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The Fish Fauna of the Göksu River (Türkiye): Taxonomic and Zoogeographic Features

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Abstract

In order to establish the taxonomic and zoogeographic features of the fish fauna of the Göksu River Basin, fish samples were collected using electrofishing equipment, gill nets, trammel nets, seine nets and cast nets in October 2004 and May 2005. Among the samples, ten species and three subspecies belonging to seven families were identified: *Anguilla anguilla, Sardinella aurita, Salmo trutta macrostigma, Cyprinus carpio, Barbus capito pectoralis, Capoeta capoeta angorae, Chondrostoma regium,* species from *Gobio gobio* group*, Seminemacheilus cf. ispartensis, Clarias gariepinus, Mugil cephalus, Liza ramada* and *Liza saliens*. The most dominant family in the river and its branches are the Cyprinidae with three species and two subspecies.

Key Words : Göksu River basin, fish taxonomy, osteology, freshwater fishes.

Introduction

The first studies concerning the fish fauna of the inland waters of Türkiye started in 1835 and were followed by regional surveys between 1872 and 1897 (Kuru, 2004; Sarı *et al.*, 2006). Hanko (1924), Pietschmann (1933) and Battalgil (1942, 1944) provided the first information about the species distribution of the Central Anatolian Cyprinidae. During the fieldworks carried out between 1940 to 1967, C. Kosswig, F. Battalgil and W. Villwocki collected fish samples from various localities in Anatolia that were deposited in the Hamburg Zoological Museum and Zoological Institute (ZMH), the London Natural History Museum (BMNH) and the Vienna Natural History Museum (NMW).

Mainly on the basis of those museum specimens, Ladiges (1960, 1966), Karaman (1969, 1971, 1972) and Bogutskaya (1992, 1994, 1996, 1997a, b) described several endemic new species and subspecies for Anatolia. A recent review of the literature by Kuru (2004) concerning the ichthyological research carried out in Anatolia since 1856 has shown that thus far 236 taxa, belonging to 26 families, have been reported from the inland waters of Türkiye. Information on the Göksu River is lacking, however, as can be noticed from the taxonomic and zoogeographic research carried out in adjacent basins (Krupp, 1983, 1985; Balık, 1988).

The aim of the present study is to fill in this gap by documenting the taxonomic features of the Göksu River ichthyofauna and by comparing the fish fauna with that of neighboring basins from a zoogeographical point of view.

Materials and Methods

The headwaters of the Göksu River are located south-west of the town of Hadim (Konya province), in the Central Mediterranean part of Türkiye (Figure 1). The two main branches are the Hadim Creek and Ermenek Creek which join in to Suçatı, located near Mut (İçel provinces). From here onwards the river is called Göksu; it discharges into the Mediterranean Sea near Silifke. On the Ermenek tributary, dams are both presently under construction at Ermenek and already constructed at Gezende. The aim of the dams is to provide electrical power and to protect an area of approximately 250 km from overflow (Munsuz and Ünver, 1983).

This ichthyological survey was carried out on the Göksu River in October 2004 and May 2005. The fish were collected using electrofishing equipment (AC/DC 220/12V, 2 Hp portable electrical generator and with 2 circular 10 cm diameter electrodes), gill nets (mesh size of 9x9 mm and 12x12 mm), trammel nets (various mesh seize), seine nets (2 mm) and cast nets. The samples were fixed and preserved in a 4% formalin solution. Metric measurements were carried out with 0.01 mm sensitive calipers. Meristic characters such as number of gill rakers, pharyngeal teeth, dorsal and anal fin rays, lateral line scales and vertebrae were counted under a stereomicroscope. The last two branched dorsal and anal fins are counted "$1^{1/2}$" (Kottelat and Barbieri, 2004). The number of vertebrae in the Cyprinidae and Balitoridae was determined by radiography. Of the head skeleton, circumorbitale, premaxilla, maxilla, dentale and operculum bones were fixed in a 3% KOH and drawn

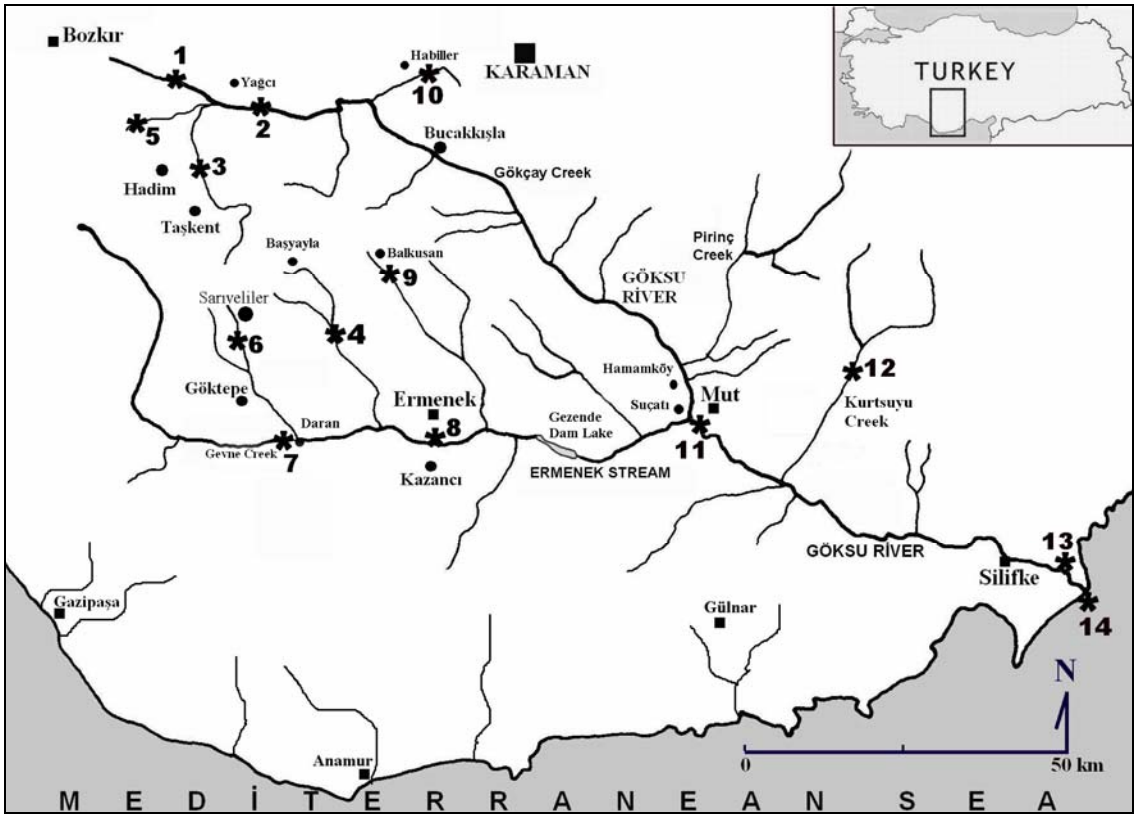

Figure 1. The map of Göksu River and sampling stations; 1- Yağcı Village-Hadim, 2- Yerköprü Waterfall-Hadim, 3- Hadim, 4- Başyayla-Ermenek, 5- Gökdere-Bozkır, 6- Sarıveliler, 7- Daran-Sarıveliler, 8- Ermenek Stream-Anamur Road, 9- Balkusan, 10- Habiller-Kazan, 11- Hamam Village-Suçatı, 12- Kurtsuyu Creek, 13- Drainage canals-Atakent, 14- River Mouth (Kurtuluş).

under a stereo drawing microscope. Vertebrae and skeleton bones were named according to Bogutskaya (1994, 1996, 1997b) and Naseka (1996).

For the genus and species identifications, the following sources were referred to: Küçük and İkiz (2004) for the Salmonidae; Bogutskaya (1997a,b), Elvira (1987), Ladiges (1960, 1966), Karaman (1969, 1971, 1972), Naseka *et al.* (2006) for the Cyprinidae; Erk'akan *et al.* (2007) for the Balitoridae; Teugels (1982) for the Clariidae; Fisher *et al.* (1987) for the Clupeidae and Mugilidae.

The rates of species in the stream were shown by relative abundance (Krebs, 1989 in Sarı *et al.*, 2006). Relative abundance %= $(n_i/N)*100$, where n_i refers to the number of individuals of the species in the samples and N refers to the total number of individuals of fish caught.

Results

Ten species and three subspecies belonging to seven families were identified from the Göksu River samples.

Family: Anguillidae

***Anguilla anguilla* (Linnaeus, 1758)**

Material examined: River mouth-Silifke (3 specimens, SL: 16-46 cm), Hamam Village-Mut (2 specimens, SL: 26-40 cm)

Diagnostic characters: D 241-260; A 178-196; P 17-18; C 9-11.

Family: Clupeidae

***Sardinella aurita* Valenciennes, 1847** (Figure 2)

Material examined: River mouth-Silifke (8 specimens, SL: 9.64-18.36 cm)

Diagnostic characters: D III 13-14; A II 15; V III 9; keel scales 32-34, gill rakers 190-210.

Family: Salmonidae

***Salmo trutta macrostigma* (Dumeril, 1858)** (Figure 3)

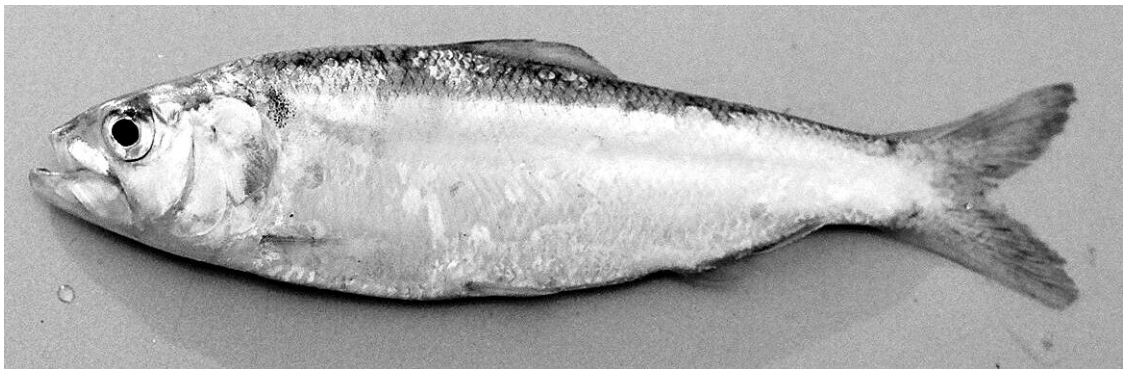

Figure 2. *Sardinella aurita* Valenciennes, 1847**.**

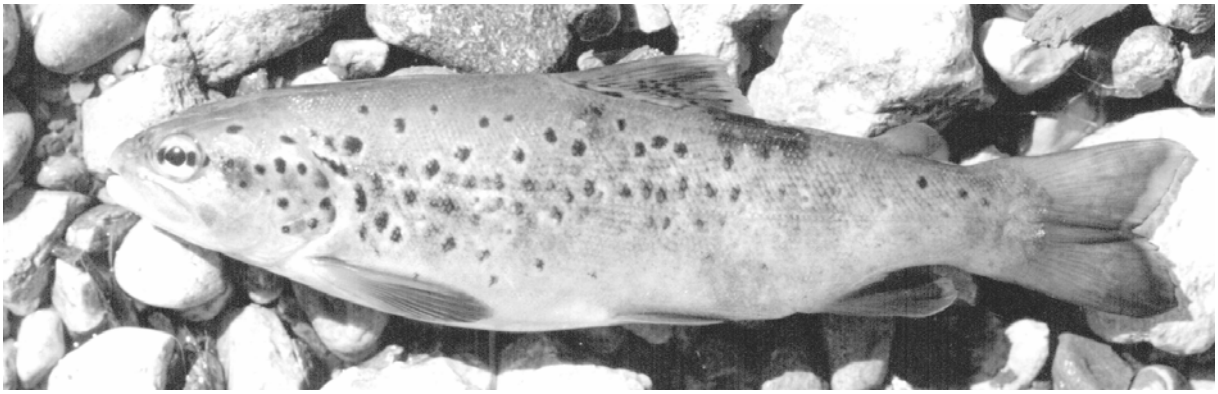

Figure 3. *S.trutta macrostigma* (Dumeril, 1858).

Material examined: Başyayla Brook-Ermenek 36° 41' 94" N: 32° 45' 83" E (1 specimen, SL: 23.50 cm)

Diagnostic characters: D III $10^{1/2}$; A III $8^{1/2}$; L.lat. 119; L.trans. 21/19, vertebrae 55-57; pyloric appendages 24-28

Family: Cyprinidae

***Cyprinus carpio* Linnaeus, 1758**

Material examined: River mouth-Silifke (4 specimens, SL: 13.6-28.6 cm)

Diagnostic characters: D III 18-$20^{1/2}$; A II-III 5-$6^{1/2}$; L.lat. 36-39;L.trans. 6-7/5-7, pharyngeal teeth, 1.1.3-3.1.1; gill rakers 26-30; vertebrae 36-37

***Barbus capito pectoralis* Heckel, 1843** (Figure 4)

Material examined: Hamam Village-Mut (16 specimens, SL: 10.60-13.67 cm) River mouth-Silifke (3 specimens, SL: 10.23-15.54 cm)

Diagnostic characters: D IV $8^{1/2}$; A III $5^{1/2}$; L.lat. 52-54; L.trans. 10-11/6-7; pharyngeal teeth 2.3.5-5.3.2; gill rakers 14-15; vertebrae 43-44

The *B. c. pectoralis* caught from Suçatı have 43-44 vertebrae consisting of 25-26 abdominal vertebrae and 18-19 caudal vertebrae, 13 predorsal vertebrae, 3-4 intermediate vertebrae, and 3-4 preanal vertebrae. The abdominal vertebrae 57-59% total vertebrae, caudal vertebrae 41-43% total vertebrae and predorsal vertebrae 50-52% abdominal vertebrae. The Çine Creek specimens have 42 vertebrae consisting of 24 abdominal vertebrae and 18 caudal vertebrae, 13 predorsal vertebrae, 3 intermediate vertebrae and 3 preanal vertebrae. The abdominal vertebrae 57% total vertebrae, caudal vertebrae 43% total vertebrae, predorsal vertebrae 54% abdominal vertebrae. When the operculum, maxilla, circumorbitale and the last dorsal fin-ray of the Suçatı specimens were compared with those from Çine Creek, important differences were established. It is seen in the Suçatı specimens that the number of pores in the preoperculum is higher, that the last dorsal fin-ray is more thickened and that the notched segment of the operculum is smaller (Figure 5a, b).

The standard length 1.93 times of predorsal distance, 3.77 times of maximum body depth, 3.64 times of head length, 3.79 times of prepectoral

Figure 4. *Barbus capito pectoralis* Heckel, 1843.

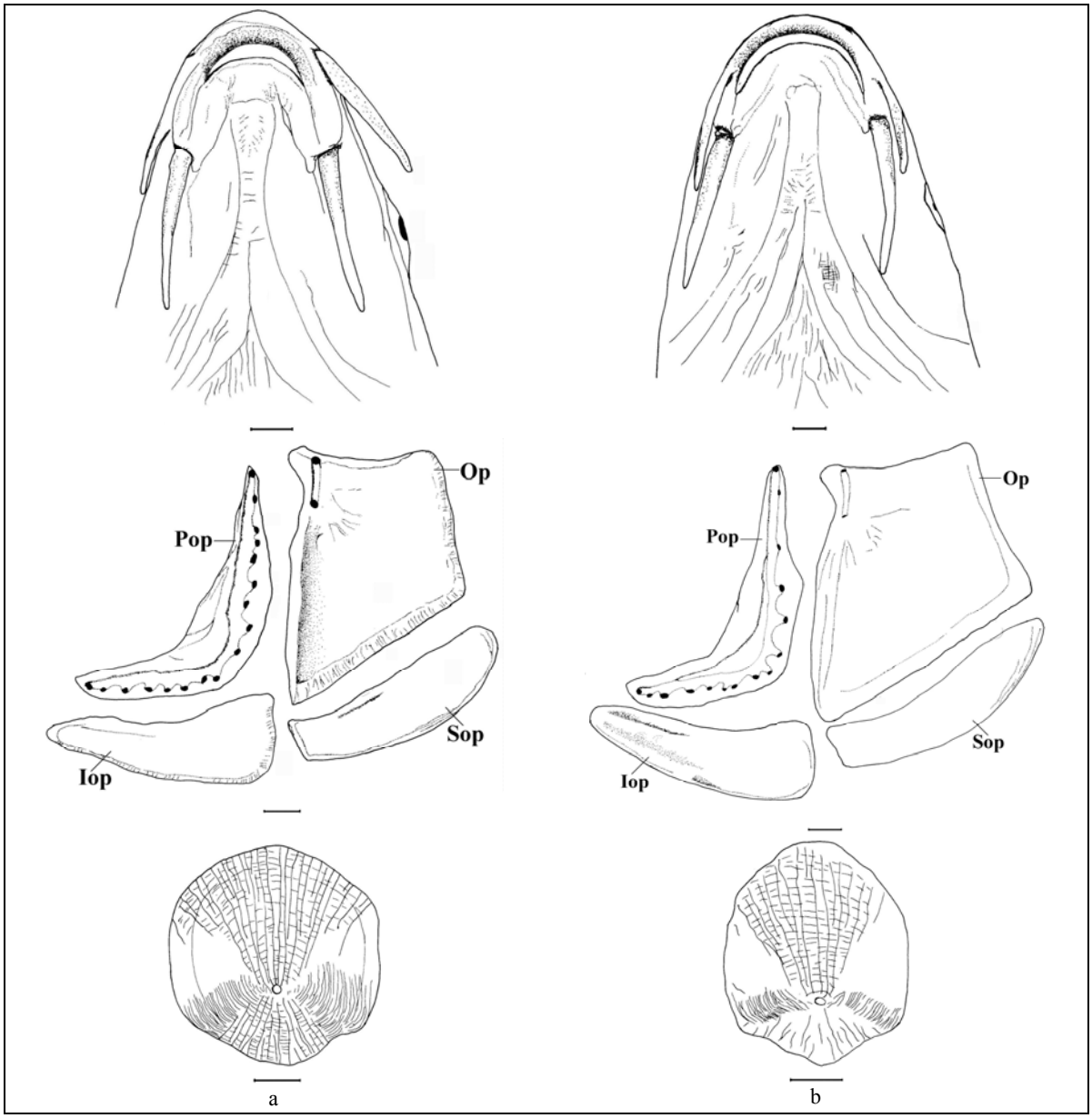

Figure 5a. Head, bones of opercular and scale of *B. capito pectoralis* (a: Suçatı-Göksu River, b: Çine Brook) (Pop: Preoperculum, Op: Operculum, Iop: Interoperculum, Sop: Suboperculum) (Scale bars: 1 mm).

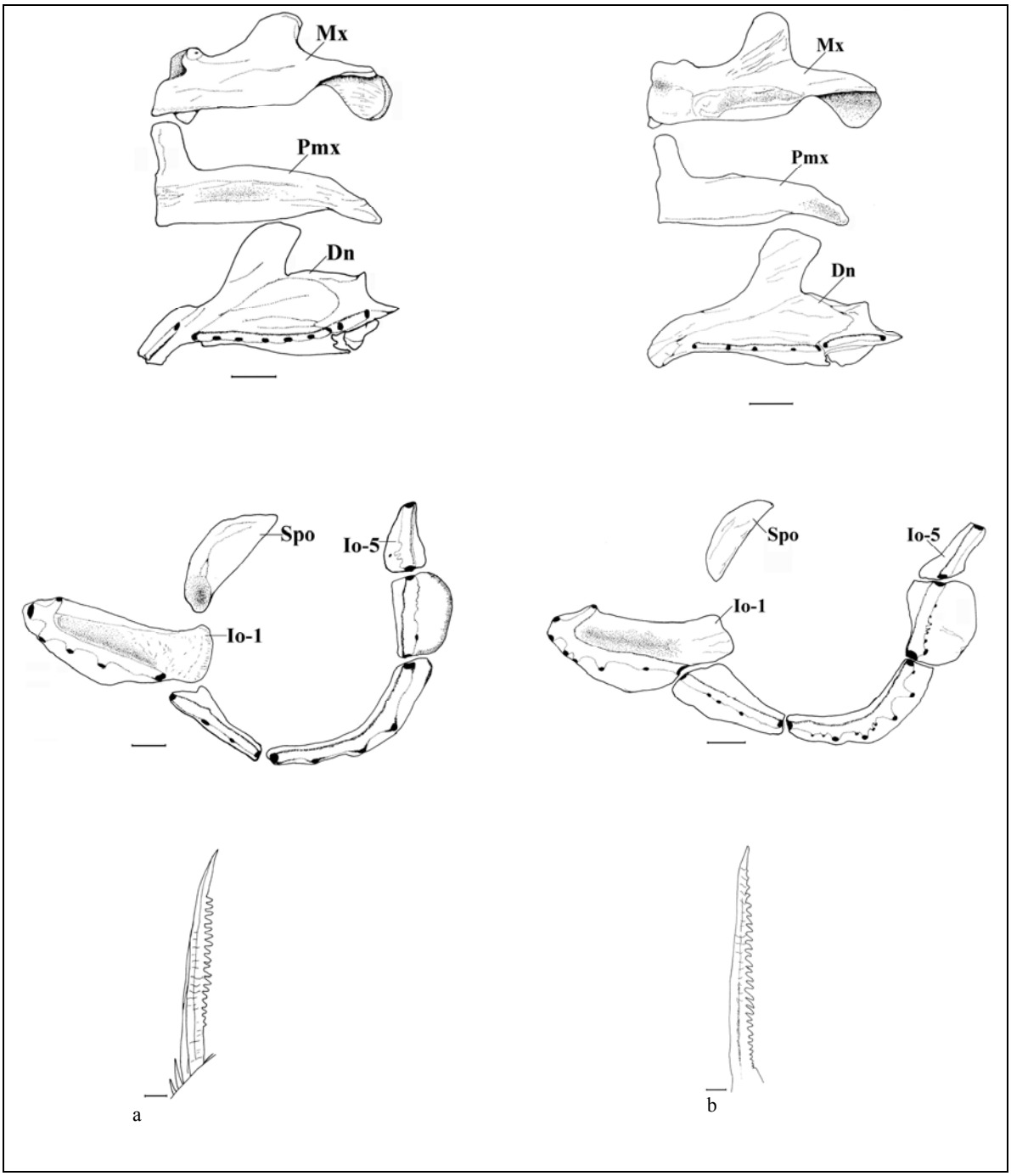

Figure 5b. Jaws, circumorbitals and last simple dorsal fin-ray of *B. capito pectoralis* (a: Suçatı-Göksu River, b:Çine Brook) (Spo: Supraorbitale, Io Infraorbitale, Mx: Maxillare, Pmx: Premaxillare, Dn: Dentale) (Scale bars: 1 mm).

distance, 1.87 times of preventral distance and head length 4.65 times of eye diameter in the Suçatı specimens. The on the other hand, in the Çine Creek specimens, standard length 1.80 times of predorsal distance, 3.91 times of maximum body depth, 3.61 times of head length, 3.91 times of prepectoral distance, 1.90 times of preventral distance and head length 5.23 times of eye diameter.

This subspecies is found in the Küçük Menderes, Büyük Menderes and Gediz River in Western Anatolia (Balık, 1974), the Tarsus Stream, the Seyhan region (Balık, 1988) and the Asi River (Krupp, 1985) in the Mediterranean Region. Our findings clearly showed that there were morphologic differentiations between populations living in two different regions where they do not become genomic transferees. Additional morphological and genetic analyses of all Turkish *Barbus* taxa will be needed to resolve the taxonomic relationships.

***Capoeta capoeta angorae* (Hanko, 1924)** (Figure 6)

Material examined: Yağcı Village-Hadim (9 specimens), Yerköprü Waterfall-Hadim (18 specimens), Hadim (12 specimens), Başyayla (18 specimens), Gökdere-Bozkır (4 specimens), Sarıveliler (4 specimens), Daran-Sarıveliler (4 specimens), Başyayla Brook-Ermenek (3 specimens), Ermenek-Anamur road (11 specimens), Balkusan Brook-Ermenek (5 specimens), Hamam Village-Mut (9 specimens), Kurtsuyu Creek (7 specimens) (SL: 8.51-15.15 cm)

Diagnostic characters: D IV $8^{1/2}$; A III $5^{1/2}$; L.lat. 60-68; L.trans. 11-12 / 7-8; pharyngeal teeth 2.3.5-5.3.2 (2.3.4-4.3.2); gill rakers 16-20; vertebrae 43-45

The total number of vertebrae of *C. capoeta angorae* is 43-45, consisting of 18-19 ventral vertebrae and 25-27 caudal vertebrae, 14 predorsal vertebrae, 3-4 intermediate vertebrae, and 3-4 preanal vertebrae. The abdominal vertebrae 58-60% total vertebrae, caudal vertebrae 40-42% total vertebrae and predorsal vertebrae 54-60% abdominal vertebrae. Infraobitalis are complete and the 2nd with 2 pores, 3rd with 5 pores, 4th with 2 pores and the last bone no pores; wide and short supraorbitale; preoperculum with 7 wide pores; narrow suboperculum; interoperculum clearly wide and sharply; narrow and concave premaxilla; the last simple dorsal fin-ray extremely weak and its posterior margin without a notch; the pharyngeal teeth 2.3.5-5.3.2, rarely 2.3.4-4.3.2 and extremely long (Figure 7).

The standard length 1.95 times of predorsal distance, 4.05 times of maximum body depth, 3.92 times of head length, 1.81 times of prepelvic distance and head length 4.71 times of eye diameter. Our findings were compared with the *C. capoeta angorae* specimens from Kargı Brook (Alanya), but no important morphological differences were noted. Previous studies by Küçük and İkiz (2004), Alp *et al.* (2005) and Balık *et al.* (2005) had already shown that this subspecies is the dominant taxon in the whole Mediterranean Region up to Köyceğiz (Yuvarlakçay).

***Chondrostoma regium* (Heckel, 1843)** (Figure 8)

Material examined: Hamam Village-Mut 36° 37' 875" N: 033° 22' 032" E (4 specimens, SL: 7.88-13.77 cm)

Diagnostic characters: D III 9-$10^{1/2}$; A III 9-$10^{1/2}$; L.lat. 62- 64; L.trans. 11-13/7-9, pharyngeal teeth (5) 6-6; gill rakers 25-32; vertebrae 46-47

The total number of vertebrae of *C. regium* is 46-47, consisting of 26-27 abdominal vertebrae and 19-20 caudal vertebrae, 14 predorsal vertebrae, 3 intermediate vertebrae, and 2 preanal vertebrae. The abdominal vertebrae 56-57% total vertebrae, caudal vertebrae 43-44% total vertebrae and predorsal vertebrae 52-54% abdominal vertebrae.

Comparisons were made by the premaxilla, maxilla, dentale, pharyngeal teeth, gill rakers and scales of the Göksu *Chondrostoma* with those of *C. beysehirense* (Beyşehir Lake; see Bogutskaya, 1997b) and *C. kinzelbachi* (Asi River; see Krupp, 1985). The latter two species live in nearby geographic regions, but are seen distinctively different from the Göksu specimens that are identified as *Chondrostoma regium* (Figure 9).

Species from *Gobio gobio* group (Figure 10)

Material examined: Habiller-Kazan 37° 07' 82" N: 32° 42' 30" E (5 specimens, SL: 9.26-12.04 cm)

Diagnostic characters: D III 7 $^{1/2}$; A II-III 5-$6^{1/2}$; L.lat. 42 - 44; L.trans. 6/4-5; pharyngeal teeth 3.5-5(4).3; gill rakers 9-11; vertebrae 39-40; predorsal scale 17-18

In species from *Gobio gobio group* 39-40 vertebrae are found, consisting of 21-22 abdominal vertebrae and 18 caudal vertebrae, 10-11 predorsal vertebrae, 2-3 intermediate vertebrae, and 2 preanal vertebrae. The abdominal vertebrae 54-55 % total vertebrae, caudal vertebrae 45-46 % total vertebrae and predorsal vertebrae 48-50% abdominal vertebrae.

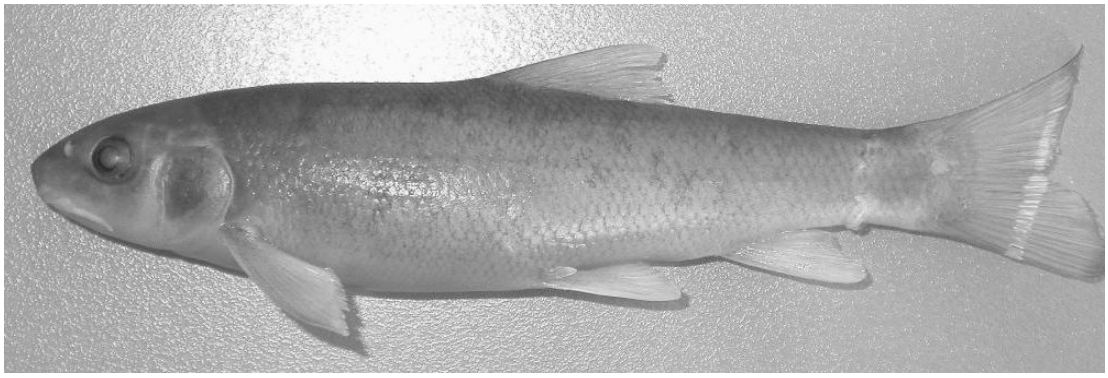

Figure 6. *Capoeta capoeta angorae* (Hanko, 1924) **.**

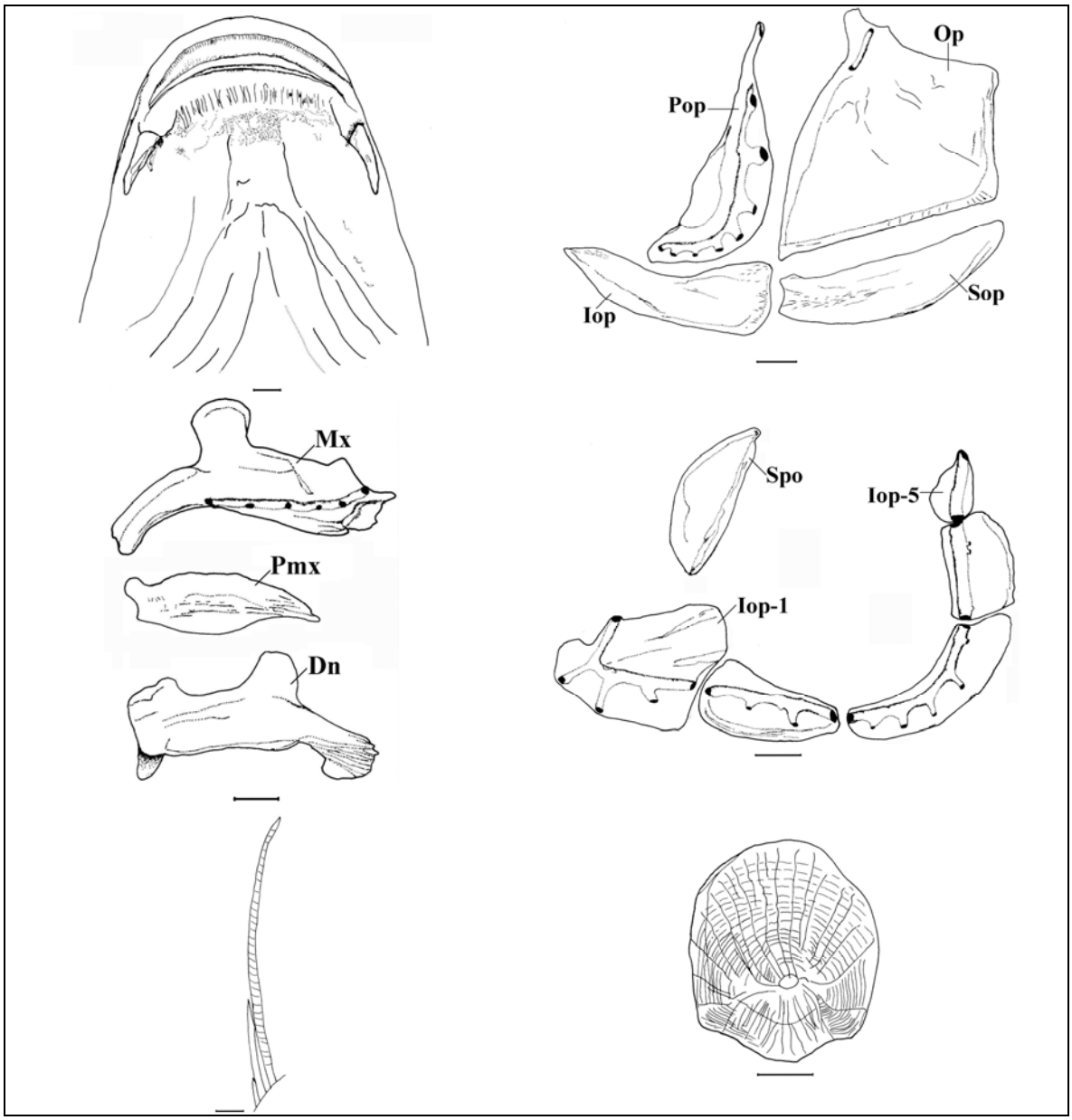

Figure 7. Head, bones of opercular, jaws, circumorbitals, last simple dorsal fin-ray and scale of *C. c. angorae* (Scale bars: 1 mm).

Figure 8. *Chondrostoma regium* (Heckel, 1843)**.**

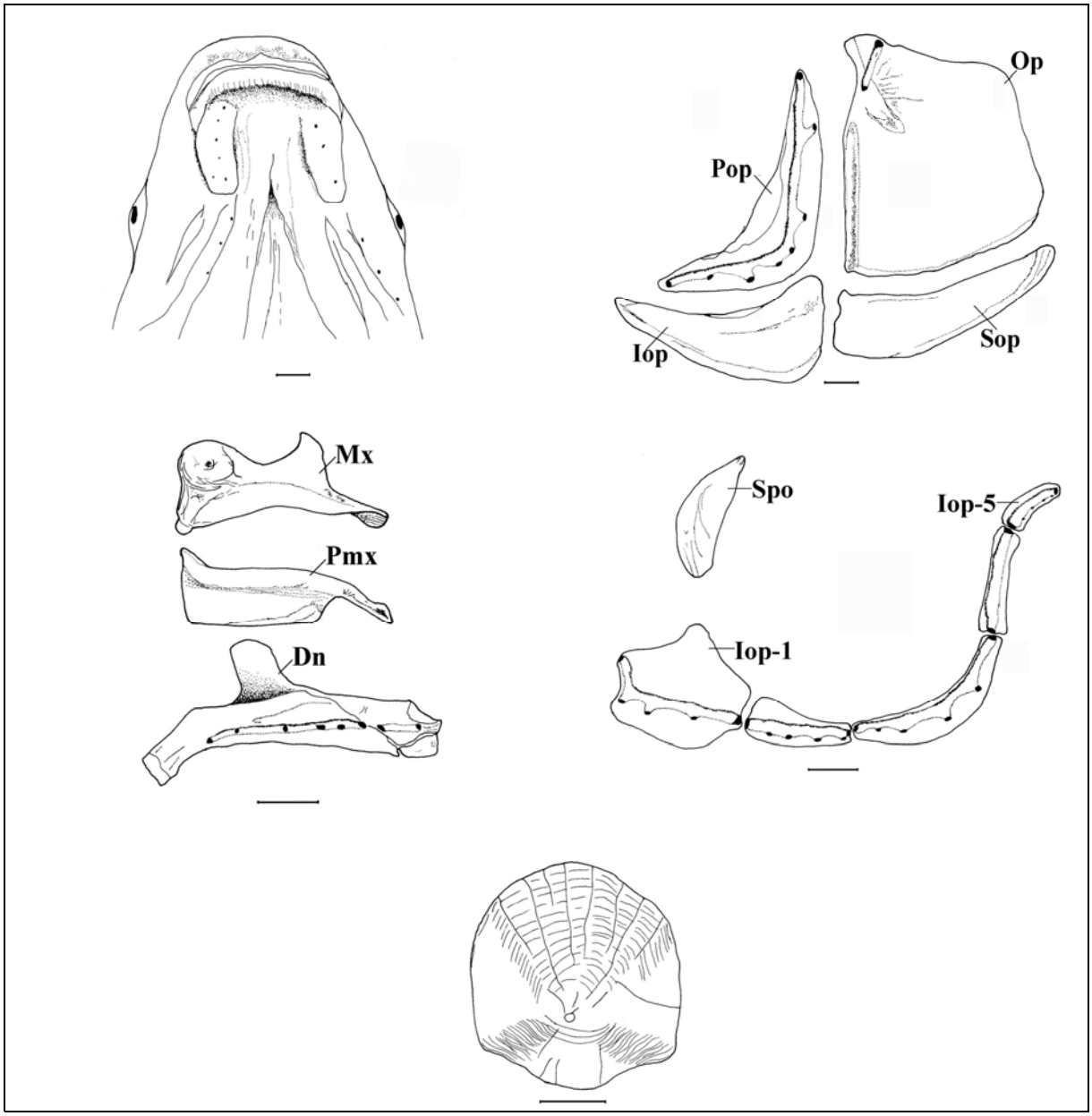

Figure 9. Head, bones of opercular, jaws, circumorbitals and scale of *C.regium* (Scale bars: 1 mm).

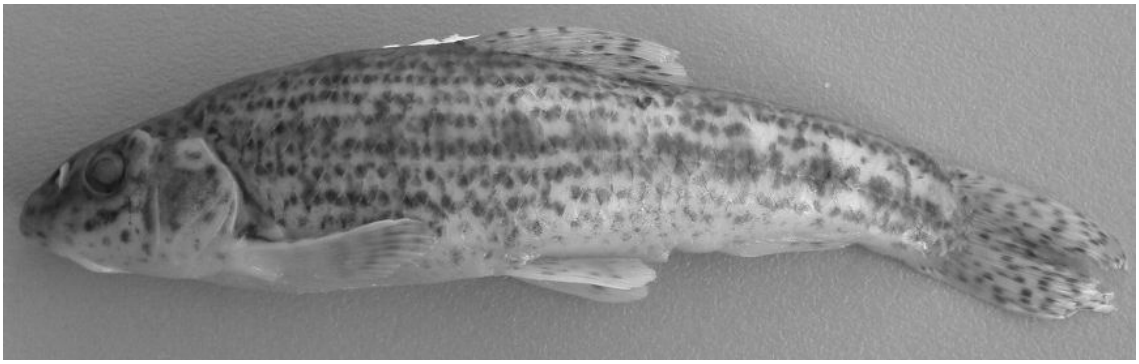

Figure 10. Species from *Gobio gobio* group**.**

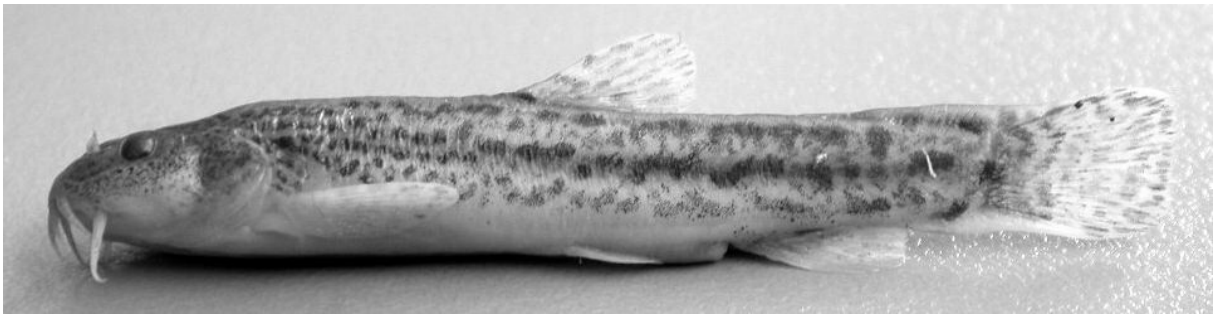

Figure 11. *Seminemacheilus cf. ispartensis*.

Family: Balitoridae

Seminemacheilus cf. ispartensis (Figure 11)

Material examined: Habiller-Kazan 37° 07' 82" N: 32° 42' 30" E (8 specimens, SL: 3.76-9.26 cm)

Diagnostic characters: D III $7^{1/2}$; A II 5-$6^{1/2}$; P I 9-10; V II 5-6; C 16; vertebrae 36

Family: Clariidae

***Clarias gariepinus* (Burchell, 1822)**

Material examined: River mouth-Silifke (4 specimens SL: 23-40)

Diagnostic characters: D 66-72; A 45-47; P I 11-13; V I 6-9; gill rakers 39-62

The morphological features of the *Clarias* specimens caught in this study match with those described by Teugels (1982) for *C. gariepinus*.

Family: Mugilidae

***Mugil cephalus* Linnaeus, 1758**

Material examined: Drainage canals-Atakent (6 specimens, SL: 26-42 cm); River mouth-Silifke (3 specimens, SL: 18-23.6 cm)

Diagnostic characters: D_1 IV; D_2 I-II 7-9; A III-8; Sq. 40-48; pyloric appendages 2

***Liza ramado* (Risso, 1810)**

Material examined: River mouth-Silifke 36° 18' 915" N: 034° 02' 025" E (4 specimens, SL: 16.95-20.85 cm)

Diagnostic characters: D_1 IV; D_2 I (II) 7-8; A III 9 (10); Sq. 42-47; pyloric appendages 6-8

***Liza saliens* (Risso, 1810)**

Material examined: River mouth-Silifke (2 specimens, SL: 15.54-15.79 cm)

Diagnostic characters: D_1 IV; D_2 I (II) 8-9; A III 8-9; Sq.42-48; pyloric appendages7-8

Discussion

Göksu River upstream basins slope is too much because of following from narrow canyon and deep valley up to Suçatı, where two main branches reunite, and typically trout zone. In this region, there is plenty of *C. c. angorae*, rarely Species from *Gobio gobio* group and *S .cf. ispartensis* taxons. Our *Balitoridae* specimens was identified as *S. cf. ispartensis,* incomplete lateral line; mouth horseshoe shaped; lower lib distinctly folding and small space in the midst of lib; caudal peduncle distinctly skin folding. The first record species in Göksu River are *S. t. macrostigma* caught from Başyayla on Ermenek branches. Our specimen taxonomical features are similar to İkiz and Küçük (2004) findings in Köprüçay and Alara specimens.

The taxonomic features of the Göksu River species from *Gobio gobio* group specimens were compared with data of Naseka *et al.* (2006) which are *G. battalgilae* (Eyilikler Brook connection with Beyşehir Lake), *G. insuyanus* (İnsuyu-Cihanbeyli), *G. gymnostethus* (Kızılcık Brook-Niğde), *G. microlepidotus* (Beyşehir Lake) and *G. hettitorum* (Gökdere-Karaman) in the near geographic regions. Our specimens are differentiated from *G. battalgilae, G. insuyanus*, *G. gymnostethus,* by reducing of predorsal scale count 17-18 (vs. 20-32) and small eye diameter, and from *G. microlepidotus* and *G. hettitorum* also by reducing of predorsal scale count (vs. 22-32, 23-30) and lateral line (vs. 43-48, 45-47). For the species from *Gobio gobio* group from Anatolia, it was considered probably as a new species.

B. c. pectoralis and *C. regium* are, on the other hand, found a little at Suçatı and its downstream region. *A. anguilla* distributes from river mouth up to upstream basins, with a length of approximately 100 km. The mugilids *M. cephalus*, *L. ramado* and *L. saliens* are widely distributed at the river mouth and in drainage canals (Table 1).

Sampling in the river mouth area did not yield

Table1. Fish taxons, percent distributions and sampling stations in Göksu River

Family	Species	Specimen Numbers	Distribution (%)	Sampling station
Anguillidae	*Anguilla anguilla* (L., 1758)	5	2.7	11, 13, 14
Clupeidae	*Sardinella aurita* Valenciennes, 1847	8	4.5	14
Salmonidae	*S. trutta macrostigma* (Dumeril, 1858)	1	0.6	4
Cyprinidae	*Cyprinus carpio* L., 1758	4	2.3	13, 14
Cyprinidae	*B. capito pectoralis* Heckel, 1843	19	10.7	11, 14
Cyprinidae	*C. capoeta angorae* (Hanko, 1924)	104	59.0	1-3, 5-12
Cyprinidae	*Chondrostoma regium* (Heckel, 1843)	4	2.3	11
Cyprinidae	*Species from Gobio gobio group*	5	2.7	10
Balitoridae	*Seminemacheilus cf. ispartensis*	8	4.5	10
Clariidae	*Clarias gariepinus* (Burchell, 1822)	4	2.3	13
Mugulidae	*Mugil cephalus* L., 1758	9	5.1	13, 14
Mugulidae	*Liza ramado* (Risso, 1810)	4	2.3	13, 14
Mugulidae	*Liza saliens* (Risso, 1810)	2	1.1	13, 14

any Cyprinodontidae as far as 5-6 km inland, but euryhaline marine species such as *Diplodus sargus*, *Umbrina cirrosa*, *Pomatomus saltator*, *Selar djeddaba*, *Sphyraena chrysotaenia* and *Lichia amia* occurred.

The hydro-electric power plants, dams and irrigation regulators have a negative effect on certain taxa such as *A. anguilla*, *S. t. macrostigma* and some cyprinids whose migrations and their reproduction are hampered. It is, in addition, likely that the river dams have an adverse effect on the breeding areas of the cyprinids because of the irregular water flow changes.

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