ANATIROSTRUM PROFUNDORUM: A RARE DEEP-WATER GOBIID SPECIES FROM THE CASPIAN SEA

by

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ABSTRACT. – *Anatirostrum profundorum*, the duck-bill goby, a rare deep-water gobiid fish, is reported for the Southern Caspian Sea, Iran. Four females, dredged in 45-80 m depth reveal morphological features which allow a more detailed description of the lateral line system, squamation (tuberculation), osteology (in part) and meristic characters. Important diagnostic features used for the description of the species and the genus, such as interorbital rows of sensory papillae and bony tubercles on the head and body, differ from the original description and make a redescription and discussion of the generic status of *A. profundorum* necessary.

RÉSUMÉ. – *Anatirostrum profundorum*: une espèce rare de Gobiidae de profondeur de la Mer Caspienne.

Anatirostrum profundorum, le gobie à bec de canard, espèce rare de profondeur, est présente dans le sud de la Mer Caspienne (Iran). Quatre femelles ont été capturées à la drague par 45-80 m de profondeur. Leurs caractères morphologiques ont permis une meilleure description du système latéral, des tubercules osseux, de l'ostéologie (en partie) et des caractères méristiques. Des caractères importants utilisés dans la diagnose des espèces et du genre, comme les rangées interorbitaires de papilles sensorielles et les tubercules osseux de la tête et du corps, étant différents de ceux qui sont définis dans la description originale, une nouvelle description d'*Anatirostrum profundorum* est donnée et son statut générique discuté.

Key words. – Gobiidae - *Anatirostrum profundorum* - Caspian Sea - Iran - Lateral line system - Postcranial skeleton.

The majority of marine gobiid fishes inhabit littoral waters and they are rarely found below 150 m. Only a few genera are reported as secondary deep-water forms and little is known about them (Andriyashev, 1953; Miller, 1988).

In the landlocked Caspian Sea, the endemic duck-bill goby (*Anatirostrum profundorum* (Berg, 1927)) and a few species of the close related genus *Benthophilus* (*B. leptorhynchus* Kessler, 1877 and *B. grimmi* Kessler, 1877; compiled from Berg, 1949; Ragimov, 1977, 1978, 1982) are known to occur in depths distinctly below 100 m. With a recorded depth of 294 m, *A. profundorum*, reaches waters rarely occupied by any other gobiid. This species is only found by chance and few captures have been recorded.

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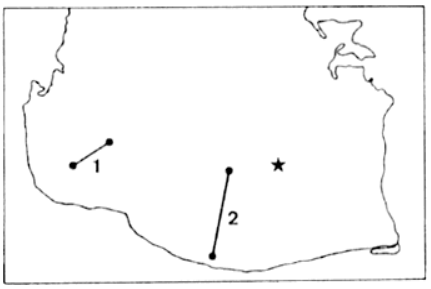

Fig. 1. Distribution of *Anatirostrum profundorum* in the Southern Caspian Sea. **1**: Collection site off Astara, 38°00'N, 49°30'E to 38°20'N, 50°00'E, Iran. **2**: Visual observation, off Nowshahr, 36°47'N, 51°25'E to 37°55'N, 51°40'E, Iran. Star: Type-locality, 37°58'N, 52°22'E, Turkmenistan. Additional records off Azerbaijan and off Turkmenistan («…near eastern and western coast of Southern Caspian Sea.» Ragimov (1985)) are not considered.

Anatirostrum profundorum is to date known only from two descriptions; the original description, as *Benthophilus profundorum* by Berg (1927), which is based on juvenile specimens, and from ten adult specimens described by Ragimov (1985). Most information which we have for the duck-bill goby, even the description of the genus *Anatirostrum* Iljin, 1930, is based on Berg's original text and figures; no record of this goby is reported since 1985. Ragimov (1985) realized that Berg (1927) based his description on juvenile specimens only and gave morphometric data for adult specimens, their coloration, and counts of spines and rays of the dorsal and anal fins. Otherwise he followed Berg (1927, 1949) and Iljin (1930), especially in their interpretation of the lateral line system and the covering of spiny tubercles. Both characters were important for establishing the new species and later also the new genus; but the data on these characters are partly based on erroneous interpretations and omissions, very likely due to the small size of the type specimens and of their condition after being taken by a dredge from nearly 300 m.

Additional specimens from the Southern Caspian Sea (Iran) (Fig. 1) collected by two of us (A.A., M.N.) in comparison with a part of the type series enable a more detailed description of this rare gobiid fish from deep waters.

MATERIAL, METHODS AND ABBREVIATIONS

The Iranian specimens were collected in the southwest Caspian Sea off the town of Astara between 38°00'N, 49°30'E and 38°20'N, 50°00'E on two successive days, the 20-21 February 1997 at 20:25 and 20:00 respectively. Further details on materials are given in the species description and in Appendices 1 and 2.

In the description of the lateral line system we generally follow Sanzo (1911) and Miller (1986), but in the nomenclature of the interorbital sensory papillae rows **v** and **w** we follow Iljin (1930). We use the system based on Sanzo (1911) with some modifications primarily for the following reasons: (1) since Berg's and Iljin's fundamental studies on Ponto-Caspian fishes this system has been widely used; (2) species of the "benthophiline" gobies (*sensu* Beling and Iljin, 1927; Iljin, 1930) differ in some aspects of the lateral line system from those of characteristic Atlantic-Mediterranean gobiids on which Sanzo based his nomenclature; (3) based on a single and rare deep-water species only, it seems to be inappropriate to introduce the recent system developed by Wongrat and Miller (1991). Nevertheless these latter authors demonstrate that their system and nomenclature of the sensory papillae is widely useable within gobiid fishes and our data has also been interpreted following their system (see Appendix 2). The pterygiophore formula follows Birdsong *et al.* (1988); pterygiophores that support no spine or finray

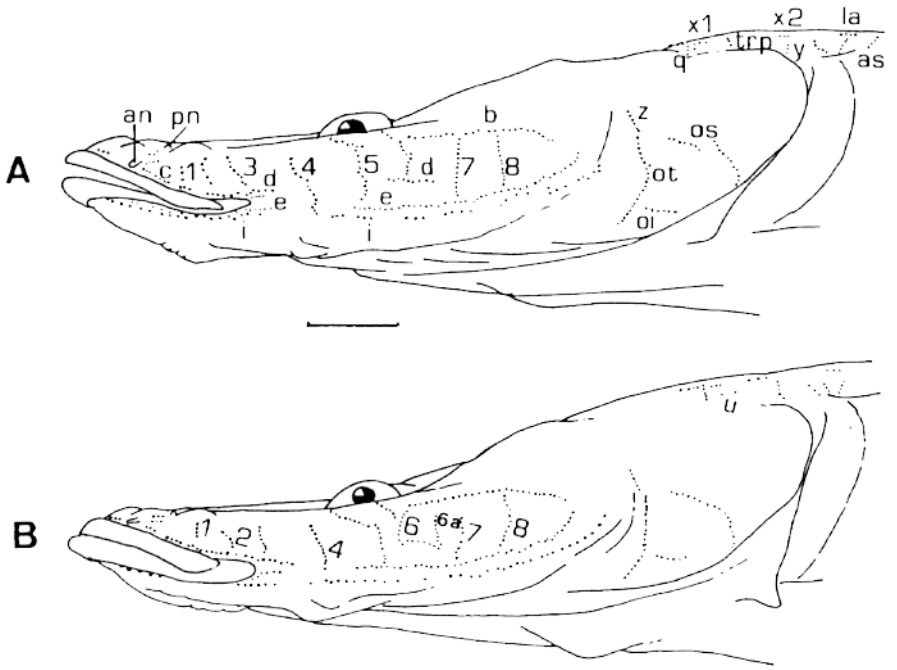

Fig. 2. *Anatirostrum profundorum*. Lateral line system of the head in lateral view. **A**: CMNFI 1999-0023, female, 79.1+17.4 mm. **B**: CMNFI 1999-0023, female, 76.6+17.5 mm; atypical nine transverse suborbital series of sensory papillae (explanation in text). All: Iran, Southwest Caspian Sea, off Astara, 20-21 February 1997. an, pn: anterior and posterior nostrils. Scale bar = 2 mm.

are indicated by superscript asterisk. Lengths of specimens are given as standard length and caudal fin length.

A, anal fin; C, caudal fin; d, damaged; CVT, caudal vertebra; D1, D2, first and second dorsal fins; P, pectoral fin; PT, pterygiophores; V, pelvic disc; VT, vertebrae.

Institutions

CMNFI and NMC, Canadian Museum of Nature, Ottawa; CAS, California Academy of Sciences, San Francisco; ZISP, Zoological Institute, St. Petersburg.

ANATIROSTRUM ILJIN, 1930

Anatirostrum Iljin, 1930: 48 (type-species: *Benthophilus profundorum* Berg, 1927).

Body elongate, somewhat compressed posteriorly (Fig. 4B); head elongated, two-fifths of standard length, depressed; snout elongated and duck-bill shaped; eyes small, oval shaped, longer than high; interorbital wide, three-quarters to four fifths of eye diameter. First dorsal fin with four spines; dorsal fins separated by wide interdorsal space; caudal fin long, with rounded rare margin, longer than pectoral fin; pectoral fin with upper rays within membrane; pelvic disc truncate to slightly emarginate, short; pelvic anterior

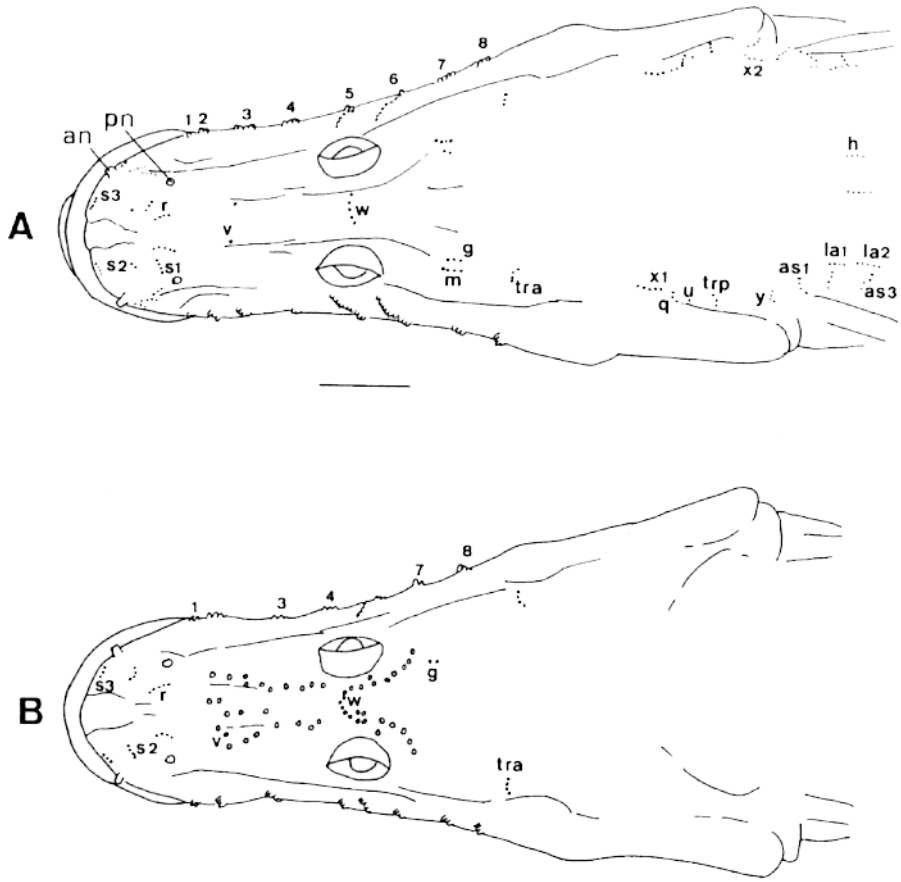

Fig. 3. *Natirostrum profundorum*. Lateral line system of the head in dorsal view. **A**: CMNFI 1999-0023, female, 79.1+17.4 mm. **B**: CMNFI 1999-0023, female, 76.1+16.4 mm; series of small circles = bony platelets (explanation in text); interorbital sensory papillae row **v** (represented by a single papilla only) on right side not found. All: Iran, Southwest Caspian Sea, off Astara, 20-21 February 1997. an, pn: anterior and posterior nostril. Scale bar = 2 mm.

membrane well developed. Scales absent, but not naked; head on snout, nape and dorsal parts of opercle and cheek, dorsal part of body and ventral part from anus to caudal fin base covered with small spinulose granules and platelets (females), extending on caudal fin base in juveniles; mouth horizontal; jaws of equal length or lower jaw slightly projecting; posterior angle well in advance of anterior margin of eye; upper lip width more or less uniform; chin lacking folds, processes or barbels; cheek flaps behind angle of jaws absent; teeth in jaws caniniform; anterior nostril tubular, over upper lip, lacking process from rim; posterior nostril distinctly in front of eye; distance between tip of snout (or mandibular symphysis) and posterior nostril shorter than distance from latter to anterior margin of orbit; branchiostegal membrane not free from isthmus, broadly attached ventral to pectoral fin origins.

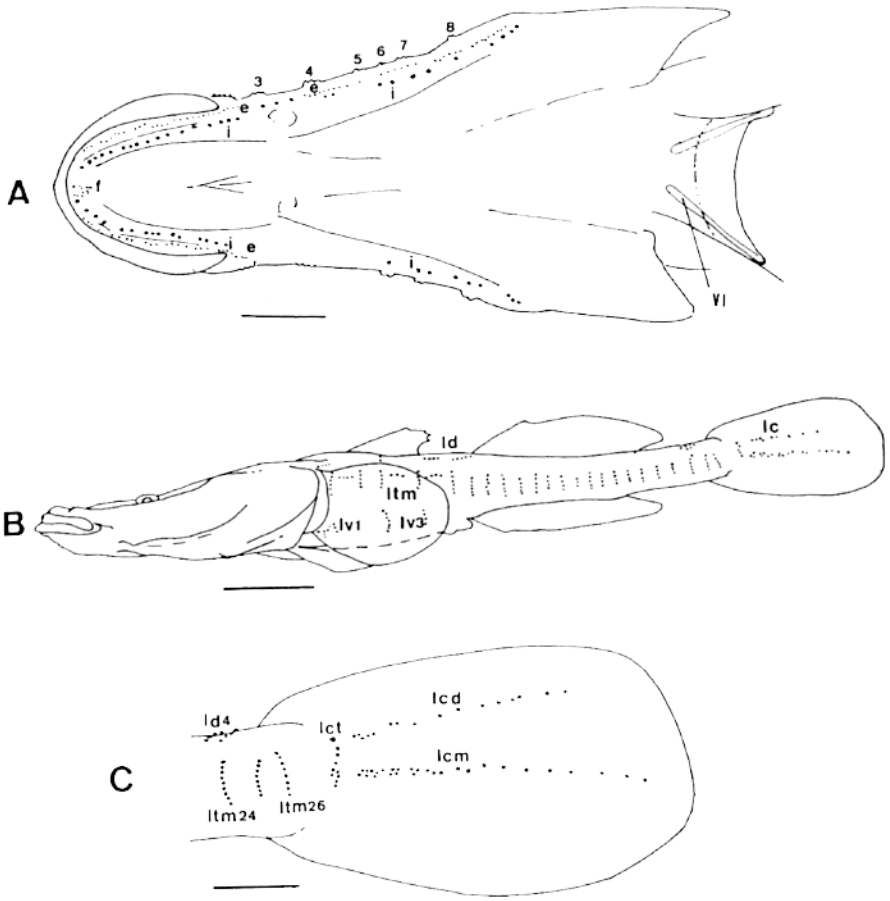

Fig. 4. *Anatirostrum profundorum*. Lateral line system. **A**: of the head in ventral view, CMNFI 1999-0023, female, 76.1+18.1 mm, VI: spine of ventral disc; scale bar = 2.0 mm; **B**: of the trunk in lateral view, CMNFI 1999-0023, female, 76.1 + 18.1 mm; scale bar = 10 mm; **C**: of the caudal fin (explanation in text); scale bar = 2.0 mm. All: Iran, Southwest Caspian Sea, off Astara, 20-21 February 1997.

Lateral line system (Figs 2-4) represented by sensory papillae (free neuromasts); head lateral line canals absent; longitudinal interorbital series **p** and postorbital occipital series **po** absent; median preorbital and interorbital series with mostly six transverse rows (**s**, **r**, **v**, **w**), **v** represented by a single papilla only, well in advance of the transverse interorbital row **w**; suborbital papillae in eight transverse rows, with six before and two below longitudinal suborbital row **b**; row **b** long, reaching near or to rear margin of eye; suborbital series **d** divided in two parts; body with three series of sensory papillae, dorsal series **ld** short with most anterior row transverse, but more posterior longitudinal; series of caudal fin with two longitudinal rows, a dorsal and a midline only.

Skeleton (Figs 5A, 6A); vertebral mode 29, including urostyle; dorsal pterygiophore formula 3-2211*01*1*; one pterygiophore before first haemal spine; pterygio-

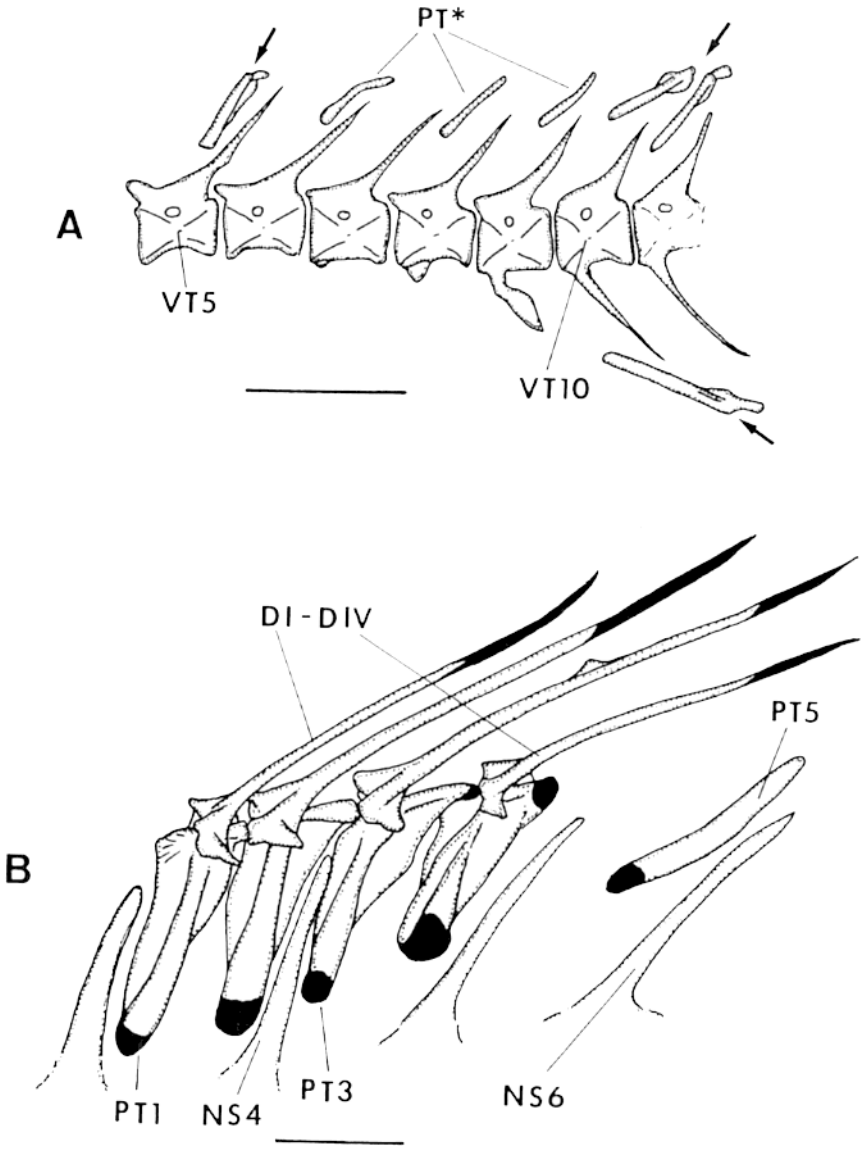

Fig. 5. **A**: Anterior vertebrae and pterygiophores of median fins of *Anatirostrum profundorum* (from X-ray), CMNFI 1999-0023, female, 76.1+18.1 mm, Iran, Southwest Caspian Sea, off Astara, 20-21 February 1997; PT*: three pterygiophores which support no spine or finray between first and second dorsal fins; arrows indicate position of last spine of the first dorsal, spine of second dorsal and spine of anal fins; VT10: first caudal vertebra; scale bar = 4 mm. **B**: Elements of first dorsal fin in *Benthophilus stellatus*, CAS 52847, male, 51.3+10.4 mm, Romania, Danube river drainage, Lake Crapina, 3 Dec. 1968; DI-DIV: spines of first dorsal fin; PT5: fifth pterygiophore and first supporting no spine or fin ray; NS: neural spine; cartilage blackened; scale bar = 1 mm.

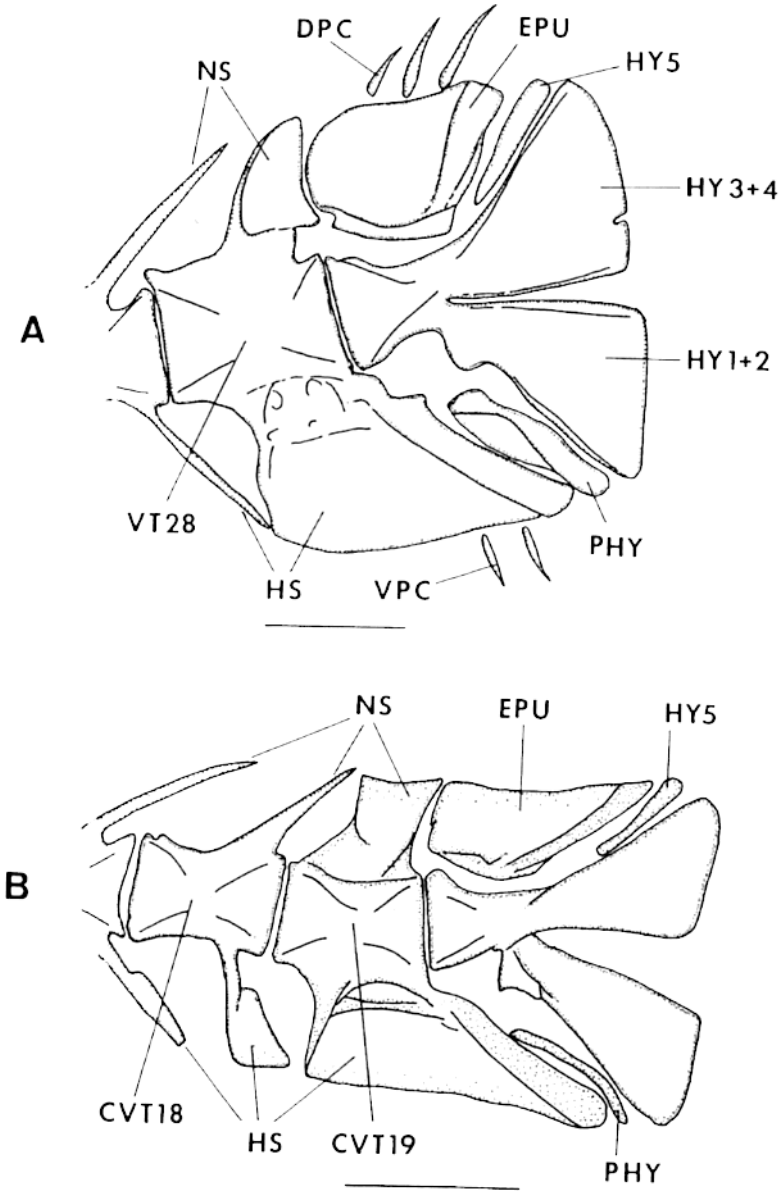

Fig. 6. Caudal skeleton. **A**: *Anatirostrum profundorum* (from X-ray), CMNFI 1999-0023, female, 76.1+18.1 mm, Iran, Southwest Caspian Sea, off Astara, 20-21 Feb. 1997. **B**: *Benthophilus stellatus*, CAS 52847, male, 51.3+10.4 mm, Romania, Danube river drainage, Lake Crapina, 3 Dec. 1968. CVT: caudal vertebra; DPC: dorsal procurrent spines; EPU: epural; HS: haemal spine; HY: hypural; NS: neural spine; PHY: parhypural; VPC: ventral procurrent spines. Scale bars: 1 mm.

phore singly between caudal, neural and haemal spines; haemal spine of last vertebra before urostyle modified and distinctly broadened.

A Caspian Sea endemic genus, occurring in deep waters to approximately 300 m. This genus is delimited from the genus *Benthophilus* by a combination of following characters: (1) unique head and body shape, (2) eight transverse suborbital sensory papillae series, (3) no postorbital occipital series **po** developed, and (4) absence of a chin barbel and cheek flaps behind angle of jaws.

The genus is monotypic.

ANATIROSTRUM PROFUNDORUM (BERG, 1927)

Benthophilus profundorum Berg, 1927: 335, figs 5-8 (Caspian Sea, 37°58'N, 52°22'E).

Anatirostrum profundorum: Iljin, 1930: 48, figs 25-27 (based on type description).

Anatirostrum profundorum: Berg, 1949: 1123, figs 873-875 (Caspian Sea, 37°58'N, 52°22'E).

Pugolovka-utkonos (Profundorum): Ragimov, 1977: 90 (Southern Caspian, 38°20' to 38°30'N, depth 100 m).

Anatirostrum profundorum: Ragimov, 1985: 923 (near eastern and western coast of Southern Caspian Sea).

Nomenclature

The description of the species *Benthophilus profundorum* and of the genus *Anatirostrum* is partly based on the misinterpretation of important diagnostic characters; these characters concern the lateral line system and the tuberculation and were not questioned by Ragimov (1985). Both the species and the genus are valid. To avoid nomenclatorial problems, it is in our opinion necessary to redescribe this rarely found gobiid species.

Material

CMNFI 1999-0023; Caspian Sea, Iran, off Astara, 38°00'N, 49°30'E to 38°20'N, 50°00'E, depth 45-60 m; four females, 76.1+16.9 mm - 79.1+7.6 mm; 20-21 Feb. 1997; leg. A. Abdoli and M. Naderi. ZISP 23134; Caspian Sea, Turkmenistan, 37°58'N, 52°22'E; 14 subadult specimens (as X-rays), 23.1+4.3 mm - 31.7+6.1 mm; out of these specimens, 7 fish with sex specific but not fully developed urogenital papillae, 4 subadult males, 24.8+5.9 mm - 31.4+6.3 mm, and 3 subadult females, 25.7+5.8 mm - 26.3+d mm; syntypes, 22 April 1904 (in Berg (1927), 9-10 April 1904 in ZISP files); leg. N.M. Knipovich.

Note. A.A. had the possibility to investigate seven type specimens; due to collecting techniques they are not in good condition. Nevertheless, it was possible to determine several important diagnostic features. The redescription of *A. profundorum* is mainly based on the 4 adult females collected by A.A. and M.N. Data from 7 type specimens are included as far as available and some characters from X-rays for the rest of the type series.

Type specimens are deposited in the Zoological Institute of St. Petersburg, designated as syntypes (pers. comm., A. Naseka to B.C., 3 June 1998). Berg (1927) mentions in his description 15 specimens, but Ragimov (1985) states that Berg described this species on the basis of a single young specimen and also visually observed 15 fish, thus

suggesting the type series consists of 16 specimens, the holotype and 15 paratypes. Only 14 specimens are available in ZISP. We agree with Eschmeyer *et al*. (1998) that the status of the types is that of syntypes.

General description

Urogenital papilla.—Adult males: not known. Adult females: nearly as broad as long; short, not reaching origin of anal fin; opening surrounded with papillae.

Subadult males and females are distinguished by the shape of the urogenital papilla. Subadult males: longer and narrow than in same sized juvenile females, reaching near origin of anal fin. Subadult females: shape as in adult females, papillae less distinct.

Tongue.—Truncate.

Gill opening.—Wide, not extending anteriorly; opercular membrane attached opposite dorsal origin (first ray) of pectoral fin; branchiostegal membrane attached to isthmus ventral of origin of pectoral fin.

Otherwise as in generic description.

Fins

D1 IV, D2 I/10, A I/11, P 14-16 (14: 1, 15: 2, 16: 1), V I/5+5/I, C 13 (branched rays) (1,13,1: 2; 2,13,1: 1; 1,13,2: 1), procurrent spines dorsal 2-4 (2: 1, 3: 1, 4: 2) and ventral 2-3 (2: 1, 3: 3). Syntypes (n=7): D1 IV, D2 I/9-10 (9: 3, 10: 4), A I/8-10 (8: 1, 9: 3, 10: 3), P 16, V I/5+5/I, C d.

Berg (1927) mentions only three spines in D1; even though it is not possible to determine the exact number of rays in the D2 and A from the X-rays, the spines of D1 are easily determinable as IV for the 14 syntypes. Differences in the numbers of finrays in the second dorsal and anal fins are possibly due to interspecific variation; this seems to be supported by data of Ragimov (1985): D2 I/8-11 (usually 10) and A I/8-11 (usually 9).

Scales

Absent. Tiny platelets and granules, knob-like with few posteriad directed spines arranged as one or several irregular transverse rows or as a patch; smallest on dorsal side of the head, larger on opercle and preopercle; these bony structures are not arranged in rows; on both sides of nape a patch of densely but not imbricate platelets, separated by a narrow, nearly-naked space; predorsal area covered with similar platelets, midline naked; sides of trunk dorsal and ventral (behind anus) covered with platelets increasing in size posteriorly, largest and with spines on caudal peduncle; dorsal and ventral groups separated by naked area occupied by neuromasts of lateral series **ltm**; ventral side of head and lateral rearwards to preopercle (area of well developed sensory papillae), breast and abdomen naked; interorbital region characteristically covered with tiny platelets arranged as two longitudinal rows, from posterior of eye extending anteriorly on the snout, ending somewhat behind posterior nostril and external to sensory papilla **v** (Fig. 3B); between the anterior ends of these interorbital rows of platelets and internal to papillae **v** a few additional tiny platelets; these two rows are figured by Berg (1927: figs 7-8) and were seemingly interpreted by Iljin (1930) as longitudinal interorbital sensory papillae series **p**. Otherwise as in generic description.

Berg (1927, 1949), for juveniles, and Ragimov (1985), for adult specimens of both sexes, describe head and body naked without any granules and other bony structures. Mentioning that the body is naked, Berg (1949) added a feature to the diagnostic characters of the genus. The lack of bony structures was not used by Iljin (1930) to separate the

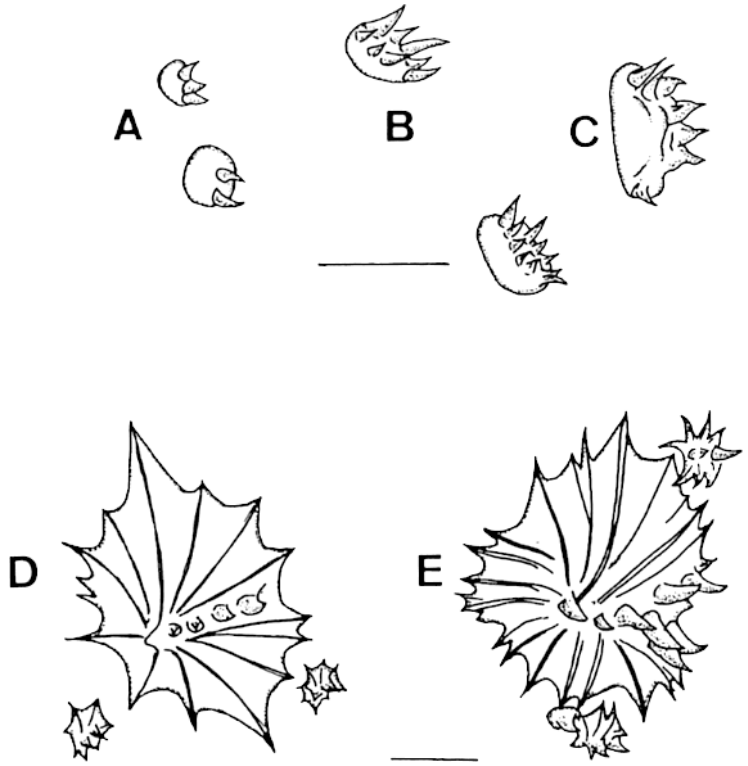

Fig. 7. **A-C**: bony granules and platelets, left side, *Anatirostrum profundorum*, CMNFI 1999-0023, female, 76.1+18.1 mm, Iran, Southwest Caspian Sea, off Astara, 20-21 Feb. 1997; **A**: nape; **B**: below middle of base of second dorsal fin; **C**: last platelet on ventral side of caudal peduncle, close to base of caudal fin; note increase of size from A to C; scale bar = 1.0 mm; **D-E**: bony tubercles, left side, *Benthophilus stellatus*, CAS 52847, female, 46.7+10.1 mm, Romania, Danube river drainage, Lake Crapina, 3 Dec. 1968; **D**: second tubercle of dorsal row + two platelets (in situ), dorsal of origin of pectoral fin; **E**: ninth tubercle of dorsal row + two platelets and one granula (in situ), below interdorsal space; scale bar = 1.0 mm.

new genus from *Benthophilus*. All seven syntypes examined are covered with platelets and granules in the above described pattern. These bony structures are tiny even in the adult females (Fig. 7A-C). They are easily overlooked and may also not be felt by touch when specimens are covered with mucus. We have not examined Ragimov's specimens but strongly feel that he overlooked these small structures in the females, whereas mature males may become naked as in the species of the genus *Benthophilus* (Berg, 1949; Miller, 1986).

Lateral line system

Not described in detail yet, but partly erroneously figured by Berg (1927, 1949) and Iljin (1930).

Cephalic canals. Absent.

Sensory papillae. Nomenclature follows Sanzo (1911) (Figs 2-4).

Preorbital.—Median series in three to four rows, **r**, **s1** (may be absent), **s2** and **s3**; **r** as longitudinal row opposite posterior nostril; **s1**-**s3** as transversal rows with **s1** (if present) anterior to base of posterior nostril, **s2** opposite anterior nostril and **s3** at tip of the snout close to upper lip. Lateral series in three rows, $\mathbf{c}^2$, $\mathbf{c}^1$ and $\mathbf{c}_1$; $\mathbf{c}^2$ as a doubled longitudinal row approximately between anterior and posterior nostrils, $\mathbf{c}^1$ and $\mathbf{c}_1$ parallel to upper lip; $\mathbf{c}^1$ lateral to anterior nostril, and, with a short interspace, $\mathbf{c}_1$ in its elongation; $\mathbf{c}_2$ absent.

Suborbital.—Usually eigth transversal (**1**-**8**) and two longitudinal (**b**, **d**) rows on cheek; the papillae forming the eigth transverse series are large; rows **1**, **2** and **3** dorsal of upper lip and increasing in length; **4** long and ventrally extending to or below level of **d1**; rows **1**-**4** before anterior margin of eye; rows **5** and **6** the only transversal rows below the orbit, both reaching close to ventral margin of eye, bent forward in their dorsal course and not divided by the longitudinal row **b**; **5** long nearly reaching propercular-mandibular row **e**, **6** ventrally bordered by **d2**; **7** and **8** extending between **b** and **e**, both long. Longitudinal row **b** long and undivided, anteriorly reaching near or to vertical from posterior margin of orbit but not to transversal row **6**, the posterior end well before rear margin of cheek; longitudinal row **d** divided in anterior (**d1**) and posterior (**d2**) series; **d1** long from below transversal row **1** parallel to and exceeding upper lip with its posterior end between rows **3** and **4**; **d2** much shorter and positioned distinctly rearwards, between rows **5** and **7**, immediately below row **6**, always somewhat distant from **5** and **7**.

A specimen with row **6** placed forward to anterior end of **d2** and an additional short row of papillae at its posterior end (**6a**), dorsally reaching near row **b** (Fig. 2A) thus showing nine instead the characteristic eigth transverse suborbital papillae; three immature specimens with similar variability in the development of sensory papillae series around **6**-**8** but only one on both sides of the head: one with an additional row as described above on the left side, a second with a short horizontal and a third (on both sides) with a transverse row posterior of row **8**. There is seemingly a certain variability in this character. Nevertheless eigth transverse suborbital rows are the characteristic pattern.

Benthophilus species (six rows) display a remarkable similar pattern of sensory papillae in the suborbital region and on the cheeks as *A. profundorum* (eigth rows), obvious in *B. leptorhynchus* and *B. grimmi* (Berg 1927, 335, 341: figs 4, 12, 13). Elongating the preorbital region and adding in the new space two additional transverse rows, gives the typical pattern of *A. profundorum*.

Preopercular-mandibular.—Three rows, external **e** and internal **i** and mental **f**; rows **e** and **i** divided in mandibular (**e1**, **i1**) and preopercular (**e2**, **i2**) sections by gap in the region of the lower jaw articulation; this gap is distinct in **e**, less distinct in **i**; mandibular sections of both rows continuous, preopercular sections discontinuous, most conspicious in **i2**; no primary replacement neuromasts (usually two) in course of preopercular canal as in other gobiids dorsal of **i2**. Mental row **f** well developed, not united with the anterior ends of **e1** and **i1**.

In a lateral view Berg (1927) and Iljin (1930) figure a specimen with continuous rows **e** and **i**. In the syntypes (n=7) a gap between the mandibular and preopercular sections of both (if not damaged) is visible.

Oculoscapular.—Eight transversal (**tra**, **z**, **q**, **trp**, **y**, **as1**, **as2** and **as3**) and five longitudinal (**x1**, **u**, **x2**, **la2** and **la3**) rows including the axillary series; primary replacement neuromasts on the course of the anterior oculoscapular canal of other gobiids (anterior section of row **u** between pores □ and □) absent; anterior transverse row **tra**

dorsal of suborbital row **8**; **z** ending below shortly before dorsal end of opercular row **ot**; **x1** short, above anterior third of opercle, anteriorly not extending over dorsal edge of cheek; **q** below **x1**, behind former, on the dorsal margin of the opercle, the longitudinal row **u** represented by one to two papillae only; **x2** in elongation of **x1**, above posterior third of opercle; **y** below **x2**, above dorsal end of opercle; transverse axillary rows **as1**-**as3** well developed with longitudinal rows **la2** dorsal of **as2** and **la3** dorsal of **as3**; **la1**, usually dorsal of **as1**, absent.

This area is covered by small sensory papillae and is most exposed to abrasion during collecting; none of the four females or seven syntypes display the complete pattern of neuromasts in this area due partly to damage of the skin; it is no surpise that these papillae are not or incompletely shown in the figures of Berg (1927, 1949) and Iljin (1930).

Opercular.—Three rows, one transversal (**ot**) and two longitudinal rows (**os** and **oi**); **ot** from about lowered end of oculoscapular row **z** to ventral edge of subopercle; **os** long, oblique, reaching to posterior margin of opercle; **oi** short.

Occipital.—Three longitudinal rows (**g**, **m** and **h**); longitudinal row **po** at posterior margin of eye and transversal rows **n** and **o** absent; rows **g** and **m** short, parallel, near to margin of nape, about midline between posterior border of orbit and oculoscapular row **tra**; **h** anterior of origin of first dorsal fin.

Comments same as for oculoscapular series of sensory papillae.

Interorbital.—Two transverse interorbital rows (**v** and **w**); longitudinal row **p** absent; anterior row **v** represented by a single papilla only, distinctly in advance of the eye; **w** short, confluent with its counterpart thus forming a single row between the eyes.

Iljin (1930) seemingly concluded from Berg's drawings (1927: figs 7-8) that interorbital papillae series **p** are developed and used them as a diagnostic character for the genus *Anatirostrum*. Actually these two interorbital rows represent tiny bony platelets and no sensory papillae (Fig. 3B). In a lateral view Berg (1949: fig. 875) still figures the left row, but in his generic diagnosis he does not mention them in the diagnostic features.

Row **v** is placed well in advance of the orbits (Fig. 3); this is obviousely due to elongation of the anterior section of the frontal bones, thus shifting the original snout region further in advance of the orbit; this is most significant in the position of the posterior nostril which is also well in advance of the eyes; the most obvious preorbital elongation occurs between the sensory papillae series **v** and **w** and between **v** and **r**.

Trunk (Fig. 4B).—Three series of longitudinal and transversal rows (**ld**, **ltm** and **lv**). Dorsal lateral series **ld** in three or four rows close to dorsal midline; first (**ld1**) as transverse row below midline of first dorsal fin; **ld2** and **ld3** (if present) longitudinal below interdorsal space, former more close to first, latter to second dorsal fins; **ld4** on caudal peduncle, doubled and close to origin of caudal fin, not confluent with its counterpart from the other side; **ld3** found in three of seven type specimens. Median lateral transversal series **ltm** on body in 26 mostly transversal rows, a few longitudinal rows below pectoral fin; **ltm1** below dorsal origin of pectoral fin, **ltm26** on rear of caudal peduncle. Ventral lateral series **lv** usually in three transverse rows; **lv1** below ventral origin of pectoral fin, **lv3** near anus, **lv2** between **lv1** and **lv3**, more close to latter; one subadult female with two **lv** rows below ventral origin of pectoral fin. The exact number and location of trunk series, especially of **ld**, are difficult to detect.

Caudal fin (Fig. 4C).—In three rows, one transverse (**lct**) and two longitudinal (**lcd**, **lcm**). Longitudinal row **lcv** absent. **lct** distinctly posterior of **ltm26**, extending transversely between fourth and eigth branched caudal fin rays, anterior to **lcd** and **lcm**;

lcd originates opposite dorsal end of **lct** and extends between fourth and fifth branched rays of caudal fin, more close to former, shorter than **lcm** and ending distinctly before rear margin of caudal fin; **lcm** originates opposite ventral end of **lct** and extends between seventh and eigth branched rays of caudal fin, more close to former; longer than **lcd**, nearly reaching rear margin of caudal fin.

Characteristically for the gobiids of the North-eastern Atlantic, Mediterranean and the Ponto-Caspian regions are three longitudinal series of papillae on the caudal fin; this feature, only two longitudinal series and **lcv** absent, is in these areas only known from species of the genera *Anatirostrum* and *Benthophilus* (Appendix 1). But it seems likely to us that it also occurs in the monotypic genus *Benthophiloides*.

Osteology

The description of the osteological features is based on X-rays only. One of us (H.A.), who investigated these features, did not get the permission to clear and stain a specimen (an understandable problem with collections consisting of a very small number of specimens only). Therefore it was not possible to study the cranial osteology properly. Nevertheless the X-rays of the four specimens from the Southern Caspian Sea provide good information on the postcranial skeleton.

Cranial skeleton

From X-rays only. Obviously several bones of the neurocranium and the suspensorium are modified in size due to elongation of the head. Seemingly most elongated are the frontal and the parasphenoid, bridging the longest distance between the posterior (by the hyomandibula) and anterior (by the palatine) articulation of the suspensorium.

Dentition.—Praemaxilla and dentary with caninoid teeth in 4-5 rows medially; outer row bears largest teeth; no large canines developed.

Postcranial skeleton

Vertebrae.—29, including urostyle; 9 precaudal and 20 caudal; 10th vertebra (VT 10) with first haemal spine and complete haemal arch.

Simonovic *et al.* (1996) conclude from Birdsong *et al.* (1988) that 10 precaudal and 16 caudal vertebrae were the plesiomorphic state for the suborder Gobioidei. We could not find that Birdsong *et al.* explicitely mentioned that these numbers are the plesiomorphic state. But the combination 10+16 vertebrae seems to occur frequently among gobioids and represents a generalized state (McKay and Miller, 1997). Nevertheless, all these authors do not mention species with nine precaudal vertebrae only (except for *Barbuligobius*, «…an arrangement that appears to be unique among gobioids» Birdsong *et al.* (1988)), even though their data cover about 75% of all gobioid genera. The overwhelming majority of Atlantic-Mediterranean gobiids has 10-12, with mostly 11-12 precaudal vertebrae, the Ponto-Caspian genera *Knipowitschia*, *Neogobius* and *Proterorhinus* have 12 precaudal vertebrae (Birdsong *et al.*, 1988; Simonovic *et al.*, 1996; McKay and Miller, 1997). Simonovic *et al.* (1996) state that this is a constant number, whereas the number of caudal vertebrae may typically vary from 20-21 (19-23). A short review of 25 specimens covering seven *Neogobius* and one *Proterorhinus* species (Appendix 3), revealed that nine of them had 11 (n=1) or 13 (n=10) instead of 12 precaudal vertebrae, thus the variability within these vertebrae is seemingly higher than expected to date.

Nine precaudal vertebrae are obviously a derived state in which *Anatirostrum* is synapomorphic with *Benthophilus* (Appendix 1).

Dorsal and ventral pterygiophores (Fig. 5A).—3-221*01*1*; three pterygiophores that support no spine or fin ray developed between first and second dorsal fins; the first in the interneural space between neural spines of VT 5 and VT 6, close to latter and posterior of last PT of D1, followed by a free interneural space; second between neural spines of VT 7 and VT 8, more close to former; third between neural spines of VT 8 and VT 9, close to latter and anterior of the first PT of D2. Last PT of D1 in interneural space between neural spines of VT 4 and VT 5; first PT of D2 in interneural space between neural spines VT 9 and VT 10, thus positioned dorsal of the first caudal vertebra. One (first) PT of anal fin extends before first haemal spine (VT 10); it lines up with the first pterygiophore of D2.

There is no other species within the more than 500 (from about 200 genera) investigated by Birdsong *et al.* (1988) with a formula of 3-221*01*1* or even with 3-221*0. We consider this formula as unique and maybe derived from 3-2210.

The initial sequence of 22 pterygiophores and a single space between the dorsal fins is a plesiomorphic feature and found in the majority of goby-grade genera (Hoese, 1984; Birdsong *et al.*, 1988; McKay and Miller, 1997). This single space may represent a specialization by displacement of D2 more posteriorly (Hoese and Gill, 1993).

Pterygiophores without associated spines are rarely found in gobioids, either accidentally in single specimens or in specialized groups in which they frequently are retained. Such reductions in the spinous dorsal fin are attributed to a decrease in the swimming and signal function in burrowing species (Birdsong, 1975; Birdsong *et al.*, 1988). Such a feature has not been reported for any North-eastern Atlantic, Mediterranean or Ponto-Caspian gobiid. This is also the case for the origin of the second dorsal fin which is positioned in *A. profundorum* dorsal of the first caudal vertebra. The plesiomorphic state is an origin dorsal of the ultimate or penultimate precaudal vertebra, and the first pterygiophore of the anal fin lines up with the second or third dorsal PT (Hoese and Gill 1993, and authors summarized there). From the presence of three PT that support no spine or fin ray and their position, from the position of the first PT of D2 between neural spines of VT 9 (last precaudal vertebra) and VT 10, and its lining up with the first PT of the anal fin, we conclude that this state may have derived from an ancestor with (1) five spines in D1 and (2) D2 originating more anteriorly, dorsal of VT 8. Lining up of the first anal fin PT with the first PT of D2 fin is apomorphic and obviously related to a backward shift of D2.

Anatirostrum is in these features synapomorphic with *Benthophilus*.

An interesting character is that only one pterygiophore is anterior to the first haemal spine in *A. profundorum* (and all investigated *Benthophilus* species (Appendix 1)). In most Gobioids two ore more pterygiophores precede the first haemal spine (Birdsong *et al.*, 1988; Murdy 1989). Only in a few gobiod taxa as, e.g., in the Oxudercinae, which are typically associated with soft bottom habitats, this character seems to occur regularly.

Epipleural ribs.—Ten; first articulates with VT 1, second with parapophysis of VT 2, third to tenth with pleural ribs.

Pleural ribs.—Six; articulate with corresponding parapophysis of VT 3-VT 8.

Neural spines and caudal skeleton (Fig. 6A).—The neural spines of the caudal vertebrae 1-10 arise above midline of vertebral body, from CVT 11, the first behind last PT of D2, the neural spines are more oblique and progressively arise more posteriorly. The haemal spines on CVT 1-15 arise below anterior half of vertebral body, at CVT 16-17

more to the middle and at CVT 18 (penultimate of the urostyle) below the end. Vertebra 28, last before the urostyle, with modified neural and haemal spines. The neural spine is shortened and broadened with flat posterior margin; it is not oblique as the preceding neural spines and therefore, despite its relative shorter length, it reaches with its tip to the same height as the posterior positioned epural. The haemal spine is lengthened and greatly broadened; its base covers about the posterior three quarters of the vertebral body, whereas its distal part is drastically expanded, thus being distinctly broader than long; its cylindrical posterior margin articulates with two segmented caudal fin rays.

Dorsal of the posterior most vertebral centrum (ural centrum) is a single large and broadened epural with cylindrical posterior margin which articulates with a segmented caudal fin ray. Posterior of the epural is a short, strut like hypural 5 which articulates with a segmented and branched caudal fin ray; it lies anterior to the fan-shaped hypurals 3-4 which are fused with the ural; a notch is visible at the rear margin of this hypural fan in two of the four specimens. From the X-ray, it is not clearly determinable if the fused hypurals 1-2 are inserting in a groove on the ventral side of the ural centrum, as in most gobiids, or if they are fused to it. Ventral to hypurals 1-2 is the short parhypural with a cylindrical posterior margin which articulates with a segmented caudal fin ray; ventro-anterior to the parhypural lies the modified haemal spine of VT 28. There are only few procurrent spines developed, typically four dorsal and three ventral.

In all investigated Atlantic-Mediterranean and Ponto-Caspian gobiids, the epural and the last haemal spine are longer than broad (Ahnelt, unpubl. data; compare Miller 1973, 1984; Economidis and Miller 1990; Scsepka *et al*., 1999). In these features *Anatirostrum* differs remarkably from other gobiids of these areas. Both, the epural and the haemal spine are broader than long at their distal margins. This is possibly an apomorphic feature in which *Anatirostrum* is synapomorphic with *Benthophilus*. In *B. stellatus* this feature is still more distinct (Fig. 6B).

Coloration

Preserved specimens. Females: pale fawn, ventrally whitish, somewhat darker dorsally, with inconspicuous speckles; sides of head from snout to cheek also dark with transversal suborbital papillae series whitish, giving the impression of narrow light stripes below the eye and on cheek; fins dusky and transparent, P, D1, D2 and C with inconspicuous banding. Juveniles in poor condition and faded; Berg (1949) mentions their coloration uniform light.

Biology

Geographical distribution is given in figure 1. To date, this species is known only from the Southern Caspian Sea, reported for waters off Azerbaijan, Turkmenistan and Iran. This report is the first record for Iran. The species was also caught off Nowshahr at 36°47'N, 51°25'E to 37°55'N, 51°40'E, but no specimens were taken in the Eastern Caspian Sea off Behshahr at 36°50'N, 53°30'E to 37°50'N, 53°40'E.

Originally reported by Berg (1927) from a depth of 294 m, the ZISP data states depth as 244 sazhems (1 marine sazhem = 1.83 m). Capture depth in Iran range from 45 to 80 m. The bottom is composed of white silt (Berg, 1927, 1949) and the characteristic shape of the head, and especially of the snout region, is possibly an adaptation for feeding on this substrate (Ragimov, 1985).

Water temperature at the surface was 8.8°C and 9.5°C respectively for the two collection dates while at 50 m depth temperatures were 9.8°C and 9.7°C for the Iranian

specimens examined here. Capture sites off Nowshahr had surface temperatures of 9.4°C on 23 February at 20:45 to 15.9°C on 9 December at 16:30 while at 50 m depth temperatures were 9.9°C and 16.4°C.

Maximum length is 112 mm (Ragimov, 1985), thus distinctly larger then investigated specimens. This author give only a range for the total lengths and for both sexes mean values; possibly females (mean 84 mm TL) larger than males (mean 77 mm TL).

Food and reproduction are unknown.

DISCUSSION

Anatirostrum profundorum is closely related to the species of the genus *Benthophilus*. Because of similarities in the external morphology, Berg (1927) originally placed this species within the latter genus. Some features such as lack of head appendages, shape of head and snout, drastically reduced spinulose granules and platelets, and differences in the head lateral line system, justify a separation of this species from those of the genus *Benthophilus* on a generic level.

The close relationship of the species of these two genera is well expressed by a characteristically developed lateral line system (presence of horizontal series of interorbital replacement neuromasts versus longitudinal series, and only two longitudinal rows of sensory papillae on caudal fin versus three) and replacement of scales by spinulose bony structures. It is also obvious in osteological features in which they differ remarkably from all other gobiids of the North-eastern Atlantic, Mediterranean and Ponto-Caspian regions. Several of this features seem to be apomorphic such as: (1) low numbers of precaudal vertebrae (9 versus plesiomorphic 10), (2) posterior placement of the second dorsal fin (first pterygiophore of D2 inserts in interneural space of last pre- and first caudal vertebrae versus insertion between ultimate and penultimate precaudal vertebrae or even more anterior), and (3) first pterygiophore of anal fin lines up with first pterygiophore of D2 versus with second or third. Other characters may be apomorphic but are at least common for the species of both genera such as (1) broader than long epural and last haemal spine, (2) characteristic pattern of pterygiophores between the dorsal fins that support no spines or fin rays and (3) only one pterygiophore before first haemal spine. These three characters are not known from other gobiids of the North-eastern Atlantic, Mediterranean and the Ponto-Caspian.

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APPENDIX 1

***Benthophilus stellatus* (Sauvage, 1874)**

Material.—CAS 27893. 13 specimens; 6 females 41.7+d - 46.9+11.8 mm, 7 males 46.6+12.1 mm - 53.5+13.4 mm; Romania, Danube River drainage, Lake Crapina; floodplain of the Danube near Vacareni, NNE from Macin, Dobrogea; 3 Dec. 1968; leg. P. Banarescu. CAS 52847. 2 spms; 1 female 46.7+10.1 mm, 1 male 51.3+10.4 mm; cleared and stained; same data.

Fins.—D1 III-IV (III:12, IV: 3), D2 I/7-8 (7: 2, 8: 13), A I/8 (8: 15).

Scales.—Absent. Head and body with spinulose granules, platelets and plates (tubercles); larger in females; plates forming three longitudinal rows on each side of body.

Lateral line system.—Transverse interorbital sensory papillae series v and w developed; caudal fin with two longitudinal rows (lcd, lcm) only. For the head otherwise as Miller (1986).

Postcranial skeleton.—Two cleared and stained and six X-rayed specimens.

Vertebrae.—28-30, including urostyle (28: 2, 29: 5, 30: 1); 9 precaudal and 19-21 caudal (19: 2, 20: 5, 21: 1).

Dorsal and ventral pterygiophores (n=7).—3-221*01*1* (n=3) (Fig. 5B) and 3-211*1*01*1*1* (n=4); three or five spineless PT between the two dorsal fins; latter four specimens with three spines in the first dorsal fin, thus the last of the two PT in the interneural space between VT 4 and VT 5 supporting no spine; this last PT is still formed like the preceding three PT of D1.

One (first) PT of anal fin extends before first haemal spine; it lines up with the first PT of D2 in three and with the last spineless PT in four specimens.

Caudal skeleton.—Similar to *A. profundorum*. One epural, at distal margin broader than its length at posterior margin; haemal spine of last vertebra before urostyle with distal margin distinctly broader than at its posterior margin (Fig. 6B).

***Benthophilus macrocephalus* (Pallas, 1788)**

Material.—Three specimens, X-rays. NMC 70-543. 1, large, specimen of two. Caspian Sea, Iran, Gilan, near Bandar Anzali, 37°28'N, 49°27'E; 13 Mar. 1962; leg. V.D. Vladykov. NMC 70-544. 2 spms. Caspian Sea, Iran, Gilan, near Bandar Anzali, 37°28'N, 49°27'E; 20 Mar. 1962; leg. V.D. Vladykov.

Vertebrae.—27-28, including urostyle (27: 2, 28: 1); 9 precaudal, 18-19 caudal (18: 2, 19: 1).

Dorsal and ventral pterygiophores.—3-211* (rest of dorsal PT not determinable in NMC 70-543) and 3-211*1*01*1* (n=2); four spineless PT between the two dorsal fins in latter two specimens; three spines in the first dorsal fin, thus the last of the two PT in the interneural space between VT 4 and VT 5 supporting no spine; this last PT is still formed like the preceding three of D1.

One (first) PT of anal fin extends before first haemal spine; it lines up with the first PT of D2, positioned between VT 10 and VT 11, in two and with the interneural space between VT 9 and VT 10 in one specimen.

Caudal skeleton.—As in *B. stellatus*.

***Benthophilus stellatus leobergi* Iljin in Berg, 1949**

Material.—2 specimens, X-rays. NMC 71-326A. Caspian Sea, Iran, Gilan, near Bandar Anzali, 37°28'N, 49°27'E; 10 Apr. 1962; leg. V.D.Vladykov. NMC 93-0150. Caspian Sea, Iran, Golestan, Gorgan bay; Feb. 1987; leg. B.H. Kiabi.

Vertebrae.—28-29, including urostyle (28: 1, 29: 1); 9-10 precaudal (9: 1, 10: 1) and 19 caudal.

Dorsal and ventral pterygiophores.—3-221*01*1*1*0; four spineless PT between the two dorsal fins; untypically first PT of second dorsal fin together with second PT in the interneural space between VT 10 and VT 11 instead between VT 9 and VT 10, thus the interneural space anteriorly to the origin of the second dorsal fin without PT (n=1; NMC-71-326A); anterior series of PT in the other specimen not determinable from X-ray, but three spineless PT anterior to origin of second dorsal fin, last in the interneural space immeditately anterior to the origin of D2.

One (first) PT of anal fin extends before first haemal spine; it lines up with the first PT of D2.

Caudal skeleton.—As in *B. stellatus*.

Nomenclature.—The name *B. stellatus leobergius* Iljin, 1949 is a nomen nudum in Iljin (1949: 28) (Kottelat, 1997). Berg (1949: 1116-1117, figs 858, 859) figured this taxon and possibly used data from Iljin for a description. His use of the name accompanied with diagnostic characters makes the name available as *B. stellatus leobergi* Iljin in Berg, 1949 (see also Eschmeyer *et al.*, 1998). We follow Kottelat (1997), that the name *leobergius* is based on a personal name and thus should be changed in *leobergi*.

APPENDIX 2
Anatirostrum profundorum: Lateral line system

Wongrat and Miller (1991) developed for eleotrid fishes a nomenclature following the innervation of the sensory papillae by the anterior and posterior lateral line nerves, whose fibres leave the central nervous system with the trigeminal (V), facial (VII), glossopharyngeal (IX) and vagus (X) cranial nerves. They also differ between primary and secondary replacement neuromasts. We give a brief synopsis for the sensory papillae following their system:

Anterior lateral line nerve (V, VII)

1. Supraorbital trunk (V)

Primary replacement of supraorbital canal: longitudinal line p absent.

Secondary accessory: dorsal supraorbital lines n and o absent; supraorbital accessory transverse lines v and w present (=transverse p of Wongrat & Miller); supraorbital rostral replacement line: s1 (may be absent), s2 present.

2. Infraorbital trunk (V)

Primary replacement of infraorbital canal: longitudinal suborbital line a, c absent;

Secondary replacement of infraorbital canal: transverse suborbital line 1 - 8 present;

Secondary accessory: caudal fork replacement s3, r present; rostral fork replacement line c^1, c_1, c^2 present, c_2 absent.

3. Hyomandibular trunk (VII)

Primary replacement of preopercular canal: longitudinal line z, i present;

Secondary replacement of preopercular canal: transverse line i absent;

Secondary accessory: median mandibular line b, d present; ventral mandibular line e present; rostral mandibular line f present; ventral opercular line ot, oi present; dorsal opercular line os present.

4. Otic ramus (VII)

Secondary accessory of otic-postotic canal: transverse line tra present.

Posterior lateral line nerve (IX, X)

5. Supratemporal ramus (IX)

Primary replacement of otic-postotic canal: longitudinal line u present;

Secondary replacement of otic-postotic canal: transverse line q, trp present;

Secondary accessory: supratemporal accessory longitudinal line x1, x2, g, m present.

6. Posterior lateral ramus (X)

Primary replacement of lateral line canal: longitudinal line la1 absent, la2, la3 present;

Secondary replacement of lateral line canal: transverse line ltm, lv and longitudinal line ld present;

Secondary accessory: trunk accessories h, y, as1, as2, as3, lc present.

Note.—The sensory papillae rows trp and y are not considered in the compilation of the new system by Wongrat and Miller (1991: 40) but are shown in their figures 4 and 6. Thus trp has to be placed with q as a secondary replacement line innervated by the supratemporal ramus and y with the trunk accessories innervated by the posterior lateral ramus of the posterior lateral line nerve (Wongrat and Miller, 1991: figs 4, 6).

APPENDIX 3
Comparative material

Shape and size of epural and haemal spine of the last vertebra before urostyle; number of precaudal and caudal vertebrae; no spineless pterygiophores between first and second dorsal fins. From X-rays.

Ponto-Caspian species

Neogobius sp. (*cephalargoides*?), CAS 62205 (3 specimens). *Neogobius fluviatilis*, CAS 62211 (3 spms). *Neogobius gymnotrachelus*, CAS 62210 (2 spms); CAS 22973 (2 spms). *Neogobius kessleri*, CAS 62208 (3 spms); CAS 23423 (2 spms). *Neogobius melanostomus.* CAS 62209 (4). *Neogobius ratan*, CAS 162206 (1 spm). *Neogobius syrman*, CAS 23433 (1 spm); CAS 62207 (3 spms). *Proterorhinus marmoratus*, CAS 62216 (1 spm).

North-eastern Atlantic and Mediterranean species

Gobius cruentatus, CAS 101983 (2 spms). *Gobius niger*, CAS 101970 (3 spms). *Thorogobius ephippiatus*, CAS 62428 (1 spm). *Zosterisessor ophiocephalus*, CAS 58326 (4 spms).