

Some Osteological Distinction among Four Arabian Cyprinid Species

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A survey of literature reveals that, with the exception of *Acanthobrama hadiyahensis* (Coad et al., 1983), all known cyprinid fishes recorded from the Arabian Peninsula by Boulenger (1887), Trewavas (1941), Fowler and Steinitz (1956), Balleto and Spano (1977), Banister and Clarke (1977), Howes (1982), Krupp (1982, 1983), Alkahem (1983) and Alkahem and Behnke (1983) belong to the genera *Barbus*, *Cyprinion* and *Garra*. Taxonomic studies carried out in the past on the species of these genera have been restricted mainly to the meristic and morphometric characters. There has been very little anatomical information on Arabian cyprinids so far (i.e. Howes, 1982). Osteological studies provide additional information for a better understanding of the phylogeny of these Arabian cyprinids. The objectives of this study are to reveal both intergeneric and interspecific differences in vertebral structure, maxilla, premaxilla and lower jaw and to make a significant contribution to a better classification of the Arabian cyprinids.

Materials and methods

All the specimens examined were collected with cast nets and seines from Wadi Hadiyah, Ain Al Jayma and Wadi Al Mhaleh (Abha). Clearing and bone preparation were made according to Vladykov (1962). Osteological terminology followed Hubbs et al. (1974), Howes (1982) and Potthoff and Kelley (1982). Observations were made on the following specimens:

Barbus apoensis Banister et Clarke, 1977: BA-011, 2 specimens, 180 and 175 mm SL.

Cyprinion acinaces Banister et Clarke, 1977: CA-022, 2 specimens, 120 and 112 mm SL.

Cyprinion mhalensis Alkahem et Behnke, 1983: CM-033, 2 specimens, 130 and 120 mm SL.

Garra tibanica Trewavas, 1941: GT-044, 2 specimens, 105 and 100 mm SL.

All the bones are deposited in the museum of

the Zoology Department, King Saud University with the above catalogue numbers.

Results

Vertebrae. It was observed in each species that all the centra are quite uniform in size and shape, with the exception of the anteriormost (Weberian apparatus) and caudal vertebrae (Fig. 1). The neural spines of the species of *Garra* and *Cyprinion* are stout, while those of *Barbus apoensis* are not strongly ossified and are flexible in their distal third. The neural spine of the second post Weberian vertebra, namely 6th abdominal vertebra, is notched at its distal tip in *Garra tibanica* and this well distinguishes it from the other three species.

All the post Weberian vertebrae except the first bear neural prezygapophyses of varying shapes and sizes. The neural prezygapophyses of *B. apoensis* are thick, elongated and expanded; they articulate with each neural spine. This peculiarity was not seen in the species of the other genera here examined. The neural prezygapophyses of the members of *Cyprinion* are relatively long with anteroprojections from the neural arch. Some of the projections fuse with their respective neural spines, while others remain separated. *G. tibanica* has long and broad neural prezygapophyses.

The postzygapophyses of *C. acinaces*, *C. mhalensis* and *B. apoensis* are present on all the post Weberian vertebrae except the caudal complex. They are postero-dorsal, spine-like on the upper part of the centra in *Cyprinion*, and thin, narrow and short in *Barbus*. All the centra of *G. tibanica* lack postzygapophyses, which diagnostically distinguishes this species from the species of *Barbus* and *Cyprinion* examined. Another distinctive feature of the centra in *G. tibanica* is the presence of a very thin plate-like structure which covers the anterior portion of each centrum. This was found in all the precaudal vertebrae except the four anteriormost vertebrae. Of the Arabian cyprinids examined here, only *G. tibanica* was found to have this "supra centrum" bony structure.

In all the species studied, all the abdominal vertebrae except the four anteriormost ones have parapophyses.

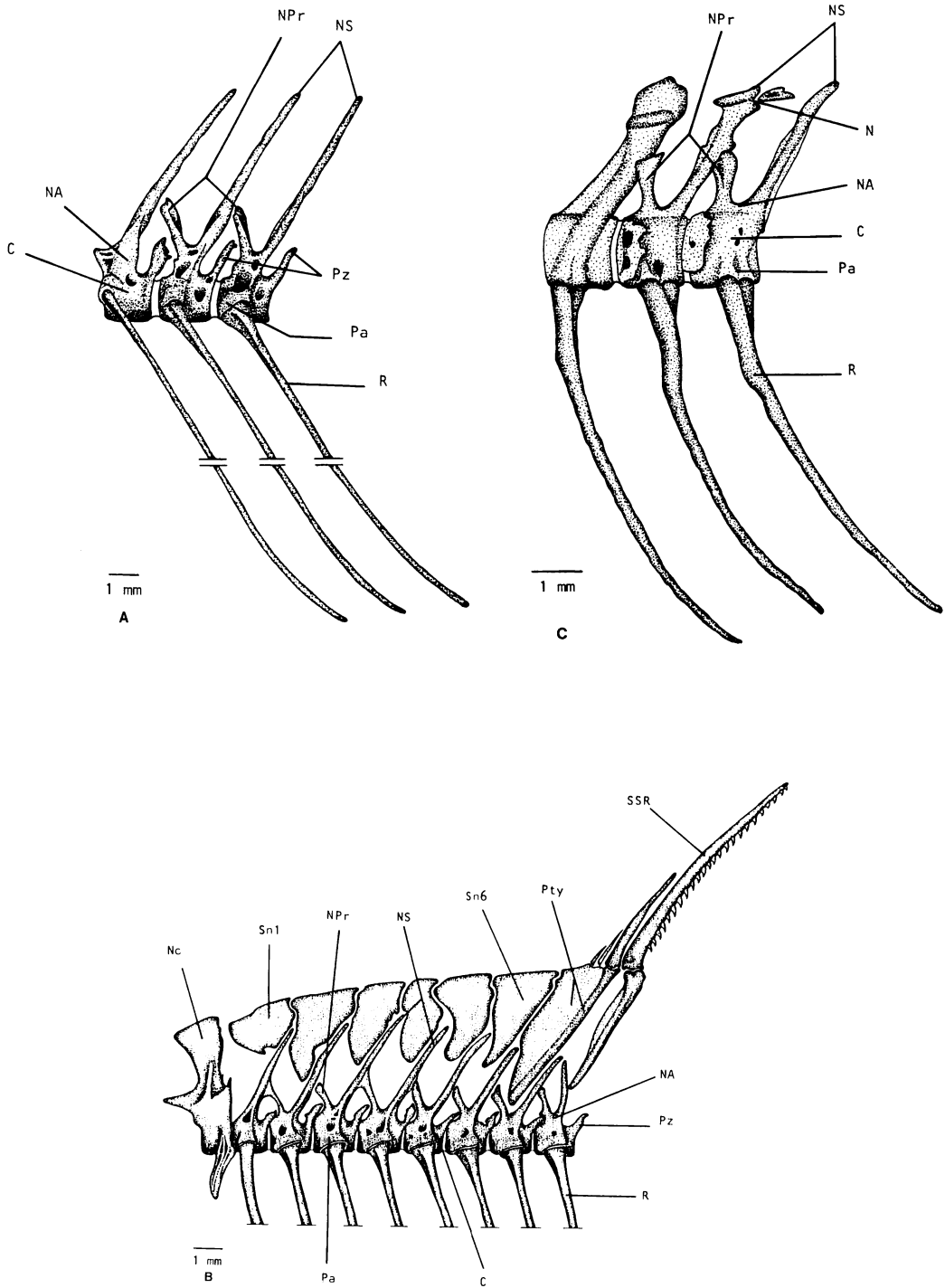


Fig. 1. Post Weberian vertebrae in lateral view. A, *Barbus apoensis*; B, *Cyprinion acinaces*; C, *Garra tibanica*. C, centrum; N, notch; NA, neural arch; NC, neural complex; NPr, neural prezygapophysis; NS, neural spine; Pa, parapophysis; Pty, pterygiophore; Pz, postzygapophysis; R, rib; Sn, supraneural; SSR, spiny soft ray.

Barbus apoensis has 5 to 6 supraneurals, which are thin, relatively large and separated from their respective neural spines and neighbours. The supra neurals in *C. mhalensis* and *C. acinaces* vary in number from 7 to 8 and 5 to 6, respectively. They are thick and large in *C. acinaces* or thin and large in *C. mhalensis*, usually articulating with neighbouring supraneurals. This type of articulation was found only in *Cyprinion*. Variation in number of supraneurals in *G. tibanica* was from 5 to 6. They are thin, narrow, feeble and widely separated from each other. The first supraneural of *C. mhalensis* is fused with its neural spine. The last supraneural in *G. tibanica* is separated from the anterior margin of the first pterygiophore, but that in *B. apoensis* overlaps the anterior margin of the first pterygiophore. The last supraneural articulates with the anterior margin of the first dorsal pterygiophore in the two species of *Cyprinion*.

The neural complex remains separated from the supraneurals in each species. The neural complex of *B. apoensis* is sickle-shaped, while those of the species of *Cyprinion* and *Garra* have an axe-shaped appearance. Dorsally they remain separated from the posteriorly directed supraoccipital processes.

Premaxilla. Differences are apparent in the shape and size of the premaxilla among the representatives of the Arabian cyprinid genera (Fig. 2). In *B. apoensis*, it is thin and narrow, tapering posteriorly. Its anterior dorsal part forms an ascending ramus which is directed towards the anterior tip of the neurocranium to contact with the bone. The anterobasal portion of the premaxilla is notched. A slight concavity is present at the pointed posterior process of the premaxilla. The greatest width of the premaxilla is 46% of its total length.

The premaxilla is thin and narrow in *C. mhalensis*, but thick and broad in *C. acinaces*. The posterior process is distally bifurcated in *C. acinaces*, and flat in *C. mhalensis*. The bone curves mesially to meet the anterior margin of the opposite fellow along the mid-line.

The premaxilla of *G. tibanica* is thick and curved with only a slight anterior process. The posterior process is bifurcated, fused and twisted, which gives it a braided appearance.

Maxilla. The maxilla of all the species examined are thick and broad. The dorsal borders

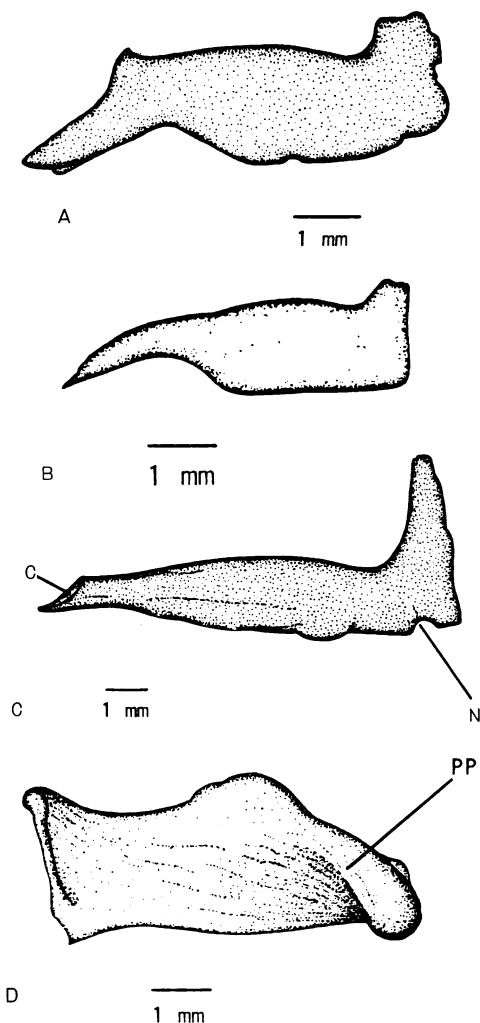


Fig. 2. Dorsolateral view (A–C) and innerview (D) of the right premaxilla. A, *Cyprinion acinaces*; B, *Cyprinion mhalensis*; C, *Barbus apoensis*; D, *Garra tibanica*. C, concavity; N, notch; PP, posterior process.

are convex. *B. apoensis* and *C. mhalensis* share two thin and large anterior ascending processes in the maxilla, while *G. tibanica* and *C. acinaces* do only one anterior process (Fig. 3). The posterior process is well defined in all the species studied except *G. tibanica*. The posterior process of *B. apoensis* and of *C. acinaces* is expanded to form a plate-like structure. In *C. mhalensis* it is short and expanded at its tip, which gives it a triangular appearance. The posterior portion of this bone in *G. tibanica* has two small notches at its posterior rim. A large foramen is present at

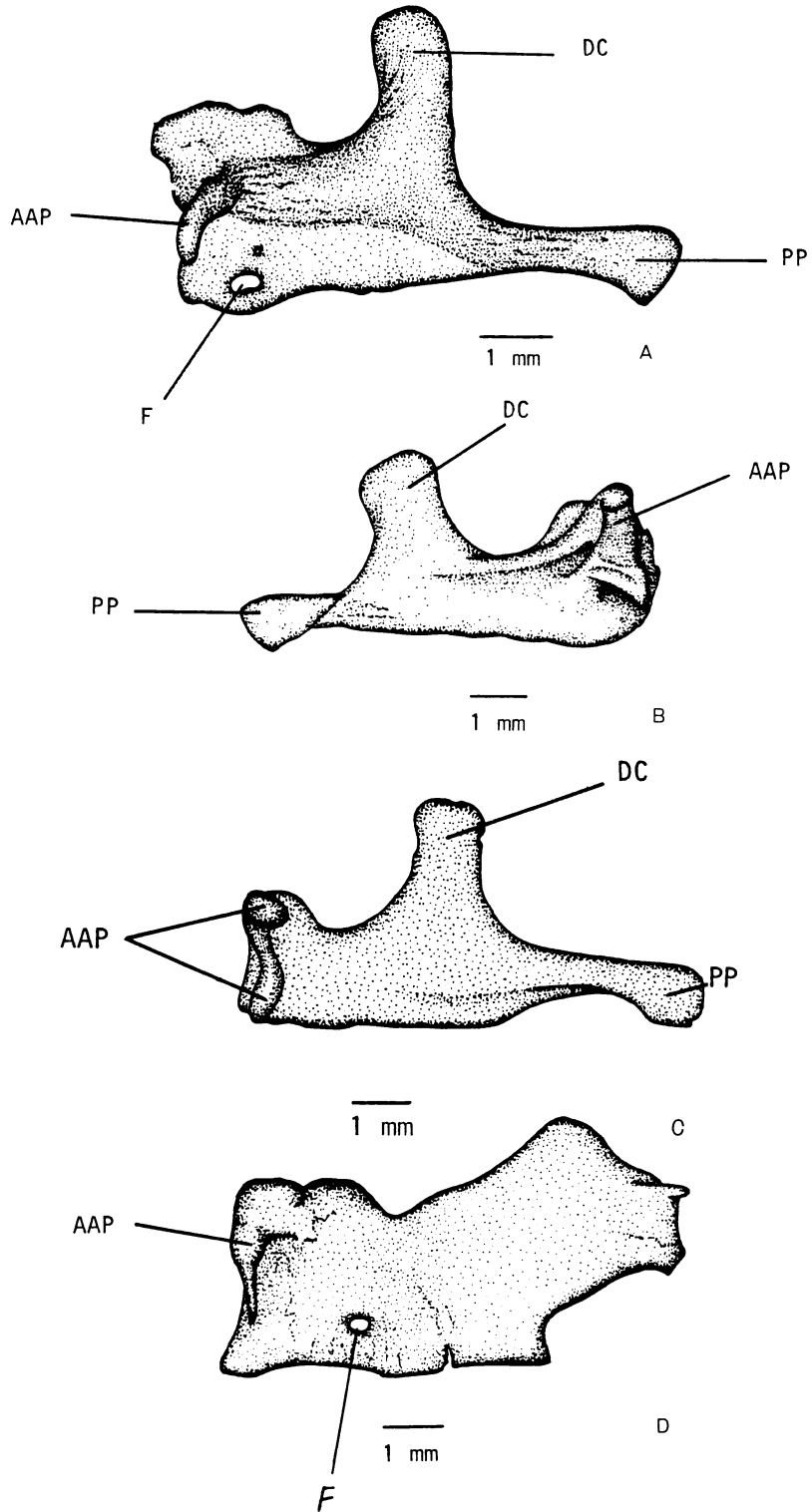


Fig. 3. Inner view of the maxilla. A, *Cyprinion acinaces* (right side); B, *Cyprinion mhalensis* (left side); C, *Barbus apoensis* (right side); D, *Garra tibanica* (right side). AAP, anterior ascending process; DC, dorsal crest; F, foramen; PP, posterior process.

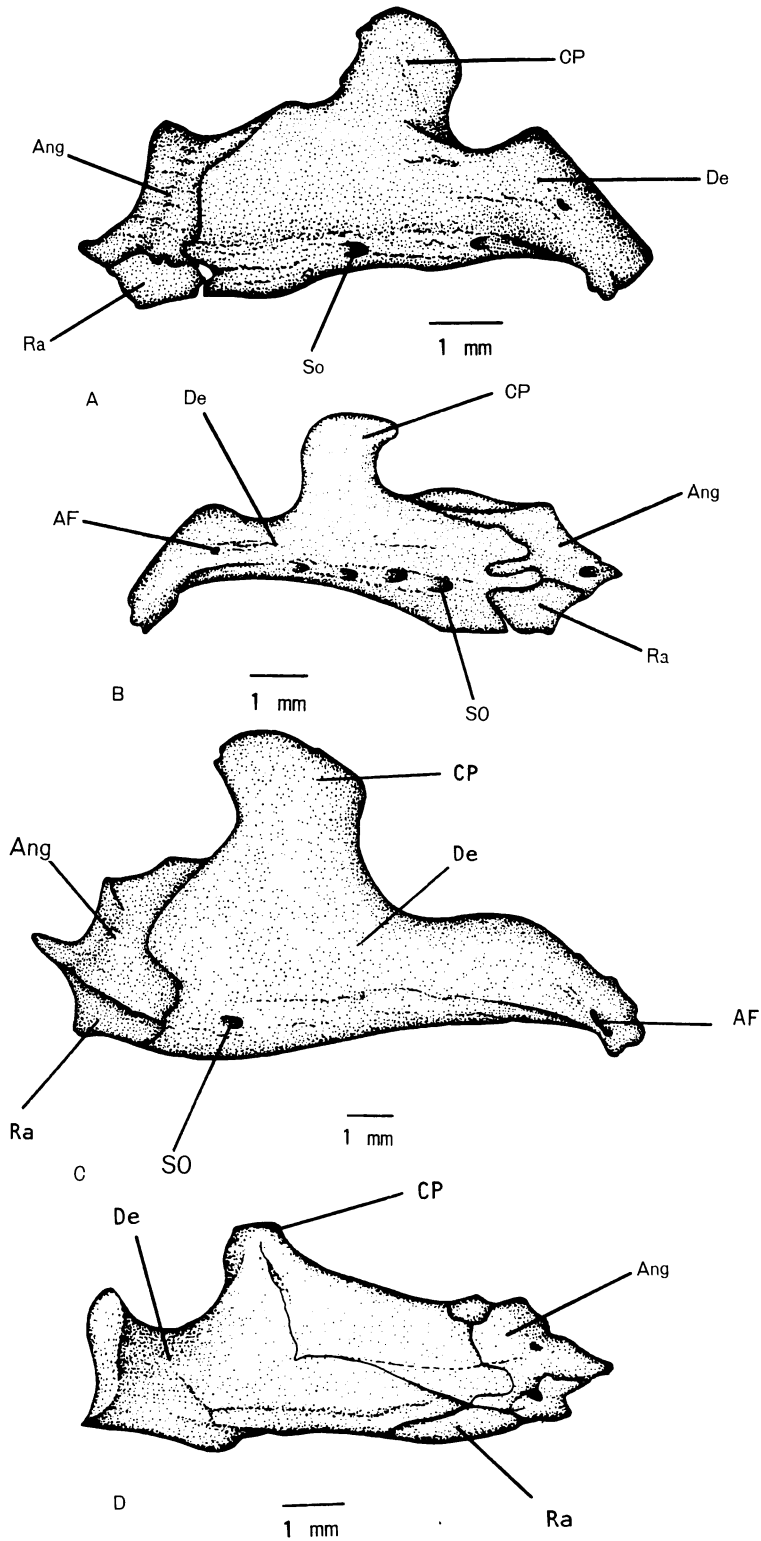


Fig. 4. Lateral view of the lower jaw. A, *Cyprinion acinaces* (right side); B, *Cyprinion mhalensis* (left side); C, *Barbus apoensis* (right side); D, *Garra tibanic* (right side in dorsal view). AF, antero-lateral foramen; Ang, angular; De, dentary; SO, sensory opening; Cp, coronoid process; Ra, retro-articular.

the upper part of the maxilla of *G. tibanica* and *C. acinaces* but the foramen is relatively small in *B. apoensis*. It is absent in *C. mhalensis*. A thick and narrow dorsal crest is present along the midway of the length of the maxilla in *C. acinaces* and *B. apoensis*, but such a crest is absent in *G. tibanica*. The crest is more anteriorly located in *C. mhalensis*.

Lower jaw. The dentary curves anteriorly to form a symphysis with its counterpart (Fig. 4). The dorsal and ventral parts taper to a thin edge in *B. apoensis* and make a thick edge in the species of *Cyprinion* and *Garra*, curving mesially to form a sloped labial surface. The coronoid process is remarkable in *Barbus* and *Cyprinion*, but it is comparatively small in *G. tibanica*. The coronoid process is positioned posteriorly in *B. apoensis* and *C. acinaces*, or mesially in *C. mhalensis* and *G. tibanica*. The posterior border of the coronoid process in *B. apoensis* and *C. mhalensis* is concave while the anterior end is slightly convex. The ventrolateral surface of the dentary has two sensory openings in *B. apoensis* and *C. acinaces* and a series of openings in *C. mhalensis*.

The angular is thin and large in *B. apoensis* while thick and trapezoid in the two species of *Cyprinion*. It is variable in *G. tibanica*. The bone is notched at the dorsal and ventral surface in *B. apoensis* and the species of *Cyprinion* to receive the articulating surface of the head of the quadrate and retroarticular, respectively. The retroarticular is of variable shapes in *G. tibanica*, and thick and small in *B. apoensis*.

Literature cited

- Alkahem, H. F. 1983. The freshwater fishes of Saudi Arabia; systematics and conservation. Ph. D. thesis, Colorado State Univ., U.S.A., 194 pp.
- Alkahem, H. F. and R. J. Behnke, 1983. The freshwater fishes of Saudi Arabia. Fauna Saudi Arabia, 5: 545-567.
- Balleto, E. and S. Spano, 1977. Cyprinidi del genera *Garra* Hamilton 1822, rarecolti, Nelo Yemen. Ann. Mus. Civ. Ster. Nat. "Giacomo Doria", 81: 245-287.
- Banister, K. E. and M. A. Clarke, 1977. The freshwater fishes of Arabian Peninsula. J. Oman. Stud. Spec. Rep. (Sci. Results Oman Flora and Fauna Survey): 111-154.
- Boulenger, C. A. 1887. An account of the fishes obtained by A. Jayakar at Muscat, east coast of Arabia. Proc. Zool. Soc. London, 1887: 653-667.
- Coad, B. W., H. F. Alkahem and R. J. Behnke. 1983. *Acanthobrama hadiyahensis*, a new species of the cyprinid fish from the Saudi Arabia. Natn. Mus. Nat. Sci. Pub., Nat. Sci., (2): 1-6.
- Fowler, H. W. and H. Steinitz. 1956. Fishes from Cyprus, Iran, Iraq, Israel and Oman. Bull. Res. Coun. Israel, 5b(3/4): 270-292.
- Howes, G. 1982. Anatomy and evolution of jaws in semiplotine carps with a review of the genus *Cyprinion* Heckel 1843 (Teleostei, Cyprinidae). Bull. Brit. Mus. Nat. Hist. (Zool.), 42: 299-335.
- Hubbs, C. L., R. Miller and L. Hubbs, 1974. Hydrographic history and relict fishes of the North-Central great basin. Mem. Calif. Acad. Sci., 7, 259 pp.
- Krupp, F. 1982. *Garra tibanica ghorensis* n. ssp. (Pisces—Cyprinidae) an African elements in cyprinid fauna of Levent. Hydrobiologia, 88: 318-324.
- Krupp, F. 1983. Freshwater fishes of Saudi Arabia and adjacent regions of the Arabian Peninsula. Fauna Saudi Arabia, 5: 568-636.
- Potthoff, T. and S. Kelly. 1982. Development of vertebral column, fins and fin supports, branchiostegal rays, and squamation in the swordfish, *Xiphias gladius*. Fish. Bull., 80: 161-186.
- Trewavas, E. 1941. Freshwater fishes. Pages 7-15 in British Museum of Natural History Expedition to South-West Arabia, 1937-38, 1. London.
- Vladykov, V. D. 1962. Osteological studies on Pacific Salmon of the genus *Onchorhynchus*. J. Fish. Res. Bd. Can., Bull. 136, 172 pp.
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アラビア産コイ科魚類 4 種の骨格の比較

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アラビア半島に分布するコイ科の *Barbus apoensis*, *Cyprinion acinaces*, *C. mhalensis*, *Garra tibanica* の骨格を比較した。これら 3 属は脊椎骨・主上顎骨・前上顎骨・下顎の形態で差異が認められた。