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**FISHES OF THE FAMILY MULLIDAE IN THE RED SEA, WITH A KEY TO THE
SPECIES IN THE RED SEA AND THE EASTERN MEDITERRANEAN**

by

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ABSTRACT

Ben-Tuvia, Adam and George Wm. Kissil. 1988. Fishes of the Family Mullidae in the Red Sea, with a Key to the Species in the Red Sea and the Eastern Mediterranean. *Ichthyological Bulletin of the J.L.B. Smith Institute of Ichthyology* No. 52, 16 pages.

Thirteen species of Mullidae (goatfishes or red mullets) occur in the Red Sea: *Mulloides flavolineatus*, *M. vanicolensis*, *Parupeneus cyclostomus*, *P. forsskali*, *P. heptacanthus*, *P. macronemus*, *P. rubescens*, *Upeneus asymmetricus*, *U. moluccensis*, *U. subvittatus* (previously known only from the western Pacific), *U. sulphureus*, *U. tragula* and *U. vittatus*. Descriptions, biological observations and black and white photographs are given for each of these 13 species. Keys are provided to the genera of Mullidae, to the species occurring in the Red Sea, and to the two Mediterranean species of *Mullus* that have been reported from the Suez Canal. The distinction between the genera *Pseudupeneus* and *Parupeneus* is discussed.

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FISHES OF THE FAMILY MULLIDAE IN THE RED SEA, WITH A KEY TO THE SPECIES IN THE RED SEA AND THE EASTERN MEDITERRANEAN

by

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INTRODUCTION

Fishes of the family Mullidae (goatfishes or red mullets) are represented in the Red Sea by at least 13 species belonging to the genera *Mulloides*, *Parupeneus* and *Upeneus*. Dor and Ben-Tuvia (1984) provided synonymies and the relevant literature for 11 species. Randall (1983) described and illustrated in colour 5 species of *Parupeneus* and 2 of *Mulloides* from the Red Sea. Colour illustrations of 9 of the Red Sea goatfishes, photographed by J.E. Randall, can be found in Kumaran and Randall (1984).

Randall and the senior author examined an 84 mm SL specimen (MNHN 1967-557) of an apparently undescribed species of *Parupeneus* from the Gulf of Suez. It seems to be closely related to *P. macronemus*, but it is entirely pale, has a more slender body, narrower caudal peduncle and the last dorsal and anal fin rays are not clearly longer than the penultimate rays. A description of this form is deferred until adult specimens can be obtained, life colour determined and the habitat elucidated.

Two of the Red Sea species, *Upeneus moluccensis* and *U. asymmetricus* immigrated by way of the Suez Canal into the eastern Mediterranean Sea (Ben-Tuvia, 1985). The early reports of *Upeneus tragula* from the Mediterranean Coast of Turkey (Tortonese, 1953) and from the Mediterranean Coast of Israel (Ben-Tuvia, 1966) are misidentifications of *U. asymmetricus*. Both Mediterranean red mullets, *Mullus barbatus* and *M. surmuletus*, have been reported from the Suez Canal (Tillier, 1902) but not from the Red Sea proper.

There are clear ecological differences among the goatfishes of the three Red Sea genera. The species of *Mulloides* appear to forage not only on sandy bottoms but also from schools in the water column. The species of *Parupeneus* are closely associated with coral reefs while those of *Upeneus* inhabit sandy and muddy bottoms free of corals and rocks. Species of the genus *Mullus* (temperate and subtropical Atlantic Ocean and adjacent seas) and of the genus *Upeneichthys* (southern Australia and New Zealand) also occupy sandy or muddy bottom habitats (Ben-Tuvia, 1986a).

The unique character of the hyoid barbels of goatfishes has been discussed by Gosline (1985). Their efficient use of barbels in searching for cryptic zoobenthos is remarkable. Other fishes are often observed in close association with species of *Parupeneus* in order to take advantage of the small animals that are exposed or frightened by rooting of the goatfishes in the sediments. According to Fricke (1970) groups of *P. forsskali* (quoted as *P. barberinus*) and *P. macronemus* in Elat are followed by the triggerfish *Sufflamen albicaudatus*, the nemipterid *Scolopsis ghanam* and certain

labrids, lethrinids and lutjanids. Near Dahab we observed a specimen of *P. cyclostomus* (about 4 cm total length) and a *Gomphosus caeruleus* of slightly larger size, swimming alongside each other, almost in body contact. Both individuals were bright yellow in colour.

There has long been confusion whether the genus *Parupeneus* Bleeker 1863 is distinct from *Pseudupeneus* Bleeker, 1862. In the present paper we follow Bleeker (1876) who separated *Parupeneus* from *Pseudupeneus* on the differences in dentition: *Parupeneus* with 2 rows of teeth in the upper jaw, versus *Pseudupeneus* with a single row. Rosenblatt and Hoese (1968) checked this character in *Pseudupeneus grandisquamis* (Gill) and *P. maculatus* (Bloch) and found that a second row of teeth occurs only in adult males. Several authors synonymized these two genera (Fowler, 1933; Smith, 1949; Shen, 1976; Dor and Ben-Tuvia, 1984). Examination of the two American species of *Pseudupeneus* and *P. prayensis* (Cuvier), the type species from West Africa, by the senior author confirmed the differences in dentition that seem to justify the separation of the two genera (Ben-Tuvia, 1986b). In all 3 species of *Pseudupeneus*, males larger than 110 mm have a second (outer) row of strong, conical teeth in the upper jaw with 1 — 3 recurved enlarged canines on each side. In both *grandisquamis* and *maculatus* there is also a second row of teeth in the lower jaw in both adult males and females. In *prayensis* a few enlarged canines appear at the front of the jaws in both adult males and females. Another common feature of the three species of *Pseudupeneus* is that the teeth of the upper jaw are visible when the mouth is closed. By contrast, the teeth of species of *Parupeneus* (with the exception of *P. heptacanthus*) cannot be seen when the mouth is closed. There is also the geographical separation of the two genera: The species of *Parupeneus* occur only in the Indo-Pacific region; those of *Pseudupeneus* are found only in the Atlantic and eastern Pacific.

MATERIAL AND METHODS

The present study is based on material from the Gulf of Aqaba (Gulf of Elat), Gulf of Suez and coast of Ethiopia (southern Red Sea) preserved in the collections of the Hebrew University of Jerusalem. Included in the descriptions are measurements and counts of three specimens from the Red Sea preserved in other collections and one specimen of *U. sulphureus* from Djibouti (Gulf of Aden).

Most of the taxonomic characters used by Lachner (1954, 1960) and by Randall and Gueze (1983) were followed in the present paper. In the list of material examined the collection number is given first, then the number of specimens, followed by the standard length (SL) of the specimen or the range in SL when there is more than one specimen in the sample. Range of pro-

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portional measurements is followed by the average value given in parenthesis. Counts of supporting elements in the first and second dorsal fins (D) are given in Roman numbers for spiny rays and in regular numbers for soft rays. Pectoral fins are abbreviated as P and the lateral line as LL. Gill-raker counts include rudimentary rakers. The raker in the angle of the two limbs was included in the lower-limb count. The number of scales between the end of the first dorsal fin and the front of the second varies between genera and groups of species. Only those scales are counted that do not touch or surround the adjacent rays of the two dorsal fins and have a complete, rounded posterior edge (Figure 1). The number of dorsal and anal spines and rays are rather constant in each species. In *Mulloides* and *Parupeneus* there are 8 spines in the first dorsal fin, 9 rays in the second and one spine and 7 rays in the anal fin. In *Upeneus* one group of species has 8 spines in the first dorsal fin, the first one minute; in the second group there are only 7 spines, the first one approximately equal in length to the second. The number of rays in the pectoral fins often varies within a species. The number of scales in a transverse line is constant in all species, 2½ above the lateral line and 6½ below. Vertebrae were counted on X-ray photographs of 22 specimens representing all six genera and the number was invariably 24.

Colour descriptions of most of the species were made from fresh specimens. In some cases colour slides were used. Underwater observations were made of the colour patterns of 8 species found in the Gulf of Aqaba.

The photographs included in this paper were taken by Dr John E. Randall of the Bishop Museum, Hawaii, from freshly caught specimens in the Red Sea when available, or from other regions otherwise.

Keys are provided to the worldwide genera of goatfishes and to the species that occur in the Red Sea and in the eastern Mediterranean (*Mullus barbatus* and *M. surmuletus*). Descriptions are given only for the Red Sea species. Species accounts are presented alphabetically by genus and species. Synonyms used in literature for the Red Sea Mullidae are quoted.

Material in the following institutions was examined but not necessarily quoted in the present paper: Australian Museum, Sydney — AMS; British Museum (Natural History), London — BM (NH); Bernice P. Bishop Museum, Honolulu — BPBM; California Academy of Sciences, San Francisco — CAS; Hebrew University, Jerusalem — HJU; Kyoto University, Fisheries Research Laboratory, Maizuru — FRSKU; Muséum National d'Histoire Naturelle, Paris — MNHN; National Science Museum, Tokyo — NSMT; J.L.B. Smith Institute of Ichthyology, Grahamstown — RUSI; Rijksmuseum van Natuurlijke Historie, Leiden — RMNH; U.S. National Museum of Natural History, Washington, D.C. — USNM; Zoological Museum of Copenhagen — ZMC.

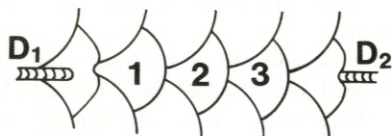


Figure 1. Semi-diagrammatic presentation of scales between the two dorsal fins of *Upeneus asymmetricus*. Only scales with rounded posterior edges and not those adjoining the bases of the nearest fin rays were counted.

KEY TO GENERA OF MULLIDAE

- 1a. No teeth on upper jaw; vomer enlarged, forming a broad plate *Mullus*
(Suez Canal, Mediterranean, eastern and western Atlantic)
- 1b. Teeth present on upper jaw; vomer not enlarged 2
- 2a. Maxilla covered completely by preorbital bone; no axillary scale at base of pelvic fins *Upeneichthys*
(southern Australia and New Zealand)
- 2b. Maxilla at least partly exposed; a distinct axillary scale at base of pelvic fins 3
- 3a. Teeth present on jaws, vomer and palatines; second dorsal and anal fins scaly; 3 or 5 scales between dorsal fins *Upeneus*
(Indo-Pacific, eastern Mediterranean and western Atlantic)
- 3b. Teeth on jaws only, none on vomer or palatines; second dorsal and anal fins not scaly; 2 or 4 scales between dorsal fins 4
- 4a. Teeth villiform; 4 scales between dorsal fins *Mulloides*
(Indo-Pacific and western Atlantic)
- 4b. Teeth conical, strong; 2 scales between dorsal fins 5
- 5a. Teeth on upper jaw usually not visible when mouth is closed; no second row of teeth on jaws, and no enlarged recurved teeth on upper jaw *Parupeneus*
- 5b. Teeth on upper jaw visible when mouth is closed; upper jaw of adult males (> ~ 10 cm SL) with an additional row of conical teeth and 1 or 2 enlarged recurved teeth anteriorly on each side of symphysis; teeth on lower jaw of adults in 1 row (*prayensis*) or 2 rows (*grandisquamis* and *maculatus*) *Pseudupeneus*

KEY TO THE MEDITERRANEAN SPECIES OF MULLUS

- 1a. Distance from lower edge of eye to lower edge of head 2.2 — 2.4 in head length; no horizontal streaks on body or fins (fresh specimens) *M. barbatus*
- 1b. Distance from lower edge of eye to lower edge of head 2.6 — 3.1 in head length; body and first dorsal fin with horizontal streaks (fresh specimens) *M. surmuletus*

Genus *Mulloides* Bleeker, 1849

Mulloides Bleeker, 1849: 6 (type-species *Mullus flavolineatus* Lacepède, 1801, by subsequent designation of Bleeker, 1876: 333).

Mulloidichthys Whitley, 1929 : 122 (type species *Mullus flavolineatus* Lacepède; proposed as a replacement for *Mulloides* Bleeker on the assumption that the name is preoccupied, however Richardson (1843) used it only in synonymy (P.C. Heemstra, personal communication).

KEY TO THE RED SEA SPECIES OF MULLOIDES

- 1a. Posterior end of maxilla closer to anterior nostril than to front of eye; length of upper jaw greater than depth of caudal peduncle; gill-rakers on lower limb 18 — 19 *M. flavolineatus*

- 1b. Posterior end of maxilla closer to front of eye than to anterior nostril; length of upper jaw less than or equal to depth of caudal peduncle; gill-rakers on lower limb 21 — 23 *M. vanicolensis*

Mulloides flavolineatus (Lacepède)

Figure 2

Mullus flavolineatus Lacepède, 1801 : 384, 406, 409, 410 (based on description by Commerson, no locality).

Upeneus flavolineatus: Rüppell, 1838 : 101, P1. 26, Fig. 1.

Mullides auriflamma (non Forsskål): Klunzinger, 1870 : 742.

Mulloides samoensis Gunther, 1874 : 57, P1. 43, fig B (Samoa).

MATERIAL: Measurements and counts from 12w specimens, 66 — 260 mm SL, all HUI numbers: 6927, 3 : 140 — 190 mm, Elat; 6928, 2 : 115 — 130 mm, Elat; 6929, 1 : 76.4 mm, Elat; 6930, 1 : 66.0 mm, Elat; 8315, 1 : 165 mm, Ras Mohammad; 8445, 3 : 200 — 230 mm, Nuweiba; 8642, 1 : 260 mm, Nabeq.

DESCRIPTION: Body depth 3.9 — 4.6 (4.1), head length 3.2 — 3.4 (3.2) in SL. Snout length 2.0 — 2.6 (2.2); orbit diameter 3.1 — 3.9 (3.7); interorbital width 3.6 — 4.2 (3.9); length of pectoral fins 1.5 — 1.9 (1.6); length of pelvic fins 1.6 — 1.8 (1.7); height of first dorsal fin 1.5 — 1.9 (1.6); height of second dorsal fin 2.4 — 2.8 (2.6); height of anal fin 2.6 — 3.2 (2.8); depth of caudal peduncle 3.4 — 3.8 (3.6); length of caudal peduncle 1.1 — 1.4 (1.3); length of barbels 1.4 — 1.8 (1.5); and length of axillary scale 3.9 — 4.6 (4.2), all in head length.

D VII + 9; A I,7: P16 — 17 (usually 16); LL 33 — 34 + 3; scales between dorsal fins 4; gill-rakers 18 — 19 (18) on lower limb; 6 — 9 (8) on upper limb.

Colour of fresh specimen: Back grey to olive, sides and belly white; yellow stripe from eye to upper base of caudal fin; a faint black rectangular blotch usually appears on the background of the stripe below mid first dorsal fin. Head dorsally dark grey; front of snout

yellow-brown; a few wavy yellow lines from upper area of opercle, around eye, to end of snout; black blotch on inner side of opercle. Dorsal fins with yellow tint; pectoral fins clear with yellow-red tint; pelvic and anal fins clear to white; caudal uniformly yellow.

Colour of live fish similar to that of fresh specimen. Blotches of carmine may appear on head or body when captured and may be seen on individuals at night.

Colour of preserved specimen: Body dusky dorsally, head and snout darker; lateral and ventral surfaces white to beige; remnants of yellow lateral stripe may be present; dorsal and caudal fins, white to beige, some rays and spines dusky; pelvic, pectoral and anal fins white to beige.

TAXONOMIC REMARKS: The name *flavolineatus* was considered by many authors to be a junior synonym of Forsskål's *auriflamma* (see explanation under *Parupeneus forsskali*).

BIOLOGICAL OBSERVATIONS: *M. flavolineatus* is a common goatfish in the Gulf of Aqaba. It usually occurs in sandy areas in aggregations of various sizes, sometimes composed of more than a thousand fish. Commercial catches by beach seines, trammel nets and traps in the Red Sea often include this goatfish (Al-Kholi, 1965; Ben-Tuvia, 1968). According to Klunzinger (1870) the fish is most common from the start of the spawning season in June and through July and August.

DISTRIBUTION: Indo-Pacific.

Mulloides vanicolensis (Valenciennes)

Figure 3

Upeneus vanicolensis Valenciennes, in Cuv. & Val., 1831 : 521 (Vanicoro Id., syntypes MNHN A. 3520 and A. 3521).

Mulloides ruber Klunzinger, 1870 : 743 (Red Sea)

Mulloides erythrinus Klunzinger, 1884 : 50 (new name for *M. ruber*).

MATERIAL: Measurements and counts from 13 specimens, 81 — 264 mm SL, all HUI numbers: 6935, 2 : 105 — 107 mm, Elat; 6936, 3 : 81 — 107 mm, Elat; 6937, 3 :

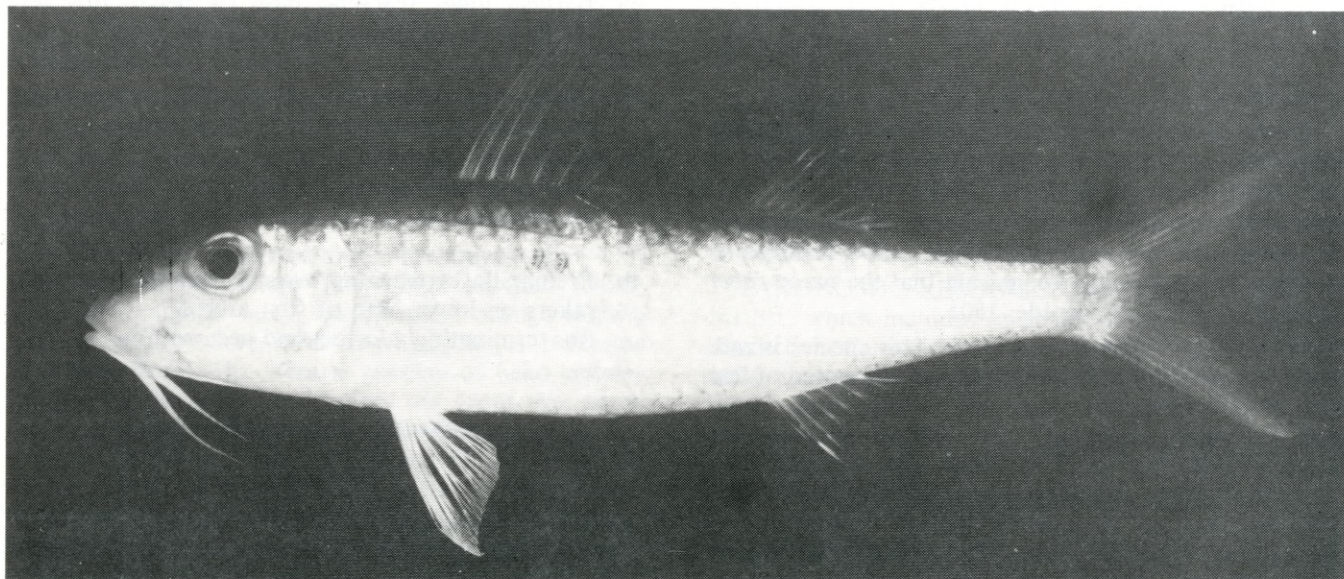


Figure 2. *Mulloides flavolineatus*, 117 mm SL, Gulf of Aqaba.

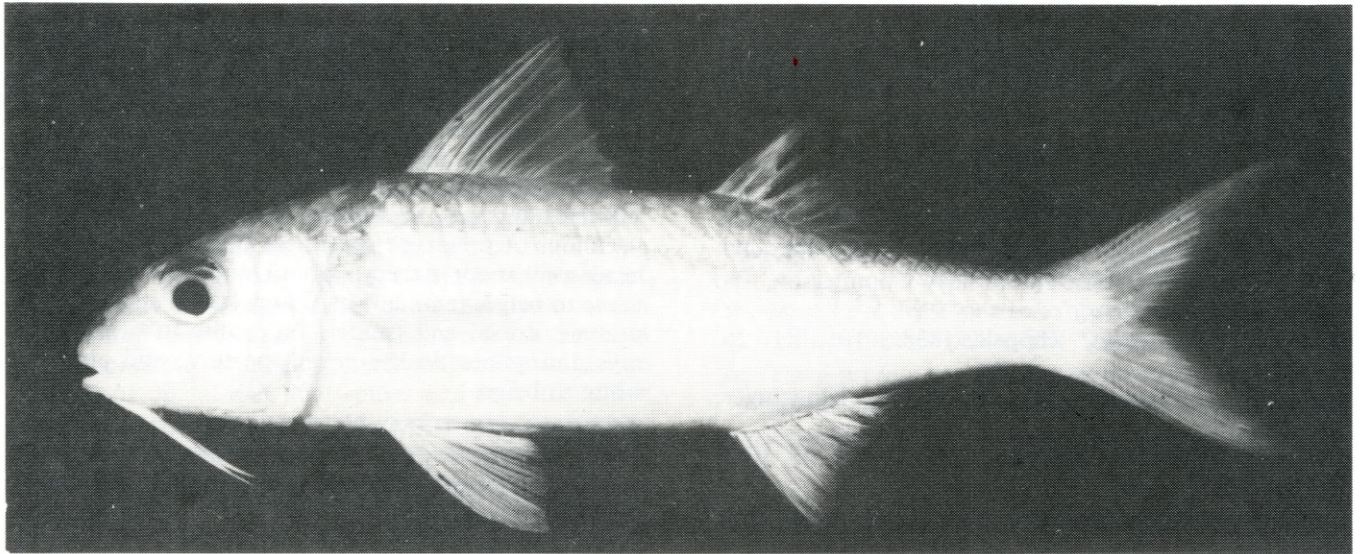


Figure 3. *Mulloides vanicolensis*, 160 mm SL, Mafia Is., Coast of Tanzania.

98 — 109 mm, Elat; 8314, 1 : 240 mm, Ras Muhammad; 10611, 1 : 210 mm, Nuweiba; 10628, 3 : 186 — 264 mm, Nuweiba.

DESCRIPTION: Body depth 3.5 — 4.1 (3.8), head length 3.3 — 3.4 (3.4) in SL. Snout length 2.3 — 2.8 (2.6); orbit diameter 2.8 — 4.0 (3.3); interorbital width 3.1 — 3.8 (3.5); length of pectoral fins 1.4 — 1.6 (1.5); length of pelvic fins 1.4 — 1.5 (1.5); height of first dorsal fin 1.4 — 1.6 (1.5); height of second dorsal fin 1.9 — 2.2. (2.0); height of anal fin 2.0 — 2.3 (2.1); depth of caudal peduncle 2.9 — 3.5 (3.2); length of caudal peduncle 1.2 — 1.3 (1.3); length of barbels 1.3 — 1.4 (1.4); length of axillary scale 4.1 — 4.9 (4.5), all in head length.

D VII + 9; A I,7; P 16 — 17; LL 33 — 34 + 3; scales between dorsal fins 4; gill rakers 21 — 23 on lower limb; 6 — 8 on upper limb.

Colour of fresh specimen: Body shape and colouration similar to *M. flavolineatus*; back red-orange to olive; sides and belly white with a carmine tint after death; orange yellow stripe from posterior edge of orbit to base of caudal fin; additional 2 — 3 parallel stripes occasionally visible. No black blotch under dorsal fin and none inside opercle. Head to tip of snout dusky red. Dorsal, pelvic, anal and caudal fins bright dusky-yellow with red tint; pectoral fins clear with carmine tint.

Colour of preserved specimen: Similar to *M. flavolineatus* but, as in fresh specimens, no dark blotch below first dorsal fin or on inner side of opercle.

TAXONOMIC REMARKS: Klunzinger (1870) described *Mulloides ruber* and later (Klunzinger, 1884) changed its name to *M. erythrinus*, recognising that the name *ruber* was preoccupied by Lacepède, 1801.

BIOLOGICAL OBSERVATIONS: This species is rare in the Red Sea. Schools were observed composed of less than 30 individuals.

DISTRIBUTION: Indo-Pacific

Genus *Parupeneus* Bleeker, 1863

Parupeneus Bleeker, 1863: 234 (type-species *Mullus bifasciatus* Lacepède, 1802 by subsequent designation of Jordan, 1919 : 322). Note: Although Jordan's

type designation was incorrect (as *Mullus bifasciatus* was not one of the four species originally included in *Parupeneus*) it is now validated by fiat of the International Commission on Zoological Nomenclature (Opinion 846, *Bull. Zool. Nomen.*, 25 (1): 14).

KEY TO THE RED SEA SPECIES OF *PARUPENEUS*

- 1a. Distinct black stripe along lateral line and a black spot on caudal peduncle 2
- 1b. No black stripe along lateral line and no black spot on caudal peduncle (with the exception of *P. rubescens* which often has a black saddle on caudal peduncle) 3
- 2a. Gill-rakers on lower limb of first arch 22 — 25; no black band on lower half of second dorsal fin *P. forsskali*
- 2b. Gill-rakers on lower limb of first arch 27 — 30; a black band on lower half of second dorsal fin *P. macronemus*
- 3a. Barbels long, reaching base of pelvic fins; eye diameter less than one-third of snout length *P. cyclostomus*
- 3b. Barbels not reaching base of pelvic fins; eye diameter much more than one-third of snout length 4
- 4a. Premaxilla tapering toward posterior end; gill-rakers on lower limb of first arch 19 — 21; pelvic fins terminating before end of pectoral fins *P. heptacanthus*
- 4b. Premaxilla broadening toward posterior end; gill-rakers on lower limb of first arch 22 — 24; pelvic fins terminating at or beyond pectoral fins *P. rubescens*

Parupeneus cyclostomus (Lacepède)

Figure 4

Mullus cyclostomus Lacepède, 1801 : 383, 404, 405, P1.14, Fig. 3 (based on description and drawing of Commerson, neotype MNHN A 5702, locality probably Mauritius [Bauchot et al., 1985]).

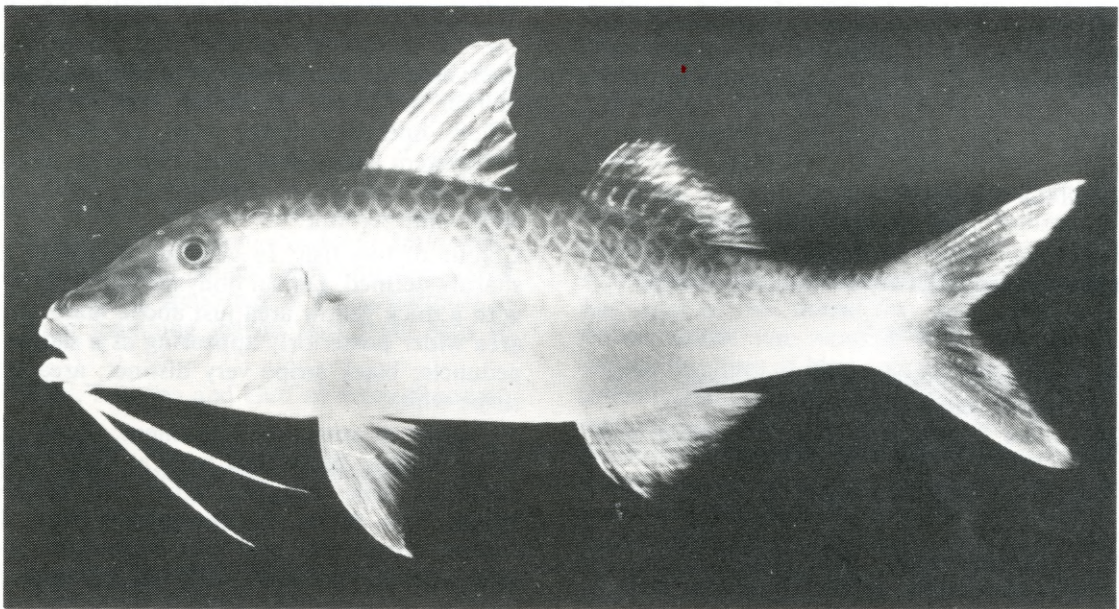


Figure 4. *Parupeneus cyclostomus*, 150 mm SL, Gulf of Aqaba.

Mullus chryserydros Lacepède, 1801 : 384, 406, 408 (Mauritius, based on description by Commerson).

Upeneus cyclostoma: Rüppell, 1838 : 101.

Parupeneus chryserythrus: Klunzinger, 1884 : 52.

MATERIAL: Measurements and counts from 10 specimens, 110 — 305 mm SL, all HUI numbers: 3680, 2 : 237 — 260 mm; 6920, 1 : 195 mm Taba; 6921, 1 : 190 mm, Elat; 6922, 1 : 130 mm, El Hamira (Gulf of Elat); 6923, 1 : 135 mm, Elat; 6924, 1 : 305 mm, Elat; 9020, 1 : 224 mm, Tiran I.; 9983, 1 : 110 mm, Eritrea; 10658, 1 : 248 mm, Nuweiba.

DESCRIPTION: Body depth 3.2 — 3.6 (3.4), head length 2.8 — 3.0 (2.9) in SL. Snout length 1.7 — 1.9 (1.8); orbit diameter 5.0 — 7.3 (6.0); interorbital width 4.1 — 4.5 (4.3); length of pectoral fin 1.7 — 1.9 (1.8); length of pelvic fin 1.6 — 1.8 (1.7); height of first dorsal fin 1.5 — 1.7 (1.6); height of second dorsal fin 2.6 — 3.2 (2.8); height of anal fin 2.6 — 3.0 (2.8); depth of caudal peduncle 2.8 — 3.1 (2.9); length of caudal peduncle 1.3 — 1.6 (1.5); length of barbels 1.0 — 1.2 (1.1); length of axillary scale 4.0 — 5.6 (4.5), all in head length.

D VIII + 9, A I, 7; P 15 — 16; scales between dorsal fins 2; LL 27 + 3; gill-rakers 22 — 26 on lower limb; 5 — 7 on upper limb.

Colour of fresh specimen: Three common colour phases (yellow, blue and an intermediate phase) can be distinguished.

1) Blue phase: back and body blue-grey to olive with some fish having yellow outer edges on their scales; laterally a lighter grey mixed with orange-yellow; ventrally yellow-white, faint yellow saddle just posterior to second dorsal fin. Ventral portion of head yellow-orange; bright blue lines radiate out from eye, some reaching snout; barbels proximally pink becoming distally bright yellow. First two spines of first dorsal fin dusky yellow, remaining spines clear to blue; membranes between spines tinted dusky red to bright yellow; second dorsal blue-black on lower half; upper half with yellow longitudinal lines alternating with equal sized clear areas; pectoral fins clear with a slight orange tint;

outer borders of pelvic fins dusky, rays clear, membranes between rays bright yellow; anterior border of anal fin may be dusky, rest of fin with yellow longitudinal lines alternating with thinner clear areas; caudal fin rays clear with yellow-orange tint, membranes between rays on outer border of fin light blue, brighter in more medial membranes; inner edge of caudal fin clear with yellow areas between fin rays.

2) Yellow phase: entire fish appears bright yellow, caudal peduncle and base of first dorsal fin appears brighter.

3) Intermediate phase: from snout to second dorsal fin light blue-grey with yellow tint, remaining area light yellow with bluish tint.

The different colour phases may be related to size of the fish and to habitat but not to sex. The yellow phase seems to occur more often in fish smaller than 18 cm; blue phase predominates in larger specimens. The intermediate phase, observed mostly during summer months may be a transitional one from yellow to blue.

P. cyclostomus caught in depth of 100 — 300 m off Elat were red.

Colour of live fish: Fish in the blue phase appear totally light blue-grey with a yellow saddle. The yellow and intermediate phases appear as described above.

Colour of preserved specimen: Head and body dorsally uniformly dusky becoming lighter laterally and ventrally; bases of both dorsal and caudal fins and outer margins of pelvic fins dusky.

TAXONOMIC REMARKS: Lacepède (1801 : 383) in his list, which includes scientific names, mentions two distinctive characters for *cyclostomus*: the lack of bands or spots, and the long barbels reaching the origin of the pelvic fins. Cuvier (in Cuv. and Val., 1829 : 472) referred to a specimen of “15 pouces” (406 mm) from Commerson’s collection. It is a half skin, without barbels and gill-rakers and difficult for full taxonomic comparisons. It was designated as neotype and redescribed by Bauchot et al. (1985). For further discussion of the available type material see Maugé and Guézé (1984).

BIOLOGICAL OBSERVATIONS: Individuals and small aggregations of up to eight fish can be observed on or near the coral reefs. Larger aggregations of 15 to 20 individuals are seen rarely. Juveniles 50 — 80 mm SL first appear on the reefs in the Elat area in the beginning of August.

DISTRIBUTION: Indo-Pacific.

Parupeneus forsskali (Fourmanoir and Guézé)

Figure 5

Pseudupeneus forsskali Fourmanoir and Guézé, 1976 : 45 (based on *Mullus auriflamma* Forsskål, 1775).

Mullus auriflamma Forsskål, 1775 : 30 (Jiddah, Red Sea; holotype ZMUC 49343).

Upeneus barberinus (non Lacepède): Rüppell, 1838 : 101.

MATERIAL: Measurements and counts from 10 specimens, 86 — 214 mm SL, all HUI numbers: 5289, 1 : 175 mm, Elat; 5636, 2 : 138 — 192 mm, A-Tur; 6925, 3 : 86 — 175 mm Elat; 6926, 2 : 190 and 190 mm, Elat; 8628, 1 : 195 mm, Elat; 9979, 1 : 214 mm, Elat.

DESCRIPTION: Body depth 3.4 — 3.8 (3.6), head length 2.7 — 3.2 (2.8) in SL. Snout length 1.7 — 2.1 (1.7); orbit diameter 4.2 — 5.6 (5.5); interorbital width 4.0 — 4.6 (4.4); length of pectoral fins 1.4 — 1.8 (1.7); length of pelvic fins 1.5 — 2.0 (1.6); height of first dorsal fin 1.4 — 2.1 (1.7); height of second dorsal fin 2.2 — 3.0 (2.7); height of anal fin 2.0 — 3.4 (2.7); depth of caudal peduncle 2.9 — 3.4 (3.2); length of caudal peduncle 1.3 — 1.6 (1.5); length of barbels 1.5 — 1.9 (1.6); length of axillary scale 4.4 — 4.7 (4.5), all in head length.

D VIII + 9; A I,7; P16; LL 27 + 3; scales between dorsal fins 2; gillrakers 22 — 25 on lower limb and 6 — 8 on upper limb.

Colour of fresh specimen: Back grey-yellow, sides and belly silverish; caudal peduncle dorso-laterally yellow; black stripe, its width less than diameter of eye, running from tip of snout through eye and along lateral line to below penultimate ray of second dorsal fin; black spot on each side of caudal peduncle with lateral line touching its lower edge. First dorsal fin similar to *P.*

macronemus, but not as black along anterior margin of fin; second dorsal fin clear with bright yellow, wavy lines; anal fin pattern similar to second dorsal fin; outer margin of caudal fin dusky, rest of fin with bright yellow lines alternating with thinner blue-white to transparent lines (these lines radiate out along fin rays); pectorals transparent with red tint; pelvics transparent with white red tint.

Colour of live fish: In general, all colour areas more sharply defined. Dorsal body surface grey to light olive with a thick yellow area just above black stripe; yellow area wider posteriorly appearing as a saddle on caudal peduncle; black stripe very distinct; area below black stripe white.

Colour of preserved specimens: Body above black stripe dusky, below tan with a slight dusky tint on posterior scale margins; stripe and peduncular spot black; first dorsal fin transparent with dusky tint; second dorsal and anal fins beige with dusky, wavy lines; pelvic, pectoral, and caudal fins tan; outer margins of caudal fin dusky.

TAXONOMIC REMARKS: Fourmanoir and Guézé (1976) provided a new name, *P. forsskali* for a goatfish described by Forsskål (1775) as *Mullus auriflamma*. Forsskål's name was suppressed (ICZN, 1968) following the application of Nielsen and Klauswitz (1965) on the grounds that "Forsskal's type specimen is identical or very closely related to *P. barberinus* Lacepède" and that the two names were confused in the Red Sea literature. Moreover, until the recent study of Forsskål's type specimen (Klauswitz and Nielsen, 1968; Randall, 1974) the name *auriflamma* of Forsskål was used by many authors (Klunzinger, 1870, 1884; Day, 1875; Weber and Beaufort, 1931; Fowler, 1933) as a senior synonym of *Mulloidies flavolineatus* (Lacepède). This identification was followed by practically all authors who reported *M. flavolineatus* from the Red Sea (for references see Dor and Ben-Tuvia, 1984).

A study of large numbers of Mullidae by the senior author in several museums (BM (NH), BPBM, HUI, MNHN, USNM) confirms that *P. barberinus* does not occur in the Red Sea, although it is widely distributed in the Indo-Pacific. No case is known of the two species occurring together (J.E. Randall, personal communication).

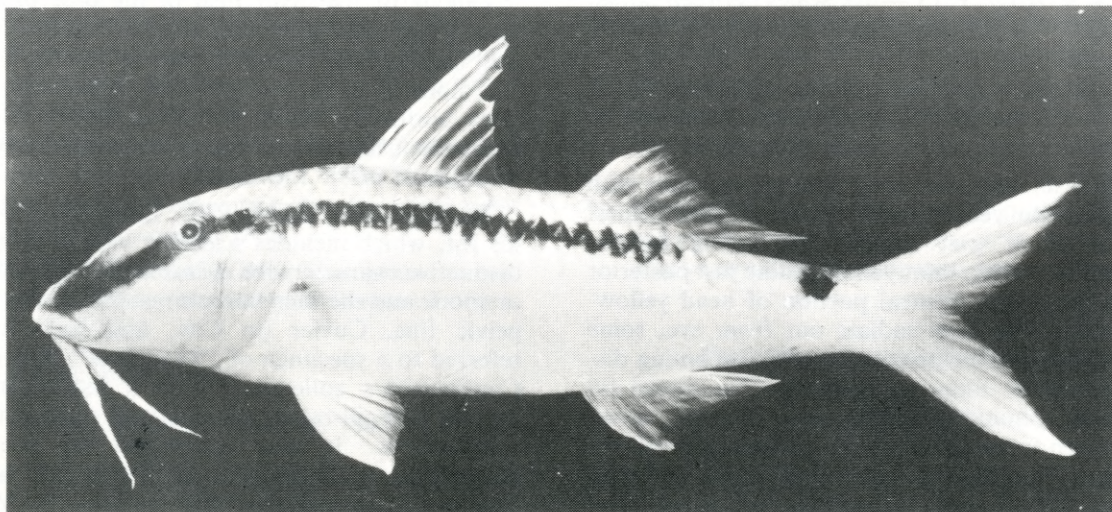


Figure 5. *Parupeneus forsskali*, 165 mm SL, Gulf of Aqaba.

BIOLOGICAL OBSERVATIONS: This species is the most abundant goatfish on and around coral reefs and coral heads in the Gulf of Aqaba. Individuals and aggregations of up to 40 individuals can be observed feeding throughout the day in sandy areas in front of and on top of reef flats. Examination of gonads indicates that spawning occurs from April to at least June. Juveniles of 30 — 50 mm appear in summer over sandy bottoms having extensive growths of *Halophila*. According to Wahbeh and Ajiad (1985) who studied the biology of this goatfish (reported as *P. barberinus*) in Aqaba, the main spawning season lasts from May to August.

DISTRIBUTION: Red Sea and Gulf of Aden (Randall, 1983).

Parupeneus heptacanthus (Lacepède)

Figure 6

Sciaena heptacantha Lacepède, 1802 : 308, 312, (no locality; holotype MNHN A.5438).

Upeneus cinnabarinus Cuvier, in Cuv. & Val., 1829 : 475, (Ceylon; holotype MNHN A.1696).

Upeneus pleurospilus Bleeker, 1853 : 110 (Amboina; syntypes RMNH 5743, 25005).

Parupeneus luteus (*non* Valenciennes): Klunzinger, 1884 : 52.

MATERIAL: Measurements and counts from 10 specimens, 127 — 220 mm SL, all HUI numbers: 6069, 1 : 208 mm, Elat; 6931, 2 : 135 — 170 mm, Elat; 6932, 1 : 160 mm, Elat; 6933, 1 : 190 mm, Taba (south of Elat); 6934, 1 : 205 mm, Elat; 8330, 1 : 220 mm, Nuweiba; 9981, 2 : 165 — 208 mm, Elat; 9991, 1 : 127 mm, Taba (south of Elat).

DESCRIPTION: Body depth 3.0 — 3.3 (3.1), head length 2.8 — 3.2 (3.0) in SL. Snout length (1.8 — 2.0 (1.9); orbit diameter 4.2 — 5.8 (5.0); interorbital width 3.8 — 4.3 (3.9); length of pectoral fin 1.3 — 1.5 (1.4); length of pelvic fin 1.6 — 1.8 (1.7); height of first dorsal fin 1.6 — 1.8 (1.7); height of second dorsal fin 2.6 — 3.2 (2.9); height of anal fin 2.9 — 3.6 (3.2); depth of caudal

peduncle 3.1 — 3.5 (3.2); length of caudal peduncle 1.2 — 1.5 (1.4); length of barbels 1.1 — 1.4 (1.2); length of axillary scale 3.1 — 3.3 (3.2), all in head length.

D VIII + 9; A I,7; P 16; LL 26 — 27 + 3 — 4; scales between dorsal fins 2; gill-rakers 19 — 22 (usually 20) on lower limb and 6 — 7 on upper limb.

Colour of fresh specimen: Back red, sides and belly white; a broad, faint yellow band follows lateral line; two lines of blue dots above lateral line extending from mid-snout to caudal fin; usually a dark spot below the last spine of first dorsal fin; faint yellow and red lines below lateral line running from opercle to base of caudal fin; lines of blue dots may also be present. Head dorsally reddish with purple-blue lines running below and through eyes; lips red anteriorly becoming lighter posteriorly, barbels uniformly carmine. Spines of first dorsal fin clear proximally becoming red distally; area between spines clear with a yellow tint; second dorsal fin with bright yellow wavy lines with reddish borders; anal fin of similar pattern; paired fins with faint yellow lines, like those of second dorsal and anal fins, at an angle to fin rays; areas between caudal fin rays alternately bright red or yellow and white.

Colour of live fish: Body white; broad horizontal yellow stripe from eye to caudal fin along lateral line; above stripe are thinner yellow stripes alternating with light grey-blue lines; blue lines present on snout; in some specimens dark spot on broad yellow stripe just posterior of first dorsal fin.

Colour of preserved specimens: Body uniformly light tan, in some cases with a carmine tint; two parallel lines of blue dots on body appear dusky.

TAXONOMIC REMARKS: *P. heptacanthus* has often been identified in the Red Sea under the junior synonyms *cinnabarinus* Cuvier and *pleurospilus* Bleeker. The name *luteus* Valenciennes has also been applied to this species, but it is a junior synonym of *cyclostomus* according to Bauchot et al. (1985).

Among all the species of *Parupeneus* examined in various museums by the senior author, only in *heptacanthus* are the teeth in upper jaw in large males

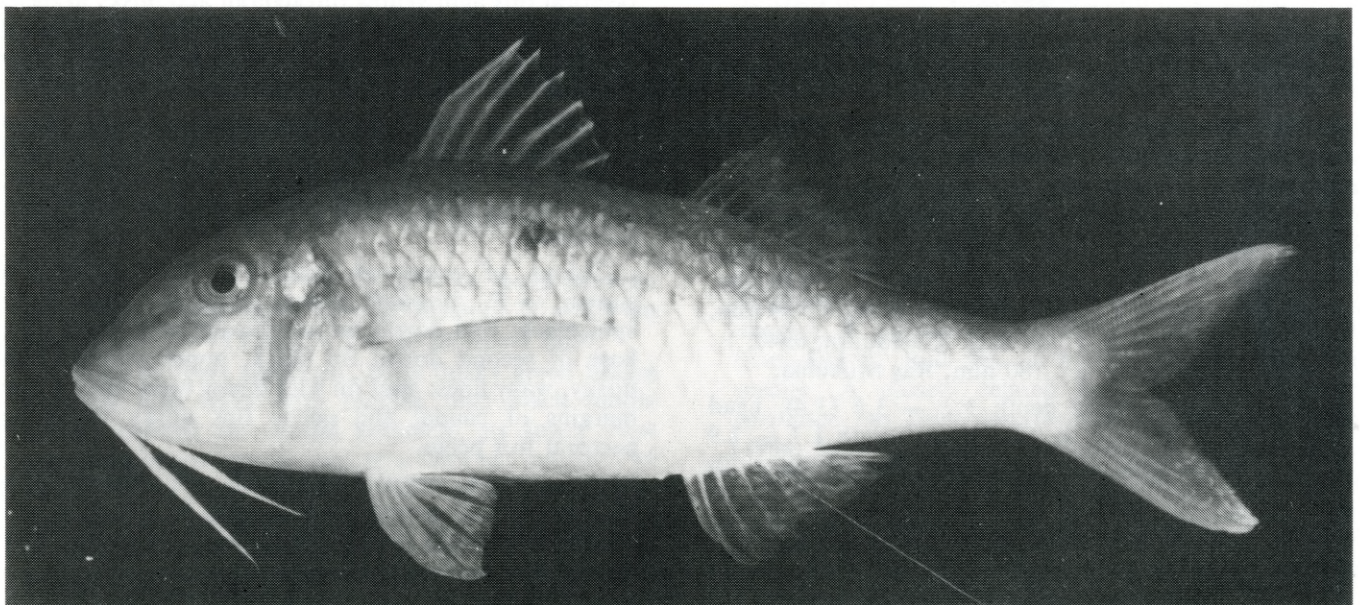


Figure 6. *Parupeneus heptacanthus*, 234 mm SL, Lord Howe Is.

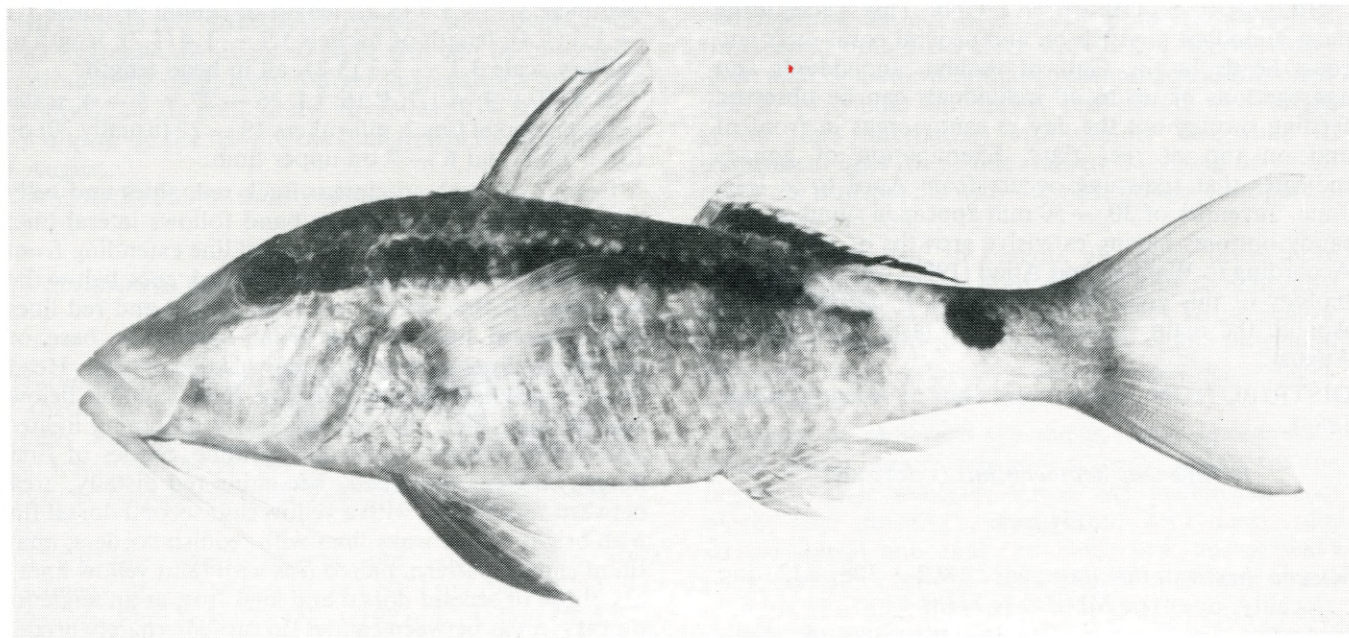


Figure 7. *Parupeneus macronemus*, 151 mm SL, Gulf of Aqaba.

partially visible when the mouth is closed; enlarged canines may occur, but in the regular row, and not recurved as in *Pseudupeneus*.

BIOLOGICAL OBSERVATIONS: This species has occasionally been observed feeding in shallow water with other goatfishes. Individuals and schools of up to ten fish have been observed. The relative abundance of this species in catches of deep water fish traps suggests a preference for deep water as was also observed by Klunzinger (1870). A specimen of 255 mm SL was caught in Elat at depth of 350 m. Abdul-Nabi (1980) reported a large specimen (364 mm TL weighing 631 g) from Aqaba under the name *pleuropilus*.

DISTRIBUTION: Red Sea and East Africa to the Central Pacific.

Parupeneus macronemus (Lacepède)

Figure 7

Mullus macronemus Lacepède, 1801 : 383, 404, 405, P1.13, Fig. 2 (based on description and drawing by Commerson, no locality).

Mullus lateristriga Cuvier, in Cuv. & Val., 1829 : 463 (no locality).

MATERIAL: Measurements and counts from 10 specimens, 51 — 197 mm SL, all HUI numbers: 5397, 1 : 197 mm, Elat; 6914, 2 : 160 — 185 mm, Elat; 8915 mm, 1 : 150 mm, Elat; 8916, 1 : 180 mm, E1-Hamira; 6917, 1 : 123 mm, Elat; 6918, 1 : 59 mm, off Solar Lake; 6919, 1 : 51 mm, E1-Hamira; 6940, 1 : 174 mm, Elat; 11123, 1 : 180 mm, Ras Mukebla.

DESCRIPTION: Body depth 3.2 — 3.6 (3.4), head length 2.8 — 3.2 (3.0) in SL. Snout length 1.7 — 1.9 (1.8); orbit diameter 4.7 — 5.9 (5.3); interorbital width 3.8 — 4.1 (3.9); length of pectoral fins 1.4 — 1.7 (1.5); length of pelvic fins 1.4 — 1.5 (1.4); height of first dorsal fin 1.4 — 1.7 (1.5); height of second dorsal fin, third ray 4.3 — 4.8 (4.5) and last ray 1.8 — 2.7 (2.0); height of anal fin, second ray 3.6 — 3.8 (3.7) and last ray 1.7 — 2.7 (2.0); depth of caudal peduncle 2.9 — 3.2

(3.0); length of caudal peduncle 1.3 — 1.7 (1.4); length of barbels 1.1 — 1.4 (1.2); length of axillary scale 3.3 — 4.2 (3.7), all in head length.

D VII + 9; A I,7; P 16; LL 27 + 3; scales between dorsal fins 2; gill rakers 27 — 30 (usually 28) on lower limb; 8 — 9 (usually 8) on upper limb.

Colour of fresh specimen: Back olive, sides and belly whitish with carmine or yellow tint; black stripe running from eye to below penultimate ray of second dorsal fin; black spot on caudal peduncle greater than or equal to eye diameter with lateral line running through it. Blue-white lines on snout, eye and forehead; first dorsal fin translucent, dusky black with yellow and red areas throughout, red areas concentrated along length of spines while yellow areas are between spines and at base of fin; base of second dorsal fin and last ray black; upper part with bright yellow wavy lines; anal fin with similar yellow lines; outer margins of caudal fin dusky; pectoral fins light yellow throughout and dusky at base; pelvic fins dusky with yellow-orange lines; lines on all fins run at angle to fin rays; barbels proximally dusky becoming whitish red with yellow tips.

Colour of live fish: Body grey to light green sometimes mottled olive or charcoal grey; ventral surface may also take on an additional carmine tint; black stripe, white saddle and peduncular black spot prominent.

Colour of preserved specimen: Body coloration similar to *P. forsskali*; lateral stripe and peduncular spot black; first dorsal fin transparent with dusky tint; base of second dorsal fin black, upper portion with dusky, wavy lines; anal fin with dusky wavy lines; outer margins of caudal and pelvic fins dusky to black; pectoral fins beige.

BIOLOGICAL OBSERVATIONS: *P. macronemus* often occurs in mixed schools with *P. forsskali* and occasionally with other goatfishes. Juveniles first appear over *Halophila* beds in August.

DISTRIBUTION: Red Sea and East Africa to Indonesia.

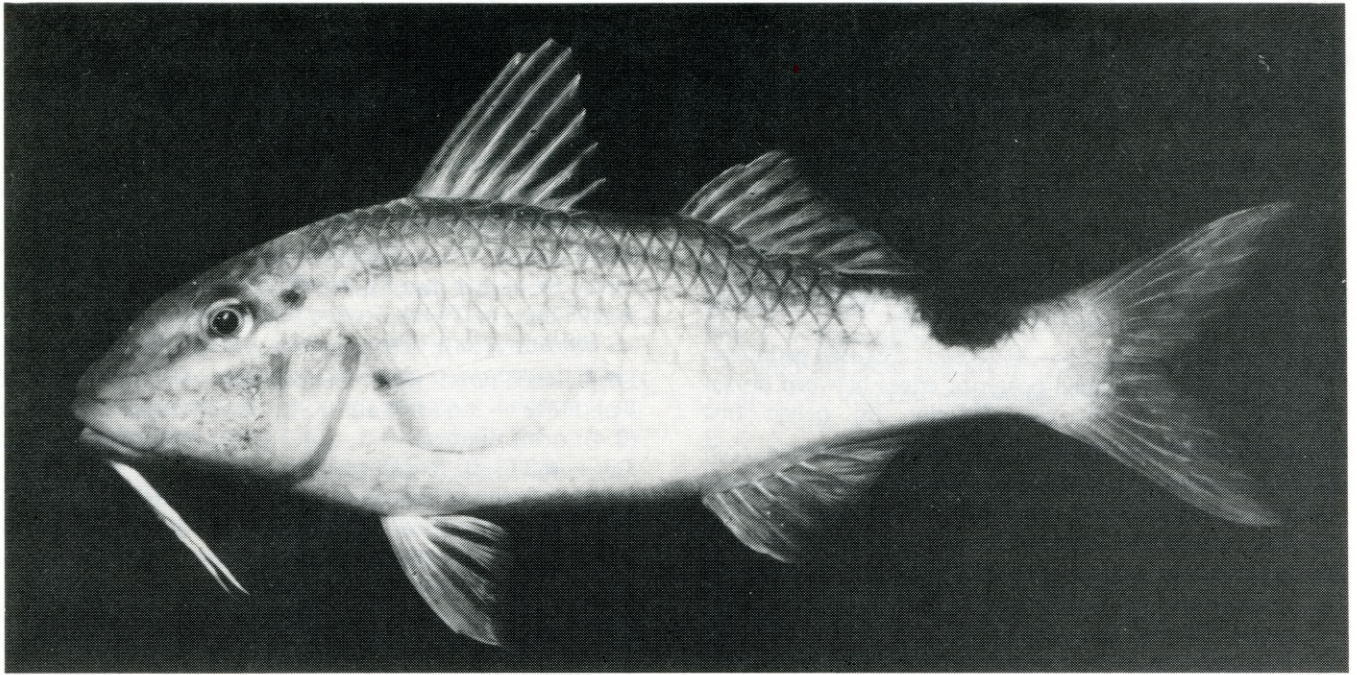


Figure 8. *Parupeneus rubescens*, 212 mm SL, Gulf of Aqaba.

Parupeneus rubescens (Lacepède)

Figure 8

Mullus rubescens Lacepède, 1801 : 384, 408 (based on description by Commerson; neotype MNHN 1965 — 58, from Réunion, designated by Maugé and Guézé, 1984).

Upeneus spilurus Bleeker, 1854 : 395, Nagasaki, Japan, holotype RMNH 1879.

Parupeneus notospilus Klunzinger, 1884 : 51, P1. 5, Fig. 3 (Quseir, Red Sea).

MATERIAL: Measurements and counts from 15 specimens, 80 — 197 mm SL, all HUI numbers: 5906, 1 : 91.5 mm, Elat; 6749, 1.197 mm, Dahab; 6938, 1 : 138 mm, Elat; 9976, 1 : 128 mm, Elat; 12455, 4 : 80 — 138 mm, Elat; 12456, 7 : 75 — 85 mm, Elat.

DESCRIPTION: Body depth 3.0 — 3.3 (3.2), head length 2.9 — 3.3 (3.0) in SL. Snout length 2.1 — 2.3 (2.2); orbit diameter 3.7 — 4.4 (4.0); interorbital width 3.6 — 4.1 (3.9); length of pectoral fins 1.3 — 1.6 (1.4); length of pelvic fins 1.4 — 1.6 (1.5); height of first dorsal fin 1.6 — 2.1 (1.8); height of second dorsal fin 2.3 — 2.6 (2.4); height of anal fin 2.3 — 2.5 (2.4); depth of caudal peduncle 2.7 — 3.0 (2.9); length of caudal peduncle 1.3 — 1.7 (1.4); barbels length 1.3 — 1.6 (1.5); length of axillary scale 3.5 — 3.9 (3.8), all in head length.

D VIII + 9; A I, 7 : P16; LL 27 + 3; scales between dorsal fins 2; gill-rakers 22 — 25 (usually 22 — 23) on lower limb; 5 — 8 (usually 5 — 6) on upper limb.

Colour of fresh specimen: Body dusky green fading ventrally into white with reddish tint; black saddle usually present on caudal peduncle, its lower edge extending below lateral line; area between insertion of second dorsal fin and black saddle lighter than dorsal body surface; indistinct longitudinal yellow lines, some of which run from snout to tail on a dusky to red background. Spines and rays of dorsal fins reddish with dusky yellow membranes; pectoral fins clear with orange-red tint; outer rays of pelvic fins orange-red,

inner rays becoming white; anterior rays of anal fin orange-red; posterior rays more yellowish; membranes between pelvic and anal fin rays yellow-orange; caudal fin rays clear, membranes between them tinted orange-red, dorsal and ventral edges orange-red and posterior edges yellow. Barbels bright yellow distally, with lighter yellow area proximally; lips reddish to dusky.

Colour of live fish: Body light green with reddish tint on belly; two distinct white parallel lines starting from snout; upper one extending through dorsal edge of eye to beyond insertion of second dorsal fin; lower one passing through lower edge of eye and terminating between two dorsal fins; a third more ventral and wider line may appear, running from mouth to below first dorsal fin; just posterior to second dorsal fin are a large white saddle followed by a black saddle. When sitting on bottom, fish becomes mottled, body appears blotched carmine, white and tan and longitudinal white lines usually disappear.

Colour of preserved specimen: Back and sides of body dusky, belly whitish; saddle on caudal peduncle dusky to black.

TAXONOMIC REMARKS: Lacepède's (1801) name *rubescens* is the oldest available for this species. Although no original type specimen or drawings are available, the reddish colour of the body and the dark spot on the dorsal part of the caudal peduncle mentioned by Lacepède leave little doubt about its identity. *P. notospilus* described by Klunzinger (1884) from Quseir, Red Sea, is a junior synonym of this species. A closely related species, *Parupeneus margaritatus*, has been described by Randall and Guézé (1984) from the Persian Gulf and Gulf of Oman.

BIOLOGICAL OBSERVATIONS: *P. rubescens* is relatively rare in the Red Sea. Individuals or aggregations of up to 35 fish have been observed in sandy areas at Elat feeding in mixed schools with *P. forsskali*, *P. macronemus* and *P. heptacanthus*.

DISTRIBUTION: Red Sea and Indian Ocean.

Upeneus Cuvier, in Cuv. & Val., 1829 : 448 (type-species *Mullus vittatus* Forsskål, 1775, by subsequent designation of Bleeker 1876: 333).

KEY TO SPECIES OF UPENEUS OF THE RED SEA AND EASTERN MEDITERRANEAN

- 1a. Lateral line scales 27 — 28 to end of caudal peduncle; 3 scales with round posterior edges between dorsal fins; pectoral fin rays usually 14; pelvic fins terminating beyond end of pectoral fins 2
- 1b. Lateral line scales 33 — 34 to end of caudal peduncle; 5 scales with rounded posterior edges between dorsal fins; pectoral fin rays usually 16; pelvic fins terminating before end of pectoral fins. 3
- 2a. Seven spines in first dorsal fin, the first one long; inner part of lower caudal lobe with a continuous dark band from base to tip. *asymmetricus*
- 2b. Eight spines in first dorsal fin, the first minute; no continuous dark band on inner part of lower lobe of caudal fin *tragula*
- 3a. Posterior edge of maxilla not reaching vertical at anterior margin of pupil; a bright yellow stripe as wide as pupil extending from posterior edge of eye to base of caudal fin (remnants often visible in preserved specimens) *moluccensis*
- 3b. Posterior edge of maxilla reaching or extending beyond vertical at anterior margin of pupil, almost to middle of eye; several narrow longitudinal yellow stripes on body (fresh specimens) 4
- 4a. No oblique bars on lobes of caudal fin . . . *sulphureus*
- 4b. Dark oblique bars on both lobes of caudal fin . . . 5
- 5a. Head length 27 — 30% SL, less than or equal to distance between origins of dorsal fins; axillary scale more than half pelvic fin length *vittatus*
- 5b. Head length 33 — 36% SL, greater than distance between origins of dorsal fins; axillary scale less than half of pelvic fin length *subvittatus*

Figure 9

Upeneus asymmetricus Lachner, 1954: 511, P1. 13, fig. B, (Philippines, holotype USNM 154659).

Upeneus bensasi (non Temminck & Schlegel): Norman, 1939 : 63.

Upeneus tragula (non Richardson): Tortonese, 1953 : 75.

MATERIAL: Measurements and counts from 12 specimens, 87 — 141 mm SL, all HUI numbers: 6281, 3 : 87 — 109 mm, off Wadi Tayiba (Gulf of Suez); 6540, 2 : 99 — 109 mm, Elat; 6548, 7 : 106 — 141, Elat.

DESCRIPTION: Body depth 4.0 — 4.7 (4.3); head length 3.2 — 3.6 (3.3) all in SL. Snout length 2.3 — 2.6 (2.4); orbit diameter 3.3 — 4.2 (3.6); interorbital width 3.3 — 4.2 (3.8); length of pectoral fins 1.4 — 1.7 (1.6); length of pelvic fins 1.4 — 1.8 (1.6); height of first dorsal fin 1.4 — 1.6 (1.5); height of second dorsal fin 1.8 — 2.4 (2.1); height of anal fin 1.9 to 2.8 (2.4); depth of caudal peduncle 2.8 — 3.9 (3.5); length of caudal peduncle 1.2 — 1.7 (1.5); barbels length 1.4 — 1.7 (1.5); length of axillary scale 2.9 — 4.1 (3.5), all in head length.

D VII + 9; A I,7; P 14; LL 27 — 28 + 2; scales between dorsal fins 3; gill-rakers 18 — 20 (usually 18) on lower limb and 6 — 8 on upper limb.

Colour of fresh specimen: Upper part of body (above lateral line) and of head, mottled brown grey; below lateral line white-pink fading into white ventrally, with red-brown spots. Cheeks white-pink without spots; barbels white. Dorsal fins clear with 3 — 4 rows of red-brown spots forming horizontal bars; pectoral fins clear with pinkish tint; pelvic fins white with pink brown blotches, rays of anal fin white with transparent membranes between them; upper lobe of caudal fin with 3 — 6 oblique red-brown bars; lower lobe with 5 — 8 bars, more prominent on outer side of lobe than on inner side; number of bars on both lobes increases with size (Golani, personal communication).

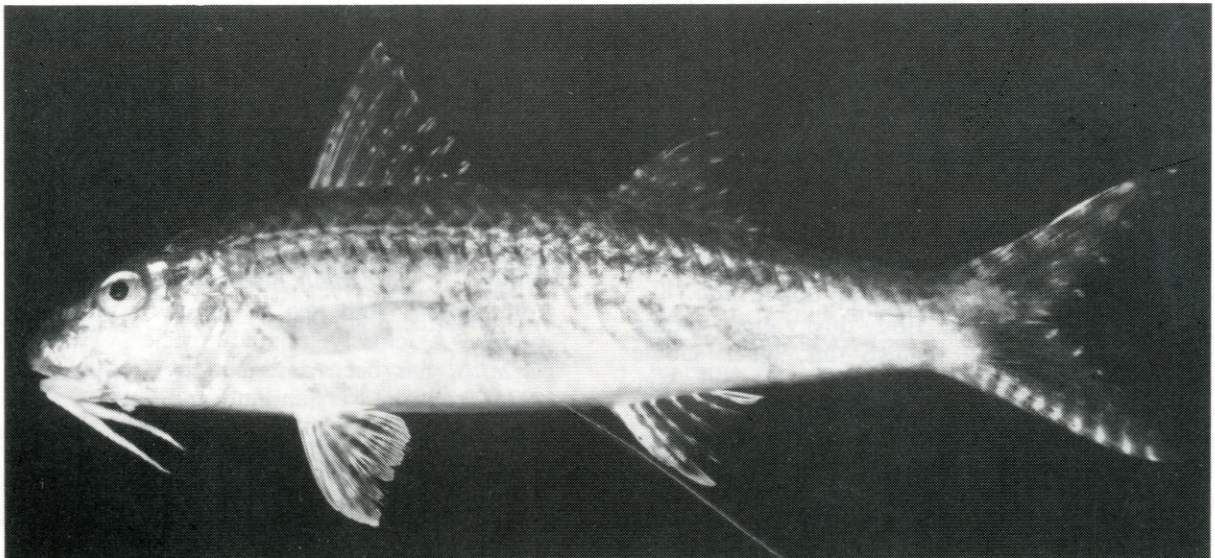


Figure 9. *Upeneus asymmetricus*, 114 mm SL, Gulf of Aqaba.

Colour of live fish: As described for fresh specimen but red-brown spots more prominent.

Colour of preserved specimen: Upper part of body dusky brown with mottled appearance; lower part lighter becoming white ventrally; on border of two sections more solid brown coloration appearing frequently as a longitudinal band continuing along inner part of lower caudal lobe; fins may retain bars depending upon the length and mode of preservation.

TAXONOMIC REMARKS: Preserved specimens of *U. asymmetricus* resemble *U. bensasi* (Temminck and Schlegel, 1843). In fresh specimens, the lower lobe of the caudal fin in *asymmetricus* has dark brown bars across at least half of the lobe, whilst in *bensasi* it is uniformly brown.

BIOLOGICAL OBSERVATIONS: *U. asymmetricus* occurs on sandy and muddy bottoms in coastal waters. Many specimens have been collected in shallow waters of the northern coast of Elat (Kissil, 1971). It is also fairly common on the trawling grounds of the Gulf of Suez (Ben-Tuvia and Grofit, 1973) and in the eastern Mediterranean along the coast of Israel and Lebanon (Ben-Tuvia, 1985; George and Athonassiou, 1966).

DISTRIBUTION: Red Sea, Philippine Islands and eastern Mediterranean.

Upeneus moluccensis (Bleeker)

Figure 10

Upeneus moluccensis Bleeker, 1855 : 409, (Amboina, holotype RMNH 5722).

Mulloides auriflamma (non Forsskål): Hass and Steinitz, 1947 : 28.

MATERIAL: Measurements and counts from 11 specimens, 71 — 144 mm SL, all HUI numbers: 4941, 5:71 — 119 mm, Ethiopia; 110 — 112 mm, Ethiopia; 8994, 2:97 — 98 mm, Ethiopia; 11348, 1:138 mm, Nuweiba (Gulf of Aqaba); 11393, 1:144 mm, Elat.

DESCRIPTION: Body depth 3.5 — 4.0 (3.8), head length 3.1 — 3.5 (3.2) in SL. Snout length 2.4 — 3.0

(2.7); orbit diameter 3.2 — 3.8 (3.5); interorbital width 3.5 — 4.3 (3.8); length of pectoral fins 1.2 — 1.6 (1.4); length of pelvic fins 1.5 — 1.8 (1.7); height of first dorsal fin 1.1 — 2.3 (1.4); height of second dorsal fin 1.7 — 2.5 (2.0); height of anal fin 1.9 — 3.0 (2.2); depth of caudal peduncle 2.6 — 3.5 (3.1); length of caudal peduncle 1.3 — 1.9 (1.5); barbels length 1.4 — 1.9 (1.7); length of axillary scale 2.8 — 3.3 (3.1), all in head length.

D VIII + 9; A I,7; P 16; LL 34 + 2 — 3; scales between dorsal fins 5; gill-rakers 18 — 21 on lower limb and 5 — 8 on upper limb.

Colour of fresh specimens: a lemon-yellow horizontal stripe from anterior margin of eye to base of caudal fin; body above stripe including snout and upper jaw with dark carmine tint; head and body below yellow stripe uniformly silver; barbels white. First dorsal fin with dusky margin and 3 horizontal dusky-yellow bars alternating with thicker clear to white areas; a second dorsal fin with 2 horizontal dusky brown bars alternating with clear to white areas; pectoral clear with a slight orange tint; base of pelvic and anal fins light yellow; rest of fin clear with yellow tint; upper lobe of caudal fin with 4 — 7 oblique dusky-brown bars alternating with whitish bars; proximally dusky-brown bar of upper lobe continues along inner edge of lower lobe; remainder of lower lobe with slight orange and white tint.

Colour of preserved specimen: Longitudinal stripe usually visible but its yellow colour faded; area above stripe takes on a tan colour, while below the stripe may remain silver; remnants of dusky bars on dorsal and upper lobe of caudal fins may be recognizable.

BIOLOGICAL OBSERVATIONS: *U. moluccensis* is abundant on the trawling grounds of the Gulf of Suez (Ben-Tuvia and Grofit, 1973) and along the Ethiopian Coast (Ben-Tuvia, 1968). It has been collected in the Gulf of Elat in deep waters, 300 — 500 m. Its abundance in the eastern Mediterranean fisheries is indicative of its success in colonizing the Mediterranean Levant via the Suez Canal.

DISTRIBUTION: Eastern Mediterranean, Red Sea and east coast of Africa to the western Pacific.

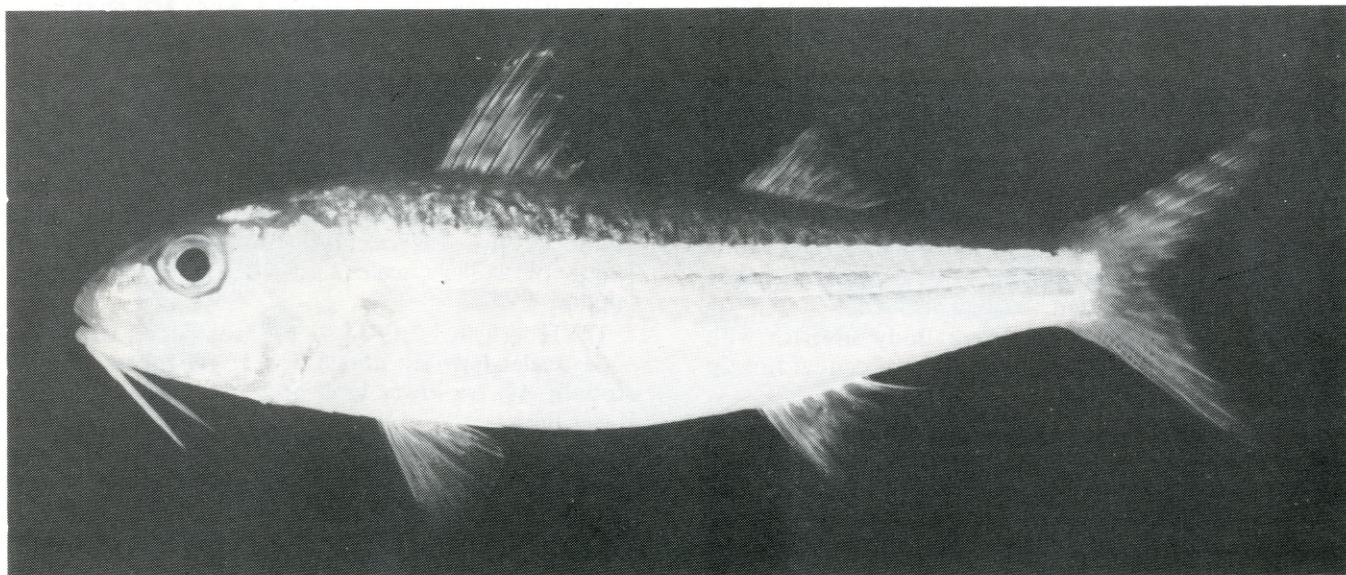


Figure 10. *Upeneus moluccensis*, 119 mm SL, Negros, Philippines.

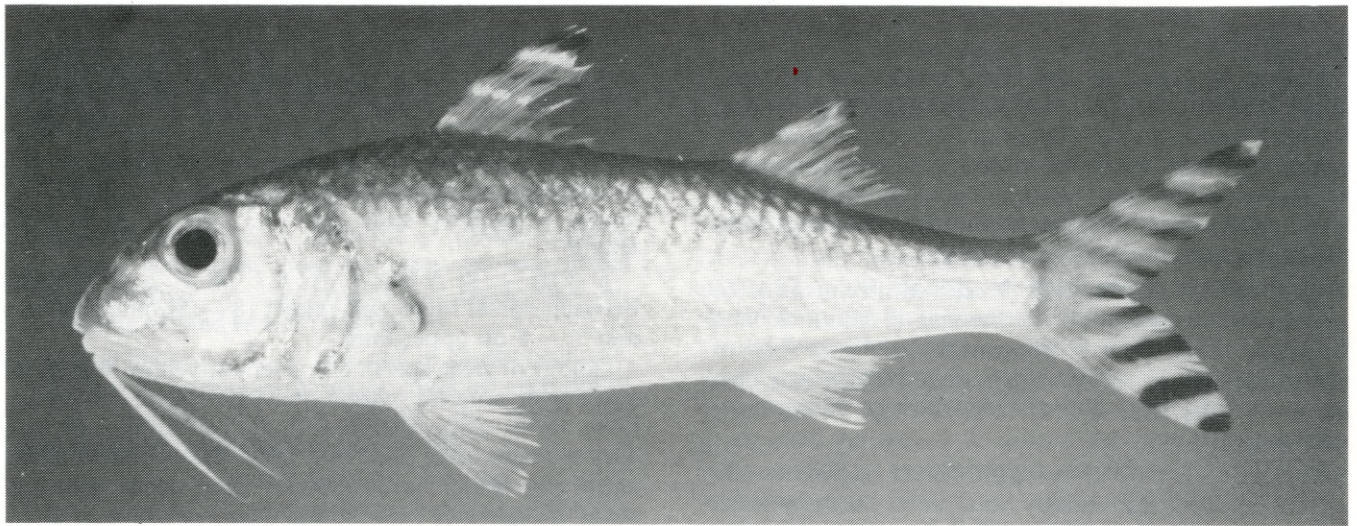


Figure 11. *Upeneus subvittatus*, 156 mm SL, Gulf of Aqaba.

Upeneus subvittatus (Temminck & Schlegel)

Figure 11

Mullus subvittatus Temminck and Schlegel, 1843 : 30 (Nagasaki, Japan).

MATERIAL: Measurements and counts from 11 specimens, 122 — 195 mm SL. HUI numbers: 10520, 2 : 120 — 152 mm, Nuweiba; 11394, 1 : 133 mm, Elat; 11670, 5 : 142 — 195 mm, Elat; 11671, 1 : 180 mm, Elat; 11760, 1 : 156 mm, Elat. Additional material; BPBM, 1 : 124 mm, Nuweiba.

DESCRIPTION: Body depth 3.4 — 4.2 (3.7), head length 2.8 — 3.0 (2.8), and predorsal 2.2 — 2.3 (2.3) in SL. Snout length 2.6 — 2.9 (2.8); orbit diameter 3.3 — 3.9 (3.7); interorbital width 3.9 — 4.4 (4.2); length of pectoral fins 1.3 — 1.6 (1.4); length of ventral fins 1.8 — 2.2 (2.0); height of first dorsal fin 1.8 — 2.1 (1.9); height of second dorsal fin 2.3 — 3.0 (2.6); height of anal fin 2.5 — 2.7 (2.6); depth of caudal peduncle 3.5 — 4.0 (3.7); length of caudal peduncle 1.4 — 1.8 (1.6); length of barbels 1.4 — 1.8 (1.5); length of axillary scale 4.1 — 4.7 (4.5), all in head length.

D VIII + 9; A I,7; P 15 — 16 (usually 16); LL 34 + 3 — 4; scales between dorsal fins 5; gill rakers 18 — 20 on lower limb and 6 — 7 (usually 7) on upper limb.

Colour of fresh specimens: Back pink, flank and belly silverish; 3 faint yellow longitudinal stripes along upper half of body. First dorsal fin with 3 horizontal bands on a white background; lower band light gold, middle one golden and black tint and upper one blackish; tip of fin white; second dorsal fin with 2 light orange horizontal bands; caudal fin with orange-black bands; one in the middle of the fin and 4 on each lobe; pectoral, pelvic and anal fins transparent; barbels whitish.

Colour of preserved specimen: Body silverish with crossbars clearly visible on both lobes of caudal fin; tip of first dorsal fin dusky.

TAXONOMIC REMARKS: *U. subvittatus* resembles *U. vittatus* but differs in having a more elongated body, larger head and eye, and shorter axillary scale. J.E. Randall (personal communication) compared a specimen of *subvittatus* from Japan, loaned by Mr Takeshi Yamakawa, with a specimen from the Red Sea and could not find any significant differences between them.

BIOLOGICAL OBSERVATION: This goatfish is occasionally caught in gill nets and trammel nets in the Gulf of Aqaba at depths of 200 — 600 m. Abdul-Nabi (1980) reported 2 specimens of large “*vittatus*” (213 — 235 mm) from Aqaba; these fish probably belong to *subvittatus*.

DISTRIBUTION: *U. subvittatus* is known from Japan, China and Philippines (Fowler, 1933) and now from the Gulf of Aqaba. There are no records of this species from the Indian Ocean (Thomas, 1969; Kumaran and Randall, 1984) perhaps because it occurs in depths greater than 200 m where collections are seldom made.

Upeneus sulphureus Cuvier

Figure 12

Upeneus sulphureus Cuvier, in Cuv. & Val., 1829 : 450 (Antjer, Straits of Sunda; syntypes MNHN A. 3458).

MATERIAL: Measurements and counts from 5 specimens, 37 — 117 mm SL, all HUI numbers: 5349 1 : 117 mm, Massawa; 11665, 3 : 63 — 83 mm, Massawa; Private collection number of J.M. Rose, 3/03181, 1 : 37 mm, Ras Bir, off Djibouti (11 59'N;43 28'E).

DESCRIPTION: Body depth 3.4 — 3.7 (3.5), head length 3.1 — 3.4 (3.3) in SL. Snout length 2.9 — 3.2 (3.0); orbit diameter 3.3 — 3.8 (3.5); interorbital width 3.7 — 3.8 (3.7); length of pectoral fins 1.1 — 1.5 (1.3); length of pelvic fins 1.5 — 1.6 (1.6); height of first dorsal fin 1.1 — 1.5 (1.4); height of second dorsal fin 1.9 — 2.3 (2.2); height of anal fin 1.8 — 2.2 (2.0); depth of caudal peduncle 2.5 — 2.7 (2.6); length of caudal peduncle 1.4 — 1.6 (1.5); barbels length 1.6 — 1.8 (1.7); length of axillary scale 2.4 — 2.9 (2.6), all in head length.

D VII + 9; A I,7; P 15 — 16 (usually 16); LL 34 + 3 — 4; scales between dorsal fins 5; gill rakers 19 — 20 (usually 19) on lower limb and 7 — 8 (usually 8) on lower limb.

Colour of fresh specimen: Back greenish red, body silverish; 2 yellow stripes along the body, upper, more prominent, from posterior edge of opercle, above LL, to upper side of caudal peduncle; lower stripe from axil of pectoral fin to lower side of caudal peduncle; 3 faint brown-grey longitudinal stripes on back; edge of belly

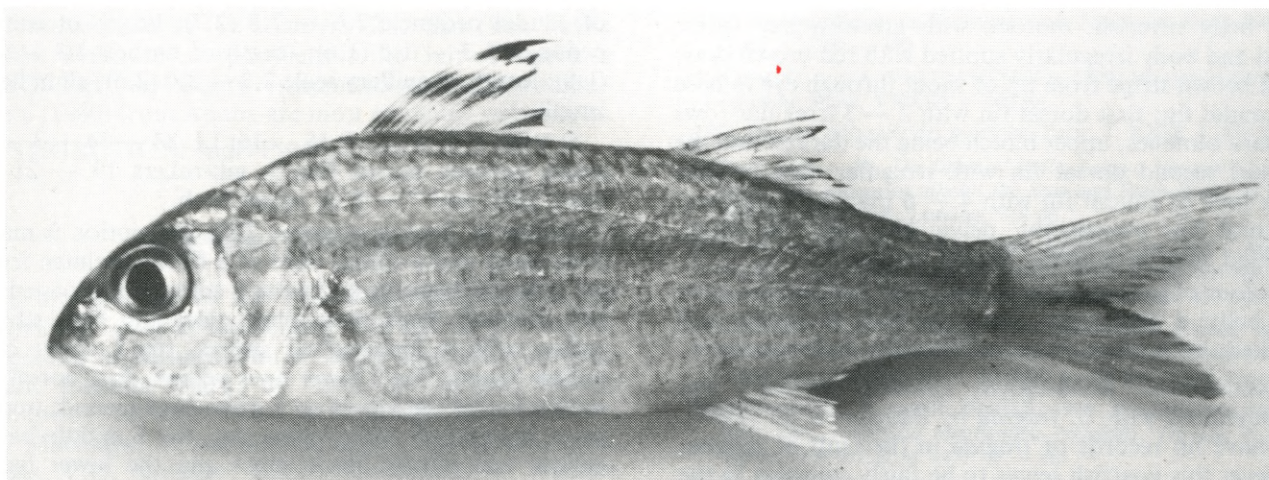


Figure 12. *Upeneus sulphureus*, 137 mm SL, Djibouti, Gulf of Aden.

yellowish. First dorsal fin with 3 dark olive-grey bands and black tip; second dorsal fin with 2 to 3 light olive-grey bands; pectoral fins transparent; pelvic, anal and caudal fins yellowish.

Colour of preserved specimen: Body silverish, dorsally darker; tip of first dorsal fin blackish.

TAXONOMIC REMARKS: In morphometric characters *U. sulphureus* closely resembles *U. vittatus*. The body colouration of the two species is very much alike except for the absence of blackish bars on the tail in *U. sulphureus*.

BIOLOGICAL OBSERVATIONS: Specimens of *U. sulphureus* were found on trawling grounds of the Eritrean Coast of Ethiopia in depths of 20 — 40 m. No specimens were found in collections from the Gulf of Aqaba and Gulf of Suez.

DISTRIBUTION: Red Sea and coast of East Africa to the western Pacific.

Upeneus tragula Richardson

Figure 13

Upeneus tragula Richardson, 1846 : 220 (Canton, syntype BM (NH) 1968.3.11.12).

Upeneus niebuhri Guézé, 1976 : 596 (Gulf of Suez, holotype MNHN 1977 — 174).

MATERIAL: Measurements and counts from 16 specimens, 58 — 140 mm SL, all HUI numbers: 5348, 8 : 69 — 112 mm Massawa; 5695, 3 : 58 — 65 mm (from a larger sample 12 : 45 — 65) A-Tur, Gulf of Suez; 6665, 2 : 96 — 140 mm (from a larger sample 52 : 65 — 140 mm), Ethiopia; 8957, 3 : 78 — 110 mm, Ethiopia.

DESCRIPTION: Body depth 3.6 — 4.1 (3.8), head length 3.1 — 3.4 (3.3) in SL. Snout length 2.2 — 3.0 (2.6); orbit diameter 3.3 — 4.5 (3.9); interorbital width 3.6 — 4.1 (3.8); length of pectoral fins 1.4 — 1.6 (1.5); length of pelvic fins 1.4 — 1.6 (1.5); height of first dorsal fin 1.3 — 1.7 (1.5); height of second dorsal fin 1.6 — 2.3 (1.9); height of anal fin 1.8 — 2.3 (2.0); depth of caudal peduncle 2.6 — 3.0 (2.8); length of caudal peduncle 1.1 — 1.5 (1.3); barbels length 1.6 — 1.9 (1.7); length of axillary scale 2.9 — 3.8 (3.3), all in head length.

D VIII + 9; A I, 7; P 14; LL 29 + 3; scales between dorsal fins 3; gillrakers 16 — 17 on lower limb and 6 — 7 (usually 6) on upper limb.

Colour of fresh specimen: This description is made from a colour slide of a fresh specimen from Bahrain loaned to us by J.E. Randall. Back greenish-grey, sides

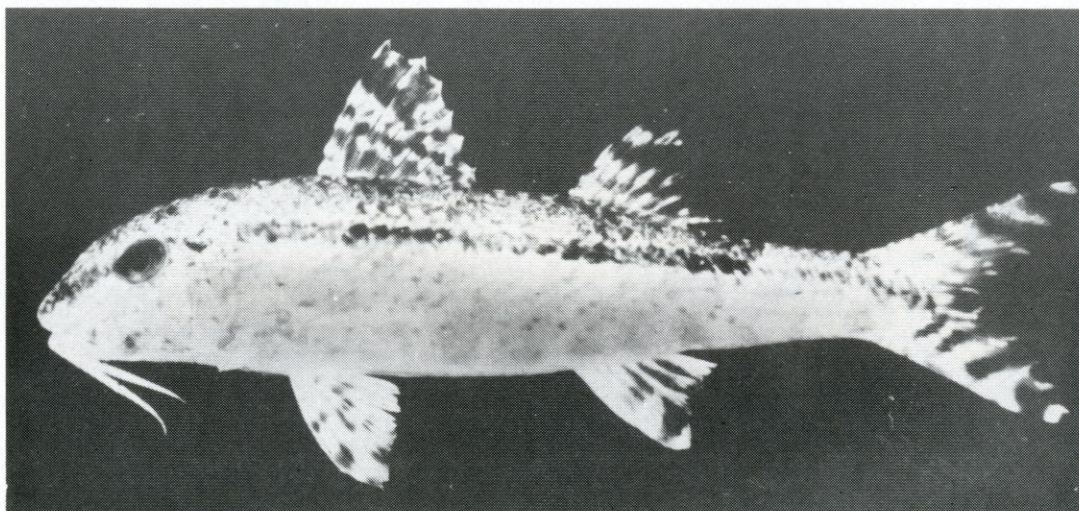


Figure 13. *Upeneus tragula*, 116 mm SL, Bahrain, Persian Gulf.

and belly silverish, mottled with greenish-grey spots; head and body irregularly spotted with red brown dots; dark brown stripe from tip of snout through eye to base of caudal fin; first dorsal fin with 2 — 3 irregular rows of dark blotches, upper blotch being the darkest and the widest; second dorsal fin with irregular dark stripes; each lobe of caudal fin with 4 — 6 blackish crossbars; pectoral fins transparent; pelvic and anal fins white, mottled with dark spots; barbels yellow.

Colour of preserved specimen: Back darker than sides and belly; a dark stripe along the body is usually well marked; both lobes of caudal fin with dark crossbars.

TAXONOMIC REMARKS: *Upeneus niebuhri* was synonymized with *U. tragula* by Bauchot et al. (1985). We have no records of *tragula* in the Gulf of Aqaba; however this goatfish seems to be fairly common in the southern Red Sea and in the Gulf of Suez. It has been reported in the Red Sea, probably correctly, by Saunders (1960) and by Bayoumi (1972).

DISTRIBUTION: Red Sea and East Africa to the western Pacific.

Upeneus vittatus (Forsskål)

Figure 14

Mullus vittatus Forsskål, 1775 : 31, (Jiddah, Red Sea; holotype ZMUC P — 49344)

MATERIAL: Measurements and counts from 10 specimens, 83 — 144 mm SL, all HUI numbers: 4944, 5 : 83 — 111 mm, Massawa; HUI 8555, 1 : 123 mm, Massawa; HUI 11664, 1 : 105 mm, Massawa; HUI 11669, 1 : 142 mm, Ethiopia; MNHN A 3465, 2 : 134 — 144 mm, Red Sea.

DESCRIPTION: Body depth 3.2 to 3.9 (3.5), head length 3.0 — 3.4 (3.2) in SL. Snout length 2.7 — 3.2 (2.9); orbit diameter 3.3 — 3.9 (3.6); interorbital width 3.7 — 4.1 (3.9); length of pectoral fins 1.2 — 1.5 (1.4); length of pelvic fins 1.5 — 1.8 (1.6); height of first dorsal fin 1.2 — 1.4 (1.4); height of second dorsal fin 2.0 — 2.6 (2.3); height of anal fin 2.0 — 2.4 (2.2); depth

of caudal peduncle 2.6 — 2.8 (2.7); length of caudal peduncle 1.3 — 1.8 (1.6); length of barbels 1.7 — 2.1 (1.8); length of axillary scale 2.3 — 3.0 (2.6), all in head length.

D VIII + 9; A I,7; P 15 — 16; LL 33 — 34 + 3 — 4; scales between dorsal fins 5; gill-rakers 19 — 21 on lower limb and 7 — 8 on upper limb.

Colour of fresh specimens: This description is made from notes and a colour slide of a fresh specimen from the coast of Ethiopia and from a colour slide loaned by J.E. Randall. Back silver pink, sides and belly silver-yellow with 4 longitudinal stripes, the 2 upper ones yellow-brown, the 2 lower ones yellow; first dorsal fin with 4 horizontal bands on a white background; uppermost band black with yellow tint, the 2 middle bands yellow with dusky black edges and the lower band, which may be incomplete, yellow with dusky black edges; second dorsal fin with 3 yellow bands, lowest being incomplete; lobes of caudal fin with yellow bars having dusky black edges, 4 to 6 on upper lobe and 3 to 4 on lower lobe; pectoral fins colourless and transparent; ventral and anal fins yellow at bases, transparent and colourless at free edges, barbels whitish.

Colour of preserved specimen: Body uniformly cream coloured except for darker line remaining along the mid line of the body from head to tail; dusky bands on dorsal fins and especially on caudal fin may remain; pectoral and ventral fins opaque to cream.

TAXONOMIC REMARKS: Klauswitz and Nielsen (1965) found that the supposed type specimen of *vittatus* is evidently a fish belonging to the genus *Mulloidis*. As pointed out by Randall (1974), the description of *Mullus vittatus* by Forsskål leaves no doubt that it refers to the Indo-Pacific species characterized by yellow longitudinal lines and oblique dark bands on both lobes of caudal fin. We agree with Randall's conclusion that the dried specimen marked as the type of *U. vittatus* "has been mislabelled and thus has no nomenclatorial significance".

BIOLOGICAL OBSERVATIONS: *U. vittatus* is known from small numbers taken in trawl catches with

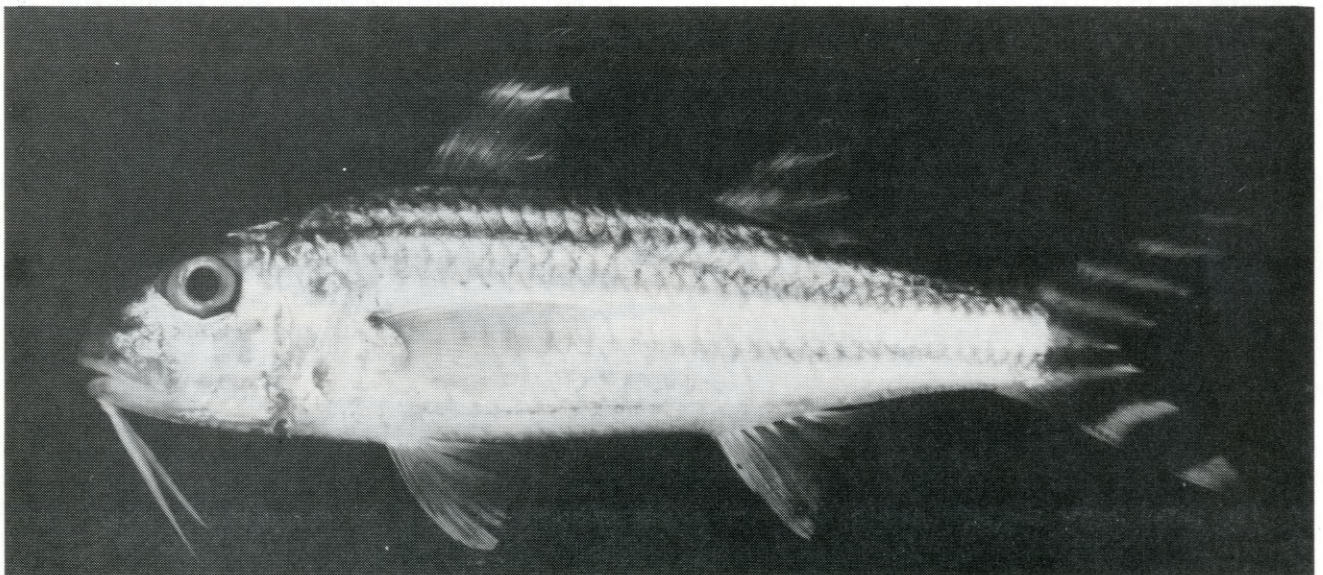


Figure 14. *Upeneus vittatus*, 151 mm SL, Moorea, Society Is.

U. moluccensis in the southern Red Sea (Ben-Tuvia, 1968). We found no specimens in the Gulf of Aqaba or the Gulf of Suez. The two specimens reported by Abdul-Nabi (1980) from Aqaba are most probably *subvittatus*.

DISTRIBUTION: Indo-Pacific.

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