. Maximum size: 100.8 mm SL (BMNH 1940.8.15:192, type of *Garra britoni*). Body gracile (depth 16.0–20.7, m. 18.4% SL), greatest body depth located at level of pelvic-fin tips. Head somewhat depressed, with characteristic tuberculation consisting of large rounded tubercles concentrated in rows around nostrils. Eyes positioned medially on head. Dorsal head profile rises steeply over snout; dorsum of head more-or-less contiguous with dorsal body profile and smoothly convex to dorsal-fin origin. Disc well-developed (type C), with a wide free posterior margin, and abundant papillae on lower lip and around disc periphery. Disc length 22.8–26.8% HL, wider than long (width 34.4–47.3% HL). Rostral cap well developed, extending ventrally over upper jaw and with invecked ventral margin. Two pairs of barbels: maxillary barbels usually slightly longer than rostral pair. Between 33 and 35 scales along lateral line; predorsal region fully scaled; 3.5 scales from lat-

eral line to origin of pelvic fin; 3.5–4 scales from lateral line to dorsal-fin origin. Belly, chest, and postpelvic regions fully scaled; scales often small and deeply embedded. Dorsal-fin rays iii, seven, inserted well anterior to pelvic fin, with subacuminate tip, first and second unbranched rays longest, extending slightly beyond last ray; posterior margin concave, posterior rays extending almost to pelvic-fin tip. Predorsal length 47.4–49.7% SL. Anal-fin rays iii, five, blunt tip; posterior margin straight. Pectoral rays iv, 11; pectoral length 19.0–19.6% SL, with pointed tips. Vent located very close to anal fin (vent distance 8.6–19.1, mean 12.3%). Intestine long (SL 20.9–24.2% Int.L). Gas bladder well-developed (posterior chamber 19.0–30.0% SL).

Distribution: Found mainly on the Arabian Peninsula (Saudi Arabia and Yemen) but present also in south-eastern Eritrea, south-eastern Ethiopia, and possibly also Somalia. The Somalian specimens mentioned by Menon (1964) cannot be located, and we have been unable to confirm the presence of *G. quadrimaculata* in that country.

Remarks: Considerable confusion exists in the literature regarding the identity of *G. quadrimaculata*, and much of this dates to Boulenger's (1903) comment that *Discognathus* (i.e. *Garra*) *quadrimaculatus* have 'a small mental disc, feebly marked and a little longer than broad'. Apparently Boulenger had not examined Rüppell's type specimen and instead based his remarks on Rüppell's abbreviated description, and on specimens he received from Ethiopia (and erroneously assumed to be *D. quadrimaculatus* Rüppell). It appears that most subsequent workers followed Boulenger's description of *D. quadrimaculata* as having a weakly developed disc, and this has resulted in numerous misidentifications of this species in museum holdings.

Based on examination of type materials, two Arabian species, *Garra ghorensis* Krupp, 1982 and *Garra sahilia* Krupp, 1983 appear very similar to *G. quadrimaculata*, but study of additional material is necessary before their synonomy can be justified.

Material examined – type material: Holotype of *G. quadrimaculatus,* SMF 5396, 28.9 mm SL, Abyssinia; Paralectotype of *G. hirticeps,* SMF 5403, 39.9 mm SL, Abyssinia; Syntypes of *G. tibanica,* BMNH 1940.2.15:2–11, ten ex., 70.7–97.9 mm SL, Pond at Usaifira, one mile north of Taizza, Yemen; Type of *G. brittoni,* BMNH 1940.8.15:192, 100.8 mm SL, Migyal al Alaf, cistern 8 miles south of Sana, Yemen.

GARRA AETHIOPICA (PELLEGRIN, 1927) (FIG. 16C, D; TABLE 8)

Discognathus aethiopicus Pellegrin, 1927, *Bull. Soc. Zool. Fr.*, Vol. 52, p. 232 [original description, type locality: Ethiopia, Kabana River, tributary of Aouche River (Awash River basin)]
Garra aethiopicus Menon, 1964, *Memoires of the Indian Museum*, Vol. 14, p. 193 (as synonym of *G. quadrimaculata*; should have been mentioned as *Discognathus aethiopicus*), Daget *et al.*, 1984, *CLOFFA,* Vol. 1, p. 304 (as synonym of *G. quadrimaculata*; should have been mentioned as *D. aethiopicus*)

Diagnosis: Distinguished from African congeners by the following combination of features: intermediate (type B) disc; scaled predorsal, belly, and postpelvic regions; either smooth or weakly invecked ventral margin to rostral cap; and pale ash-grey markings in both fresh and preserved specimens.

Description: Morphometric and meristic data presented in Table 8. Maximum size: 114.3 mm SL (AMNH 223672). Most individuals are relatively robust (depth 18.9–25.2, m. 22.2% SL); greatest body depth well in advance of dorsal-fin origin, at level of pectoral-fin tips. Head somewhat depressed, no tubercles on snout. Eyes positioned anteriorly on head. Dorsal head profile rises steeply over snout, then more-or-less smoothly convex and contiguous with dorsal body profile to dorsal-fin origin. Disc of intermediate development (type B), with narrow free posterior and lateral margins but usually not enlarged and without abundant papillation around posterior edge. Rostral cap well developed, extending ventrally over upper jaw. Ventral margin either smooth or only weakly invecked, and often incurved so that margin is obscured. Two pairs of barbels of similar length. Between 33 and 36 scales along lateral line; predorsal region fully scaled to dorsal fin; 3.5 scales from lateral line to origin of pelvic fin; 4–4.5 scales from lateral line to dorsal-fin origin. Entire dorsum, belly, and postpelvic regions scaled, although scales often deeply embedded; chest asquamate. Dorsal-fin rays iii–iv, seven, inserted well anterior to pelvic fin, with subacuminate tip, first and second unbranched rays longest, extending beyond last ray; posterior margin weakly concave, posterior rays not extending to pelvic-fin tip. Predorsal length: 43.3–51.1% SL. Anal-fin rays iii–iv, five, with subacuminate tip; posterior margin concave. Pectoral rays iv, 11; pectoral length 17.9–23.0% SL, with somewhat pointed tips. Vent medially located (vent distance 19.2–29.5, m. 25.9%). Intestine of medium length (SL 47.0–76.0% Int.L). Gas bladder well-developed (posterior chamber 18.3–21.1% SL).

Colour in preservation: Well-defined dark streak over dorsum of head and body, and broad dark ash-grey midlateral band to base of caudal peduncle usually present. Grey midlateral band somewhat expanded and wedge-shaped at caudal base. Head and body

Table 8. Morphometric and meristic data for *Garra aethiopica* (Pellegrin, 1927). Proportional measurements (mm) are given in either percentage standard length (SL) or percentage head length (HL), unless noted otherwise. Values in parentheses indicate the number of specimens examined with that count

Character	*n*	range	mean	SD
Standard length (SL)	30	21.3–114.3		
% SL				
Body depth	30	18.9–25.2	22.2	1.67
Head length	30	19.8–25.6	21.6	1.15
Predorsal length	30	43.3–51.1	47.3	1.62
Pectoral fin length	30	17.9–23.0	20.9	1.35
Caudal peduncle length	30	14.2–18.9	17.3	1.15
Caudal peduncle depth	30	10.7–12.8	11.7	0.65
Dorsal fin length	30	19.6–22.5	21.3	1.15
Anal fin length	30	16.6–19.8	17.9	0.61
Pelvic fin length	30	19.2–15.5	17.6	1.05
% HL				
Head width	30	63.3–81.0	71.9	3.79
Head depth	30	58.4–78.0	67.2	4.00
Snout length	30	27.9–42.2	35.5	3.85
Orbit diameter	30	15.5–27.2	20.2	3.04
Interorbital width	30	38.6–50.4	45.0	3.24
% Orbit diameter				
Rostral barbel length	30	65.7–107.0	71.9	7.02
Maxillary barbel length	30	65.7–92.5	80.0	7.30
Dorsal fin rays		III + 7(20), IV + 7(10)		
Anal fin rays		III + 5(15), IV + 5(15)		
Pectoral fin rays		IV + 11		
Pelvic fin rays		II + 6		
Lateral line scales		33–36		
Scale rows lateral line–dorsal fin		4.5		
Scale rows lateral line–pelvic fin		3.5		
Scale rows lateral line–anal fin		3		
Predorsal scale rows		15		

between dorsal streak and midlateral band pale creamy brownish-grey, body uniformly pale ventrally. Well-defined, small, black spot present just behind opercle, in region of first lateral line scale. Lips, gular region, posterior margin of opercle, and branchiostegal membranes: creamy yellow-brown. Dorsal fin more-or-less uniformly dusky creamy-yellow, with no obvious dark submarginal band. Either four or five small black spots between rays in basal membrane of dorsal fin. Anal fin uniformly pale creamy yellow. Caudal fin pale dusky brown, with median rays a darker brown. Pelvic and pectoral fins uniformly pale creamy yellow.

Distribution: Currently known only from the Awash River basin of Ethiopia.

Material examined – type material: Lectotype, MNHN 1927-125, 88.4 mm SL, Kabana River, tributary of Awash, in Addis Ababa city at an altitude of 2400 m, Ethiopia; paralectotype, MNHN 1927-126, 84.4 mm SL, Kabana River, tributary of Awash, in Addis Ababa city at an altitude of 2400 m, Ethiopia.

Material examined – non-type material: BMNH 1985.7.16.113–117, five ex., 63.7–79.7 mm SL, Abo River near Addis Ababa, Ethiopia (misidentified as *G. dembeensis*); BMNH 1985.7.16:111–112, two ex., 26.8–110.9 mm SL, Awash River, Ethiopia (misidentified as *G. dembeensis*); BMNH 1984.9.7:48, one ex., 44.9 mm SL, Mojo River, Ethiopia (misidentified as *G. dembeensis*); AMNH 223672, eight ex., 45.4–114.3 mm SL, Kabana River, Addis Ababa, Ethiopia (9°N, 38°45′E); AMNH 223649, nine ex., 41.1–81.5 mm SL, Meki River, Near Meki Town, Ethiopia (8°15′N, 38°50′E); AMNH 223674, 17 ex., 38.8–78.5 mm SL, Akaki River, Near Addis Ababa (9°N, 38°45′E); AMNH 223676, one ex., 85.8 mm SL, Mekanisa River, Near Addis Ababa, Ethiopia (9°N,

38°45′E); AMNH 227315, 66 ex., 28.8–105.4 mm SL, Megecha (Gubre) River, in Gubre town, about 10 km south of Welkite town on the road to Hosaina, Ethiopia (8°5 N, 37°55E); AMNH 223836, 86 ex., 21.3–99.1 mm SL, Awash River, 1 km east of Ginchi town, 80 km from Addis Ababa on the way to Nekempte, Shoa, Ethiopia (9°5 N, 38°5E).

GARRA DEMBEENSIS (RÜPPELL, 1836) (FIG. 17 A, B; TABLE 9)

Chondrostoma dembeensis Rüppell, 1836, *Mus. Senckenberg Abhandl. Beschr. Naturg*. Vol. 2, p. 16, plate 2, fig. 4 (original description, type locality: 'Dembea' Lake at Goraza, Abyssinia, type unavailable) *Discognathus chiarinii* Vinciguerra, 1883, *Ann. Mus. Genova*, Vol. 18, p. 696 (original description, type locality: Lake Arsadé, Adda, Ethiopia), Daget *et al*., 1984, *CLOFFA*, Vol. 1, p. 302 (as synonym of *G. dembeensis*) *Discognathus johnstonii* Boulenger, 1901), *Proc. Zool. Soc. Lond*., Vol. 2, p. 159 (original description, type locality: Victoria Nyanza), Daget *et al*., 1984, *CLOFFA,* Vol. 1, p. 302 (as synonym of *G. dembeensis*), Menon 1964, *Memoirs of the Indian Museum,* Vol. 14, p. 199 (as synonym of *G. dembeensis*)

Diagnosis: Distinguished from African congeners by the following combination of features: well-developed disc; between zero and four predorsal scales anterior to dorsal fin; asquamate chest, belly, and postpelvic region; intestine of medium length (SL 39.0–42.0% Int.L); and moderately sized gas bladder (posterior chamber 20.9–21.6% SL).

Description: Morphometric and meristic data presented in Table 9. Maximum size: 146.1 mm SL (BMNH 1937.4.20:27). Body relatively gracile (depth

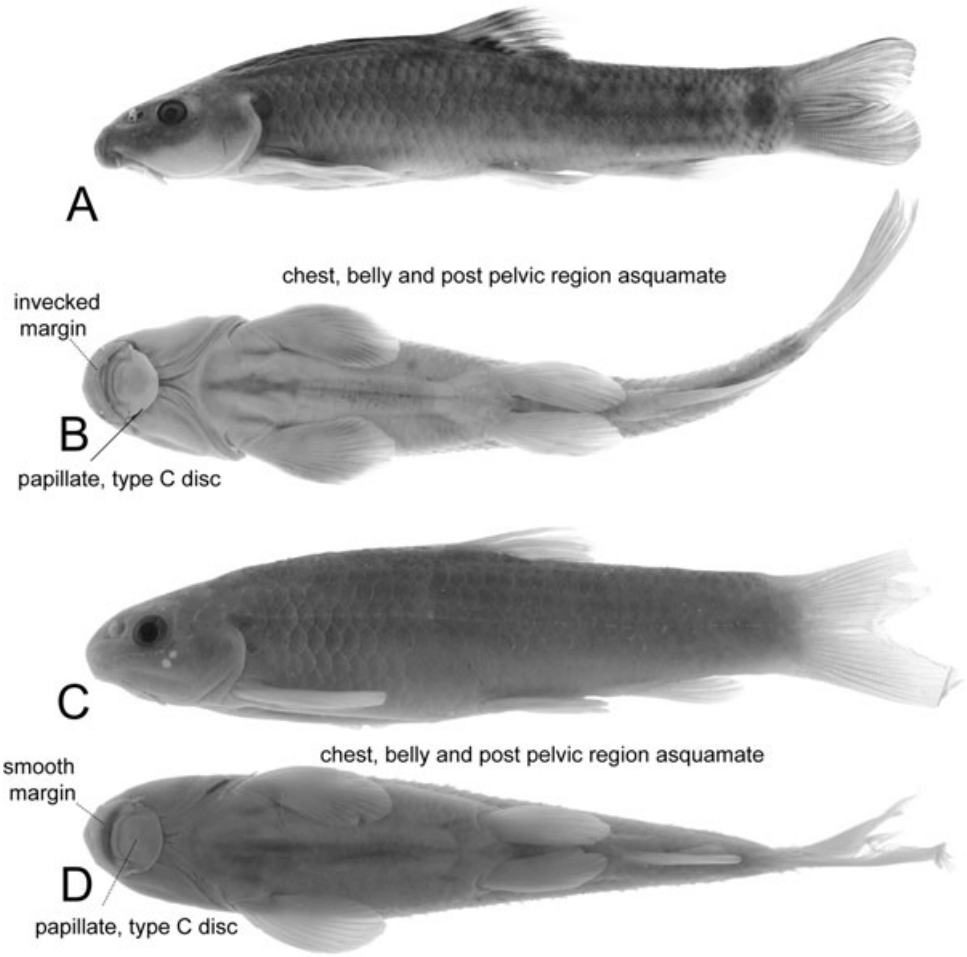

Figure 17. (A) and (B) *Garra dembeensis*, neotype, AMNH 2233731, 73.8 mm standard length. (C) and (D) *Garra blanfordii,* AMNH 223686, 65.8 mm standard length.

Table 9. Morphometric and meristic data for *Garra dembeensis* (Rüppell, 1836). Proportional measurements (mm) are given in either percentage standard length (SL) or percentage head length (HL), unless noted otherwise. Values in parentheses indicate the number of specimens examined with that count. When range of values, meristics of neotype (N) are given in parenthesis

Character	n	neotype	range	mean	SD
Standard length (SL)	30	73.8	10.7–146.1		
% SL					
Body depth	30	19.1	15.6–23.9	20.4	1.95
Head length	30	19.9	19.9–27.1	23.8	1.62
Predorsal length	30	45.7	44.0–52.1	49.3	1.77
Pectoral fin length	30	21.2	15.1–23.9	19.9	1.96
Caudal peduncle length	30	15.8	12.7–19.4	15.6	1.39
Caudal peduncle depth	30	8.7	8.3–11.6	9.9	0.86
Dorsal fin length	30	21.6	19.9–23.5	21.1	0.97
Anal fin length	30	17.9	17.0–19.7	18.3	0.82
Pelvic fin length	30	17.4	16.6–20.3	18.3	1.09
% HL					
Head width	30	75.7	63.3–84.7	71.5	5.53
Head depth	30	64.3	50.0–68.7	59.1	4.26
Snout length	30	48.1	33.3–48.1	40.8	4.39
Orbit diameter	30	21.0	15.7–28.0	20.2	3.04
Interorbital width	30	43.5	36.4–48.9	41.5	2.73
% Orbit diameter					
Rostral barbel length	30	45.2	33.0–68.0	54.3	10.78
Maxillary barbel length	30	44.3	30.1–91.0	51.1	15.19
Dorsal fin rays		III + 7 (20) (N), IV + 7 (10)			
Anal fin rays		IV + 5			
Pectoral fin rays		IV + 11 (12), IV + 12 (18) (N)			
Pelvic fin rays		II + 6			
Lateral line scales		36–38 (N, 37)			
Scale rows lateral line–dorsal fin		3.5–5.5 (N, 5.5)			
Scale rows lateral line–pelvic fin		3.5–4.5 (N, 4.5)			
Scale rows lateral line–anal fin		4			
Predorsal scales		0 (16), 2–4 (14, N)			

15.6–23.9, mean 20.4% SL), greatest body depth located at level of pelvic-fin tips. Head gracile and moderately depressed, often with small circular tubercles in front of nostrils, becoming tubular beneath eyes. Eyes positioned medially on head. Dorsal head profile rises steeply over snout, then smoothly rounded, more-or-less contiguous with dorsal body profile and smoothly convex to dorsal-fin origin. Disc usually well-developed (type C) with a wide free posterior margin and abundant papillae on lower lip and over disc periphery. However, disc development displays considerable variation with some individuals bearing an almost intermediate (type B) disc with little papillation over disc periphery. In these individuals the disc has free lateral, as well as posterior, margins and is never as weakly developed as in type-A discs. Rostral cap well developed, extending ventrally over upper jaw and with weakly invecked ventral margin. Two pairs of barbels: maxillary barbels usually slightly longer than rostral pair. Between 36 and 38 (modally 37) scales along lateral line; between zero and four predorsal scales anterior to dorsal fin; 3.5–4.5 scales from lateral line to origin of pelvic fin; 3.5–5.5 scales from lateral line to dorsal-fin origin. Belly and chest asquamate; postpelvic region usually asquamate, although occasionally with either one or two deeply embedded scales present. Dorsal-fin rays iii–iv, seven, inserted well anterior to pelvic fin, with short subacuminate tip, first and second unbranched rays longest, extending to last ray; posterior margin either weakly concave or straight, posterior rays may or may not extend to pelvic-fin tip. Predorsal length 44.0–52.0% SL. Anal-fin rays iv, five, with subacuminate tip; posterior margin concave. Pectoral rays iv, 11–12; pectoral length 15.1–23.9% SL, with somewhat pointed tips. Vent located relatively

distant from anal fin (vent distance 18.2–38.2, m. 26.0%). Intestine of medium length (SL 39.0–42.0% Int.L). Gas bladder of moderate size (posterior chamber 20.9–21.9% SL).

Colour in preservation: Variable, but most specimens are from medium to dark brown over most of the head and body, with some slight lightening ventrally. Ventral surface of head and body usually a deep creamy yellow-brown. Dorsal-fin pigmentation variable, either with or without a well-marked submarginal black band. Between two and four large black spots between rays in basal membrane of dorsal fin. Anal fin usually with broad submarginal band of dusky brown pigment. Caudal fin pale dusky grey-brown; median rays often a slightly darker brownish grey. Pelvic and pectoral fins dark brownish-grey with pale leading edges.

Distribution: As currently recognized, this is one of the most widespread of African *Garra*, present in 75% of localities surveyed in Ethiopia (Getahun & Stiassny, 1998), as well as in Cameroon, Nigeria, Tchad, Egypt, Kenya, and Tanzania. Further analysis, particularly of material from western regions, is necessary to confirm the conspecificity of specimens from those areas.

Remarks: Getahun (2000) established that no type specimen for *C. dembeensis* Rüppell, 1836 was ever deposited at the Senckenberg Museum, and considered that Rüppell's description was probably based upon information from field observations. Because Rüppell's original description is inadequate for unambiguous identification, and because considerable taxonomic confusion persists regarding the identity of this widespread species and its synonyms, Getahun (2000) proposed the designation of a neotype to taxonomically fix the name, and we concur. A specimen from the same locality as Rüppell's type (Lake Tana, Ethiopia) has been selected as a neotype and is illustrated here (Fig. 17A, B).

Material examined – type material: Neotype of *G. dembeensis,* AMNH 223731, 73.8 mm SL, Lake Tana at Gorgora, Ethiopia (12°15′N, 37°20′E); paratypes of *D. chiarinii,* BMNH 1903.8.10:14–16, three ex., 27.4–29.9 mm SL, Lake Arsade, 'Adda Gallaland', Abyssinia; type of *D. johnstonii,* BMNH 1901.6.24:94, 98.4 mm SL, Lake Victoria (Victoria Nyanza).

Material examined – non-type material: BMNH 1902.12.13:421–423, three ex., 53.0–84.7 mm SL, Lake Tana, Ethiopia; BMNH 1908.1.20:50, one ex., 132.9 mm SL, Didessa River, Western Ethiopia; BMNH 1937.4.20:24–26, three ex., 95.4–107.9 mm SL, Ghibe River, south-western Ethiopia; BMNH 1902.11.8:10, one ex., 75.3 mm SL, Nairobi River, Kilimanjaro at 1980 m, Kenya; BMNH 1937.4.20:28, one ex., 116.5 mm SL, Didessa River, western Ethiopia; BMNH 1937.4.20:27 and 1900.1.20:51–52, three ex., 123.1–146.1 mm SL, Juju River, Ethiopia; BMNH 1912.3.22:40–49, nine ex., 53.8–84.4 mm SL, Saya River, Ethiopia; BMNH 1975.10.7:69–70, two ex., 24.9–58.8 mm SL, Kikuletwa River entering Nyumba Ya Munga dam, Upper Pangani, Tanzania; BMNH 1985.7.16:107–110, four ex., 22.6–39.8 mm SL, Bilate River entering into Lake Abaya, Ethiopia; BMNH 1981.4.9:363–366, one ex., 52.4 mm SL, Athi River at Kithimani (Yatta), Kenya; BMNH 1971.8.12:15–17, three ex., 35.4–38.0 mm SL, tributary of Sanya-Pangani River, Arush National Park, Tanzania; BMNH 1981.4.9:340, one ex., 61.8 mm SL, Athi River above Lugardo falls, Kenya; BMNH 1984.9.7:49–52, four ex., 10.7–41.6 mm SL, Muger River, Ethiopia; BMNH 1971.3.22:13–24, 12 ex., 28.6–35.0 mm SL, Savo River, Ethiopia; BMNH 1915.12.2:1, one ex., 47.4 mm SL, Makindu and Isavo Rivers, Achi system, Kenya; BMNH 1969.2.11:215–230, 16 ex., 21.4–53.8 mm SL, Soni River, trib. of Pangani, Tanzania; BMNH 1981.4.9:337–339, three ex., 102.1–121.0 mm SL, Ewsso Nyiro, Kenya; BMNH 1936.12.22:42–47, six ex., 13.6–69.5 mm SL, Migaboti River, Athi system; BMNH 1937.6.4:24–27, four ex., 42.2–54.7 mm SL, Athi River, Kenya; BMNH 1971.3.22:25–41, 17 ex., 36.2–67.1 mm SL, Tsavo River, Kenya; BMNH 1908.1.20:53–58, six ex., 93.9–115.5 mm SL, Sibe River; BMNH 1908.1.20:45–48, four ex., 121.6–125.5 mm SL, Sibe River; MNHN 85-93-18-4, two ex., 34.7–74.6 mm SL, Tchad; MNHN 85-93-18-5, two ex., 63.4–86.7 mm SL, Cameroon; MNHN 85-93-10-4, two ex., 84.8–100.6 mm SL, Kabana River, Abyssinia; MNHN 85-93-10-5, 22 ex., 30.3–95.3 mm SL, Ethiopie meridionale; MNHN 85-93-10-1, two ex., 26.4–30.5 mm SL, Abyssinia; MNHN 85-93-27-2, one ex., 74.1 mm SL, Courema River, Affluent of Awash, Arsi, Ethiopia; MRAC 94-074-p-1111–1120, 10 ex., 36.7–69.0 mm SL, Cameroon; MRAC 91-051-P-11–15, 10 ex., 29.8–50.2 mm SL, Kotta creek, Ethiopia (misidentified as *G. quadrimaculata*); MHNG 2317.81, nine ex., 23.3–48.5 mm SL, Athi River, 14 Fall pres de Thika, Kenya; MHNG 1446.100, one ex., 72.6 mm SL, Prov. Simien, Balaghes Valley, Tsion Mariam, 2500 m altitude, Ethiopia; MHNG 1525,58–61, four ex., 48.9–57.6 mm SL, de l'Ouest du lac Chamo, Rift Valley, ambouchure d'un petit affluent, III, Ethiopia; MHNG 1523.10–12, three ex., 33.4–39.5 mm SL, Athi River, Falls pres Thika, Kenya; SMF 1446.100, one ex., 72.9 mm SL, Prov. Simien, Balaghes Valley, Tihon Mariam, 2500 m altitude, Ethiopia; SMF 1525.58–61, four ex., 45.0–55.6 mm SL, de l'Ouest du lac Chamo, Rift valley, ambouchoure d'un petit affluent, III, Ethiopia; CAS 63736, ten ex., 17.9–51.9 mm SL, Muheza dis-

trict, Tanga region, Zigi River at corn mill, in the Usambara mountains, 70 km south-east of Amani, Tanzania; USNM 339720, three ex., 40.9–62.3 mm SL, Mayo Sabere, a stream draining to Mayo Gashaka, which eventually drains to the River Taraba that joins the River Benue, Nigeria (07°0′20″N and 011°34′30″E); USNM 339707, three ex., 31.4–61.8 mm SL, Hot spring at Matashrip, which eventually drains to the River Taraba which joins the river Benue, Nigeria (07°04′00″N, 011°26′00″E); USNM 339699, three ex., 16.3–24.3 mm SL, Warm spring, tributary of River Jiagum, which eventually drains to the River Taraba that joins the River Benue, Nigeria (07°23′40″N, 011°31′50″E); USNM 338339, three ex., 32.0–50.1 mm SL, Mayo Dundere, the Upper reaches of the Mayo Gashaka/Mayo Korngal, which eventually drains to the River Taraba which joins the Benue, Nigeria (07°01′50″N, 011°34′00″E); AMNH 223771, 223772, 60 ex., 27.6–99.0 mm SL, Ardaba River 9 km north of Arsi Negele on route to Wendo Genet, Shoa, Ethiopia (7°30′N, 38°40′E); AMNH 223653, 223654, 223775, 50 ex., 29.6–71.1 mm SL, Worka River, Wondo Genet, small stream along the hot spring, Shoa, Ethiopia (7°10′N, 38°40′E); AMNH 223788, one ex., 58.9 mm SL, Chufa stream, *c*. 4 kilometers south of Abura village, Arsi, Ethiopia (7°55′N, 39°5′E); AMNH 223657, 27 ex., 26.7–68.5 mm SL, Wondo Genet River, crossing southern part of Wondo Genet town, Ethiopia (7°10′N, 38°40′E); AMNH 223668, six ex., 60.8–70.7 mm SL, Acamaja River, about 10 km north of Butajira town on the way to Addis Ababa, Ethiopia (8°10′N, 38°35′E); AMNH 223671, 29 ex., 32.9–91.1 mm SL, Lebu River, about 20 km north of Butajira on the way to Addis Ababa, Ethiopia (8°30′N, 38°40′E); AMNH 223683, 223684, 36 ex., 27.1–73.1 mm SL, Gurunz River, near Debre Libanos, *c*. 100 km north of Addis Ababa, Ethiopia (9°40′N, 38°50′E); AMNH 223690, three ex., 28.8–62.9 mm SL, Gedeb River, c.20 km north of Debre Markos town, Gojam, Ethiopia (10°30′N, 37°40′E); AMNH 223679, eight ex., 35.8–75.8 mm SL, Duberkela River, 70 km north of Addis Ababa, Shoa, Ethiopia (9°30′N, 38°50′E); AMNH 223782, five ex., 39.5–67.5 mm SL, Katar River, *c*. 30 km west of Abura village, Arsi, Ethiopia (7°55′N, 39°E); AMNH 223673, 17 ex., 32.9–70.5 mm SL, Akaki River, crossing south-eastern part of Addis Ababa, Addis Ababa, Ethiopia (9°N, 38°45′E); AMNH 223758, six ex., 22.9–109.6 mm SL, Borkena River, at southern end of Kombolcha town, Wollo, Ethiopia (11°10′N, 39°50′E); AMNH 223705, 44 ex., 34.5–45.2 mm SL, Kakist River, near Tillili town c.50 km north of Finote Selam town, Gojam, Ethiopia (10°55′N,37°5′E); AMNH 223650, 16 ex., 41.6–87.4 mm SL, Meki River, crossing southern part of Meki town, Rift Valley, Ethiopia (8°15′N, 38°50′E); AMNH 223681, 45 ex., 36.0–65.4 mm SL, Duberkela River, 70 km north of Addis Ababa, Shoa, Ethiopia (9°30′N, 38°50′E); AMNH 227265, 15 ex., 21.0–33.7 mm SL, Dogi River, 2 km west of Kumbabe town on the way to Metu, Illubabor, Ethiopia (8°10′N, 36°50′E); AMNH 227272, nine ex., 30.0–73.6 mm SL, Sore River, at the eastern end of Metu town, Illubabor, Ethiopia (8°15′N, 35°40′E); AMNH 227326, one ex., 99.0 mm SL, Borkena River, southern end of Kombolcha town, Wollo, Ethiopia (11°10′N, 39°50′E); AMNH 227296, 65 ex., 24.5–87.7 mm SL, Meni River, *c*. 75 km east of Tepi town on the way to Bonga town, Sueda/Gaweta area, Kefa, Ethiopia (7°10′N, 35°50′E); AMNH 227315, 66 ex., 28.8–105.4 mm SL, Megecha/Gubre River, Gubre town, *c*. 10 km south of Welkite town, on the way to Hosaina, Shoa, Ethiopia (8°5′N, 37°55′E); AMNH 223832, 34 ex., 26.9–91.7 mm SL, Berga River, 2 km west of Addis Alem town, on the way from Addis Ababa to Nekempte, Shoa, Ethiopia (9°5′N, 38°20′E); AMNH 227289, nine ex., 48.6–116.7 mm SL, Yebeg Wuha River (Boko river), at the eastern end of Tepi town, Kefa, Ethiopia (7°10′N, 35°10′E); AMNH 227303, five ex., 40.9–88.6 mm SL, Arer River, *c*. 30 km north-east of Jima town, on the road to Addis Ababa, Kefa, Ethiopia (7°50′N, 37°10′E); AMNH 223840, four ex., 27.9–61.8 mm SL, Melka Gufu River, 50 km east of Bako town, 200 km west of Addis Ababa, travelling from Addis Ababa to Nekempte, Welega, Ethiopia (9°5′N, 37°15′E); AMNH 227293, 15 ex., 17.7–85.4 mm SL, Minjibat River, *c*. 30 km east of Tepi town, on the way to Bonga town, Kefa, Ethiopia (7°N, 35°35′E); AMNH 223838, 60 ex., 28.2–97.4 mm SL, Guder River, at the western end of Guder town, Shoa, Ethiopia (9°N, 37°50′E). AMNH 227248, two ex., 42.2–70.3 mm SL, Gibe River, western end of Bako town, 255 km west of Addis Ababa on the way to Nekempte, Welega, Ethiopia (9°10′N, 37°5′E); AMNH 227268, three ex., 25.3–58.8 mm SL, Geyi River, *c*. 5 km east of Metu town, Illubabor, Ethiopia (8°20′N, 35°45′E); AMNH 227260, nine ex., 21.3–94.2 mm SL, Dabena River, 2 km south-west of Bedelle town, Illubabor, Ethiopia (8°20′N, 36°15′E); AMNH 227274, 22 ex., 24.3–59.0 mm SL, Wangus River, *c*. 15 km west of Gore town on the way to Gambella, near Uka town, Illubabor, Ethiopia (8°10′N, 35°20′E); AMNH 227301, four ex., 54.2–79.1 mm SL, Bulbul River, *c*. 10 km north-east of Jima town on the way to Addis Ababa, Kefa, Ethiopia (7°45′N, 36°50′E); AMNH 227298, nine ex. 29.4–69.5 mm SL, Weshi River, *c*. 10 km south-west of Bonga town, Kefa, Ethiopia (7°20′N, 36°10′E); AMNH 227287, six ex., 48.3–90.4 mm SL, Sasa River, 12 km south of Gore town, Illubabor, Ethiopia (8°20′N, 35°35′E); AMNH 223692, six ex., 29.09–42.9 mm SL, Bula River, crossing southern part of Dembecha town, Gojam, Ethiopia (10°35′N, 37°30′E); AMNH 223783, 11 ex., 37.05–47.2 mm SL, Katar River, *c*. 30 km west of Abura village, Arsi, Ethiopia (7°55′N, 39°E).

GARRA BLANFORDII BOULENGER, 1901 (FIG. 17C, D; TABLE 10)

Discognathus blanfordii Boulenger, 1901, *Proc. Zool. Soc. Lond*., p. 160 (original description, type locality: Erythrea or Ethiopia), Daget *et al*., 1984, CLOFFA, Vol. 1, p. 304 (as synonym of *G. quadrimaculata*), Menon, 1964, Mem. Indian Museum, Vol. 14, p. 192 (as synonym of *G. quadrimaculata*)
Discognathus vinciguerrae Boulenger, 1901, *Proc. Zool. Soc. Lond*., p. 160 (original description, type locality: Nile River, north of Kermeh, Sudan), Daget *et al*., 1984, CLOFFA, Vol. 1, p. 304 (as synonym of *G. quadrimaculata*), Menon, 1964, Mem. Indian Museum, Vol. 14, p. 199 (as synonym of *G. quadrimaculata*)
Discognathus giarrabensis Gianferrari, 1932, *Boll. Zool. Napoli*, Vol. 1, p. 2 (original description, type locality: Giarraba, Eritrea), Daget *et al*., 1984, CLOFFA, Vol. 1, p. 302 (as synonym of *G. dembeensis*). Menon, 1964, Mem. Indian Museum, Vol. 14, p. 200 (as synonym of *G. dembeensis*)
Discognathus blanfordii cimmaruta Gianferrari, 1936; *Atti. Soc. Ital. Milano*, Vol. 75, p. 295 (original description, type locality: Gherungura Stream, Adua, Ethiopia), Daget *et al*., 1984, CLOFFA, Vol. 1, p. 304 (as synonym of *G. quadrimaculata*)

Diagnosis: Unique among African *Garra* in a uniformly either cream or pale yellow-brown coloration and with the absence of distinct markings on head, body, or fins. Further distinguished from African congeners by the following combination of features: well developed disc; either smooth, or only very weakly incised ventral margin to rostral cap; fully scaled predorsal region; asquamate chest, belly, and postpelvic region; and relatively large gas bladder (posterior chamber 21.7–24.4% SL).

Description: Morphometric and meristic data presented in Table 10. Maximum size: 91.7 mm SL (AMNH 223832). Relatively robust and deep-bodied (depth 20.0–25.1, m. 22.8% SL); greatest body depth well in advance of dorsal-fin origin, at level of pectoral-

Table 10. Morphometric and meristic data for *Garra blandfordii* (Boulenger, 1901). Proportional measurements (mm) are given in either percentage standard length (SL) or percentage head length (HL), unless noted otherwise

Character	*n*	range	mean	SD
Standard length (SL)	30	24.4–91.7		
% SL				
Body depth	30	20.0–25.1	22.8	1.53
Head length	30	21.7–27.3	23.9	1.38
Predorsal length	30	45.2–53.3	49.4	1.99
Pectoral fin length	30	17.0–24.0	19.5	1.50
Caudal peduncle length	30	15.1–21.6	17.9	1.57
Caudal peduncle depth	30	10.7–13.9	12.4	0.83
Dorsal fin length	30	19.4–22.6	20.9	1.09
Anal fin length	30	14.7–18.6	17.2	1.10
Pelvic fin length	30	16.1–18.8	17.3	0.72
% HL				
Head width	30	63.8–76.4	70.4	3.32
Head depth	30	58.6–75.2	67.1	4.23
Snout length	30	22.2–40.0	32.6	3.88
Orbit diameter	30	17.6–29.0	21.6	2.45
Interorbital width	30	17.6–52.8	45.4	3.15
% Orbit diameter				
Rostral barbel length	30	33.0–87.5	58.6	14.66
Maxillary barbel length	30	30.2–80.0	57.3	14.26
Dorsal fin rays		IV + 7		
Anal fin rays		IV + 5		
Pectoral fin rays		V + 11		
Pelvic fin rays		III + 7		
Lateral line scales		34–38		
Scale rows lateral line-dorsal fin		4–4.5		
Scale rows lateral line-pelvic fin		3.5		
Scale rows lateral line-anal fin		4.5		
Predorsal scales		14		

fin tips. Head small, snout blunt, and without tubercles. Eyes positioned anteriorly on head. Dorsal head profile rises steeply over snout, then rises more-or-less smoothly convex and contiguously with dorsal body profile to dorsal-fin origin. Disc development, somewhat variable, usually well developed, type-C disc, with abundant papillae on lower lip and around disc periphery. Disc papillation reduced in some specimens, but wide free posterior and lateral margins always present. Rostral cap well developed, extending ventrally over upper jaw. Ventral margin smooth, occasionally very weakly incised. Two small pairs of barbels: rostral barbels usually slightly longer than maxillary pair. Between 34 and 38 scales along lateral line; predorsal region fully scaled to dorsal fin, scales often deeply embedded; 3.5 scales from lateral line to origin of pelvic fin; 4–4.5 scales from lateral line to dorsal-fin origin. Chest, belly, and postpelvic regions asquamate; region between vent and anal fin also asquamate. Dorsal-fin rays iv, seven, inserted well anterior to pelvic fin, with short rounded tip, first and second unbranched rays longest, not extending beyond last ray; posterior margin straight, posterior rays not extending to pelvic-fin tip. Vent distance (20.6–39.5, m. 28.5%). Intestine of moderate length (SL 40.0–50.0% Int.L). Gas bladder well-developed (posterior chamber 21.7–24.4% SL).

Colour in preservation: Noteworthy in lacking all dark pigmentation and markings on head, body, and fins. Head and body more-or-less uniformly either cream or pale yellow-brown, a few individuals with some slight lightening ventrally. Dorsal fin pale hyaline, with no black spots in basal membranes. All other fins similarly uniformly pale hyaline with no markings.

Distribution: Recorded from Eritrea, Sudan, and Ethiopia (where it is abundant in the Abbay River basin).

Remarks: Getahun (2000) notes that sympatric individuals of *G. dembecha* are often depigmented and may superficially resemble *G. blandfordii* in coloration. The two species are readily distinguished by disc morphology (well developed in *G. blandfordii* vs. vestigial in *G. dembecha*).

Material examined – type material: Lectotype of *D. blanfordii,* BMNH 1869.11.4:39, 56.6 mm SL. Stream at Suru and small pool at Amba, about 25 miles north of Massawa, Eritrea; Paralectotypes of *D. blanfordii,* BMNH 1869.2.8:4–11, eight ex., 36.2–51.3 mm SL, Abyssinia; Paralectotype of *D. blandfordii,* BMNH 1872.12.18:3, 41.6 mm SL, Abyssinia; Syntype of *D. vincuguerrae,* BMNH 1907.12.2:1175–1179, one ex., 35.4 mm SL, near Kermeh, 3rd Cataract (Nile River), Abyssinia; holotype of *D. giarrabensis,* MSNM 22 (ex. 4290), 59.2 mm SL, Giarraba, Eritrea; Holotype of *G. blanfordii cimmaruta,* MSNM 21 (ex. 4844), 72.9 mm SL, Gherungura, Adua, Abyssinia.

Material examined – non-type material: BMNH 1962.10.31:18–32, 13 ex., 37.3–76.3 mm SL, Blue Nile, 25 miles north of Debre Marcos, Ethiopia (misidentified as *G. quadrimaculata*); BMNH 1962.10.31:1–17, 18 ex., 37.2–68.9 mm SL, Blue Nile, 25 miles north of Debre Marcos (misidentified as *G. quadrimaculata*); BMNH 1902.12.13:410–419, ten ex., 46.3–85.5 mm SL, Jerrer River, near Harrar, Ethiopia (misidentified as *D. quadrimaculatus*); BMNH 1903.11.16:15–17, three ex., 26.4–61.7 mm SL, Gadshimboda River, Ethiopia (misidentified as *D. quadrimaculatus*); MNHN 85-93-10-2, three ex., 53.4–68.0 mm SL, Afrique Orientale; MNHN 85-93-10-3, two ex., 53.4–67.3 mm SL, Abyssinia; MSNM 2108 (ex. 4424), one ex., 44.4 mm SL, Abyssinia; MSNM 20 (ex. 4321), one ex., 45.6 mm SL, Massawa, Abyssinia; AMNH 223686, 45 ex., 24.4–62.9 mm SL, Chimuga River, 3 km south of Debremarkos town, Gojam, Ethiopia (37°45E, 10°15 N); AMNH 223748, 35 ex., 27.1–48.5 mm SL, Geba River, 2 km south of Hagere Selam town, Tigrai, Ethiopia (13°35 N, 39°25E); AMNH 223832, 34 ex., 26.9–91.7 mm SL, Berga River, 2 km west of Addis Alem town on the way to Nekempte from Addis Ababa, Shoa, Ethiopia (9°5 N, 38°20′E); AMNH 223685, 18 ex., 26.4–79.0 mm SL, Chimuga River, 3 km south of Debremarkos town, Gojam, Ethiopia (10°15′N, 37°45′E).

GARRA IGNESTII (GIANFERRARI, 1925) (FIG. 18 A, B; TABLE 11)

Discognathus ignestii Gianferrari, 1925, Atti. Soc. Ital. Milano, Vol. 64, p. 185 (original description, type locality: Torrent Kahha & Angrab, Ethiopia), Eschmeyer, 1998, *Catalogue of fishes,* Vol. 1, p. 759 (year of description incorrectly quoted as 1926)

Diagnosis: Distinguished from African congeners by the following combination of features: extremely well-developed, large papillate disc; scaled predorsal and postpelvic regions; chest and belly asquamate; vent located close to anal fin (vent distance 19.4–25.0, m. 18.2%); and intestine long (SL 20.9–24.2% Int.L).

Description: Morphometric and meristic data presented in Table 11. Maximum size: 103.1 mm SL (AMNH 223709). Robust and deep-bodied (depth 15.3–27.3, m. 21.6% SL); greatest body depth in advance of dorsal-fin origin at level of pectoral-fin tips. Head robust and only slightly depressed, snout prominent with large horny tubercles in both sexes. Eyes positioned medially on head. Dorsal head profile rises

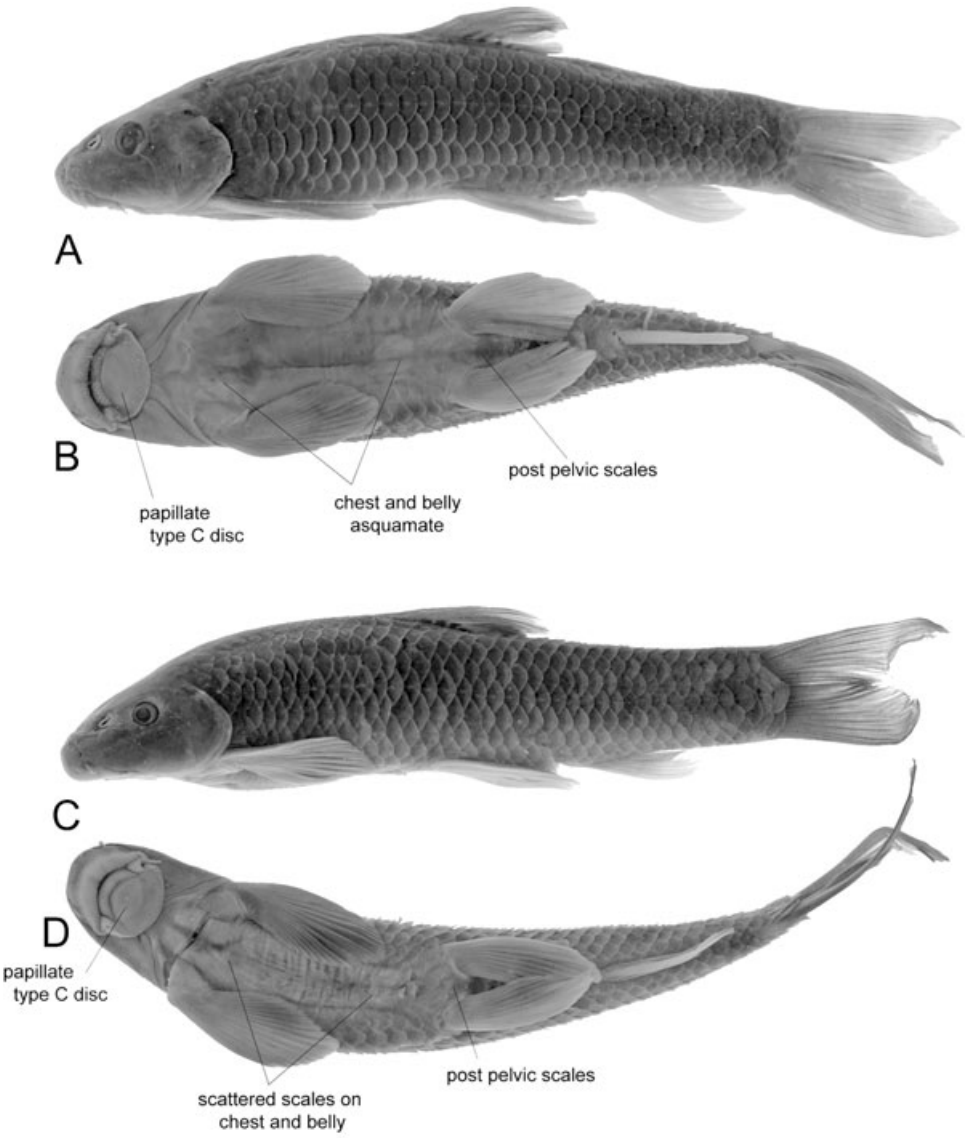

Figure 18. (A) and (B) *Garra ignestii*, AMNH 223750, 81.4 mm standard length. (C) and (D) *Garra makiensis*, AMNH 223667, 107.2 mm standard length.

steeply over snout, dorsum of head smoothly rounded and contiguous with dorsal body profile, which is steeply convex to dorsal-fin origin in most specimens. Disc well-developed, large, type C, with wide free posterior and lateral margins. Numerous batteries of papillae over lower lip and around disc periphery. Disc wider than long. Rostral fold very well developed and ventrally downgrown to lower lip, with invecked ventral margin. Two pairs of barbels: rostral barbels usually well developed and longer than maxillary pair. Between 34 and 36 scales along lateral line: predorsum scaled (10–12 scales) anterior to dorsal fin; 3.5 scales from lateral line to origin of pelvic fins; 4.5 scales from lateral line to dorsal-fin origin. Chest and belly asquamate. Usually a few embedded scales on postpelvic region. Dorsal-fin rays iv–v, seven, inserted well in advance of pelvic fin, with a slightly rounded tip, first and second unbranched rays longest, extending slightly beyond last ray; posterior margin concave, posterior rays not approaching pelvic-fin tip. Predorsal length 30.6–49.0% SL. Anal-fin rays iv, five, with pointed tip; posterior margin straight. Pectoral-fin rays iv, 11–12; pectoral length 12.4–23.3% SL, large and paddle-shaped with somewhat pointed tips. Vent moderate distance from anal fin (vent distance 19.4–25.0, m. 18.2%). Intestine is long (SL 20.9–24.2%

Table 11. Morphometric and meristic data for *Garra ignestii* (Giamferrari, 1925). Proportional measurements (mm) are given in either percentage standard length (SL) or percentage head length (HL), unless noted otherwise. Values in parentheses indicate the number of specimens examined with that count

Character	*n*	range	mean	SD
Standard length (SL)	30	18.3–103.1		
% SL				
Body depth	30	15.3–27.3	21.6	2.18
Head length	30	20.3–25.4	23.1	1.33
Predorsal length	30	30.6–49.0	46.2	3.21
Pectoral fin length	30	12.4–23.3	20.6	2.08
Caudal peduncle length	30	11.9–20.7	16.4	1.78
Caudal peduncle depth	30	6.9–13.3	10.9	1.28
Dorsal fin length	30	19.0–25.3	21.1	1.61
Anal fin length	30	15.4–19.6	17.6	1.09
Pelvic fin length	30	16.2–19.7	17.8	0.90
% HL				
Head width	30	57.8–90.2	71.8	6.48
Head depth	30	52.6–71.9	61.1	5.32
Snout length	30	33.0–46.0	40.0	3.79
Orbit diameter	30	16.0–27.6	20.0	3.37
Interorbital width	30	37.2–52.0	43.9	3.36
% Orbit diameter				
Rostral barbel length	30	44.0–116.7	81.6	17.78
Maxillary barbel length	30	38.6–100.2	68.4	16.02
Dorsal fin rays		IV + 7 (21), V + 7 (9)		
Anal fin rays		IV + 5		
Pectoral fin rays		IV + 11 (19), IV + 12 (11)		
Pelvic fin rays		II + 7		
Lateral line scales		34–36		
Scale rows lateral line–dorsal fin		4.5		
Scale rows lateral line–pelvic fin		3.5		
Scale rows lateral line–anal fin		4.5		
Predorsal scales		10–12		

Int.L). Gas bladder well-developed (posterior chamber 19.0–30.0% SL).

Colour in preservation: Either dark brown or brownish-black; more-or-less uniformly so over head and body, somewhat paler along lower third of body, and ventral surface uniformly either pale creamy-yellow or orange. Faint traces of a darker midlateral band sometimes discernable on posterior flanks. Dorsal fin usually uniformly dusky grey-brown with no clearly demarcated black submarginal band. Either three or four black spots between rays in basal membrane of dorsal fin. Anal fin usually uniformly pale creamy brown without broad submarginal band of dusky brown pigment. Caudal fin uniformly pale dusky grey-brown. Pelvic and pectoral fins pale brownish-grey with pale cream leading edges.

Distribution: Known only from Ethiopia, where it occurs in the Tekezze and Abbay River drainages in northern Ethiopia.

Material examined – type material: Syntypes of *D. ignestii,* MSNM 24 (ex. 4315), 25 ex., 39.1–89.4 mm SL, Kahha and Angereb Rivers, Abyssinia.

Material examined – non-type material: MSNM 2155 (ex. 4316), 14 ex., 39.4–67.7 mm SL, Kahha River, Abyssinia; SMF 1447.1–2, two ex., 80.2–84.5 mm SL, Tihou Mariam, 2500 m, Balaghes valley, Simien province, Ethiopia; BMNH 1984.9.7:50–60, 11 ex., 31.3–83.2 mm SL, Tributary of Awash on Dessie road, Ethiopia (misidentified as G. dembeensis); MHNG 1447.1–2, two ex., 79.9–83.4 mm SL, Balaghes valley, Simien prov., Tihou Mariam (2500 m), Ethiopia; MHNG 1525.49–57, nine ex., 28.3–80.4 mm SL, 'embouchure d'un petit affluent l'Quest du Lac Chamo', Ethiopia; AMNH 223738, 223739, 29 ex., 45.0–100.4 mm SL, Angereb River, 1 km north of Gondar town, Gondar, Ethiopia (12°50′N, 37°35′E); AMNH 223744, 223746, 22 ex., 38.9–80.4 mm SL, Elala River, crossing northern part of Makale town,

Tigrai, Ethiopia (13°30′N, 39°30′E); AMNH 223749, 223750, 12 ex., 27.5–80.5 mm SL, Kechen Abeba River, c. 20 km south of Lalibela town on the way to Woldiya town, Wollo, Ethiopia (11°55′N, 39°10′E); AMNH 223752, 223753, 12 ex., 19.7–64.8 mm SL, Tekezze River, c. 50 km south of Lalibela town, Wollo, Ethiopia (11°50′N, 39°15′E); AMNH 227275, 101 ex., 23.1–100.3 mm SL, Uka River, c. 20 km west of Gore town on the way to Gambella, near Uka town, Illubabor, Ethiopia (8°15′N, 35°10′E); AMNH 223759, seven ex., 45.3–89.3 mm SL, Borkena River, southern end of Kombolcha town, Ethiopia (11°10′N, 39°50′E); AMNH 223678, 223680, 29 ex., 31.5–77.8 mm SL, Duberkela River, 70 km north of Addis Ababa, Ethiopia (9°30′N, 38°50′E); AMNH 223691, eight ex., 33.3–69.0 mm SL, Gedeb River, c. 20 km north of Debremarkos town, Gojam, Ethiopia (10°30′N, 37°40′E); AMNH 223695, 223696, 15 ex., 25.0–75.5 mm SL, Chereka River, Ethiopia (10°40′N, 37°25′E); AMNH 223697, 223698, 9 ex., 30.7–70.3 mm SL, Kechen River, 30 km south of Finote Selam town, Gojam, Ethiopia (10°45′N, 37°20′E); AMNH 223701, four ex., 31.8–43.4 mm, Lah River, south of Finote Selam town, Ethiopia (10°50′N, 37°15′E); AMNH 223709, 223710, four ex., 42.5–103.1 mm SL, Muat River, north of Durbete town, Gojam, Ethiopia (11°10′N, 37°E); AMNH 223712, 223713, six ex., 32.8–35.0 mm SL, Ernu River, near Tara Gedam, c. 100 km south of Gondar town, Ethiopia (12°20′N, 37°40′E); AMNH 223718, two ex., 33.1–49.8 mm SL, Wenbaha River, c. 80 km south of Gondar town, Ethiopia (12°20′N, 37°40′E); AMNH 223719, five ex., 25.8–37.8 mm SL, Garno River, southern end of Enfraz town, c. 50 km south of Gondar town, Ethiopia (12°40′N, 37°40′E); AMNH 223722, 223723, 223725, 34 ex., 29.6–66.0 mm SL, Gumara (Maksegnit) River, northern end of Maksegnit town, Ethiopia (12°40′N, 37°40′E); AMNH 223726, three ex., 32.4–39.2 mm SL, Megech River, Ethiopia; AMNH 223742, three ex., 24.6–31.5 mm SL, Zarima River, within Tekezze valley, c. 150 km north of Gondar town, Ethiopia (13°25′N, 37°55′E); AMNH 223840, four ex., 28.0–61.8 mm SL, Melka-Gufu River, 50 km east of Bako town, 200 km west of Addis Ababa, traveling from Addis Ababa to Nekempte, Wellega, Ethiopia (9°5′N, 37°15′E); AMNH 223734, 223737, 22 ex., 30.2–50.0 mm SL, Dirma River, about 80 km south of Gondar on the way to Gorgora, in Koladiba town, Ethiopia (37°20′E, 12°25′N); AMNH 223791, 223792, 34 ex., 20.4–66.9 mm SL, Angordgood creek 4 km north-east of Bahirdar town, Gojam, Ethiopia (11°35′N, 37°30′E); AMNH 223800, 223801, 53 ex., 18.3–60.1 mm SL, Gelder River, c. 30 km north of Bahirdar town, Gondar, Ethiopia (11°40′N, 37°30′E); AMNH 223804, three ex., 30.1–34.2 mm SL, Idiyemo creek, c. 20 km north of Bahirdar on Gondar road, Gojam, Ethiopia (11°40′N, 37°30′E); AMNH 227253, three ex., 70.5–95.9 mm SL, Loko River, 60 km south-west of Nekempte, near Didessa River, Welega, Ethiopia (8°45′N, 36°25′E); AMNH 227263, two ex., 51.6–63.0 mm SL, Tipecha River, 5 km south-west of Bedele town on the way to Metu, Illubabor, Ethiopia (8°15′N, 36°10′E).

GARRA MAKIENSIS (BOULENGER, 1903) (FIG. 18C, D; TABLE 12)

Discognathus makiensis Boulenger, 1903, *Proc. Zool. Soc. Lond.*, Vol. 2, p. 330, plate 21, fig. 1 (original description, type locality: Maki River at Lake Zwai, Ethiopia), Eschemeyer, 1998, *Catalogue of fishes*, Vol. 2, p. 1006 and Vol. 3, p. 2220 (date incorrectly quoted as 1904)

Discognathus rothschildi Pellegrin, 1905, *Bull. Mus. Hist. Nat. Paris*, p. 291 (original description, type locality: Gotta River, Ethiopia), Menon, 1964, *Memoirs of the Indian Museum*, Vol. 14, p. 198 (as synonym of *G. makiensis*), Daget *et al.*, 1984, *CLOFFA*, Vol. 1, p. 303 (as synonym of *G. makiensis*), Eschemeyer, 1998, *Catalogue of fishes*, Vol. 2, p. 1474 and Vol. 3, p. 2226 (as synonym of *G. makiensis*)

Diagnosis: Distinguished from African congeners by the following combination of features: well-developed, large papillate disc; scaled predorsal and postpelvic regions; chest and belly with a few non-overlapping scales over chest and belly; vent located very close to anal fin (vent distance 10.3–16.9, m. 13.6%); and intestine very long (SL 15.9–18.1% Int.L).

Description: Morphometric and meristic data presented in Table 12. Maximum size: 135.3 mm SL (MNHN 1905-0246-0247, syntype of *D. rothschildi*). Robust and deep-bodied (depth 17.5–27.8, m. 24.7% SL); greatest body depth well in advance of dorsal-fin origin at mid-level of pectoral fin. Head robust, moderately depressed, snout large and prominent, studded with variously sized tubercles in both sexes. Eyes positioned either medially or slightly posteriorly in large specimens. Dorsal head profile rises steeply over snout, dorsum of head smoothly rounded and contiguous with dorsal body profile, which is steeply convex to dorsal-fin origin. Disc fleshy and well-developed, large type C, with wide free posterior and lateral margins. Numerous batteries of papillae over lower lip and around disc periphery. Disc slightly wider than long. Wide free posterior margin studded with large and conspicuous papillae. Rostral fold very well developed and ventrally downgrown to lower lip, with invecked ventral margin. Two pairs of barbels: rostral barbels well developed and longer than maxillary pair. Between 35 and 37 scales along lateral line; predorsum scaled (14–15 scales) anterior to dorsal fin; either three or four scales from lateral line to origin of

Table 12. Morphometric and meristic data for *Garra makiensis* (Boulenger, 1903). Proportional measurements (mm) are given in either percentage standard length (SL) or percentage head length (HL), unless noted otherwise. Values in parentheses indicate the number of specimens examined with that count

Character	*n*	range	mean	SD
% SL				
Body depth	30	17.5–27.8	21.7	2.11
Head length	30	19.5–26.9	22.6	1.46
Predorsal length	30	43.6–50.6	46.7	1.74
Pectoral fin length	30	15.3–24.3	20.2	1.91
Caudal peduncle length	30	11.1–20.1	17.1	1.85
Caudal peduncle depth	30	7.7–13.1	10.9	1.04
Dorsal fin length	30	22.8–25.6	24.1	0.79
Anal fin length	30	15.9–19.7	17.5	0.91
Pelvic fin length	30	19.0–22.7	20.6	1.06
% HL				
Head width	30	58.7–79.0	70.3	4.31
Head depth	30	54.0–70.0	62.1	4.17
Snout length	30	26.3–50.0	41.9	5.70
Orbit diameter	30	14.6–31.9	21.2	4.03
Interorbital width	30	33.7–50.0	44.1	3.64
% Orbit diameter				
Rostral barbel length	30	38.0–100.0	69.1	18.21
Maxillary barbel length	30	35.9–91.0	65.2	17.97
Dorsal fin rays		IV +7		
Anal fin rays		IV +5 (25), IV +4 (5)		
Pectoral fin rays		IV +11		
Pelvic fin rays		III +7		
Lateral line scales		35–37		
Scale rows lateral line–dorsal fin		3.5–4.5		
Scale rows lateral line–pelvic fin		3–4		
Scale rows lateral line–anal fin		3.5–4.5		
Predorsal scales		14–15		

pelvic fins; 3.5–4.5 scales from lateral line to dorsal-fin origin. Predorsal and postpelvic regions scaled; belly with some large, non-overlapping scales embedded in skin. Chest asquamate. Dorsal-fin rays iv, seven, inserted well in advance of pelvic fin, with short subacuminate tip, first and second unbranched rays longest extending to last ray; posterior margin slightly concave, posterior rays not approaching pelvic-fin tip. Predorsal length 43.6–50.6% SL. Anal-fin rays iv, either four or five, with pointed tip; posterior margin straight. Pectoral-fin rays iv, 11; pectoral length 15.3–24.3% SL, large with somewhat pointed tips. Vent close to anal fin (vent distance 10.3–16.9, m. 13.6%). Intestine very long (SL 15.9–18.1% Int.L). Gas bladder well developed (posterior chamber 19.0–22.0% SL).

Colour in preservation: Either dark brown or brownish-black; somewhat paler along lower third of body and ventral surface either uniformly pale creamy yellow or orange. Faint traces of a darker midlateral band often discernable on flanks and caudal peduncle. Dorsal fin usually uniformly pale dusky grey-brown, usually with no clearly demarcated black submarginal band (submarginal present in a few specimens). Between three and five small black spots between rays in basal membrane of dorsal fin. Anal fin usually uniformly pale creamy brown, sometimes with faint submarginal band of dusky brown pigment. Caudal-fin: uniformly pale dusky grey-brown. Pelvic and pectoral fins pale brownish-grey with pale cream leading edges.

Distribution: Known only from Ethiopia, where it occurs in Lake Langano and the rivers that drain this and other rift valley lakes (Ziwai and Abaya), also found in the Awash and Ghibe-Omo basins in southern Ethiopia.

Material examined – type material: Lectotype of *D. makiensis,* BMNH 1905.7.25:87, 69.4 mm SL, Maki River running into Lake Ziwai, Ethiopia; paralectotype of *D. makiensis,* BMNH 1905.7.25:88, 48.6 mm

SL, Maki River running into Lake Ziwai, Ethiopia; syntypes of *D. rothschildi,* MNHN 1905-0246-0247, two ex., 108.7–135.3 mm SL, Gotta River, Awash basin, Ethiopia.

Material examined – non-type material: BMNH 1970.10.28:57, one ex., 121.8 mm SL, Elgo River, Lake Abaya basin, Ethiopia (misidentified as *G. dembeensis*); BMNH 1968.7.24:49–53, five ex., 37.6–66.6 mm SL, Ethiopia N.O.O (undefined acronym) (misidentified as *G. quadrimaculata*); BMNH 1984.9.7:61–62, two ex., 31.9–56.0 mm SL, Didessa River, Ethiopia (misidentified as *G. quadrimaculata*); MRAC 91.051-p-65–74, five ex., 48.9–70.5 mm SL, Gota River, Harar province, Ethiopia (misidentified as *G. quadrimaculata*); AMNH 223655, three ex., 51.2–60.4 mm SL, Wondo Genet River, crossing southern part of Wondo Genet town, Ethiopia (7°10′N, 38°40′E); AMNH 223774, four ex., 70.2–103.7 mm SL, Worka River, Wendo Genet, small stream along hot spring, Ethiopia (7°10′N, 38°40′E); AMNH 223652, three ex., 30.8–80.9 mm SL, Worka River, adjacent to the hot spring of the Wabi-Shebelle hotel, Wondo Genet, Ethiopia (7°10′N, 38°40′E); AMNH 223666, 31 ex., 32.5–87.5 mm SL, Mesha River, north of Butajira town, in the rift valley, Ethiopia (8°10′N, 38°30′E); AMNH 223667, three ex., 90.1–98.6 mm SL, Acamaja River, about 10 km north of Butajira town on the way to Addis Ababa, in the rift valley, Ethiopia (8°20′N, 38°35′E); AMNH 223669, 14 ex., 72.5–105.6 mm SL, Acamaja River, about 10 km north of Butajira town on the way to Addis Ababa, in the rift valley, Ethiopia (8°20′N, 38°35′E); AMNH 223656, four ex., 32.3–50.8 mm SL, Wondo Genet Rriver, crossing southern part of Wondo Genet town, Ethiopia (7°10′N, 38°40′E); AMNH 223670, two ex., 56.8–91.7 mm SL, Lebu River, about 20 km north of Butajira on the way to Addis Ababa, Ethiopia (8°30′N, 38°40′E); AMNH 223762, three ex., 42.7–61.9 mm SL, Lake Langano, about 150 km south of Addis Ababa, Ethiopia (7°35′N, 38°45′E); AMNH 223763, 15 ex., 31.2–47.2 mm SL, Lake Langano, about 150 km south of Addis Ababa, Ethiopia (7°35′N, 38°45′E); AMNH 223789, 31 ex., 26.1–59.3 mm SL, Chufa stream, about 4 km south of Abura village, Arsi, Ethiopia (7°55′N, 39°5′E); AMNH 223770, four ex., 38.7–52.3 mm SL, Katar River, about 30 km west of Abura village, Arsi, Ethiopia (7°55′N, 39°E); AMNH 227289, nine ex., 48.6–116.7 mm SL, Yebeg Wuha River, at the eastern end of Tepi town, Kefa, Ethiopia (7°10′N, 35°10′E); AMNH 223723, 14 ex., 72.6–130.8 mm SL, Errer Gota River, Eastern side of Errer town, pools near main road, Hararge, Ethiopia (09°30′N, 41°15′E); AMNH 227290, 19 ex., 25.8–114.0 mm SL, Bitin River, 2 km east of Tepi town, on the way to Bonga town, Kefa, Ethiopia (7°10′N, 35°15′E); AMNH 227296, 65 ex., 24.5–87.7 mm SL, Meni River, 75 km east of Tepi town on the way to Bonga town, Sheda/Gawete area, Kefa, South-west of Ethiopia (7°10 N, 35°50E); AMNH 227275, 101 ex., 23.1–100.3 mm SL, Uka River near Uka town about 20 km west of Gore town on the way to Gambella, Illubabor, Ethiopia (8°15′N, 35°10′E); AMNH 223664, three ex., 45.9–100.8 mm SL, Mesha River, north of Butajira town, Rift Valley, Ethiopia (8°10′N, 38°30′E); AMNH 223655. three ex., 51.1–60.4 mm SL, Wondo Genet River, crossing southern part of Wondo Genet town, Shoa, Ethiopia (7°10′N, 38°40′E).

CONCLUDING REMARKS

During the course of this study over 6000 specimens of *Garra* have been collected at about 109 localities from all the major river basins of Ethiopia (Fig. 19). Based on observations of the Ethiopian species it is evident that the genus occupies a wide range of habitats from severely degraded to pristine, at altitudes from 1500 m to over 3000 m asl, in water temperatures ranging from 12°C to 32°C, and with pH values ranging from 6.1 to 8.9. Although the most frequented habitats are either relatively slow-moving or stagnant pools edged with either long grass or other emergent vegetation, *Garra* are to be found throughout the region. Nonetheless, in Ethiopia species richness tends to decline from north to south. The rivers of the north-western highlands have the highest species diversity of *Garra,* whereas the freshwater bodies of the south-eastern Highlands, Rift Valley and coastal plains are relatively depauperate. The Abbay (including Lake Tana) and Tekezze basins alone contain 75% of the Ethiopian *Garra* species, a pattern which is consistent generally with the overall distribution of species diversity in the country (Getahun & Stiassny, 1998).

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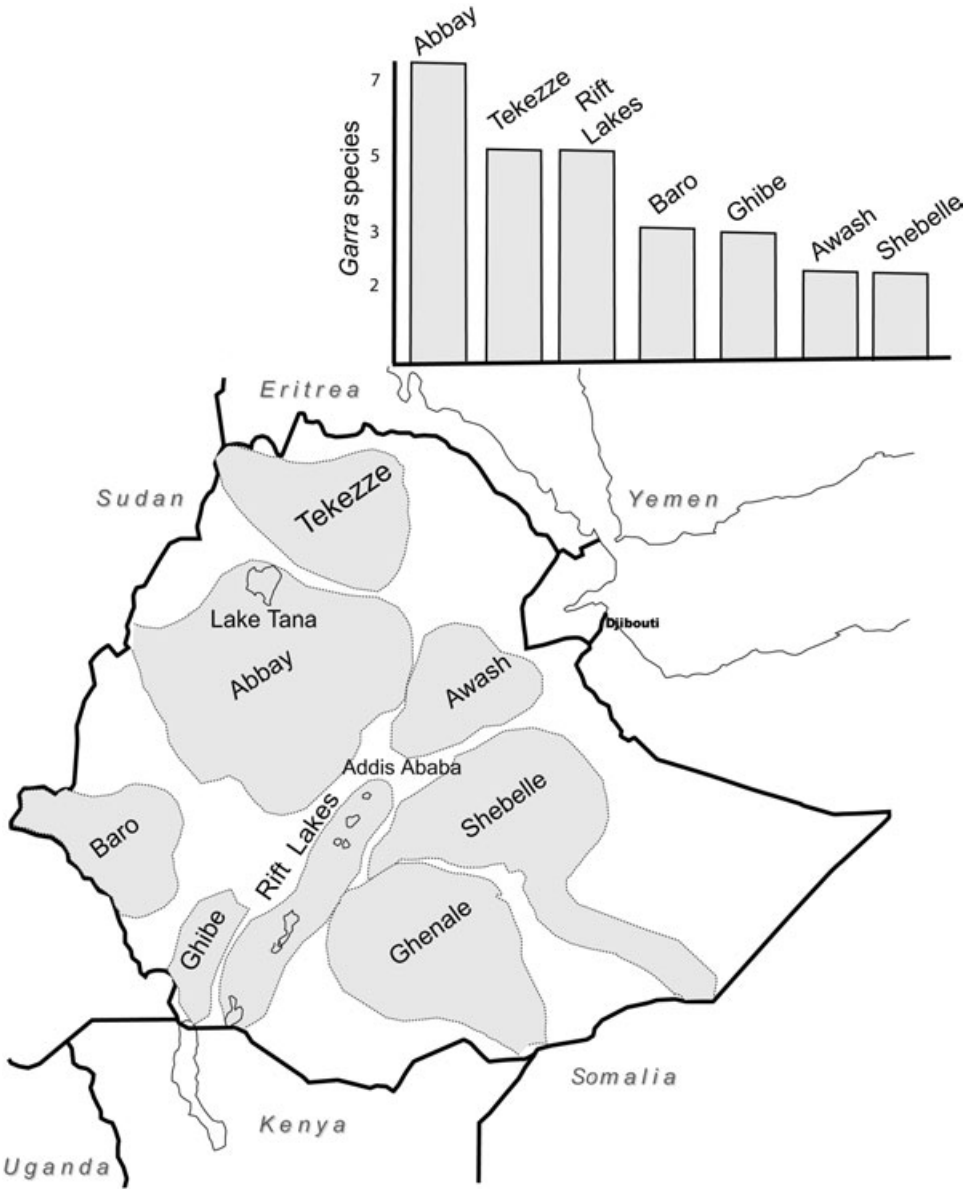

Figure 19. Main river basins of Ethiopia with numbers of *Garra* species for each basin indicated in the inset bar graph.

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APPENDIX

COMPARATIVE MATERIALS EXAMINED

Cyprinidae
- Gobioninae
  - *Abbottina rivularis* AMNH 11002
  - *Gobio gobio* AMNH 37609
  - *Saurogobio drakei* AMNH 10595
- Acheilognathinae
  - *Rhodeus sinensis* AMNH 10785
- Rasborinae
  - *Parachela oxygastroides* AMNH 14508
  - *Rasbora daniconius* AMNH 13818
- Leuciscinae
  - *Xenocypris davidi* AMNH 10933
  - *Leuciscus leuciscus* AMNH 36884
  - *Ochetobius elongatus* AMNH 10891
  - *Pachychilon pictum* AMNH 40973
  - *Tinca tinca* AMNH 37597 (inc. sedis)
- Cyprininae
  - Squaliobarbini
    - *Ctenopharyngodon idella* AMNH 77912
  - Cyprinini
    - *Carassius auratus* AMNH 20990
    - *Cyprinus carpio* AMNH 79330
  - Barbini
    - *Barbus barbus* AMNH 47876
    - *Barbus oreas* AMNH 223760
    - *Barbus radiatus* AMNH 215925
    - *Labeobarbus caudovittatus* AMNH 6136
    - *Prolabeops melanohypoptera* MRAC 95–054-P-0855–57
    - *Varicorhinus barbatulus* AMNH 11634
    - *Varicorhinus beso* AMNH 223675
  - Systomini
    - *Puntius conchonius* AMNH 14622
    - *Balantiocheilus melanopterus* AMNH 59319
  - Labeonini
    - Labeoina
      - *Barbichthys laevis* AMNH 14573, 13836
      - *Cirrhinus molitorella* AMNH 37020, 37021
      - *Cirrhinus cirrhosus* AMNH 37936
      - *Henicorhynchus siamensis* AMNH 36379
      - *Labeo alluadi* AMNH 215411
      - *Labeo cylindricus* AMNH 215929
      - *Labeo niloticus* AMNH 9548
      - *Labiobarbus leptocheila* AMNH 14598
      - *Lobocheilus bo* AMNH 36378
      - *Osteochilus hasseltii* AMNH 217800
      - *Osteochilus melanopleurus* AMNH 1474
      - *Osteochilus salsburyi* AMNH 10624
      - *Osteochilus schlegelii* AMNH 9297
    - Garraina
      - *Crossocheilus diplochilus* USNM 271252
      - *Crossocheilus siamensis* AMNH 235856
      - *Discocheilus wui* IHAWS (uncat.)
      - *Discogobio yunnanensis* IHAWS (uncat.)
      - *Epalzeorhynchus kalopterus* AMNH 10202, 48921
      - *Epalzeorhynchus frenatum* AMNH 10202
      - *Epalzeorhynchus munense* AMNH 55777, 77916
      - *Garra barriemiae* AMNH 71928
      - *Garra bicornuta* AMNH 29713
      - *Garra imberbis* AMNH 228015
      - *Garra nasuta* AMNH 228004
      - *Garra rossica* AMNH 35533
      - *Garra rufa* AMNH 40950
      - *Mekongina erythrospila* USMN 219808
      - *Paracrossocheilus vittatus* AMNH 48926
      - *Paracrossocheilus acerus* AMNH 36375
      - *Pseudogyrinocheilus prochilus* USNM 91807
      - *Ptychidio jordani* USNM 94591
      - *Semilabeo notabilis* AMNH 12754
      - *Semilabeo obscurus* AMNH 12766

Psilorhynchidae
- *Psilorhynchus sucatio* AMNH 19648
- *Psilorhynchus balitora* AMNH 13811

Cobitidae
- *Cobitis taenia* AMNH 20366

Gyrinocheilidae
- *Gyrinocheilus aymonieri* AMNH 77898