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U S A

Aktenzeichen Tel.-Durchwahl 39- Datum

9 March 1983

Dear Dr. Behnke,

enclosed, please find my ms. I asked Dr. Wittmer to arrange your paper before my one to ensure page priority for your C. mhalensis. For the same reasons, I would like to ask you not to cite any of the new names in my ms together with a description.

As I decided to write the paper in English, it took me loger than I had thought. As there is no native speaker here who might have a look at the ms, I apologize for linguistic insufficiencies.

Please let me know whether you changed the taxonomic status of any of your taxa and whether you have any objections. I would like to inform Dr. Wittmer as soon as possible that the paper can go to print.

Yours sincerely

Friedhelm Krupp

Friedhelm Krupp

- our ms title is Freshwater fishes of Saudi Arabia not Fr. F. of Arabia.
- No change w/regard to C. sinhalensis taxonomic status. pharyngeal teeth of ~~our sinhalensis~~ same is the same as his description.
- Can he write my last name as Alkahem not Al-Kahem.?
- All our specimens the same as his except the unusual Garra from west of Almadinah. Later we will shed more light on its status.
- Cyprinion acinaces acinaces was collected from Ain Adi, Ain ~~Salaleem~~ Salaleem ~~&~~ Ain Aljimyma, etc. Khaybar (see our ms).

3?/31 C. a. hijazi was collected from Hadiyah.

-p. Hadiyah located at 25°33'N 38°.44'E not as mentioned in his MS.

- We got one specimen of Garra buettikeri from Wadi Nejran (ArRubalkhali Basin). this spec. was sent to ~~C~~ Brain Coad.
- Two specimens of Garra tibanica were collected from W. Almhaleh, about 9 km southeast of Abha. other localities are described in our ms.

P. 22 Barbus apoensis was collected from Red sea dranages (Hadiyah al Ain Aljimyma, ~~Khaybar~~ Khaybar) i.e. not endemic to Ar Rubalkhali basin as indicated (see our ms).

→ over

P. 48

~~In some~~ He mentioned in his ms that *G. buettikeri* and ~~[illegible]~~ tibanica has 8 branched dorsal ray ---
Is he sure? in the key said 7?

— Can he send us a copy of → P. 102 ATAUR-RAHIM (1981-2) and
P. 117 Villwock, Scholl & Krupp 1983 papers -?

— Page 93 *B. arabicus* also has smooth dorsal spine -
B. luteus, *canis*, *chantrei*, *apoensis*, *exulatus*
have 6 branched anal rays not 5 as mentioned -

P. 99 line 14 - levant, Iranean not Arabian.
P. 100 line 10. *G. dhalensis* is not endemic to
the red sea but it is endemic to Aru Rub al Khali' Basin ?

P. 102 line 4 ~~Compare~~ Unlike ..... Africa
please Compare this statements w/ page 100 line
12 i.e. the ancestor of *G. tibanica* ...

P. 107 our address is Ft. Collins, Colorado
USA.

unbranched
" branched
48: 21
55: 7

Freshwater Fishes of Saudi Arabia and Adjacent Regions

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Alkahe

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At-Kahem

Ar

Alkahem

Abstract: The freshwater fishes of the Arabian peninsula are described from 4500 specimens. The following new taxa are added to a list of 10 species known so far: *Cyprinion acinaces hijazi*, *Garra buettikeri*, *G. mamshuqa*, *G. sahilia* and *G. sahilia gharbia*. All subspecies of *G. tibanica* Trewavas, 1941, which have so far been described from Yemen, are synonymized with the nominal subspecies. On the other hand at least three species of *Garra* were included in *G. tibanica* by earlier authors. Thus a revised diagnosis of this species is given. *G. barreimiae* Fowler & Steinitz, 1956 and *G. longipinnis* Banister & Clarke, 1977 are aligned with *G. persica* Berg, 1913.

Based on the distribution and affinities of primary freshwater fishes, the Arabian peninsula is divided into three ichthyogeographical subprovinces: 1. The Oman mountains with three species closely related to or conspecific with Iranian Cyprinidae; 2. The Red Sea and Gulf of Aden drainage systems with a remarkably uniform fishfauna of seven endemic species, and 3. The western part of the Rub' al-Khali drainage with three endemic species. No primary freshwater fishes are known from other parts of the peninsula. A hypothesis on the evolution and zoogeography of the circum Arabian *Aphanius dispar* complex is presented.

CONTENTS

INTRODUCTION

Since BANISTER & CLARKE published the first comprehensive work on Arabian freshwater fishes in 1977 several new collections were made, above all by Prof. W. Büttiker, Jeddah, who kindly sent me the freshwater fishes he caught during his extensive zoological expeditions in Saudi Arabia. This new material enlarges our knowledge about the Arabian ichthyofauna considerably and thus inspired this paper. Büttiker's material is stored in the 'Naturhistorisches Museum Basel'. In addition the extensive collections of the British Museum (Natural History), including type specimens from most Arabian freshwater fishes, were studied. Furthermore fishes collected by the late Prof. G. Scortecci in Yemen, which are stored in Genova, and material from the authors collections are included in this survey.

Although an emphasis is put on Saudi Arabia, all freshwater fishes of the Arabian peninsula, in the following refered to as Arabia, are considered. The northern boundry of this area is roughly the border of Saudi Arabia, although Wadi as-Sirhan is included in its full length and populations of two species from the Dead Sea rift valley with otherwise mainly or entirely Arabian distribution are dealt with in this paper as well. The coast lines of the Persian-Arabian Gulf, the Indian Ocean and the Red Sea define the other boundaries of the peninsula. With approximately three millon km^2 this area almost reaches the size of India, but while c. 700 species are known to occur there, only about ten species have so far been described from Arabia. This situation is mainly to be attributed to the arid climate. Fishes are largely restricted to higher altitudes where precipitation is higher than in the low lands.

The first to report a freshwater fish from Arabia in modern biological literature was PLAYFAIR (1870) who communicated a record of Discognathus lamtus from Aden. From Jayakar's collection of mainly marine fishes, BOULENGER (1887) described Scaphiodon muscatensis and recorded Cyprinodon dispar. In 1921 HORA described Garra arabica from Yemen. In a paper on the zoogeographical division of the palearctic region based on the distribution of fishes, BERG (1934) refers the northern part of Arabia to the 'Syrian province' while he tentatively includes the central and southern part of the peninsula in the 'Anterior Asian' province, together with parts of Iran and Turkey.

In 1937-38 the British Museum (Natural History) carried out the first systematic zoological collections in SW Arabia. From the material obtained during this expedition, TREWAVAS (1941) described three new species: Barbus arabicus, Garra tibanica and Garra brittoni. In 1950 ERDMAN reports killifishes and mugilids from al-Hasa, Saudi Arabia, without giving scientific names. Six years later FOWLER & STEINITZ describe Garra barreimiae from Oman.

MENON (1964) in his revision of the genus Garra synonymizes G. brittoni with G. tibanica and regards G. arabica as a possibly mislabeled G. nasuta. In 1963 and 1965 Scortecci carries out extensive zoological collections in Yemen. From his material BALLETTO & SPANÓ (1977) describe seven new subspecies of Garra tibanica, furthermore they regard G. brittoni as a subspecies of the latter. In the same year BANISTER & CLARKE publish the so far most comprehensive paper on Arabian freshwater fishes. They agree with BERG (1949) in synonymizing Scaphiodon muscatensis with Cyprinion microphthalmum. Furthermore they describe four new species: Barbus apoensis, B. exulatus, Cyprinion acinaces and Garra longipinnis, and one new subspecies: G. barreimiae shawkahensis. In 1982 KRUPP describes G. tibanica ghorensis from the Dead Sea rift valley and in 1983 VILLWOCK, SCHOLL and KRUPP describe Aphanius sirhani from Azraq.

Fossil freshwater fishes were recorded by BROWN (1970) from the Jizan basin ('... a cyprinid... which falls within the structural range of the recent Barbus. The other is of a cichlid, close, if not identical, to the living Tilapia...'). VAN COUVERING (1977) reports on a Barbus and an unidentified cichlid from the Red Sea coast of Saudi Arabia.

In this paper the following taxa are recognized as valid: Barbus apoensis, B. arabicus, B. exulatus, Cyprinion acinaces, C. mhalensis, Garra b. barreimiae, G. b. shawkahensis, G. longipinnis, G. t. tibanica, G. t.

ghorensis, Aphanius d. dispar, A. d. richardsoni and A. sirhani. Cyprinion muscatensis is regarded as a subspecies of C. microphthalmum. Three new species and two new subspecies are described.

Sor far six species of freshwater fishes have been introduced within the area characterized above: Barbus canis, Cyprinus carpio, Clarias gariepinus, Tilapia zillii T. aurea and Gambusia affinis (AL-KAHEM & BEHNKE 1983; VILLWOCK, SCHOLL & KRUPP 1983). They are not described here. Furthermore unidentified species of marine fishes entering freshwaters or secondary freshwater fishes were reported from Arabia (Gobiidae, Mugilidae). These two families are included in the key but not described.

Paleogeography and hydrography

From the Precambrian to the Paleogene the African-Arabian block forms a continous plate. Tectonic movements during the Mesozoic result in an eastward tilting of the Arabian shield. During the Cenozoic the Arabian plate splits away from Africa along the Red Sea rift valley. The separation from the African shield is accompanied by extensive volcanism in the western part of the peninsula and the Zagros orogeny in the east. Both processes influence the drainage network of the peninsula.

The extant drainage system was mainly formed during the Pliocene. Pluvial freshwater lakes existed in the internal basins of the peninsula. Hyperaridity of present day intensity began only 17,000 years B.P. The present hydrographic situation is characterized by the fact that not a single larger water course reaches the sea throughout the year. The wadi (pl.= widyan) is a typical feature of the peninsula. This Arabic word refers to a river bed, while a water course is called 'nahr'. Unlike the latter, a wadi is not regarded as being continuous thus different names are given to different sections (e.g. Wadi Hadramaut and Wadi Masila refer to the upper and lower course respectively of the same river bed). Water courses are interrupted for most time of the year. They frequently disappear shortly behind the source and continue below the surface. The central courses of the widyan are often restricted to a series of pools which form a refuge for freshwater animals. In addition, salinity is high in the internal drainage basins. Thus potential living space for freshwater fishes is limited in Arabia.

No review of paleogeography covering the whole peninsula has so far been published. Because of its significance for the present pattern of fish distribution a short outline of paleogeography during the relevant period will be given below. It is based on a large number of geological publications with different and sometimes conflicting results, above all: PICARD 1952; BEYDOUN 1966; GEUKENS 1966; POWERS et al. 1966; GREENWOOD & BLEACKLEY 1967; WOLFART 1967; BROWN 1970; DUBERTRET 1970; KASSLER 1973; NELSON 1973; BENDER 1975; CHAPMAN

1978; McCLURE 1978; BUDAY & TYRACK 1980 and WOHLFAHRT 1980.

The Persian-Arabian Gulf and the east coast of Arabia: The Gulf is a shallow epicontinental sea of late Pliocene to Pleistocene age. The Zagros orogeny and the coastal structures of Arabia are results of the same tectonic events that led to the formation of the Gulf. Towards the end of the Pliocene the basin reaches its present shape, but the water level is about 150 m higher than today. The lowering of sea level results in marine terraces and sabkhas on the east coast of Arabia. During the Pleistocene glaciations, the sea falls at least 120 m below its present level, thus the basin, which is only 110 m deep is separated from the Indian Ocean and a river valley conducts the waters of Mesopotamia to the Gulf of Oman.Tributaries from the Arabian peninsula and from the Zagros-Laristan chains drain into this basin. Only about 20,000 years B. P. the sea begins to rise again reaching its present level some 5000 years ago. Thus a freshwater connection which allowed a faunal exchange between Iran and Arabia existed almost without interruption between 70,000 and 20,000 years B.P.

The Mesopotamian basin: Up to the Paleogene, the African-Arabian landmass is separated from Europe and Asia by the Tethys sea. During the Eocene and Oligocene an extensive regression results in continental conditions all over E Syria towards the late Oligocene. The short-termed Miocene transgression connects the

Mediterranean for a last time with the Persian-Arabian Gulf. A continous land bridge between Eurasia and Africa, which serves as a pathway of migration for freshwater animals is in existance since the upper Miocene. The Tigris and Euphrates drainage network formed during the Pliocene and stabilized during the lower Pleistocene. It was colonized by primary freshwater fishes not earlier than the late Pliocene when mesohaline conditions disappeared.

The Wadi as-Sirhan depression: The as-Summan plateau is the southern prong of the larger Syrian plateau. The whole physiographic unit extends from 300 km S of al-Hufhuf across NE Saudi Arabia and W Iraq to Syria where it meets the Jordan highlands. It separates Mesopotamia from the Azraq - Wadi as-Sirhan basin, a N-S trending depression of about 300 km length and 30 to 50 km width. Azraq lies in its northern extension. There is no geological evidence of a former freshwater connection between Wadi as-Sirhan and the Jordan system or the Euphrates. The Miocene transgression into the Jordan rift valley reaches Wadi as-Sirhan. During the Pleistocene the Azraq area is covered by a vast freshwater lake of 4000 km^2. Today there are about 5 km^2 of perennial water bodies within the Azraq area. The water is mainly discharged from the Hauran-Jabal Druz mountains in S Syria.

The Wadi Araba - Dead Sea - Jordan rift valley: The Wadi Araba - Jordan depression is a 360 km long section of a vast rift valley system that extends from

N Syria to E Africa. The successive formation of the Orontes - Jordan rift valley is of Pliocene and lower Pleistocene age. During the Pluvial B, which corresponds to the European Riss glaciation, the rift valley is covered by a freshwater lake (Lake Samra) which extends from a point 50 km S of the Dead Sea to Lake Tiberias. With increasing desiccation it changes into the brackish Lake Lisan. During the Interpluvial C, increased evaporation results in the formation of two highly saline lakes. Fish fossils indicate that Lake Lisan itself was less saline than the Dead Sea. The present network of the Jordan system formed during the Pluvial C.

The Red Sea and the west coast of Arabia: The Tertiary faulting in the area between Africa and Arabia results in the lowering of the Erytrean rift valley. During the Eocene and Oligocene a branch of the Mediterranean extends to the level of Qusair in the N Red Sea depression. At the same time a series of freshwater lakes exists in the southern part of the rift valley while marine conditions dominate during the Miocene. Only the narrow Abyssinian land bridge still separates theErytrean basin from the waters of the Indian Ocean. During the Pliocene the Indian Ocean breakes through the strait of Bab al-Mandab. An uplift in the Suez region interrupts the connection between the Red Sea and the Mediterranean. Thus an exchange of African and Arabian freshwater fishes was easily possible until the Miocene. Thereafter only the narrow land barrier in the south served as a potential pathway. Since the upper Pliocene the Sinai peninsula is the only remaining connection between Africa and the Middle East, although it obviously was of little importance for an exchange of freshwater faunas between Africa and the Arabian peninsula. The Red Sea rift valley is the result of Tertiary faulting which is connected with a renewed movementon regional Precambrian faults. Along the east side of the Red Sea three fault-bounded blocks arise: The Midian block in the north, an inhomogenous central block and the Asir block in the south. This mountain belt between Aqaba and the Bab al-Mandab is 40 to 140 km wide. It is characterized by a steep western edge and the gently eastward tilted Arabian shield. The uplift of the mountain chains influenced the drainage pattern. The lower courses of some larger widyan, which formerly flowed to the south were captured by westward flowing drainages and diverted to the Red Sea. An extremely dry coastal plain lies between the mountains and the sea.

Yemen and Dhufar: Faulting in this region is mainly of Mesozoic origin with repeated rejuvenation. The main phase of faulting in the Red Sea trend lasts from the late Cretaceous until the Eocene. In the Gulf of Aden trend the faulting is of early Miocene age. Behind the coastal plain the country has a pronounced E-N tilt, which determines the primary drainage pattern. Most strike streams of Yemen are fault controlled and headwater erosion frequently results in capture by a few larger streams such as Wadi Bana and Wadi Dayqah, which demonstrate both N and NE flowing components. Widyan from the Nisab Bayhan and Yemen mountains swing toward the line of the Wadi Hadramaut and disappear in the internal drainage basin of the Ramlat Sab'atayn. Subterrane seepage into the Wadi Hadramaut flows along former Wadi courses thus indicating that the above widyan are a former part of this drainage system. In Dhufar a few very short widyan drain into the Arabian Sea, the majority flows towards the Rub' al-Khali.

Geological processes in the Yemen highlands allowed a faunal exchange between the Wadi Hadramaut-Masila drainage system, the tributaries of the Ramlat Sab'atayn and the coastal drainages of the southern Red Sea and Gulf of Aden until recent geological times, which is of great importance for the composition of the extant ichthyofauna.

The Oman mountains: The Oman mountains or al-Hajar sweep along the eastern edge of the Arabian peninsula roughly parallel to the Gulf of Oman. They reach an altitude of 3000 m and receive, together with the Asir and the Yemen mountains, the highest precipitation in the entire peninsula. A network of widyan carries the drainage towards the Gulf of Oman, the Arabian Sea or into the Rub' al-Khali. The faulting of the Oman mountains is of Neogene origin and continues into the recent. It is in close connection with the Zagros orogeny.

Central highlands and internal basins: One third of the peninsula is covered by mobile sands. They accumulate in several internal basins: Between the Syrian plateau, the Hisma plateau and the Jabal Shammar lies the Great Nafud with a surface of 57,000 km^2. The Jafurah ranges E of the as-Summan plateau. Ad-Dahna forms a narrow belt which in a long arc extends from the Nafud to the Rub' al-Khali ('empty quarter'). Parallel to ad-Dahna, an area of eolian sand follows along the W edge of the Tuwayq escarpment. The Rub' al-Khali in the south is the largest desert basin of Arabia with a surface of 600,000 km^2. The oasis belt of the Cuesta region ranges east of the Tuwayq. The central plateau region to the west forms an important water shed. The Tuwayq escarpment is transected by several major wadi channels, e.g. Wadi ad-Dawasir.

The Rub' al-Khali and other internal drainage basins were covered by a series of inland lakes during the pluvial phases of the Pleistocene. Hyperarid conditions began about 17,000 years B. P. A northernly displacement of the SW monsoon during the Holocene resulted in a sub-pluvial phase in the Rub' al-Khali from 9000 to 6000 years B. P. Holocene lake beds existed in the middle of Wadi ad-Dawasir while the main wadi had ceased to flow by this time. Mastodon, rhinoceros and crocodile remains from the Dam formation in central Arabia indicate a formerly subtropical climate. The potential importance of the internal basins for the migration of freshwater fishes will be discussed below.

MATERIALS AND METHODS

Freshwater fishes collected by Professor Büttiker or by the author were preserved in 4 % formalin and later transfered to 70 % ethanol. Nothing can be said about the museum material.

Specimens from museum collections were often inaccurately labeled.Contradictory data were not uncommon (e.g.'Wadi Hadramaut, Saudi Arabia'). Different transliterations of original Arabic localities are an additional problem. The international transliteration as recommanded by the congress of orientalists in Rome (1935) would avoid a lot of confusion. It is not applied here as usually only orientalists are able to read it properly. Anyhow spellings of geographical names were standardized throughout the text.

Based on information from labels and, if available, reports on the collectors' travels it has been tried to establish exact locality data. Longitudes and latitudes are given for collecting sites which were located unequivocally.

Morphometric measurements were taken with dial calipers to the nearest tenth millimetre. Measurements follow mainly BANISTER & CLARKE (1977). They are modified as stated below. The following abbreviations are used:

Morphometric characters:

aa- distance between the anus and the origin of the anal fin bd- greatest depth of the body

cd- least depth of the caudal peduncle

cl- length of the caudal peduncle, distance between a line perpendicular to the posterior margin of the anal fin origin and a line perpendicular to the end of the hypural plate

ed- horizontal eye diameter

hl- head length, distance between a line perpendicular to the tip of the snout and a line perpendicular to the posterior margin of the opercular bone

iow- least bony interorbital width

la- length of the largest anal fin ray

lab- length of the anal fin base

lba- length of the anterior barbel

lbp- length of the posterior barbel

ld- length of the longest dorsal fin ray

ldb- length of the dorsal fin base

lmd- maximum length of the mental disc

lp- length of the largest pelvic fin ray

lpc- length of the largest pectoral fin ray

sa- distance between a line perpendicular to the tip of the snout and a line perpendicular to the origin of the anal fin

sd- distance between a line perpendicular to the tip of the snout and a line perpendicular to the origin of the dorsal fin sl- standard length, distance between a line perpendicular to the tip of the snout and a line perpendicular to the end of the hypural plate

sp- distance between a line perpendicular to the tip of the snout and a line perpendicular to the origin of the pelvic fin

tl- total length, distance between a line perpendicular to the tip of the snout and a line perpendicular to the posterior margin of the caudal fin

wm- width of the widest part of the mouth

wmd- maximum width of the mental disc

Meristic characters:

A- number of anal fin rays; in Cyprinidae Roman numerals refer to unbranched rays, Arabic numerals refer to branched rays; in Cyprinodontidae the total number of fin rays is given

ALL- number of scales between the lateral line and the anterior margin of the dorsal fin origin, scales on the dorsal mid line are counted by half

BLL- number of scales between the lateral line and the anterior margin of the anal fin origin

CCP- number of scales arround the least circumference of the caudal peduncle

D- number of dorsal fin rays (counted as under A)

GR- number of gill rakers on the lower limb of the first gill arch in Cyprinidae; total number of gill rakers in Cyprinodontidae

LL- number of scales in the lateral line series, from the first pore-bearing scale to the last scale on the caudal fin in Cyprinidae; from the first complete scale to the scale lateral to the end of the hypural plate in Cyprinodontidae

PT- number of pharyngeal teeth

Other abbreviations:

f- frequency

n- sample

SD- standard deviation

$\bar{x}$- mean value

BMNH- British Museum (Natural History), London

KMMA- Koninklijk Museum voor Midden-Afrika, Tervuren

MCSN- Museo Civico di Storia Naturale, Genova

NHMB- Naturhistorisches Museum Basel

SMF- Senckenberg Museum, Frankfurt

UDG- Università di Genova

UJZM- University of Jordan Zoological Museum, Amman

ZMH- Zoologisches Institut und Zoologisches Museum, Hamburg

ZSI- Zoological Survey of India, Calcutta

DESCRIPTIONS

Key to the families

1. Two dorsal fins present 2
- One dorsal fin present 3

2. Pelvic fins fused forming a ventral sucker . Gobiidae
- Pelvic fins separated .... Mugilidae

3. Three pairs of barbels, very long dorsal and anal fin .... Clariidae
- Less than three pairs of barbels 4

4. No teeth in jaws .... Cyprinidae
- Teeth in jaws 5

5. Several ossified dorsal and anal spines .. Cichlidae
- No ossified dorsal or anal spines 6

6. Anal fin forming a gonopodium in males, teeth in jaws conical .... Poeciliidae
- No gonopodium, jaw teeth tricuspid . Cyprinodontidae

Only Cyprinidae and Cyprinodontidae will be described below.

Fam. Cyprinidae

Key to the genera

1. Mental disc present on ventral surface of the head .... Garra

- No mental disc 2

2. Lower lip covered with sharp-edged horny sheath .... Cyprinion

- No horny sheath on lower lip 3

3. Barbels present, less than 7 branched anal rays .... Barbus

- No barbels, more than 10 branched anal rays .... Acanthobrama

The genus Acanthobrama is not described here as there was no material available.

Gen. Barbus Cuvier, 1817

Key to the species

1. Anal fin with 5 branched rays .... B. arabicus

- Anal fin with 6 branches rays 2

2. One pair of barbels .... B. apoensis

- Two pairs of barbels 3

3. Dorsal fin with 10 branched rays .... *B. canis*
- Dorsal fin with 7-9 branched rays .... *B. exulatus*

Barbus canis is not included in the descriptions as it is not native to Arabia (see above).

Barbus apoensis Banister & Clarke, 1977

Barbus apoensis Banister & Clarke, 1977: J. Oman studies, special report: 113, Khamis Mushyat, Wadi Turabah, Wadi Adama.

Material:

(1) 1 specimen, 53.9 mm sl; Saudi Arabia, Wadi Turabah, 20°29'N 41°09'E, 1580 m above sea-level, 07.-08.X. 1979, leg. W. Büttiker. NHMB 5343

(2) 1 specimen, 90.7 mm sl; Saudi Arabia, Wadi Turabah, 20°30'N 41°17'E, 1430 m above sea-level, 15.-16. IX.1980, leg. W. Büttiker. NHMB 5591

(3) 1 specimen, 129.1 mm sl; Saudi Arabia, Wadi Turabah, 20°29'N 41°12'E , 1470 m above sea-level, 15.-16. IX.1980, leg. W. Büttiker. NHMB 5592

(4) 2 specimens, 50.0-58.6 mm sl; Saudi Arabia, Wadi Shuqub, c. 20°39'N 41°13'E, 1390 m above sea-level, 02.04.1980, leg. W. Büttiker. NHMB 5593-5594

(5) 1 specimen, 213 mm sl; Saudi Arabia, Khamis Mushyat, $18^{o}17$'N $42^{o}34$'E, 1950 m above sea-level, 12.XII.1968, leg. F. Tippler. Holotype, BMNH 1976.4.7: 166

(6) 2 specimens, 137-148 mm sl; Saudi Arabia, Wadi Adama, $19^{o}53$'N $41^{o}57$'E, 1700 m above sea-level, 27.X.1969, leg. J. P. Mandaville. Paratypes, BMNH 1971.2.11: 1-2

A detailed description, including morphometric characters, is given by BANISTER & CLARKE (1977). A juvenile *B. apoensis* is shown in Fig. 3. In young specimens the dorsal profile of the head is convex. It changes to concave in adult specimens. The mouth is terminal. Anterior barbels are absent, posterior barbels are short (2.3-5.6 % of sl) and largely controlled by allometric growth.

The dorsal fin contains 4 unbranched and 10 branched rays in all specimens examined. The posterior margin of the last unbranched ray is smooth. There are 3 unbranched and 6 branched rays in the anal fin.

Gill rakers are long and widely spaced, they number 6-9 on the lower limb of the first gill arch.

For 7 specimens they examined, BANISTER & CLARKE (l.c.) give 2.3.5-5.3.2 pharyngeal teeth. 4 specimens examined here had 2.3.4-5.3.2 (f3) or 2.3.5-5.3.2 (f1).

Alcohol preserved *B. apoensis* are grey-brown laterally and dark brown dorsally. The flanks below the lateral line are yellow ochre and gradually change to whitish on the ventral surface.

Barbus apoensis is endemic to the Wadi Dawasir drainage system. Its distribution is shown in Fig. 5 a.

This species can be distinguished from all other *Barbus* in Arabia by the lower number of barbels. The affinities of Arabian *Barbus* will be discussed below.

Barbus arabicus Trewavas, 1941

Synonymy

Barbus arabicus Trewavas, 1941; Brit. Mus. (Nat. Hist.) Expedition to SW Arabia 1937-8, 1: 14, Wadi Kharid.

Tor arabicus: Karaman 1971; Mitt. Hamburg. Zool. Mus. Inst., 67: 226.

Barbus arabicus: Banister & Clarke 1977; J. Oman studies, special report: 120, Wadi Hadramaut, Wadi Madhab, Wadi Sahama, Wadi Maur, Wadi al-Cain, Wadi Sirdud.

Material:

(1) 1 specimen, c. 351 mm sl; Yemen, Wadi Kharid 20 km NE San'a, c. 15°36'N 44°13'E, 1937-38, leg. P. W. R. Petrie (obtained as dried specimen from the fish market in San'a). Holotype, BMNH 1940.2.15: 1

(2) 1 specimen, 149.5 mm sl; Yemen, Wadi Sahama, c. 14°40'N43°00'E, leg. G. Popov. BMNH 1976.4.7: 198-200

(3) 4 specimens, 18.0-28.6 mm sl; Saudi Arabia, Wadi Juva, 17°20'N 42°08'E, 70 m above sea-level, 22.IX.1981, leg. W. Büttiker. NHMB

(4) 20 specimens, 47.0-78.2 mm sl; Yemen, Wadi al-Bahr, 13°23'N 43°45'E, c. 500 m above sea-level, 02.VIII. 1965, leg. G. Scortecci. UDG

(5) 15 specimens, 38.0-102.9 mm sl; Yemen, Wadi al-Kasaba, c. 15°10'N 43°40'E, 24.VIII.1965, leg. G. Scortecci. UDG

(6) 7 specimens, 51.7-68.1 mm sl; Yemen, Wadi al-Gadan, 16.VIII.1965, leg. G. Scortecci. UDG

(7) 46 specimens, 39.2-129.2 mm sl; Yemen, Wadi Hammam Ali, 14°43'N 44°07'E, 06.-08.IX.1965, leg. G. Scortecci. UDG

(8) 7 specimens, 53.8-103.6 mm sl; Yemen, Wadi Multaka, 13°35'N 43°53'E, 10.X.1965, leg. G. Scortecci. UDG

(9) 21 specimens, 73.8-159.0 mm sl; Yemen, Resian, 13°41'N 43°42'E, October 1965, leg. G. Scortecci. UDG

(10) 59 specimens, 37.1-159 mm sl; Yemen, Madinat al-Abid, 14°42'N 44°02'E, 10.IX.1965, leg. G. Scortecci. UDG

(11) 25 specimens, 33.8-172.0 mm sl; Yemen, Wadi Railama, 14°43'N 43°37'E, 10.-11.IX.1965, leg. G. Scortecci. UDG

A detailed description is given in BANISTER & CLARKE (1977). Morphometric measurements were taken in the 32 largest specimens from the material listed under (4) to (11). They are within the range of data given by BANISTER & CLARKE (l.c.) thus they are not listed here.

The position of the dorsal and anal fin, the length of the dorsal and caudal fin, the head length, the length of the barbels and the eye diameter are largely influenced by allometric growth.

The habitus of an adult specimen is shown in Fig. 1, a juvenile specimen can be seen in Fig. 2. The dorsal surface of the head is convex in juveniles and concave in adult B. arabicus.

The mouth is terminal. Two pairs of barbels are present. The length of the anterior barbel ranges from 3 % of sl in young specimens to 12 % of sl in adults, the length of the posterior barbel is 5.3 to 12.3 % of sl.

The dorsal fin is relatively larger in juvenile specimens. It contains 4 unbranched rays, the last of which is strongly ossified. Its posterior margin is smooth. The number of unbranched rays in 103 specimens examined was 6 (f1), 7 (f2), 8 (f98) or 9 (f2). There are 3 unbranched and 5 branched rays in the anal fin (f103).

In the lateral line series there are 30 (f1), 31 (f5), 32 (f12), 33 (f11), 34 (f6) or 35 (f1) scales in the specimens from N Yemen. This number is slightly higher than the number given by BANISTER & CLARKE (l.c.), which may at least partly be attributed to the different ways of counting (see materials and methods). Between the lateral line and the origin of the dorsal fin there are 3.5 (f1), 4.5(f24), 5 (f8) or 5.5 (f3) scales and 3 (f4), 3.5 (f1), 4 (f24), 4.5 (f2) or 5 (f2) between the lateral line and the origin of the anal fin. In all specimens examined 12 scales encircled the least circumference of the caudal peduncle. Squamation varies between different populations. The degree of scale reduction on the chest is very variable.

Gill rakers are slender and widely spaced. In 39 specimens examined, there were 9 (f1), 10 (f5), 11 (f15), 12 (f15) or 13 (f3) gill rakers on the lower limb of the first gill arch.

Pharyngeal teeth numbered 2.3.5-5.3.2 in all specimens examined.

Preserved B. arabicus are grey-brown dorsally and whitish-yellow ventrally. There is a small black spot in the caudal peduncle of juvenile specimens.

As can be seen in Fig. 5 this species is widely distributed in the southern Red Sea and Gulf of Aden drainage, ranging from southern Saudi Arabia to the Wadi Hadramaut.

B. arabicus differs from other Arabian Barbus in the possession of only 5 branched anal fin rays.

Barbus exulatus Banister & Clarke, 1977

Barbus exulatus Banister & Clarke, 1977; J. Oman studies, special report: 116, Wadi Hadramaut.

Material:

(1) 1 specimen, 178 mm sl; Yemen, Qasam, Wadi Hadramaut, 16°10'N 49°04'E, leg. W. A. King-Webster. Holotype, BMNH 1976.4.7: 299

All paratypes are in the British Museum (Natural History). As there is no new material available, only a brief description is given here.

There are 4 unbranched and 7-9 branched rays in the dorsal fin and 6 branched rays in the anal fin. The number of scales in the lateral line series ranges from 24 to 28. Gill rakers on the lower limb of the first gill arch number 6-9. Preserved specimens are yellow-brown with a darker dorsal surface.

B. exulatus resembles B. apoensis in general body shape but can easily be distinguished from the latter by the possession of two pairs of barbels and its mouth being subterminal. It differs from B. arabicus in the possession of 6 unbranched anal fin rays.

This species is so far only known from the Wadi Hadramaut drainage system and its Pleistocene tributaries (Fig. 5a).

Gen. Cyprinion Heckel, 1843

Key to the species and subspecies

1. Last unbranched dorsal ray in large specimens short and slightly serrated, species occuring in SE Arabia .... C. microphthalmum muscatensis

- Last unbranched dorsal ray large and strongly serrated 2

2. 20 scales arround the least circumference of the caudal peduncle, more than 7 scales between the lateral line and the origin of the dorsal fin .... C. mhalensis

- 16-18 scales arround caudal peduncle, less than 8 scales between lateral line and dorsal fin origin 3

3. 10-13 gill rakers on lower limb of first gill arch, occuring N of al- Qunfidha .... C. acinaces hijazi

- 8-11 gill rakers on lower limb of first gill arch, occuring S of al-Qunfidha .. C. a. acinaces

Cyprinion acinaces Banister & Clarke, 1977

This species occurs in the Red Sea and Gulf of Aden drainage basins of Arabia. It is characterized by D: 10-12, A: 6-7, LL: 37-41, GR: 8-13.

Cyprinion acinaces acinaces Banister & Clarke, 1977

in part: only part of them

Cyprinion acinaces partim Banister & Clarke, 1977; J. Oman studies, special report:123, Wadi Hadramaut, Wadi Kudam.

Cyprinion acinaces : Howes 1982; Bull. Br. Mus. nat. Hist. (Zool.), 42: 332.

Material:

(1) 1 specimen, 109.7 mm sl; Yemen, Qasam area, Wadi Hadramaut, c. 16°10'N 49°04'E, leg. W. A. King-Webster. Holotype, BMNH 1976.4.7: 1

(2) 2 specimens, 78.0-79.1 mm sl; Yemen, al-Ghuraf, Wadi Hadramaut, 16°00'N 49°00'E, leg. W. A. King-Webster. Paratypes, BMNH 1976.4.7: 36-38

(3) 3 specimens, 28.9-48.5 mm sl; Yemen, c. 15°19'N 47°58'E, leg. I. G. Dunn. Paratypes, BMNH 1976.4.7: 39-41

(4) 116 specimens, 17.3-43.3 mm sl; same locality and collector as (3). BMNH 1976.4.7: 42-157

(5) 7 specimens, 33.7-56 mm sl; Yemen, Khun, Wadi Hadramaut, c. 16°10'N 49°10'E, February 1952, leg. Corkill. BMNH

(6) 2 specimens, 52.8-74.6 mm sl; Yemen, Hamdam, c. $15^{o}24$'N $44^{o}09$'E, 02.IX.1965, leg. G. Scortecci. UDG

(7) 1 specimen, 17.7 mm sl; Yemen, al-Ghuraf, Wadi Hadramaut, $16^{o}00$'N $49^{o}00$'E, 1963, leg. G. Scortecci. UDG

A detailed description is given by BANISTER & CLARKE (1977). Anyhow, their material is inhomogeneous as specimens from Taif belong to C. mhalensis. Morphometric characters of specimens examined here are within the range given by BANISTER & CLARKE (l.c.).

The body is high and compressed. The mouth is subterminal and the lower lip carries a sharp-edged horny sheath. The lower jaw is gently arched. Only the posterior barbels are present. Horny tubercles may occur on the snout, in few specimens they cover the fin rays and the entire body surface.

In 12 specimens meristic characters were taken. There are 4 unbranched and 10 (f3) or 11 (f9) branched rays in the dorsal fin and 3 unbranched and 6 (f 2) or 7 (f10) branched rays in the anal fin.

The lateral line is complete. There are 38 (f1), 39 (f4), 40 (f4), 41 (f2) scales in the lateral line series. Between the lateral line and the dorsal fin origin there are 6 (f3) or 7 (f9) scales and 5 (f10) or 6 (f2) between the lateral line and the anal fin origin. Scale reduction occurs on the chest.

Pharyngeal teeth in two specimens examined numbered 2.3.5-5.3.2 . The fifth tooth of the inner row is very small. BANISTER & CLARKE (l.c.) give 2.3.4-4.3.2 for 10 specimens examined. It seems likely, that they oversaw the minute tooth in at least some specimens.

Gill rakers are short and widely spaced, they number 8 (f1), 9 (f1), 10 (f5) or 11 (f3) on the lower limb of the first gill arch.

Preserved specimens are grey-brown dorsally, silvery laterally and silver-white ventrally. Irregular dark spots are present on the flanks of juvenile specimens.

C. a. acinaces is endemic to the recent and Pleistocene tributaries of Wadi Hadramaut (Fig. 6).

The species can be distinguished from C. microphthalmum by the possession of a larger dorsal spine which is strongly serrated. Distinctive characters of other species of Cyprinion in the Arabian peninsula will be given below.

Cyprinion acinaces hijazi n. subsp.

Material:

(1) HOLOTYPE: 1 specimen, 109.4 mm sl; Saudi Arabia, Wadi Hediya (Hadiyah), c. 24°00'N 39°00'E, leg. D. Vesey-Fitzgerald. BMNH 1969.1.27: 50

(2) PARATYPE: 1 specimen, 108.8 mm sl; same locality and collector as (1). BMNH 1969. 1.27; 51

(3) PARATYPES: 2 specimens, 63.8-84.1 mm sl; Saudi Arabia, closed pool near Jeddah, leg. A. Faray. BMNH 1976.11.19: 12-13

(4) PARATYPES: 3 specimens, 41.0-55.2 mm sl; Saudi Arabia, pool near Jeddah, leg. A. Faray. BMNH 1976.11.19: 9-11

(5) 1 specimen, 68 mm sl; Saudi Arabia, c. 25°42'N 39°12'E, leg. Pal. BMNH 1981.4.13: 18

(6) 14 specimens, 15.0-19.4 mm sl; Saudi Arabia, Wadi Sulaym, Khaibar 25°36'N 39°16'E, 680 m above sea-level, 24.IV.1979, leg. W. Büttiker. NHMB

Diagnosis:

A subspecies of Cyprinion acinaces, which is endemic to the Red Sea tributaries of the Hijaz. It is characterized by D: 11-12, LL: 37-40, GR: 10-13.

Description:

The body shape is extremely variable (Figs 7 and 15). The mouth is subterminal and arched. The lower lip is covered by a horny sheath.

The dorsal fin is usually shorter than in the nominate subspecies. It contains 4 unbranched rays, the last of which is ossified and strongly serrated, and 11 (f15) or 12 (f7) branched rays. There are 3 unbranched and 7 branched rays in the anal fin.

The lateral line is complete. Scales in the lateral line series number 37 to 40. Between the lateral line and the origin of the dorsal fin there are 6 or 7 scales and 4 to 6 scales between the lateral line and the anal fin origin. 16 (f2) or 18 (f5) scales encircle the least circumference of the caudal peduncle in 7 specimens examined. Scales in the pelvic and pectoral region are reduced and hidden beneath the skin or missing completely.

Gill rakers are short and gently curved. They number 10-13 on the lower limb of the first gill arch.

Pharyngeal teeth are in 3 rows: 2.3.4-5.3.2 (f4) or 2.3.5-4.3.2 (f4) in 8 specimens examined. Their shape does not vary considerably from those shown in Fig. 8. The fifth tooth of the interior row, if present, is very small.

Preserved specimens are light to dark grey-brown dorsally and lighter brown to yellow below the lateral line. Dark spots are present on the flanks of young specimens. This color pattern is very variable.

The subspecies is endemic to the Red Sea tributaries of the Hijaz. Its distribution can be seen in Fig. 6.

With the nominate subspecies it shares most morphometric characters. Both subspecies show a tendency to reduce the fifth pharyngeal tooth of the interior row. C. a. hijazi differs from the nominate subspecies in having a shorter dorsal spine, more gill rakers and less scales in the lateral line series, although all these characters overlap to a certain degree.

The known pattern of distribution of *C. acinaces* shows a gap between the northern and southern populations. Anyhow, further collections might modify this picture. It is interesting to note, that this pattern of distribution is shared by *Garra tibanica*.

Cyprinion mhalensis Al-Kahem & Behnke, 1983

Synonymy:

Cyprinion acinaces non sensu Banister & Clarke, partim: Banister & Clarke 1977; J. Oman studies, special report: 123, Taif.

Material:

(1) 1 specimen, 35.6 mm sl; Saudi Arabia, Wadi Turabah, 20°29'N 41°09'E, 1580 m above sea-level, 07.X.1979, leg. W. Büttiker. NHMB 5342

(2) 29 specimens, 24.8-35.8 mm sl; Saudi Arabia, Wadi Turabah, 20°29'N 41°12'E, 1470 m above sea-level, 15.-16.IX.1980, leg. W. Büttiker. NHMB 5520-5547

(3) 12 specimens, 34.4-102.4 mm sl; Saudi Arabia, Wadi Turabah, 20°30'N 41°17'E, 1430 m above sea-level, 15.-16.IX.1980, leg. W. Büttiker. NHMB 5499-5510

(4) 4 specimens, 33.1-44.4 mm sl; Saudi Arabia, Wadi Turabah, 20°29'N 41°09'E, 1580 m above sea-level, October 1979, leg. W. Büttiker.

(5) 1 specimen, 81 mm sl; Saudi Arabia, Wadi Afrak, 19°48'N 41°59'E, 1830 m above sea-level, 29.IX.1980, leg. W. Büttiker. NHMB

(6) 2 specimens, 61.7-65.4 mm sl; same locality and collector as (5).

(7) 1 specimen, 104.7 mm sl; Saudi Arabia, Adama, 19°41'N 42°04'E, 1770 m above sea-level, 17.IV.1980, leg. W. Büttiker. NHMB

(8) 8 specimens, 9.5-11.1 mm sl; Saudi Arabia, Wadi Shuqub, c. 20°39'N 41°13'E, 04.IV.1980, leg. W. Büttiker. NHMB

(9) 9 specimens, 32.1-43.3 mm sl; Saudi Arabia, Wadi Buwah, 20°47'N 41°12'E,1390 m above sea-level, 19.IX.1980, leg. W. Büttiker. NHMB 5511-5519

(10) 1 specimen, 19.9 mm sl; Saudi Arabia, Wadi Shumrukh, 20°26'N 41°18'E, 1660 m above sea-level, 20.IV.1980, leg. W. Büttiker. NHMB 5548

(11) 4 specimens, 26.8-89.2 mm sl; Saudi Arabia, Wadi Noaman c. 5 km E of Abha, 18°14'N 42°35'E, 01.VIII. 1977, leg. C. H. Lowe. BMNH 1977.8.25: 1-5

(12) 2 specimens, 63.4-71.5 mm sl; Saudi Arabia, Asir, leg. C. H. Lowe. BMNH 1977.8.25: 38-39

(13) 3 specimens, 73.5-77.4 mm sl, Saudi Arabia, near Taif, 21°20'N 40°21'E, leg. G. Popov. BMNH 1976. 4.7: 162-164

(14) 1 specimen, 97.5 mm sl; Saudi Arabia, Wadi Habayaba between Taif and Sarfa, leg. A. Faray. BMNH 1980.7.1: 16

The description is based on the 70 specimens listed under (1) to (14). Morphometric characters are shown in Tab. 2.

The shape of the body is very variable and controlled by allometric growth. 3 specimens of different size and shape are shown in Figs 9-11 and 14.

The dorsal profile of the head is convex. Eyes lie in a lateral position. The mouth is subterminal. The sides of the lower lips form an almost straight angle, the anterior margin is gently arched or straight. Horny tubercles are present on the top and the sides of the snout in many specimens. They may cover large areas of the body surface and the fin rays.

The length of the dorsal fin is largely controlled by allometric growth. It is relatively larger in juvenile than in adult specimens. There are usually 4 unbranched rays, the last of which is ossified and strongly serrated, above all in juvenile specimens. Branched rays number 10 (f52) or 11 (f15).

The shape of the anal fin is variable. Specimens with a rounded and others with a pointed anal fin may occur in the same population. It contains 3 unbranched and 7 branched rays.

There are 39 (f1), 40 (f5), 41 (f8), 42 (f18), 43 (f7) or 44 (f3) scales in the lateral line series. Scales between the lateral line and the origin of the dorsal fin number 8 (f27) or 9 (f2) and 5 (f9), 6 (f15) or 7 (f5) between the lateral line and the anal fin origin.
19 (f4), 20 (f16), 21 (f1) or 22 (f1) scales encircle the least circumference of the caudal peduncle. Scale reduction occurs in the ventral and dorsal region. A large scaled appendage is present at the base of the pelvic fin.

Gill rakers are usually short, strongly curved and narrowly spaced. They number 8(f1), 9 (f2), 10 (f5), 11 (f7), 12 (f3) or 13 (f3) on the lower limb of the first gill arch.

The shape of the pharyngeal bones and teeth is shown in Fig. 12. In 8 specimens examined, pharyngeal teeth numbered 2.3.5-5.3.2 . The fifth tooth of the interior row is relatively large. In young specimens it may almost reach the size of the fourth tooth but it grows slower than the other teeth. The significance of this character will be discussed below.

Larger specimens are grey to grey-brown above the lateral line. The intensity of coloration increases towards the dorsal mid-line. The ventral surface is yellow-ochre to whitish. There is a varying number of dark spots on the flanks and in the caudal peduncle of juvenile and subadult specimens.

C. mhalensis occurs in a large number of recent and Pleistocene tributaries of Wadi ad-Dawasir. It seems to be endemic to this drainage system (see Fig. 13).

C. mhalensis shares most morphometric characters and the strongly serrated dorsal spine with C. acinaces. It can be distinguished from the latter species by the shape of its mouth, the pharyngeal teeth, the higher number of scales in the lateral line series, between the lateral line and the dorsal fin origin and arround the least circumference of the caudal peduncle. C. microphthalmum has a shorter and less serrated dorsal spine. C. macrostomum and C. kais from the Tigris-Euphrates basin have more unbranched rays in the dorsal fin.

Cyprinion microphthalmum (Day, 1880)

Scaphiodon microphthalmum Day, 1880; Proc. Zool. Soc. London: 227, Quetta.

This species is widely distributed in Iran, Afghanistan and Pakistan. It is characterized by D:III/10(11), A:II/7, LL:37-41 (after BERG, 1949: 817)

Cyprinion microphthalmum muscatensis (Boulenger, 1887) n.comb.

Synonymy:

Scaphiodon muscatensis Boulenger, 1887; Proc. Zool. Soc. London: 665, Muscat.

Cyprinion microphthalmum partim: Berg 1949; Trud. Zool. Ist. Akad. Nauk SSSR, 8: 665.

Cyprinion microphthalmum partim: Banister and Clarke 1977; J. Oman studies, special report: 130, Oman.

BERG (1949) tentatively synonymized Scaphiodon muscatensis with Cyprinion microphthalmum without having seen material from Oman. He obviously based his decision on meristic characters. There are certain morphological differences between C. microphthalmum muscatensis and the nominate subspecies which will be discussed below. Furthermore the geographic isolation justifies the separation of the two taxa on the subspecific level. In recognizing C. m. muscatensis as a distinct subspecies the author follows a proposal of Prof. P. Banarescu (pers. com.).

Material:

(1) 1 specimen, 87.5 mm sl; Oman, Muscat, leg. A. S. Jayakar. Lectotype of Scaphiodon muscatensis, specimen selected by P. Banarescu, BMNH 1885.11.7: 35

(2) 5 specimens, 67.0-81.8 mm sl; same locality and collector as (1). Paralectotypes of Scaphiodon muscatensis, BMNH 1885.11.7: 36-40

(3) 3 specimens, 101.7-129.0 mm sl; Oman, Wadi Fida, 23°37'N 56°31'E, leg. M. D. Gallagher. BMNH 1981.10.1: 15-22

(4) 2 specimens, 68.9-74.0 mm sl; Oman, Wadi Dayqah, Mazara, leg. M. D. Gallagher. BMNH 1978.9.6: 148-150

The lectotype is a specimen of 87.5 mm sl. D:IV/11, A: III/7, LL: 37, CCP:14. Dorsal and caudal fin are damaged.

The body shape can be seen in Fig. 16. Morphometric characters are given by BANISTER & CLARKE (1977).

The mouth is subterminal. The lower lip is almost truncate anteriorly and forms an angle at the sides. Horny tubercles may occur in the head region.

There are 4 unbranched rays in the dorsal fin, the last of which is slightly serrated in young specimens. In larger specimens only the lower third is serrated while the distal part is almost smooth and contains a series of persistent articulations. In 9 specimens examined there were 10 (f5) or 11 (f4) branched rays. The anal fin contains 3 unbranched and 7 branched rays.

There are 37 (f1), 38 (f2), 39 (f3) or 40 (f3) scales in the lateral line series, 6 (f7) or 7 (f2) scales between the lateral line and the dorsal fin origin and 4 (f6) or 5 (f3) scales between the lateral line and the anal fin origin. 14 (f7) or 16 (f2) scales encircle the least circumference of the caudal peduncle.

Gill rakers are widely spaced. They number 7 (f2), 8 (f3) or 9 (f2) on the lower limb of the first gill arch.

Pharyngeal teeth are in three rows: 2.3.5-5.3.2 or 2.3.4-4.3.2. The fifth tooth of the interior row is very small if present at all.

C. m. muscatensis is dark grey above the lateral line and light silvery-grey below the lateral line. Two dark stripes may occur between the lateral line and the dorsal mid-line. In young specimens there is a dark spot in the caudal peduncle.

C. m. muscatensis differs from the nominal subspecies in general body shape and color pattern as well as in a statistically slightly higher number of dorsal fin rays. It can easily be distinguished from other Arabian *Cyprinion* by the possession of a shorter and less serrated dorsal spine. Furthermore the number of scales arround the caudal peduncle is lower than in other Arabian *Cyprinion*.

The subspecies is restricted to Oman. It is so far known from the region shown in Fig. 54.

Gen. *Garra* Hamilton, 1822

Key to the species and subspecies

Meristic characters used in this key are modal values. There is a certain degree of overlap in some cases.

1. 12 scales arround least circumference of caudal peduncle 2
- 14-20 scales arround least circumference of caudal peduncle 5

2. Body very slender 3
- Body stocky 4

3. Pectoral fins long ($\bar{x}$= 28 % of sl), less than 15 gill rakers on lower limb of first gill arch .... *G. longipinnis*
- Pectoral fins short ($\bar{x}$ = 19.5 % of sl), more than 14 gill rakers on lower limb of first gill arch .... *G. mamshuqa*

4. Less than 15 gill rakers on lower limb of first gill arch .... *G. barreimiae barreimiae*

- More than 14 gill rakers on lower limb of first gill arch .... *G. barreimiae shawkahensis*

5. 7 branched dorsal fin rays 6

- 8 branched dorsal fin rays 8

6. 20 scales arround least circumference of caudal peduncle .... *G. buettikeri*

- 14-16 scales arround least circumference of caudal peduncle 7

7. 14 scales arround least circumference of caudal peduncle, endemic to Dead Sea rift valley .... *G. tibanica ghorensis*

- 16 scales arround least circumference of caudal peduncle .... *G. tibanica tibanica*

8. More than 9 gill rakers on lower limb of first gill arch .... *G. sahilia sahilia*

- Less than 10 gill rakers on lower limb of first gill arch .... *G. sahilia gharbia*

Garra barreimiae Fowler & Steinitz, 1956

This species is endemic to the Oman mountains. It has 6-8 unbranched dorsal rays, 12 scales arround the least circumference of the caudal peduncle and 11-18 gill rakers on the lower limb of the first gill arch.

not in the sense of

Garra barreimiae barreimiae Fowler & Steinitz, 1956

Synonymy:

Garra barreimiae Fowler & Steinitz, 1956; Bull. Res. Counc. Israel, 5 B: 262, Barreimi.

Discognathus lamta non sensu Hamilton: Boulenger 1892; Proc. Zool. Soc. London: 135, Muscat.

Garra barreimiae: Menon 1964; Mem. Ind. Mus., 14:206, Oman.

Garra barreimiae barreimiae: Banister & Clarke 1977; J. Oman studies, special report: 135, Baraimi, Wadi Sahtan, Muscat.

Material:

(1) 4 specimens, 27.7-62.0 mm sl; Oman, Wadi Sahtan, 23°14'N 57°19'E, leg. M. D. Gallagher. BMNH 1975. 8.15: 360-364

(2) 10 specimens, 41.6-55.0 mm sl; Oman, leg. M. D. Gallagher. BMNH 1978.9.6: 14-22

The original description was based on 6 specimens. BANISTER & CLARKE (1977) re-described the nominal subspecies from 11 specimens. Only little more material was examined here, thus only a brief description will be given.

The body shape can be seen in Fig. 17. The dorsal fin has 4 unbranched rays. The number of branched rays seems to vary from population to population. All specimens from Wadi Sahtan examined here had 7 branched rays, all specimens from an unspecified locality in Oman (see material (2)) had 8 branched rays. FOWLER & STEINITZ (1956)quote 7 for the six type specimens they examined. MENON (1964) gives 6 for four specimens he studied. According to BANISTER & CLARKE (1977) branched dorsal fin rays numbered 6 (f17) or 8 (f8) in 25 specimens of G. b. barreimiae and G. b. shawkahensis they examined. More material is necessary to settle this question.

The anal fin has 3 unbranched and 5 branched rays. Meristic characters were taken in 12 specimens. The scales in the lateral line series number 31 (f1), 32 (f2), 33 (f6), or 34 (f3), there are 3.5 (f2), 4 (f1) or 4.5 (f9) scales between the lateral line and the caudal fin origin and 3 (f3) or 3.5 (f9) between the lateral line and the anal fin origin. 12 (f10) or 14 (f2) scales encircle the least circumference of the caudal peduncle.

Gill raker counts on the lower limb of the first gill arch are: 11(f1), 12 (f1), 13 (f2) or 14 (f8).

Pharyngeal teeth number 2.4.5-5.4.2, FOWLER & STEINITZ(l. give 5.3.2 for one pharyngeal bone they examined.

The color pattern of preserved specimens is light brown mottled . Dark spots are present on the bases of the unbranched dorsal fin rays.

The distribution of G. barreimiae is shown in Fig. 20.

Garra barreimiae shawkahensis Banister & Clarke, 1977

Garra barreimiae shawkahensis Banister & Clarke, 1977; J. Oman studies, special report: 136, Wadi Shawkah.

Material:

(1) 1 specimen, 71.6 mm sl, U.A.E., Wadi Shawkah, leg. M. D. Gallagher . Holotype, BMNH 1973.9.10: 53

(2) 2 specimens, 45.9-46.5 mm sl; U.A.E., Wadi Shawkah, 10.VII.1972, leg. M. D. Gallagher. Paratypes, BMNH 1973.5.21: 135-136

(3) 4 specimens, 48.8-64.6 mm sl; same locality and collector as (2). Paratypes, BMNH 1973.5.21:144-147

(4) 3 specimens, 45.1-60.0 mm sl, same locality and collector as (1). Paratypes, BMNH 1973.9.10:54-55

(5) 10 specimens, 37.4-47.7 mm sl, U.A.E., Wadi Shawkah, 10.VI.1973, leg. M. D. Gallagher. BMNH 1973.9.10: 56-154

The shape of the body is shown in Fig. 18. The size and shape of the mental disc is very variable, but it is usually larger than in the nominal subspecies.

The dorsal fin has 4 unbranched and 6 (f3) or 7 (f9) branched rays, in the anal fin there are 3 unbranched and 5 branched rays.

Scales in the lateral line series number 32 (f1), 33 (f6), 34 (f2) or 35 (f2), there are 3.5 (f3) or 4.5 (f8) scales between the lateral line and the dorsal fin origin and 3.5 (f8), 4 (f1) or 4.5 (f2) between the lateral line and the anal fin origin. 12 (f9) or 14 (f3) scales encircle the least circumference of the caudal peduncle.

Gill rakers on the lower limb of the first gill arch number 16 (f3) 17 (f7) or 18 (f1).

In preserved specimens the body is dark brown mottled . On the unbranched rays and the membranes of the caudal fin dark pigments are present. The caudal peduncle carries a dark spot at the level of the hypural bones.

Comparative remarks: Apart from their geographical separation the two subspecies differ in the number of gill rakers, color pattern and size and shape of the mental disc.

The only other species of _Garra_ to occur in the Oman mountains is _G. longipinnis_. It differs from _G. barreimiae_ in the possession of extremely long pectoral fins. The affinities of E Arabian _Garra_ will be discussed below.

Garra buettikeri n. sp.

Material:

(1) HOLOTYPE: 1 specimen, 100.0 mm sl; Saudi Arabia, Wadi Turabah, 20°29'N 41°12'E, 1470 m above sea-level; 15.-16.IX.1980, leg W. Büttiker. NHMB 5552

(2) PARATYPES: 3 specimens, 46.6-72.5 mm sl; Saudi Arabia, Wadi Turabah, 20°30'N 41°17'E, 1430 m above sea-level, 15.-16.IX.1980, leg. W. Büttiker. NHMB 5553-5555

(3) PARATYPES: 3 specimens, 68.9-78.8 mm sl; Saudi Arabia, 10 km NW Adama, Asir, 19°26'N 42°03'E, 1650 m above sea-level; 06.X.1980, leg W. Büttiker. NHMB 5549-5551

(4) PARATYPES: 3 specimens, 68.6-90.0 mm sl; Saudi Arabia, Adama, Asir, 19°41'N 42°04'E, 1770 m above sea-level, 17.IV.1980, leg. W. Büttiker. NHMB 5588-5590

(5) PARATYPES: 32 specimens, 26.8-44.5 mm sl; Saudi Arabia, Wadi Noval, 20°23'N 41°19'E, 1800 m above sea-level, 30.IX.1982, leg. W. Büttiker. NHMB

(6) PARATYPES: 10 specimens, 34.0-40.6 mm sl; same locality and collector as (5).

(7) 12 specimens, 24.4-33.0 mm sl; Saudi Arabia, Wadi Shumrukh, Asir, 20°27'N 41°19'E, 1510 m above sea-level, 20.IV.1980, leg W. Büttiker. NHMB

(8) 7 specimens, 19.6-23.4 mm sl; Saudi Arabia, Abalah, 7 km from Athnen, Asir, $18^{o}51$'N $42^{o}13$'E, 2390 m above sea-level, 06.X.1980, leg W. Büttiker.
NHMB 5574-5580

(9) 5 specimens, 37.4-77.2 mm sl; Saudi Arabia, Wadi Noaman, c. 5 km E of Abha, $18^{o}14$'N $42^{o}35$'E, 01.VIII. 1977, leg. C. H. Lowe. BMNH 1977.8,25: 9-13

(10) 1 specimen, 49.5 mm sl; Saudi Arabia, Abha, Asir, c. $18^{o}13$'N $42^{o}29$'E, 2260 m above sea-level, July 1977, leg. C. H. Lowe. BMNH 1977.8.25: 8

Diagnosis:

A species of Garra with 7 unbranched dorsal rays, 36-39 scales in the lateral line series and 20 scales arround the least circumference of the caudal peduncle, which is endemic to the larger Wadi Dawasir drainage system.

Holotype:

A ♂ of 100 mm sl, D: 7, LL: 36, ALL: 7.5, CCP: 20 and GR: 13. The specimen is slightly curved.

Description:

The body shape is shown in Figs 21 and 35. The head is pointed in side view, blunt and wedge-shaped or pointed in dorsal view. Horny tubercles on the head, if present at all, are very small. A specimen of 46.9 mm sl is the smallest one to show such tubercles.

The mouth is arched. The mental disc is variable in shape and size, but usually it is small and shows little variation within a single population. The central disc is smooth or covered by minute papillae. Large papillae are present on the anterior part. The posterior membrane is moderately developed and only slightly papillose. The mental disc is much wider than long in all adult specimens examined (see Fig. 22). It is longer than wide in young specimens of less than 30 mm sl. The smallest specimen with a well-developed mental disc was 25.5 mm long, the largest one without a disc 28.0 mm.

The distance between the anus and the anal fin origin is small and within the range of Garra tibanica. The peritoneum is black with lighter areas in the ventral region.

There are usually 4 unbranched rays in the dorsal fin. The last one is slightly thickend proximally and bears persistent articulations in the two distal thirds. The first or second branched ray is the longest one, it exceeds the length of the last unbranched ray. Unbranched rays number 7 (f51) or 8 (f4). There are 3 unbranched and 5 (f54) or 6 (f1) branched rays in the anal fin.

There are 36 (f10), 37 (f24), 38 (f16) or 39 (f5) scales in the lateral line series. In the 10 largest specimens there are 6.5 (f4), 7.5 (f5) or 8.5 (f1) scales between the lateral line and the dorsal fin origin and 4 (f2) or 5 (f8) scales between the lateral line and the anal fin origin. In 20 specimens examined, 18 (f2) or 20 (f18) scales encircle the least circumference of the caudal peduncle.

Gill rakers are short, feeble, slightly hooked and widely spaced. There are 10 (f17), 11 (f24), 12 (f6), 13 (f4) or 14 (f1) gill rakers on the lower limb of the first gill arch.

Pharyngeal teeth numbered 2.4.5-5.4.2 in 6 specimens examined. The crowns are flat or concave with straight tips (Fig. 23).

Alcohol preserved specimens have a whitish or light yellow-ochre ventral surface which gradually changes through light grey-brown to olive-grey dorsally. Very small specimens show a dark band at the level of the lateral line which may end in a diffuse dark spot on the caudal peduncle. Fins are transparent with a light grey pigmentation. Dark spots are present on the bases of the second to fifth unbranched dorsal rays.

Derivatio nominis:

The specific name was selected in honour of Prof. W. Büttiker, Jeddah, who collected the type specimens.

Comparative remarks:

G. buettikeri differs from all other Arabian *Garra* in having a higher number of scales in the lateral line series, between the lateral line and the dorsal fin origin and arround the caudal peduncle. Furthermore it differs from *G. tibanica* in general body shape. The mental disc is smaller than in the latter species. The mouth is arched while it is more or less straight in *G. tibanica*.

Distribution:

The species is only known from the localities listed under material. The distribution is shown in Fig. 24. G. buettikeri occurs in the streamlets of the eastern Asir range which drain towards the Wadi ad-Dawasir. All specimens were caught at an altitude of 1400 to 2400 m above sea-level. This pattern of distribution is shared by Cyprinion mhalensis and Barbus apoensis.

The Abalah population

An aberrant population is found at Abalah, 2390 m above sea level. The specimens agree with other populations in most meristic characters but have only 6(f2), 7(f4) or 8 (f1) gill rakers on the lower limb of the first gill arch (against 10 to 14 in other G. buettikeri).Unfortunately there are only 7 very small specimens available. It is unknown whether the Abalah population is permanently or occasionally connected to other populations of G. buettikeri. No further conclusions can be drawn unless a larger sample is available.

Garra longipinnis Banister & Clarke, 1977

Garra longipinnis Banister & Clarke, 1977; J. Oman studies, special report:137, Saiq.

Material:

(1) 1 specimen, 52.6 mm sl; Oman, Jabal Akhdar, Saiq, 23°02'N 57°28'E , leg. Elliott-Legg. Holotype, BMNH 1968.10.11: 1

(2) 7 specimens, 36.5-49.4 mm sl; same locality and collector as (1). Paratypes, BMNH 1968.10.11: 2-8

This species has been described and figured by BANISTER & CLARKE in the original description. No new material is available since then, thus the species is only briefly characterized here.

The body is slender. The pectoral and pelvic fins are extremely long. There are 4 unbranched and 6 or 7 branched rays in the dorsal fin and 3 unbranched and 5 branched rays in the anal fin. Scales in the lateral line series number 31-33 (BANISTER & CLARKE give 29-31 as they count to the end of the hypural plate). 4.5 to 5.5 scales lie between the lateral line and the dorsal fin and 3.5 to 4.5 between the lateral line and the anal fin. 12 scales encircle the least circumference of the caudal peduncle. Gill rakers number 12-14.

This species is distinguished from other Arabian Garra by the length of its pectoral fins. It is only known from the type locality (Fig. 20)

Garra mamshuqa n. sp.

Synonymy

Garra tibanica non sensu Trewavas: Banister & Clarke, 1977, partim; J. Oman studies, special report: 140, Wadi Hadramaut.

Material:

(1) HOLOTYPE: 1 specimen, 63.2 mm sl; Yemen, Wadi Hadramaut, Qasam area, c. 16°10'N 49°04'E, leg. W. A. King-Webster. BMNH 1976.4.7: 380

(2) PARATYPES: 7 specimens, 55.1-63.6 mm sl; same locality and collector as (1). BMNH 1976.4.7: 381-387

(3) PARATYPES: 3 specimens, 56.7-74.8 mm sl; Yemen, Ghail Umar, 15°44'N 48°51'E, leg. W. A. King-Webster. BMNH 1976.4.7: 374-376

Diagnosis:

A species of *Garra* from S Arabia with 8 branched dorsal fin rays, 12 scales arround the least circumference of the caudal peduncle, 15-17 gill rakers on the lower limb of the first gill arch and a distance between anus and anal fin origin of $\bar{x}$ = 4.9 % of sl.

Holotype:

A specimen of 63.2 mm sl, D: IV/8, LL: 35, CCP: 12 and GR: 16

Description:

The shape of the body can be seen in Figs 25 and 29. G. mamshuqa is very slender in general appearance. The snout is more or less pointed in dorsal and lateral view. In most specimens a large number of distinctive patches of breeding tubercles is present arround the snout and between the nostrils.

The mental disc is very small and usually about as long as wide. In a few specimens it is even longer than wide. Only the anterior part is covered by papillae. They are absent from the central disc and the membranous lateral and posterior part.

The distance between the anus and the anal fin origin is larger than in any other Arabian Garra (see Tab. 4).

The dorsal fin contains 3 or 4 unbranched rays, the last of which is neither thickend nor ossified. It contains persistant articulations in the distal half. There are usually 8 unbranched rays, one specimen had 7. The anal fin contains 3 unbranched and 5 branched rays.

In the lateral line series there are 34 (f3), 35 (f5) or 36 (f2) scales, 4 (f4) or 5 (f6) between the lateral line and the dorsal fin origin and 4 or 4.5 (f5 each) between the lateral line and the anal fin origin. 12 (f9) or 13 (f1) scales encircle the least circumference of the caudal peduncle. In all specimens examined scales were reduced on the dorsal mid-line and in the pectoral region but never arround the anus.

Pharyngeal teeth usually number 2.4.5-5.4.2 but 3.4.5-5.4.2 occured in one specimen. The crowns are flat and never hooked. The shape of the pharyngeal bone and teeth differs considerably from that of other <u>Garra</u> (see Fig. 27).

Gill rakers are short, flat and sometimes slightly hooked. There are 15 (f3), 16 (f4) or 17 (f3) gill rakers on the lower limb of the first gill arch.

The ventral surface of <u>G. mamshuqa</u> is whitish-silvery. The flanks are light brownish-grey below the lateral line and gradually turn darker towards the dorsal mid-line. A large dark spot is present behind the upper margin of the operculum. Black spots occur on the bases of the branched dorsal fin rays, they turn to a lighter grey distally. Anal and caudal fins show dark pigmentation.

Derivatio nominis:

The specific name is derived from the Arabic word mamshuq (ممشق = slender) refering to the slender shape of the body.

Comparative remarks:

<u>Garra mamshuqa</u> differs from other Arabian <u>Garra</u> in body shape, color pattern and most morphometric characters. It is the only species with 8 unbranched rays that has only 12 scales arround the caudal peduncle.

Distribution:

This species is only known from the localities listed under material, all of which lie within the Wadi Hadramaut system (Fig. 28).

Garra sahilia n. sp.

Diagnosis: A species of *Garra* from the Gulf of Aden and Red Sea coastal drainages with 8 unbranched dorsal fin rays, 16 scales arround the caudal peduncle, 32-36 scales in the lateral line series and a dark pigmantation on the membranes of the dorsal fin.

Garra sahilia sahilia

Synonomy

Garra tibanica non sensu Trewavas: Trewavas 1941, partim; Brit. Mus. (Nat. Hist) Expedition to SW Arabia 1937-8, 1: 9, Wadi Tiban, Lahej.

Garra tibanica non sensu Trewavas: Banister & Clarke 1977, partim; J. Oman studies, special report: 141, Wadi Bana.

Material:

(1) HOLOTYPE: 1 specimen, 68.2 mm sl; Yemen, Wadi Bana, 13°26'N 43°09'E, leg. W. A. King-Webster. BMNH 1976. 4.7; 419

(2) PARATYPES: 6 specimens, 59.3-82.7 mm sl; same locality and collector as (1). BMNH 1976.4.7: 420-425

(3) PARATYPES: 47 specimens, 25.8-84.6 mm sl; same locality and collector as (1). BMNH 1951.5.9: 12-65

(4) PARATYPES: 10 specimens, 40.8-87.0 mm sl; Yemen, Wadi Bana, 14°08'N 44°30'E, leg. P. W. R. Petrie. BMNH 1944.4.3: 1-10

(5) 3 specimens, 22.5-54.5 mm sl; Yemen, Wadi al-Kabir, c. 12°47'N 44°55'E. BMNH 1899.12.13: 100-105

(6) 12 specimens, 27.4-67.5 mm sl; Yemen, Aden peninsula, 12°47'N 45°00'E, leg. Haythornwaite. BMNH 1935.7.11:2-10

(7) 40 specimens, 20.6-68.9 mm sl; Yemen, Wadi Lahej, N of Aden, leg. A. Fraser-Brunner. BMNH 1950.5.1: 225-264

(8) 2 specimens, 18.2-63.3 mm sl; Yemen, Lahej, 13°02'N 44° 53'E, leg. W.T. Blanford. BMNH 1869.9.8: 2

(9) 3 specimens, 61.8-100.5 mm sl; Yemen, Wadi Tiban, NW of Jabal Jihaf, 1130 m above sea-level, leg. E. B. Britton. BMNH 1940.2.15: 12-18

(10) 6 specimens, 13.9-42.2 mm sl; Yemen, Wadi Abd, Lahej governate, leg. Taba (WHO). BMNH 1981.5.19: 74-79

(11) 10 specimens, 16.7-68.7 mm sl; Yemen, Aden, leg. Yerbury. BMNH 1895.5.23: 113-122

(12) 3 specimens, 28.2-65.7 mm sl ; Yemen, Wadi Murlwani, near Wadi Khalays, leg. P. Scot. BMNH 1976.11.19: 4-6

(13) 2 specimens, 47.9-48.6 mm sl; Yemen, Sayun, 15°59'N 48°44'E, 03.I.1980, leg. Taba (WHO). BMNH 1980.4.24: 8-9.

(14) 1 specimen, 47.1 mm sl; Yemen, Wadi Maur, c. 15°39'N 42°56'E, leg. I. G. Dunn. BMNH 1976.4.7: 443-460

(15) 4 specimens, 90.0-94.5 mm sl; Yemen, Aden, leg. Playfair. BMNH 1910.1.28: 1-3

Diagnosis:

The nominal subspecies is widely distributed in the tributaries of the Gulf of Aden and the southern Red Sea. It is characterized by the possession of 10-16 gill rakers on the lower limb of the first gill arch.

Holotype:

The holotype is a ♀ of 68.2 mm sl, D: 8, LL: 35, CCP: 16, GR: 16. The habitus is shown in Fig. 36.

Description:

The shape of the body can be seen in Fig. 32. The snout is blunt in side view and wedge-shaped in dorsal view. Horny tubercles are present on some specimens, they are usually small. The mental disc is variable in shape, the anterior part and the lateral and posterior membrane are papillose.

There are 3 or 4 unbranched rays in the dorsal fin, the last of which is weak and not ossified. In 57 specimens examined unbranched rays numbered: 7 (f7) or 8 (f50). There are 3 unbranched and 5 (f57) branched rays in the anal fin.

In the lateral line series there are 33(f5), 34(f16), 35 (f21), or 36 (f15) scales, from the lateral line to the dorsal fin origin there 4.5-5.5 and from the lateral line to the anal fin origin 3.5-4.5 scales. 16 (f54) or 17 (f3) scales encircle the least circumference of the caudal peduncle.

Gill rakers are curved and narrowly spaced, in 20 specimens examined they numbered 10 (f3), 11 (f2), 12 (f4), 13 (f4), 14 (f4), 15 (f2) or 16 (f1) on the lower limb of the first gill arch. Pharyngeal teeth numbered 2.4.5-5.4.2 in all specimens examined. Their shape does not differ considerably from those shown in Fig. 33 for G. sahilia gharbia.

The coloration of preserved specimens is grey to brown. They are darker dorsally.Between the bases of the unbranched dorsal fin rays dark spots are present. The entire membrane of the dorsal fin is covered by dark pigments, which may be hardly visible in old preserved material. There is a dark spot behind the upper margin of the operculum.

The distribution of *G. sahilia* is shown in Fig. 34.

Derivatio nominis:

The specific name is derived from the Arabic word sahili (ساحلي = coastal) as the species occurs in the coastal drainages.

Garra sahilia gharbia n. subsp.

Synonymy

Garra tibanica non sensu Trewavas: Banister & Clarke 1977, partim; J. Oman studies, special report: 141, Wadi N of Jizan, Wadi Daga.

Material:

(1) HOLOTYPE: 1 specimen, 72.6 mm sl; Saudi Arabia, Wadi Daga, Tihama, c. 100 m above sea-level, January 1962, leg. G. Popov. BMNH 1972.7.25:14

(2) PARATYPES: 5 specimens, 51.8-67.6 mm sl, same locality and collector as (1). BMNH 1972.7.25:15-19

(3) 4 specimens, 52.0-61.4 mm sl; Saudi Arabia, Wadi N of Jizan, 17°32'N 42°25'E, leg. Gibbons. BMNH 1976.4.7; 346-354

(4) 18 specimens, 20.4-30.1 mm sl; Saudi Arabia, Bani Sharfa, 19°42'N 41°24'E, 290 m above sea-level, 12.II.1980, leg. W. Büttiker. NHMB 5556-5573

(5) 1 specimen, 25.8 mm sl; same locality and collector as (4). NHMB 5587

(6) 6 specimens, 17.3-25.3 mm sl; Saudi Arabia, Wadi Gaanah, 18°26'N 41°53'E, 470 m above sea level, 13.-14.II.1980, leg. W. Büttiker. NHMB 5581-5586

Diagnosis:

A subspecies of G. sahilia with 6-9 gill rakers on the lower limb of the first gill arch, which occurs in the tributaries of the Red Sea N of Wadi Maur.

Description:

The holotype is a specimen of 72.6 mm sl with 8 unbranched dorsal fin rays, 36 scales in the lateral line series and large horny tubercles on the snout.

The body shape is shown in Fig. 37. The majority of the material consists of juvenile specimens. The few larger specimens are in poor condition. For this reason no morphometric characters are given.

There are 3 or 4 unbranched and 7 (f3) or 8 (f37) branched dorsal fin rays in 40 specimens examined. Branched anal fin rays numbered 5 in all specimens.

In the lateral line series there are 32 (f5), 33 (f10), 34 (f5), 35 (f3) or 36 (f2) scales. 15 (f1), 16 (f23) or 18 (f1) scales encircle the least circumference of the caudal peduncle.

Gill rakers are curved and widely spaced. They number 6 (f2), 7 (f9), 8 (f10) or 9 (f4) on the lower limb of the first gill arch.

The shape of the pharyngeal bone and pharyngeal teeth can be seen in Fig. 33. There are 2.4.5-5.4.2 pharyngeal teeth in all specimens examined.

The coloration does not differ from that of the nominal subspecies. The pigmentation of the dorsal fin is slightly stronger.

Derivatio nominis:

The subspecific name is derived from the Arabic word (غربي = western) as the area of distribution west of that of the nominal subspecies.

Comparative remarks:

Most meristic and morphometric characters of G. sahilia are within the range of G. tibanica. With larger samples at hand the two species can easily be distinguished from each other by the number of branched dorsal fin rays (7 in G. tibanica, 8 in G. sahilia). There is a certain degree of overlap in this character. Specimens of G. sahilia with 7 branched dorsal fin rays still differ from G. tibanica in the dark pigmentation of the dorsal fin. The two species are sympatric. G. sahilia is unlikely to be confused with the sympatric G. mamshuqa, as the two species differ in body shape and most meristic and morphometric characters, above all the number of scales arround the caudal peduncle (16 against 12) and the distance between the anus and the anal fin origin ($\bar{x}$ = 3.1 % against $\bar{x}$ = 4.9 % of sl). *G. sahilia* can easily be distinguished from *G. buettikeri* by the higher number of scales and lower number of dorsal fin rays in the latter species. It differs from SE Arabian *Garra* in the possession of 16 scales arround the caudal peduncle.

Garra tibanica Trewavas, 1941

Most widely distributed cyprinid fish in Arabia, occurring from the Gulf of Aden in the S to the Dead Sea rift valley in the N. *G. tibanica* is characterized by the possession of 7 branched dorsal fin rays, a short distance between anus and anal fin origin ($\bar{x}$ = 3.1 % of sl), (32) 34-36 (38) scales in the lateral line series and 6-13 gill rakers on the lower limb of the first gill arch.

Garra tibanica tibanica Trewavas , 1941

Synonymy:

Garra tibanica Trewavas, 1941, partim; Brit. Mus. (Nat. Hist.) Expedition to SW Arabia 1937-8, 1: 8, Usaifira.

Discognathus lamta non sensu Hamilton: Playfair 1870; Proc. Zool. Soc. London: 85, Aden.

Garra brittoni Trewavas, 1941; Brit. Mus. (Nat. Hist.) Expedition to SW Arabia 1937-8, 1: 11, near San'a.

<u>Garra</u> <u>tibanica</u>: Menon 1964; Mem. Ind. Mus., 14: 191.

<u>Garra</u> <u>tibanica</u>: Banister & Clarke 1977, partim; J. Oman studies, special report: 140, Usaifira, San'a, Khaibar, Wadi Maur, Wadi Dar ash-Sharaf.

<u>G</u>. <u>t</u>. <u>tibanica</u>: Balletto & Spanò 1977; Ann. Mus. Civ. Stor. Nat., 81: 260, Wadi Usaifera.

<u>G</u>. <u>t</u>. <u>brittoni</u>: Balletto & Spanò 1977; Ann. Mus. Civ. Stor. Nat., 81: 261, San'a, Vahar Hamdan, Rumrum, al-Asfura.

<u>G</u>. <u>t</u>. <u>kasaba</u> Balletto & Spanò, 1977; Ann. Mus. Civ. Stor. Nat., 81: 264, Wadi al-Kasaba.

<u>G</u>. <u>t</u>. <u>yemenica</u> Balletto & Spanò, 1977; Ann. Mus. Civ. Stor. Nat., 81: 267, Hammam Ali, Wadi Rimah, Railamah, Wadi al-Gadan.

<u>G</u>. <u>t</u>. <u>nakalani</u> Balletto & Spanò, 1977; Ann. Mus. Civ. Stor. Nat., 81: 270, Wadi Nakalani.

<u>G</u>. <u>t</u>. <u>scorteccii</u> Balletto & Spanò, 1977; Ann. Mus. Civ. Stor. Nat., 81: 272, Wadi Nakar.

<u>G</u>. <u>t</u>. <u>dhamarica</u> Balletto & Spanò, 1977; Ann. Mus. Civ. Stor. Nat., 81: 274, Bir al-Manzil near Dhamar.

<u>G</u>. <u>t</u>. <u>elbahrica</u> Balletto & Spanò, 1977; Ann. Mus. Civ. Stor. Nat., 81: 277, Wadi al-Bahr.

G. t. multaka Balletto & Spanò, 1977; Ann. Mus Civ. Stor. Nat., 81: 279, Wadi Multaka, Wadi al-Mughabbiya

Material:

(1) 1 specimen, 108.4 mm sl; Yemen, Usaifira, 13°35'N 44°02'E, 1937-38, leg. E. B. Britton. Lectotype, BMNH 1940.2.15: 2

(2) 10 specimens, 69.4-110.0 mm sl; same locality and collector as (1). Paralectotypes, BMNH 1940.2.15: 3-11

(3) 1 specimen, 97.2 mm sl; Yemen, Migyal al-Alaf, 15°17'N 44°13'E, 1937-38, leg. E. B. Britton. lectotype of G. brittoni, BMNH 1940.2.15: 19

(4) 8 specimens, 66.1-103.3 mm sl; same locality and collector as (3). BMNH 1940.2.15: 20-27

(5) 17 specimens, 30.6-79.9 mm sl; Yemen, Wadi Maur, 15°39'N 42°56'E, leg. I. G. Dunn. BMNH 1976. 4.7: 443-460

(6) 12 specimens, 10.9-17.7 mm sl; Yemen, Musaimir, Wadi Tiban, 13°27'N 44°36'E, 07.III.1940, leg. P. W. R. Petrie. BMNH 1947.1.15: 1-8

(7) 23 specimens, 25.3-80.7 mm sl; Yemen, Wadi Matbar, 15.VIII.1934, leg. Ingrams. BMNH 1935.2.28: 1-10

(8) 3 specimens, 70.2-86.6 mm sl; Yemen, Wadi al-Yawant, leg. Taba (WHO). BMNH 1982.4.13: 4915-4917

(9) 80 specimens, 22.3-39.8 mm sl; Yemen, Wadi Dhar, 15°29'N 44°07'E, leg. I. G. Dunn. BMNH 1976.4.7: 552-631

(10) 16 specimens, 73.0-128.0 mm sl; Yemen, Wadi Sirdud, 31.XII.1973, leg. I. G. Dunn. BMNH

(11) 5 specimens, 31.0-55.0 mm sl; Yemen, Wadi Amagin, 14°30'N 47°50'E, leg. N. L. Corkill. BMNH 1952.5.7: 13 - 18

(12) 50 specimens, 20.5-38.7 mm sl; Yemen, Wadi al-Kougbeh, 16°37'N 43°58'E, leg. I. G. Dunn. BMNH 1976.4.7: 461-511

(13) 40 specimens, 28.7-74.2 mm sl; Yemen, Wadi Dar ash-Sharaf, 17.I.1974, leg. I. G. Dunn. BMNH 1976.4.7: 512-551

(14) 17 specimens, 23.1-32.2 mm sl; Yemen, Wadi Kudam, c. 15°19'N 47°58'E, 12.I.1974, leg. I. G. Dunn. BMNH 1976.4.7: 426-442

(15) 11 specimens, 23.3-51.3 mm sl; Saudi Arabia, Hijaz mountains, 80 km from Jeddah, SW Madraga, January 1945, leg. D. Vesey- Fitzgerald. BMNH 1976.4.7: 355-365

(16) 1 specimen, 49.7 mm sl; Saudi Arabia, Wadi Fatima, 27.XI.1945, leg. D. Vesey-Fitzgerald. BMNH 1969.1. 27: 52

(17) 5 specimens, 20.7-34.6 mm sl; Saudi Arabia, Wadi near Jizan, leg. Gibbons. BMNH 1976.4.7: 346-354

(18) 2 specimens, 33.0-34.0 mm sl; 'Arabia', leg. R. J. Stauder. BMNH 1980.7.1: 50-51

(19) 1 specimen, 78.8 mm sl; Yemen, Wadi Sahama, c. 14°40'N 43°00'E, leg. G. Popov. BMNH 1976.4.7: 338

(20) 10 specimens, 21.0-94.2 mm sl; Yemen, Wadi al-Kain, leg. I. G. Dunn. BMNH 1976.4.7: 632-641

(21) 2 specimens, 57.3-58.7 mm sl; Saudi Arabia, near Jeddah, leg. Faray. BMNH 1976.11.19:7-9

(22) 1 specimen, 68.8 mm sl; Saudi Arabia, Khaibar, c. 1000 m above sea-level, leg. G. Popov. BMNH 1976.4.7: 339

(23) 91 specimens, 36.5-98.2 mm sl; Saudi Arabia, Wadi Damad, 17°17'N 43°06'E, 24.IX.1981, leg. W. Büttiker. NHMB

(24) 15 specimens, 36.9-88.2 mm sl; Saudi Arabia, Wadi Damad, currents, 24. IX.1981, leg. W. Büttiker. NHMB

(25) 7 specimens, 17.1-47.3 mm sl; Saudi Arabia, Wadi Damad, river, 24.IX.1981, leg. W. Büttiker. NHMB

(26) 35 specimens, 18.4-74.1 mm sl; Saudi Arabia, Wadi Juva, 17°20'N 42°08'E, 22.IX.1981, leg. W. Büttiker. NHMB

(27) 52 specimens, 18.1-67.1 mm sl; Saudi Arabia, Ayban, 24.IX.1981, leg. W. Büttiker. NHMB

(28) 15 specimens, 15.8-29.7 mm sl; Saudi Arabia, Hesu'a, 18°05'N 42°21'E, 610 m above sea level, 26.IX.1981, leg. W. Büttiker. NHMB

(29) 2 specimens, 31.7-34.3 mm sl; Saudi Arabia, Khaibar, 25°42'N 39°12'E, 01.V.1981, leg. W. Büttiker. NHMB

(30) 1 specimen, 98.1 mm sl; Yemen, Wadi Nakar, 13°57'N 45°35'E, 18.-19.IX.1965, leg. G. Scortecci. Holotype of G. t. scorteccii, MCSN 46542

(31) 1 specimen, 96.4 mm sl; Yemen, Wadi al-Kasaba, c. 15°10'N 43°40'E, 24.VIII.1965, leg. G. Scortecci. Holotype of G. t. kasaba, MCSN 46544

(32) 1 specimen, 51.3 mm sl; Yemen, Wadi Nakalani, c. 13°40'N 44°10'E, 12.VIII.1965, leg. G. Scortecci. Holotype of G. t. nakalani, MCSN 46543

(33) 8 specimens, 33.6-70.6 mm sl; same locality and collector as (32). Paratypes of G.t. nakalani, MCSN 46543

(34) 1 specimen, 49.1 mm sl; Yemen, Bir al-Manzil, 14°32'N 44°28'E, 18.VII.1965, leg. G. Scortecci. Holotype of G. t. dhamarica, MCSN 46541

(35) 5 specimens, 37.3-83.4 mm sl; same locality and collector as (34). Paratypes of G. t. dhamarica, MCSN 46541

(36) 1 specimen, 70.4 mm sl;Yemen,Hammam Ali, 14°43'N 44°07'E, 06-08.IX.1965, leg. G. Scortecci. Holotype of G. t. yemenica, MCSN 46546

(37) 4 specimens, 32.3-99.4 mm sl; same locality and collector as (36). Paratypes of G. t. yemenica, MCSN 46546

(38) 1 specimen, 44.4 mm sl; Yemen, Wadi al-Bahr, 13°23'N 43°45'E, 02.VIII.1965, leg. G. Scortecci. Holotype G. t. elbahrica, MCSN 46547

(39) 50 specimens, 31.8-88.4 mm sl; same locality and collector as (38). Paratypes of G. t. elbahrica, MCSN 46547

(40) 1 specimen, 58.9 mm sl; Yemen, La Ache, 27.IV.1884, leg. Dabbene. MCSN 31956

(41) 1 specimen, 63.5 mm sl; Yemen, Wadi Multaka, 13°35'N 43°53'E, 13.X.1965, leg. G. Scortecci. Holotype of G. t. multaka, MCSN 46548

(42) 2 specimens, 56.0-98.6 mm sl; same locality and collector as (41). Paratypes of G. t. multaka, MCSN 46548

(43) 13 specimens, 36.4-72.6 mm sl; Yemen, Wadi al-Mughabbia, 13°29'N 43°46'E, 09.X.1965, leg. G. Scortecci. Paratypes of G. t. multaka, MCSN 46545

(44) 19 specimens, 32.4-49.2 mm sl; Yemen, Wadi al-Gadan, 1965, leg. G. Scortecci.(albinotic population), UDG

(45) 154 specimens, 22.9-88.9 mm sl; Yemen, Usaifira, 13°35'N 44°02'E, 28.VII.1965, leg. G. Scortecci. UDG

(46) 195 specimens, 27.9-108.4 mm sl; Yemen, Wadi Nakar, 13°57'N 45°35'E, 18.-19.IX.1965, leg. G. Scortecci. UDG

(47) 68 specimens, 17.4-101.1 mm sl; Yemen, San'a, town, 15°26'N 44°12'E, 14.IX.1965, leg.G. Scortecci. UDG

(48) 72 specimens, 40.4-131.1 mm sl; Yemen, Wadi al-Kasaba, c. 15°10'N 43°40'E, 24.VIII.1965, leg. G. Scortecci. UDG

(49) 7 specimens, 30.5-49.4 mm sl; Yemen, San'a near Dar al-Bashair, 13.IX.1965, leg. G. Scortecci. UDG

(50) 2 specimens, 100.9-107.2 mm sl; Yemen, Wadi al-Asfura, 15°16'N 43°59'E, 2700 m above sea-level, 09.IX.1965, leg. G. Scortecci. UDG

(51) 60 specimens, 30.2-76.7 mm sl; Yemen, Wadi Rumrum, c. 15°11'N43°55'E, 30.VIII.1965, leg. G. Scortecci. UDG

(52) 85 specimens, 33.8-76.5 mm sl; Yemen, Wadi Hamdam, 15°24'N 44°09'E, 02.IX.1965, leg. G. Scortecci. UDG

(53) 1574 specimens, 22.3-95.9 mm sl; Yemen, Wadi Hammam Ali, 14°43'N 44°07'E, 06.VIII.1965, leg. G. Scortecci. UDG

(54) 26 specimens, 30.7-67.2 mm sl; Yemen, Wadi Nakalani, 12.VIII.1965, leg. G. Scortecci. UDG

(55) 131 specimens, 30.7-77.8 mm sl; Yemen, Bir al-Manzil, 14°32'N 48°51'E, 19.IX.1965, leg. G. Scortecci. UDG

(56) 78 specimens, 28.7-88.7 mm sl; Yemen, Madinat Abid, Wadi Rimah, 14°42'N 44°02'E, September 1965, leg. G. Scortecci. UDG

(57) 78 specimens, 25.0-72.3 mm sl; Yemen, Wadi Railama, 14°43'N 43°37'E, 10.-11.IX.1965, leg. G. Scortecci. UDG

(58) 5 specimens, 11.1-19.8 mm sl; Yemen, al-Ghuraf, 16°00'N 49°00'E, 1963, leg. G. Scortecci. UDG

As several species were included in earlier descriptions of G. t. tibanica, a revised diagnosis is given here: 7 branched dorsal rays, very rarely 6 or 8, 32-38 scales in the lateral line series with a mode of 35, usually 16 scales arround the least circumference of the caudal peduncle (6) 7-9 (12) gill rakers on the lower limb of the first gill arch.

The shape of the body is very variable, even within the same population as can be seen in Figs 42 and 43. The snout is more or less pointed in side view and wedge shaped in dorsal view. The largest specimen examined had 131 mm sl. Breeding tubercles on the top and the sides of the snout are common and may reach a considerable size (Fig. 38). They occur even on small specimens. On some specimens from Ayban, the entire dorsal surface is covered by horny tubercles.

The size and shape of the mental disc may vary considerably. The anterior part is always covered by papillae. The sides and posterior part may be smooth or papillous. Papillae on the central disc are small, if present at all (Fig. 39).

Morphometric characters of 200 well preserved specimens from recent collections are given in Tab. 6.

The dorsal fin has 4 unbranched rays, the last of which is feeble. Specimens with only 3 unbranched dorsal rays occur occasionally. There are 6 (f26), 7 (f364) or 8 (f10) branched dorsal fin rays in 400 specimens examined. The anal fin has 3 unbranched and 4(f3), 5 (f395) or 6 (f2) branched rays.

Scales were counted on 200 specimens. They number 32 (f3), 33 (f9), 34 (f44), 35 (f87), 36 (f50), 37 (f6) or 38 (f1) in the lateral line series, 3.5 (f3), 4 (f1), 4.5 (f45), 5 (f24), 5.5 (f125) or 6 (f2) between the lateral line and the dorsal fin origin and 3 (f3), 3.5 (f19), 4 (f104), 4.5 (f62), 5 (f10) or 5.5 (f2) between the lateral line and the anal fin origin. The least circumference of the caudal peduncle is encircled by 14 (f2), 15 (f1), 16 (f169), 17 (f6) or 18 (f22) scales. Scale reduction may occur on the dorsal mid-line and on the ventral surface.

Gill rakers are variable in shape. They are usually slightly hooked and widely spaced. There are 6 (f5), 7 (f27), 8 (f53), 9 (f34), 10(f23), 11 (f5),12 (f2) or 13 (f1) gill rakers on the lower limb of the first gill arch. In most cases there is little variation in the number of gill rakers within a single population, although exceptions from this rule occur (e.g. specimens from the Wadi Gadan population have 7-13 gill rakers).

The shape of the pharyngeal bone and teeth can be seen in Fig. 40. Pharyngeal teeth numbered 2.4.5-5.4.2 in 20 specimens examined.

Preserved specimens are grey-brown dorsally and light yellow-ochre or whitish ventrally. A description of live specimens is given by BANISTER & CLARKE (1977). Among the material examined there was an albinotic population from Wadi Gadan. The scales of these specimens were feeble. Otherwise no significant meristic or morphmetric differences towards other populations of G. tibanica were found.

G. t. tibanica is the most widely spread freshwater fish in Arabia. Its distribution ranges from the Wadi Hadramaut drainage system in the south to Khaibar in the north (Fig. 41). Within this range there are no morphological differences which would justify separating certain populations as distinct subspecies.

Garra tibanica ghorensis Krupp, 1982

Garra tibanica ghorensis Krupp, 1982; Hydrobiologia, 88: 319, Dead Sea rift valley.

Material:

(1) 1 specimen, 61.4 mm sl; Jordan, Ain al-Haditha, 31°18'N 35°32'E, 02.VII.1980, leg. F. Krupp & W. Schneider. Holotype, SMF 16436

(2) 2 specimens, 38.3-41.5 mm sl; same locality and collectors as (1). Paratypes, UJZM

Further material and a detailed description are given by KRUPP (1982). The body shape of the holotype is shown in Fig. 44. The snout is rounded in side view and wedge-shaped in dorsal view. In most specimens the entire mental disc is covered by papillae.

The dorsal fin has 4 unbranched and 7 branched rays. There are 3 unbranched and 5 branched rays in the anal fin. Scales in the lateral line series number 33-34. There are 3.5-4.5 scales between the lateral line and the dorsal fin origin and 3 -4.5 scales between the lateral line and the anal fin origin. 12-16 scales encircle the caudal peduncle (modal value: 14).

Gill raker counts are 10 or 11 on the lower limb of the first gill arch. Pharyngeal teeth do not differ from those of the nominal subspecies.

G. t. ghorensis differs from the nominal subspecies in having a larger mental disc and longer barbels, the number of scales between the lateral line and the dorsal fin origin and arround the caudal peduncle is lower than in G. t. tibanica. The caudal fin is only moderately forked in *G. t. ghorensis*.

G. t. ghorensis is endemic to the southern Dead Sea rift valley (Fig.41 a). No population of *G. tibanica* has so far been found between Khaibar and the Dead Sea.

Garra: Incertae sedis (1)

Material:

(1) 1 specimen, 75.5 mm sl; Yemen, Ghail Umar, Wadi Hadramaut, 15°44'N 48°51'E,leg. W. A. King-Webster. BMNH 1976.4.7: 374-377

(2) 2 specimens, 72.3-74.9 mm sl; Yemen, Qasam area, Wadi Hadramaut, c. 16°10'N 49°04'E, leg. W. A. King-Webster. BMNH 1976.4.7: 647-648

(3) 1 specimen, 68.7 mm sl; same locality and collector as (2). BMNH 1976.47:380-406

(4) 2 specimens, 72.3-80.4 mm sl; Yemen, al-Ghuraf, Wadi Hadramaut, 16°00'N 49°00'E, leg. W. A. King-Webster. BMNH 1976.4.7: 645-646

The body shape can be seen in Fig. 30. The snout is pointed in side view and in dorsal view. Morphometric characters are given in Tab. 7.

The mental disc is extremely small. Papillae on the posterior part are small, if present at all.

In the dorsal fin there are 4 unbranched rays and 7 (f5) or 8 (f1) branched rays. The last unbranched ray is much stronger than in G. tibanica . There are however persistent articulations in the distal half. The anal fin has 3 unbranched and 5 branched rays.

Scales in the lateral line series number 34 (f3), 35 (f1) or 36 (f2), there are 4.5-5.5 scales between the lateral line and the dorsal fin origin and 3.5-4.5 scales between the lateral line and the anal fin origin. 14 (f1) or 16(f5) scales encircle the least circumference of the caudal peduncle.

Gill rakers on the lower limb of the first gill arch number 12(f2), 15 (f2) or 16 (f1).

Preserved specimens are silvery-grey dorsally and whitish to silvery on the ventral surface. Nothing is known about live specimens.

Garra: Incertae sedis (1) occurs in Wadi Hadramaut where it is sympatric with G. mamshuqa. It can easily be distinguished from the latter species by having 7 branched dorsal fin rays (against 8 in G. mamshuqa) and 16 scales arround the caudal peduncle (against 12). It resembles G. tibanica in all meristic and most morphometric characters. Only the number of gill rakers is higher, a character which is of little significance in Garra. It differs considerably from G. tibanica in general body shape (compare Fig. 30 and Figs. 42-44). The last dorsal spine is stronger and the mental disc is much smaller than in G. tibanica. Anyhow, with only 6 specimens at hand, I hesitate to describe these Garra as a new species.

Garra: Incertae sedis (2)

Material:

1 specimen, 47.6 mm sl; Yemen, Wadi Sharif, between Dhufar and Wadi Masila, Bait Khawar country, 1947, leg. W. Thesiger. BMNH 1968.1.1:1

The shape of the body can be seen in Fig. 31. The specimen is a ripe ♀ which is extremely stocky. There are 8 branched dorsal fin rays and 5 branched anal fin rays. Scales in the lateral line series number 34, there are 4.5 scales between the lateral line and the dorsal fin origin and 4 scales between the lateral line and the anal fin origin. The anus is immediately in front of the anal fin .

The collecting site of this specimen is quite isolated. The next locality from where freshwater fishes are known lies 250 km to the W. The author feels unable to refer this specimen to any known species of Garra.

On the status of Garra arabica Hora, 1921

Material:

1 specimen, 65.8 mm sl; 'Lahej near Aden', leg. W. T. Blanford. Paratype of Garra arabica, ZSI F 8124/1

The shape of the body can be seen in Fig. 45. Meristic characters are D IV/8, A: III/5, LL: 32, ALL: 4.5, BLL: 3.5, CCP: 16, PT: 2.4.5-5.4.2 and GR: 12.

According to HORA (1921) Blanford collected the fishes at Lahej and presented three specimens to the Indian Museum. The same collector gave 15 specimens to the British Museum (Natural History). These were refered to *G. tibanica* by TREWAVAS (1941). The same author examined a paratype of *G. arabica* from the Indian Museum and concluded that it differed markedly from *G. tibanica* in having a well-developed proboscis on top of the snout (in addition to other distinctive characters). She stated that *G. arabica* is 'evidently closely related to *G. gotyla* and *G. stenorhynchus*'.

MENON (1964) examined the types of *Garra arabica* and came to the conclusion that it 'seems to be *G. nasutus* in every respect ... After examining all *Garra* from the Wadi Tiban drainage and after having failed to find a single specimen with a well-defined proboscis on the snout, I have come to the conclusion that probably it was due to some mistaken labelling that certain specimens of *G. nasutus* were happend to be described as *G. arabica*'. He does not consider *G. arabica* as a valid species.

As there are by now thousands of specimens of *Garra* available from Yemen and there is not a single one with a well-developed proboscis the author is in agreement with MENON (l.c.) in regarding *G. arabica* as mislabeled *G. nasuta*.

Fam. Cyprinodontidae

The family Cyprinodontidae or killifishes is represented in Arabia by the genus *Aphanius* Nardo, 1827.

Key to the species and subspecies

1. ♂♂ laterally with 8-11 black transverse bars on on a white surface, ♀♀ with a series of dark spots at the level of the lateral line .... *A. sirhani*
- Transverse bars absent or restricted to caudal peduncle in ♂♂, narrow brown bars present on females 2

2. Dorsal fin in large ♂♂ only slightly longer than in ♀♀, endemic to Dead Sea rift valley ....*A. dispar richardsoni*
- Dorsal fin in large ♂♂ reaching caudal fin base .... *A. dispar dispar*

Aphanius dispar (Rüppell, 1828)

Widely distributed between NE Africa and NW India, living in freshwater, brackish to highly saline or marine waters. D: 8-11, A: 9-11, LL: 24-28, GR: (11) 14-16 (17). Two subspecies are recognized here.

Aphanius dispar dispar (Rüppell, 1828)

Synonymy

Lebias dispar Rüppell, 1828; Atlas zu der Reise im nördlichen Afrika; Fische des rothen Meeres: 66, Red Sea.

Cyprinus leuciscus non sensu Linnaeus: Forsskål 1775; Descriptiones animalium: 71, Red Sea.

Cyprinodon lunatus Val. in Cuv. & Val., 1846; Hist. Nat. Poiss., 18:161, Red Sea.

Cyprinodon dispar: Günther 1866, partim; Cat. Fish. Brit. Mus., 6: 303, Abyssinia.

Cyprinodon stoliczkanus Day, 1872; J. Asiat. Soc. Bengal, 41: 258, Cutch.

Cyprinodon dispar: Boulenger 1887; Proc. Zool. Soc. London: 666, Muscat.

Cyprinodon dispar: Boulenger 1907; Fishes of the Nile: 412, coast of Abyssinia, Muscat, Gala near Muscat, Makalla, Cutch.

Cyprinodon dispar: Steindachner 1907; Denkschr. Akad. Wiss. Wien, 71: 156, Makalla, Gishin, E and S Arabia.

Cyprinodon dispar: Boulenger 1915; Cat. Fresh-water Fish. Africa, 3: 20, Abyssinia, Muscat, Gala.

Lebias dispar: Trewavas 1941; Brit. Mus. (Nat. Hist.) Expedition to SW Arabia 1937-8, 1: 7, S Arabia.

Cyprinodon dispar: Blegrad 1944; Danish Sci. Invest. Iran, 3: 79, Port of Bahrain.

Aphanius dispar: Klausewitz 1967; 'Meteor' Forschungsergebnisse, D 2: 44, Farasan Islands.

Aphanius dispar: Ataur-Rahim 1981; Ann. Trop. Med. Parasit., 75: 359, al-Kharj.

Aphanius dispar: Relyea 1981; Inshore fishes of the Arabian Gulf: 56, Shatt al-Arab, Kuwait Bay, Khar al-Khiran, Ain al-Abed, Bahrain.

Material:

(1) 1 specimen, 28.9 mm sl; Red Sea, 1828, leg. E. Rüppell. Lectotype of Lebias dispar, SMF 821

(2) 10 specimens, 26.1-35.8 mm sl; same locality and collector as (1). Paralectotypes of Lebias dispar, SMF 1988

(3) 26 specimens, 10.4-45.0 mm sl; Sudan, Ghor Arbaat, December 1981, leg. H. J. Dumont. KMMA 83-02-P-37-62

(4) 19 specimens, 22.7-35.4 mm sl; Sudan, Ghor Arbaat, December 1981, leg. H. J. Dumont. KMMA 83-02-P-63-81

(5) 38 specimens, 11.3-36.9 mm sl; Saudi Arabia, al'Qatif, 26°33'N 50°00'E, 8 m above sea-level, 18.IX.1979, leg. W. Büttiker. NHMB 5348-5383

(6) 1 specimen, 24.6 mm sl; Saudi Arabia, al-Hufuf , $25^{o}24$'N $49^{o}28$'E, 150 m above sea-level, 31. I.1978, leg. W. Büttiker. NHMB 5595

(7) 30 specimens, 26.0-50.2 mm sl; Saudi Arabia, al-Hasa oasis, artesian well, c. $25^{o}29$'N $49^{o}27$'E, 150 m above sea-level, 21.XI. 1981, leg. W. Büttiker. NHMB

(8) 43 specimens, 26.3-43.9 mm sl; Saudi Arabia, Ghoria spring, al-Hasa oasis, 26.XI,1981, leg. W. Büttiker. NHMB

(9) 42 specimens, 13.4-40.6 mm sl; Saudi Arabia, Bataliah, al-Hasa oasis, 26.XI.1981, leg. W. Büttiker. NHMB

(10) 41 specimens, 9.2-45.3 mm sl; Saudi Arabia, Khodod spring, al-Hasa oasis, 26.XI.1981, leg. W. Büttiker. NHMB

(11) 3 specimens, 45.3-46.3 mm sl, Saudi Arabia, Khaibar, Hijaz, c. 1000 m above sea-level, 19.V.1962, leg. G. Popov. BMNH 1974.4.7: 649-651

(12) 5 specimens, 19.1-34.8 mm sl; Saudi Arabia, Wadi Fatima near Jeddah, Hijaz, leg. D. Vesey-Fitzgerald. BMNH 1969.1.27: 58-59

(13) 2 specimens, 43.4-43.8 mm sl; Saudi Arabia, Wadi Daga, Tihama, leg. G. Popov. BMNH 1972.7.25: 54-57

(14) 3 specimens, 30.3-47.9 mm sl; Saudi Arabia, al-Qatif, c. $26^{o}23$'N $50^{o}00$'E, leg. Faray

(15) 5 specimens, 14.9-39.0 mm sl; Saudi Arabia, al-Qatif, leg. Pitcher. BMNH 1973.9.10: 229-234

(16) 5 specimens, 40.9-50.0 mm sl; Saudi Arabia, al-Kharj, 24°21'N 47°11'E, 450 m above sea-level, 29.III.1978, leg. S. Al-Ogily. BMNH

(17) 11 specimens, 18.9-27.6 mm sl; Oman, al-Khasab, 26°14'N 56°11'E, leg. G. Popov. BMNH 1976.4.7: 652-662

(18) 3 specimens, 13.7-18.9 mm sl; Yemen, al-Hana al-Nuima, 1965, leg. G. Scortecci. UDG

For a complete synonymy and a detailed description see VILLWOCK, SCHOLL & KRUPP 1983. The variability in body shape and color pattern can be seen in Figs 47-49. According to BANISTER & CLARKE (1977) the species reaches 80 mm sl. This is probably an error. KLUNZINGER (1871) gives 60 to 80 mm total length, mostsubsequent authors refered to him. The largest specimen examined here reached 52 mm sl.

The mouth is superior. There are 12-20 tricuspid teeth per jaw. Contrary to BERG (1949) no difference in the number of teeth was observed between different populations or subspecies.

In adult males the dorsal fin may be extremely long and reach beyond the base of the caudal fin origin ($\bar{x}$ = 25 %, max. = 34 % of sl). In 105 specimens examined there were 8 (f8), 9 (f75), 10 (f20) or 11 (f2) rays in the dorsal fin. The anal fin may be much longer in ♂♂ than in ♀♀. It has 9 (f6), 10 (f65) or 11 (f34) rays.

Scales are large and well-developed. There are 24 (f24), 25 (f 42), 26 (f31), 27 (f6) or 28 (f2) scales in the lateral line series. Between the lateral line and the origin of the dorsal fin there are 3.5 scales and 4-6 from the lateral line to the anal fin origin. Scales arround the least circumference of the caudal peduncle number 16 in almost all specimens examined.

Gill rakers are large, slightly curved and widely spaced. There are 11-17 (mostly 13-16) gill rakers on the anterior side of the first gill arch.

Sexual dimorphism is expressed in the length in the length of the fins and color pattern. Preserved ♂♂ are brownish with scales having a darker margin. On the flanks and above all in the caudal peduncle there are light whitish blotches and transverse or irregular bars. The caudal fin contains 2-3 broad dark transverse bars. There are irregular stripes in the dorsal fin and the posterior third of the caudal fin. In ♂♂ from the Red Sea drainage the transverse bars in the caudal fin are usually narrower. The number of ♂♂ with well-developed bars on the flanks is lower than in populations from the Persian-Arabian Gulf drainage. In the E Mediterranean most specimens have rows of light blotches.

Preserved ♀♀ are brownish-grey. There are 8-20 narrow transverse bars on the flanks. Fins are light grey and transparent.

The distribution is shown in Fig. 46. Most populations are found along the shore lines of the Red Sea, Gulf of Aden, Arabian Sea and Persian-Arabian Gulf. In the Red Sea A. dispar is common in coral reefs. Furthermore this euryhaline species enters estuaries and may even live and reproduce in pure freshwater. On the other hand it resists high salinities and extreme temperatures. Land-locked populations occur in Africa, Arabia, Iran and Pakistan.

Despite its unique color pattern, this species has often been confused with other Aphanius, above all with A. fasciatus from the E Mediterranean. Meristic characters of both species overlap, but well-developed transverse bars in the caudal fin are missing in A. fasciatus. A. sirhani differs from A. dispar in color pattern. All other Aphanius of the Middle East can easily be distinguished from A. dispar by the pattern of frontal squamation (see VILLWOCK, SCHOLL & KRUPP 1983).

Aphanius dispar richardsoni (Boulenger, 1907)

Synonymy

Cyprinodon richardsoni Boulenger, 1907; Fishes of the Nile: 412, 'Syria'.

Cyprinodon dispar, partim: Günther 1866; Cat. Fish. Brit. Mus., 6: 303, Dead Sea.

Cyprinodon dispar: Tristram 1884; Survey of W Palestine: 170, Jabal Usdum, Ain Fashkha, Ain as-Saghir, mouth of Wadi Mujib.

Aphanius dispar richardsoni, partim: Berg 1949; Trud. Zool. Ist. Akad. Nauk SSSR, 8: 848, Palestine.

Aphanius richardsoni: Steinitz 1954; Ist. Üniv. Fen. Fak. Hidrobiol., B 1: 264, Ain Fashkha, Usdum.

Material:

(1) 36 specimens, 16.3-32 mm sl; Jordan, Wadi al-Hasa near Safi, 31°04'N 35°30'E, 02.VIII. 1980, leg. F. Krupp and W. Schneider. SMF 17101

(2) 29 specimens, 18.3-41.1 mm sl; Jordan, 1 km S of Safi, 08.XII.1980, leg. F. Krupp & W. Schneider. SMF 17102

For a complete list of synonyms and a detailed description see VILLWOCK, SCHOLL & KRUPP 1983. The two subspecies do not differ in meristic characters. Differences in color pattern can be seen in Fig. 50. Furthermore *A. d. richardsoni* does not reach the size of the nominal subspecies and anal and dorsal fins of adult ♂♂ are shorter. Anyhow these characters are not very stable (see AKŞIRAY 1955) and must at least partly be attributed to ecological conditions.

In the original description BOULENGER gives a short diagnosis of *A. d. richardsoni*, 'I regard the Syrian specimens referred by Günther ... and by Gaillard ... to *C. dispar*, by Richardson ... to C. hammonis, as a distinct species for which I propose the name C. richardsoni. The caudal fin is rounded instead of truncate, the teeth number only 12 or 14 in each jaw, and the coloration is different.' Studying a larger series of specimens, these characters prove not to be significant, except for the coloration. In the material examined by the author, there were 12-20 teeth in each jaw. The caudal fin may be rounded or truncate. The subspecies is mainly characterized by its distribution. It is restricted to the widyan and freshwater sources of the Daed Sea rift valley.

Aphanius sirhani VILLWOCK, SCHOLL & KRUPP, 1983

Synonymy

Aphanius dispar non sensu Rüppell: Nelson 1973; Azraq: desert oasis: 50, 66, 402, Azraq.

Aphanius dispar non sensu Rüppell: Banister & Clarke 1977; J. Oman studies, special report: 145, Azraq.

Aphanius dispar non sensu Rüppell: Rzoska 1980; Monogr. Biol., 38: 37, Azraq.

Aphanius aff. chantrei non sensu Gaillard: Villwock 1981; Mitt. hamb. zool. Mus. Inst., 78: 209, Azraq.

Material:

(1) 1 specimen, 36.4 mm sl; Jordan, Azraq oasis, 32°51'N 36° 49'E, 31.III.1980, leg. F. Krupp & W. Schneider. Holotype, ZMH 6444

(2) 4 specimens, 25.1-28.9 mm sl, Jordan, Azraq oasis, 24.III.1977, leg. F. Krupp. Paratypes, SMF 14015

(3) 12 specimens, 19.7-22.0 mm sl; Jordan, Azraq, 1965, leg. J. Rzoska. BMNH 1966.7.8: 1-10

A complete list of type specimens and a detailed description is given in VILLWOCK, SCHOLL & KRUPP(1983). The body shape and color pattern are shown in Fig. 51, the coloration of living specimens can be seen in plate 1 and 2.

The mouth is superior. There are 12-20 teeth in each jaw. Teeth are usually tricuspid but may be conical in the posterior part of the jaw. Pharyngeal teeth are hooked, only a few marginal ones are tricuspid. The jaw bones do not differ considerably from those of A. dispar, the maxillary is slender and gently curved.

Gill rakers are of medium size and widely spaced. There are 9 (f1), 10 (f8), 11 (f20), 12 (f11) or 13 (ff3) gill rakers on the lower limb of the first gill arch.

The dorsal fin is shorter ($\bar{x}$ = 18 %, max. = 20 % of sl) than in A. dispar. There are 9 (f2), 10 (f31), 11 (f8) or 12 (f1) rays in the dorsal fin and 10 (f6), 11 (f28), 12 (f7) or 13 (f3) rays in the anal fin. The pelvic fins are extremely short (max. = 11 % of sl against 18 % in A. dispar).

Squamation was complete in all specimens examined. There are 25 (f1), 26 (f1), 27 (f9), 28 (f17) or 29 (f2) scales in the lateral line series, between the lateral line and the dorsal fin origin there are 3.5 and between the lateral line and the anal fin origin there are 3.5-5 scales. 16 scales encircle the least circumference of the caudal peduncle. Frontal squamation does not differ considerably from that of A. dispar.

In ♂♂ there are 8-11 dark transverse bars on the flanks and 2-3 in the caudal fin. In ♀♀ the number of dark spots at the level of the lateral line ranges from 8 to 12.

So far this species is only known from Azraq oasis in Jordan, but it may be expected to inhabit other parts of the Wadi Sirhan drainage in Saudi Arabia as well.

Phyletic relationships of the Aphanius dispar complex

The close relation of A. dispar and A. fasciatus has already been stated by STEINITZ (1951). A crossbreading analysis by VILLWOCK (1964, 1970) revealed that A. dispar A. fasciatus, A. iberus and A. apodus may be regarded as a group of related species (species line) distinct from Anatolian Aphanius. A. mento and A. sophiae are quite isolated in their systematic position.

Among the E mediterranean species of Aphanius, A. fasciatus, A. dispar and A. sirhani share the pattern of frontal squamation, it sets them apart from all other E mediterranean Aphanius. This character is regarded as a synapomorphy of the A. fasciatus / A. dispar group which comprises the following species: A. apodus A. iberus, A. fasciatus, A. dispar and A. sirhani.

A. fasciatus and *A. sirhani* share the possession of transverse bars on the flanks. This character does not indicate a close relationship between the two species. *A. dispar* populations which live close to the center of evolution of this species (see below) have a high percentage of ♂♂ with well-developed transverse bars on the flanks and in the caudal peduncle while the percentage decreases towards the marginal areas of distribution and almost disappears in E meditarranean populations. Thus it is likely, that the ancestor of *A. dispar* possessed this character as well. It is to be regarded as a synplesiomorphous character of *A. fasciatus* and *A. sirhani*. Furthermore, the higher number of dorsal and anal fin rays which is shared by the two latter species, is an ancestral character as well. Evolution in *A. dispar* goes towards a reduction of fin rays.

The shape of the jaw bones, above all the maxillary and the shape of the pharyngeal bones place *A. sirhani* closer to *A. dispar* than to *A. fasciatus*. Furthermore *A. sirhani* and *A. dispar* share the transverse bars in the caudal fin, although this is a common ancestral character.

According to VILLWOCK, SCHOLL & KRUPP (1983) enzymatic tests give additional evidence in favour of a close relation between *A. dispar* and *A. sirhani*. *A. dispar* X *A. sirhani* crossbreedings on the other hand resulted in male sterility in the F_1 offsprings;

this confirms the status of A. sirhani as a valid species. (A. fasciatus X A. sirhani offsprings died within the first two weeks).

The cladogram below is based on morphological characters. From the above findings, it may be concluded, that shortly after the ancestor of the A. fasciatus / A. dispar species group split into a western and an eastern population, A. sirhani was isolated from its common ancestral stock with A. dispar. The A. fasciatus / A. dispar species group may be divided into two species complexes, the A. dispar complex (so called after the most common species) in the east, comprising A. sirhani, A. d. dispar and A. d. richardsoni and the A. fasciatus complex in the west which includes A. fasciatus, A. iberus and A. apodus (reasoning for the position of the species within this complex will be given in a later paper). A zoogeographical analysis is given below.

A. Primary freshwater fishes

Since their revision by BANISTER (1973) large Barbus from East and Central Africa are quite well known. In 1971 KARAMAN revised the Barbus of the Middle East. His work is very superficial, he combines extreme splitting and extreme lumping in the same paper, thus little substential information is added to our knowledge of SW Asian Barbus. Barbus arabicus was the first species of this genus to be described from Arabia. TREWAVAS (1941) regarded it as being close to B. canis. Based on pharyngeal bone characters, squamation and the number of barbels, KARAMAN (l. c.) included B. arabicus, B. canis, B. grypus and B. reinii in the genus Tor (B. canis occurs in the Levant, B. grypus in Mesopotamia and B. reinii in Morocco). Above all the number of barbels is hardly appropriate to define species lines within Barbus. In many respects the genus Tor (sensu KARAMAN) is polyphyletic and has to be rejected. BANISTER & CLARKE (1977) align B. arabicus with the E African B. intermedius complex without mentioning KARAMAN's revision. They base this decision mainly on the fact, that B. arabicus shares the possession of 5 branched anal fin rays with E African Barbus. Furthermore they align B. apoensis and B. exulatus with three Middle Eastern species, namely B. canis, B. luteus and B. chantrei (KARAMAN synonymizes the latter species with B. canis without having seen material; this synonymy is likely to be unjustified).

Above all the exterior similarity of *B. canis* and *B. apoensis* is striking. According to BANISTER & CLARKE the two species can be distinguished from each other by the number of scales in the lateral line series. 55 specimens of *B. canis* examined by the author had 29-35 scales in the lateral line while in *B. apoensis* their number ranged from 29 to 31, thus lying within the range of the former species. The number of barbels (1 pair in *B. apoensis*, 2 pairs in *B. canis*) is the most important difference between the two species. It is obvious, that they are very closely related to each other.

B. exulatus shares most meristic characters with *B. canis* (the statement by BANISTER & CLARKE 1977: 118 that they differ from each other in the number of barbels is obviously an error). The two species can be distinguished by the following characters: 1. The shape of the mouth which is inferior in the former and terminal in the latter species; 2. The number of branched dorsal fin rays (7-9 in *B. exulatus*, 10 in *B. canis*), and 3. The number of scales in the lateral line which is slightly higher in *B. canis*. In the last character, *B. exulatus* resembles *B. chantrei*.

BANISTER (1980) suggests that the majority of Mesopotamian *Barbus* can be divided into two stocks, each of which may be monophyletic: a European stock with a cylindrical body, small scales and a serrated dorsal spine, and an Afro-Indian stock with compressed body, large scales and a smooth dorsal spine. In the latter group he includes *B. capito*, *B. grypus* and *B.* sharpeyi, all of which have 5 branched anal rays (*B. capito* probably has to be excluded from this group as its dorsal spine is serrated). *B. arabicus* has to be placed within this lineage The author agrees with BANISTER & CLARKE (l. c.) that it is closer to *B. intermedius* than to any of the Mesopotamian *Barbus.* It resembles *B. grypus* in most meristic characters (e.g. 4 barbels, 8 dorsal fin rays) but the two species differ considerably from each other in general body shape.

On the other hand *B. luteus*, *B. canis*, *B. chantrei* *B. apoensis* and *B. exulatus* are likely to form a monophyletic group. They share the following characters: 1. shape of pharyngeal bones and teeth; 2. possession of large scales; 3. more or less compressed body; 4. a smooth dorsal spine, and 5. unbranched anal fin rays.

Thus summarizing, all Arabian Barbus belong to the Afro-Indian stock. *B. arabicus* is closely related to E African species, *B. apoensis* and *B. exulatus* may be aligned with Levantine and Mesopotamian species.

The genus *Cyprinion* (sensu BERG 1949) inhabits Arabia, N Syria, Mesopotamia, Iran, Pakistan and Afghanistan. Until 1949, 15 species had been described from the region E of Mesopotamia. According to BERG (l. c.) 4 of them are valid. In his revision MIRZA (1969) recognizes only *C. watsoni*, *C. microphthalmum* and *C. milesi*. KARAMAN (1971) synonymizes the latter two with C. watsoni. Furthermore he synonymizes C. kais with C. macrostomum and thus confines the whole genus to two species (obviously without having studied any material!). In 1977 BANISTER & CLARKE describe C. acinaces. In 1982 HOWES revises the genus Cyprinion. He recognizes C. watsoni, C. milesi and C. microphthalmum from the Iranian region and C. kais and C. macrostomum from Mesopotamia. Furthermore he includes Semiplotus in Cyprinion. According to his cladogram, C. acinaces and C. milesi are most closely related to each other, they are the sister-group of all other Cyprinion. HOWES' revision is the first attempt to clarify phyletic relations within this genus, but his work remains unsatisfactory for several reasons: 1. He accepts MIRZA's revision without re-examining the type specimens of all Cyprinion; 2. Relationships are only based on jaw anatomy, other characters are largely excluded; 3. The variability of osteological characters within a species remains insufficiently known, and 4. Synapomorphies used to establish the cladogram are not unequivocal. Anyhow, in the light of HOWES' recent revision, the relationships of Arabian Cyprinion will only be briefly commented here.

It is without doubt that C. mhalensis and C. acinaces are very closely related to each other, probably forming sibling species. The fact, that the fifth pharyngeal tooth of the interior row is well-developed in juvenile C. mhalensis while it is reduced in adult specimens suggests that there is a tendency towards tooth reduction. The absence of the fifth tooth in C. acinaces might thus be a derived character. W Arabian Cyprinion resemble C. macrostomum and C. kais in general body shape and in the possession of a strongly serrated dorsal spine. The two groups differ from each other in the shape of the pharyngeal teeth and in the number of dorsal fin rays (10-12 in W Arabian Cyprinion, 11-15 in Mesopotamian species). Contrary to the statement by BANISTER & CLARKE (1977: 129) the latter character overlaps. The W Arabian species differ from Irano-Pakistani Cyprinion in general body shape, size and shape of the dorsal spine and the number of scales arround the caudal peduncle.

I have no hesitation in aligning SE Arabian Cyprinion with C. microphthalmum . As the type specimens of this species are obviously lost (see WHITEHEAD & TALWAR 1976, BANISTER & CLARKE 1977) it is hard to find evidence for BERG's synonymy. As stated above, there are morphological differences that justify the status of C. microphthalmum muscatensis as a distinct subspecies. Altogether, morphological findings and the pattern of distribution (Fig. 54) are in agreement with the taxonomic status.

About 40 species of Garra are known from Africa and S Asia. As is the case in Cyprinion , E Arabian Garra are distinct from those of W Arabia. G.barreimiae is the most widely distributed species in Oman. According to MENON (1964) it is closely related to G. rufa (Fig. 19) from Mesopotamia and the Levant. This opinion is shared by BANISTER & CLARKE (1977). They base their decision mainly on the color pattern.

I found little similarity between G. rufa and G. barreimiae. Only in a few populations of G. rufa the body is mottled, this character is extremely variable, most populations are uniformly grey or grey-brown. In G. barreimiae 12 scales encircle the least circumference of the caudal peduncle, against 16 in G. rufa. The number of branched dorsal fin rays is modally lower in G. barreimiae. MENON (l. c.) erroneously gives 7 branched dorsal rays for G. rufa, 198 specimens examined by the author had 7 (f6), 8 (f188) or 9 (f4) while G. barreimiae has 6-8 (modally 7) dorsal rays. These two characters, which are quite stable in most species of Garra are shared by G. barreimiae and G. persica from Baluchestan and Hormozdgan, which is a valid species distinct from G. rufa (COAD 1982). In addition, the pattern of distribution of G. barreimiae and G. persica (Fig. 55) supports this assumption. G. longipinnis has to be aligned with the latter two species due to a number of common characters (e. g. 7 branched dorsal rays, 12 scales arround caudal peduncle, distance between anus and anal fin).

Among W Arabian Garra, G. mamshuqa is quite isolated in its systematic position. It can be separated from all other Garra of this region on a variety of characters (e.g. position of fins, head length, distance between anus and anal fin, length of dorsal fin base, size and shape of mental disc, eye diameter, interorbital width). It cannot be aligned unequivocally with any extant species in the Middle East either. According to MENON (l. c.), one evolutionary trend in the genus Garra is for the anus to approach the anal fin. Considering this character, G. mamshuqa has to be placed within the G. rufa complex (sensu MENON), together with G. persica, G. barreimiae and G. longipinnis. Several morphometric characters support the assumption that these species form a distinct complex within the genus Garra.

TREWAVAS (1941)pointed out the close relationship of G. tibanica with African species of this genus. Further evidence in favor of this assumption is given by MENON (1964) and BANISTER & CLARKE (1977). G. buettikeri and G. sahilia share most morphometric characters with G. tibanica and with African Garra. The anus is close to the anal fin origin in all three species. They are likely to share a common ancestor. G. buettikeri cannot be confused with any other species, as it has a higher number of scales in the lateral line, between the lateral line and the dorsal fin origin and arround the caudal peduncle. It is more difficult to separate G. sahilia from G. tibanica. G. sahilia has a higher number of branched dorsal fin rays, but there is about 10 % overlap in this character. It thus seemed first likely, that the two taxa differ at the subspecific level, but this cannot be the case as the two species occur sympatrically in several localities (e.g. Wadi Bana, Wadi Tiban). They do not only inhabit the same wadi systems but even the same localities within the wadi. In a single sample almost all specimens have the same number of branched dorsal fin rays. If there was no reproductive isolation between the populations, this character would have destabilized. Within a large sample of adult *G. sahilia* usually a few young *G. tibanica* occur and vice versa. This fact might be interpreted as indicating a seasonal change in the number of fin rays. But this assumption is disproved, as in other samples specimens of all sizes have the same number of dorsal fin rays. The color pattern of the dorsal fin is an additional character which might help to distinguish the two species from each other. Both *G. tibanica* and *G. sahilia* are extremely variable in body shape, this is another obstacle in telling them apart.

Beside *G. t. tibanica* only *G. t. ghorensis* is recognized here. In addition to their geographical separation the two subspecies differ from each other in a number of morphological characters. BALLETTO & SPANO (1977) recognize 9 subspecies of *G. tibanica* in N Yemen. They based their decision on a statistical analysis of morphometric characters. Their results are not of great value, as they operate with measurements in mm instead of relating them to the standard length. On the other hand statistical differences will always be found in isolated populations which inhabit arid zones. Samples of *G. rufa* from the same locality, which were caught in different years or seasons varied in several morphometric characters (unpublished data). Subspecies should always be based on clear cut morphological differences and a zoogeographical concept. Morphometric measurements of the type specimens of all subspecies of G. tibanica from Yemen did not reveal significant differences, nor does the pattern of distribution argue in favor of a splitting into subspecies.

Thus summarizing, within the Arabian peninsula Barbus arabicus, Garra tibanica, G. sahilia and G. buettikeri show affinities to African species, all other Cyprinidae may be aligned with oriental species. BANISTER & CLARKE (1977) divide Arabian freshwater fishes into three groups: The Levantine, the Arabian and the African group. While the latter is well defined, there are no clear cut differences between the Levantine, Mesopotamian and Iranian ichthyofaunas, but rather a gradual change in the composition of species.

Except for C. microphthalmum all species of Cyprinidae are endemic to Arabia (MENONS's record of G. tibanica from Somalia is doubted, see also AL-KAHEM & BEHNKE 1983).

According to the distribution and affinities of primary freshwater fishes, the Arabian peninsula may be divided into three ichthyogeographical subprovinces (Fig.56): 1. The Oman mountains; 2. The Red Sea and Gulf of Aden drainage, and 3. The Rub' al-Khali drainage. No primary freshwater fishes have so far been recorded from other parts of the peninsula.

The fish fauna of the Oman mountains is very distinct from that of the two other subprovinces. This region is inhabited by Cyprinion microphthalmum muscatensis , G. barreimiae and G. longipinnis. In the first species, populations W and E of the Gulf of Oman differ from each other only at the subspecific level, the two latter are closely related to a species from Baluchestan. This pattern of distribution may be explained by the fact, that the marine barrier became effective only some 20,000 years ago.

Barbus arabicus, B. exulatus, Cyprinion acinaces, C. mhalensis, G. tibanica, G. sahilia and G. mamshuqa are endemic to the Red Sea and Gulf of Aden drainage of Arabia. Out of these species there are 4 with Oriental and 3 with African affinities. The ancestor of G. tibanica obviously entered SW Arabia coming from Africa, and migrated south along the Red Sea coast (KRUPP 1982). The pattern of distribution of B. arabicus suggests that the same might be true for this species. Headwater capture in the Yemen mountains allowed an exchange between the upper tributaries of the Wadi Hadramaut and the Red Sea coastal drainage. Due to a lowering of sea-level during the Pleistocene glaciations, the Red Sea coastal drainages might have got into contact thus allowing an exchange of freshwater fishes. This explains the fact, that between Khaibar and the Gulf of Aden, populations of G. tibanica do not show any clear morphological differences. C. acinaces shares this pattern of distribution with G. tibanica but populations from the Hijaz and from Yemen belong to different subspecies.

In the Asir block, the former and recent tributaries of Wadi ad-Dawasir, which drains to the W Rub' al-Khali, are inhabited by three endemic cyprinids: B. apoensis, C. mhalensis and G. buettikeri. Not a single species is shared by the drainages E and W of the Asir. C. mhalensis is closely related to C. acinaces. G. tibanica and G. sahilia are probably the sister group of G. buettikeri, only B. apoensis has no counterpart west of the Asir watershed. Before the uplift of the Asir mountains, the entire region was obviously inhabited by continuous ancestor populations of C. mhalensis / C. acinaces and G. buettikeri / G. tibanica. With the uplift of the Asir, the populations became separated, isolation became effective and resulted in the evolution of the extant species.

The ancestor of B. apoensis entered the area of its present distribution coming from the Levant or Mesopotamia. The Wadi al-Batin Wadi ar-Rima system might have served as a potential pathway. A changing system of Pliocene and Pluvial freshwater lakes in the Rub' al-Khali basin obviously resulted in a connection to the Wadi Hadramaut drainage system which explains the occurrence of B. exulatus there.

In the Arabian peninsula speciation of Cyprinidae took place in recent geological times. It is most likely, that increasing aridity since the Pleistocene resulted in the eradication of numerous freshwater fishes. The low number of genera represented in Arabia in alliance with the low age of many species suggests that Arabia did not have a rich freshwater fish-fauna, at least in recent geological times. Unlike the situation in the Levant, there are no indications, that the Arabian peninsula ever served as a transition area in an exchange of freshwater fishes between Asia and Africa.

Secondary freshwater fishes

The taxonomy of Aphanius, the only genus of secondary freshwater fishes so far described from Arabia, is commented above. The distribution of Aphanius dispar along the coasts of the Arabian peninsula, in the E Mediterranean and in the Dead Sea rift valley gave rise to different hypotheses on the origin and evolution of this species.

STEINITZ (1951) considers A. dispar to be of Tethys age. This age determination is linked with the assumption that the Dead Sea populations belong to A. dispar (this assumption is doubted by the same author in 1954).According to STEINITZ (l. c.), the area of A. dispar was dissected into two main parts, the Mediterranean in the NW and the Indian in the SE, at the close of the Mediterranean. In between, some populations were trapped in inland waters of the dividing continental barrier. A deterioration of climate in the late Tertiary led to the eradication of most land-locked populations of *A. dispar*. The species found a refuge in the Dead Sea valley. It lateron re-entered the Mediterranean via the Suez canal.

POR (1975) regards the Dead Sea populations of *A. dispar* as relicts of a marine transgression during the Pliocene.

The hypothesis of STEINITZ (l. c.) has to be rejected as the geological periods of time he takes into condideration do not agree with the morphological differences and the phylogenetic distances between the taxa concerned. The close of the Mediterranean priliminarily came to an end during the Oligocene and finally during the Miocene. No extant species of *Aphanius* is of Oligocene or Miocene age. The low degree of variety between *A. d. richardsoni* and the nominal subspecies stands against POR's assumption that they are separated since the Pliocene.

Based on the comparison of *A. fasciatus*, *A. sirhani* and *A. dispar* (see above) it is likely that the two species complexes of the *A. fasciatus* / *A. dispar* group were separated during the Miocene. After a first establishment of a land bridge in the Levant, the Mediterranean came again into contact with the Indian Ocean via the Kara su basin and the Mesopotamian basin during the Middle Miocene transgression. The retreat of the Sea resulted in the separation of a formerly continuous population of the *A. fasciatus* / *A. dispar* ancestral stock. In the mediterranean basin this stock gave rise to the species of the *A. fasciatus* complex, while in the SE the A. dispar complex evolved. During the Pliocene, part of the SE population reached the Wadi Sirhan depression, where it gave rise to A. sirhani in geographical isolation. This process took place at a time when the Mesopotamian basin was still filled with brackish water. Thus it is not surprising that no freshwater fishes or invertebrates indicate a former freshwater connection between Azraq and the Euphrates. The last marine transgression, that reached the Wadi Sirhan depression is of Miocene age.

It is hard to propose a pathway of migration of Aphanius from Mesopotamia to Wadi Sirhan. As the two drainages come closely together in the northern extension of the as-Summan plateau, headwater capture in this region might be considered as a possible solution. The distribution of a single species does not allow a final decision. Even a displacement of eggs by water birds may not be completely excluded.

Conditions in the Mesopotamian basin during the early Pliocene were favorable for the evolution of A. dispar. In the brackish waters it hardly met competitors as neither marine nor freshwater species were able to establish themselves under such conditions. From Mesopotamia the species migrated through the Gulf into the Arabian Sea. Its SE-wards distribution was limited by the unprotected sandy shorelines of India. Conditions in the Red Sea were more favorable, thus after the waters of the Indian Ocean broke through the strait of Bab al-Mandab, A. dispar colonized the Red Sea reefs and established itself along the African and Arabian coast of the Gulf of Aden.

Headwater capture in the Midian block of Saudi Arabia connected the Wadi al-Akhdar Wadi al-Jizl system, which had formerly drained to the south, with the Red Sea. This explains the distribution of A. dispar in Khaibar. Furthermore this drainage system allowed A. dispar - as well as Garra tibanica - to migrate northwards. They had reached the Dead Sea valley during the Pleistocene Pluvial B when there existed a freshwater lake (Lake Samra) ranging from Lake Tiberias to the Dead Sea. During the Interpluvial C, when this lake was converted into the brackish Lake Lisan Garra tibanica ghorensis had to retreat to the freshwater sources arround the lake (KRUPP 1982). The same is true for A. dispar, but as a secondary freshwater fish, it was able to colonize the lake for much longer. When Lake Lisan dried out during the Interpluvial C A. dispar found a refuge in the widyan and sources arround the Dead Sea. Thus the populations are diconnected since 75,000 and 12, 000 years B. P. The preference of high temperatures restricted A. dispar (as well as G. tibanica) to the southern part of the Jordan rift valley. They are the only immigrants from Arabia in this region among the freshwater fishes.

A. dispar is likely to have reached the E Mediterranean before the opening of the Suez canal (VILLWOCK, SCHOLL & KRUPP 1983). When it came into contact with A. fasciatus speciation had been completed. The majority of landlocked populations of *A. dispar* is of Pleistocene age.

Thus in the circum Arabian *A. dispar* complex, morphological differences between populations, the present pattern of distribution and geological events are in perfect agreement.

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REFERENCES

AKŞIRAY, F., 1955. Beiträge zur Kenntnis des Formenkreises Aphanius dispar (Rüppell). Ist. Üniv. Fen. Fak. Hidrobiol., 3: 63-73.

AL-KAHEM, H. F. & R. J. BEHNKE, 1983. Freshwater fishes of Arabia. Fauna of Saudi Arabia, 5 (in press).

AL-NAQIB, K. M., 1967. Geology of the Arabian Peninsula: Southwestern Iraq. Prof. Pap. U. S. geol. Surv., 560-G: 1-54.

AL-SAYARI, S. S. & J. G. ZÖTL, editors, 1978. Quarternary Period in Saudi Arabia. 334 pp., Wien.

ATAUR-RAHIM, M., 1981. Observations on Aphanius dispar (Rüppell, 1828) a mosquito larvivorous fish in Riyadh, Saudi Arabia. Ann. Trop. Med. Parasit., 75: 359-362.

BALLETTO, E. & S. SPANÒ, 1977. Ciprinidi del genere Garra Hamilton, 1822 raccolti nello Yemen dal Prof. Giuseppe Scortecci. Ann. Mus. Civ. Stor. Nat. "Giacomo Doria", 81: 246-287.

BANARESCU, P., 1977. Position zoogéographique de l'ichtyofaune d'eau douce d'Asie occidentale. Cybium, 3. Sér., 2: 35-55.

BANISTER, K. E., 1973. A revision of the large Barbus (Pisces, Cyprinidae) of East and Central Africa. Bull. Br. Mus. nat. Hist. (Zool.), 26: 1-148.

BANISTER, K. E., 1980. The fishes of the Tigris and Euphrates rivers. Mong. Biol., 38: 95-108.

BANISTER, K. E. & M. A. CLARKE, 1977. The freshwater fishes of the Arabian Peninsula. J. Oman studies, special report: The Scientific Results of The Oman Flora and Fauna Survey 1975: 111-154.

BENDER, F., 1969. Beiträge zur Geologie Jordaniens. 247 pp., Hannover.

BENDER, F., 1975. Geology of the Arabian Peninsula, Jordan. Prof. Pap. U. S. geol. Surv., 560-I: 1-36.

BERG, L. S., 1913. Description of a new species of Garra (= Discognathus) from eastern Persia. Ann. Mus. Zool. St. Petersb., 18: 16-17.

BERG, L. S., 1934. Razdelenie Palearktiki na zoogeograficheskie oblasti na osnovanii rasprostraneniya presnovodnykh ryb. Trudy I Vsesoyuznogo geograficheskogo s'ezda, 3: 3-10.

BERG, L. S., 1949. Presnovodnye Ryby Irana i sopredelnych stran. Trudy Zool. Inst. Akad. Nauk SSSR, 8: 783-858.

BINDAGJI, H. H., 1978. Atlas of Saudi Arabia. 61 pp., Oxford.

BEYDOUN, Z. R., 1966. Geology of the Arabian Peninsula: Eastern Aden Protectorate and part of Dhufar. Prof. Pap. U. S. geol. Surv., 560-H: 1-49.

BEYDOUN, Z. R., 1970. Southern Arabia and northern Somalia: comparative geology. Phil. Trans. Roy. Soc. Lond., A 267: 267-292.

BOTROS, G. A., 1971. Fishes of the Red Sea. Oceanogr. Mar. Biol. Ann. Rev., 9: 211-348.

BOULENGER, G. A., 1887. An account of the fishes obtained by A. Jayakar at Muskat, east coast of Arabia. Proc. Zool. Soc. London: 653-667.

BOULENGER, G. A., 1892. Third account of fishes obtained by Surgeon-Major A. S. G. Jayakar at Muscat, east coast of Arabia. Proc. Zool. Soc. London: 134-136.

BOULENGER, G. A., 1907. The fishes of the Nile. In: ANDERSON: Zoology of Egypt. 2 vols., 578 pp., London.

BROWN, G. F., 1970. Eastern margin of the Red Sea and the coastal structures in Saudi Arabia. Phil. Trans. Roy. Soc. Lond., A 267: 75-87.

BUDAY, T. & J. TYRACEK, 1980. The regional geology of Iraq. 1: Stratigraphy and palaeogeography. 445 pp., Baghdad.

CHAPMAN, R. W., 1978. Geology. In: Quarternary Period in Saudi Arabia, ed. AL-SAYARI, S. S. & J. G. ZÖTL: 4-19.

COAD, B. W., 1982. Garra persica Berg, 1913, a valid species of cyprinid fish from south-eastern Iran. Cybium, 3. Sér., 6: 97-100.

CRACRAFT, J., 1973. Vertebrate evolution and biogeography in the Old World tropics: implications of continental drift and palaeoclimatology. In: Implications of continental drift to earth sciences, I., eds. TARLING, D. H. & S. K. RUNCORN, Academic Press: 371-392.

CUVIER, G. & A. VALENCIENNES, 1846. Histoire naturelle des poissons. Vol. 18, Paris.

DAY, F., 1878-88. The fishes of India; being a natural history of the fishes known to inhabit the seas and freshwaters of India, Burma and Ceylon. 2 vols., XX + 778 pp., London.

DUBERTRET, L., 1970. Review of the structural geology of the Red Sea and surrounding areas. Phil. Trans. Roy. Soc. Lond., A 267: 9-20.

ERDMAN, D. S., 1950. Fishing in Arabia. Scientific Monthly, 70: 58-65.

FALCON, N. L. et al., 1970. A discussion on the structure and evolution of the Red Sea and the nature of the Red Sea, Gulf of Aden and Ethiopian Rift junction. Phil. Trans. Roy. Soc. Lond., A 267: 1-417.

FORSSKÅL, P., 1775. Descriptiones Animalium Avium, Amphibiorum, Piscium, Insectorum, Vermium, que in Itinere Orientali observavit. 19 + XXXIV + 164 pp., Havniae.

FOWLER, H. W., 1956. Fishes of the Red Sea and Southern Arabia. Vol. 1, 240 pp., Jerusalem.

FOWLER, H. W. & H. STEINITZ, 1956. Fishes from Cyprus, Iran, Iraq, Israel and Oman. Bull. Res. Counc. Israel, 5 B: 260-292.

GEUKENS, F., 1966. Geology of the Arabian Peninsula: Yemen. Prof. Pap. U. S. geol. Surv., 560-D: 1-23.

GREENWOOD, J. E. G. W. & D. BLEACKLEY, 1967. Geology of the Arabian Peninsula: Aden Protectorate. Prof. Pap. U. S. geol. Surv., 560-C: 1-96.

GREENWOOD, P. M., 1974. Review of Caenozoic freshwater-faunas in Africa. Ann. Geol. Surv. Egypt, 4: 211-232.

GÜNTHER, A., 1866. Catalogue of the Physostomi in the collection of the British Museum. 356 pp., London.

HENNIG, W., 1982. Phylogenetische Systematik. 246 pp., Berlin & Hamburg.

HORA, S. L., 1921. Indian cyprinoid fishes, belonging to the genus Garra with notes on related species from other countries. Rec. Indian Mus., 22: 633-687.

HOWES, G., 1982. Anatomy and evolution of the jaws in the semiplotine carps with a review of the genus Cyprinion Heckel, 1843 (Teleostei: Cyprinidae). Bull. Br. Mus. nat. Hist. (Zool.), 42: 299-335.

KARAMAN, M. S., 1969. Süßwasserfische der Türkei, 7. Teil: Revision der kleinasiatischen und vorderasiatischen Arten des Genus Capoeta (Varicorhinus, partim). Mitt. Hamburg. Zool. Mus. Inst., 66: 17-54.

KARAMAN, M. S., 1971. Süßwasserfische der Türkei, 8. Teil: Revision der Barben Europas, Vorderasiens und Nordafrikas. Mitt. Hamburg. Zool. Mus. Inst., 67: 175-254.

KASSLER, P., 1973. The structural and geomorphic evolution of the Persian Gulf. In: The Persian Gulf, ed. PURSER, B. H., pp. 11-33, Berlin.

KINZELBACH, R. & F. KRUPP, 1982. Zur Einbürgerung des Moskitofisches (Gambusia affinis) in Mitteleuropa. Mainzer naturwiss. Archiv, 20: 67-77.

KLUNZINGER, C. B., 1870-71. Synopsis der Fische des Rothes Meeres. 1. und 2. Theil. Verh. zool.-bot. Ges. Wien, 20: 669-834, 21: 441-688, 1352-1368.

KOSSWIG, C., 1967. Tethys and its relation to the peri-Mediterranean faunas of fresh-water fishes. System. Assoc. Publ., 7: 313-323.

KRUPP, F., 1980. Die Verbreitung syrischer Süßwasserfische unter dem Einfluß des Menschen. Natur u. Museum, 110: 157-164.

KRUPP, F., 1982. Garra tibanica ghorensis subsp. nov. (Pisces: Cyprinidae), an African element in the cyprinid fauna of the Levant. Hydrobiologia, 88: 319-324.

KRUPP, F. & W. SCHNEIDER, 1980. Zoological collections in Jordan, Syria and Lebanon in 1980. 36 pp., Mainz.

LAUGHTON, A. S., R. B. WHITMARSH & M. T. JONES, 1970. The evolution of the Gulf of Aden. Phil. Trans. Roy. Soc. Lond., A 267: 227-266.

LORTET, L., 1883. Etudes zoologiques sur la faune du lac de Tibériade suivies d'un aperçu sur la faune des lacs d'Antioche et de Homs, I: poissons et reptiles du lac de Tibériade et de quelques autres parties de la Syrie. Arch. Mus. hist. nat. de Lyon, 30: 99-194.

McCLURE, H. A., 1978. Ar Rub' Al Khali. In: Quarternary Period in Saudi Arabia, ed. AL-SAYARI, S. S. & J. G. ZÖTL: 252-263.

MENON, A. G. K., 1951. Distribution of clariid fishes and its significance in zoogeographical studies. Proc. nat. Inst. Sci. India, 17: 291-299.

MENON, A. G. K., 1964. Monograph of cyprinid fishes of the genus Garra Hamilton. Mem. Indian Mus., 14: 173-260.

MILTON, D. I., 1967. Geology of the Arabian Peninsula: Kuwait. Prof. Pap. U. S. geol. Surv., 560-F: 1-7.

MIRZA, M. R., 1969. Fishes of the genus Cyprinion Heckel (Cyprinidae, Osteichthyes) from West Pakistan. Pakistan Journ. Zool., 1: 141-150.

MIRZA, M. R., 1974. Freshwater fishes and ichthyography of Baluchistan and adjoining areas of the Indus plain, Pakistan. Biologia, (Lahore), 20: 67-82.

NELSON, B., 1973. Azraq: desert oasis. 436 pp., London.

NOVACEK, M. J. & L. G. MARSHALL, 1976. Early biogeographical history of Ostariophysan fishes. Copeia: 1-12.

PICARD, L., 1952. The Pleistocene peat of Lake Hula. Bull. Res. Counc. Israel, 2 B: 147-156.

PLAYFAIR, 1870. Note on a fresh-water fish from the neighbourhood of Aden. Proc. Zool. Soc. London: 85-86.

POR, F. D., 1975. An outline of the zoogeography of the Levant. Zool. Scripta, 4: 5-20.

POWERS, R. W., L. F. RAMIREZ, C. D. REDMOND & E. L. ELBERG, 1966. Geology of the Arabian Peninsula: sedimentary geology of Saudi Arabia. Prof. Pap. U. S. geol. Surv., 560-D: 1-147.

RELYEA, K., 1981. Inshore Fishes of the Arabian Gulf. 149 pp., London.

RICHARDSON, J., 1856. On some fish from Asia Minor and Palestine. Proc. Zool. Soc. London, 24: 371-377.

ROBERTS, T. R., 1975. Geographical distribution of African freshwater fishes. Zool. J. Linn. Soc., 57: 249-319.

RÜPPELL, E., 1828. Atlas zu der Reise im nördlichen Africa, Fische des rothen Meeres. 144 pp., Frankfurt.

RZÓSKA, J., 1980. Euphrates and Tigris, Mesopotamian ecology and destiny. Mong. Biol., 38: 1-122.

SCORTECCI, G., 1963. Viaggio nell'Arabia meridionale. Società geografica italiana. 32 pp., Roma.

SCORTECCI, G., 1966 a. Ambienti biologici dello Yemen. Arch. zool. italiano, 51: 385-393.

SCORTECCI, G., 1966 b. Relazione di un viaggio di esplorazione biologica nello Yemen. Boll. mus. ist. biol. univ. Genova, 34: 5-106.

STEINITZ, H., 1951. On the distribution and evolution of cyprinodont fishes of the mediterranean region and the Near East. Bonn. zool. Beitr., 1-2: 113-124.

STEINITZ, H., 1954. The distribution and evolution of the fishes of Palestine. Ist. Fen. Fak. Hidrobiol., Ser. B, 1: 225-275.

STERBA, G., 1962. Freshwater fishes of the world. 878 pp., London.

TEUGELS, G. G., 1982. A systematic outline of the African species of the genus Clarias (Pisces; Clariidae) with an annotated bibliography. Ann. Mus. Roy. Afr. centr., sér. IN 8° Sci. zool., 236: 1-249.

TREWAVAS, E., 1941. Freshwater fishes. In: British Museum (Natural History), Expedition to South-West Arabia 1937-8, 1: 7-15, London.

VAN COUVERING, J. A. M., 1977. Early records of freshwater fishes in Africa. Copeia: 163-167.

VILLWOCK, W., 1958. Weitere genetische Untersuchungen zur Frage der Verwandtschaftsbeziehungen anatolischer Zahnkarpfen. Mitt. Hamb. Zool. Mus. Inst., 56: 81-153.

VILLWOCK, W., 1964. Genetische Untersuchungen an altweltlichen Zahnkarpfen der Tribus Aphaniini, (Pisces, Cyprinodontidae) nach Gesichtspunkten der Neuen Systematik. Z. zool. Syst. Evolutionsforsch., 2: 267-382.

VILLWOCK, W., 1970. Distribution, ecology and relationship of Near East and mediterranean cyprinodonts of the genus Aphanius. Journées ichthyol., Rome C. I. E. S. M.: 89-92.

VILLWOCK, W., A. SCHOLL & F. KRUPP, 1983. Zur Taxonomie, Verbreitung und Speziation des Formenkreises Aphanius dispar (Rüppell, 1828) und Beschreibung von Aphanius sirhani n. sp. (Pisces: Cyprinodontidae). Mitt. hamb. zool. Mus. Inst., 80 (in press).

WHITEHEAD, P. J. P. & K. K. TALWAR, 1976. Francis Day (1829-1889) and his collections of Indian fishes. Bull. Br. Mus. (Nat. Hist.), Historical series, 5: 5-189.

WOHLFAHRT, E., 1980. Die Arabische Halbinsel. 1726 pp., Berlin

WOLFART, R., 1967. Geologie von Syrien und dem Linanon. 326 pp., Berlin.

Tab. 1: Morphometric characters of <u>Cyprinion acinaces hijazi</u> (in % of sl)

	$\bar{x}$	SD	Range	n
sl			43.2 - 109.4 mm	7
hl	27.9	1.2	25.9 - 30.8	7
bd	27.1	2.2	24.0 - 33.3	7
cd	9.3	0.3	8.9 - 9.6	7
ldb	21.5	1.9	19.0 - 23.7	7
lab	9.7	0.6	8.9 - 10.3	7
ld	24.9	2.2	22.3 - 27.8	7
la	21.6	2.3	18.3 - 23.9	7
lpc	21.3	1.6	18.9 - 23.7	7
wm	6.7	0.4	6.3 - 7.3	5
lbp	3.9	0.4	3.4 - 4.7	7
ed	6.3	0.7	5.4 - 7.6	7
iow	7.7	0.4	7.1 - 8.3	7

Tab. 2: Morphometric characters of <u>Cyprinion mhalensis</u> (in % of sl)

	$\bar{x}$	SD	Range	n
sl			29.9 - 104.7 mm	23
tl	127.4	1.5	124.1 - 130.1	21
sd	48.0	1.6	44.5 - 51.6	23
sp	53.9	1.6	51.5 - 56.9	23
hl	26.8	1.7	24.6 - 29.8	23
bd	26.1	1.4	23.1 - 28.4	23
cd	9.4	0.5	8.5 - 10.1	23
ldb	19.2	1.3	16.8 - 21.3	23
lab	9.6	0.8	8.0 - 11.4	23
ld	24.9	2.7	18.3 - 29.5	23
la	18.6	1.2	16.9 - 21.8	23
lpc	20.1	1.3	17.3 - 22.7	23
wm	7.2	1.1	5.6 - 10.4	23
lbp	3.3	0.7	2.0 - 5.1	23
ed	6.8	1.1	5.2 - 8.5	23
iow	6.6	0.7	5.4 - 8.3	23

Tab. 3: Morphometric characters of <u>Garra buettikeri</u> (in % of sl)

	$\bar{x}$	SD	Range	n
sl			46.6 - 100.0 mm	10
tl	125.1	1.4	123.4 - 127.8	10
sd	47.4	1.1	45.6 - 49.6	10
sp	52.4	1.1	50.2 - 54.3	10
sa	75.3	1.6	72.9 - 77.7	10
hl	23.6	1.4	22.0 - 26.2	10
cl	16.0	1.2	15.3 - 18.7	10
bd	22.7	2.1	19.9 - 25.5	10
cd	10.7	0.5	10.2 - 11.6	10
aa	2.9	0.4	2.1 - 3.7	10
ldb	13.1	0.5	12.1 - 13.5	10
lab	7.7	0.4	6.6 - 8.4	10
ld	22.9	1.3	21.0 - 24.6	10
la	17.5	0.8	15.7 - 18.4	10
lp	18.3	1.1	16.5 - 19.7	10
lpc	20.5	0.8	19.0 - 22.5	10
wm	7.8	0.7	6.6 - 9.0	10
lmd	7.0	0.7	5.7 - 8.5	10
wmd	8.3	0.7	7.2 - 9.2	10
lba	3.6	0.3	3.0 - 4.3	10
lbp	2.6	0.4	2.5 - 3.2	10
ed	4.3	0.4	3.9 - 4.9	10
iow	8.8	0.6	8.0 - 9.9	10

Tab. 4: Morphometric characters of <u>Garra</u> <u>mamshuqa</u>

(in % of sl)

	$\bar{x}$	SD	Range	n
sl			45.5 - 48.0 mm	10
tl	127.3	0.6	126.6 - 129.1	9
sd	46.4	1.0	45.5 - 48.0	10
sp	50.6	1.0	48.5 - 52.2	10
sa	73.3	0.9	71.2 - 74.5	10
hl	20.6	0.6	19.7 - 22.3	10
cl	16.4	0.6	15.1 - 17.8	10
bd	21.5	1.3	19.7 - 23.4	10
cd	9.8	0.3	9.4 - 10.3	10
aa	4.9	0.4	4.3 - 5.5	10
ldb	17.4	0.7	15.8 - 18.7	10
lab	8.7	0.4	8.2 - 9.2	10
ld	23.5	1.1	21.7 - 25.2	10
la	19.4	0.9	17.9 - 20.5	10
lp	18.9	1.0	16.8 - 20.3	10
lpc	19.5	1.0	18.4 - 21.3	10
wm	6.5	0.5	5.7 - 7.4	10
lmd	5.5	0.4	5.0 - 6.1	10
wmd	5.6	0.4	5.2 - 6.4	10
lba	3.5	0.5	2.8 - 4.2	10
lbp	2.8	0.5	1.9 - 3.5	10
ed	5.8	0.3	5.2 - 6.2	10
iow	6.7	0.4	6.0 - 7.2	10

Tab. 5: Morphometric characters of <u>Garra sahilia sahilia</u> (in % of sl)

	$\bar{x}$	SD	Range	n
sl			47.1 - 100.5 mm	25
tl	125.8	1.4	123.9 - 128.3	20
sd	49.2	1.2	46.5 - 52.0	25
sp	54.2	1.2	52.5 - 57.0	25
sa	76.1	1.5	73.3 - 79.4	25
hl	23.9	1.1	22.3 - 25.8	25
cl	14.4	0.9	12.9 - 16.3	25
bd	23.1	1.5	20.1 - 24.6	25
cd	11.5	0.6	10.6 - 12.6	25
aa	3.1	0.5	2.1 - 4.1	25
ldb	13.5	1.0	12.5 - 14.9	25
lab	7.3	0.8	6.1 - 8.6	25
ld	20.8	1.4	19.0 - 23.6	23
la	17.9	1.0	16.3 - 19.6	25
lp	18.2	1.2	16.0 - 20.2	25
lpc	20.8	1.6	18.5 - 24.0	25
wm	8.3	1.0	6.6 - 10.3	25
lmd	7.2	1.2	5.5 - 9.1	25
wmd	8.8	1.3	6.9 - 11.4	25
lba	4.4	0.7	2.9 - 5.5	25
lbp	3.1	0.6	1.5 - 4.2	25
ed	4.9	0.4	4.5 - 5.8	25
iow	9.3	0.5	8.2 - 10.8	25

Tab. 6: Morphometric characters of <u>Garra tibanica</u>
(in % of sl)

	$\bar{x}$	SD	Range	n
sl			40.1 - 99.4 mm	200
tl	127.7	1.6	124.7 - 130.1	200
sd	48.6	1.4	45.9 - 52.9	200
sp	53.3	1.7	49.9 - 57.5	200
sa	76.0	1.4	72.6 - 79.4	200
hl	25.8	1.6	22.1 - 29.6	200
bd	22.5	2.6	17.2 - 28.6	200
cd	10.9	0.8	8.4 - 12.2	200
aa	3.1	0.3	1.0 - 4.2	200
ldb	14.9	1.0	11.8 - 17.1	200
lab	8.6	1.0	6.2 - 11.8	200
ld	24.9	1.8	17.9 - 28.7	200
la	19.5	1.6	16.5 - 22.4	200
lpc	22.3	1.5	18.6 - 27.4	200
lmd	7.8	0.9	6.0 - 9.7	200
wmd	9.6	1.0	6.8 - 11.6	200
lba	4.7	0.5	2.5 - 5.9	200
lbp	3.6	0.6	2.2 - 5.2	200
ed	5.2	0.5	3.7 - 6.8	200
iow	8.6	0.5	7.3 - 9.9	200

Tab. 7: Morphometric characters of <u>Garra</u>: Incertae sedis (1)
(in % of sl)

	$\bar{x}$	SD	Range	n
sl			68.7 - 80.4 mm	6
sd	45.8	0.8	44.7 - 46.9	6
sp	50.4	1.2	48.5 - 51.6	6
sa	74.5	1.4	72.5 - 76.4	6
hl	22.9	0.9	22.0 - 24.6	6
bd	19.1	2.6	16.6 - 23.3	6
cd	9.5	0.7	8.3 - 10.2	6
aa	3.4	0.5	2.8 - 3.9	6
ldb	15.0	1.1	13.8 - 16.8	6
lab	8.4	0.5	7.6 - 8.9	6
ld	26.4	1.8	24.8 - 29.4	6
la	18.9	0.5	18.3 - 19.7	6
lpc	20.7	1.7	18.9 - 23.5	6
lmd	5.7	0.5	4.8 - 6.2	6
wmd	6.9	0.2	6.6 - 7.2	6
lba	3.7	0.4	3.0 - 4.2	6
lbp	2.9	0.5	2.3 - 3.6	6
ed	5.3	0.2	5.0 - 5.5	6
iow	8.1	0.5	7.6 - 8.9	6

Captions to figures

Figs 1-4: The genus Barbus. 1,Adult specimen of _B. arabicus_ from Wadi Sahama. 2, Juvenile specimen of _B. arabicus_ from Wadi Juva. 3, Juvenile specimen of _B. apoensis_ from Wadi Shuqub. 4, Adult specimen of _B. canis_ from the Jordan rift valley (s. discussion).- (Scale bar: 10 mm).

Fig. 5a: Map showing the distribution of _Barbus_ in the Arabian peninsula.

Fig. 5b. Map showing the distribution of _Barbus arabicus_ in N Yemen.

Fig. 6: Map showing the distribution of _Cyprinion acinaces_.

Fig. 7: _Cyprinion acinaces hijazi_.

Fig. 8: Left pharyngeal bone and pharyngeal teeth of _Cyprinion acinaces hijazi_.

Figs 9-11: _Cyprinion mhalensis_. 9, Adult specimen. 10, Subadult specimen. 11, Juvenile specimen.- (Scale bar: 10 mm).

Fig. 12: Right pharyngeal bone and pharyngeal teeth of _Cyprinion mhalensis_.

Fig. 13: Map showing the distribution of _Cyprinion mhalensis_.

Figs 14-16: The genus _Cyprinion_. 14, _C. mhalensis_ from Wadi Turabah. 15, _C. acinaces hijazi_ from Wadi Hediya, holotype. 16, _C. microphthalmum muscatensis_ from Wadi Dayqah.- (Scale bar: 10 mm).

(2

Figs 17-19: E Arabian Garra and G. rufa. 17, G. barreimiae barreimiae from Oman. 18, G. b. shawkahensis from Wadi Shawkah. 19, G. rufa from the Jordan rift valley (s. discussion).- Each specimen in side and ventral view. (Scale bar: 10 mm).

Fig. 20: Map showing the distribution of E Arabian Garra.

Fig. 21: Garra buettikeri.

Fig. 22: Ventral view of the head of Garra buettikeri to show the mental disc.

Fig. 23: Right pharyngeal bone and pharyngeal teeth of Garra buettikeri.

Fig. 24: Map showing the distribution of Garra buettikeri.

Fig. 25: Garra mamshuqa.

Fig. 26: Ventral view of the head of Garra mamshuqa to show the mental disc.

Fig. 27: Right pharyngeal bone and pharyngeal teeth of Garra mamshuqa.

Fig. 28: Map showing the distribution of Garra mamshuqa.

Figs 29-31: S Arabian Garra: 29, G. mamshuqa from Qasam area. 30, G.: Incertae sedis (1) from Qasam area. 31, G.: Incertae sedis (2) from Wadi Sharif.- 29 and 30 in side and ventral view. (Scale bar: 10 mm).

Fig. 32: *Garra sahilia sahilia*.

Fig. 33: Right pharyngeal bone and pharyngeal teeth of *Garra sahilia gharbia*.

Fig. 34: Map showing the distribution of *Garra sahilia*.

Figs 35-37: W and SW Arabian *Garra*. 35, *G. buettikeri* from Adama. 36, Holotype of *G. sahilia sahilia* from Wadi Bana. 37, *G. s. gharbia* from Wadi Daga.- Each specimen in side and ventral view. (Scale bar: 10 mm).

Fig. 38: Side view of a large ♂ of *Garra tibanica* with breeding tubercles.

Fig. 39: Ventral view of the head and pectoral region of *Garra tibanica*.

Fig. 40: Right pharyngeal bone and pharyngeal teeth of *Garra tibanica*.

Fig. 41a: Map showing the distribution of *Garra tibanica* in the Arabian peninsula.

Fig. 41b: Map showing the distribution of *Garra tibanica* in N Yemen.

Figs 42-44: *Garra tibanica*, to show the variability in body shape. 42 and 43, *G. t. tibanica* both from Wadi Damad. 44, Holotype of *G. t. ghorensis* from the Dead Sea rift valley.- Each specimen in side and ventral view. (Scale bar: 10 mm).

Fig. 45: Paratype of *Garra arabica*, sl: 65.8 mm.

Fig. 46: Map showing the distribution of the <u>Aphanius dispar</u> complex. (After KRUPP in VILLWOCK, SCHOLL & KRUPP 1983, modified).

Figs 47-49: <u>Aphanius dispar dispar</u>, variability in body shape and color pattern. 47, ♂ from Qatif. 48, Specimens from Qatif: a- ♂, b- ♀. 49, Specimens from the Red Sea drainage: a- ♂, b- ♀.

Figs 50-51: N Arabian <u>Aphanius</u>. 50, <u>A. dispar richardsoni</u> from the Dead Sea rift valley: a- ♂, b- ♀. 51, <u>A. sirhani</u> from Azraq: a- ♂ (holotype), b- ♀.

Fig. 52: Synapomorphy scheme of the <u>Aphanius dispar</u> complex: 1- reduced maxillary; 2- lower number of scales and fin rays, reduction of transverse bars on flanks; 3- shorter dorsal fin, different color pattern (see text).

Fig. 53: Proposed cladogram of the <u>Aphanius fasciatus</u>/ <u>A. dispar</u> species group.

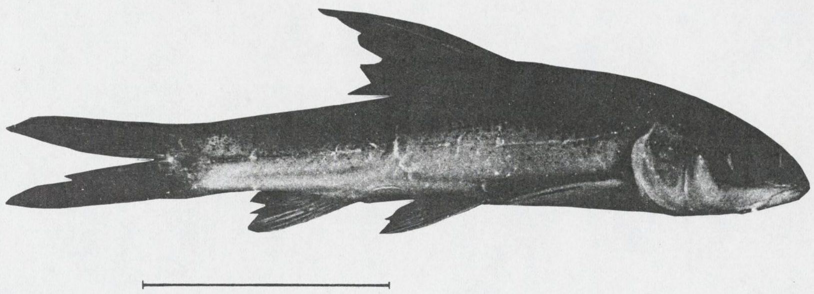
Fig. 54: Map showing the distribution of <u>Cyprinion microphthalmum</u>.

Fig. 55: Map showing the distribution of <u>Garra barreimiae</u> and <u>G. persica</u> (locality data of <u>G. persica</u> taken from COAD 1982).

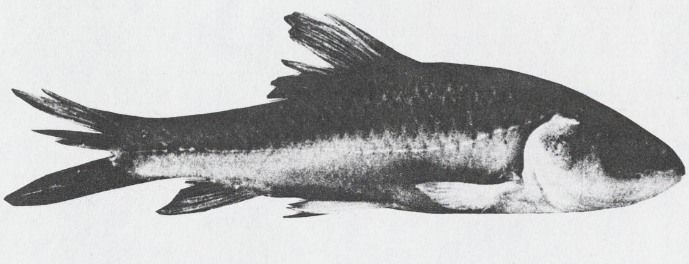
Fig. 56: Map showing the ichthyological subprovinces of the Arabian peninsula: 1- Oman mountains, 2- Red Sea and Gulf of Aden drainage, 3, W Rub' al-Khali drainage.

Fig. 57: Map showing the supposed pathways of migration of <u>Aphanius dispar</u>.

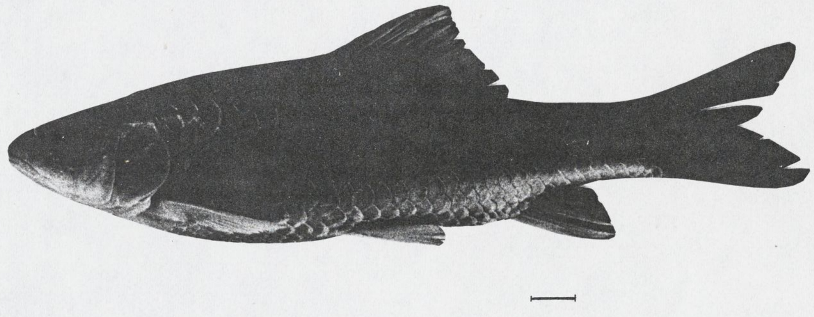
1



2

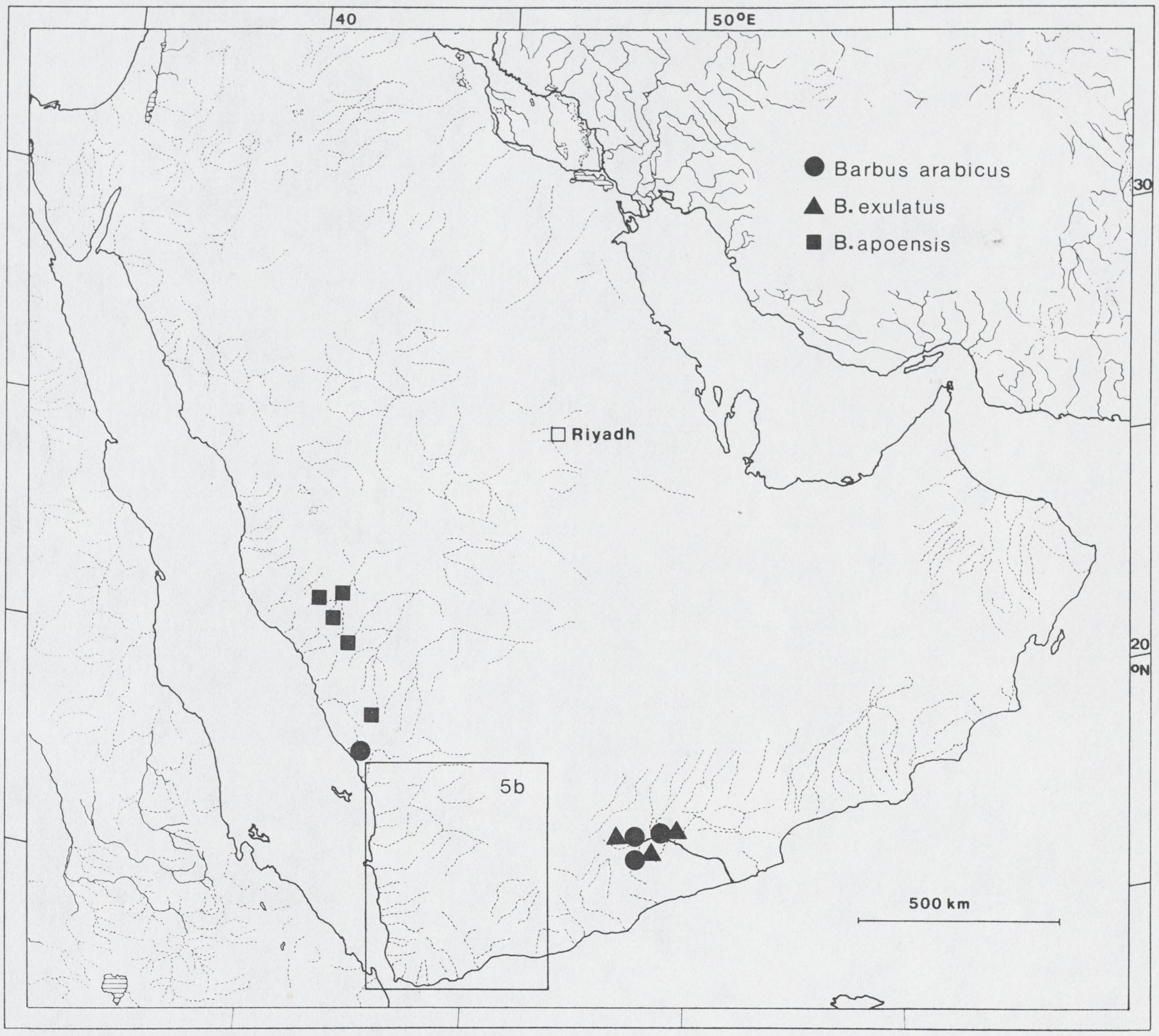


3



4

Figs 1-4



40
50°E
30
20
°N
Barbus arabicus
B. exulatus
B. apoensis
Riyadh
5b
500 km

Fig. 5a

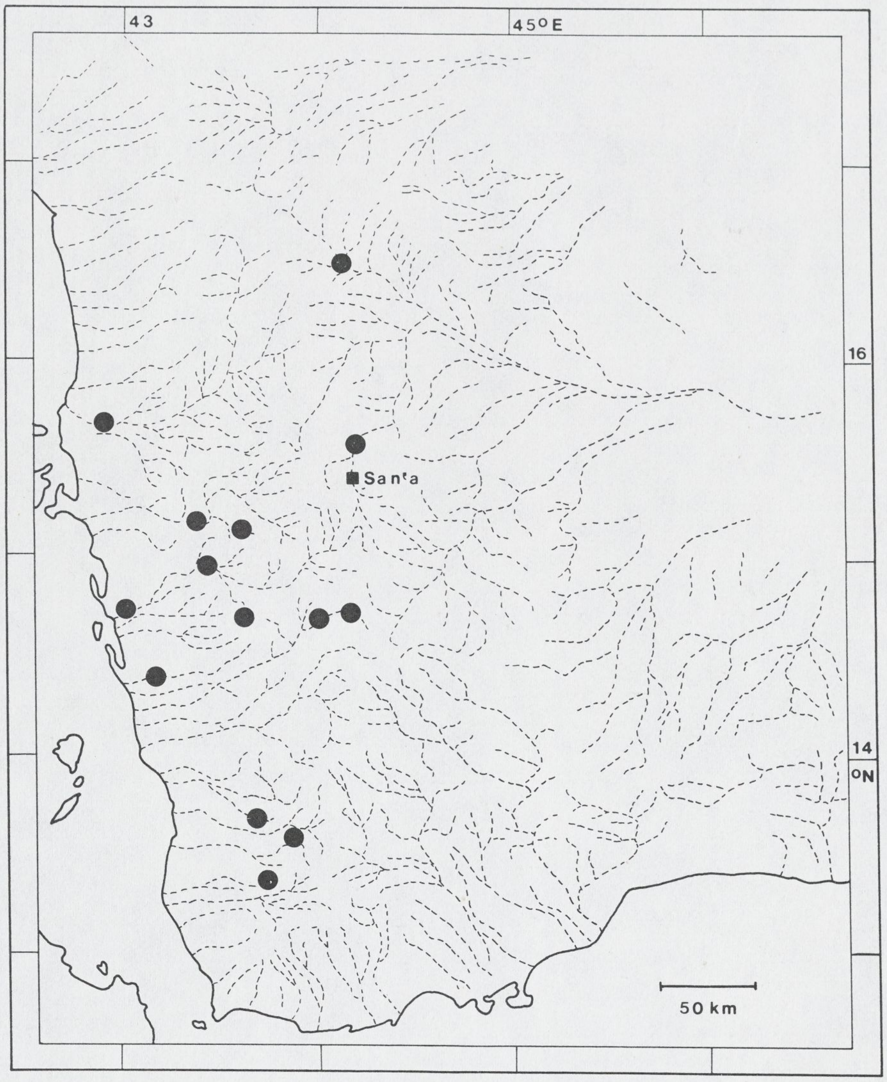


Fig. 56

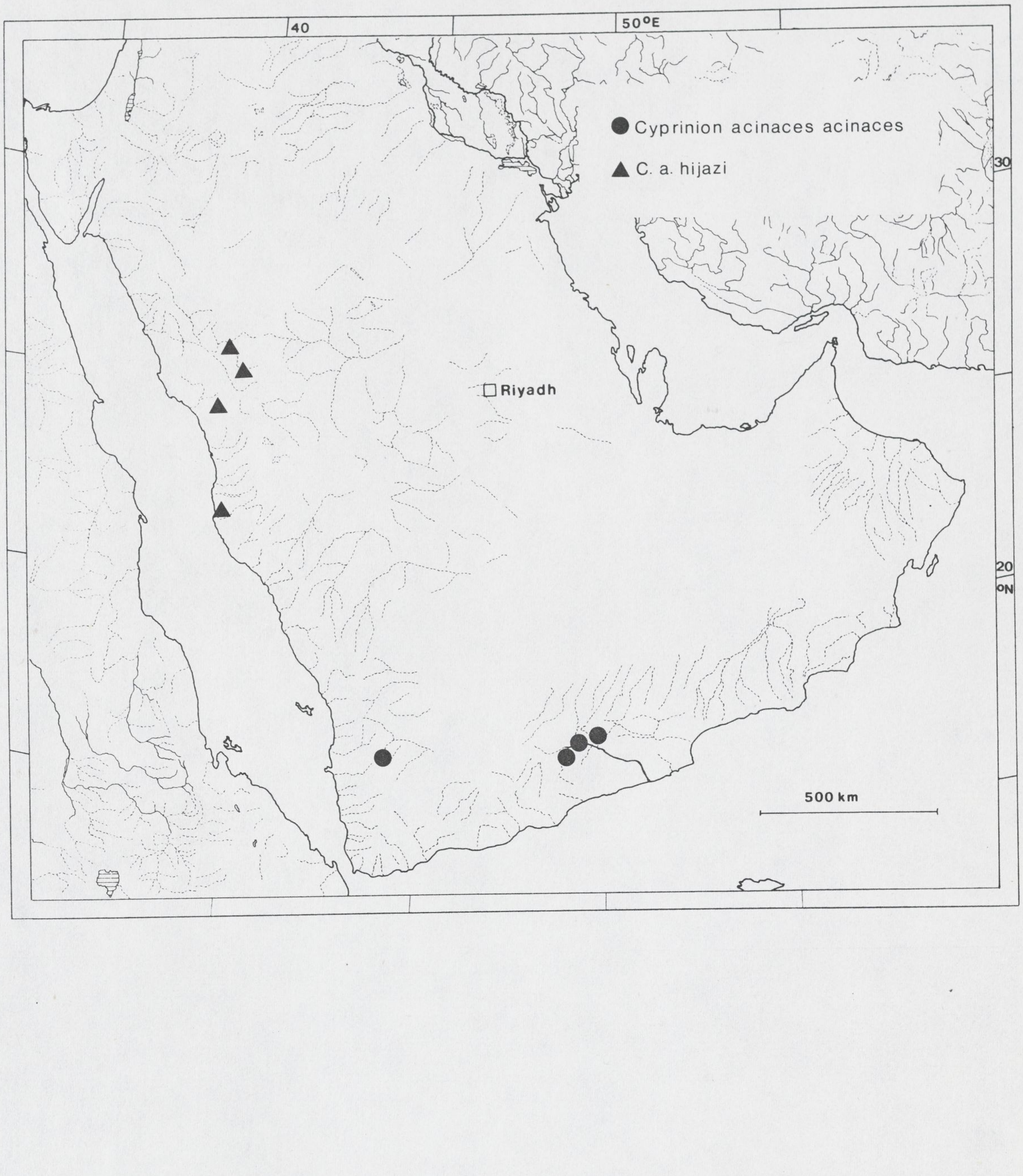

40
50°E
30
20
°N
Cyprinion acinaces acinaces
C. a. hijazi
Riyadh
500 km

Fig. 6

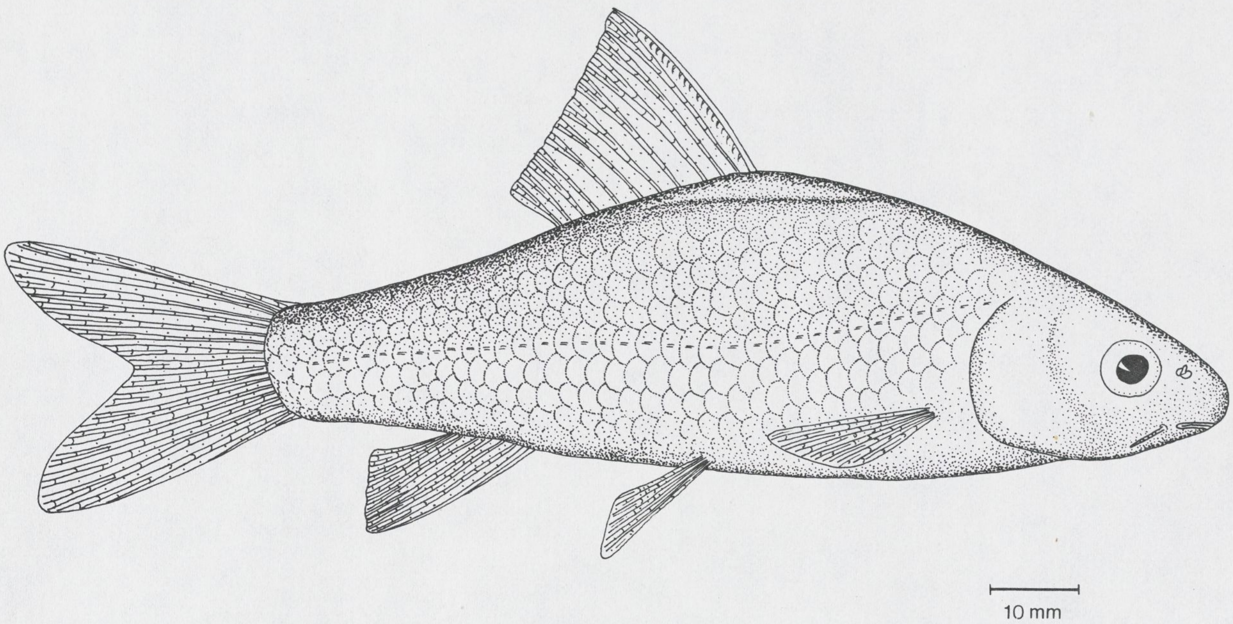


Fig. 7

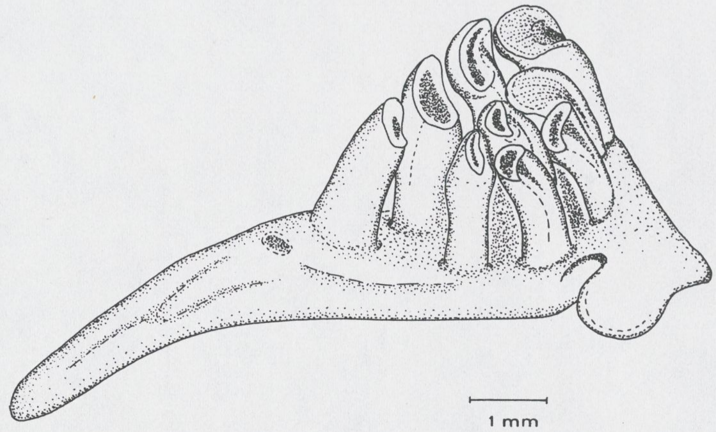


Fig. 8

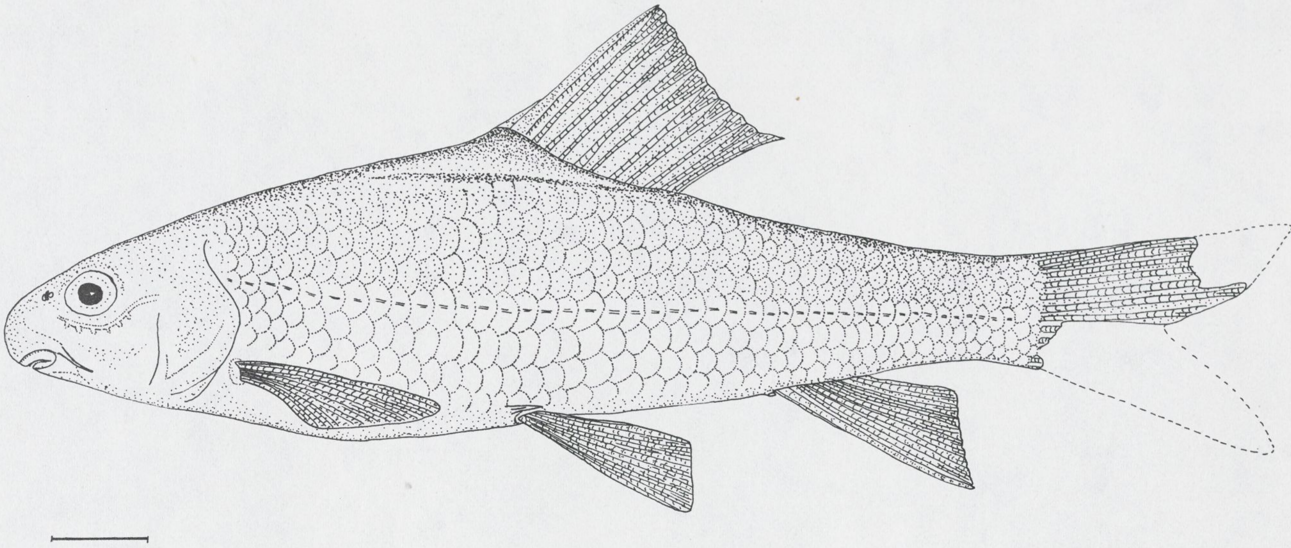


Fig. 9

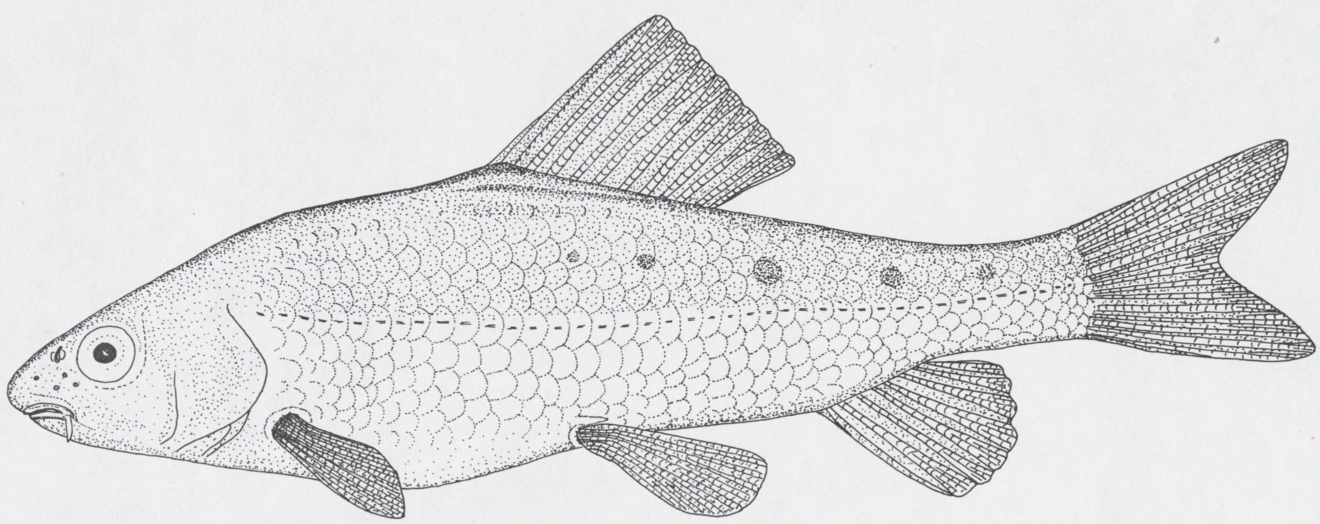


Fig. 10

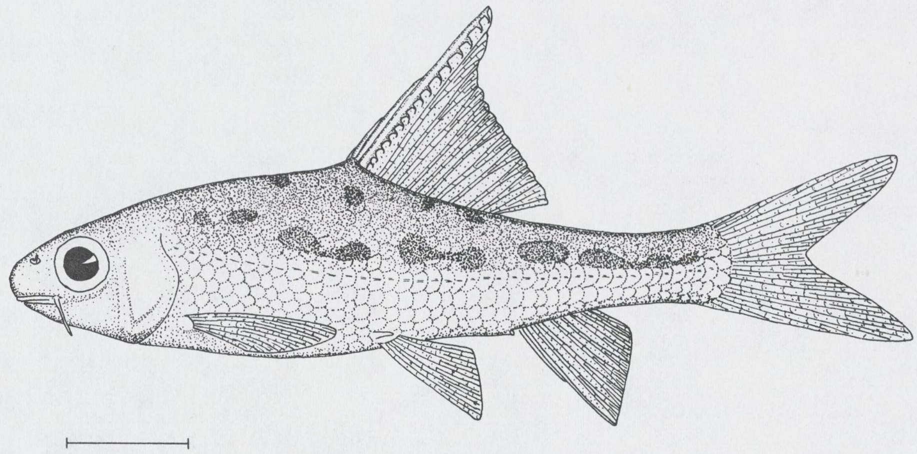


Fig. 11

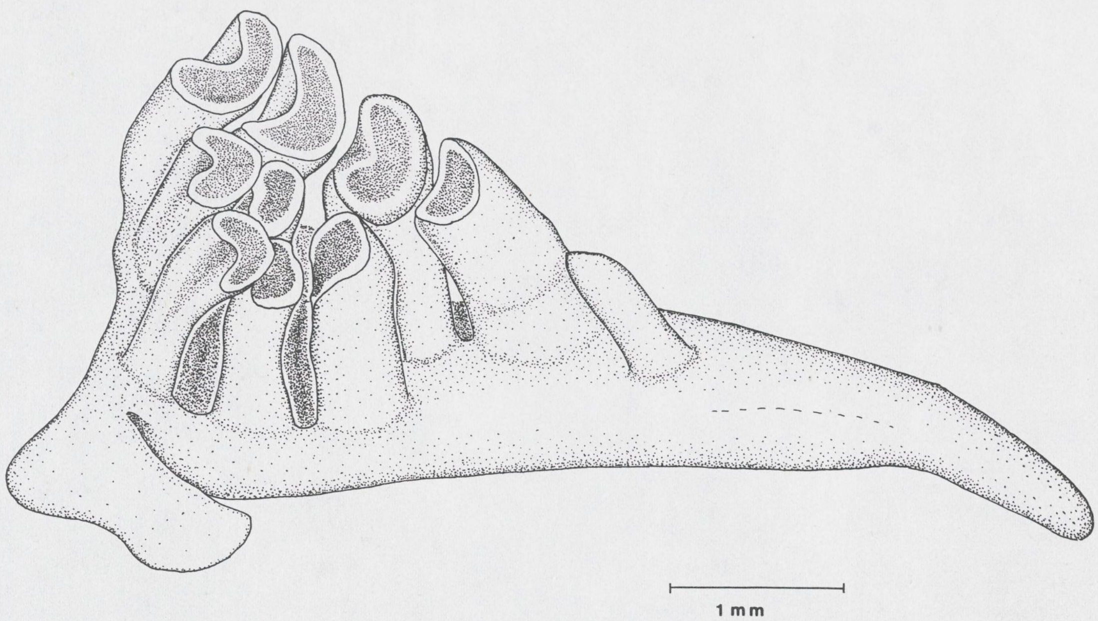


Fig. 12

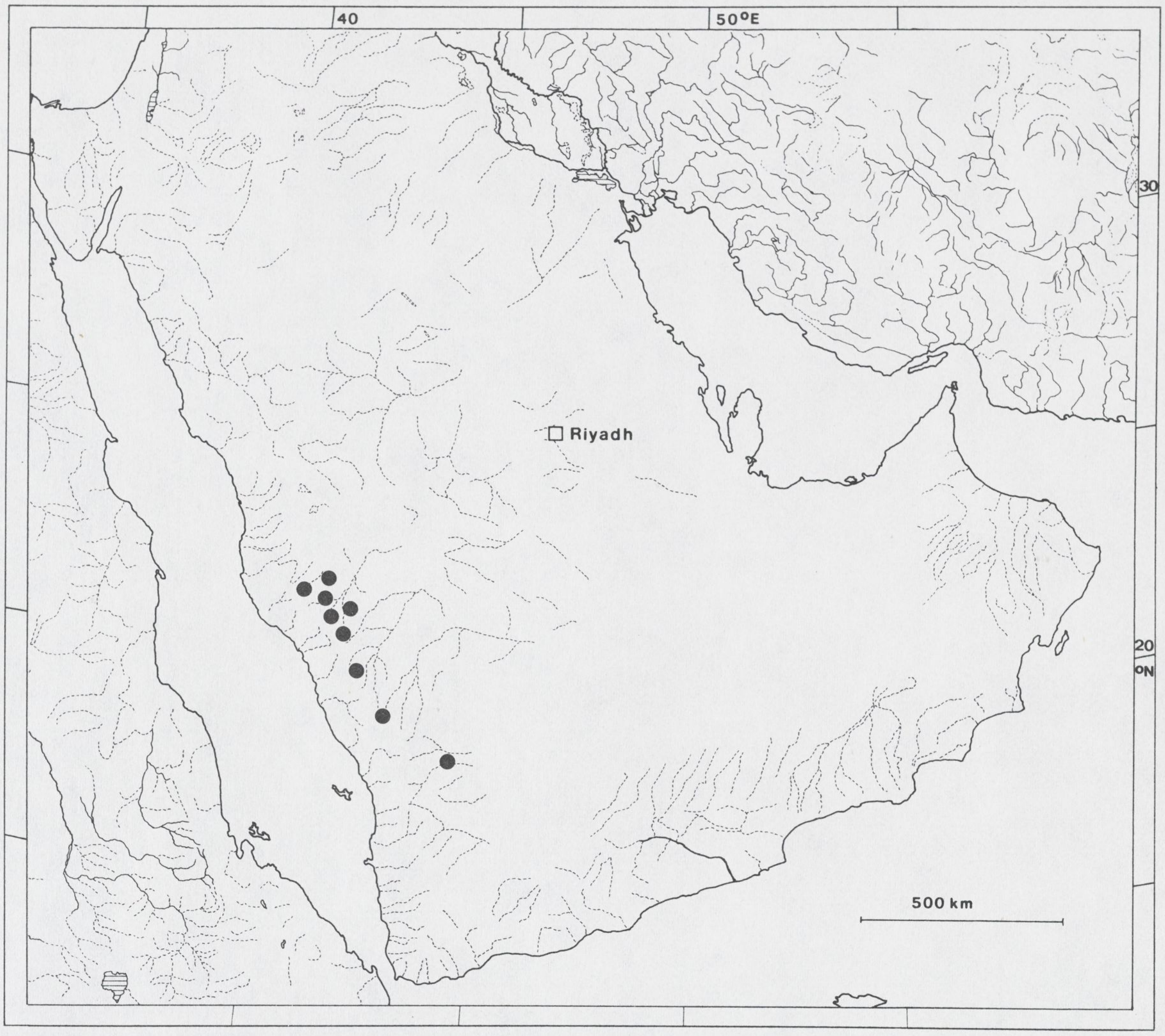
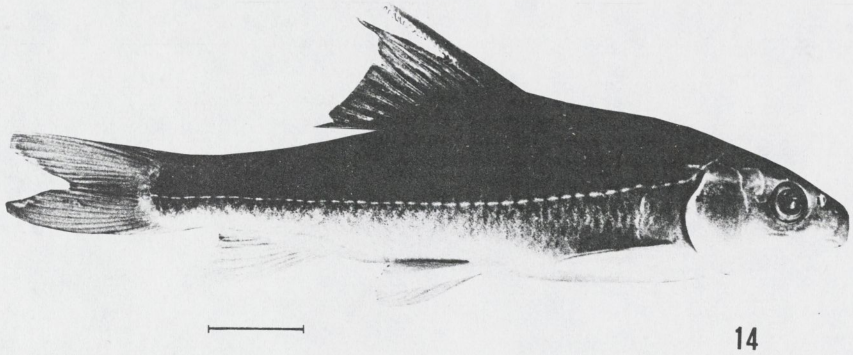
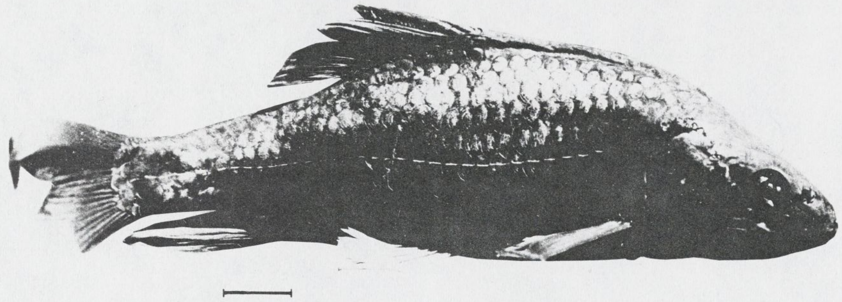


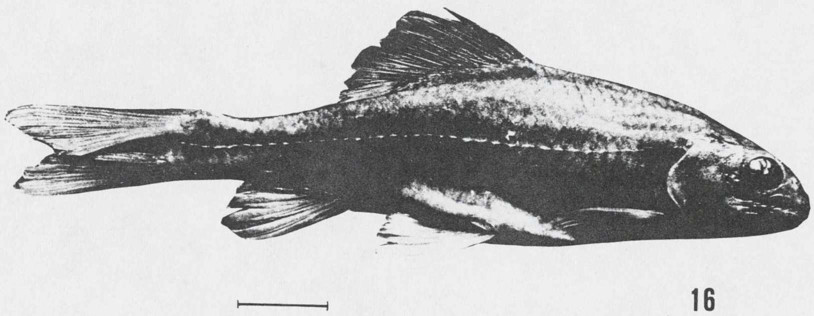
Fig. 13



14



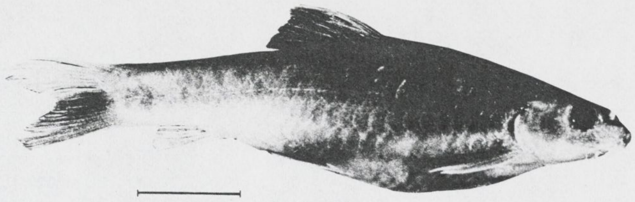
15

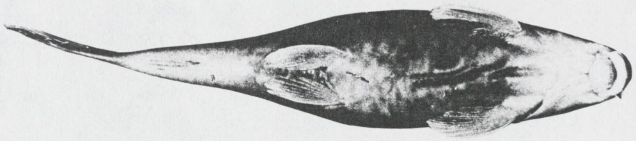


16

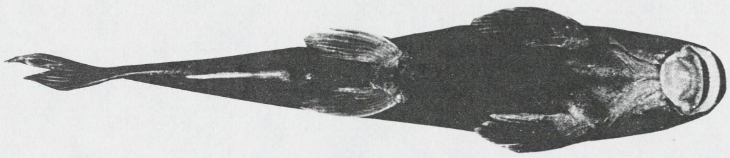
Figs 14-16

17

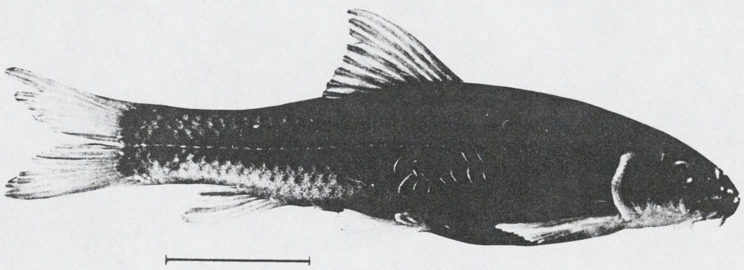


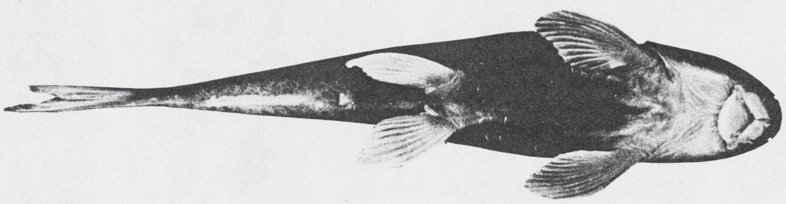


18



19





Figs 17-19

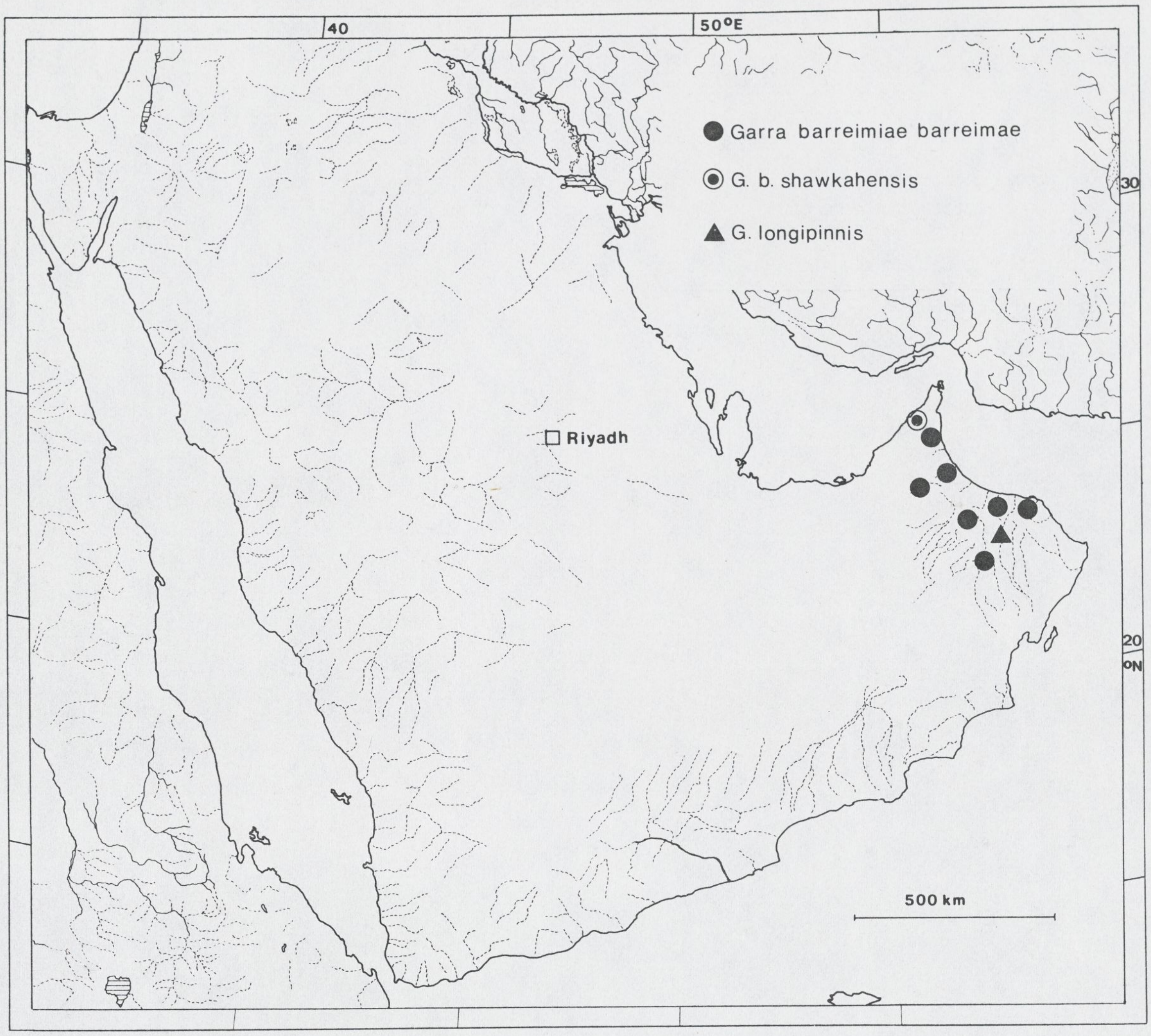
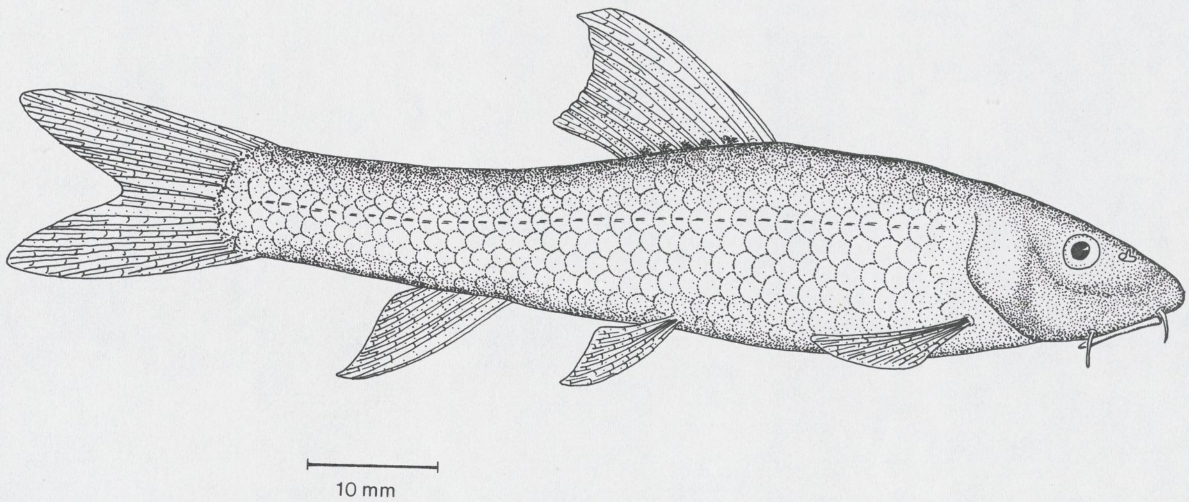
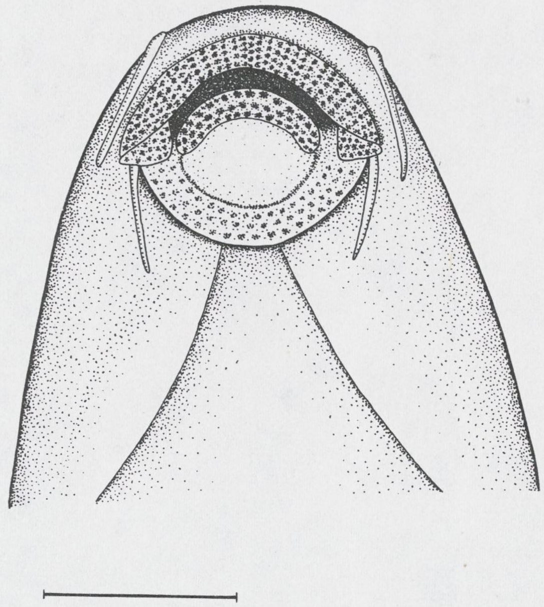

40
50°E
30
20
°N
Garra barreimiae barreimae
G. b. shawkahensis
G. longipinnis
Riyadh
500 km

Fig. 20



G. buettikeri

Fig. 21



5 mm

buettikeri

Fig. 22

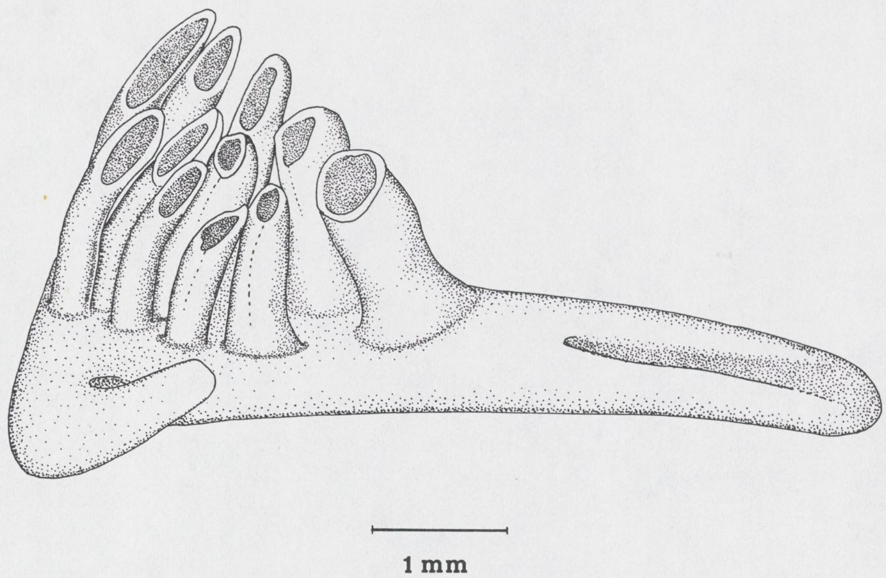
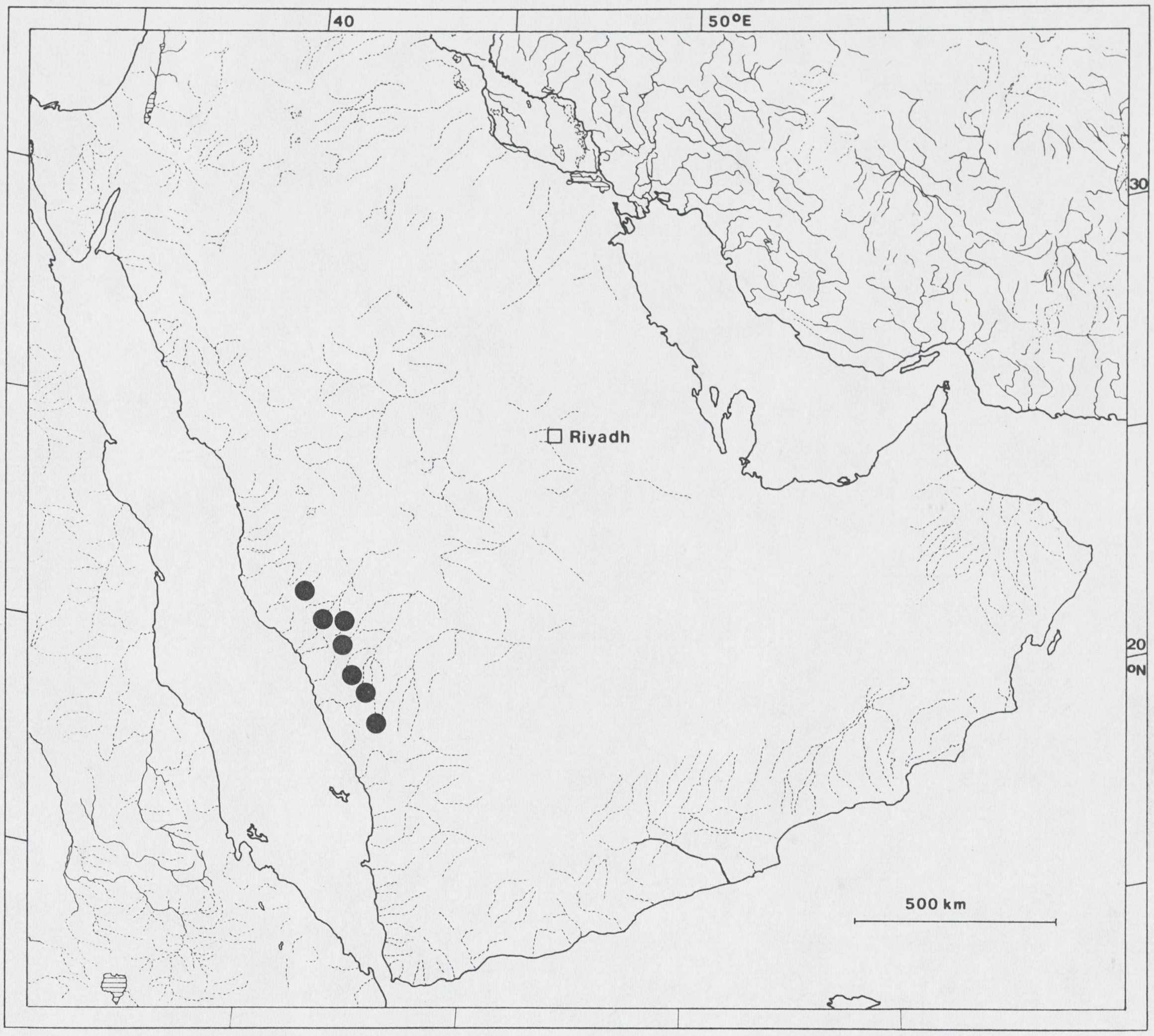
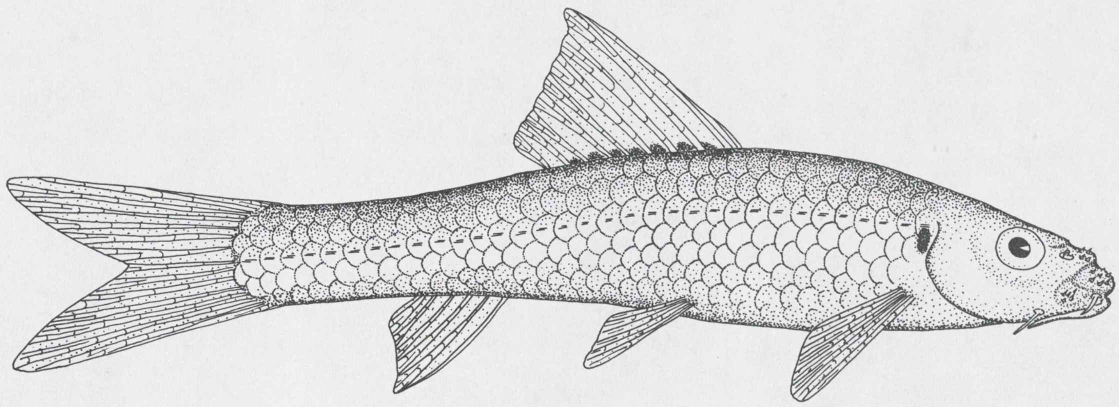


Fig. 23



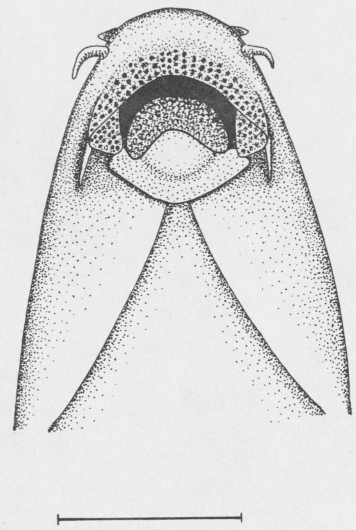
boettikeri

Fig. 24



10 mm

Fig. 25



5mm

Fig. 26

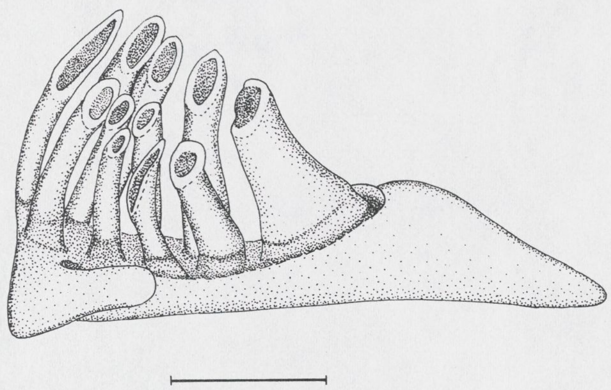


Fig. 27

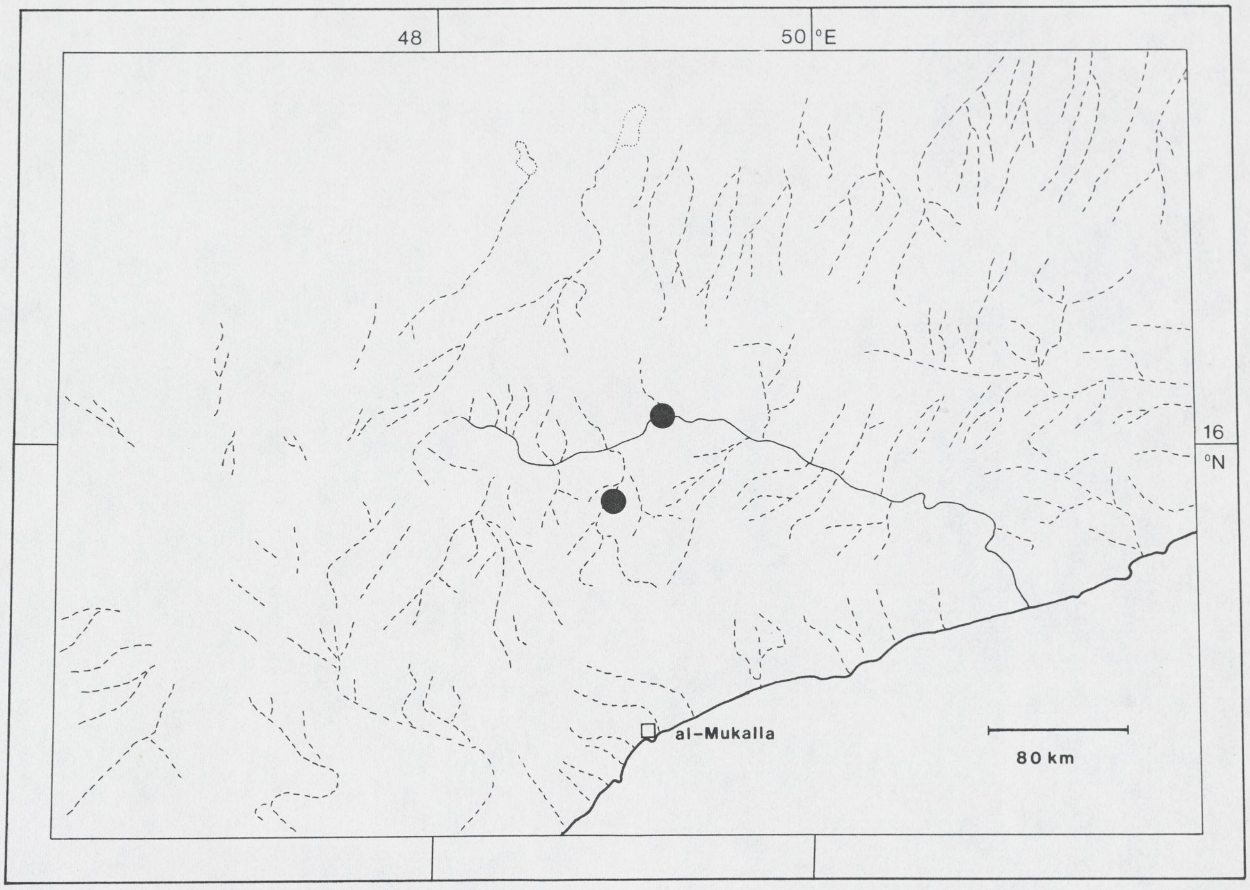
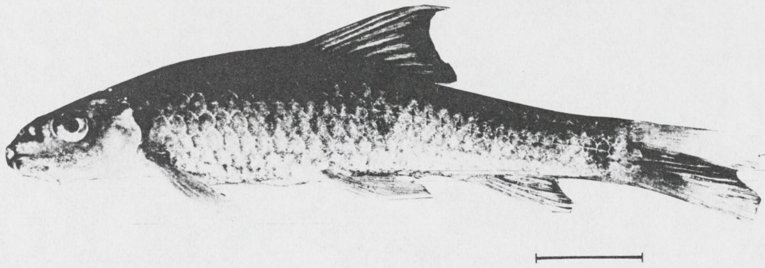
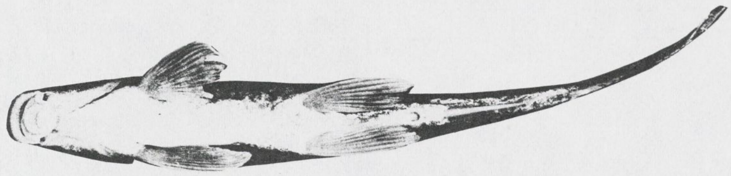
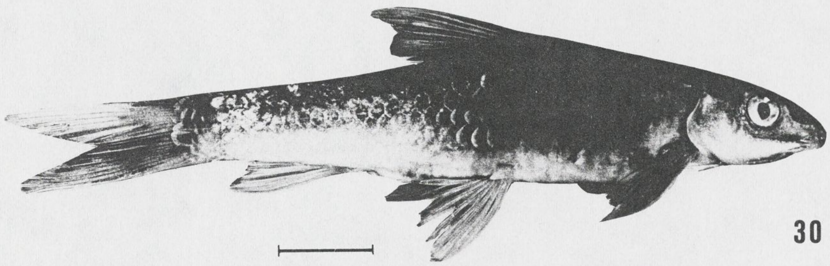


Fig. 28

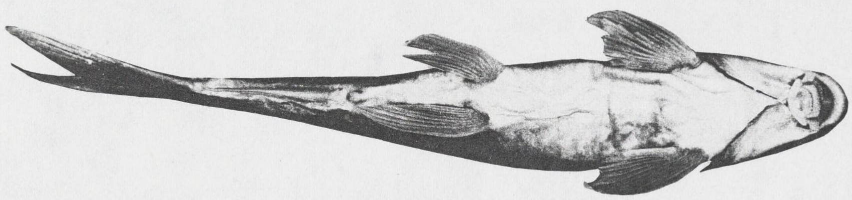


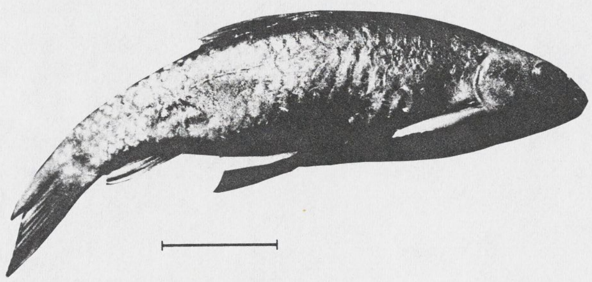
29





30





31

Figs 29-31

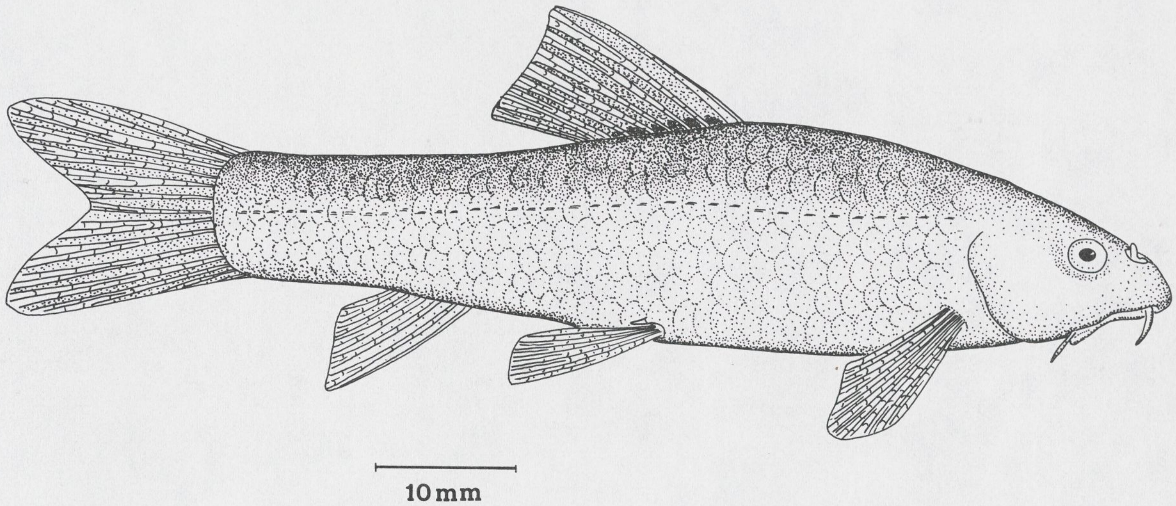


Fig. 32

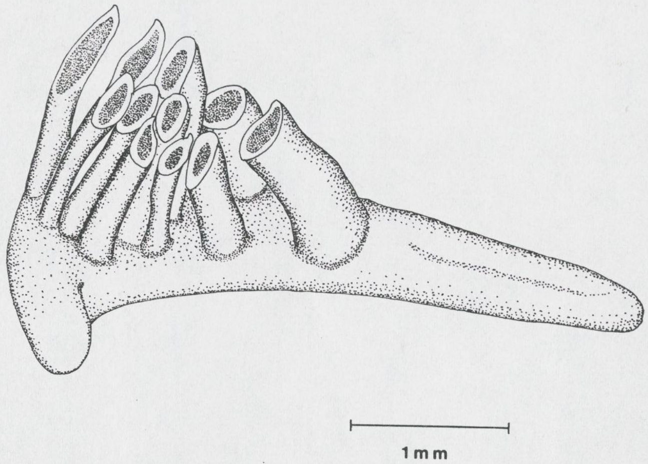


Fig. 33

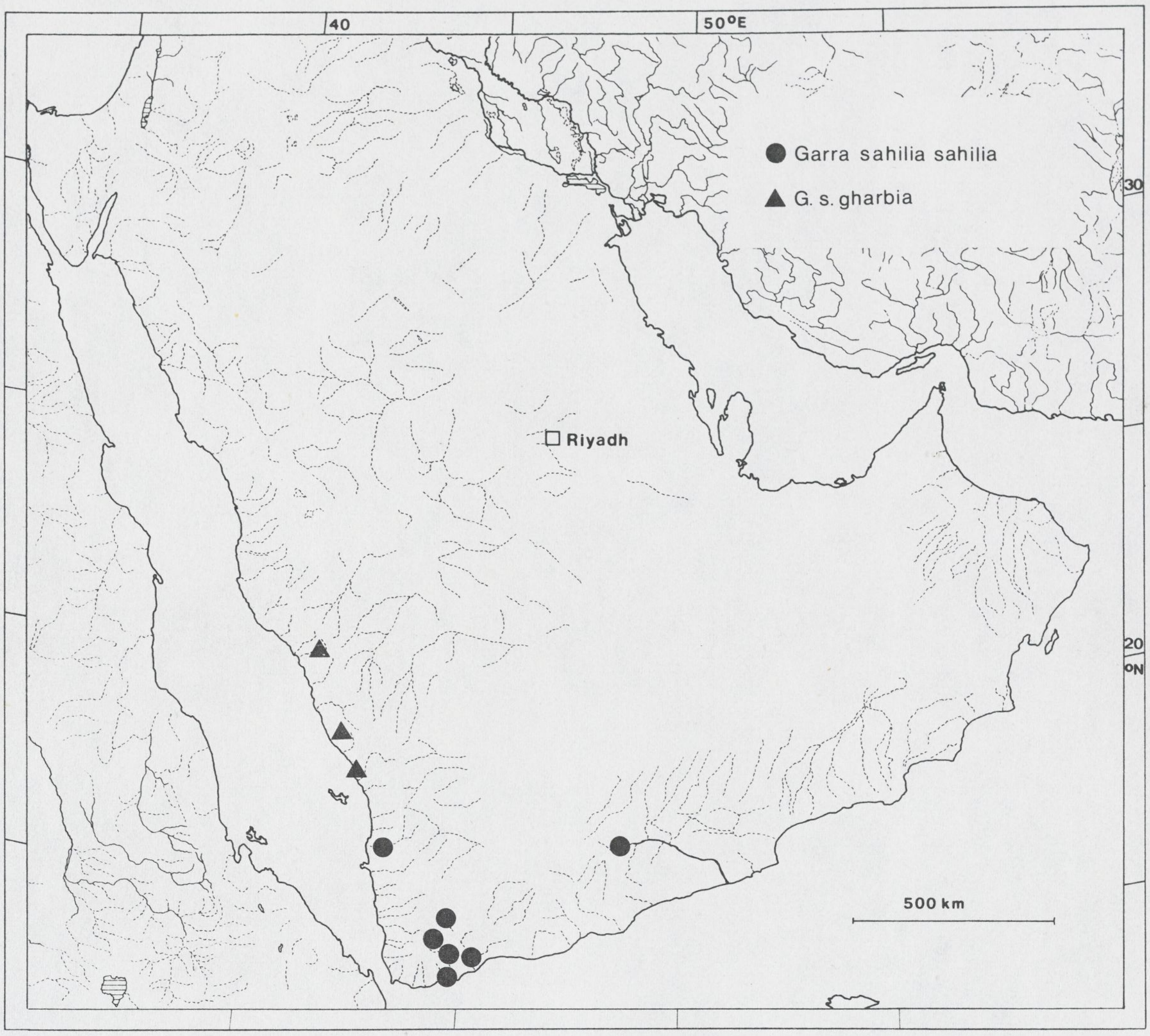
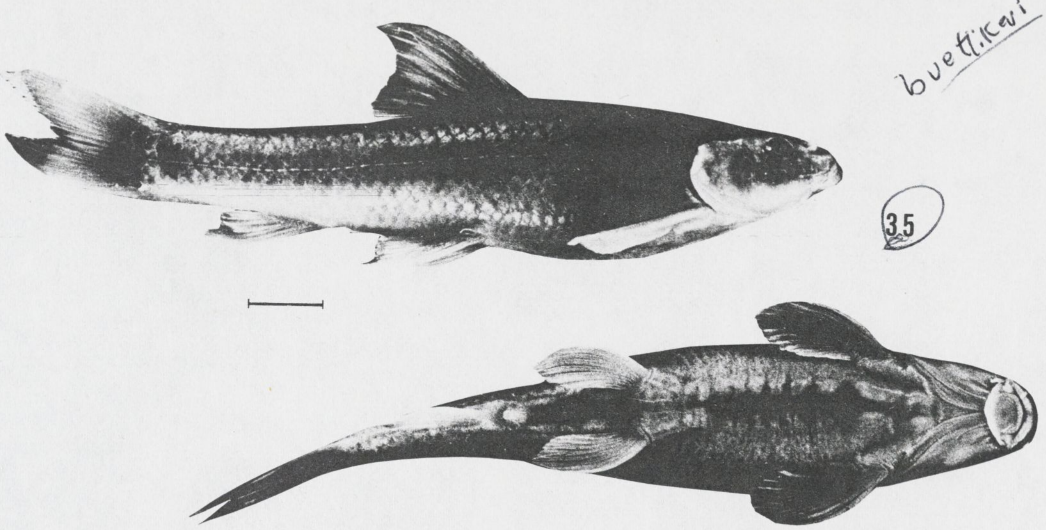
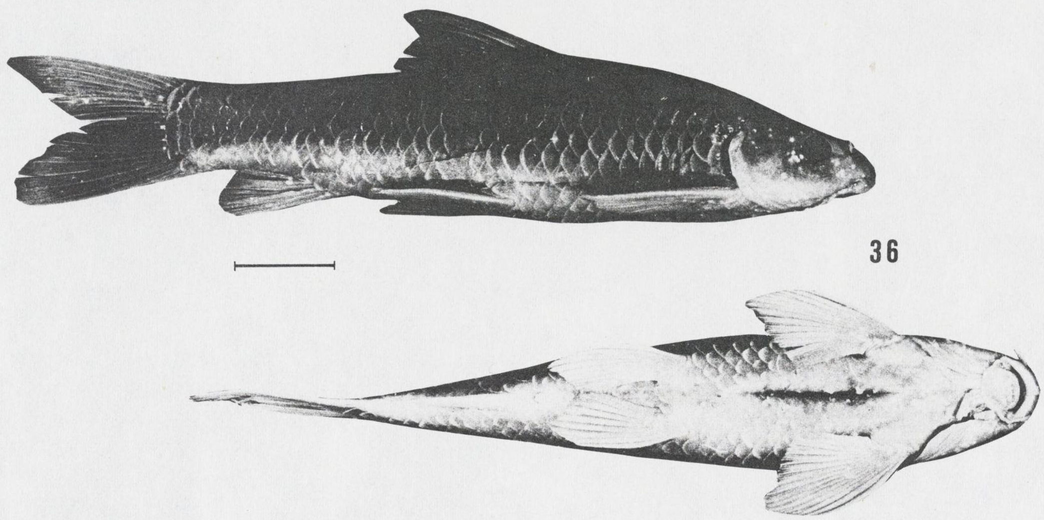


Fig. 34

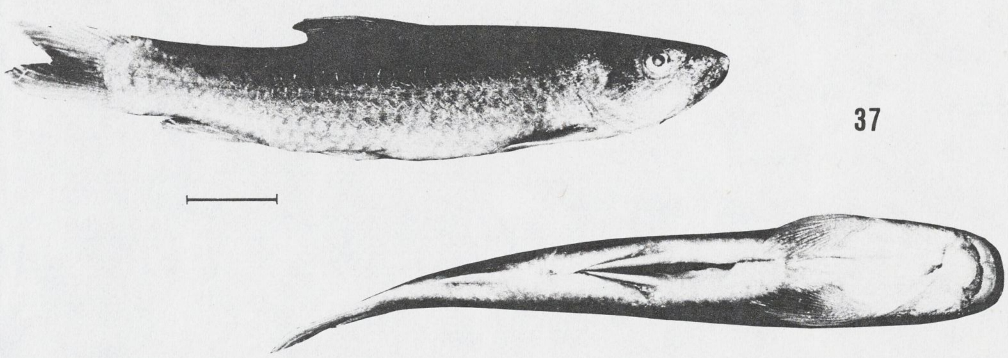
buettikeri



35



36



37

Figs 35-37

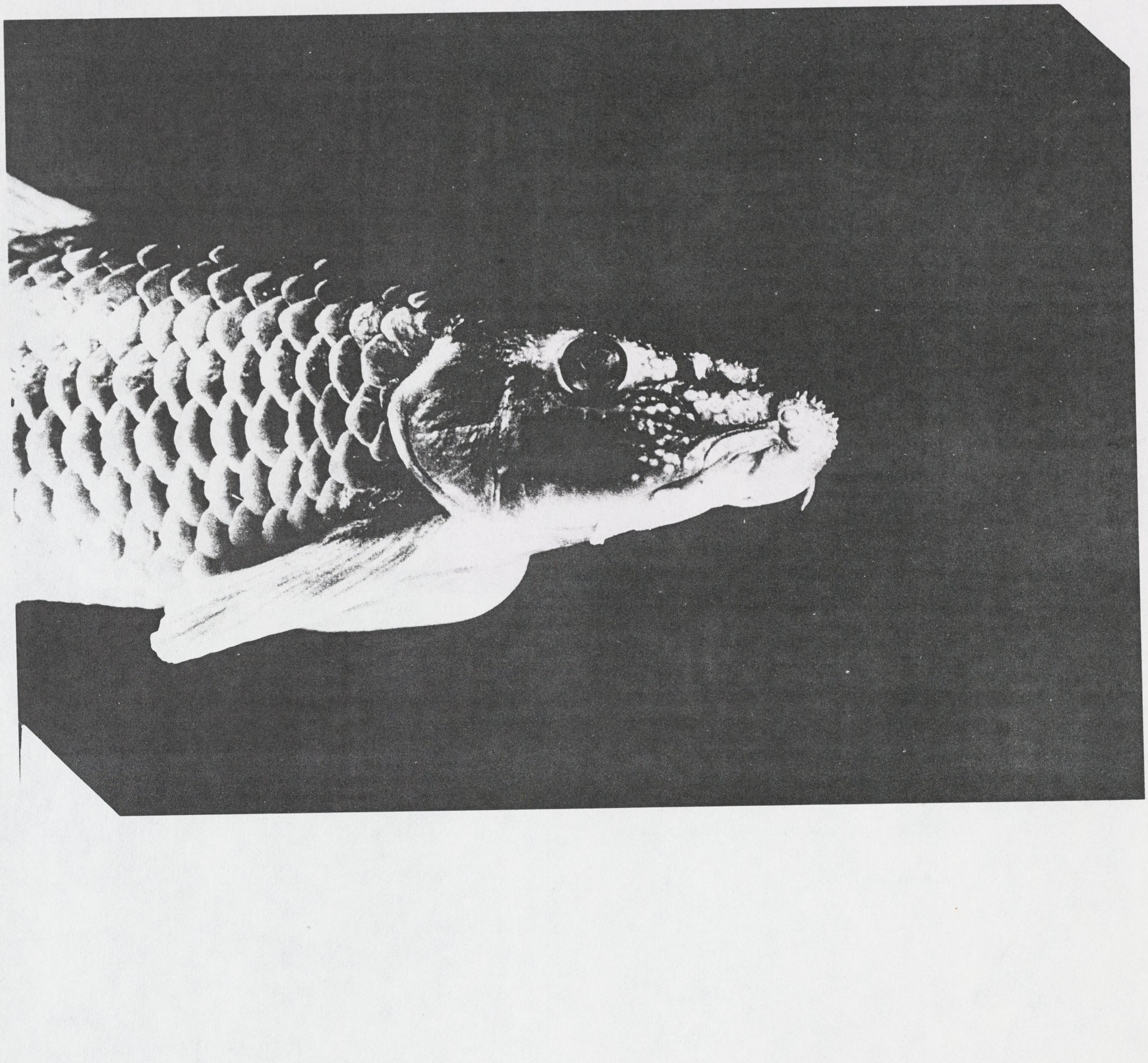


Fig. 38

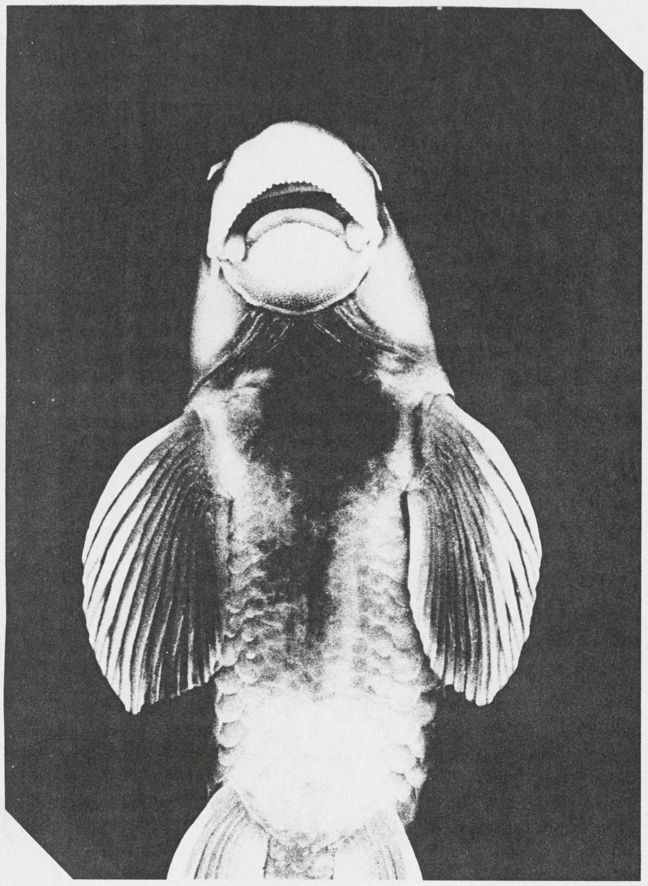


Fig. 39

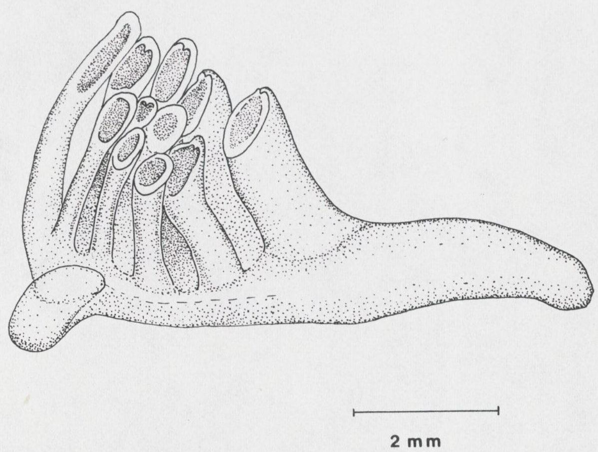


Fig. 40

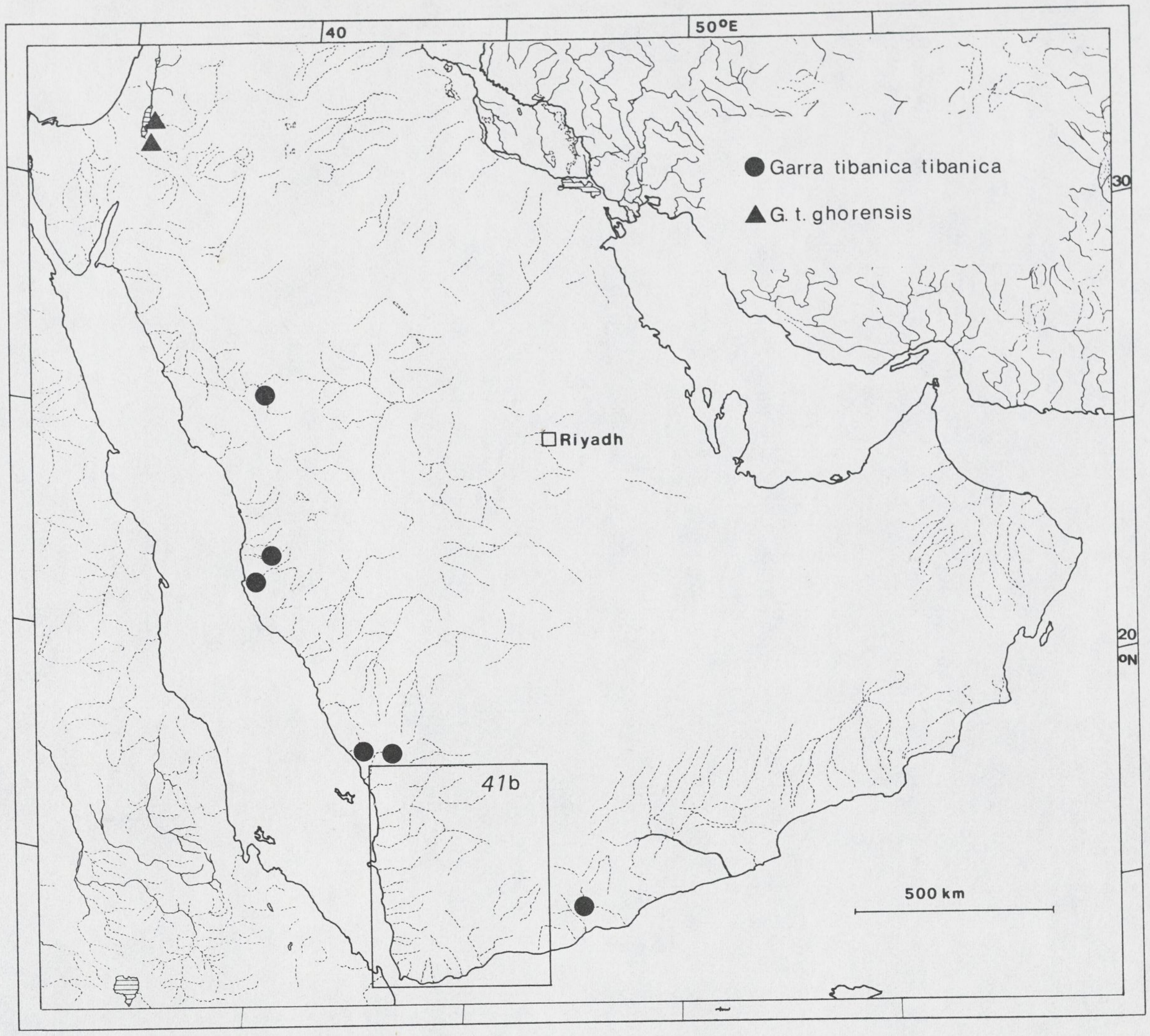

40
50°E
30
20
°N
Garra tibanica tibanica
G. t. ghorensis
Riyadh
41b
500 km

Fig. 41a

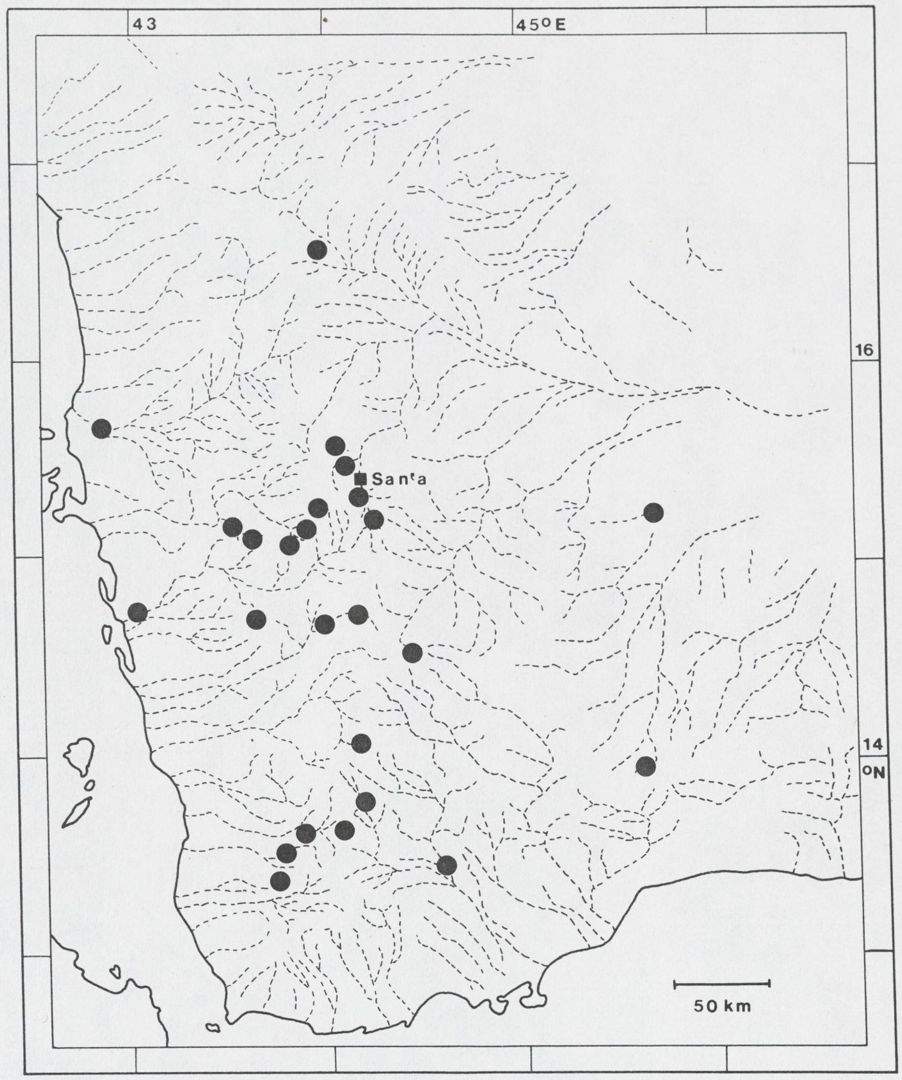
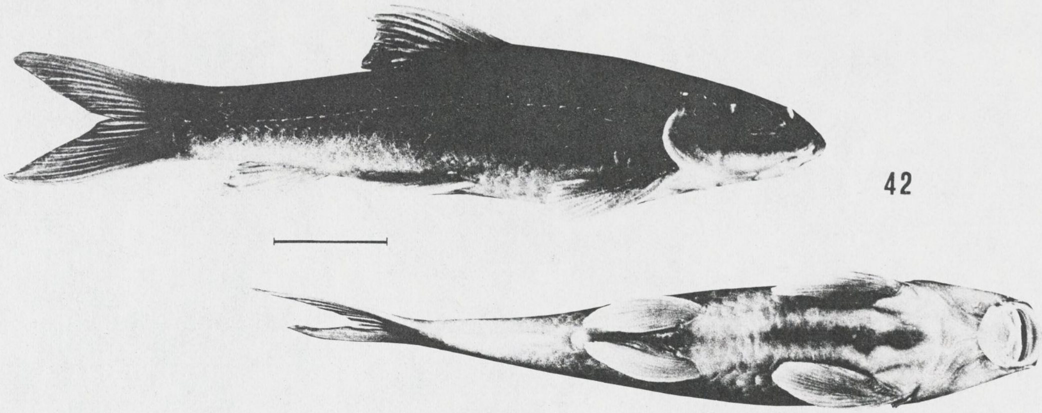
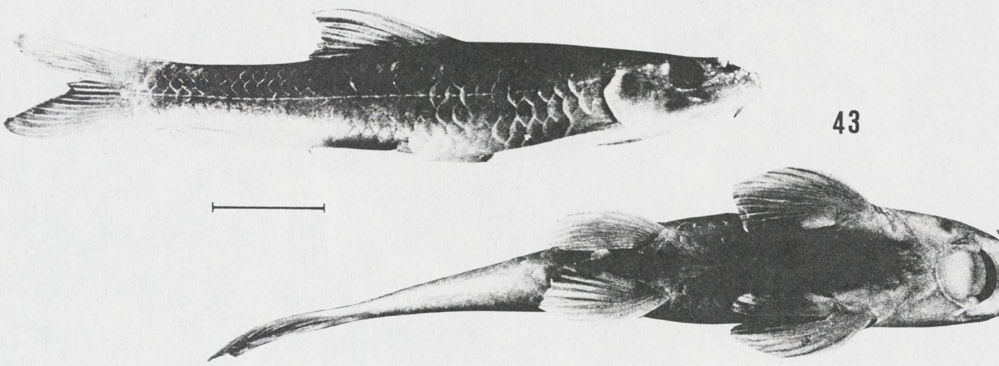


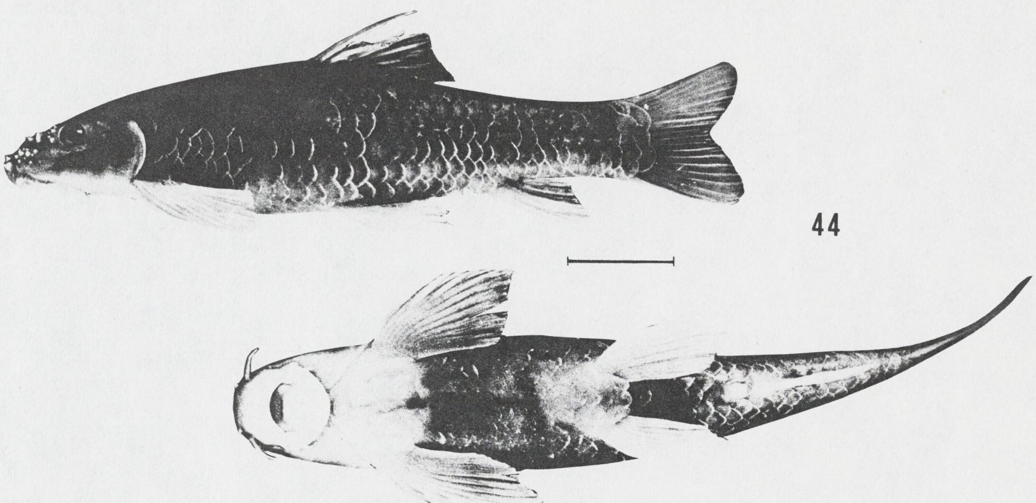
Fig. 416



42



43



44

Figs 42-44

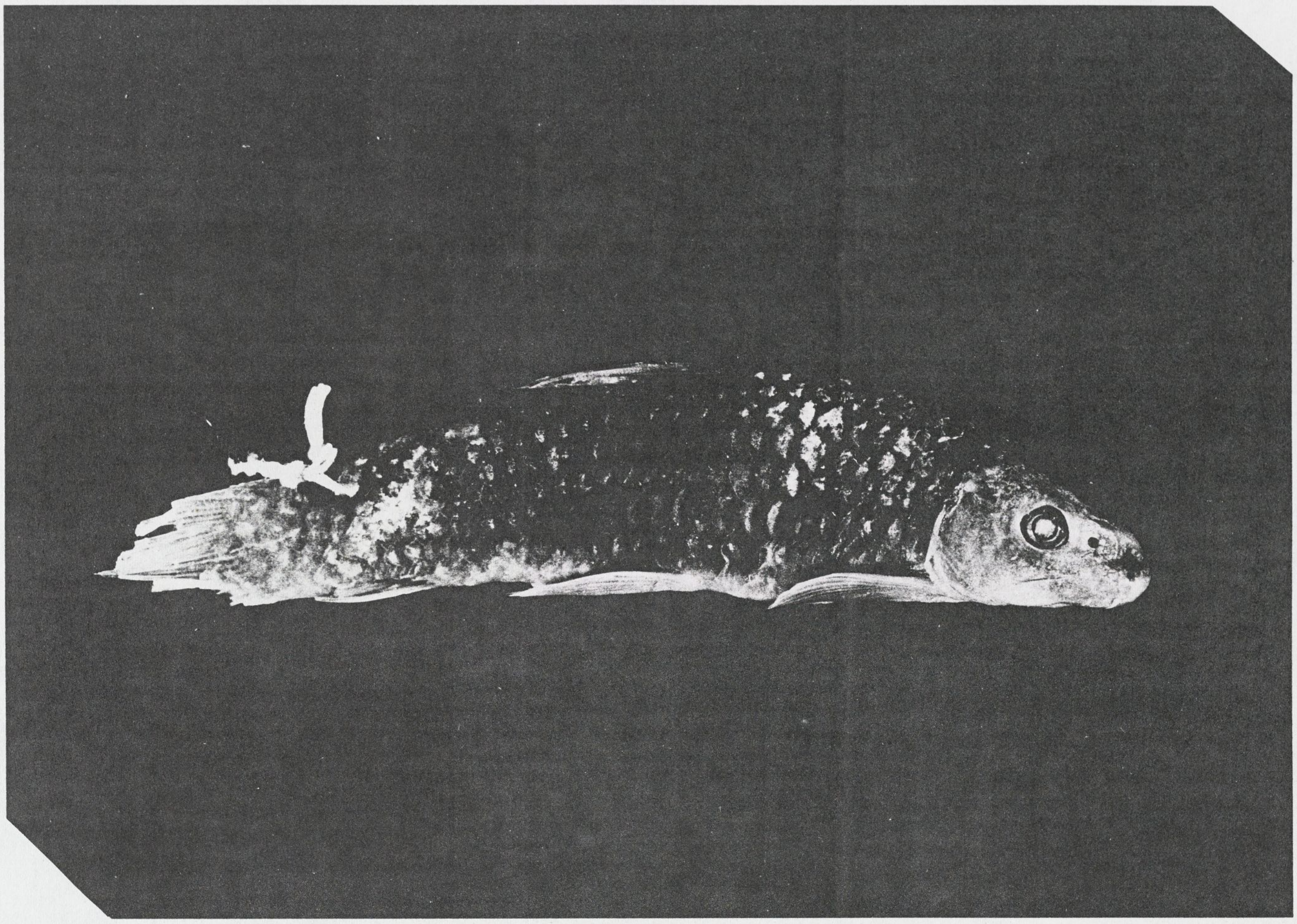
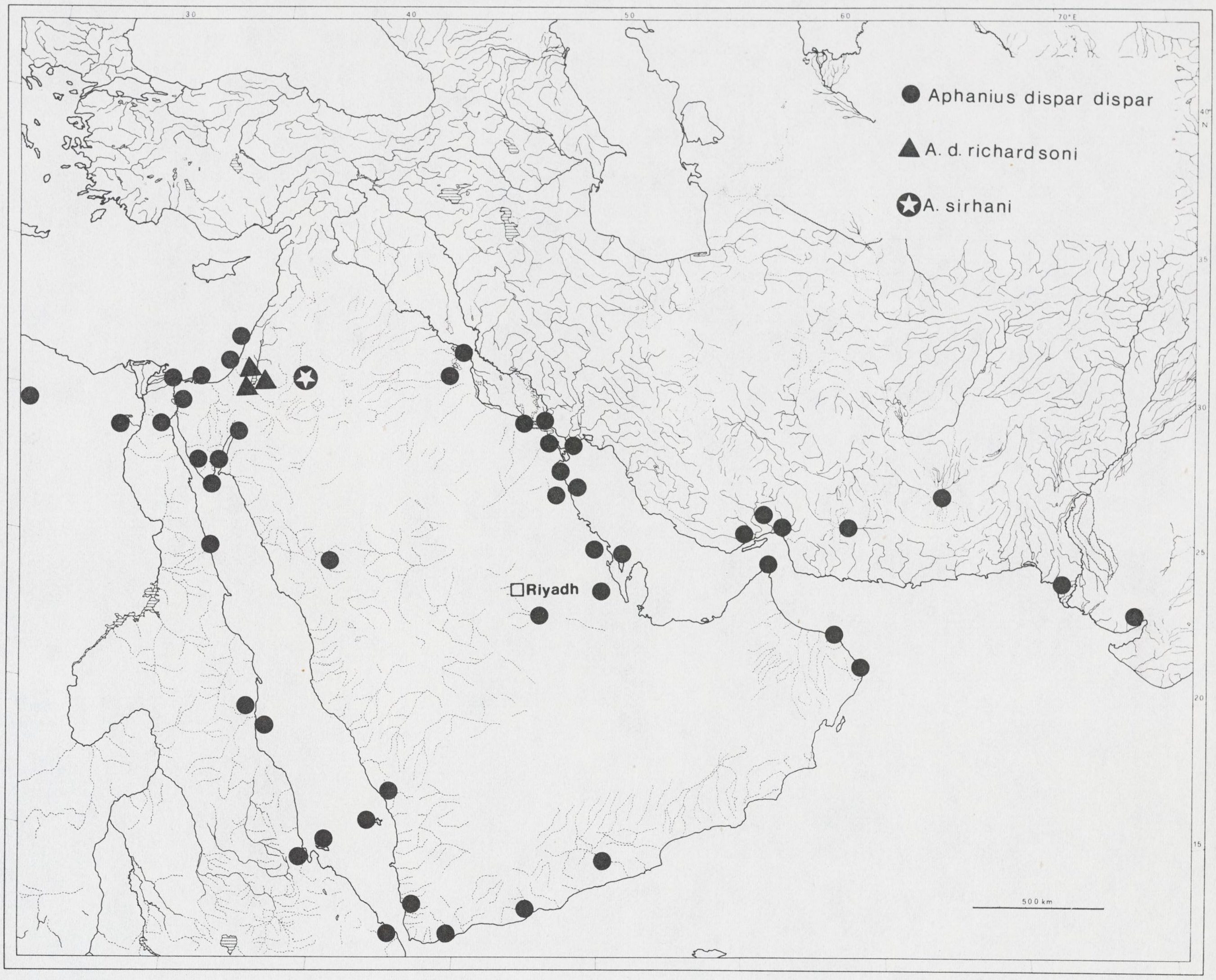
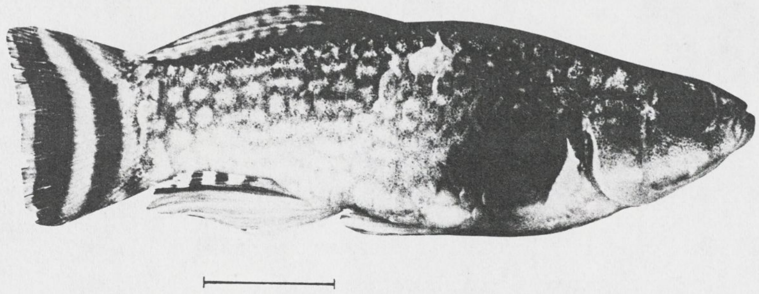


Fig. 45

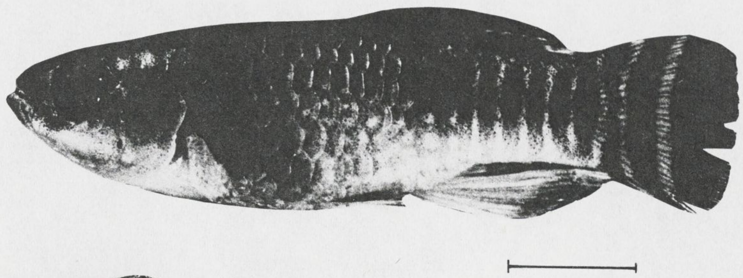


Aphanius dispar dispar
A. d. richardsoni
A. sirhani
Riyadh
500 km

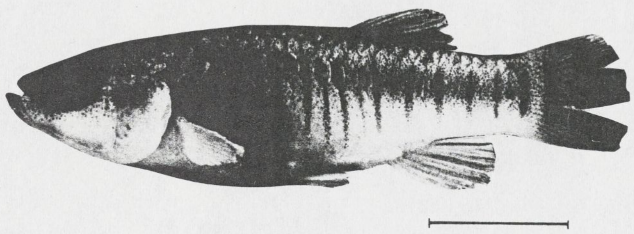
Fig. 46



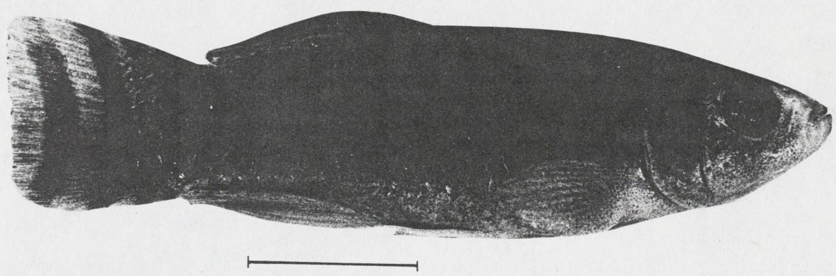
47



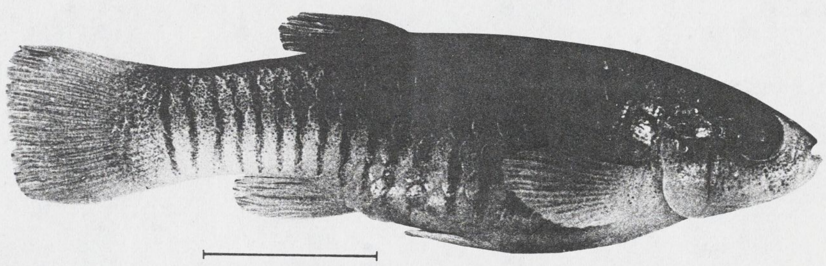
48a



48b

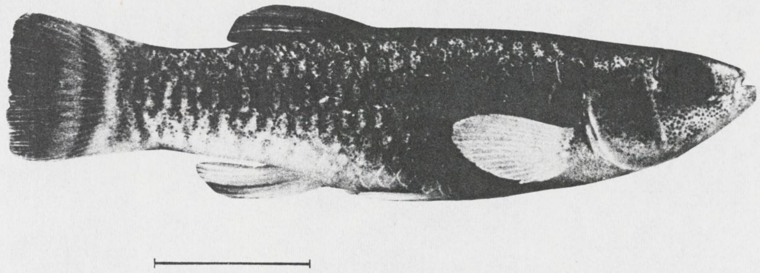


49a

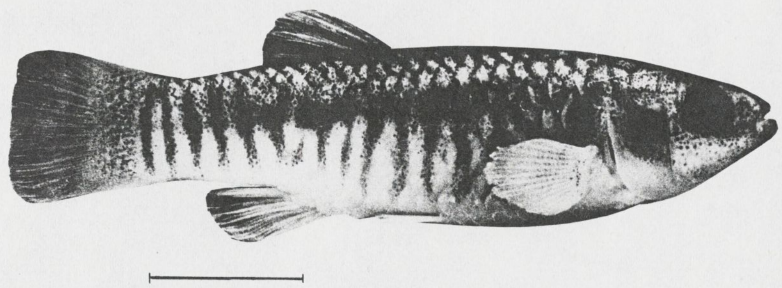


49b

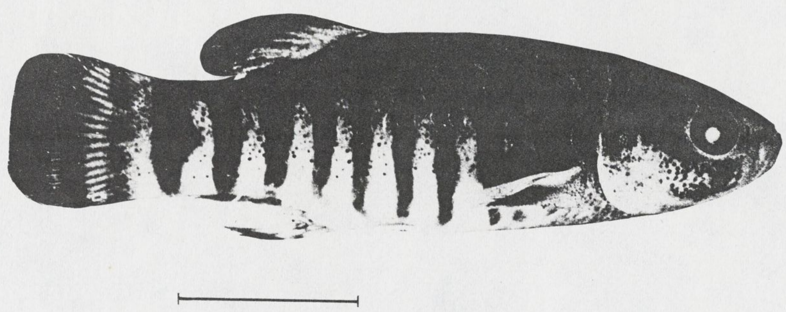
Figs 47-49



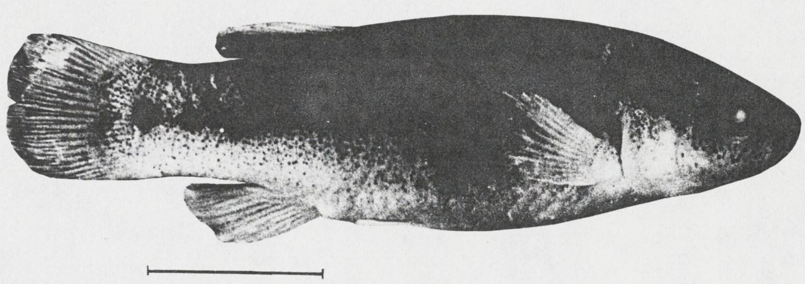
50a



50b



51a



51b

Figs 50-51

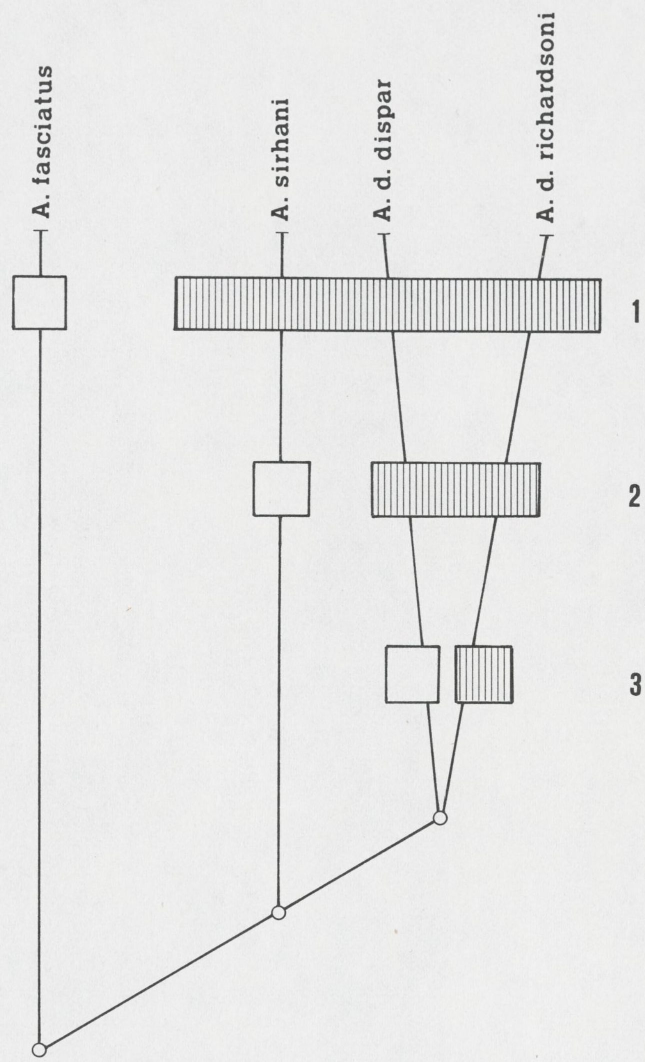


Fig. 52

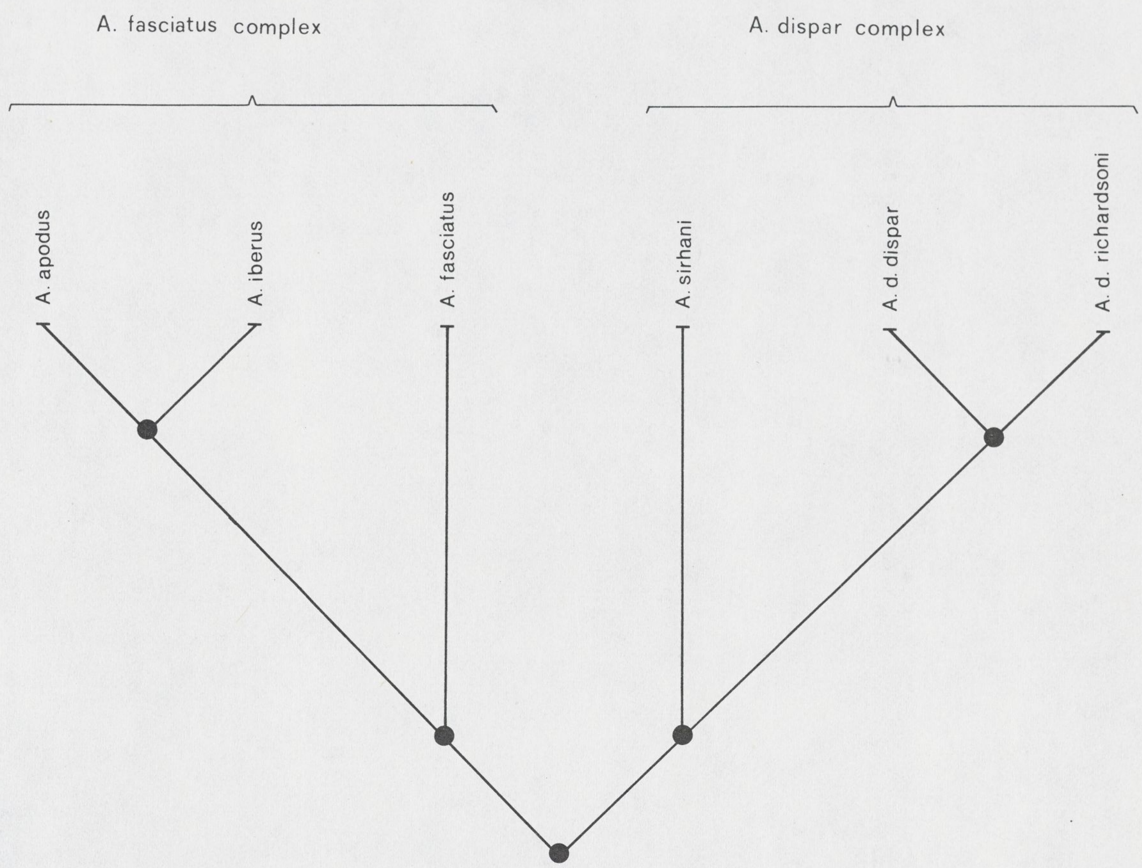

A. fasciatus complex
A. dispar complex
A. apodus
A. iberus
A. fasciatus
A. sirhani
A. d. dispar
A. d. richardsoni

Fig 53

Fig. 54

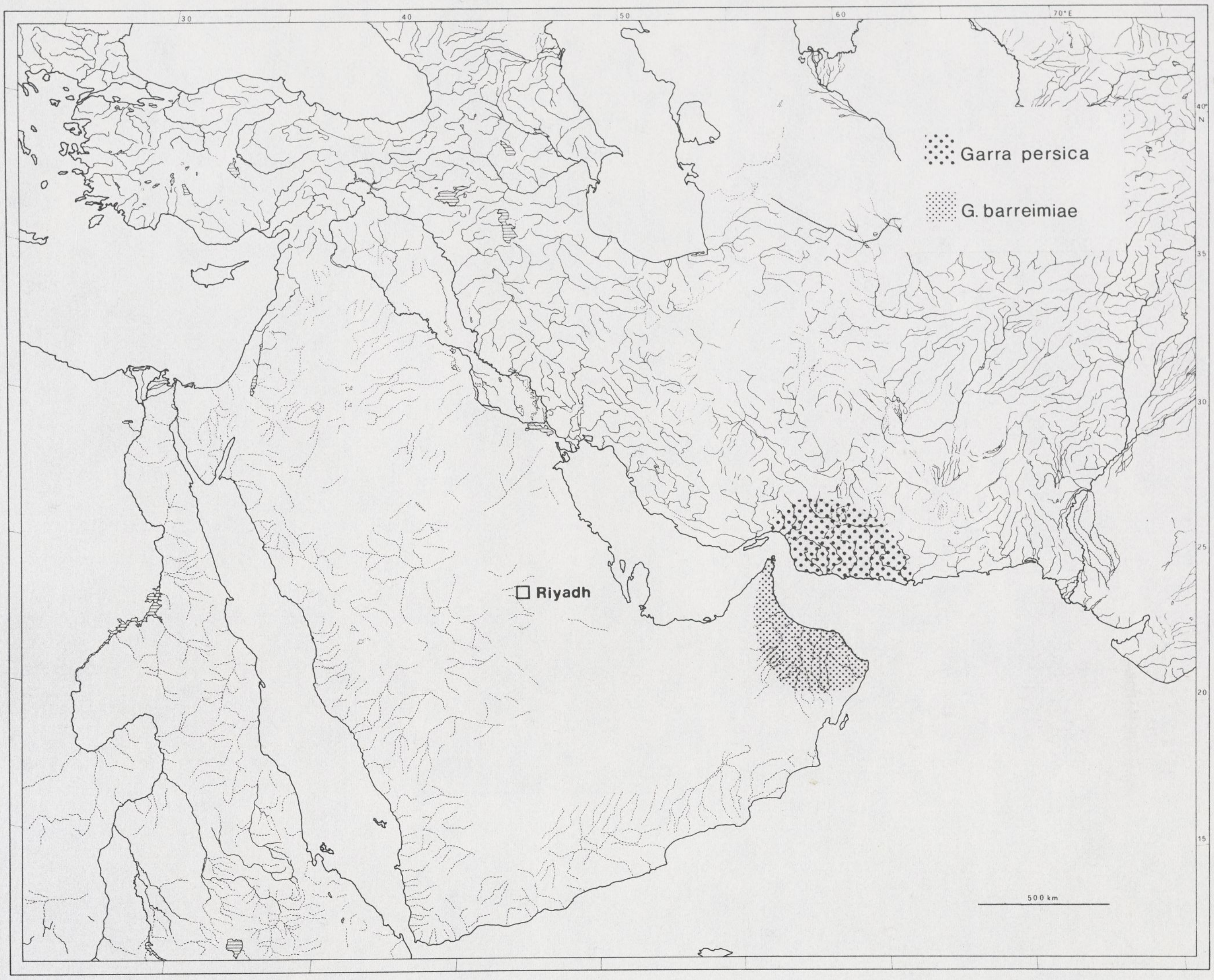


Fig. 55

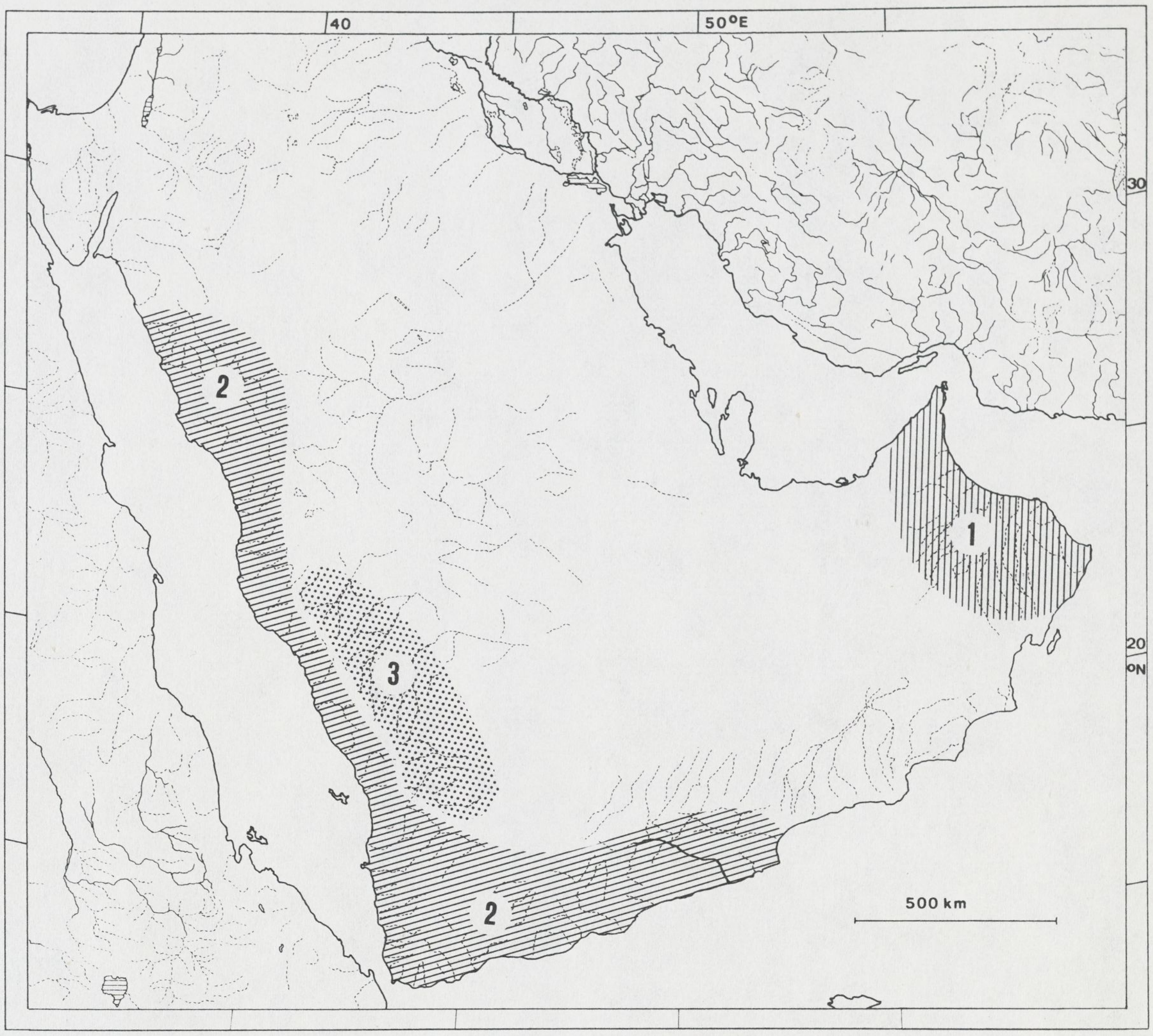


Fig. 56

Fig 57

Captions to plates

Plate 1: ♂ of <u>Aphanius sirhani</u> from Azraq.

Plate 2, ♀ of <u>Aphanius sirhani</u> from Azraq.

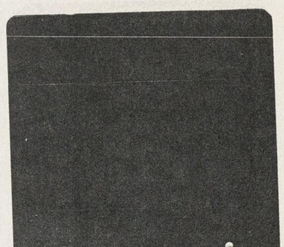
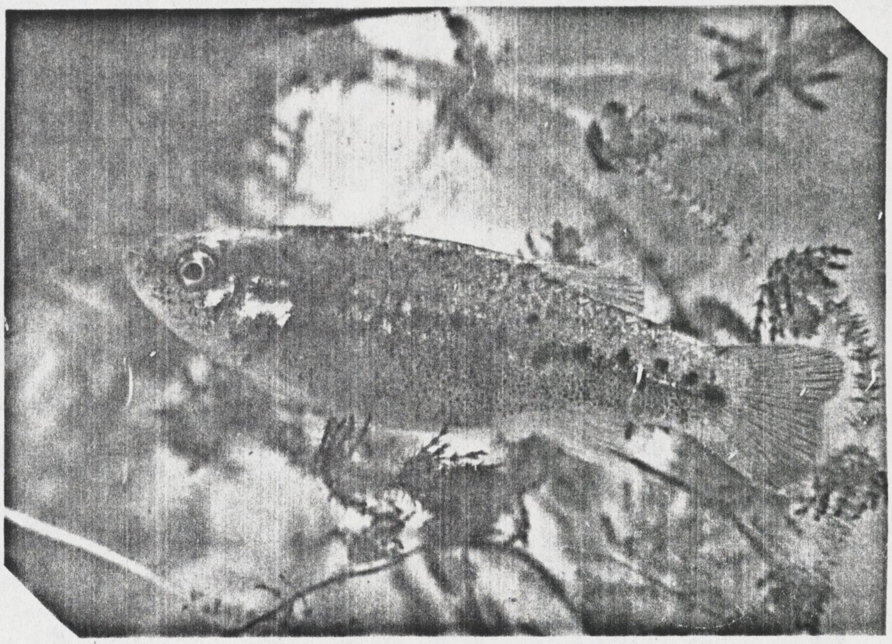


plate 1

pl 2



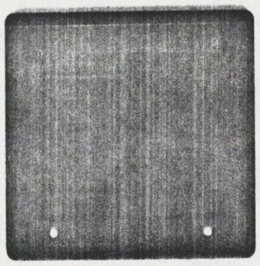


plate 2