Nicht einzeln im Buchhandel erhältlich

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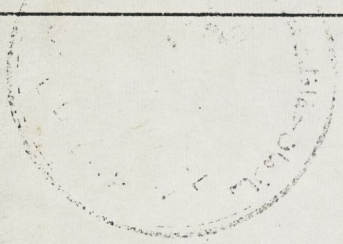

Late Quaternary Alluvial Chronology of Iran

By C. Vita-Finzi, London

With 13 Figures

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Zusammenfassung

Zwei größere Phasen alluvialer Ablagerung waren für die Füllung der Becken und Täler des westlichen und nördlichen Iran entscheidend. Die Anhäufung des Teheran-Alluviums fing wahrscheinlich vor nicht mehr als 50 000 Jahren an und dauerte bis zum Ende des 4. Jahrtausends vor Christus. Nach einer Erosionsphase wurde während des Mittelalters das Khorramabad-Alluvium abgelagert, das zur Zeit auch abgetragen wird.

Die Folge entspricht der, die für das Nachbargebiet im irakischen Kurdistan und das Mittelmeergebiet erarbeitet worden ist. Als vorläufiges Ergebnis wird eine Korrelation zwischen den zwei Ablagerungsphasen und der Würmeiszeit beziehungsweise der kleinen Eiszeit aufgestellt.

Abstract

Two major phases of alluvial deposition have been responsible for the infilling of the basins and valleys of western and northern Iran. The accumulation of the Tehran Alluvium began no more than 50,000 years ago and had probably ended by the 4th millennium B. C. Following an erosional interlude, the Khorramabad Alluvium was laid down during the Middle Ages; it is now being actively eroded. This sequence duplicates that worked out for neighbouring Iraqi Kurdistan and the Mediterranean area. The two depositional phases are tentatively correlated with the Würm Glacial and with the Little Ice Age respectively.

Résumé

Le comblement des bassins et des vallées de l'Iran occidental et septentrional fut accompli par deux phases principales d'alluvionnement. L'accumulation des Alluvions de Tehran commença probablement il n'y a pas plus de 50,000 ans et s'acheva avant le 4e. millénaire. Après une période d'érosion, les Alluvions de Khorramabad furent déposées pendant le Moyen Âge; elles sont maintenant à leur tour sujettes à l'érosion. Cette succession correspond à celle qui a été reconstruite pour la zone voisine du Kurdistan Irakéen et pour la région méditerranéenne. On pourrait lier tentativement les deux phases alluvionnaires avec la Glaciation Würmienne et la Petite Ère Glaciale, respectivement.

Краткое содержание

Отложение аллювиальных осадков в бассейнах и долинах западного и северного Ирана происходило двуфазово. Накопление аллювия в районе Тегерана началось 50 000 лет тому назад и продолжадось вплоть до 4000 лет до нашей эры. Аллювий Хорамабад отложился в течение средневековья,

*) Address of author: Dr. C. Vita-Finzi, Department of Geography, University College London, Gower Street, London W.C. 1, England.

Rezaiyeh

el 1300 m

1923 - 182.3 ppm / gm/liter mineral residue

1971 200+ NaCl 130

size 140 km x 40 km ·5000 km²
longest widest

6-15 m deep

only Artemia

после фазы эрозии. Соответствующие серии встречаются в соседнем иранском Курдистане и в области Средиземного моря. Устанавливается взаимосвязь между фазами отложения осадков и вюрмской ледниковой эпохой.

Acknowledgments

The fieldwork on which this paper is based was made possible by a grant from the Nuffield Foundation, and formed part of a long-term investigation into recent geological change financed by that body. I thank Dr. Brian Spooner, Dr. and Mrs. Alan Wells, and Dr. and Mrs. R. R. B. Kearton for their help and advice. Mrs. K. Gillette carried out the mechanical analysis of the samples. The maps were drawn by Mr. D. Helmore. Prof. H. E. Wright, Jr., kindly read and commented on the first draft of this paper.

Introduction

The alluvial deposits that dominate the topography of much of Iran have attracted the attention of geologists since the earliest days of exploration; this interest has been reinforced in recent years by the extension of groundwater investigations. Yet the age of the various superficial formations has long remained a matter either for surmise or for neglect. The aim of the fieldwork reported in this paper was primarily to elucidate the chronology of the alluvial formations that underlie the valley floors and plains of northern and western Iran, for this seemed a prerequisite for any discussion of their origin and of their subsequent erosion.

The area of study is bounded on the west by the Turkish and Iraqi frontiers; it extends south to the latitude of Esfahan, and east to include the Elburz Range and the Caspian lowlands (fig. 1).

Alluvial morphology

Alluvial deposition has dominated the recent morphological history of Iran. One can do no better than to quote Blanford (1876, p. 450):

> The most striking circumstance noticed during a journey in Persia is the great prevalence of formations, such as gravel, sand, and clay, of apparent recent origin; the whole of the great plains covering at least one-half the surface of the country consist either of a fine, pale-coloured alluvial loam, which covers the lowest portion of the surface, or of gravel, fine or coarse, which usually forms a long gentle slope from the surrounding hills to the alluvial flat, and fills up with long slopes the broad valleys opening into the lower plains . . . Nor is this prevalence of recent or subrecent detrital accumulations confined to the plains, for the slopes of the hills up to a considerable elevation are in some cases composed of similar unconsolidated formations from which only occasional peaks of solid rock emerge.

This statement is applicable to the majority of the valleys and basins of the area under review, in that they are floored by an aggradational surface which rises to a bahada at their margins and which extends into branch valleys either as a fan or as a terrace (fig. 2). The chronology outlined here starts at this deposit; older alluvial material, which some-

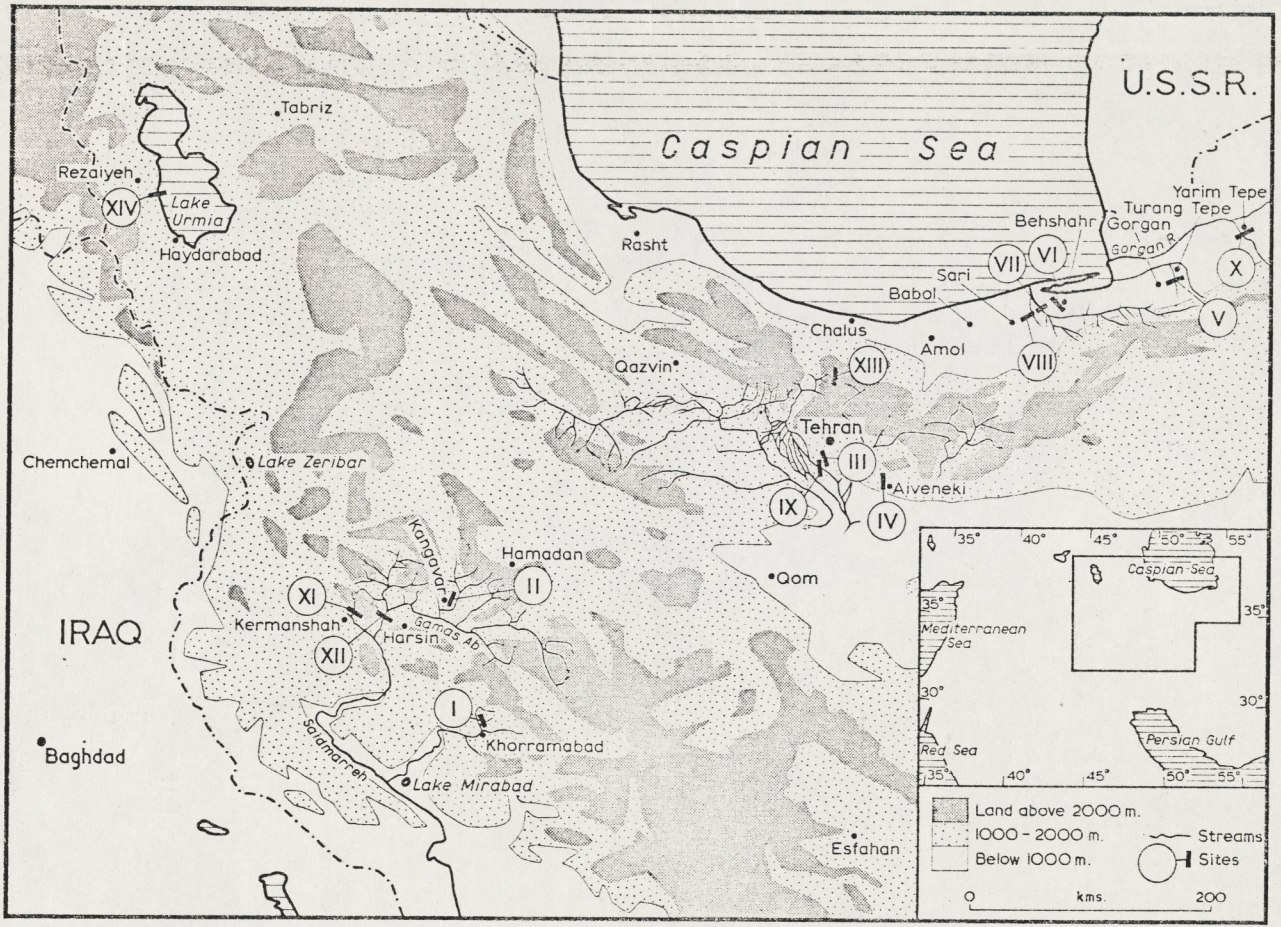

Fig. 1. Location map showing sites mentioned in text.

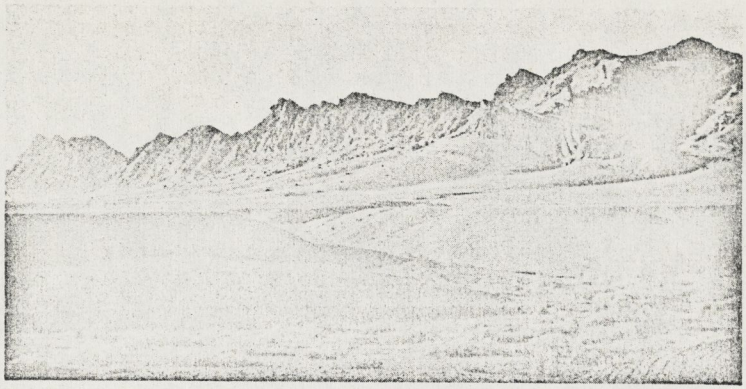

Fig. 2. Bahada at Section I (Khorramabad) composed of Tehran Alluvium.

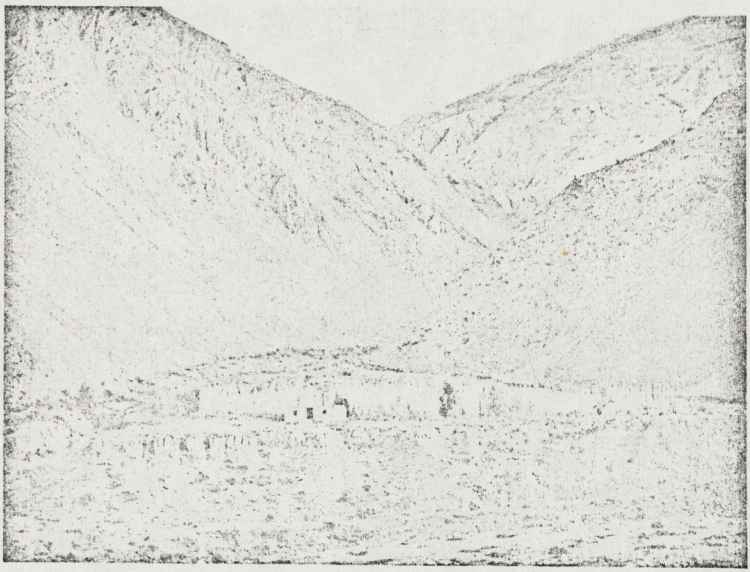

Fig. 3. Fan composed of Tehran Alluvium in the Elburz Mountains.

times gives rise to spurs or isolated hills rising above the basin floor, have therefore been disregarded. This decision was one of expediency; the only basis on which to begin erecting an alluvial chronology is morphology, and for it to be of regional validity requires a morphological feature which recurs throughout the area.

Some of these alluvial floors, such as those crossed by the road between Tehran and Isfahan, are several kilometers in width, and their central portions are effectively horizontal. Where their development has been

restricted by the bounding uplands, as in the valleys of the Elburz, they retain the form of alluvial fans (fig. 3, Section XIII). The streams that trench these deposits are commonly bounded by a terrace or by a smaller fan; the morphological evidence thus suggests there has been some interruption in the incision that produced the modern channels.

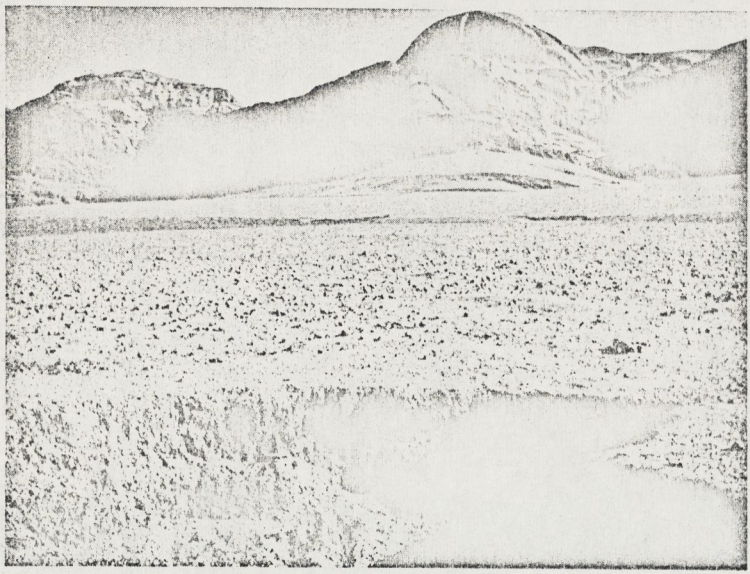

Fig. 4. Surface of bahada at Section I showing Khorramabad Formation overlying Tehran Formation. Contact and location of radiocarbon sample indicated by hammer.

Stratigraphy

Since BLANFORD's day geologists working in Iran have on the whole been content to embroider on his descriptive account while substituting "Recent", "Pleistocene" or "Quaternary" for his "recent or subrecent". This may be seen in the various stratigraphic schemes summarized by CLAPP (1940) and even in specialized geological reports which concentrate on alluvial deposits, such as that prepared by Italconsult (1959) for the south-east of the country. CLAPP (1940, p. 24—25) himself produced a composite succession for eastern Iran wherein the Quaternary was divided into a Pleistocene and a Recent. The former, with a maximum known thickness of 1000 feet, included fanglomerates, gravels, lape deposits and loess; the latter, with a maximum known thickness of 500 feet, included artifical mounds, alluvium, fanglomerates, gravels, lake deposits and travertines.

The attempts by RIEBEN (1955; 1966) to disentangle an alluvial sequence have been handicapped by their being based on the Tehran

Plain where, since alluvial deposition was already the rule in the later Tertiary, it is difficult not only to demarcate the junction between Pleistocene and earlier deposits but (more important in the present context) also to distinguish between deposits related to the present stream system from others unrelated to it; this vitiates any eventual inference regarding changes in hydrological conditions. The succession outlined here is based on sections in alluvial deposits with a definite fan or terrace form, and with a distinct unconformity separating them from older

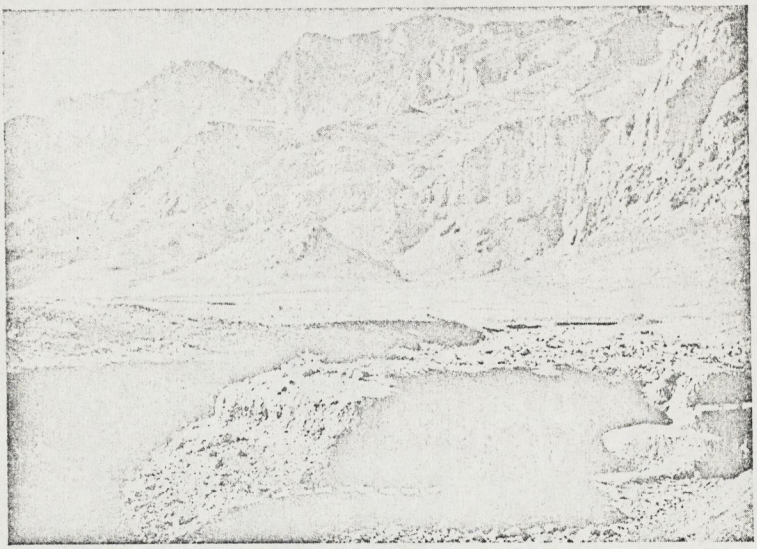

Fig. 5. Section II: Khorramabad Formation filling channels cut in Tehran Formation.

material. The resulting scheme gives some measure of agreement with RIEBEN's; hence the retention of one of his stratigraphic terms, as will be seen later.

Typical of the stratigraphic sequence proposed is the section exposed by a ravine running east-west towards a tributary of the Kashgan Rud 4½ km north of Khorramabad (fig. 1, I; fig. 2). A bahada which slopes westwards and which abuts on the east against an escarpment developed in conglomerates dating from the Eocene or the Upper Cretaceous (1 : 250,000 geological map of Iran, Khurrāmabād Sheet, 1963) is underlain by a major alluvial formation. The surface of the bahada south of the ravine was restored, after an intervening period of gullying, by the deposition of a second fill (fig. 4). Renewed aggradation also affected the main channel; the resulting deposit has been terraced. The modern stream has not yet cut down to bedrock at this point; but it has exposed the contact between the main bahada fill and the conglomerates at the head of the ravine. The

Quaternary is represented by no other alluvial formations; screes and patches of downwashed material are restricted to the scarp foot.

The dual stratigraphic and physiographic occurrence of the younger fill recurs throughout the region examined: as at Khorramabad it was laid down both in minor channels which had barely cut into the main fill, and within axial streams which had trenched it almost to its base. The suspicion that a single aggradational phase (rather than a series of localised episodes of deposition) was responsible for both the younger deposits at Khor-



Fig. 6. Dissected Khorramabad material at Aiveneki (Section IV).

ramabad gained credence from their lithological character, and was later to be supported by archaeological and radiocarbon dating. Elsewhere the deposit occurred in either one or other situation; which was to be the case evidently depended on the depth and place of dissection at the time deposition began.

Before turning to lithological characteristics and to dating, a few further representative sections displaying both fills must be mentioned. They have been selected from the many sections that were found to denote a similar sequence of events either because they yielded datable material or because they displayed a particular feature with especial clarity. Figure 5 illustrates the situation at Section II, a quarry 2 km east of Kangavar, 89 km southwest of Hamadan along the road to Kermanshah. Here the bahada fill has been gullied to a maximum depth of 1 m and then healed. Similarly, a quarry about 20 km south of Tehran (Section III) on the Qom road shows that the material underlying the Tehran Plain has also been eroded locally (this time to a depth of 4 m) and then restored. A third example in this category is the plain 1 km west of Aiveneki (IV, figure 1), SE of Tehran, where once again 4 m of younger fill occupies channels cut into a smooth-topped alluvial bahada (fig. 6). Section V lies about 14 km east of Gorgan, immediately to the

east of the turning off to the site of Turang Tepe. The older fill, part of the piedmont alluvial apron between the Elburz and the Caspian, retains its individual fan form; the younger material has a maximum observed thickness of 4 m and can be seen to thin laterally away from the summit axis of the fan over a distance of some 200 m. Section VI has been exposed by a small stream at the foot of the Belt and Hotu caves (Coon 1957), about 3 km west of Behshahr (fig. 7); the younger fill has a maximum thickness of 3 m, and thins westwards towards the crest of

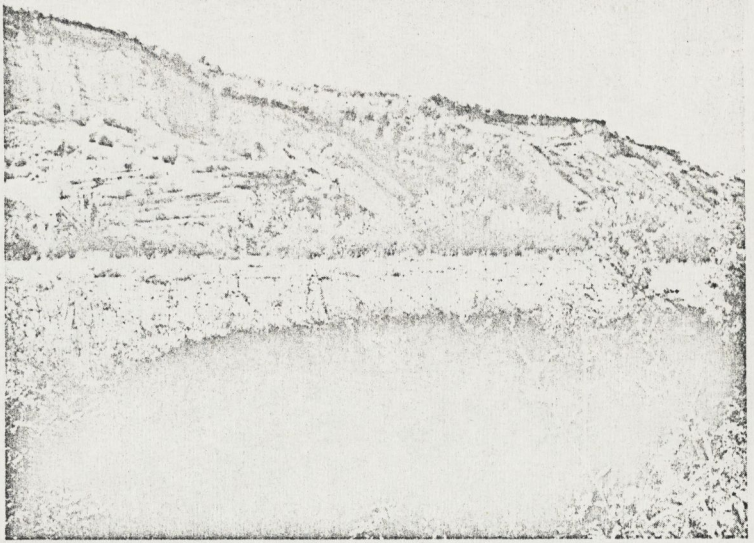

Fig. 7. Section VI: Khorramabad Formation at the food of Belt and Hotu caves.

the alluvial fan that slopes from the escarpment in which the caves are situated down to the Caspian littoral. Sections IX and XII display the younger deposit as a true fill terrace. The former lies some 5 km south of Section III, where the Qom road crosses an eastward-flowing tributary of the Karadj Rud System; the younger fill underlies a terrace in places over 2 km wide and below the level of the Tehran Plain to the north, and attains a maximum thickness of 4 m (fig. 8). Section XII shows 3½ m of the younger fill underlying the alluvial plain of the Gamas Ab, where it is crossed by the Harsin Road SE of Kermanshah (fig. 9); the older fill here is represented by a fan of which a thickness of 6 m is exposed on the eastern bank of the stream. The younger fill also underlies the plain of a tributary of the Kara Su about 10 km to the NE of the same town (Section XI) and is bordered by fans of older alluvium.

A number of exposures on the Caspian littoral display two successive deposits of which the older cannot be related unhesitatingly to fans or



Fig. 8. Section IX: channel cut into Khorramabad Formation. Qanat shaft visible on left.

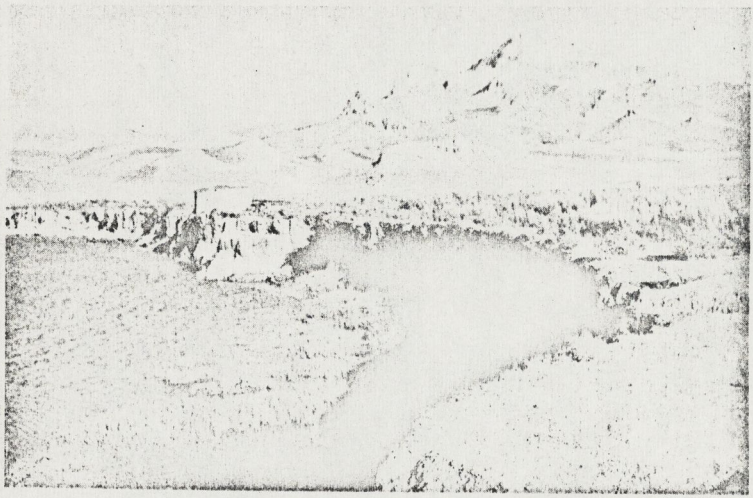

Fig. 9. Section XII: Khorramabad Formation bordering Gamas Ab.

river terraces, while its lithology does not immediately betray an alluvial origin. They remain of value in that the younger fill is well developed in them. At Section VIII, for example, 15½ km east of Sari, this deposit has a maximum thickness of 6 m and thins away from the modern channel, which is thus seen to be aligned approximately along the buried axis of drainage (fig. 10). Section X is exposed in the sides of a shaft dug to accommodate a well at the foot of Yarim Tepe, 80 km NE of

Gorgan. As RAIKES (1967, plate 16 and legend) has pointed out, the Kara Su (a tributary of the Gorgan River) displays a terrace which represents a phase of aggradation subsequent to the incision of the Caspian Plain on which the tepe stands. In the well section the terrace material is 2 m thick. A deposit very similar to the younger fill of Section VIII is found at Neka (Section VII), but its base is not exposed.

It is proposed to adopt I (Khorramabad) as the type section. The system of nomenclature proposed by the American Commission on Stratigraphic



Fig. 10. Section VIII: fossil soils in Khorramabad Formation.

Nomenclature (1961) will be followed. The older alluvial fill will be designated the Tehran Alluvium; the younger, the Khorramabad Alluvium. The former name has already been applied by RIEBEN (1955, 1966) to the uppermost ("C") of the three alluvial formations that he found overlying the Upper Miocene in the Tehran area. It has been retained here because, as far as can be made out from his description, the deposit in question is the older fill of the sections described above. Thus, in the Tehran area, the northward extensions of the "C" beds "form the top of ancient alluvial fans" (RIEBEN 1955, p. 624); they are overlain by a shallow veneer of Recent alluvium ("D"), and rest unconformably on the Kahrizak Formation ("B") which is moderately folded or faulted (RIEBEN 1966, p. 3). As will be seen below, lithology and the dates that are available support this correlation.

The younger fill is named after the type section, since there appears to have been no previous attempt to give it formal status. RIEBEN's "D"

beds are not described or dated sufficiently closely for comparison with our younger fill to be feasible.

Lithology and age

Tehran Alluvium

In section I, the Tehran Alluvium is a deposit of sand and silt, with horizons of gravel at all stages of rounding and with a maximum diameter of 20 cm. Scattered pebbles occur in the fines; bedding is most marked where sands predominate and within the gravel horizons, and is roughly horizontal. The gravels grade upwards into fines but often have a sharp base. Calcareous cementation is locally strong. Some of the fine gravel lenses have an abundant silt matrix and are dark brown in colour, but the deposit as a whole is grey/tan in hue. The greatest thickness of fill exposed is 13 m, but its base is exposed only at the head of the ravine. Rieben (1966, p. 3—4) ascribes to his "C" beds a maximum thickness of 60 m.

Elsewhere the deposit ranges from clay to gravel and boulders, although it is generally characterised, as in Section I, by diversity in texture and internal structure (cf. Blanford 1876, p. 466; Rieben 1955, p. 624). Composition is closely linked to the local country rock. In the gorges of the Elburz and in Azerbaijan, for example, adjacent fans which have contributed to the Tehran fill retain almost unadulterated the composition of the outcrops at which they head, which may be basalt in one fan and limestone in the next. Although sorting is poor, there is usually an overall decrease in grain size with increasing distance from outcrops and uplands, or, to put it more picturesquely, "The more superficial detrital accumulations are of graded granulosity" (Italconsult 1959, p. 136). Colour is very variable, being grey-white in Section IV, due to exceptionally high calcareous content, and tinged with red iron oxides in Sections II, III, V and IX. Indeed, Rieben (1955, p. 624) found definite tufaceous and lateritic crusts in the Tehran Alluvium, and de Morgan (1905, p. 6) did not hesitate to depict the deposits between Qazvin and Tehran as r o u g e â t r e s.

The Khorramabad area had been selected for intensive study because it was known to contain a number of Palaeolithic sites. de Morgan (1897, p. 1) had found some crude (f o r t b a r b a r e s) artifacts in an alluvial deposit north of Tehran, but neither the artifacts nor the deposits could be dated. At Section I, the Tehran Alluvium yielded one implement (fig. 11) near its base. According to Dr. C. B. M. McBurney (personal communication, 21. 11. 1967) it is probably a punch-struck angle-burin of Baradostian type. Hole & Flannery (1967, 161) place the bulk of the Baradostian within the period between 29,000 and 38,000 years ago; Baradostian material from Yafteh cave, 15 km west of Khorramabad, has been dated to between 32,500 and 38,000 radiocarbon years (Hole 1966). Since the implement from the Tehran beds shows little sign of rolling despite its deposition within abrasive material, it cannot have travelled

far; but it is safer nonetheless to regard it as a terminus post quem, rather than a contemporary of deposition.

Rieben (1955, p. 626) suspects that two "Palaeolithic instruments" of Mousterian type which were found in 1939 and 1949 came from deposits of Tehran Alluvium. The Mousterian of Ḳunji Cave, near Khorramabad, has yielded a radiocarbon date in excess of 40,000 years and is thought

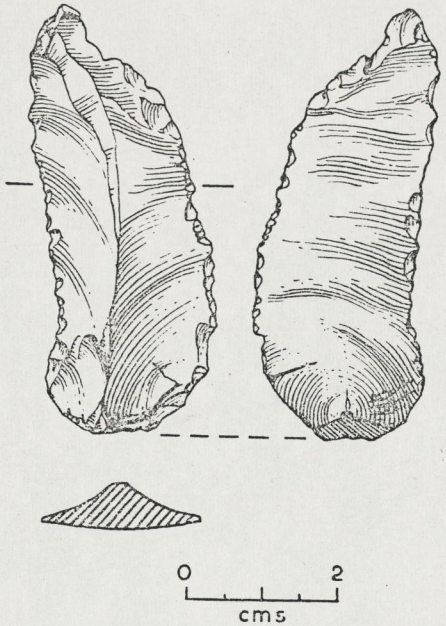

Fig. 11. Artifact from Tehran Formation, Section I.

to be nearly the same as that found at Shanidar and dated to 46,900 and to 50,600 years ago (Hole 1966).

It should eventually prove possible to obtain a terminal date or a series of dates for the close of deposition by noting the age of the earliest occupation layers of those tepes (or tells) that rest on the Tehran Alluvium and also their relationship to the underlying alluvium. Unfortunately, few excavators have been concerned with the geological evolution of their sites. Stronach (quoted by Raikes 1967, p. 175) found that the lowest occupation layers of Yarim Tepe (dating from about 4,000—5,000 B. C.) are "a couple of meters or so below the plain level", but this is insufficient basis on which to decide whether burial was due to the continuation of Tehran deposition or to a later such phase. Kearton (personal communication) states that at Balov Tepe, at the southern end of Lake Rezaiyeh, there has been alluviation to a depth of 6.70 m since about 4200 B. C.; once again this observation cannot be evaluated until

we know more about the deposits themselves. The erosional interlude that followed may also eventually be dated archaeologically, by reference to ancient dams and analogous structures (cf. Vita-Finzi 1960); at Saveh, for example, an elegant barrage built towards the end of the 13th century was soon undermined (Goblot 1963, p. 516), which suggests that the stream was not then aggrading; but such information needs to be supplemented by data at various points on the same stream and spanning longer periods.

Khorramabad Alluvium

In Section I the younger fill differs from the Tehran Alluvium (from which it is separated by a clear unconformity) chiefly in being unconsolidated and predominantly dark brown. Elsewhere the distinction between the two fills is likewise facilitated by contrasts in induration and hue. The colour values, however, are not always as at Section I. Thus at Sections II and III the Khorramabad Alluvium is grey or buff, whereas reddish brown hues typify the Tehran Alluvium (cf. Rieben 1953, p. 9). Further, the two deposits may contrast markedly in texture; in Sections III and V, for example, the younger fill is, unlike the older, dominated by gravel. Both deposits vary greatly in character from place to place, so that generalisations are hazardous; but on the whole the Khorramabad Alluvium is better bedded (particularly in its sandy horizons) than its predecessor (fig. 12), while its gravel is more rounded and tends to be concentrated at the base of the deposit.

The Khorramabad Alluvium is commonly rich in fragments of bone and in dispersed charcoal (notably in Sections VI, VII and VIII); more important, it yields abundant potsherds. As early as 1865 de Filippi reported in his "Note di un Viaggio in Persia" the presence of pottery below the level of the plain near Sainkála, north-west of Qazvin. He was led to conclude "that the present surface of the plain near Sainkála, and probably of the other plains of the Persian plateau, is of later date than human occupation" (Blanford 1876, p. 447).

Sherds from the various sections already described were submitted to Mr. David Stronach of the British Institute of Persian Studies in Tehran for identification. The dates listed below by courtesy of Mr. Stronach (personal communication, 8. 11. 1967) must be viewed in the light of the fact that few of the fragments were handles, rims or bases; this, and the effects of rolling in the course of deposition, rendered their study very difficult. Site I, in fact, yielded fragments of pottery too small for identification.

Site III : probably Islamic
Site IV : Islamic, probably before 900 A. D.
Site V : Bronze Age, 3rd millennium B. C.
Site VI : c. 700 B. C.
Site VIII: Islamic, post 900 A. D.
Site IX : Islamic, probably Mongol (i. e. post 1200 A. D.)
Site X : c. 3000 B. C.

Four sites show the deposits to be mediaeval or later. The three others are dominated by material from earlier occupation sites nearby; no later sherds were to be seen on the ground, so that the dates given above are maxima. A hearth at the base of the Khorramabad deposit in Section I yielded sufficient charcoal, charred seeds and charred twigs for a radiocarbon assay; this indicated an age of 330 ± 105 years (I—3214). The case for a late mediaeval date for the Khorramabad Alluvium is thereby reinforced.

The succession elicited from the above observations thus runs as follows. Less than 40,000 years ago (50,000 if we take into account RIEBEN's Mousterian finds) the Tehran Alluvium began to be deposited. In the Elburz piedmont, aggradation had probably ended by the 4th millennium B. C. Following an erosive interlude, the Khorramabad Alluvium was laid down largely, if not wholly, in the late Middle Ages. Both deposits are now being trenched.

The material underlying the younger fill in section VIII is not exposed to a sufficient depth for its character to be clear; it consists of a compact clay containing nodules of calcareous material, and is marked by vertical structure. At Section X, the Khorramabad Alluvium rests unconformably on cross-bedded ferruginous sands (which, incidentally, exude sodium chloride when freshly exposed). Similar sands may be seen at the base of the alluvial deposits of the Tehran Alluvium in the lower reaches of the Elburz streams draining to the Caspian, notably at Gorgan (where the section measures 8 m), at Gonbad, in the Gorgan valley (12 m of Tehran Alluvium), and at various points on the Caspian shore. The sands grade into the overlying alluvium and in places contain both freshwater and salt-water molluscs. It seems reasonable to regard the sands as beach deposits which were ultimately overwhelmed by the Tehran phase of continental aggradation. This would account for the conformable relationship of the two deposits, as compared with the unconformity between the sands and the Khorramabad Alluvium. The elevation of the Caspian sea-level during the deposition of the Tehran Alluvium is, however, not easy to determine, but there is nothing to suggest it was any higher than at present, while a lower sea-level would have provided a source for the sands and would accord with the presence of several metres of Tehran Alluvium on the present Caspian shore. On the other hand, there is some indication that the Caspian stood higher than at present during the deposition of the Khorramabad Alluvium. About 35 km east of Chalus, this formation grades into deltaic material whose surface stands 3 m above water level and which yielded a small fragment of fired pottery. But the question was not pursued because, as the Caspian derives 75% of its annual inflow from the Volga and only 6% from the coast of Iran (BUTZER 1958 a, p. 130—131), fluctuations in its level are not the most direct guide to hydrological changes in the catchments under review, while uncertainty over the history and magnitude of these fluctuations (FEDOROV 1965) limits their value as a source of dates.

The basin of Lake Rezaiyeh (Urmia) has more to recommend it in this

respect since it has no exotic sources of water, and it was accordingly searched for evidence of higher water levels related to the alluvial history of its tributary streams. Previous workers have found traces of dramatic increases in the volume of the lake, among them de Morgan (1905, vol. III a, p. 49), Bobek (1937, p. 163—173), and Rieben (1935, cited by Bobek, 1937, p. 165—166). Bobek concluded that at its maximum the lake had a depth of 60—70 m and a surface area of 10,500 km², as compared with its present maximum depth of 16 m and area of 5775 km² (Bobek 1937, p. 169). Loftus (1855, p. 307), however, claimed that he "could detect no indications of the lake having ever been higher than at present." A circuit of the basin yielded one well-defined beach deposit; 36 km north of Hyderabad (Section XIII), whose surface lies 4 m above present water level and which passes laterally into Tehran Alluvium. As regards subsequent events, Dr. Regnar Kearton (personal communication) reports that the lake appears to have encroached on an Islamic site 53 km north of Rezaiyeh which dates from the 10th—11th century A. D.; this suggests that, between the Tehran and Khorramabad periods of alluviation, lake level was lower than it is today.

Discussion

A twofold alluvial sequence has already been reported by workers other than those desirous of finding evidence in Iran for both Pleistocene and Holocene deposits (e. g. Clapp 1940). In his account of the Central Elburz, Rivière (1934, p. 69—79) mentioned two main terraces, one 150—200 m and the other 40—60 m above the present stream bed. To judge from his description, both could consist of Tehran Alluvium, although in those localities where it occurs outside the limits of the present catchments (Rivière 1934, p. 74), the upper may correspond to the Mio-Pliocene Hezardarreh Formation (or "A" beds) of Rieben (1966). Rivière also described a third terrace, lower than the others, but did not specify whether it represented an independent aggradational phase. Working in the Tehran area, Dresch (1959) also found three terraces related to alluvial cones and erosional surfaces upvalley, although the details he gives suggest that only two deposits are involved. The lower terrace in the Karadj valley consists of finer material than that of the other two, and Dresch attributed this to a decrease in competence. Stöcklin et al. (1965, p. 54) found that the valleys of the Shotori Range of eastern Iran are followed by terraces, in places 35 m high, which pass into gravel fans, and that at the mountain foot these are covered by shorter and steeper talus fans. Finally, Scharlau (1958), working in the middle Torgabeh valley, also in eastern Iran, identified two alluvial terraces which were associated with rock-cut terraces further upstream. The older, 40 m high, contained reddish products of weathering; the younger, 20 m high, was a brown gravelly deposit. No datable material was found, and Scharlau proposed an interglacial age for the deposits, Mindel/Riss for one and Riss/Würm for the other. One may safely conclude that the

validity of the scheme proposed in the present paper is not impaired by the above accounts.

Of greater interest are the observations made by WRIGHT (1960) in Iraqi Kurdistan, for he employed archaeological dating in the study of the alluvial bodies of the Chemchemal plain. These include a silt deposit up to 50 feet thick (c. 14.4 m), which has buried the Acheulian site of Barda Balka, and a later alluvial fill up to 30 feet (c. 8.6 m) thick which contains Late Assyrian (c. 750—600 B. C.) potsherds. Most of the dissection that



Fig. 12. Section III: segregation of current-bedded gravel and sand/silt components.

separates the two deposits was accomplished by about 6750 B. C.; renewed downcutting has left the younger fill as a terrace. Equally close is the resemblance between the Iranian alluvial sequence and that of the Mediterranean area (VITA-FINZI, in press), which also consists of two fills of which the older contains Middle and Upper Palaeolithic industries and was being dissected some 8000 years ago, and the younger is of mediaeval age. Any attempt to reconstruct the environmental conditions that prevailed in Iran during the last 50,000 years cannot fail to take these parallels into account. At the same time it seems advisable to obtain the maximum information from the local evidence before considering the broader picture.

Morphologically, the two Iranian formations differ chiefly in that the Tehran Alluvium occurs in fans or bahadas whereas the Khorramabad Alluvium is a channel fill which, given sufficient distance from the headwaters, has been integrated into a single deposit. The distinction is endorsed by differences in sedimentary structure, for the younger deposit is better bedded and sorted (fig. 12). In the terminology of TWENHOFEL

(1961, p. 800—806), the older fill indicates a piedmont, the younger a valley-flat environment; in terms of stream regimes, the former suggests deposition by flash floods, the latter by through-flowing streams.

A prerequisite for the satisfactory evaluation of the palaeohydrology of the two depositional phases is information on current sediment yield, and this is almost entirely lacking. None the less, further comparison between the two deposits is of some value. The analysis of mechanical composition in terms of maximum grain size (e.g. Passega 1957), whether in itself or associated with other attributes, yields information on competency, and thus may reflect peak discharge without throwing any additional light on stream regime. The clay-silt fraction would seem a more useful index of regimes, for it furnishes some measure of the frequency and duration of flows exceeding the threshold value for transport in suspension, and thus indicates the prevalence of perennial flow as opposed to flash-flood (or stillwater) conditions. Accordingly, spot sample "couplets" were taken from adjacent exposures of the two formations where their morphology justified the assumption that they were derived from the same catchment. It will be seen from figure 13 that there is in general a relative deficiency in silt and clay in the younger deposit; this feature, which it is proposed to term s i l t - c l a y d e p l e t i o n, becomes more marked the further downstream one proceeds. The one sample where the situation is reversed (Curve 1, Aiveneki) comes from a site immediately at the foot of an exposure of "A" beds (Rieben 1966, end map), where the Khorramabad sediments are not related to a particular drainage system but are more akin to slope deposits. With this exception, then, mechanical analysis would seem to lend further support to what has already been inferred regarding the contrasting modes of deposition of the two alluvial formations. The alternation between downcutting and aggradation remains to be explained.

By good fortune, the last few years have seen the appearance of a number of studies on the vegetational and climatic history of southwestern Iran based on the analysis of cores taken from lakes Zeribar and Mirabad in the Zagros Mountains (van Zeist & Wright 1963; Hutchinson & Cowgill 1963; Megard 1966; Wright 1966; van Zeist 1967; Wasylikowa 1967). The burden of these studies is as follows. Between 22,600 and 14,000 years ago, A r t e m i s i a steppe (Core I—12, zone A) prevailed in the hills surrounding Lake Zeribar (elevation 1,300 m); then came a change to oak-pistachio savanna (Core I—12, zone B—1; Core I—13, zone B—2) which, by about 5,500 years ago, had thickened to oak forest (Core I—13, zone C). Lake Mirabad (elevation 800 m), which lies 75 km southwest of Khorramabad, unfortunately yielded no dates, but its core (63—B) displays a similar change, from P i s t a c i a to oak followed by a rise in herb pollen which suggests increasing degradation of the forest (van Zeist & Wright 1963; van Zeist 1967). Chemical analysis of one of the cores from Lake Zeribar (Hutchinson & Cowgill 1963) supports the pollen evidence for intermittently low lake levels, and less frequent overflow to the Diyala headwaters than at present, during

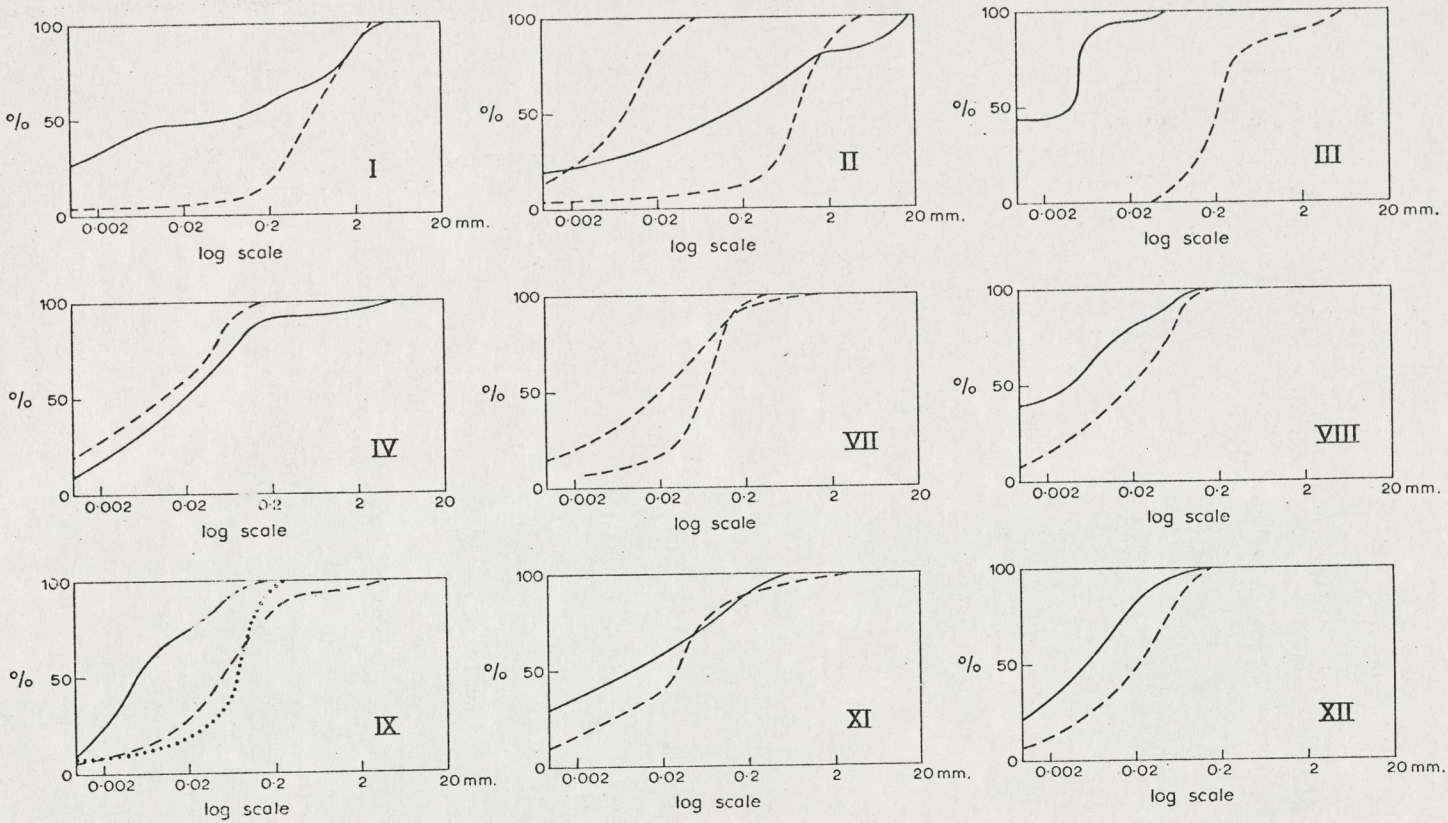

Fig. 13. Grain-zize analyses of samples from nine sections (numbered as in fig. 1). Continuous line: Tehran Formation. Dashed line: Khorramabad Formation. Dotted line: modern flood deposit. Where two dashed lines are shown (graphs II and VII) they indicate different beds in the Khorramabad Alluvium.

the accumulation of zone B—2. Plant microfossils from the same lake (Wasylikowa 1967) indicate that it was rather deep between 22,500 and 14,000 years ago, and fluctuated considerably in level between 14,000 and 6,000 years ago. The cladoceran record (Megard 1966, cited by Wright 1966, p. 170) shows that in the earlier part of the sequence the lake was inhabited by two species now confined to higher latitudes, and that after 11,000 years ago, four southern species became common and the fauna became more diversified; about 5,500 years ago Bosmina, a planctonic form, became common, and this implies a deeper lake.

Interpretation of the record from Zeribar in the light of studies of the modern pollen rain in western Iran (Wright, McAndrews & van Zeist 1967, p. 441) leads to the following climatic sequence. During the period corresponding to the full-glacial of northern Europe, the area had a cool, dry climatic regime resembling that of the higher parts of the interior Iranian plateau today. About 11,500 years ago (= at the A/B zone boundary) the climate became warmer and precipitation increased slightly. By about 5,500 years ago, further increase in moisture had converted the original savanna to the oak woodland that still prevails in the area despite the attentions of fuel collectors. The lower part of the Mirabad sequence indicates an Amygdalus-Pistacia savanna, supposedly the modern climax vegetation in the foothills of the Zagros; the subsequent increase in oak-pollen is equated in time with that at Zeribar (van Zeist 1967, p. 310) and presumably has similar climatic implications. If this correlation is accepted, two minor dry phases indicated at Mirabad can be taken postdate 5,500 B. P.; during the earlier of these, the lake was subject to strong fluctuations and dried out intermittently, possibly in response to drier summers (van Zeist 1967, p. 310—311).

Both Mirabad and Zeribar lie within Zohary's Zagrosian xerophilous deciduous oak forest (van Zeist 1967, fig. 1), although the extent of deforestation is not the same throughout this zone (Zohary 1963); it therefore seems legitimate to extend the evidence from the lower part of Lake Zeribar to the Khorramabad area. The available dates permit a tentative correlation to be made between pollen zones A and possibly B, and the Tehran phase of aggradation at site I. (As it happens, evidence of alluvial deposition in zone B—2 and even into zone C is noted by van Zeist & Wright [1963, p. 66]; they suggest that the virtual absence of pollen grains from the upper part of core I—12 may have resulted from the periodic exposure of the lake sediments to the air due to deposition by a nearby alluvial fan.) The inference is that aggradation took place under climatic conditions resembling those now reigning in northwest Iran, where the predominant vegetation cover is Artemisia steppe, and this is in harmony with the lithological and morphological evidence already discussed, with the additional bonus that greater cold, which would foster frost weathering, might help to explain the prevalence of gravel in the Tehran Formation.

The problem lies in extending the argument to other areas where the Tehran Alluvium is well developed. Lustig (1966) has shown, in discuss-

ing an analogous situation in Arizona, that it pays to consider present-day analogs of the palaeoclimatic conditions that are being postulated in order to explain a particular geological feature. In the present case, we should accordingly expect to find active alluvial deposition by fans in the Artemisia steepes of northwestern Iran, whereas downcutting prevails there too. Furthermore, climate presumably did not stand still in Azerbaijan, but it is rash to assume, on the basis of the Zeribar sequence, that it merely became yet cooler and drier, let alone to suppose that this would in itself lead to active fan aggradation. Extrapolation as far as the Zagros or the Caspian littoral requires even greater audacity. In the absence of palynological or other palaeoclimatic data from other parts of the country we can merely indicate the changes required by the geological evidence.

As Bobek (1963, p. 406) suggests, streams draining the higher mountainous areas probably deposited fluvioglacial and periglacial material in their upper reaches in the course of upland glaciation during the Pleistocene. In areas outside the range of significant frost action, changes in discharge regimes may have been sufficient to initiate aggradation. Studies carried out in Wyoming and Arizona have shown that the rate of sediment production (insofar as one can speak of mean rates in such matters) during past periods of alluviation in these areas were similar to those prevailing during the present period of valley degradation (Leopold & Miller 1954; Miller & Wendorf 1958); but whether or not the material is exported will be determined by the magnitude and duration of individual flows. These in turn reflect variations in the relative incidence of rains of different size and intensity, even when annual precipitation totals remain unchanged. The mechanism works in collusion with vegetation, particularly that developed on the channel floor; Melton (1966, p. 32) has illustrated the profound effect of a dense grass cover on channel roughness and hence on the critical velocity required for entrenchment. The Tehran Alluvium would seem to indicate deposition by powerful though short-lived flows, and hence the predominance of intense and brief downpours. This may involve greater annual precipitation totals than at present; Lustig (1965, p. 177—178), who found that certain alluvial fans in California have much greater clay content than more recent deposits, attributed this feature to the prevalence of higher precipitation in the past and not, as we have done here, to mudflow deposition. At any rate to account for such a condition throughout northern and western Iran is, in a sense, easier than to explain aggradation in terms of "drier" or "cooler" conditions; a reduction in the relative importance of cyclonic (as opposed to convectional) precipitation, which is responsible for the bulk of Iran's precipitation (Ganji 1955, p. 260), would seem to be sufficient. Such a change would be in harmony with the palynological evidence for dry conditions and indeed with Bobek's contention that Iran did not experience pluvial conditions during the Pleistocene (Bobek 1937). The rise in level of Lake Rezaiyeh need not conflict with this suggestion in that it could result from a reduction in evaporation rather than from an

increase in rainfall. Furthermore, a reduction in cyclonic activity also makes sense in terms of the pattern of global precipitation during the Pleistocene (Galloway 1965), although it is opposed to traditional thinking regarding conditions in the Mediterranean area during the glacial maximum.

Interpreted in this light, the limnological record of a subsequent increase in moisture may be seen as a return to the cyclonic pattern which, as we see today, is accompanied by stream incision and the reduction of channel gradients.

The Khorramabad alluvium betrays discharge regimes which, if not wholly perennial, were at least markedly less ephemeral than those of the present day. That a vegetative mat on the valley floors contributed to the aggradational state is suggested by the presence of fossils soils within the deposit (fig. 10). In this case, an increase in the relative importance of cyclonic precipitation is tentatively postulated. A southward shift in the European depression tracks has already been visualized by Lamb (1964, p. 336—337) for the period of the Little Ice Age (A. D. 1550—1850). The Caspian Sea record is no less confused (or suspect) for the postglacial (Butzer 1958 b, p. 117—125) than it is for earlier periods, but it is worth noting that there is historical evidence for a rise above its present level in the Middle Ages (as already suggested by the deltaic material mentioned above) which prevailed until 1800 A. D. (Lamb 1963, p. 128). Its subsequent fall (Lamb 1966, p. 58; Butzer 1958 a) tallies with widespread indications of greater aridity in western Asia since the late 19th century (Butzer 1961, p. 49—51). A return to the postglacial rainfall pattern would, according to the scheme being proposed, suffice to account for the current phase of stream degradation, although devegetation and other changes associated with land-use (Whyte 1961) doutbless have contributed to this tendency. The answer to the apparent discordance between the limnological record and the alluvial history of the area since the deposition of the Tehran Alluvium (and indeed during it) may lie in the choice of a suitable common point of reference, for runoff and vegetation cover are rarely susceptible to a common "climatic" classification.

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The Fishes of Iran

A Preliminary Checklist

Neil B. Armantrout

September, 1969

This checklist is an attempt to collect all possible listings of the fishes of Iran into a single list. It is in no way a definitive list. The initial edition was produced in Iran from rather limited sources. Since returning to the United States, I have made many corrections and revisions in the checklist as further references became available.

This present checklist still contains a good deal of inaccuracy. In addition, many of the original listings, for locations not in Iran, have been left in the checklist. This is because I feel the fishes of Iran, and the sea fishes in particular, are so poorly known that the inclusion of these species may prove useful in further research.

THE FISHES OF IRAN: A PRELIMINARY CHECKLIST

Class Agnatha
Subclass Cyclostomata
Order Petromyzoniformes
Family Petromyzontidae - the lampreys

× 1. Caspiomyzon wagneri Kessler: Caspian Sea, Volga, Ural, Tarak, Kura, Babul, Sefid-Rud, Iranian Rivers. (17, 3, 60, 41, 7)

× 2. Lampetra planeri Bloch: Europe; North, Central and Eastern Asia; Upper reaches of the Rivers of the Black and Caspian Seas; Volga; Basins of the Baltic and North Seas. (17, 55, 41, 7)

Class Chondrichthyes
Subclass Elasmobranchii
Order Squaliformes

Fam. Squalidae-dogfish sharks.
1. Chiloscyllium indicum Indo-Pacific (36)
2. Chiloscyllium griseum Indo-Pacific (36)
3. Echinorhinus brucus Bonnaterre: Cosmopolitan; Muscat. (19, 12)

Fam. Rhincodontidae-whale sharks.
1. Rhincodon typus : All tropical seas; Red Sea; Persian Gulf. (36, 19, 9, 37).

Fam. Sphyrnidae -hammerhead sharks.
1. Sphyrna zygaena, smooth hammerhead: Circumtropical, cosmopolitan. (36, 37, 57, 41, 12).
2. Sphyrna mokarran Tropical and subtropical waters of the Indo-Pacific. (37, 29).
3. Sphyrna tudes: Red Sea (19). According to Briggs (12), Tortonese list S. mokarran and S. tudes as synonyms for the same species.
4. Sphyrna oceanica: Muscat (19)
5. Sphyrna blochii: Iran, Persian Gulf (19)
Zygaena blochii (9)

Fam. Heterodontidae -horn sharks
1. Heterodontus sp. Port Jackson Sharks: Parts of Indian and Pacific Oceans. (36, 41).

Fam. Scyliorhinidae -cat sharks
1. Cephaloscyllium sufflans: Red Sea (19)
2. Halaelurus quagga Red Sea (19)
3. Apristurus indicus Oman (19)

Fam. Lamnidae -Mackerel sharks
1. Isurus glaucus: Muscat (19, 37)
Isuropsis glauca: Blue-pointer; Mako shark (45, 29)
2. Carcharodon carcharias: White shark; All tropical and temperate waters; Red Sea; South Africa, Austrasia (19, 37, 57, 29)
Carcharodon rondeleti: Circumtropical (12)
3. Alopes vulpinus Bonnaterre: Arabia, Red Sea (19, 37, [illegible], 12)

Fam. Orectolobidae -nurse sharks, wobbegongs
1. Nebrium concolor: Red Sea (19)
2. Ginglymostoma ferrugineum Red Sea (19)
3. Hemiscyllium griseum: Red Sea, Persian Gulf (19, 9)
4. Stegostoma fasciatum Muscat (19)

Fam. Squatinidae- angel sharks.
1. Squatina squatina: Red Sea (19)

Fam. Hexanchidae -cow sharks.
1. Hexanchus griseum Bonnaterre: sixgill shark; Atlantic, Pacific, Indian Oceans. (37, 41, 12)

Fam. Carcharhinidae -cat sharks, grey sharks, topes, requiem sharks.
1. Triaenodon obesus: Indo-Pacific; Red Sea (36, 19)
2. Galeolamna melanoptera: Indo-Pacific; Muscat (19)
   Carcharhinus melanoptera (36).
3. Galeolamna menisorrah: Indo-Pacific; Muscat, Persian Gulf (19)
   Carcharhinus menisorrah (36)
   Carcharias menisorrah (9)
4. Galeolamna limbata: Red Sea, Indian Ocean (19)
   Carcharhinus limbatus Muller & Henle (37, 12)
5. Galeolamna sorrah:Red Sea (19)
6. Galeolamna spallanzani: Red Sea (19)
7. Galeolamna gangetica: Red Sea (19)
8. Galeolamna lamia: Muscat (19)
9. Galeolamna albimarginata: Red Sea (19)
10. Galeolamna ellioti:Muscat (19)
11. Triakis sp. Indo-Pacific (36)
12. Galeorhinus omanensis: Gulf of Oman (19)
13. Dirrhizodon elongatus: Red Sea (19)
14. Hemigaleus balfouri: Persian Gulf (19, 9)
15. Galeocerdo cuvier Peron & Lesueur: All tropical seas; Red Sea; Muscat (19, 37, 29, 12)
16. Loxodon macrorhinus:Red Sea (19)
17. Longmania brevipinna: Muscat (19)
18. Negraprion acutidens: Muscat (19)
19. Scoliodon walbeehmii: Red Sea (19)
20. Scoliodon palassorah: Persian Gulf, Muscat (19)
   Carcharias acutus (9)
21. Eridacnis radcliffei: Red Sea (19)
22. Mustelus mustelus: Tropics and subtropics; Red Sea (19, 41)
23. Mustelus manazo: Persian Gulf, Muscat; Off Bombay (19, 9, 5)
   M. manaze
24. Mustelus canis: Red Sea (19)
25. Mustelus punctatus: Red Sea (19)
26. Carcharinus glaucus Linnaeus: All warm and temperate seas(12, 41)
   Prionace glauca (37, 29)
27. Carcharhinus leucas: Pakistan,India, Tigris and Euphrates (29)
28. Carcharias tricuspidatus: Red Sea (19)
29. Carcharias taurus: Muscat (19)
   Odontaspis taurus (29)

Order Rajiformes
Fam. Myliobatidae- eagle rays
1. Aetobatus narinari Euphrasen: Circumtropical; Red Sea, Persian Gulf; West coast of India (36, 19, 9, 37, 53, 12)
2. Aetomylus maculatus: Persian Gulf (19)
   Myliobatus maculatus (9)
   Myliobatis maculata: Bombay (5)
3. Aetomylus milvus: Red Sea (19)
4. Aetomylus nichofii: Persian Gulf (19)
   Myliobatus nichofii (9)
5. Rhinoptera jayakari: Muscat (19)

Fam. Pristidae -saw fishes
1. Pristis pectinatus: Muscat (19)
2. Pristis zysron: Persian Gulf (19)
   P. zijsron (9)
3. Pristis cuspidatus: Persian Gulf (9, 19)

Fam. Rhinobatidae -guitar fishes
1. Rhynchobatus ancylostomus: Persian Gulf, Muscat (19, 9)
   Rhina ancylostoma
2. Rhynchobatus djiddensis: Persian Gulf, Muscat, plentiful off Chittagong (9, 19, 53)
3. Rhinobatus schlegelii: Oman (19)
4. Rhinobatos granulatus: Persian Gulf (9, 19)
   Rhinobatus granulatus
5. Rhinobatos thouin: Red Sea (19)
6. Rhinobatos halavi: Muscat (19)

Fam. Rajidae -skates
1. Raja johnnis-davis: Red Sea (19)
2. Raja philipi: Red Sea (19)
3. Raja fullonica: Red Sea (19)

Fam. Dasyatidae -stingrays
1. Taeniura grabata: Red Sea (19)
2. Taeniura lymma: Muscat (19)
3. Dasyatis uarnak: Persian Gulf, Muscat (19)
   Trygon uarnak: Off west coast of India (9, 53)
4. Dasyatis gerrardi: Persian Gulf (19)
   Trygon gerrardi (9)
5. Dasyatis sephen: Persian Gulf, Muscat, west coast of India (19, 53)
   Hypolophus sephen (9)
6. Dasyatis imbricatus: Muscat (19)
7. Urogymnus africanus: Muscat (19)
8. Gymnura tentaculata: Red Sea (19)
9. Gymnura poecilura: Persian Gulf (19)
   Pteroplatea poecilura (9)
10. Trygon walga Mull. & Henle: Muscat (48)

Fam. Mobulidae -devil fish, mantas
1. Mobula diabolus: Muscat (19)
2. Manta ehrenbergii: Red Sea (19)

Fam. Torpedinidae -electric rays
1. Torpedo marmorata: Muscat (19)
   Torpedo panthera: Persian Gulf (9)
2. Torpedo sinus-persici: Red Sea (19,18)
3. Narcine maculata: Red Sea (19)
4. Heteronarce mollis Red Sea (19)

Subclass Holocephali
Order Chimaeriformes
Fam. Chimaeridae -chimaeras
1. Harriotta indica: Red Sea. Only egg case found (19)

Class Osteichthyes
Subclass Actinopterygii
Order Acipenserformes
Fam. Acipenseridae -sturgeons

× 1. Huso huso Linne: Beluga; Caspian, Volga, Ural, Tarak, Kura, Iranian Rivers, Sefid-Rud, off Babul, Surkh-Rud, Gorgan, estuary of Atrek (16, 7, 7, 41, 14, 49, 58, 17, 36, 3, 59, 60)

× 2. Acipenser nudiventris Lovetzky: Black, Caspian and Aral Seas; abundant in southern Caspian, entering Sefid-Rud, Kura, Araks, Astara, Lenkoranka, and Ural: rare in Volga and Ural, perhaps in Atrek. (41, 17, 58, 60, 49,7)
A. schipa Lov. Caspian. (3)

× 3. Acipenser guldenstadti Brandt: Black and Caspian Sea. Volga, Tarak, Ural (1,58, 3, 60, 49, 14, 41, 16, 7)

× 4. Acipenser guldenstadti persicus Borodin: Main distribution in the Kura, Sefid-Rud, Astara, Lenkoranka, Babul, Palarud, South Caspian Rivers (1, 7)

× 5. Acipenser ruthenus Linne: Bains of Black and Caspian seas; Volga, Ural. (41, 14, 55, 49, 60, 59, 3, 17, 7).
A. persicus: May be synonym of A. guldenstadti, uncertain (58)

× 6. Acipenser stellatus Pallas: Blac, Caspian and Sea of Azov; Volga, Ural, Tarak (16, 14, 60, 58, 17, 3, 49, 7)

× 7. Acipenser stellatus n. cyrensis Berg: Kura, Iranian Rivers (17, 7)

Order Clupeiformes (Isospondyli)
Suborder Clupeoidei
Fam. Elopidae -tarpons

1. Elops machnata: Muscat (19)
2. Elops saurus: Circumtropical (37, 12)

Fam. Albulidae -bonefish

1. Albula vulpes: Red Sea; all tropical seas (19, 37)

Fam. Clupeidae -herrings

× 1. Clupeonella delicatula Nordmann: All coasts of Black and Caspain Seas: delta of Volga, Ural, Tarak (17, 30, 3, 7)
Clupea delicatula Nordmann (3)

× 2. Clupeonella delicatula caspia Svetovidov: Caspian, Volga, Ural, Tarak, Iranian rivers. (41) Berg (7) does not accept a special subspecies of this form.

3. Clupeonella delicatula m. tscharchalensis Borodin: A special form found in the Volga (7)

× 4. Clupeonella engrauliformis Borodin: Central and Southern Caspian; does not enter freshwater. (17, 7, 41).

× 5. Clupeonella grimmi Kessler: Central and Southern Caspian (7, 17, 3, 41)

× 6. Alosa saposhnikovi Grimm: Northern and central Caspian; southern Caspian only in cold winters (17, 3, 41, 29)

× 7. Alosa sphaerocephala Berg: Northern part of Caspian (7, 17)

× 8. Caspiolosa sp.: Caspian (58, 59)

× 9. Caspiolosa caspia Eichwald: Caspian Sea, Volga, Black Sea (41, 17, 7, 3, 60)

× 10. Caspiolosa caspia aestuarina Berg: Caspian Sea (7)

× 11. Caspiolosa caspia caspia Eichwald: Caspian (17)

× 12. Caspiolosa caspia knipowitschi Iljin: Caspian, near Mordab Bay, west to Astara, Astarabad Bay (17, 7)

× 13. Caspiolosa caspia knipowitschi n. saraica Berg: Soutwest Caspian, Astara northward. (7, 17)

14. Caspiolosa caspia persica Iljin: Southeastern Caspian, Astarabad, Krasnovodsk (17, 7, 41)
15. Caspiolosa caspia salina Svetovidov: Bays of the Caspian (7, 17)
16. Caspiolosa brashnikovi brashnikovi Borodin: Caspian (17, 41)
17. Caspiolosa brashnikovi agrachanica Mikhailovskaja: Winters in south Caspian, spawns in the north (7, 17)
18. Caspiolosa brashnikovi sarensis Mikhailovskaja: Southern and Central Caspian: Astara to Daghestan (7, 17)
19. Caspiolosa brashnikovi orientalis Mikhailovskaja: Krasnovodsk to Astarabad Bay; Baku area of Caspian (7, 17)
20. Caspiolosa brashnikovi autumnalis Berg: Gasan-Kuli-Chikishlyar, Cape Byandoran to Nordostov Kultuk; Caspian (7, 17)
21. Caspiolosa brashnikovi kisselewitschi Bulgacov: Gasan-Kuli; Astara north; important in southeastern Caspian. (7, 17, 41)
22. Caspiolosa brashnikovi nirchi Morosow: Krasnovodsk Bay; Kendyrli Bay (7, 17, 41)
23. Caspiolosa brashnikovi grimmi Borodin: Gurganchai, Astara, Astarabad Bay, Gurgan (7, 17)
24. Caspiolosa curensis Suworow: Caspian region of Kizilagach Bay (7, 17)
25. Caspiolosa kessleri Grimm: Volga; Ural; In Caspian south of Astara in winter, moving north in summer. (7, 17, 41, 60)
26. Caspiolosa kessleri volgensis Berg: North and east Caspian, Volga. (7, 17, 60)
    C. volgensis Berg (41)
27. Caspiolosa kessleri isp. volgensis imitans Berg: North and South Caspian; Ural (7)
28. Caspiolosa kessleri isp. volgensis N. tanassijtschuk Berg: Ural, Volga, Northern Caspian (7)
29. Caspiolosa kessleri kessleri Grimm: (17)
30. Caspiolosa pontica Eichwald: Black and Caspian Seas (7)
    Clupea pontica (3)
31. Anodontostoma chacunda: Persian Gulf (19)
    Dorosoma chacunda (9)
32. Nematolosa arabica : Muscat (19)
33. Nematolosa nasus: Muscat (19)
    Dorosoma nasus: Persian Gulf (9)
    Chatoessus nasus: Bombay (5)
34. Stolephorus japonicus: Red Sea (19)
35. Dussumieria acuta: Persian Gulf; Bombay (9, 19, 5)
36. Dussumieria productissima: Red Sea (19)
37. Harengula bulan: Red Sea (19)
38. Harengula ovalis: Muscat (19)
39. Sardinella longiceps: Muscat, Persian Gulf, India (19, 52)
40. Sardinella perforata: Persian Gulf (9, 19, 51)
41. Sardinella fimbriata: Persian Gulf (9, 19, 51)
42. Sardinella maderensis: Red Sea (19)
43. Sardinella sindensis: Persian Gulf (9, 19, 51)
44. Sardinella jussieu: Red Sea (19)
45. Sardinella melanura: Persian Gulf (9, 19, 51)
46. Sardinella sirm: Persian Gulf, Red Sea (9, 19, 51)
47. Sardinella clupeoides: Red Sea (19)
48. Macrura kelee: Iran (19)
49. Kowala coval: Red Sea (19)
50. Opisthopterus tardoore: Oman, Persian Gulf (19)
51. Opisthopterus indicus: Persian Gulf (9)

52. Hilsa ilisha: Persian Gulf; off Fao; off Bombay (19, 2, 9, 5)
Macrura ilisha
53. Hilsa kanagurta: Persian Gulf (9); figure agrees with H. blochii of Folwer (18)
54. Ilisha indica: Persian Gulf (9, 18)
55. Sardinops sagax Africa, Japan, Pacific (37, 41)

Fam. Engraulidae -anchovies
1. Thrissocles malabaricus: Persian Gulf (19)
Engraulis vitrirostris (9)
2. Thrissocles setirostris: Red Sea (19)
3. Thrissocles baelama: Red Sea, Mediterranean, Western Africa (19, 41)
4. Engraulis encrasicorlus: Red Sea (19)
5. Amentum heterolobum: Red Sea (19)
6. Amentum zollingeri: Red Sea (19)
Stolephorus zollingeri: Persian Gulf (9)
7. Amentum commersonii: Muscat, Bombay (19, 5)
8. Amentum indicum: Persian Gulf (19)
Stolephorus indicus (9)

Fam. Alepocephalidae -deepsea slickheads, black heads
1. Alepocephalus bicolor: Red Sea (19)
2. Narcetes affinis: Oman (19)
3. Bajacalifornia burragei: Red Sea (19)
4. Aulastomatopmorpha caeruleiceps: Muscat, Oman (19)
5. Rouleina guentheri: Red Sea (19)
6. Aleposomus copei: Red Sea (19)
7. Tetraroge guentheri Blgr: Oman; may belong in another family (11)

Suborder Chirocentroidei
Fam. Chirocentridae -wolf herring, wolf eels
1. Chirocentrus dorab: Muscat, Persian Gulf, India (9, 19, 57)

Suborder Chanoidei
Fam. Chanidae -milk fish
1. Chanos chanos: Muscat, Red Sea, Africa, Northern Indian Ocean (9, 19).
Chanos salmeneus: (34)

Suborder Salmonoidei
Fam. Salmonidae -salmon, trout, whitefish, graylings
× 1. Salmo trutta Linnaeus: Europe, Asia, U.S. Karadj River, Jajehrud, Lar Rud: Introduced from Europe into Iran (44, 37)
× 2. Salmo trutta fario Linnaeus: Karadj River, Asia Minor (44,50,55) There seems to be confusion over the exact nomenclature for the introduced form, so I am including both names given.
3. Salmo trutta aralensis: Middle Asia, perhaps Atrek (60)
4. Salmo trutta aralensis m. oxianus(fario): Upper Amu-Darya, Oxus system (20, 21)
× 5. Salmo trutta caspius Kessler: Caspian, Volga, Tarak, Kura, Araks, Ural, Western coasts of Iran to Sefid Rud; Rivers of Mazanderan (17, 58, 60, 7, 41)
× 6. Salmo trutta caspius m. lacustris (Linne): Kura, drainage of the Sevan Lake (17, 7, 16)
× 7. Salmo trutta caspius m. fario: Volga, Tarak, Kura, Iranian Rivers (17, 41, 7)

8. Salmo trutta labrax Pall.:Barimani (3) says this is found in the Caspian, but it is not listed by Berg (7)
× 9. Salmo trutta macrostigma: Upper Euphrates; northern Iran south of the Elborz (7, 8)
10. Salmo ischchan Kessler: Kura, Araks, basin of Lake Sevan (7, 17,41)
11. Salmo trutta oxianus Kessler: Northern declivities of the Hindu Kush; Bamean River (Oxus system). (7)
Salmo orientalis McClelland (20)
12. Hucho taimen Pallas: Volga, Ural (17, 60)
× 13. Stenodus leucichthys Guldenstadt: Caspian, Volga, Ural, Terek (17, 7, 3)
Stenodus leucichthys leucichthys Guld.: (41)
14. Coregonus albula Linne: Volga (17, 60)
15. Coregonus albula pereslavicus Borisov: Volga basin. Berg (7) feels this is a special subspecies. (7, 17)
16. Coregonus sardinella vessicus Drjagin: Volga drainage (7, 17)
17. Thymallus thymallus Linne: Upper reaches of the Volga and Ural (7, 17).

Fam. Osmeridae -smelts
1. Osmerus eperlanus Sparlingi: Same distribution as the freshwater perch (60).
2. Osmerus eperlanus spirinchus:European smelt; European, same locals as freshwater perch. (60)
3. Osmerus eperlanus eperlanus m. spirinchus Pallas: Lakes in upper Volga (17, 7)

Suborder Esocidae -pikes
Fam. Esocidae -pikes
× 1. Esox lucius: Europe, north and west Asia, North America, Atrek, Volga, Caspian and Aral Seas, Ural, Kura, Tarak, Iranian waters. (7, 17, 3, 37, 60, 57, 55, 16)

Suborder Stomiatoidei
Fam. Gonostomidae -bristlemouths
1. Cyclothone signata Garman: Red Sea, worldwide (19, 12)
2. Cyclothone pallida Brauer: Oman, worldwide (12, 19)
3. Cyclothone acclinidens Garman: Oman, Cosmopolitan (12, 19)
4. Gonostoma elongatum Red Sea (19)
5. Yarrella corythoela Red Sea (19)
6. Ichthyococcus ovatus: Red Sea (19)
7. Maurolicus mucronatus: Red Sea (19)
8. Vinciguerria nimbaria Jordan & Williams: Oman, worldwide (12, 19)
9. Diplophos taenia: Red Sea (19)

Fam. Sternoptychidae -hatchet fish.
1. Sternoptyx diaphana Hermann: Red Sea, many parts of Indian Ocean (12, 19)
2. Argyropelecus affinis: Red Sea (19)
3. Argyropelecus sladeni: Red Sea (19)

Fam. Stomiatidae -scaly dragonfish.
1. Stomias affinis Gunther: Red Sea (19)

Fam. Chauliodontidae -viperfish
1. Chauliodus pammelas: Oman (19)

Fam. Astronesthidae -snaggletooths
1. Astronesthes martensii: Red Sea (19)

Fam. Malacosteus niger: Red Sea (19)

Order Myctophiformes
Fam. Synodidae -lizard fishes.
1. Trachinocephalus myops: Red Sea (19)
2. Synodus indicus:Red Sea (19)
3. Synodus japonicus: Muscat (19)
4. Saurida gracilis: Red Sea (19)
5. Saurida longimanus: Oman (19)
6. Saurida undosquamis: Oman (19)
7. Saurida tumbil: Muscat, Persian Gulf, Bombay (9, 19, 18, 5)
8. Bathymicrops sewelli: Red Sea (19)

Fam. Harpodontidae -bombay ducks, bummalos
1. Harpodon squamosus Alcock: Oman (11, 48)
Peltharpodon squamosus: (19)

Fam. Myctophidae -lantern fish.
1. Scopelengys tristis: Red Sea (19)
2. Myctophum pterotum : Oman (19)
3. Myctophum fibulatum: Red Sea (19)
4. Myctophum reinhardtii: Red Sea (19)
5. Myctophum pyrsobolus: Oman (19)
Lepidophanes pyrsobolus Alcock: Circumtropical (12)
Scopelus pyrsobolus Alcock: Oman (11, 48)
6. Diogenichthys laternatus: Red Sea (19)
7. Lampanyctus pusillus: Red Sea (19)
8. Lampanyctus macropterus: Red Sea (19)
9. Diaphus rafinesquii: Red Sea (19)
10. Diaphus splendidus: Red Sea (19)
11. Diaphus garmani: Red Sea (19)
12. Diaphus coeruleus: Red Sea (19)

Fam. Sudidae
1. Chlorophthalmus bicornis: Red Sea (19)
2. Paralepis ringens: Red Sea (19)
3. Bathyoterois atricolor: Red Sea (19)

Order Cypriniformes
Suborder Cyprinoidei
Fam. Cyprinidae -minnows and carps
1. Rutilus rutilus L Linne: Volga, Europe, southern Russia (17, 36, 60, 7, 37, 55).
2. Rutilus rutilus fluviatilis Jakowlew: Volga, Ural, perhaps the Tarak (17, 60, 7)
3. Rutilus rutilus uzboicus Berg: Lakes along Uzboi (channel between Sarykamysh depression and the Caspian). 7, 17)
4. Rutilus rutilus caspicus Jakowlew: Caspian, Volga, Ural, Tarak, Kura, Sefid-Rud, Southeastern and southwestern shor of Caspian. (7, 17, 59, 60, 41,58, 1)
5. Rutilus rutilus caspicus n. kurensis Berg: Kura, Araks (7, 17)
6. Rutilus rutilus caspicus n. knipowitschi Pravdin: Atrek, Gorgan, Karasu, Gasan-kuli, Astarabad Bay, southwest Caspian (7, 17)
7. Rutilus rutilus caspicus n. tscharchalensis Berg: Ural (7, 17)

8. Rutilus rutilus schelkovnikovi Derjavin: Kura; Karasu, a tributary of the Araks (7, 17)
9. Rutilus rutilus aralensis Berg: Upper Amudarya, Syr-Darya, Aral drainage (7, 20, 41)
10. Rutilus rutilus aralensis n. bucharensis : Middle Asia, perhaps including the Atrek; Amu-Darya, Surkhan (7, 60)
11. Rutilus frisii Nordmann: Black Sea, Sea of Azov, Kura (60)
12. Rutilus frisii kutum Kamensky: Caspian, Kura, Gorgan, Atrek, Volga, Iranian rivers (7, 17, 3, 58, 60, 41, 16)
13. Rutilus atropatenus Derjavin: Kura (7, 17, 41)
14. Leuciscus leuciscus Linne: Europe, Turkestan, Siberia, Volga, Ural, (7, 17, 41, 60, 55)
15. Leuciscus cephalus Linne: Europe, Asia Minor, Persia, Kura, Karadj (7, 17, 57, 60, 41, 50)
16. Leuciscus cephalus orientalis Nordmann: Tarak, Araks, Kura, Karadj, Haraz, Iranian rivers, Sefid-Rud, Shalmanrud, Sardabrud, Shahsavar, Qareh Su, Rivers of Lake Rezaieh, Euphrates, upper Tigre, East and West Zakavkaze, Northern Kavkaz, Atrek drainage, Gorgan (7, 8, 17, 58, 44)
17. Leuciscus cephalus orientalis n. platycephalus Kamensky: Kura, Araks (7, 17)
18. Leuciscus cephalus orientalis n. kaznakovi Berg: Kura district, but not its drainage (7, 17)
19. Leuciscus latus Keyserling: Amu-Darya, Murghab, Tedzhen (7)
20. Leuciscus agdamicus Kamensky: Rivulet near, but not part of, the Kura. (7, 17)
21. Leuciscus idus Linne: Volga, Ural (7, 17)
22. Leuciscus idus oxianus: Turkestan (41)
23. Leuciscus lepidus Heckel: Sefid Rud, Gharasu, Gamasiab, Seymarreh, Tigre (Mosul, Mendeli), Syria(Ladakiya, Oronte). (44, 8)
24. Leuciscus lehmanni Brandt: From Syr-Darya to Turkemanian Rivers (41)
25. Phoxinus percnurus stagnalis Warpachowski: Volga (7, 17)
26. Phoxinus phoxinus Linne: Casp an, Volga, Ural, Europe (7, 17, 55)
27. Scardinium drostoma nasus: Kura (60).
28. Scardinius erythrophthalmus Linne: Caspian, Baltic, Black and Aral Seas; Europe; Ural, Kura (7, 17, 55, 41).
29. Ctenopharyngodon idella Valenciennes: Introduced into Pahlevi Mordab of Iran; seems to have survived, but not to reproduce. In 1967, some individuals still survived. (17; personnal work).
30. Aspius aspius Linne: Blac, Caspian and Aral Seas; Europe; Tarak. (7, 17, 41, 55).
31. Aspius aspius taeniatus Eichwald: Southern Caspian, Kura, Iranian Rivers, Sefid-rud, Terek, Volga, Araks. (7, 17, 41, 55, 60)
    A. erythrostomus Kessler: Caspian (3)
    A. rapax Leske: Caspian (3)
32. Aspius vorax Heckel: Gharasu, Gamasiah, Seymarreh, Tigre, Oronte (44, 8, 41)
33. Leucaspius delineatus Heckel: Blac, Caspian, and Baltic Seas; Europe, Volga (7, 17, 41).
34. Leucaspius delineatus delineatus n. caucasicus Berg: Kura (7, 17)
35. Tinca tinca Linne: Europe, Arctic basin, Siberia, Ural, Kura, Iran, Araks, Sefid-Rud (7, 17, 37, 41, 55)
36. Chondrostoma nasus variabile Jakowlew: Basin of Caspian, Ural, Volga (7, 17, 41)
37. Chondrostoma shmidti Berg: Kura (7, 17, 41)
38. Chondrostoma oxyrhynchum Kessler: Tarak (7, 17, 41)
39. Chondrostoma cyri Kessler: Kura, Araks (7, 17, 41)

40. Chondrostoma regium Heckel: Garasu, Gamasiab, Seymarrah, Oronte, Aleppo, Upper Tigre, Euphrates (44, 8)
41. Gobio gobio Linne: Europe, Asia to China, Volga, Ural, Kushk (17, 20, 7, 55, 41)
42. Gobio gobio lepidolaemus Kessler: Tedjan, Murgab (7)
43. Gobio gobio lepidolaemus n. holurus Berg: Tarak (7)
44. Gobio ciscaucasicus Berg: Tarak (7, 17)
45. Gobio persa Gunther: Kura, Araks, Iran, Qareh Su, Basin of Lake Urmii (7, 17, 58)
46. Gobio albipinatus Lukasch: Volga (7, 17)
47. Varicorhinus capoeta Guldenstadt: Kura, Sefid Rud, Shahsavar, Sardabrud, Haraz, Kazim, Shalmanrud, Araks, Eastern transcaucasus and Turkmenistan (7, 17, 41, 44, 60)
48. Varicorhinus capoeta sevangi Filippi: Kura, Lake Sevan (7, 17, 41, 60).
49. Varicorhinus capoeta gracilis Keyserling: Caspian area, Kura, Atrek northern slope of Kopet Dagh, Lake Urmii drainage, Isfahan, Rivers Gilan and Mazanderan, Astarabad. (7, 17, 58, 8)
50. Varicorhinus capoeta heratensis Keyserling: Harirud, on Iran-Afghanistan border; Tedjan, Murgab, Turkmenistan and Western Uzbekistan (7, 8).
    Scaphiodon heratensis: Harirud at Herat. (20).
    Scaphiodon asmussi: Warm springs, Sultan Karsul, eight miles N.E. of Herat. (20).
51. Varicorhinus capoeta heratensis n. steindachneri Kessler: Amu-Darya, Zeravshan. (7, 8)
52. Varicorhinus fuscus A. Nikolsky: Eastern Iran, Eastern Khorrasan, South of Meshed, Area of Zarkuh (8)
53. Varicorhinus fuscus nudiventris Nikolsky: Sefid Rud, Kazim, Shahsavar, Shalmanrud, Sardabrud (44).
54. Varicorhinus trutta Heckel: Gharasu, Gamasiab, Seymarreh, Aleppo, drainage of Tigre (44, 8)
55. Varicorhinus damascinus Valenciennes: Asia Minor and North Arabia, Especially Jordan, Israel, and Syria; Gharasu, Gamaziab, Seymarreh, Aleppo, Damasuc, South Iran; Persepolis?; Khabis in Kerman; Southeastern Iran; Yazd, Oronte, Antioch, Euphrates; Shiraz; Palestine. (8, 44, 55)
56. Varicorhinus macrolepis Heckel: Gharasu, Gamasiab, Seymarreh, Isfahan, Persepolis, Shiraz. (8, 44)
57. Varicorhinus aculeatus Valenciennes: Karadj River (8, 50).
    V. bergi Derjavin: Karadj River (44, 58).
58. Varicorhinus gibbosus A. Nikolsky: Southeastern Khorrasan, in the area of the Zarkhuh and Khafom. (8)
59. ?Varicorhinus fratercula Heckel: Damascus, Smyrna, Oronte (8)
60. Varicorhinus syriacus Valenciennes: Lake Tiberias, River Jordan (8.
61. Varicorhinus buhsei Kessler: Karadj, perhaps Sefidrud, River Abhar at Sainkale. (8, 50).
    V. nikolskii Derjavin: Karadj River (44, 58).
62. Varicorhinus umbla Heckel: Tigre, at Mosul (8).
63. Barbus ciscaucasicus Kessler: Tarak (7, 17)
64. Barbus lacerta Heckel: Aleppo; (8, 41).
65. Barbus lacerta cyri Filippi: Kura, Sefidrud, Shahsavar, Shalmanrud Sardabrud, Kazim, Drainage of Lake Urmii, Kuria, Araks, Lenkoranka Drainage of Atrek, Tigre. (7, 17, 44, 8, 58).
66. Barbus lacerta scincus Heckel: Karun (44). Berg, (8) feels this my actually be B. lacerta cyri.
67. Barbus goktschaicus Kessler: Kura, Drainage of Lake Sevan (7, 17, 41)

68. Barbus capito Guldernstadt: Tarak, Kura, Middle Asia (7, 17, 60,41)
69. Barbus capito capito Guldenstadt: Sefidrud, Shalmanrud, Shahsavar, Sardabrud, Kazim (44).
70. Barbus brachycephalus Kessler: Middle Asia; Drainage of Aral Sea. (3, 7, 60).
71. Barbus brachycephalus caspius Berg: Caspian, Volga, Ural, Tarak, Kura, Sefidrud, Gorgan. (7, 17, 36, 41).
72. Barbus mursa Guldenstadt: Kura, Sefidrud, Araks (7, 17).
73. Barbus arabicus Trewavas: Yemen (56).
74. Barbus canis Valenciennes: Drainage of Jordon; Oronte (8).
75. Barbus subquincunciatus Gunther: Gamasiab, Gharasu, Seymarreh, Tigre, Euphrates (8, 44)
76. Barbus luteus Heckel: Gamasiab, Gharasu, Seymarreh, freshwaters of Iraw, Oronte, Aleppo, Tigre, Karun system, Shiraz (probably in drainage of Kapa-agach, with mouth on the Persian Gulf).(8, 2,44)
77. Barbus grypus Heckel: Drainage of Tigre and Euphrates, Karun, freshwaters of Iraq. (2, 8, 44).
    Barbus kotschyi. Tigre (reference not taken).
78. Barbus sharpeyi Gunther: Freshwater of Iraq, Tigre from Baghdad to the Shatt-el-Arab. (2, 8)
79. Barbus xanthopterus Heckel: Freshwater of Iraq, Tigre and Euphrates (2, 8)
80. Barbus esocinus Heckel: Freshwater of Iraq; Tigre(Mosul), Euphrates (2,8)
81. Barbus bulatmaii Grm. Caspian Sea 93)
82. Barbus tor: Freshwaters of India, Pakistan. (57,5)
83. Barbus chantrei Sauvage: Oronte, Aleppo (8).
84. Barbus barbulus Heckel: Oronte, Aleppo, drainage of Tigre, River Kara-agach. (8).
85. Barbus pectoralis Heckel: Oronte, Damascus (8)
86. Barbus continii Vinciguerra: Lake Tiberias (8)
87. Barbus kersin Heckel: Oronte, Aleppo (8)
88. Barbus longiceps Valenciennes: Jordan, Oronte, Lake Tiberias (8)
89. Barbus miliaris Filippi: Karadj River (8, 50).
    B. kossleri Derjavin: Karadj River (44, 58).
90. Barbus lorteti Sauvage: Oronte (8)
91. Barbus tauricus escherichi: Kura, Caspian. (60, 41).
    B. lacerta escherichi Steindachner: Haraz River (44).
92. Barbus rajanorum Heckel: Gharasu, Gamasiab, Seymarreh, Karun, Oronte, Aleppo, Tigre (8, 44).
    B. schejk Heckel: Rivers of Mesopotamia (57).
    B. seich (35).
93. Leucalburnus satunini Berg: Kura (7, 17)
94. Chalcalburnus chalcoides Guldenstadt: Caspian, Tarak, Kura, Ural, Volga, Sefidrud, Astarabad region, Northern Persia (7, 17, 41, 60)
    Alburnus chalcoides Guld.: Caspian (3).
95. Chalcalburnus mossulensis Heckel: Kazim, Sefidrud, Shalmanrud, Shahsavar, Sardabrud, drainage of Tigre and Euphrates, Kurdistan region of Iran (8, 44).
96. Chalcalburnus sellal Heckel: Aleppo, Oronte, Lake Tiberias (8)
97. Chalcalburnus calcalburnus derjugini: Kura River (60).
98. Alburnus sp. Rivers of Lake Urmii; Qareh Su (58).
99. Alburnus alburnus Linne: Europe, USSR Lakes and Rivers, Volga, Ural. (7, 17, 41, 55, 57, 60)
100. Alburnus doriae Filippi: Shiraz (8).
101. Alburnus doriae maculatus Keyserling: Isfahan area (8).
    A. maculatus: (8)
102. Alburnus kotschyi Stein.: Syria (8)

103. Alburnus charusini Herzenstein: Ural, Tarak (7, 17).
104. Alburnus charusini hohenackeri Kessler: Kura, Araks (7, 17)
105. Alburnus charusini hohenackeri n. persicus Petrov: Iran; Sefidrud. (7, 17).
106. Alburnus filippii Kessler: Kura, Iran, Sefidrud (7, 17).
107. Alburnus orontis Sauvage: Kazim, Sefidrud, Shahsavar, Shalmanrud, Sardabrud, Oronte (8, 44)
108. Alburnus atropatenae: Rivers of Lake Urmii (7, 58).
109. Acanthalburnus microlepis Filippi: Kura, Araks (7, 17)
110. Alburnoides bipunctatus Bloch: Tarak, Rivers of Lake Urmii (7,17, 58).
Alburnus bipunctatus Linne: Black, Caspian, Aral seas; Turkmenistan Basins, Zecavshan River (55).
111. Alburnoides bipunctatus rossicus Berg: Volga (7, 17).
112. Alburnoides bipunctatus eichwaldi Filippi: Kura, Murghab, Amu-Darya, Iran, Karadj, Harirud, Araks, Gilan and Mazanderan Rivers, Atrek, Lake Urmii Basin, Southern Slopes of the Elborz Mountains, Turkemania (7, 17, 44, 58, 20, 50)
113. Alburnoides bipunctatus fasciatus: Kura. (60).
114. Blicca bjoerkna Linne: Caspian, Volga, Ural, Tarak, Europe. (7, 17, 3, 55, 41).
115. Blicca bjoerkna transcaucasica Berg: Kura; Araks; Gilan and Mazanderan, east to Babol; (7, 17).
116. Abramis brama Linne: Caspian, Volga, Ural, Tarak, Freshwaters of Europe, Kura. (7, 17, 36, 3, 59, 37, 60).
117. Abramis brama orientalis Berg: Caspian, Volga, Ural, Tarak, Kura, Southern Caspian Rivers, Atrek. (7, 17, 41, 58).
118. Abramis sapa Pallas: Volga, Tarak, Ural, Amu-Darya, Kura (7, 17, 20, 3, 60, 41).
119. Abramis sapa bergi Belyaeff: South and Central Caspian, Araks, Kura, Sefidrud (7, 17).
120. Abramis ballerus Linne: Europe; North, Baltic, Black and Caspian Seas; Volga, Ural, Northern Caspian only (7, 17, 3, 41).
121. Abramis persa Gm.: Caspian Sea (3).
122. Vimba vimba: North, Baltic, Black and Caspian Seas; Caucasus, Sefidrud (7, 17, 44, 60).
123. Vimba vimba persa Pallas: Entire Caspian Basin, esp. Azerbaijan and Daghestan; Volga; Tarak, Kura, All southern Caspian Rivers to Babol. (7, 17, 41).
124. Vimba vimba tenella: Kura. (60).
125. Pelecus cultratus Linne: Basins of the Baltic, Black, Caspian and Aral Seas; Volga, Tarak, Ural, Kura, Amu-Darya, Middle Asia, Sefidrud (7, 17, 20, 3, 57).
126. Rhodeus sericeus Pallas Asia Minor, Europe (55).
127. Rhodeus sericeus amarus Bloch: Caspian, Kura, Rivers of Gilan and Mazanderan (7, 17).
128. Carassius carassius Linne: Europe, Volga, Ural, Tarak; not confirmed from Iran (7, 17, 37, 55).
129. Carassius auratus gibelio Bloch: Europe, Asia, Volga, Ural, Tarak; Berg (7) feels this is actually Carassius carassius, but Nikolskii (41) says it is a separate species. (7, 41, 55, 17).
130. Cyprinus carpio Linne: Worldwide; Caspian Basin; In Iran, only north of Elborz Mountains. (7, 17, 41, 55, 16, 37, 20, 36, 44, 58, 3, 60).
131. Garra tibanica Trewavas: Aden, Yemen, Hadhramaut, possibly goes into sea water near shore. (56).

132. Garra brittoni Trewavas: Yemen; over 8000 ft altitude (56)
133. Garra wanae Regan: Wana Toi, tributary of the Gomal River (20).
134. Garra phryne Annandale: Baluchistan and Hamun-i-Helmand, Quetta, Pishin, Delta of Helmand. (20)
135. Garra rufa Heckel: Gharasu, Gamasiab, Seymarreh, Lattakiya, Oronte Aleppo, drainage of Lake Tiberias, Jordan River, Perhaps the Tigre at Mosul. (8, 44).
136. Garra rufa gymnothorax Berg: Drainage of the Tigre (8).
137. Garra persica Berg: Eastern Iran, Bampur River, Kiabad in lower Khorrasan, country of Zirkuh. (8).
138. Discognathus variabilis Heckel: Oronte, Aleppo, Mosul, Rivelet at Anardareh. (8, 20).
Garra variabilis Heckel: Tigris, Euphrates systems (56).
139. Discognathichthys rossicus A. Nikolsky: Tedzhen, Murgab, Seistan, Kerman. 7, 8, 41)
Discognathus lamta Playfair (Hamilton-Buchanan): Helmand River, Kushk, Aden, Bombay district. (20, 5, 56).
140. Discognathichthys rossicus infa. nudiventris Berg: Seistan, Baluchistan, Kerman, Drainage of the Indian Ocean, Quetta and Pishin Districts, drainage of the Helmand. (7, 8)
141. Orcinus sp. Afghanistan, along Himalayas to China. (22).
142. Oreinus sinuatus: Central Asia; Kabul River (20).
143. Oreinus sinuatus var. griffithii McClelland: Headwaters of Kabul River (21).
144. Oreinus maculatus McClelland: Gandamak, Khyber Pass, Himalayas (Kabul System). (20).
145. Oreinus griffthii McClelland: Pashat, Kanar River (Kabul System). (20).
146. Schizothorax sp. : Seistan (22).
147. Schizothorax esocinus Heckel: Central Asia, Kabul River, Helmand River, Upper reaches of several Central Asian Rivers, Indus. (20, 41).
148. Schizothorax intermedius McClelland: Tarnak River, Kabul River, Amu-Darya, Turkeman, Talas Basin, Upper Helmand. (20, 21, 7, 41).
Schizothorax labiatus: Central Asia, Kabul River (20, 41).
Schizothorax ritchieana McClelland: Helmand River, Afghanistan. (20).
S. ritchianus Gunther: (8)
149. Schizothorax intermedius m. eurystomus Kessler: Helmand. (8).
Oreinus plagiostomus Heckel: Helmand at Girdun Dewar (20).
150. Schizothorax intermedius m. fedtschenko Kessler: Helmand and Kabul Rivers (8)
Racoma brevis McClelland: Helmand River (20).
Racoma labiatus McClelland: Pushat, Kunar River (Kabul System). (20).
151. Schizothorax edeniana McClelland: Koti-i-Ashraf, Mydan Valley and Sir-i-Chushinah -all in Kabul system. (20).
152. Schizothorax zarudnyi Nikolsky: Hamun-i-Helmand, Helmand system, Anardare; drainage of Lake Helmand; Kushk River; Lake Hamun-i-Farah. (8, 20).
Barbus microlepis: River at Anardareh between Herat and Lash, Hamun-i-Helmand drainage. (20).
153. Schizothorax pelzami Kessler: Hari-rud, Murghab, Shahrud in Sefidrud drainage, Harirud, Germab river near Geok-Tepe in Turkeman, Tedjan, Turkemania. (7, 8, 20, 41).
?Schizothorax raulinsii Gunther: Harirud, near Khusan; Bezd; Jam River. (8).

154. Schizothorax barbatus McClelland: Jalalabad (Kabul System). (20).
155. Schizocypris sp. Regan: Seistan.
156. Schizocypris brucei Regan: Waziristan, streams in the neighborhood of Nasratabad; Wana Toi, tirbutary of Gomal River; Central Asian form. Helmand River, Hamun-i-Helmand. (8, 20).
157. Racoma chrysochlora McClelland: At Lolpore(Kabulr System). (20,21)
158. Racoma nobilis McClelland: Kabul System (20).
159. Racoma gobiodies McClelland: Bamean River, Oxus System (20).
160. Cirrhinus burnesiana McClelland: Jalalabad, Kabul System (20)
161. Opsarus bicirratus McClelland: Jalalabad, Kyber Pass (Kabul System) (20).
162. Capoeta steindachneri Kessler: Nushk and Kushk. (20).
163. Capocta fundulus Pall. Caspian Sea (3).
164. Bungia nigrescens: Hari-rud, at Herat. This may be equivalent to Gobio gobio lepidolaemus. (20).
165. Squalius latus Hari-rud, at Herat. May be equivalent to Leuciscus latus. (20).
166. Squalius cephalus Europe and Asia Minor (37, 55).
167. Capoetobrama kuschakewitschi Kessler: Amu-Darya, Middle Asia, Aral Basin (41, 60, 20).
168. Typhlogarra widdowsoni: Blind cave fish of Iraq (36)
169. Schizopygopsis stoliczkae Steind. : Delta of Helmand; headwaters of streams and rivers of the north side of the Himalayas and Hindu Kush; upper Helmand; Seistan; Upper Amu-Darya; Indus; Brahmaputra; Several Inland Asian basins. (41, 7, 20, 8).
170. Barilius vagra H.-B.: Wana Toi, Tributary of Gomal River (20).
171. Barilius mesopotamicus Berg: Hari-rud, on the Iranian Border; tributaries of the Tigre (8)
172. Barilius christyi Boulenger: China and Japan; over southern Asia to Africa. (55).
173. Crossocheilus latius diplochilus Heckel: Kashmir, Punjab, Sind, Baluchistan, Sarbaz River. (8).
    C. barbatulus Heckel: Wana Toi, Tributary of the Gomal River; Kashmir. (20).
174. Aspiolucius esocinus Kessler: Upper Amu-Darya, Syr-Darya, Middle Asia. (20, 60, 41).
    Aspidoluceus esocinus.
175. Xenocypris macrolepidotus Heckel: Gharasu, Gamasiab, Seymarreh (44)
176. Varcertinas gracilis: Sefid Rud (1)
177. Barbeau sp. Sefid Rud (1)
178. Parahodeus libani Lortet: Lebanon (8).
179. Parahodeus libani syriacus Lortet: Syria, Damascus area (8)
180. Parahodeus libani drussensis Pellegrin: Southern Syria (8).
181. Parahodeus kervillee Pellegrin: Oronte (8).
182. Tylognathus diplostomus Heckel: Assam, Kashmir, Sind, Vindar River in Baluchistan. (8)
183. Hemigrammocapoeta sauvagei Lortet: Lake Tiberius (8)
184. Cyprinion macrostomum Heckel: Syria -Antioch, Oronte, Aleppo; Tigre drainage (8)
185. Cyprinion tenuiradius Heckel: Tigre, Karun, Kara-Agach River; Lake Neriz near Shiraz (8)
186. Cyprinion watsoni Day: Sind, and Colyanoi in Punjab Range (8).
187. Cyprinion watsoni belense Zugmayer: Southeat Baluchistan; Southeast Iran, in drainage of Indian Ocean (8).

188. Cyprinion irregulare Day: Sind, Quetta, Southeast Iran, drainage of Indus at Vaziristan and Solyanom. (8).
Scaphiodon irregularis Day: Wana Toi, tributary of the Gomal River. (20).

189. Cyprinion microphthalmum Day: Baluchistan and Yozhn; Iranian drainage of Indian Ocean; East Arabia (Muscat); Delta of the Helmand River. (8).
Cirrhina afghana Gunther: Nushk and Kushk; common in India (20)
Scaphiodon macmohoni Regan: Delta of Helmand (20).

190. Cyprinion microphthalmum infra. nikolskii Berg: Yozhn; Iran; Bampur River drainage; Southwest Baluchistan (Gvadar): slopes of Quetta. (8).

191. Cyprinion milesi Day: Southern Iran and Baluchistan in rivers of the Indian Ocean drainage: Bampur; Gvadar; Dasht; Quetta; Pandjgur. (8).

192. Aspidoparia morar Hamilton-Buchanan: Southern Iran; Baluchistan; Sind; Punjab; Assam; Burma; India; Bombay. (8, 5).

193. Acanthobrama marmid Heckel: Aleppo; Mosul; Euphrates; Tigre (8)

194. Acanthobrama marmid orontis Berg: Lake Antioch; drainage Oronte. (8).

195. Labeo bicolor Smith. Africa, South and Southeast Asia. (55).

Fam. Cobitidae -loaches.

1. Nemachilus sp. van Hass: Area of the Helmand and Hari-rud basins, lakes and rivers. Middle Asia. (22, 60).
2. Nemachilus barbatulus Linne: Volga, Ural. (17)
Neomacheilus barbatulus Linne: Europe, Siberia, Korea. (41).
3. Nemachilus barbatulus caucasicus Berg: Tarak. (7, 17)
4. Nemachilus merga Krynicki: Iran, Terek, perhaps Kura. (7, 17)
5. Nemachilus angorae Steindachner: Araks, perhaps Kura and drainage of Lake Urmii (7, 17).
6. Nemachilus bergianus Derjavin: Iran, Sefid Rud (7, 17).
7. Nemachilus brandti Kessler: Kura, Karadj River, Rivers of Lake Urmii Araks. (7, 17, 44, 58)
8. Nemachilus tigris: Oronte, Damascus, Tripoli (River Kadisha), Aleppo drainage of the Tigre (8)
9. Nemachilus tigris cyri Berg: Kura (7, 17)
10. Nemachilus malapterurus Valenciennes: Atrek, Hari-rud, Murghab, Karadj River, between Sindjan and Qasvin, Southwest Iran, Sindjan River in drainage of the Kiosiol-usen River, Sefid-Rud, Helmand, "Syria", Abkhar River, South Caspian River, Rivers of landlocked lakes of Iran. (7, 8, 17, 20, 44, 58)
Adiposia macmahoni Chaud.: Delta of Helmand, streams near Nashratabad. (20).
11. Nemachilus malapterurus longicauda Kessler: Amu-Darya, Tedjan, Murgab. (7, 20).
12. Nemachilus oxianus Kessler: Upper Amu-Darya. (20, 41)
13. Nemachilus amudarjensis Rass: Upper Amu-Darya (20)
14. Nemachilus stoliczkae Steind. Upper Amu-Darya, upper Helmand (20,7)
15. Nemachilus stoliczkai var. tenuis Day: Pamirs, Seistan. (7).
16. Nemachilus kessleri Gunther: Nushk, Northern Baluchistan, Eastern Iran, Kurshk River in drainage of Murghab. (8, 20)
17. Nemachilus lendli Hanko: Basin Sakarya River in Asia Minor (7)
18. Nemachilus cristatus Berg: Rivers flowing down Kopet-Dagh, east almost to Tedjan. (7).
19. Nemachilus farwelli Hora: Helmand River (21).
20. Nemachilus tenuis Day: Kushk, Riu-i-Seistan, Oxus River System (20)

21. Nemachilus sargadensis A. Nikolsky: Southeastern Iran; Western slope of Kopet-Dagha to Gyaurse (Ashabada). (8)
22. Nemachilus rhadinaeus Regan: Delta of Helmand (8)
    Adiposia rhadinaea Regan: Delta of Helmand. (20)
23. Nemachilus montanus McClelland: Simla, Northern Baluchistan (Punjab Bampur River. (8)
24. Cobitis aurata Filippi: Kura, Hari-rud, Murghab, Araks, Sefid-rud, Tedjan. (17, 20, 7)
    Sabanejeqia aurata: Karasouh (Qareh Su) near Ardebil (58)
25. Cobitis taenia Linne: Volga, Ural, Kura, Europe, Asia, North America, Araks, Gilan, Mazanderan, Asia Minor (7, 17, 55, 41)
26. Cobitis caucasica Berg: Tarak. (7, 17)
27. Cobitis caspia Eichwald: Ural, Kura, Basin of South Caspian, Araks, Lower reaches of Babol River (7, 17, 3)
28. Misgurnus fossilis Linne: Volga, Europe. (7, 17)
29. Botia lohachata Chaudhuri: Pakistan (55)

Suborder Siluroidei

Fam. Ariidae -sea catfishes.
1. Tachysurus thalassinus: Persian Gulf. (19)
   Arius thalassinus: (9)
2. Arius sona Ham.-Buch.: Bombay. (5)

Fam. Plotosidae -eelputs, plotosid sea catfishes.
1. Plotosus anguillaris: Muscat, Persian Gulf (9, 19)
2. Plotosus arab Forsk.: Bombay. (5, 53)

Fam. Siluridae -Eurasian catfishes
1. Silurus sp. (1)
2. Silurus glanis Linne: Caspian, Volga, Ural, Tarak, Kura, Upper Amu-Darya, Sefidrud, Middle Asian waters, Europe, Western Asia, Basin of Lake Urmii, Gorgan, Atrek, Black Sea, Sea of Azov (7, 16, 20, 44, 58, 3, 60, 57, 55, 41, 16)
3. Silurus indicus McClelland: "Loodianah, the Punjab and the Cabool River at Jalalabad." (20)
4. Callichrous pabda Ham.-Buch.: Wana Toi, Tributary of Gomal River (20
5. Parasilurus sp. Southern Asia, Balkan Peninsula (41)
6. Parasilurus triostegus Heckel: Tigris, perhaps Euphrates (8)
7. Wallago attu Bloch and Schneider: Eastern Baluchistan (R. Lora near Quetta): India, Ceylon, Burma, Siam, Sumatra, Java. (8)

Fam. Pimelodidae -pimelodid catfish.
1. Pimelodus anisurus McClelland: "Loodianah and Cabool Rivers at Jalalabad." (20)

Fam. Bagridae -Bagrid catfishes
1. Macropes halepensis Cuvier-Valenciennes: Aleppo, Oronte (8)
2. Mystus colvitti Gunther: Gharasu, Gamasiab, Seymarreh (44)

Fam. Sisoridae.
1. Glyptosternum sp. McClelland: Helmand and Hari-rud basins (22)
2. Glyptosternum reticulatum McClelland: Indus, Amu-Darya, Syr-Darya, Sir-i-chushmah, Kabul, Oxus System (20, 22, 60, 7, 21)
3. Glyptosternum maculatum Regan: Eastern Tibet (22)
4. Glyptothorax kurdistanicus Berg: Drainage of Tigris (8)
5. Glyptothorax steindachneri Pietschmann: Tigris at Mosul (8)
6. Glyptothorax armeniacus Berg: Euphrate? or Araks? (7, 8)

Fam. Clariidae.
1. Clarias sp. Common in Africa and Asia. (36)
2. Clarias lazera Peters: Syria, Nile, Senegal to Nigera (55)

Order Anguilliformes
Fam. Anguillidae -freshwater eels.
1. Anguilla anguilla Linne: Europe, North Africa, Red Sea, Indian Ocean, introduced into Volga (7, 17, 19, 41)
2. Anguilla mauritiana Red Sea (19)

Fam. Muraenidae -morays
1. Gymnothorax javanicus Indo-pacific (36)
2. Gymnothorax meleagris Indo-Pacific, Red Sea (32, 19) La Seca
3. Gymnothorax undulatus Polynesia and Africa; Muscat (32, 19) —
4. Gymnothorax picta Indo-Pacific (32)
5. Gymnothorax rupelii Red Sea (19)
6. Gymnothorax geometricus Red Sea (19)
7. Gymnothorax nudivomer RedSea (19)
8. Gymnothorax nubilus Red Sea (19)
9. Gymnothorax richardsonii Red Sea (19)
10. Gymnothorax pseudothyrsoideus Muscat (19)
Muraena pseudothyrsoidea Blkr.: Muscat (48) —
11. Gymnothorax favagineus Red Sea (19)
12. Gymnothorax hepaticus Red Sea (19)
13. Gymnothorax afer (19)
14. Gymnothorax corallinus Red Sea (19)
15. Echidna nebulosa Indo-Pacific, Red Sea 919, 32)
16. Echidna polyzona Red Sea (19)
17. Siderea picta Red Sea (19)
18. Uropterygius concolor Red Sea (19)
19. Uropterygius tigrinus Red Sea (19)
20. Arudha zebra Muscat (19)

Fam. Muraenesocidae -pike eels.
1. Muroenesox arabicus: Muscat (19)
Muraenesox cinereus: Persian Gulf (9) X
2. Muroenesox talabon: Red Sea, Bombay (19, 53)
3. Muraenesox talabonoides: Off Bombay (5, 53)
4. Muraena tessalata: Bombay (53)
5. Muraena undulata: Bombay (53)

Fam. Congridae -conger eels.
1. Conger cinereus: Red Sea (19)
2. Bathycongrus mystax: Red Sea (19)
3. Ariosoma anago: Red Sea (19)
4. Uroconger lepturus: Gulf of Oman (19, 5, 48) Persian X
5. Conger conger Linne: Indian Ocean (41)

Fam. Neenchelyidae.
1. Neenchelys microtretus: Red Sea (19)

Fam. Echelidae.
1. Muraenichthys gymnotus: Red Sea (19)
2. Muraenichthys schultzii: Persian Gulf (9, 19) X

Fam. Opichthidae -snake eels.
1. Myrichthys maculosus Red Sea (19)
2. Chlevastes colubrinus: Red Sea (19)
3. Callechelys melaotaenia: Red Sea (19)
4. Pisodonophis cancrivorus: Muscat (19)
5. Pisodonophis hoevenii: Red Sea, Persian Gulf (9, 19) X
6. Ophichthus kirkii: Red Sea (19)
7. Brachysomophis crocodilinus Red Sea: (19)
8. Brachysomophis cirrhocheilos: Muscat (19)
9. Cirrhimuraena playfairii: Red Sea (19)

Order Halosauriformes
Fam. Halosauridae -halosaurid eels.
1. Halosaurus parvipennis: Red Sea (19)

Order Notacanthiformes
Fam. Notacanthidae -spiney eels
1. Notacanthus indicus: Red Sea (19)

Order Beloniformes
Fam. Belonidae -needlenoses
1. Belone sp. Probably annulata, choram or melanstigma: from Jask (33)
2. Belone platyura: Red Sea (19)
3. Strongylura leiura: Persian Gulf (19)
   Tylosurus leiurus: (9) +
4. Strongylura strongylura: Persian Gulf (19)
   Tylosurus strongylurus (9) +
   Bellone strongylurus: Bombay (54)
5. Strongylura crocodila: Muscat (19)
6. Strongylura koseirensis: Red Sea (19)
7. Strongylura robusta: Red Sea (19)
8. Strongylura appendiculata: Muscat (19)
9. Ablennes hians: Muscat (19)
   A. hians hians Valenciennes: Circumtropical (12)
10. Xenetodon cancila Ham.-Buch.: All of India, Ceylon, Burma, Thailand and Malay Peninsula (55)

Fam. Scomeresocidae -sauries
1. Scomberesox saurus: Mediterranean, Black, and Red Seas; Atlantic Ocean (19, 41).

Fam. Hemiramphidae -halfbeaks.
1. Euleptorhamphus viridis: Indo-Pacific (36)
2. Farhians far: Muscat (19)
   Hemirhamphus far: Persian Gulf (34)
3. Hemirhamphus marginatus: Persian Gulf (9, 19)
4. Hemirhamphus sindensis Regan: Karachi (48)
5. Hyporhamphus gaimardi: Persian Gulf (19)
   Hemirhamphus gaimardi: Persian Gulf (9)
6. Hyporhamphus gambarur: Iran (19)
7. Hyporhamphus xanthopterus: Muscat (19)
8. Hyporhamphus unifasciatus: Red Sea (19)
9. Rhyndhorhamphus georgii: Persian Gulf (19)
   Hemirhamphus georgii: Jask (9, 34)

Fam. Exocoetidae -flying fish.
1. Parexocoetus brachypterus: Oman. (19)
   Parexocoetus mento: Persian Gulf (9)
   Exocetus mento Cuv. & Val.: Persian Gulf (5)
2. Exocoetus volitans: Muscat (19)
3. Exocetus poeciloptérus Cuv.& Val.: Persian Gulf (5)
4. Cypsilurus cyanopterus: Red Sea (19)
5. Hirundichthys affinis: Red Sea (19)
6. Hirundichthys socotranus: Red Sea (19)
7. Hirundichthys oligolepis: Muscat (19)
   Cypsilurus oligolepsis: Persian Gulf (9)

Order Gadiformes
Fam. Gadidae -codfishes and hake.
1. Lota lota Linne: Europe, Northern Asia, Norther Caspian, USSR Rivers, Sefid-rud. Iran and Kura River reports uncertain. (7, 17, 57, 41).
2. Physiculus roseus: Red Sea (19)
3. Physiculus argyropastus: Oman (19, 11, 48)
4. Merluccius merluccius: Red Sea (19)
5. Bergmaceros moclellandii Thomps.: Oman, Bombay (19, 5)

Fam. Macrouridae -grenadiers, rat-tails.
1. Bathygadus furvescens: Red Sea (19)
2. Gadomus multifilis: Red Sea (19)
3. Odontomacrurus murrayi: Red Sea (19)
4. Coryphaenoides lophotes: Red Sea (19)
5. Hymenocephalus heterolepis: Red Sea (19)

Order Gasterosteiformes
Suborder Gasterosteoidei
Fam. Gasterosteidae -sticlebacks.
1. Pungitius platygaster: Black and Aral Seas; Volga, Ural, Caspian Sea and mouth of its rivers. (7, 17, 41, 3)
   Gasterosteus platygaster Kessler: Caspian.
2. Gasterosteus aculeatus: Black Sea, China, Japan, Europe, North Africa, Northern Asia, North America, apparently absent from Caspian Basin. (37, 17, 41, 55)

Suborder Syngnathoidei
Fam. Centriscidae -shrimpfishes.
1. Aeoliscus strigatus: Muscat (19)
   Amphisile strigata Gunther: Muscat, Persian Gulf (48)
2. Aeoliscus punctulatus Red Sea (19)
3. Centriscus acutatus: Muscat, Persian Gulf (9, 19)

Fam. Fistulariidae -cornetfishes.
1. Fistularia sp. Several species in Indo-Pacific (37)
2. Fistularia villosa: Persian Gulf (9, 19)
3. Fistularia petimba: Muscat (19)

Fam. Syngnathidae -seahorses and pipefishes.
1. Syngnathus nigrolineatus caspius Eichwald: Volga, Ural, Kura, perhaps the Tarak, Gilan, Mazanderan, throughout the Caspian (7, 17, 3, 59).
2. Syngnathus analicarcus: Persian Gulf (19)
3. Syngnathus abaster: Red Sea (19)
4. Syngnathus agassiz: Red Sea (19)
5. Syngnathus algeriensis: Red Sea (19)
6. Syngnathus spicifer Rupp: Red Sea, Bombay (19, 5)

7. Syngnathus macrophthalmus: Red Sea (19)
8. Syngnathoides biaculeatus: (19)
   Gastrotocus biaculeatus Bloch: Aden (5)
9. Doryhrhamphus excisus: Red Sea (19)
10. Gorythoichthys flavofasciatus: Red Sea (19)
11. Micrognathus brevirostris: Red Sea (19)
12. Halicampus koilomatodon: Red Sea (19)
13. Halicampoides macrorhynchus: Red Sea (19)
14. Acentronura tentaculata: Red Sea (19)
15. Hippocampus kuda: Red Sea (19)
16. Hippocampus hippocampus: Red Sea (19)
17. Hippocampus fuscus: Red Sea (19)
18. Hippocampus histrix: Red Sea (19)
   Hippocampus hystrix Kaup: (5)
19. Hippocampus jayakari: Muscat (19)
20. Hippocampus lichtensteinii: Red Sea (19)
21. Solenostomatichthys paradoxus: Red Sea (19)
22. Microphis brachyurus Bleeker: Widely distributed along coasts of southern Asia, in freshwater. (55).

Order Cyprinodontiformes
Suborder Cyprinodontoidei
Fam. Cyprinodontidae -killifishes.
1. Aphanius dispar Ruppell: Freshwater and marine areas of the Red Sea and Persian Gulf; Muscat, Abyssinia, Palestine, Southern Arabia, Kutch. (56, 15, 19, 9, 55).
   Cyprinodon dispar.
   Lebias dispar
2. Aphanius dispar richardsoni Boulenger: Syria, Palestine, Basra (8)
3. Aphanius dispar stoliczkanus Day: Halion Somali; Southern Iran (Bampur, Bandar Abbas), Kach. (8).
4. Aphanius mento Heckel: Tigris (Basra, Mosul, Baghdad); Oronte; Jordan, Damascus; Southern Asia Minor (Likaoniya, Adanio); Syria; Peria. (8, 55).
5. Aphanius sophiae Heckel: Persepolis; Lake Niriz Basin; Albustan, drainage of River Djihan; between Iosgadom and Kaisapie, drainage of the River Kizid-irmak in Asia Minor; Damascus; Palestine, Karun River in area of Shustera; Basra; Bandar Abbas; Syria, Iran. (7,8)

Fam. Poecilidae -livebearers.
1. Gambusia affinis affinis Gairdet Girard: Caspian, Volga, Ural, Tarak Kura, Iran. (17, 41).
2. Gambusia affinis holbrooki Girard: Caspian, Volga, Ural, Tarak, Kura, Iran. (17, 41). This and previous species introduced into Caspian Basin for mosquito control.

Order Beryciformes
Fam. Dirgtmidae
1. Diretmus argenteus: Red Sea (19)

Fam. Holocentridae -squirrelfishes and soldierfishes.
1. Myripristis murdjan: Muscat (19)
2. Beanea trivittata: Red Sea (19)
3. Holocentrus oscensionis: All warm seas, around coral (32)
4. Holocentrus spinifer: Red Sea (19)
5. Holocentrus ruber: Muscat (19)

6. Holocentrus caudimaculatus: Red Sea (19)
7. Holocentrus diadema Lacep: Red Sea; Bombay (19, 5)
8. Holocentrus lacteoguttata: Red Sea (19)
9. Flammee sammara: Red Sea (19)

Fam. Trachichthyidae.
1. Hoplostethus mediterraneus: Red Sea (19)

Fam. Melamphidae -deepsea bigscale fishes.
1. Melamphaes robusta: Red Sea (19)
2. Melamphaes megalops: Red Sea (19)
3. Melamphaes mizolepis Gunther: Red Sea (19, 12)

Order Ophicephaliformes.
Fam. Ophicephalidae -snakeheads
1. Ophicephalus montanus McClelland: "Baisoot, Jalalabad, Himalya and Sadoo"(Kabul system). (20)
2. Ophiocephalus gachua Ham.-Buch.: Indo-Malaya India and Indo-China, drainage of the Indus, Afghanistan, Ceylon, Andamanskie o-va, Baluchistan, and to the Bampur River in the west. (8, 5)
3. Channa asiatica Linne: Southern Asia (55)
4. Ophicephalus marulius Ham.-Buch.: India to China (55)
5. Ophicephalus striatus Bloch: India, Southoast Asia (55)

Order Synbranchiformes
Fam. Synbranchidae -swamp eels.
1. Amphipnous cuchia Ham.-Buch.: India, all along the north, including the Punjab. (55)

Order Perciformes.
Suborder Percoidei
Fam. Theraponidae -tigerfishes.
1. Therapon puta Persian Gulf (9)
2. Therapon theraps: Persian Gulf, Bombay (9, 5, 54)
3. Therapon jarbua: East Africa to Northern Australia, Bombay, Persian Gulf; will enter rivers a short way. (9, 55, 18)
4. Pelates quadrilineatus: Persian Gulf, Bombay (9, 54).

Fam. Centropomidae -snooks, glassfishes.
1. Chanda commersoni Cuv. & Val.: Red Sea; East coast of Africa to Northern Australia. (55)
2. Chanda nama Ham.-Buch.: India and Burma (55)
3. Chanda ranga Ham.-Buch.: India, Burma, Thailand, (55)

Fam. Serranidae -sea basses, groupers.
1. Plectropomus leopardus: Indo-Pacific (36)
2. Plectropomus truncatus: Indo-Pacific (36)
3. Cephalophis argus: Indo-Pacific (32).
   Epinephelus argus Bl. Aschn.: Persian Gulf (48)
4. Promicrops lanceolatus: India (57).
   Serranus lanceolatus Bloch: Bombay (5)
5. Epinephelus mara: Indo-Pacific (36)
   E. merra Bl.: Persian Gulf, Muscat (48)
6. Epinephelus areolatus: Persian Gulf, Jask (9, 33)
7. Epinephelus chlorostigma: Persian Gulf (9, 48)
8. Epinephelus taurina: Persian Gulf (9)
   E. tauvina Forks.: Persian Gulf (48)

9. Epinephelus praeopercularis Blgr.: Gulf of Oman (11, 48)
10. Epinephelus undulosus Q.G.: Sea of Oman: (48)
11. Epinephelus fuscoguttatus Forsk.: Persian Gulf (48)
12. Serranus stoliczkae: Jask (33)
13. Serranus miniatus: Jask (33,34)
14. Anthias townsendi Blgr.: Persian Gulf (48)
15. Anthias hypselosoma Blkr.: Persian Gulf (48)

Fam. Lobotidae -tripletails
1. Lobotes surinamensis: Atlantic, Pacific, Indian Oceans: Bombay (37, 5)

Fam. Leiognathidae -slipmouths.
1. Leiognathus insidiator: Persian Gulf (9)
   Equala insidiatrix Bloch: Bombay (5)
2. Leiognathus equulus: Persian Gulf (9)
3. Leiognathus daurus: Persian Gulf. (9)
   Equala nuchalis Schleg.: (48)
   Equala daura Cuv.: Bombay, Mekran Coast, Karachi (5, 48)
4. Leiognathus bindus: Persian Gulf (9)
5. Leiognathus lineolatus: Persian Gulf (9)
6. Equala blochii Cuv.&Val.: Bombay (5)
7. Equala edentula Bloch: Bombay (5)
8. Equala rivulata Shaw: Muscat (48)

Fam. Lutjanidae -snappers.
1. Lutjanus gibber: Indo-Pacific, Persian Gulf (36)
   L. gibbus:Bombay (9, 53)
2. Lutjanus ehrenbergi: Persian Gulf (9)
3. Lutjanus johnii: Persian Gulf, Bombay (9, 18, 5, 53)
4. Lutjanus lineolatus: Persian Gulf, Bombay (9, 5, 53, 54)
5. Lutjanus coccoineus: Persian Gulf (9)
6. Lutjanus sanguineus: Persian Gulf (9)
7. Lutjanus janthinuropterus: Persian Gulf (9)
8. Lutjanus fulviflamma: Persian Gulf, Jask (9, 33, 34)
9. Lutjanus russelli: Persian Gulf (9)
10. Lutjanus microlepsis: Persian Gulf (9)
11. Lutjanus argentimaculatus: Jask, Bombay (33, 53)
12. Lutjanus roseus: Jask, Bombay (33, 34, 53)
13. Lutjanus kasmira: Bombay (53)
14. Lutjanus rivulatus: Bombay (53)
15. Lutjanus annularis: Bombay (53)
16. Mesoprion annularis Cuv.&Val.: Persian Gulf (48)
17. Mesoprion erythropterus Bl.: Persian Gulf (48)
18. Genyorage bengalensis Bl.: Muscat (48)

Fam. Priacanthidae -bigeyes.
1. Priacanthus cruentatus Lacepede: Circumtropical, East Pacific, East Africa (32, 12)
2. Priacanthus tayenus: Persian Gulf (9)

Fam. Apogonidae -cardinalfishes.
1. Apogon quadrifasciatus Val. Persian Gulf (48)
2. Apogon bifasciatus Rupp.: Persian Gulf (48)
3. Apogon nigripinnis Cuv.&Val.: Persian Gulf (48)
4. Apogon novemfasciata: Indo-Pacific (32)
5. Apogon erdmani Lachner: Red Sea (30)
6. Apogon bandanensis Bleeker: West Pacific, Indo-Pacific (30)

7. Apogon savayensis Gunther: West Pacific, Indo-Pacific (30).
8. Apogon nubilus Garman: Pacific, Indo-Pacific, Red Sea (30)
9. Apogon lineolatus: Persian Gulf (9)
10. Apogon fraenatus: Persian Gulf, Bombay (9, 5)
11. Apogon thurstoni: Persian Gulf, Muscat (9, 48)
12. Apogon holotaenia Regan: Muscat (48)
13. Apogon endekataenia Blkr.: Muscat (48)
14. Apogon fasciatus White: Muscat (48)
15. Apogon balinensis Blkr.: Muscat (48)
16. Apogon melanotaenia Regan: Chahbahar, Mekran, Karachi, Nicobar and Zanzibar. (48)
17. Apogon spilurus Regan: Karachi (48)
18. Apogon gracilis Blkr.: Karachi (48)
19. Apogon notatus: Karachi (48)
20. Apogonichthys nudus Regan: Karachi (48)
21. Synagrops philippinensis Regan: Gulf of Oman (48)
22. Paramia bipunctata Lachner: Ras Tanura in Persian Gulf (30)
23. Paramia quinquelineta Cuv.&Val.: Western Pacific, Indo-Pacific (30)
24. Archamia dispilus Lachner: Formosa and Philippines; Indo-Pacific (30).
25. Archamia biguttata Lachner: West Pacific; Indo-Pacific (30).
26. Archamia lineolata Cuv.&Val.: Indo-Pacific, Red Sea (30).
27. Archamia fucata Cantor: West Pacific, Indo-Pacific (30).

Fam. Percidae -perches, walleyes and darters.

1. Lucioperca lucioperca Linne: Basins of Baltic, Black and Caspian Seas; Elba River; Volga; Ural; Tarak; Kura; USSR lakes and rivers; Sefid-Rud; Atrek; Iranian rivers. (55, 41, 17, 58, 59, 60, 57,7,16)
2. Lucioperca volgensis Gmelin: Volga, Ural; Black, Caspian Seas; Sea of Azov. (7, 17, 41, 3, 59).
3. Lucioperca marina Cuvier: Caspian and Black Seas (7, 17, 41)
4. Lucioperca margina Cuvier: Caspian (3)
5. Lucioperca sandra Cuvier: Caspian Sea (3)
6. Acerina cernua Linne: Europe, Southern Soviet Seas, Ural, Northern Caspian, perhaps the Tarak. (7, 17, 41).
7. Perca fluviatilis Cuvier: Europe and Northern Asia; Black, Caspian and Aral Seas; USSR lakes and river; Tarak, Volga, Ural, Kura; Iran; Sefid-rud. (7, 17, 41, 37, 57, 69)

Fam. Sillaginidae

1. Sillago sihama Forsk.: Persian Gulf; Bombay (9, 5, 54)

Fam. Lactariidae.

1. Lactarius lactarius: Persian Gulf (9)

Fam. Pomatomidae -bluefishes.

1. Pomatomus nobilis: Warmer seas of Atlantic and Incian Oceans (32)
2. Pomatomus saltatrix Linne: All warm seas; Atlantic and Indian Oceans. (41, 57, 12).

Fam. Rachycentridae -cobias, sergeant fishes.

1. Rachycentra canadum Linne: All warm seas (37, 12)

Fam. Carangidae -jacks, scads, pompanos.

1. Caranx melampygus: East Pacific; Indo-Pacific to East Africa (32,37
2. Caranx nigripinnis Day: Persian Gulf, Jask, Bombay (40, 33, 54)
3. Caranx djedaba Persian Gulf (9, 18)
   C. djedaba Forsk.: Bombay (5).

4. Caranx kalla; Persian Gulf (9, 18)
5. Caranx auroguttatus Persian Gulf (9)
6. Caranx armattus: Persian Gulf(9, 33, 34)
   C. armatus Forsk.: Bombay (5)
7. Caranx malabricus Bl. Schn.: Persian Gulf, Jask (9, 5, 33)
   Carangoides malabricus Schneider. (18)
8. Caranx chrysophrys: Persian Gulf (9)
9. Caranx leptolepsis: Persian Gulf (9)
10. Caranx jarra: Jask (33)
11. Caranx gallus: Jask (33)
12. Caranx carangus?: Persian Gulf (33)
13. Caranx sexfasciatus: Indo-Pacific (37)
14. Caranx lugubris Poey: Worldwide in tropics (37, 12)
15. Caranx hippos Linne: All tropical and subtropical seas (12, 37)
   C. ignobilis: Indo-Pacific
   C. sansun: Indo-Pacific.
16. Alectis ciliaris: Indo-Pacific. (32, 37)
   Caranx ciliaris: Persian Gulf, Jask (33, 34)
17. Alectis indica: Persian Gulf (9)
18. Gnathanodon speciosus: Tropics, East Africa, East Pacific, Indo-Pacific (32, 37)
   Caranx speciosus: Persian Gulf, Jask (9,33)
19. Decapterus russeli: Persian Gulf; off Fao, Iraq. (2, 9)
   Trachynotus russelli: Bombay (54)
20. Atropus atropus Persian Gulf (9)
   Caranx atropus Bl. Schn.: Bombay (5)
21. Megalopsis cordyla: Persian Gulf (9)
22. Chorinemus sp.: Indo-Pacific (37)
23. Chorinemus lysan Forsk.: Persian Gulf, Jask, Bombay (5, 9, 33)
24. Chorinemus sancti-petri: Persian Gulf, Jask (9, 33)
25. Chorinemus moadetta: Jask (33)
26. Trachinotus kennedyi: (37)
27. Trachinotus baillonii: Persian Gulf (9)
28. Naucrates ductor Linne: All tropical and subtropical seas; Persian Gulf (9, 37, 41, 12)
29. Tlagatis bipinnulatus Quoy & Gaimard: All tropical marine waters. (37, 12)
30. Selar crumenophthalmus Bloch: All tropical and subtropical seas. (12, 37)
   Caranx caumenephthalmus: Persian Gulf (9)

Fam. Menidae.
1. Mene maculata: Persian Gulf (9)

Fam. Coryphaenidae -dolphins.
1. Coryphaena hippurus Linne: Cosmopolitan in all tropical and subtropical seas (12, 32, 37, 57)

Fam. Gerridae -mojarras.
1. Gerres argyreus: Indo-Pacific (36)
2. Gerres ovena: Persian Gulf, Bombay (5, 9)
3. Gerres punctatus: Persian Gulf (9)
4. Pentaprion longimanus: Persian Gulf (9)
5. Choerodon robustus: Persian Gulf (9)

Fam. Pomadasyidae -grunts.

1. Caesio coerolaures: Western Indian Ocean; Seychelles (45)
2. Scolopsis personatus: Persian Gulf (9)
3. Scolopsis ghanam Forsk.: Persian Gulf (48)
4. Plectorhynchus cinctus: Persian Gulf (9)
5. Plectorhynchus schotaf: Persian Gulf (9)
6. Plectorhynchus pictus: Persian Gulf (9)
   Diagramma pictum Thunb.: (48)
7. Pomadasys stridens: Persian Gulf (9)
   Pristipoma stridens Forsk.: (48)
8. Pomadasys maculatus: Persian Gulf (9, 18)
   Pristipoma maculatum Day: Bombay (53)
9. Pomadasys argentea: Persian Gulf (9)
10. Parascolopsis townsendi Boulenger: Gulf of Oman (11, 48)

Fam. Scianidae -drums, croakers.

1. Cynoscion nobilis: Warm seas (32)
2. Otolithes ruber Schneider: Persian Gulf (9, 18)
3. Pseudosciaena aneus: Persian Gulf (9)
4. Pseudosciaena axillaris: Persian Gulf (9)
5. Pseudosciaena bleekeri: Persian Gulf (9)
6. Pseudosciaena diacanthus Persian Gulf (9)
   Sciaena diacanthus: Bombay, Karachi (53)
7. Johnius maculatus: Persian Gulf (9)
   Sciaena maculata Bl. Schn.: Bombay (5)
8. Sciaena dussumieri Valenciennes: Persian Gulf (9, 18)
9. Sciaenoides brunneus: Off Bombay, but not Sind Coast (53)

Fam. Mullidae -goatfishes and surfmullets.

1. Upeneus sp. (36) Also spelled Hypeneus.
2. Upeneus vittatus: Persian Gulf (9)
   Upeneoides vittatus Forsk.: Ceylon (5)
3. Upeneus tragula:Persian Gulf (9)
4. Upeneus indicus Shaw: Persian Gulf (48)
5. Mulloidichthys gariflamma: Persian Gulf (9)

Fam. Monodactylidae -fingerfishes.

1. Monodactylus argenteus Linne: Malay Archipelago to East Africa; common in Red Sea (55)

Fam. Sparidae -porgies, sea breams.

1. Sparus cuvieri: Persian Gulf (9, 15)
2. Sparus datnia: Persian Gulf; off Fao, Iraq (2, 9)
   Chrysophrys datnia: Off Bombay (54)
3. Sparus spinifer Forskal: Persian Gulf (9, 18)
   Pagrus spinifer Forsk.: Jask, Off Bombay (33, 34, 53)
4. Sparus bifasciatus: Persian Gulf (9)
   Chrysophrys bifasciata Forsk.: Bombay (5)
5. Sparus noct: Persian Gulf (9)
6. Chrysophrys haffara: Jask (33, 34)

Fam. Nemipteridae.

1. Nemipterus tolu: Persian Gulf (9)
2. Nemipterus japonicus: Persian Gulf (9)

Fam. Toxotidae -archerfishes.

1. Toxotes chatareus Ham.-Buch.: India, east through Australia (55)
2. Toxotes jaculator Pallas: All southern and southeaster Asia (55)

Fam. Pempheridae -sweepers.
1. Pempheris oualensis: Indo-Pacific (36)

Fam. Ephippidae -spadefishes.
1. Chaetodipterus sp. Indo-Pacific (32)
2. Ephippus orbis: Persian Gulf, Bombay (9, 53)

Fam. Drepanidae.
1. Drepane punctata Gmelin: Persian Gulf, Bombay, Jask (5,9,33,34,48, 18, 53).
2. Holocanthus xanthurus: Persian Gulf, Jask (5, 33, 34)

Fam. Kyphosidae -sea chubs
1. Kyphosus cinerascens: Indo-Pacific (36)

Fam. Girellidae -nibblers
1. Crenidens crenidens: Persian Gulf (9)

Fam. Scatophagidae -scats.
1. Scatophagus argus: Indo-Pacific, Persian Gulf, Bombay (5, 9, 54, 55)
2. Scatophagus tetracanthus Lacepede: North Australia, New Guinea, East Africa (55).

Fam. Chaetodontidae -butterfly fishes
1. Chaetodon auriga Forsk.: Indo-Pacific, India (5, 32, 36)
2. Chaetodon trifasciata Mugo Park: Indo-Pacific to Africa, India (5,32
3. Chaetodon ephippium: Indo-Pacific (36)
4. Chaetodon flavissimus: Indo-Pacific (36)
5. Chaetodon lunula: Indo-Pacific to Africa (32)
6. Chaetodon vagabundus: Indo-Pacific to Africa (32)
7. Chaetodon obscurus Persian Gulf (9)
8. Monotaxis grandoculis: Indo-Pacific (36)
9. Megaprotodon strigangulus: Indo-Pacific (36)
10. Forcipiger longirostris: Hawaii, East Africa, Red Sea (32)
11. Heniochus acuminatus: Indo-Pacific, Persian Gulf (9, 32)
12. Heniochus macrolepidotus Linne: Persian Gulf (48)
13. Pomacanthus maculosus: Persian Gulf (9)

Fam. Lethrinidae.
1. Lethrinus miniatus: Persian Gulf (9)
2. Lethrinus nebulosus: Persian Gulf (9)
3. Lethrinus striatus Stdr.: Persian Gulf (48)

Fam. Nandidae -leaffishes
1. Badis badis Ham.-Buch.: India. (55)
2. Nandus nandus Ham.-Buch.: India, Burma, Thailand (55)

Fam. Cichlidae -cichlids
1. Tilapia nilotica Linne: Syria through Egypt, East and West Africa (55).
2. Tilapia zillii Gervais: Africa north of Equator: Syria, Jordan (55)

Fam. Cepolidae
1. Acanthocepola ubbreviata: Persian Gulf (9)

Fam. Pomacentridae -damselfishes.
1. Abudefduf saxatilis: Atlantic, Indo-Pacific: (32)
2. Chromis caeruleus: Indo-Pacific (32)
3. Dascyllus aruanus: Indo-Pacific (32)
4. Amphiprion percula: Indo-Pacific (32)
5. Daya jerdoni: Persian Gulf (9)
   Pomacentrus jerdoni Day (48)
6. Pomacentrus obtusirostris Gunther (48)
7. Glyphidodon sindensis Day: Persian Gulf (48)
8. Glyphidodon coelestinus Cuv.&Val.: Persian Gulf (48)

Fam. Labridae -wrasses.
1. Coris angulata: Indo-Pacific (36)
2. Coris gaimard: Indo-Pacific (32)
3. Labroides dimidiatus: Indo-Pacific, Red Sea (36)
4. Halichoeres loeven: Indo-Pacific (36)
5. Halichoeres hortulanus: Indo-Pacific (36)
6. Halichoeres margaritaceus: Indo-Pacific (36)
7. Gomphosus tricolor: Indo-Pacific (32)
8. Cheilinus unifasciatus: Polynesia to East Africa; Red Sea (32)
9. Xyrichthys taenicurus: Polynesia to East Africa (32)
10. Iniistius pavoninus: Hawaii to Africa (32)
11. Duymaeria flagellifera Cuv.&Val.: Muscat (48)
12. Platyglossus dussumieri Cuv.&Val.: Mekran Coast (48)
13. Platyglossus bimaculatus Rupp: Muscat (48)
14. Platyglossus hyrtelii Blkr.: Persian Gulf (48)
15. Platyglossus roseus Day: Persian Gulf (48)

Fam. Scaridae -parrotfishes.
1. Callyodon dussumieri: Persian Gulf (9)
2. Pseudosarus jantochir Blkr.: Persian Gulf (48)

Fam. Cirrhitidae -hawkfishes.
1. Paracirrhites forsteri: Indo-Pacific (36)
2. Cirrhitichthys calliurus Regan: Muscat (48)

Fam. Trachinidae -weavers.
1. Pseudochromis persicus Blgr.: Persian Gulf (48)
2. Pseudochromis nigrorittatus Blgr.: Persian Gulf (48)

Fam. Opisthognathidae.
1. Opisthognathus nigromarginatus Rupp.: Mekran Coast (48)

Fam. Trichodontidae -sandfishes.
1. Malacanthus hoedtii: Hawaii to Africa (32)
2. Trichonotus setigerus Bl. Schn.: Muscat, Persian Gulf (9, 48)

Fam. Mugiloididae -sandperches.
1. Parapercis smithii Persian Gulf (9)
   Percis smithii Regan: Muscat (48)
2. Percis pulchella Schleg.: Muscat (48)
3. Percis nebulosa Q.C.: Persian Gulf (48)

Fam. Uranoscopidae -stargazers.
1. Uranoscopus guttatus: Persian Gulf (9)
2. Champsodon vorax Gunther: Sea of Oman (48)

Suborder Acanthuroidei

Fam. Zanclidae -moorish idols.

1. Zanclus acuminatus: Indo-Pacific (32)

Fam. Acanthuridae -surgeonfishes.

1. Acanthurus mata: Indo-Pacific (36)
2. Acanthurus lineatus: Indo-Pacific, Bombay (5, 36)
3. Acanthurus xanthopterus: Indo-Pacific (36)
4. Acanthurus lituratus: Indo-Pacific (36)
5. Acanthurus guttatus: Indo-Pacific (36)
6. Acanthurus achilles: Indo-Pacific (36)
7. Acanthurus aliala: Indo-Pacific (36)
8. Acanthurus atrimentatus: Indo-Pacific (36)
9. Acanthurus nigricans: Hawaii to Mauritius; Red Sea (32)
10. Zebrasoma veliferum: Indo-Pacific (32, 36)
11. Acanthurus xanthurus Blyth: Red Sea (5)
12. Teuthes nebulosa Q.G.: Persian Gulf (48)
13. Zebrasoma flavescens: Indo-Pacific (32)
14. Ctenochaetus striatus: Indo-Pacific (36)
15. Naso lituratus: Polynesia to Africa (32, 36)
16. Naso brevirostus: Polynesia to Africa (32)
17. Siganus siganus: Persian Gulf (15)
    Teuthis siganus (9)

Suborder Trichiuroidei

Fam. Gempylidae -snake mackerels

1. Thyrsites afun: South Africa, Australasia. (57)

Fam. Trichiuridae -cutlassfishes.

1. Trichiurus maticus: Persian Gulf (9)
2. Trichiurus lepturus: Pacific, Atlantic, Indian Oceans. (37)

Suborder Scomroidei

Fam. Scombridae -mackerels and tunas.

1. Rastrelliger kanagurta Cuvier: Indonesia to East Africa (45)
   R. chrysozona Peters.
   R. brachysoma Bleeker: All central tropical Indo-Pacific (13)
2. Thunnus albacares: Circumtropical, in Indian Ocean, mostly north of 30°S. (13, 45, 37)
3. Thunnus alalunga Bonnaterre: All subtropical and temperate seas. Indian Ocean, mostly 5°N to 30°S. (13, 26, 12, 37, 45)
   Germo alalunga Gmelin (41).
4. Thunnus obesus Lowe: Tropical and subtropical seas. Indian Ocean, mostly north of 30°S. (13, 37)
   Parathunnus obesus mebachi Kishinouye: (26)
5. Thunnus thynnus: Most subtropical and temperate waters; large gaps in distribution. In Indian Ocean, mostly around Australia, South Africa (13, 41, 57)
   Thunnus thynnus saliens: Given as the race in the Indo-Pacific region. (37)
6. Thunnus tonggol Bleeker: Red Sea; India to Philippines; Japan; Eastern Australia. (13, 26)
   Kishinoella tonggol: Maharashtra (47)
7. Scomberomorus commersonii Lecepede: East Africa to China and Japan; South Africa, Red Sea; Persian Gulf; all coast of India, Jask. (9, 57, 33, 27, 13).
8. Scomberomorus lineolatus Cuvier: East Africa, India, Ceylon, East Indies, Bombay (13, 27, 53).

9. Scomber microlepidotus Rupp: Persian Gulf, Bombay (5, 9, 48)
10. Scomber japonicus: Pacific and Indian Oceans (37)
    Penumatophorus diego.
11. Cybium guttatum B. Schn.: Persian Gulf, Bombay (5, 9, 53; 27)
    Scomberomorus guttatus Cuvier: India-Malay Archipelago, Philippines, China, Formosa, Japan, Jask. (13, 33)
12. Rhachycentrus canadus: Persian Gulf (9)
13. Auxis rochei Risso: Tropics, worldwide. (37)
14. Auxis thazard Lacepede: Indo-Pacific (37, 12, 13, 23)
15. Auxis thynnoides Bleeker: Indo-Pacific (26).
16. Euthynnus affinis Cantor: Tropical and subtropical Indo-Pacific; India. (13, 26, 37).
17. [illegible] alletteratus affinis: off Maharashtra, India (47)
17. Katsuwonus pelamis Linne: All tropical and subtropical seas (37, 57, 12, 13, 41, 26).
18. Acanthocybium solanderi Cuvier: All tropical and subtropical seas; West Coast of India. (13, 37, 27, 12)
19. Neothunnus macropterus Temminck & Schlegal: Red Sea, Indian Ocean. (57, 26, 47)
20. Regificola grandis: South Africa, New Zealand, Australia (57).
21. Sarda orientalis Temminck & Schlegel: Indian and Pacific Oceans. (26).
22. Grammatorcynus bicarinatus Quoy & Gaimardi: Indo-Malay Archipelago, Australia, Philippins; reported from Red Sea (13)
23. Gymnosarda unicolor Ruppell: Red Sea; Laccadives east to Japan; south to Australia. (13, 26).

Suborder Luvaroidei

Fam. Istiophoridae -billfish, sailfish, marlins, spearfishes.

1. Istiompax indicus: Indian and Pacific Oceans; Muscat (37).
2. Makaira nigricans: All warm and temperate seas. (37, 12)
3. Istiophorus platypterus Shaw & Nodder: Worldwide (38).
   Istiophorus greyi: Indian, Pacific Oceans (37, 57).
   Istiophorus gladius Broussonet: Laccadive Islands, Indian Ocean off western India. (25).
   Istiophorus immaculatus. (25).
4. Tetrapturus angustirostris: Pacific, Indian? Oceans (37).
5. Tetrapturus audax: Nearly all warm seas (37).

Fam. Xiphiidae -swordfish.

1. Xiphius gladius Linne: Cosmopolitan; Laccadive Islands, deep water off Bombay. (37, 57, 41, 24, 12, 36).

Suborder Gobioidei

Fam. Gobiidae -gobies.

1. Pomatoschistus caucasicus Kawrajsky: Caspian, Ural, Iran. (7, 17).
2. Pomatoschis sp. Caspian (59).
3. Knipowitschia longicaudata Kessler: Caspian; perhaps Iran (7, 17,3)
   Gobius longicaudata.
4. Knipowitschia iljini Berg: Caspian (7, 17)
5. Hyrcanogogius bergi Iljin: Volga, Ural, Iran, Caspian. (7, 17).
6. Neogobius melanostomus Pall. Caspian Sea (3).
   Gobius melanostomus.
7. Neogobius melanostomus affinis Eichwald: Caspian, Volga, Ural, Iran, perhaps Kura, Sefid-rud (7, 17, 41).
8. Neogobius cephalarges constructor Nordmann: Kura, Asia Minor, Araks, Astara, rivers of southern Caspian. (7, 17).

9. Neogobius syrman eurystomus Kessler: Northern Caspian, Ural (7, 17)
   Gobius eurystomus Kessler. (3)
10. Neogobius kessleri Gunther: Volga; all coasts of Caspian (7, 17)
   Neogobius kessleri gorlap Iljin: Volga, Tarak, Caspian. Iljin puts in a separate subspecies; Berg questions this (7).
11. Neogobius fluviatilis Pall.: Caspian Sea (3)
   Gobius fluviatilis.
12. Neogobius fluviatilis pallasi Berg: Caspian, Volga, Ural, Iran (7, 17, 41).
13. Neogobius bogdanowi Kessler: Caspian (7, 17)
   Gobius bogdanowi. (3)
14. Neogobius bathybius Kessler: Caspian. (7, 17, 3).
   Gobius bathybius.
   Chasar bathybius.
15. Neogobius caspius Eichwald: Caspian Sea (3, 7, 17)
   Gobius caspius.
16. Mesogobius nonultimus Iljin: Southeast Caspian, Volga (7, 17).
17. Mesogobius gymnotrachelus macrophthalmus Kessler: Caspian (7, 17)
   Gobius macrophthalmus. (3)
18. Mesogobius nigronotatus Kessler: Caspian (7, 17).
   Gobius nigronotatus. (3)
19. Proterohinus marmoratus Pallas: Volga, Caspian, Ural, Araks, Rivers of south Caspian. (7, 17, 3).
   Gobius marmoratus.
20. Proterohinus semipellucidus Kessler: Caspian; mouth Qarehsu(Gorgan Province). 7, 17, 3).
   Gobius semipellucidus.
21. Caspiosoma caspium Kessler: Caspian, Volga (7, 17)
22. Asra turcomana Iljin: Southern Caspian (7, 17).
23. Benthophiloides brauneri Berling&Iljin: Caspian Sea 97, 17).
24. Benthophilus macrocephalus Pallas: Caspian, Volga, Astarabad Bay. (3, 7, 17).
25. Benthophilus ctenolepidus Kessler: Caspian. (3, 7, 17).
   B. macrocephalus magistri Iljin: Given by Iljin as subspecies of B. macrocephalus; Berg gives as separate species.
26. Benthophilus stellatus leobergius Iljin: Caspian, south to Astarabad Bay. (7, 17).
27. Benthophilus spinosus Kessler: Caspian (3, 7, 17).
28. Benthophilus leptocephalus Kessler: Southern Caspian (3, 7, 17).
29. Benthophilus baeri Kessler: Southern Caspian (3, 7, 17).
30. Benthophilus granulosus Kessler: Caspian, Volga (3, 7, 17).
31. Benthophilus leptorhynchus Kessler: Caspian. (3, 7, 17).
32. Benthophilus grimmi Kessler: Central and southern Caspian (3, 7, 17
33. Anatirostrum profundorum Berg: Caspian (7, 17)
34. Gnatholepis anjerensis:Indo-Pacific (36).
35. Gobiodon hypselopterus: Indo-Pacific (32)
36. Gobius ornatus Rupp.: Mekran (48).
37. Gobius kessleri Gunther: Caspian Sea (3)
38. Gobius nasalis de Fil.: Caspian (3)
39. Gobius blennioides Kessler: Caspian (3)
40. Gobius cometes Alc.: Sea of Oman (48).
41. Gobius albopunctatus C.V.: Persian Gulf (48)
42. Gobius ophthalmotaenia Blkr.: Persian Gulf (48).
43. Gobius townsendi Blgr.: Persian Gulf (48)
44. Gobius hoplopomus C.V.: Persian Gulf (48)
45. Gobius andamanensis Day.: Muscat (48).
46. Gobiosoma caspium Kessler: Caspian (3)
47. Gobio gobio: Freshwater, old world (37)

48. Bathygobius fuscus: America, All Southeast Asia, Africa, Red Sea, Persian Gulf (9, 55).
49. Oxyurichthys tentacularis: Persian Gulf (9)
50. Oxyurichthys papuensis: Persian Gulf (9)
51. Acentrogobius ornatus: Persian Gulf (9)
    Gobius ornatus: Bombay (54).
52. Acentrogobius dayi: Persian Gulf (9)
53. Oligolepis acutipennis: Persian Gulf (9)
54. Barbatogobius asani: Persian Gulf (9)
55. Lobulogobius omanensis: Persian Gulf (9)
56. Trypauchan vagina Bl. Schn.: Persian Gulf, Bombay (9, 5).
57. Boleophthalmus dussumieri Valenciennes: Shore of Indian Ocean from Bombay to mouth of Tigris. (8)
58. Smilogobius sp. Indo-Pacific (36)

Fam. Eleotridae -sleepers, sleeper gobies.
1. Eleotris butis H.-B.: East Africa through Malay Archipelago to Australia (55).
2. Eleotris diadomatus Rupp.: Persian Gulf, Mekran (48)

Fam. Periophthalmidae -mudskippers.
1. Periophthalmus papilio: Africa (36).
2. Periophthalmus koelreuteri: West Africa; Persian Gulf? (36, 9)
3. Periophthalmus waltoni: Persian Gulf (9)
4. Periophthalmus barbarus Linne: Red Sea, East Africa, Southern Asia, to Australia. (55)
5. Scartelaos tenuis: Persian Gulf (9)

Suborder Cottoidei
Fam. Scorpaenidae -scorpionfishes and rock fishes.
1. Pterosis volitans Linne: Polynesia to East Africa, Red Sea (5, 32, 37, 41).
2. Pterosis russellii Bennett: Persian Gulf, Bombay (5, 9, 48)
3. Pterosis miles Bennett: Persian Gulf, Bombay (5, 9)
4. Pterosis cincta: Persian Gulf (9)
5. Apistus carinatus: Persian Gulf, Bombay (5, 9)
6. Minous monodactylus Bl. Schn.: Aden, Persian Gulf, Mekran (5, 9, 48)
7. Minous inermis Alc.: Muscat, Oman (48)
8. Choridactylus multibarbis: Persian Gulf (9)
9. Leptosynanceia melanostigma: Persian Gulf (9)
10. Tetraroge guentheri Blgr.: Sea of Oman (48)
11. Scorpaena cirrhosa Thunb.: Persian Gulf, Muscat (48)
12. Scorpaena rosea Day: Muscat (48)
13. Apistus alatus C.V.: Muscat (48)
14. Prosopodasys leucogaster Richards: Muscat (48)
15. Polycaulis uranoscopus Bl. Schn.: Bombay (5).

Fam. Triglidae -sea robins.
1. Lepidotrigla omanensis Regan: Persian Gulf, Oman (9, 48)
2. Lepidotrigla bispinosa Stdr.: Muscat (48)
3. Trigla arabica Blgr.: Oman (48)
    T. hemisticta non Schlegel.

Fam. Cottidae -sculpins.
1. Cottus gobio koshewnikowi Gratzianow: Vola, Ural, Europe, Asia Minor (7, 17, 60, 41).
2. Platycephalus maculipinna Regan: Persian Gulf, Muscat (9, 48)
3. Platycephalus tuberculatus: Persian Gulf (9)

4. Platycephalus nigripinnis Regan: Muscat (48)
5. Platycephalus townsendi Regan: Muscat, Karachi (48)
6. Platycephalus subfasciatus Gunther: Muscat (48)

Suborder Callionymoidei
Fam. Callionymidae -dragonets.
1. Callionymus longicaudatus Schlegel: Persian Gulf, Mekran (9, 48)
C. persicus, in Townsend's list from Mekran.
2. Callionymus sagitta Pall.: Persian Gulf, Bombay (5, 9)
3. Callionymus persicus Regan: Persian Gulf, Mekran, Muscat (9, 48)
4. Callionymus margaretae Regan: Muscat (48)
5. Callionymus muscatensis Regan: Muscat (48)
6. Callionymus carebares Alc.: Oman (48)
7. Callionymus filamentosus C.V.: Muscat (48)

Suborder Blennioidei
Fam. Blenniidae -combtooth blennies.
1. Aspidonotus taeniatus: Indo-Pacific, Red Sea (36)
2. Cirripectus sp.: Indo-Pacific (36)
3. Blennius persicus Regan: Persian Gulf (9, 48)
4. Blennius semigasciatus Rupp.: Muscat (48)
5. Salarias lineatus Cuv.& Val.: Persian Gulf, Bombay (5, 9)
6. Salarias sindensis Day: Persian Gulf (48)
7. Salarias dussumieri Cuv.&Val.: Persian Gulf (48)
8. Salarias fasciatus Bl.: Persian Gulf (48)
9. Salarias opercularis Murr.: Persian Gulf (48)
10. Salarias anomalus Regan: Persian Gulf, Mekran (48)
11. Salarias pulcher Murray: Persian Gulf, Karachi (39)
12. Salarias opercularis Murray: Persian Gulf, Karachi (39)
13. Petroscirtes variabilis: Persian Gulf (9)
14. Petroscirtes punctatus Cuv.&Val.: Persian Gulf, Bombay (5, 9)
15. Petroscirtes mekranensis Regan: Jask (48)
16. Petroscirtes townsendi Regan: Jask (48)

Suborder Ophidioidei
Fam. Ophidiidae.
1. Neobythites steaticus Alc.: Oman (48)

Suborder Stromatoidei
Fam. Stromateidae -butterfishes.
1. Stromateus cinereus Bloch: East and west coasts of India; off Bombay, Persian Gulf; off Fao, Iraq. (2, 5, 9, 53)
2. Stromateus niger Bloch: Persian Gulf, Bombay (5, 9)

Fam. Nomeidae -shepherdfish.
1. Psenes indicus Day: Persian Gulf, Bombay (5, 9, 48)

Suborder Anabantoidei
Fam. Anabantidae -climbing perches.
1. Anabas scandens Day: Bombay (5, 36)

Suborder Sphyraenoidei
Fam. Sphyraenidae -barracudas.
1. Sphyraena jello: Shores of Africa and Asia, Persian Gulf (9, 41)
2. Sphyraena obtusata: Persian Gulf, Jask (9, 33).

Suborder Mugiloidei

Fam. Mugilidae -mullets.

1. Crenimugil crenilabis: Indo-Pacific (36)
2. Mugil sp.: Iranian area (58)
3. Mugil auratus Risso: Successfully introduced into Caspian Sea (7, 17, 41, 3, 16, 59)
4. Mugil saliens Risso: Successfully introduced into Caspian Sea (7, 17, 41, 59).
5. Mugil cephalus Linne: All warm seas; Japan; Hawaii; Indo-Pacific; Europe, Africa; India; Red Sea (7, 32, 12)
6. Mugil dussumieri Cuv.&Val.: Persian Gulf, Bombay (5, 9, 54)
7. Mugil abu zarudnyi Berg: Upper Karun; Tigris at Mosul; River Khabur in Euphrates System (8).
   Liza abu zarudnyi.
8. Neomyxus chaptali: Indo-Pacific (36)
9. Chelon macrolepis: East and southeast Africa to southern Pacific (55)
10. Chelon oligolepis Bleeker: South and southeast Asia (55)

Fam. Antherinidae -silversides.

1. Antherina sp. : Caspian (59)
2. Antherina mochon pontica n. caspia Eichwald: Kura, Ural, all Caspian shores (7, 17)
   A. mochon caspia Eich.: Caspian (41)
   A. pontica. Caspian (3)
3. Antherina forskalii: Persian Gulf (9)

Suborder Polynemoidei

Fam. Polynemidae -threadfins.

1. Polydactylus plebeius Broussionet: Muscat, Arakan Coast, Bombay. (19, 18, 53, 54)
2. Polydactylus sextarius Bloch: Persian Gulf (18, 19)
   Polynemus sextarius: Persian Gulf, Bombay (5, 9)
3. Eleutheronema tetradactylum: Persian Gulf. (19).
   Polynemus tetradactylus Shaw: Persian Gulf, Jask, Bombay (5, 9, 33, 53, 54).
4. Polynemus indicus: Bombay (53)

Order Pleuronectiformes

Fam. Bothidae -lefteye flounders.

1. Psettodes sp. Indo-Pacific (36)
2. Psettodes erumei Schneider: Muscat, Persian Gulf, Bombay, East Africa and Red Sea to Pacific Ocean. (9, 19, 53, 48, 42)
3. Pseudorhombus triocellatus Schneider: Persian Gulf; East Coast India to Malay Archipelago. (9, 19, 42)
4. Pseudorhombus annulatus Norman: Muscat, Oman (19, 42)
5. Pseudorhombus melayanus Bleeker: Persian Gulf; East Coast India through Malay Archipelago to Philippines. (9, 19, 42)
6. Pseudorhombus arsius Hamilton: Muscat, Persian Gulf, Oman; East Coast Africa through Indian Ocean to Pacific (5, 9, 19, 42, 53, 55)
7. Pseudorhombus elevatus Ogilby: Persian Gulf, through Indian Ocean to Australia. (9, 19, 42).
8. Pseudorhombus javanicus Bleeker: Persian Gulf, Bombay; East Coast India through Southern China. (9, 19, 42, 54)
9. Arnoglossus aspilos Bleeker: Persian Gulf, Malay Peninsula (9,19,42.
10. Arnoglossus laterna: Atlantic Ocean; Mediterranean and Red Seas. (19, 41).
11. Arnoglossus arabicus: Red Sea (19)
12. Arnoglossus tapeinosoma Bleeker: Persian Gulf, Oman, to Malay Archipelago and beyond (19, 42).

13. Engyprosopon grandisquama Temmick&Schlegel:Oman, Muscat, Persian Gulf; South Africa through Indian Ocean to Australia and Japan. (9, 19, 42)
    Rhomboidichthys grandisquamis Rupp.: Muscat (48)
14. Engyprosopon latifrons Regan: Indian Ocean, Red Sea (19, 42)
15. Engyprosopon macrolepis Regan: Red Sea, Cargados, Carajos, Indian Ocean (19, 42)
16. Engyprosopon filimanus Regan: Muscat, Maldive Islands (19, 42)
17. Bothus pantherinus Ruppell: Oman, Muscat, Persian Gulf, Red Sea, East Africa through Indian Ocean to Australia (19, 42)
18. Bothus myriaster Temminck&Schlegel: Red Sea, Indo-China, Japan, Formosa (19, 42)
19. Laeops macrophthalmus Alcock: Oman; through Indian Ocean to Burma. (19, 42, 48)
20. Laeops nigrescens Lloyd: Oman, Gulf of Aden (19, 42)
21. Laeops guentheri Alcock: Persian Gulf, India, Burma (9, 19, 42)
22. Rhomboidichthys pantherinus Rupp.: Muscat (48)
23. Rhomboidichthys poecilurus Blkr.: Muscat (48)

Fam. Pleuronectidae -righteye flounders.

1. Pleuronectes flessus: Caspian (59, 41)
2. Pleuronectes flessus luscus Palla: Originally from Black Sea; introduced into Caspian. Occasionally taken in Iranian waters. (17, 7, 41, 42)
3. Samariscus inornatus Lloyd: Red Sea, Gulf of Aden (19, 42).

Fam. Soleidae -soles.

1. Synaptura commersoniana: Red Sea, Bombay (19, 53)
2. Synaptura orientalis: Oman, Bombay (19, 2, 53)
    Brachirus orientalis: Persian Gulf (9)
3. Synaptura zebra Bl.: Persian Gulf (48)
4. Solea solea: Red Sea, Mediterranean, Atlantic (19, 41)
5. Solea elongata: Persian Gulf (9, 19)
6. Solea heinii Red Sea (19)
7. Zebrias quagga: Persian Gulf (19)
8. Aseraggodes cyaneus: Persian Gulf, Oman (19)
    Solea umbratilis Alc.: Oman (48)
9. Aseraggodes sinus-arabici: Red Sea (19)
10. Pardachirus marmoratus: Muscat, Oman, Persian Gulf (9, 19)

Fam. Cynoglossidae -tonguefishes.

1. Paraplagushia bilineata: Persian Gulf. (19)
    Cynoglossus bilineatus. (9)
    Plagusia bilineata Bombay (53)
2. Paraplagushia blochii: Red Sea (19)
3. Paraplagushia dollfusi: Red Sea (19)
4. Plagusia marmorata: Bombay (53)
5. Cynoglossus elongatus Bombay (53).
6. Cynoglossus bilineatus: Persia (19)
    Cynoglossus quadrilineatus.
7. Cynoglossus dubius: Red Sea (19)
8. Cynoglossus lingua: Red Sea, Bombay (19, 53)
9. Cynoglossus macrolepidotus: Persian Gulf (9, 18, 19)
10. Cynoglossus puncticeps: Persian Gulf (9, 19)
11. Cynoglossus pottii: Red Sea (19)
12. Cynoglossus lida: Red Sea (19)
13. Cynoglossus brachycephalus: Persian Gulf (19)
14. Dollifusichthys sinus-arabici: Red Sea (19)

15. Symphurus gilesii: Red Sea (19)
16. Symphurus wood-masoni: Red Sea (19)
17. Symphurus macrophthalmus: Red Sea (19)
18. Trulla dollfusi: Red Sea (19)
19. Trulla carpenteri: Oman, Persian Gulf (19)
    Cynoglossus carpenteri Alcock: Oman (11, 48)
20. Trulla acutirostris: Red Sea (19)

Order Echeneiformes

Fam. Echeneidae -remoras

1. Echeneis naucrates Linne: All warm seas, Bombay, Persian Gulf. (5, 9, 32).

Order Mastacembeliformes

Fam. Mastacembelidae -mastacembelid eels.

1. Mastacembelus simack Walbaum: Kubank River; Aleppo; Tigris at Mosul, Diarbekira and Baghdad; Veroyatin; and Euphrates (8)
2. Mastacembelus armatus Lacepede: India, Indo-China, Baluchistan (8)
3. Macrognathus aculeatus Bloch: India, All southeast Asia (55)
   Rhynchobdella aculeata Bloch: Bombay (5)

Order Tetraodontiformes

Fam. Triacanthodidae -spikefishes.

1. Triacanthus indicus: Persian Gulf (15, 9)
2. Triacanthus strigilifer: Persian Gulf (9)

Fam. Balistidae -triggerfishes and filefishes.

1. Balistapus undulatus: Indo-Pacific (36)
   Balises undulatus Mungo Park: Bombay (5)
2. Rhinecanthus aculeatus: Indo-Pacific (32, 36)
3. Rhinecanthus rectangulus: Indo-Pacific; Red Sea (32, 36)
4. Xanthichthys ringens Linne: Widespread in Indo-Pacific (36, 12)
5. Alutera monoceros: Worldwide; Indo-Pacific (12, 36)
6. Balistes bursa: East Africa to Polynesia (32)
7. Abalistes stellaris: Persian Gulf (9)
8. Paramonacanthus oblongus: Persian Gulf (9)
   Monacanthus oblongus Schlegel: Persian Gulf (48)
9. Paramonacanthus choirocephalus: Persian Gulf (9)
   Monacanthus chaerocephalus Bleeker: Bombay (5)
10. Stephanolepis diaspros: Persian Gulf (9)
11. Cantherhines pardalis: Indo-Pacific (37)
12. Amans siscopas: Indo-Pacific (37)
13. Monacanthus tomentosus Linne: Persian Gulf (48)

Fam. Ostraciidae -trunkfishes.

1. Ostracion lentiginosus: Indo-Pacific (36)
2. Ostracion cubicus: Indo-Pacific (36)
3. Ostracion gibbosus Linne: Persian Gulf (9, 18)
4. Ostracion cyanurus Rupp.: Persian Gulf (48)

Fam. Tetraodontidae -puffers.

1. Spheroides maculatus: Indo-Pacific (36)
2. Spheroides inermis: Persian Gulf (9)
3. Spheroides lunaris: Persian Gulf (9)
   Tetrodon lunaris Bl. Schn.: Bombay (5)
4. Canthigaster solandri: Indo-Pacific (36)
5. Arothron hispidus: Indo-Pacific (36)

6. Lagocephalus sceleratus: Persian Gulf (9)
7. Tetraodon stellatus: Persian Gulf (9)
8. Tetraodon cutcutia H.-B.: India, Southeast Asia (55)
9. Tetraodon fluviatilis H.-B.: India, Southeast Asia, Bombay (5, 55)
10. Chilonodon patoca: Persian Gulf (9)
    Tetrodon patoca H.-B.: Bombay (5)

Fam. Diodontidae -porcupine fishes.
1. Diodon sp. Common in Indo-Pacific (36)
2. Diodon hystrix Linne: All warm seas, Indo-Pacific, Bombay (5, 36, 37)
3. Chilomycterus orbicularis: Persian Gulf (9)

Fam. Molidae -molas.
1. Mola mola Linne: Worldwide in tropical and temperate seas (12, 37)

Order Batrachoidiformes.
Fam. Batrachoididae -toadfishes.
1. Opsanus tau: Indo-Pacific (36)
2. Batrachus grunniens: Persian Gulf (9, 48)

Order Lophiiformes
Fam. Antennariidae
1. Antennarrias nummifer Cuv.: Persian Gulf (48)

Order Pegasiformes
Fam. Pegasidae -sea moths.
1. Pegasus draconis: Red Sea (19)
2. Parapegasus natans: Persian Gulf (19, 48)

Additional notes.
1. Nemachilus tenuis Day from Kushk, Seistan and Oxus Rivers (20) should be listed as synonym of N. stoliczkai var. tenuis Day. Page 15.
2. Apogon holotaenia Regan may be equivalent to A. endekataenia Blkr., A. fasciatus White, A. balinensis Blkr., or A. novemfasciatus C.V. Pg. 23.
3. Apogon melanotaenia Regan may be equivalent to A. fasciatus white & A. endekataenia Bleeker. Pg 23
4. Chorinemus moadetta may be synonym of C. sancti-petri. Pg. 25.
5. The genus Platyglossus may be under Fam. Scaridae. pg. 28
6. Pseudochromis persicus Murray should be added to Fam. Serranidae. Reported by Murray from Persian Gulf (39).
7. Alutera monoceros, page 36, was firstedescribed by Osbeck.

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Laboratory of Fishery Research, Slovak Agricultural Academy,
and Department of Systematic and Ecological Zoology, Comenius University, Bratislava

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Laboratory of Fishery Research, Slovak Agricultural Academy,
and Department of Systematic and Ecological Zoology, Comenius University, Bratislava

NOTES ON SMALL COLLECTION OF FISHES FROM AFGHANISTAN WITH A DESCRIPTION OF GLYPTOTHORAX JALALENSIS, SP. N. : (PISCES, SISORIDAE)

EUGEN K. BALON and KÁROL HENSEL

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Abstract: The work presents a description and diagnosis of four species of fish from the Afghanistan territory — *Salmo trutta oxianus* Kessler, 1874, *Schizothorax intermedius fedtschenkoi* Kessler, 1872, *Glyptothorax jalalensis* sp. n., and *Ophiocephalus gachua* Hamilton, 1822. The *Glyptothorax jalalensis* sp. n. is simultaneously the first proof of the occurence of this genus in Afghanistan.

Through the courtesy of Prof. D. Povolný and Dr. J. Gaisler we have received a few specimens of fish collected in Afghanistan during an expedition of the Zoological Institute of the College of Agriculture, Brno, in 1967.

As the available studies on fish from Afghanistan (Day, 1880; Günther, 1889; McClelland, 1842; Annandale and Hora, 1920; Hora, 1934, 1935; Vijayalakshmanan, 1949) and from adjacent territories (Berg, 1949a, b; Turdakov, 1952; Sufi, 1957, 1963; Ahmad and Mirza, 1963, 1964) deal, for the most part, with individual specimens, and since more detailed diagnoses are often lacking, it is considered useful to present here a description of these fishes.

Two specimens of trout were caught on May 20, 1967 in the rapids of a mountain stream (2700 m above sea level) which joins the river Kunduz (a tributary of Amu-Daria) in the Bamian pass. Larger specimens are currently caught here, but only the smallest of them ended in formalin. The remaining fishes described here were cought in the lowland tributaries the Kabul river in the environs of Jalal-Abad (in the Indus watershed), in March and April of 1967.

The specimens are deposited in the collections of the Slovak National Museum in Bratislava.

Salmo trutta oxianus Kessler, 1874

Two specimens, 158 and 143 mm of standard length. The larger one is a female, the smaller one a male. Radii D III 10 and III 9, radii A III 8 in both, radii C VIII 17 VIII and IX 17 VIII, radii P I 11 and I 12, radii V I 8 in both. Lateral line scales 104 in both. Branchial spines 21/21 and 21/22 (external spines on the first branchial arch on left and right side of body) are thin, long and spiniform.

In % of standard length:
head length 29.1 and 29.4; praeorbital length 7.6 and 7.7; internasal distance 5.4 and 4.9; diameter of eye 6.0 and 6.3; interorbital distance 8.9 and 8.4; postorbital distance 17.1 and 16.8; praedorsal distance 46.2 and 49.6; praeventral distance 57.6 and 55.2; praeanal distance 76.6 and 75.6; length of caudal peduncle 17.1 and 16.8; distance P-V 32.3 and 30.1; distance V-A 20.2 and 21.0; length of D 14.6 and 12.6; legth of A 9.5 and 9.1; length of P 20.9 and 21.7; length of V 15.2 and 16.1.

Both specimens still show well defined juvenile dark spots on either side of their bodies. Both have an equally well developed annulus of the year 1966 on the scales, and a new annulus closely on their margin. Hence, they belong to the 2nd age class. Evidently there is question here of autochthonous trout found in and originally described from the Bamian river (McClelland, 1842), which were later found here and in the upper Amu-Daria river-basin by several authors (Kessler, 1874; Berg, 1905; Hora, 1933, 1935; Nikol'skij, 1938). The characters in our specimens agree with those already described. According to Balon's evolutionary hypothesis (1968) these trout are derived from the extinct Mediterranean species, whose "neotenic" populations penetrated through the continental river system thus far to the East and produced the *ezenami* and *oxianus* forms.

Schizothorax intermedius fedtschenkoi Kessler, 1872

The material from the tributary of the Kabul river contains two females of 178 and 121 mm standard length. Their counts and measurements are as follows: Radii D III 8 in both, radii A III 5 in both, lateral line scales 93 and 87 on the left, and 96 and 84 on the right, transversal rows of scales 19 and 18 on the left, and 16 and 14 on the tight, number of branchial spines 14 and 12 on the left, and 17 and 17 on the right, lower pharyngeals 2.3.5 and 2.3.5, on the third hard dorsal ray the larger has 13 and the smaller one 15 little denticles.

In % of standard length:

head length 27.0 and 25.6; praeorbital distance 11.2 and 9.1; 1-st barbel length 7.9 and 6.6; 2-nd barbel length 6.7 and 8.3; internasal distance 6.2 and 5.8; diameter of eye 3.9 and 4.5; interorbital distance 9.5 and 8.3; postorbital distance 12.9 and 12.4; depth of head 18.0 and 15.7; head length 17.4 and 14. 9; praedorsal distance 53.9 and 53.7; praeventral distance 50.0 and 52.1; praeanal distance 74.7 and 76.8; depth of body 23.6 and 24.0; width of body 15.2 and 14.9; length of caudal peduncle 20.2 and 18.2; depth of caudal peduncle 12.9 and 12.4; width of caudal peduncle 8.4 and 7.4; last heigh of body 10.7 and 10.7; P-V distance 27.5 and 28.9; V-A distance 24.7 and 24.8; length of D 13.5 and 11.6; length of A 6.7 and 4.9; length of P 20.8 and 19.8; length of V 17.4 and 18.2; heigh of D 20.2 and 20.7; heigh of A 19.1 and 19.8.

The larger specimen belongs to the 4th age class (annuli 3+) the smaller one to the 3rd (annuli 2+). The smaller one shows dark irregular spots on its body, while the larger one is free of them, but the upper half of its body is darker (after imbedding in formalin). The larger specimen has strong fleshy lips, divided in the centre of the mandible and lobed at the sides. Fleshiness of lips in the smaller one is only weakly indicated, without lobes.

Glyptothorax jalalensis sp. n. (fig. 1)*

Holotype: Female 73.2 mm long (Fig. 1), caught in a tributary of the Kabul river near the town of Jalal-Abad, in March 1967. It is deposited in the Slovak National Museum under No. RY 2176.

Description: Radii D II 6, radii A III 10, radii P I 8, radii V I 5, radii C XII 17 XII.

In % of standard length:

head length 27.3; praeorbital distance 15; diameter of eye 2.2; postorbital distance 12; depth of head 12.3; width of head 19.1; interorbital distance 6.3; internasal distance 4.0; length of nasal barbel 12.8; length of maxillary barbel 23.2; length of external mandibulary barbel 16.5; length of internal mandibulary barbel 10.4; praedorsal distance 39.6; praeventral distance 47.6; praeanal distance 65.6; depth of body 19.1; width of body 17.8; length of caudal peduncle 21.9; heigh of caudal peduncle 10.9; width of caudal peduncle 7.5; last heigh of body 9.3; P-V distance 27.3; V-A distance 16.4; length of D 11.6; length of A 12.0; length of P 20.5; length of V 16.4; heigh of D 15.3; length of D spine 11.5; heigh of A 20.0; length of addipose fin 19.1.

Derivation of the name: According to the town Jalal-Abad.

The head and body are covered with little soft tubercles. The head is longer than wide, but wider than high. The eyes are small and placed dorsally. The upper jaw is longer than the lower one. The mouth is inferior, and narrower than the length of the snout. The teeth are small and sharp, and on the praemaxillaries they spread out in a narrow continuous crescent-like strip. On the dental, the strips of teeth are separated in the middle by a narrow gap. The lips are smooth, and the nostrils are situated near the tip of the snout. Nasal barbels reach beyond the eyes, the maxillary ones moderately overreach the

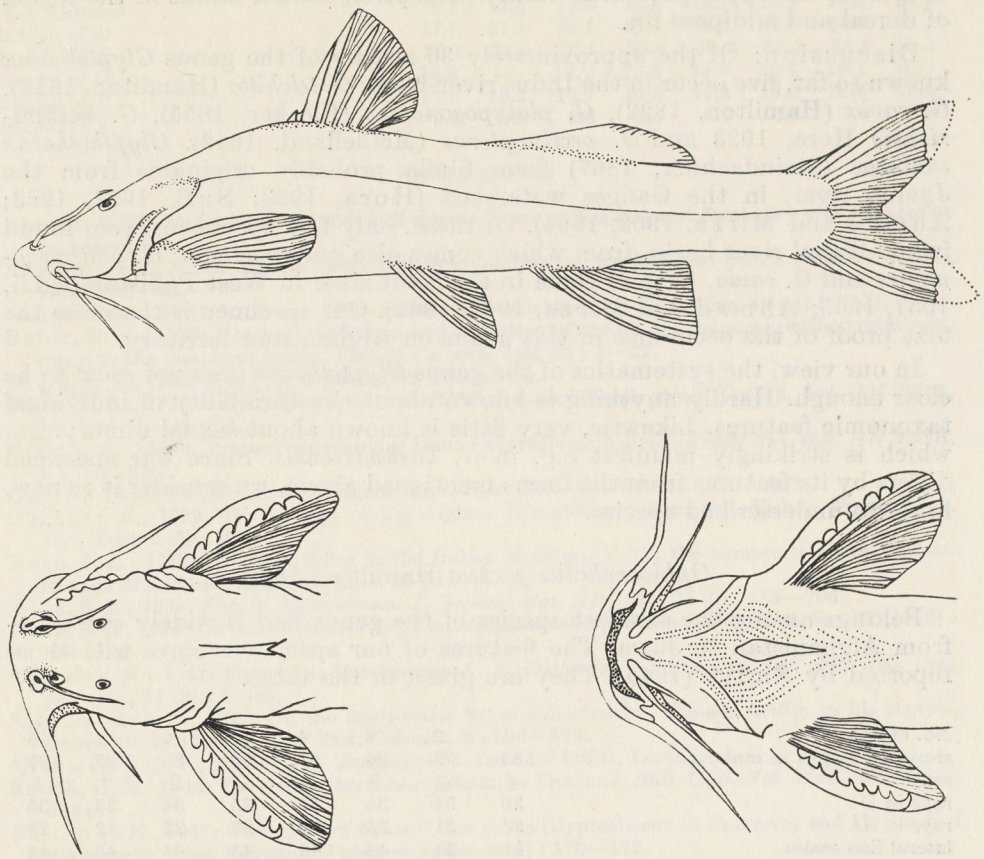

Fig. 1. The holotype of *Glyptothorax jalalensis* sp. n. SNM No. RY 2176. Standard length 73.2 mm. Drawn by Mrs. Miriam Baradlai.

base of pactorals; the external mandibular barbels go as far as base of pectorals, while the internal ones are the shortest of all. The body is pressed in from the sides. The adhesive apparatus is developed only on the chest. It is longer than wide, with a slight depression in the middle. The insertion of the dorsal fin is more proximate to the addipose fin than to the end of the snout, and is lower than the height of the body. The dorsal spine is not serrated. The addipose fin is approx. 5 times longer than high, its base twice as long as its height. The gap between the posterior edge of dorsal base and the anterior edge of the

base of addipose fin is approximately equal to the length of the addipose fin. Five osseous platelets are hidden under the skin behind D, and three are behind the addipose fin. The pectoral spine is serrated and carries large teeth bent backwards, 7 on the left and 8 on the right. It is without any adhesive apparatus. The ventral fins reach beyond the anal orificium, but do not attain the anterior edge of anal basis. The anal orificium stands closer to anal base, and has a papilla. The anal fin lies under the addipose one.

The colouring of our specimen embedded in formalin is indistinct. It is darker on the upper part with hardly perceptible darker stains in the region of dorsal and addipose fin.

Discussion: Of the approximately 36 species of the genus *Glyptothorax* known so far, five occur in the Indus river-basis: *G. telchitta* (Hamilton, 1822), *G. cavia* (Hamilton, 1822), *G. platypogonoides* (Bleeker, 1855), *G. kashmiriensis* Hora, 1923 and *G. pectinopterus* (McClelland, 1842). *Glypthothorax stolickae* (Steindachner, 1867) from Simla probably originates from the Jamna river, in the Ganges watershed (Hora, 1923; Sufi, 1957, 1963; Ahmad and Mirza, 1963, 1964). Of these, only two specimens were found in the Kabul river basin, from which comes also our specimen: *G. platypogonoides* and *G. cavia*, both of them in the Swat river in West Pakistan (Sufi, 1957, 1963; Ahmad and Mirza, 1963, 1964). Our specimen is therefore the first proof of the occurence of this genus on Afghanistan territory.

In our view, the systematics of the genus *Glyptothorax* does not seem to be clear enough. Hardly anything is known about the variability of individual taxonomic features. Likewise, very little is known about sexual dimorphism which is strikingly manifest e.g. in *G. kashmiriensis*. Since our specimen differs by its features from the forms mentioned above, we consider it as new, hinterto underscribed species.

Ophiocephalus gachua Hamilton, 1822

Belongs among the smallest species of the genus and is widely spread — from Afghanistan to Jawa. The features of our specimens agree with those reported by Smith (1945). They are given in the table.

No. of coll.	1	2	3	4	5	6	7	8
standard length in mm	83	73	96	91	90	88	99	87
sex	♂	♂	♀	♀	♀	♀	?	?
rays in D	36	34	36	35	35	34	35	35
rays in A	23	21	23	23	22	22	22	22
lateral line scales	44	44	44	44	43	44	45	44
transversal line scales	4/1/8	4/1/7	4/1/8	4/1/8	4/1/8	4/1/8	4/1/8	4/1/8
dropping row at l. l. scale	13	13	14	13	13	13	13	14
rows of scales on opercle	3	3	3	3	3	3	3	3
rows of scales between eye and angle of preopercle	5	5	5	5	5	5	5	5
in % of standard length:								
head length	31.3	32.3	32.3	31.9	33.3	31.1	31.1	33.3
praeorbital distance	6.9	6.3	6.2	6.6	7.3	6.8	7.1	7.3
internasal distance	4.8	3.6	4.6	4.4	4.7	4.8	4.5	4.5
diameter of eye	4.8	5.2	5.1	4.8	4.9	4.5	4.5	5.0
interorbital distance	9.5	9.6	9.8	9.2	9.7	9.5	9.7	10.3
postorbital distance	20.2	20.5	21.2	20.9	21.3	20.7	20.8	21.3
head depth	15.6	16.4	17.4	16.5	17.8	16.8	17.3	16.5

head length	21.4	21.9	21.9	22.0	21.7	21.0	21.2	22.3
praedorsal distance	37.3	34.2	36.4	37.4	38.2	36.0	35.3	36.8
praeventral distance	38.5	39.7	39.6	39.6	38.9	38.9	37.4	41.4
praeanal distance	57.5	54.8	57.9	58.2	57.4	55.7	56.6	58.6
body depth	21.0	20.5	20.8	20.9	21.5	19.6	19.2	19.5
body width	19.3	17.8	18.7	18.5	19.8	18.2	18.2	18.4
caudal peduncle length	7.9	10.9	11.4	9.9	10.0	11.9	10.5	9.2
caudal peduncle depth	12.4	11.5	12.2	12.1	12.8	12.7	11.1	11.5
caudal peduncle width	5.8	5.5	6.1	4.7	5.5	5.4	4.8	5.7
last heigh of body	11.8	10.4	11.8	11.0	11.1	11.4	10.8	11.9
P-V distance	15.1	13.4	14.8	13.2	13.8	13.3	13.1	14.7
V-A distance	18.5	17.5	17.4	19.6	18.1	17.1	18.2	20.2
length of D	57.8	57.5	58.1	52.7	56.2	55.2	54.5	56.3
length of A	36.1	35.6	37.5	39.6	36,7	36.4	36.4	33.3
length of C	18.8	—	17.7	19.8	20.0	20.4	19.2	20.7
length of P	17.5	19.2	16.7	18.5	17.8	18.2	15.6	18.4
length of V	6.0	8.2	6.8	7,5	6.7	6.8	7.1	8.0

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Author's addresses: Dr. Eugen K. Balon, CSc., Železná studnička, Cesta mládeže, Bratislava. Dr. Karol Hensel, Moskovská 2, Bratislava.

* not seen in original

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The fresh-water fish fauna of Eastern Anatolia
Doğu Anadolu bölgesinin tatlı su balıkları

Mustafa KURU
(Department of Zoology, Faculty of Science,
Atatürk University, Erzurum)

Özet : *Fırat-Dicle, Kura-Aras ve Çoruh nehir sistemleri Doğu Anadolu Bölgesinin yüksek yaylalarından çıkarlar. Bu nehir sistemlerinin balık faunası çok geniş bir materyale dayanılarak incelendi ve bizim kolleksiyonumuzda 34 tür ve bu türlerden ikisinin 5 alt tür'ü tesbit edildi.*

Eğer araştırma sahamızda bulunan balıkların orijinlerini araştırırsak Anadolunun diğer bölgelerinde olduğu gibi burada da bir balık faunası karışımı olduğunu görürüz. Bölgemizde bulunan balıkların orijinleri kaba olarak şu şekilde gösterilebilir ;

1) *Batı (Palearktik ve Avrupa) orijinli formlar.*

2) *Batı Asya orijinli formlar.*

3) *Güneydoğu Asya ve Hindistan orijinli formlar. Bu formlar Afrika faunası ile de bazı yakınlıklar gösterirler ve Mezopotamya faunası diye isimlendirilirler.*

4) *Sarmatik iç denizinden farklılaşarak bu iç denizin bir parçcsı olan Karadeniz vasıtasiyle yayılan formlar.*

Summary : *The Euphrates-Tigris, Kura-Aras and Çoruh river systems derive from the very high plateau of Eastern Anatolia. The fish faunae of these river systems are examined on the basis of a very large material. In our collection there are 34 species ; 2 of these have subspecies. Taking into consideration the origins of the genera found in our research area we are confronted with the mixed composition of the fish fauna as seen in other parts of Anatolia too. The origin of the faunistic elements found in our research area can be roughly distinguished as following :*

1) *Western (Palearctic, especially Europe).*

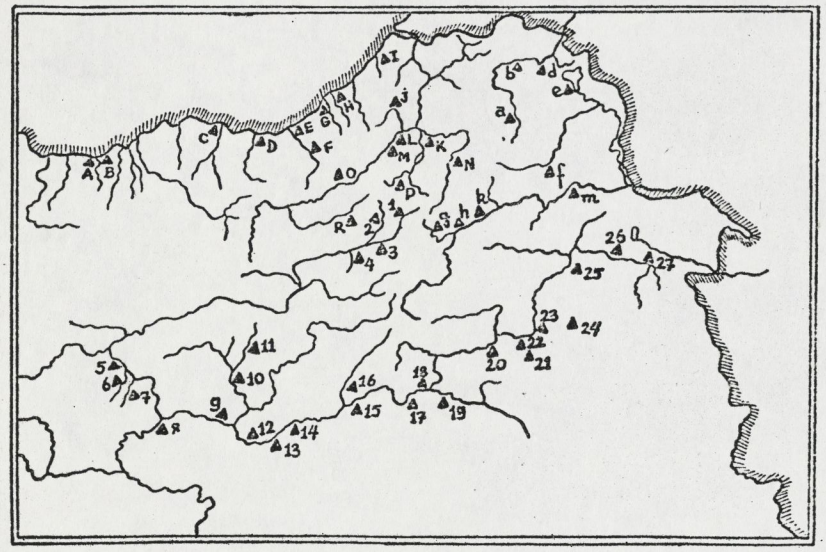
2) *Western Asia.*

3) *Southeast Asia and India, these forms, showing some relations also with the African fauna, named Mesopotamian elements in this paper.*

4) *The Sarmatian Sea, respectively the Black Sea as a part of the old Sarmatian Sea.*

Until now our knowledge about the ichthyofauna of Eastern Anatolia is relatively restricted. Especially there is no exact knowledge about the distribution of different species in different river systems of this region. Our knowledge is the best for the Kura and Aras basins where before 1920 Russian authors were working, describing some special forms for this district (BERG 1940, 1949). In the river systems of the Euphrates and of the Çoruh, material was gotten only by occasional visits of foreign scientists. A summary of the results of these collections can be found in LADIGES (1960, 1964, 1966).

Taking into consideration the fact that the three important river systems in Eastern Anatolia (Çoruh, Aras-Kura, and Euphrates) have their sources in nearest neighborhood to one another, being separated only by local differences in altitude, this study was undertaken and performed during the suitable months for fishing during 1969 and 1970. The area of investigation and the different places from where fishes were caught is shown in map 1. The closed basin of Lake Van being ichthyologically well investigated is not included in our research field (see page 143).



Map 1 : The area of investigation and the different places from where fishes were caught by us.

RESULTS

As will be seen from the following list 34 species were caught in our region. Behind the name of each species the localities are mentioned according to the following principles. Places on rivers emptying into the Black Sea are indicated by capital letters, those emptying into the Caspian Sea by small letters, and those of the two big arms of the Euphrates, the Karasu and the Murat suyu, by numbers.

The scientific names used in this paper were taken according to the present literature, the aim of this publication not being in the first line a study of systematic research.

LIST : 1

Species found during the survey :

Salmo trutta LINNE F, I , P, R ; d ; 10, 11
Acanthalburnus microlepis (FILIPPI) : e , g, h.
Acanthobrama marmid HECKEL : 3, 9, 12, 13, 14 , 15 , 18, 19 , 21, 25, 26.
Alburnoides bipunctatus fasciatus (NORDMANN) : I, K, L, M, O ; c, e, f, g ; 1, 2, 3, 5, 7, 9, 10, 13 , 14 , 21 , 27.

Alburnus filippii KESSLER : c, d, e, f, g, h.
Chalcalburnus chalcoides derjugini (BERG) : A, C, H, I.
Chalcalburnus mossulensis (HECKEL) : 1, 2, 4, 5, 7, 8, 9, 12, 13, 14, 17 , 18, 19 , 20,21 22 , 23, 24 , 25, 26 , 27.

Aspius aspius taeniatus (EICHWALD) : d, e .
Barbus capito capito (GÜLDENSTÂDT) : P ; g.
Barbus mursa (GÜLDENSTÂDT) : f.
Barbus plebejus lacerta (HECKEL) : f, g ; 1, 2, 5, 10, 11, 13, 14 , 21, 24, 25, 26, 27.
Barbus plebejus escherichi (STEINDACHNER) : A, G, I, K, M, N, P ; e .,
Barbus rajanorum mystaceus (HECKEL) : 12, 13, 14 .
Capoeta capoeta umbla (HECKEL) : 1, 2, 3, 5, 7, 10, 12, 13, 16 , 17 , 18 , 19 , 20 . 21 , 22 , 25, 27.

Capoeta capoeta capoeta (GÜLDENSTÂDT) : c, e, f, g, h.
Capoeta capoeta sieboldi (STEINDACHNER) : K, L, N. O.
Capoeta tinca (HECKEL) : A, K, L, M, N, P.
Capoeta trutta (HECKEL) : 3, 8, 9, 12, 13, 16 , 17 , 18 , 19 , 21 , 25.
Chondrostoma regium (HECKEL) : 3, 5, 8, 9, 10, 12, 13, 14 , 15 , 16 , 17 , 18 , 19 , 21 , 22 , 23 , 26, 27.

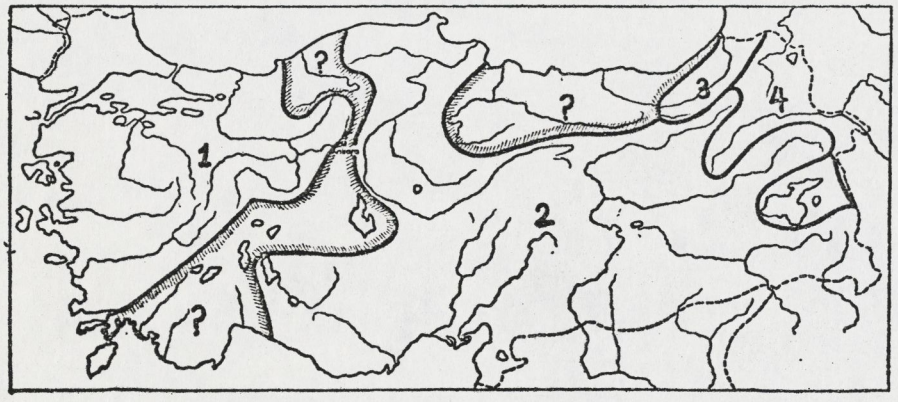
Chondrostoma cyri KESSLER : d, e, f, g, h.
Chondrostoma colchicum (KESSLER) DERJUGIN : L. O,
Cyprinion macrostomus macrostomus (HECKEL) : 12, 13, 18 .
Garra (Garra) rufa obtusa (HECKEL) : 12, 13 . 17 , 25.
Gobio persa GÜNTHER : g, h.
Leuciscus cephalus orientalis NORDMANN : A, B, C, D, G, H, I, L, N, O ; c, d, f, g, h, k ; 1, 2, 3, 5, 7, 9, 10, 12, 13, 16 , 17 , 18 , 21 , 22 , 24 , 25, 26, 27.

Rutilus frisii (NORDMANN) : G, H, I.
Vimba vimba temella (NORDMANN) : A.
Cobitis aurata (FILIPPI) : I ; f, g, h, k ; 21 , 22 , 25.
Noemacheilus angorae STEINDACHNER : L, N, P, R ; a, e, f, g, h ; 2, 3, 4, 5, 6, 7, 13 , 17, 19 , 20 , 25.

Noemacheilus panthera HECKEL : f.
Glyptothorax armeniacus (BERG) : 5, 6, 13 , 18 .
Glyptothorax kurdistanicus (BERG) : 5, 13 , 18 .
Gobius (Neogobius) fluviatilis PALLAS : A, B.
Gobius (Ponticola) cephalarges constructor (NORDMANN) : G ; c.
Mastacembelus simack (WALBAUM) : 9, 14 ,.
Mugil auratus RISSO : E.
Tor grypus (HECKEL) : 12, (in Hamburg Museum)

*I wish to express my sincerest thanks to Dr. Fethi AKŞIRAY, of the Hidrobiological Research Institute in Istanbul, for his kind allowance to study material collected by him on some places of the Murat suyu, not published until now.

The distribution of the three species of *Chondrostoma* occuring in Anatolia has been an object of some discussion in the past. It has been the merit of LADIGES (1966) to clear up the complex situation. According to LADIGES the European species *Chondrostoma nasus*, occupies the whole of Western Anatolia, i.e. the river systems between the Sakarya and the Great Menderes. *Chondrostoma colchicum* is, on Turkish territory, restricted to the Çoruh system and *Chondrostoma cyri* to those of the Kura and the Aras. Unfortunately for the fourth species, *Chondrostoma regium*, by a misleading indication of the locality Ahırköyü on his map LADIGES shows the distribution area of this species wrongly. Ahırköyü is not situated in the most Southwestern region of Turkey but really it is a place in Eastern Anatolia on the Murat river in the proximity of Elazığ, (see map 1 locality 12). *Chondrostoma regium* therefore was found until now in the Kızılırmak, emptying into the Black Sea, in the streams emptying into the Mediterranean from the Göksu to the Seyhan and the Ceyhan and in the Euphrates-Tigris system. The species even lives in the Lake of Beyşehir in the closed Central Anatolian lake region. As will be understood from map 2, only for the Filyos Çayı, the Yeşilırmak and the Harşit çayı in the North and for some streams in Southwestern Anatolia no data can be given for the moment. The differences between the four are very slight, more or less clearly expressed by different numbers of the pharyngeal teeth row. As mentioned above a systematic revision is outside the frame of this paper. But it is worth mentioning that no locality is known from where two"species" are known as living sympatrically, as claimed by earlier authors. The four Anatolian species of the genus *Chondrostoma* living allopatrically and being very near to one another in characters of systematic value the question may be raised if they have not to accepted only as subspecies of the widely distributed *Chondrostoma nasus* (LINNE).



Map 2 : The disrtibution of the *Chodrostoma species in Turkey :* 1) *Chondrostoma nasus*, 2) *Chondrostoma regium*, 3) *Chondrostoma colchicum*, 4) *Chondrostoma cyri*.

Beside the species caught in the course of many trips three species have to be added to our list. *Leucalburnus satunini* (BERG), mentioned from the upper reach of the Kura couldn't be found by us. For technical reasons *Silurus glanis* LINNE which is known within our area from the Aras, could not be caught with our fishing gear. Finally *Barbus xanthopterus* HECKEL (according to KARAMAN synonym to *Barbus esocinus* HECKEL) can be added to the species list of our region. This species occurs ascending during its spawning migrations up to the upper reaches of the Euphrates.

The comparative study of the distribution areas of the different species living in our region shows some very interesting facts. Four species (*Salmo trutta, Leuciscus cephalus, Alburnoides bipunctatus* and *Noemacheilus angorae*) are represented in the three large river systems, Çoruh, Aras-Kura and Euphrates (Karasu and Murat suyu). Three of them (*Salmo trutta, Leuciscus cephalus* and *Alburnoides bipunctatus*) existing also in the small rivers emptying into the Black Sea; these small rivers will for some reasons be discussed later, showing some peculiarities. On the other hand the large majority of our species is restricted to only one of the three systems mentioned above. There are only three species asking for special discussion. *Cobitis aurata* was found by us in the Aras and in the Murat river. This species is restricted to fast running waters with sandy bottom. It may be possible that in the Çoruh river no suitable biotop was found by us. So this species may be added to the four ubiquitous species in our region mentioned above. According to KARAMAN, *Barbus plebejus* in the same subspecific status is living as well in the Euphrates as in the Aras. By earlier authors (BERG) *Barbus lacerta* was accepted as a representative of this widely distributed species in the Euphrates-Tigris system, whereas members of this species in the Kura were described as *Barbus lacerta cyri* (FILIPPI 1865) by BERG in 1949. In our material as will be understood from table 2, we could find no remarkable differences in characters of systematic value between individuals caught in the Euphrates system and those from the Aras, e. g. in the number of scales in the lateral line. Taking into consideration the fact that *Barbus plebejus escherichi*, widely distributed in Anatolia and found in our material not only in the Çoruh but also in the small rivers emptying into the Black Sea, is only slightly different in meristic characters from *Barbus plebejus lacerta* sensu KARAMAN. This species may be added to the ubiquitous species too. *Barbus capito* is the species the distribution area of which, according to KARAMAN, is by far the largest of all fresh water fish species of Anatolia. *Barbus capito* is known from North Africa, the Pyrene peninsula, from different places in Western and Southern Anatolia, from the Kura and Aras basins, and even from rivers emptying into Lake Aral. In our material there are only six individuals from this species of high zoogeographical interest. Two of them were found in the Çoruh system, four in the Aras. This material is too small to decide if they are members of different systematic units or not. It has also to be added that the subspecies *Barbus capito pectoralis* which, according to KARAMAN, is expected to occur also in the Euphrates-Tigris system, where until now it may have been mixed with *Barbus plebejus lacerta*.

Concerning *Glyptothorax armeniacus* a matter left in doubt by BERG, could also cleared up. The Muhlis Deresi, mentioned by BERG, and in his opinion emptying into the Aras, is according to Erzurum map 1 : 200.000 C-XIII, an affluent of the Karasu, i. e. the Euphrates system. Therefore the genus *Glyptothorax* has to be accepted as restricted to the Euphrates-Tigris system.

Table 2

Scale number in the lateral line of *Barbus plebejus lacerta* (sensu KARAMAN 1971)

Aras - Kura system		1		1	1	2	2	1	1			
Euphrates basin	1	3	4	4	11	10	11	6	3	2	2	1
	59	60	61	62	63	64	65	66	67	68	69	70

DISCUSSION

It is well known that from the geological point of view, Eastern Anatolia is a very young country in comparison with Asia Minor sensu strictiori. Whereas Asia Minor, i. e. Western and Central Anatolia, became terrestial in the course of the Miocene, Eastern Anatolia is of later origin. Asia Minor was connected during a long period with Europe, the Aegean Sea being of later origin. According to this situation occupation of Asia Minor occured primarily from the West.

By this way genera like *Leuciscus* and *Chondrostoma* which were largely distributed in Asia Minor at that time, could enter our region freely when freshwater ways became opened into the new landmass of Eastern Anatolia. The wide distribution of these genera was facilitated by a large Central Anatolian lake system, into which probably the upper reaches of the Euphrates, i. e. the Karasu and the Murat Suyu, emptied too. By this way representatives of genera of European distribution found ways towards the East, differentiating into units of more or less systematical value. According to BANARESCU the nearest relative of *Noemacheilus angorae* which is abundantly represented in all Anatolian water systems (with the exception of small rivers emptying into the Eastern part of the Black Sea) is the European *Noemacheilus barbatulus*. Therefore this species has to be accepted as of European origin too. As a result of the connection of Anatolia to Western Asia by its Eastern parts, elevated from the Sea during the Pliocene, genera of West Asian origin became enabled to occupy our region and spread further to the West. By this way the genus *Capoeta* entered Anatolia down to its Western coast. So we can imagine the mixing of the faunae of different origin in our region as a result of geomorphological changes at the end of the Tertiary. With the beginning of the Glacial period a new event entered into this animated panorama. During this time the elevation of Eastern Anatolia to more than 1.500 meters over sea level caused some important changes in its faunistic composition : On the one hand relatively thermophilous forms may have been removed to more suitable regions in the lower parts of the different river systems in statu nascendi, whereas, eurythermous forms as e.g. *Leuciscus cephalus* and *Alburnoides bipunctatus* persisted in the cooled regions of higher altitude. Simultaneously a species of Northern origin, *Salmo trutta*, was able to enter the rivers

of Anatolia by two ways : the one through the glacial Mediterranean, the other via the Black Sea.

Towards the end of the Tertiary Eastern Anatolia became connected not only with Western Asia, but also with tropical Southwest Asia, the last connection of the Mediterranean with the Indian Ocean, the so called Syrian-Iranian Sea, being gradually transformed into a landmass. This sea had its Northern end in the Turkish province Hatay continuing through Syria and Mesopotamia, finding its southern end in the gulf of Umman. By the desiccation of this marine structure and its transformation into a landmass, containing freshwater systems, a contact was assured between Southern Asia on the one hand, Arabia and Africa on the other. As a result of this event an invasion of elements of the South Asian fauna into Africa began on a large scale, simultaneously members of this South Asian fauna entered Anatolia. Relicts of this tropical fauna e.g. the genera *Hemigrammocapoeta* and *Acanthobrama* persist until now on certain suitable places, even in Western Anatolia. It is easily understandable that as a result of the climatic changes during the Pleistocene, these early tropical invasors were partly destroyed and partly driven into refuges in Anatolia. This rich tropical fish fauna found suitable conditions to persist in Mesopotamia from where a reinvasion towards the north, by aid of the Euphrates-Tigris system, occured at the end of the Pleistocene. We find these Mesopotamian elements in our region only in the Karasu and in the Murat Suyu. During wet periods this Mesopotamian fauna was distributed also to Syria, Palestine and Southern Turkey (from Hatay to Tarsus).

In relation with the expansion of Mesopotamian elements to the upper reaches of the Murat suyu, the fish fauna of the closed basin of Lake Van is of special interest. In an earlier period, a large freshwater lake covered the region of the modern Lake of Van and of the plain of Muş emptying into the Murat suyu. Only later, as a result of volcanism, the Eastern part of this inland lake was separated, building the brackish Lake of Van. In the small streams emptying into this lake, relicts of the old freshwater fauna of the Van-Muş inland lake is still persisting. The following species are known from these rivers :

1) *Chalcalburnus tarichi* (PALLAS)
2) *Barbus plebejus ercisianus* KARAMAN
3) *Capoeta capoeta kosswigi* KARAMAN
4) *Noemacheilus angorae* STEINDACHNER

These species are either of European or of Western Asiatic origin, forming partly morphologically differentiated subspecies ; not a single representative of the Mesopotamian fish fauna is living in these small streams. From these facts it may be concluded that the occupation of the Murat suyu by the Mesopotamian fauna occured only after the Lake of Van was cut up from the plain of Muş. With the exception of *Salmo trutta* all freshwater fishes in our region mentioned until now are primary freshwater fishes the distribution of which was assured by freshwater ways in the past. As a result of the formation of freshwater ways between

Anatolia and Mesopotamia some genera of European origin (*Leuciscus* and *Chondrostoma*) and members of the Western Asian fish fauna as *Capoeta* expanded their area of distribution southwards to Syria, Palestine and Mesopotamia as mentioned above during the Glacial period only some cold-tolerating species persisted in the center of Eastern Anatolia. We have to imagine that during this cold period the formation of the modern river systems was not yet established and many contacts by stream capturing may have occured in this time. The cold-tolerating forms as *Salmo trutta, Leuciscus cephalus orientalis* , *Alburnoides bipunctatus fasciatus* and *Noemacheilus angorae* found chances to pass freely from one water body to the other, before the definite formation of modern river systems. In the contrary, the majority of the forms in our region is restricted to one of these systems. These species may have survived in regions of lower altitude and therefore higher temperatures during the Pleistocene. Suitable refuges were the Central Anatolian lake system in the West and the lowland of the Kura and Aras basin in the East. Finally Mesopotamia built a third refuge and later a new distribution center. In the contrary to the four ubiquitous species of our region, the other forms differentiated during the isolation in different refuges forming different species or subspecies in each of the three big river system of modern Eastern Anatolia.

The Black Sea is a brackish sea with a salt concentration of only 16‰ in its Eastern parts. Some species of primary freshwater fishes , e.g. *Vimba vimba tenella, Chalcalburnus chalcoides derjugini* and *Rutilus frisii* are able to tolerate this salt concentration, wandering between freshwater rivers and the Black Sea. Even small rivers of our region emptying into the Black Sea formed a mean for the distribution of these primary freshwater fishes over many of these streams of Eastern, Central and Western Anatolia. *Capoeta capoeta sieboldi* and *Capoeta tinca* may be shown as examples for this type of distribution, the two forms occuring e. g. in the Çoruh, the Kızılırmak and the Sakarya. The latter one is even living in the Lake of Iznik.

The Black Sea and the Caspian Sea originated from the Sarmatian inland sea, therefore a part of the fauna of these seas is of marine origin. The two Gobiids found in our material are members of this old Sarmatian fauna. It is interesting to state that the two species are living as well in the Black Sea as in the Caspian today. *Gobius platyrostris cyrius* was found by us in the Yaka Deresi emptying into the Black Sea and also, in an altitude of nearly 2.000 meters, in the upper reach of the Kura, emptying into the Caspian. *Salmo trutta* in form of its subspecies *labrax* is also an inhabitant of the Black Sea today. So it is possible that some nationes *fario* living in Anatolia derived from *Salmo truttala brax*. On the other hand the wide distribution of trouts in form of many isolated populations, practically in all river systems in Anatolia and even in the upper reaches of the Euphrates-Tigris system proves definitely that *Salmo trutta* has to be accepted on most places as a Glacial relict. After the separation of the Black Sea from the Caspian and the formation of the Bosphorus and the Dardanelles, the Black Sea was invaded on a large scale by Mediterranean species. From these, one species, *Mugil auratus*, is represented in our collection from the İyi dere. Other species of Sarmatian or Mediterranean origin may be found in future by further reseacrch of the rivers emptying into the Black Sea.

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bution pattern of th
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may be mentioned

Example

SPECIES

Salmo trutta .....
Capoeta capoeta umbla
Alburnoides bipunctatus
Leuciscus cephalus orien
Chondrostoma regium

Examp

SPECIES

Glyptothorax armeniacu
Glyptothorax kurdistani
Chondrostoma regium
Noemacheilus angorae
Alburnoides bipunctatus
Capoeta capoeta umbla
Capoeta trutta .....

Example

SPECIES

Mastacembelus simack
Leuciscus cephalus orie
Chalcalburnus mossule
Capoeta trutta .....
Alburnoides bipunctatus
Acanthobrama marmid

Example

SPECIES

Cyprinion macrostomu
Garra rufa obtusa ...
Leuciscus cephalus orie
Chalcalburnus mossule
Chondrostoma regium
Capoeta capoeta umbl
Acanthobrama marmid

Exa

SPECIES

Gobius cephalarges co
Alburnus filippii ..
Leuciscus cephalus ori
Capoeta capoeta cap
Alburnoides bipunctat

From the geological history of our region given above and from the distribution pattern of the different elements of our freshwater fish fauna it becomes evident that Eastern Anatolia gives a remarkable example for the mixing of faunae of quite different origin as a result of the changes occuring since the end of the Pliocene. For giving some examples of this mixture only the following ones may be mentioned :

Example : 1. From locality number 10 on the Murat river (map 1)

SPECIES	ORIGIN
Salmo trutta	Glacial relict
Capoeta capoeta umbla	Western Asia
Alburnoides bipunctatus fasciatus	Central and Eastern Europe
Leuciscus cephalus orientalis	Western, Central and Eastern Europe
Chondrostoma regium	Southern and Central Europe

Example : 2. From locality number 5 on the Karasu (map 1)

SPECIES	ORIGIN
Glyptothorax armeniacus	Central Asian Mountains
Glyptothorax kurdistanicus	Central Asian mountains
Chondrostoma regium	Southern and Central Europe
Noemacheilus angorae	Europe
Alburnoides bipunctatus fasciatus	Central and Eastern Europe
Capoeta capoeta umbla	Western Asia
Capoeta trutta	Mesopotamian element

Example : 3. From locality number 9 on the Murat river (map 1)

SPECIES	ORIGIN
Mastacembelus simack	Mesopotamia, Southeast Asia
Leuciscus cephalus orientalis	Western, Central and Eastern Europe
Chalcalburnus mossulensis	Eastern Europe
Capoeta trutta	Mesopotamian element
Alburnoides bipunctatus fasciatus	Central and Eastern Europe
Acanthobrama marmid	Mesopotamian element

Example : 4. From locality number 12 on the Murat river (map 1)

SPECIES	ORIGIN
Cyprinion macrostomus	Mesopotamian element
Garra rufa obtusa	Mesopotamian element
Leuciscus cephalus orientalis	Western, Central and Eastern Europe
Chalcalburnus mossulensis	Eastern Europe
Chondrostoma regium	Southern and Central Europe
Capoeta capoeta umbla	Western Asia
Acanthobrama marmid	Mesopotamian element

Example : 5. From locality d ' on the Kura river (map 1)

SPECIES	ORIGIN
Gobius cephalarges constructor	Sarmatian inland sea
Alburnus filippii	Europe
Leuciscus cephalus orientalis	Western, Central and Eastern Europe
Capoeta capoeta capoeta	Western Asia
Alburnoides bipunctatus fasciatus	Central and Eastern Europe

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(*Manuscript received on june* 19. 1971)

NATIONAL SCIENCE FOUNDATION
WASHINGTON, D.C. 20550

Dr. Robert J. Behnke
Cooperative Fishery Unit
Colorado State University
Fort Collins, Colorado 80521

Dear Dr. Behnke: Ref: 7600826

The National Science Foundation has received the enclosed proposal for a doctoral dissertation research grant on behalf of Neil B. Armantrout.

Would you kindly give us a brief statement of your view of it?

Since it is a dissertation research proposal, it is short, and the criteria of judgment should be somewhat different from those for a regular proposal. (See enclosed announcement of the program.)

I enclosed a return envelope for your convenience.

Sincerely yours,

Duncan M. Porter

Duncan M. Porter
Associate Program Director
Systematic Biology

Enclosures

76-00826

Application for National Science Foundation
Doctoral Dissertation Research Grant

On behalf of: Neil B. Armantrout - $3,537.00

Submitted by: Carl E. Bond
Carl E. Bond
Professor of Fisheries (dissertation advisor)

Approved: Neil B. Armantrout
Neil B. Armantrout

Richard A. Tubb
Richard A. Tubb, Head
Department of Fisheries and Wildlife

Approved for Institution:

JR Hay acting for Date: 7/1/75
Roy A. Young
Vice President for Research and Graduate Studies
Oregon State University
Corvallis, Oregon 97331

Application on Behalf of Neil B. Armantrout

for Doctoral Dissertation Research Grant

I. Research Proposal: Zoogeographical considerations of the freshwater fish fauna of Iran.

Iran appears to be a transitional area as concerns its fish fauna. In earlier geological times, when large rivers existed there and the central basins held large lakes, there must have been a natural passage for the exchange of African and Oriental forms. With dessication the passage, and much of the fish fauna, has been eliminated and only a few highly adaptable species persist in many areas.

Iran is shaped like a giant bowl, with the rim of mountains to 18,600 feet. The central area is mostly desert, almost totally lacking in flowing fresh water. Most fish are located in the Caspian to the north; in the Karun River, part of the Tigris-Euphrates system, to the west; and to the south in the tributaries of the Persian Gulf. Because of the mountains and central desert, little mixing of fish fauna occurs, so that the country can, in effect, be separated into four distinct areas on the basis of both drainage patterns and fish associations.

As a result of the work of Russian scientists, the fish fauna of the Caspian is the best known. Most of the species found along the Iranian shore of the Caspian have been determined, although little work has been done to determine the actual distribution of the various species. Included within the Caspian area, but not nearly as well known, is the northwestern part of Iran around the Lake Rezaiyeh (formerly Lake Urmia) basin, which once drained into the Caspian, but was disconnected because

of elevation of land. The fishes show close affinities to the Caspian Sea, but already several distinctive forms have been found in the Rezaiyeh Basin.

The Sefid Rud, the only river that cuts through the Elborz Mountains and empties into the Caspian, has headwaters near the headwater streams of rivers flowing into the Qom and Tehran basins. As a result of past connections or stream piracy, some elements of the Caspian fauna have penetrated by this route into the northwestern corner of the central inland basin.

In the northeast, the fauna is related to the Caspian-Aral fishes, but shows closer affinities with Central Asia. These fishes are found throughout the many small basins along the eastern Iranian border with Afghanistan, beginning about 100 km east of Tehran, and extending south almost to the Seistan plain.

Seistan has a rather unique fauna of its own, but is closely allied with the rest of the southeast Iran. The main source of water for Seistan is the Helmand River, arising in the mountains of central Afghanistan, and coursing across the Sind Desert to end in the Hamun-e-Helmand Lake in Seistan. Most of the fishes have arrived via the Helmand, and are quite similar to the higher mountain forms in Central Afghanistan.

The southeastern corner of Iran has, in the past, had its major connections with basins and rivers to the east. As a result, its fauna is derived from Oriental fishes, and is a depauperate western extension of the fishes of India. This fauna is found in rivers of the Jaze-Murian basin and rivers flowing into the Persian Gulf, as far west as Bandar Lengeh.

West of Bandar Lengeh, south of Rezaiyeh Basin, the fish fauna is closely associated with the rest of the Middle East. Because of prolonged contacts with the Tigris and Euphrates the Karun, largest river in Iran, has provided a natural route for fishes from the Middle East to move into the southwestern part of Iran. In the past, it appears that the Shiraz-Persepolis area also drained into the Karun River or the Persian Gulf, but has become isolated, with its streams now flowing into highly saline lakes in unconnected basins.

The Oriental zoogeographical region is generally shown extending westward only to the Indus River. The fishes of southeastern Iran, like neighbouring areas of Pakistan, are decidedly of Indian origin, and quite distinct from the rest of the country. Further study may establish for certain that the fauna of this area should, in fact, be included in the Oriental zoogeographic region, with the Oriental-Palearctic division being found in Iran rather than at the Indus River.

The majority of Iranian fishes are typical of Palearctic zoogeographical region, but show affinities to several different neighbouring areas. The northeast fauna represents the older Caspian-Aral fauna, but with many forms invading from Central Asia. In the north and west, part of the old Caspian fauna persists, but has been augmented by many northern invaders, presumably moving into the Caspian Basin via the Volga following the last ice age. Among these are the sturgeons, trout, pike, perch, and other typically northern forms not anciently found in the area. These are mostly concentrated on the western shores of the Caspian and in the northwest.

In the southwest, the fishes are predominantly Cyprinidae. This fauna, along with the rest of the area drained by the Tigris-Euphrates, contains forms derived from fishes that probably immigrated here from the east when conditions were wetter. In recent times, a number of African forms have penetrated into the area, with a few, such as Cichlids and the cyprinid genus Barbus, reaching Iran. Most of these are hardy fishes, often tolerant of high temperatures and salinities.

The Iranian ichthyofauna, despite its interesting nature, must still be classified as poorly known. What is known is mostly the result of collections made by foreign visitors, most of whom visited only limited areas, returning to study and store their materials at foreign institutions. As a result, there is still no single good collection of Iranian fishes, nor a single comprehensive outline of the systematics and distribution. The current research is an attempt to produce such an outline.

So far, much of information has been taken from the literature. Of some 4,000 references identified so far, about 300 of the more important have been used to compile a checklist and initial distribution analysis of Iranian fishes. While in Iran, Mr. Armantrout visited most parts of the country, making collections in various parts of the country. None of the material is at hand, remaining in Iran. Collections of fishes sent by Peace Corps volunteers working in Iran have been examined; these are now housed in the Oregon State University collection and in the Smithsonian Institution.

Because of the scattered nature of the collections and different systems of nomenclature used by various foreign visitors, there is

disagreement on just what fishes are found in Iran. Having had the opportunity to examine some material, and read many of the more important original papers, Mr. Armantrout is now in a position to determine just what groups and species make up the Iranian ichthyofauna, and how they are distributed in time and space.

II. Request for Support.

In order to obtain the necessary information to assist in completing this thesis on the systematics and distribution of Iranian freshwater fishes, funds are being requested for examination of collections of Iranian fishes in England, Germany, USSR, India and Iran.

There are three sizable collections of Iranian fishes which, amongst them, contain a good percentage of available Iranian species, including many types. These are: The British Museum (Natural History) in London; the Zoological Museum of the Academy of Sciences of the USSR in Leningrad, and the Indian Museum in Calcutta.

The British Museum houses a variety of specimens collected during the time the British governed what is now Iraq, Pakistan and India. Two collections of particular note are the British expedition to Lake Urmia, and the collections of the Afghan Border Delimitation Commission. Mr. Armantrout has been in contact with Mr. Alwyne Wheeler of the Department of Zoology (Fish Section), who has offered to aid in study of Iranian fishes.

The Zoological Museum of the Academy of Sciences of the USSR houses a wide variety of fishes of the kind found in northern Iran. Nearly all of the type specimens from this area are housed in the collection in Leningrad. In addition, the collections include fishes from Iran taken

by expeditions led by N. A. Zarudny, Pavlovsky, Svetovidov, and the Turkish-Persian Delimitation Commission. Mr. Armantrout had an opportunity to become aquainted with collection and examine a few particular specimens over a three day period. He was assisted by Drs. V. V. Barsukov and Vladimir Klyokanov, and has their assurance of all necessary assistance if able to return.

The third major collection is housed in the collections of the Zoological Survey of India, stored in the Indian Museum in Calcutta. Mr. Armantrout had an opportunity eight years ago to view the collection, but not to study it. This very extensive collection includes collections by officers of the Zoological Survey, 1918, in Seistan-Baluchistan; Seistan Arbitration Commission; W. T. Blanford from south and central Persia; Col. Miles, from the Mekran coastal rivers; Griffith, from Afghanistan and the Helmand River; D. D. Belayew, from Mesopotamia; and S. Ali Akhtar, from the Helmand. Additional material has been reported in papers by Day, Hora, Misra and others. In addition, at least part of the specimens located in regional museums, including Bombay, are now in the Calcutta collection.

Most of the fishes taken in recent years are housed in the new Natural History Museum, under the direction of Robert Tuck, in Tehran. This collection is not large, but does represent a wide variety of locations in Iran, including some not previously collected. Mr. Armantrout had an opportunity to look at much of this material during October, 1974, but had time only to make preliminary studies. This is a growing collection to which new material is constantly being added.

Within Iran there are two other, smaller collections worth a visit. One is in Shiraz, at Pahlevi University, containing mostly fishes from the area around Shiraz, one of the poorer known parts of Iran. The second is the Fisheries Institute of the North Shilot in Bandar Pahlevi. The latter was compiled during studies along the Caspian, and during visits to the west and northwest of Iran. At both locations, Mr. Armantrout has maintained contact with people concerned with the collections and has been offered all necessary assistance in any research.

One final collection included in this request is one made by Dr. Wilhelm Numann over a period of several years while advising the Iranian government on fisheries problems. This material is now housed in the collection at the University of Hamburg, in Germany. Some of these fishes are from little-known areas, and at least two are reported to be new species, while several others would represent major new distributional records for Iran. This collection, while not large, would appear to be of interest in the current research on the systematics and distribution of Iranian fishes.

Tentative schedule and budget
Starting date: March 1, 1976

Location	Transportation	Days subsistence
Portland to London	Air, Portland--London	
London		20
London--Hamburg	Air, London--Hamburg	1
Hamburg		5
Hamburg--Leningrad	Air, Hamburg--Leningrad	1
Leningrad		13
Leningrad--B. Pahlevi	Air, Leningrad--Baku, boat, Baku--B. Pahlevi	2
B. Pahlevi		5
B. Pahlevi--Tehran	Bus, B. Pahlevi--Tehran	1
Tehran		12
Tehran--Shiraz	Air, Tehran--Shiraz	1
Shiraz		4
Shiraz--Tehran	Air, Shiraz--Tehran	1
Tehran		9
Tehran--Calcutta	Air, Tehran--Calcutta	1
Calcutta		14
Calcutta--Portland	Air, Calcutta--Portland	

Cost of fares:

Portland--Leningrad	$ 608.00
Tehran--Shiraz, round trip	91.30
Tehran--Calcutta	343.40
Calcutta--Portland	1,094.30
Leningrad--Baku	48.00
Baku--B. Pahlevi	19.00
B. Pahlevi--Tehran	3.00
	$2,207.00

Cost of subsistence

90 days at $15.00/day	$1,350.00
Total request	$3,557.00

III. Other financial aid: None

IV. Biogeographical data:

Name: Neil B. Armantrout

Present address: 445 N.W. 12th, Corvallis, Oregon 97330

Birth date: 22 April 1941

Education: B.S. 1963, Oregon State University, Zoology

M.S. 1964, OSU, General Science

At OSU, 1969-1972, completed courses in Ichthyology, marine biology, fisheries, and zoogeography, statistics.

Approximately 40 hours of graduate work taken at the University of Oregon under joint campus enrollment program.

Society membership: Am. Fish. Soc; Sigma Delta Chi

Publications: "King Range National Conservation Area aquatic inventory," 1973 proc. Cal-Neva sect. Am. Fish. Soc. In addition, several research reports submitted to the Game and Fish Dept. of Iran and the South Shilot on studies on marine fishes, salmon, and other freshwater fish resources, with recommendations for management of resources. One report submitted to BLM on the environmental study of the geothermal area of northern Calif. (Sonoma Co.); and on the KRNCA aquatic inventory, with management recommendations.

Related work experience:

1964-1965, research biologist with the Department of Fisheries, state of Washington. Carried out studies on enumerate salmon runs and studies of factors affecting run size. Participated in stream analysis for the Puget Sound Basin Study. Carried out limnological and biological

studies, and feeding habits of immature salmon, in enclosed marine estuaries.

1965-1967, member of U.S. Peace Corps. Stationed Pahlevi University in Shiraz, Iran, where taught physiology and parasitology in the biology department, shared courses in anatomy and physiology, and obstetrics in the nursing school, and lectured in reproductive physiology at the medical school. In addition, assisted in the founding of a natural history museum at Pahlevi University, collecting some freshwater and marine aquatic organisms. During two summers, conducted some studies for the South Shilot in the Persian Gulf, and in inland streams for the Game and Fish Department of Iran.

1967-1968, worked for the Game and Fish Department of Iran, with the primary assignment being to assess the salmon runs in the Caspian and make recommendations for their management. In addition, began a program of resource analysis that included a file on the streams and lakes of Iran, with visits being made to many streams throughout the country. In addition, developed a preliminary checklist of Iranian fishes, and carried out some additional collecting and observation.

Since 1969, associated with Oregon State University graduate program. During this time, worked for a six month period in 1972 and a three month period 1973 for the BLM, carrying out resource analysis and environmental impact studies, with principle effort being directed towards the King Range National Conservation Area.

1973-1974, lecturer in ecology and environmental sciences at University of Tabriz, Tabriz, Iran. Contracted to teach in special M.S. program which never materialized. At the completion of contract,

terminated association with University. Taught ecology, environmental science and ichthyology to biology majors, juniors and seniors.

Languages: Good working knowledge of Farsi (Persian); reading knowledge of Russian.

for carbon - return to me

NATIONAL SCIENCE FOUNDATION

PROPOSAL RATING SHEET

DISSERTATION

Reviewer

Proposal No.: 7600826
Investigator: Bond, Carl E.
Institution: Oregon State Univ.
Please return to: Systematic Biology
If possible by:
AUG 28 1975

Comments (*Continue on additional sheet if necessary*)

I regret that I was requested to review the application of Mr. Armantrout because his objectives clearly conform to the guidelines for grants for improving doctoral dissertation research and are well presented. I would also like to assist Mr. Armantrout in completion of his thesis because I am also involved in a study of Iranian fishes.

The fact is, however, that the most valuable collection of Iranian fishes, representing every desiccating basin in the country, is not in the museums listed by Mr. Armantrout, but in my personal collection in Fort Collins and Mr. Armantrout helped to collect them with me in Iran last year. I have told him to come to Fort Collins and study Iranian fishes, but I believe Mr. Armantrout is obsessed with the idea of visiting museums in a never ending fashion (he has already been to the museums listed, except for Hamburg).

I was amazed to find that Mr. Armantrout had spent eight years in Iran, in all parts of the country, but never collected a specimen until I invited him to join my expedition. He had, however, compiled volumes of literature and visited many museums. I am not certain of the term to characterize this psychological condition but it will make completion of the proposed thesis a doubtful and difficult task.

OVERALL RATING

- ☐ EXCELLENT
- ☐ VERY GOOD
- ☐ GOOD
- ☐ FAIR
- ☐ POOR

Signature of Reviewer:

Other suggested reviewers (*optional*):

NSF Form 173, January 1968

"Reviewers' comments are solicited and received in confidence by the National Science Foundation, an agency of the U.S. Government, and will be given maximum protection from disclosure permitted under applicable laws, including 5 U.S.C. 522 (The Freedom of Information Act)."

نخست وزیری
سازمان حفاظت محیط زیست
Department of the Environment

27 December 1975

Dr. Robert Behnke
Department of Fishery and Wildlife Biology
Colorado State University
Fort Collins, Colorado 80523
U.S.A.

Dear Dr. Behnke:

The Department's policy is that any specimens loaned to you from the Department Museum should not be loaned out again to third parties as the dangers of loss or damage of the specimens in shipping are great and many of these specimens are unique and have never been collected before.

We have no objection to other parties examining the specimens at CSU; however, please do not loan them out to third parties. Our desire is that these specimens remain at CSU for use by Mohammad Saadati in completion of his M.S. thesis on the freshwater fishes of Iran, their taxonomy and distribution.

Sincerely yours,

Eskandar Firouz

Eskandar Firouz
Vice Premier
and
Director, Department of the Environment

EF:mp

P. O. Box 1430 Tehran, Iran Cable: Environment

1 Mokhayer, B. 1976. Fish diseases in Iran.
Riv. It. Piscic. Ittiop. 11 (4): 123-128. English with Italian summary. — Fac. Vet. Med. P.O. Box 3262, Tehran.

2 _____ Treatment of Bothriocephalosis in grass carp. Ibid: 119-121.

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3 Al-Daham, N.K., M.F. Hug and K.P. Sharma. Notes on the ecology of fishes of the genus Aphanius and Gambusia affinis in Southern Iraq. Freshwater Biol. 7(3): 245-51

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4 - The Nile - Monographiae Biologicae vol. 29
Greenwood chapter on fishes -

DEPARTMENT OF FISHERY AND WILDLIFE BIOLOGY

MEMORANDUM

ANNOUNCEMENT OF FACULTY-GRAD STUDENT SEMINAR MEETING

All Faculty and Graduate Students of the Department of Fishery and Wildlife Biology are urged to attend the third meeting of the Faculty-Grad Student Seminar.

DATE:	Monday, October 17, 3-4 p.m.
PLACE:	Room 220-222 Student Center
SPEAKER:	Fred Harrington
TOPIC:	"Conservation in Southwest Asia"

23 January 1978

Mr. Robert G. Tuck, Jr.
Department of Environment-Museum
Box 1430
Tehran, Iran

Dear Bob:

Mohammad Saadati has completed his thesis on the freshwater fishes of Iran and has returned home.

His thesis is much more comparable to a good Ph.D. thesis than to a M.S.--it is an excellent piece of work, thoroughly detailed and comprehensive. When Saadati returns with the thesis I would appreciate it if you and the Director of the Museum could take the time and read it through, with a consideration for having the Department publish a modified version in book form. It should attract favorable international attention. We have both put in considerable time and effort on this project and it would be a shame not to give this work a broader exposure and circulation than would be possible for an unpublished M.S. thesis. For a publication, we would make some modifications; I would re-write certain sections and more illustrations might be considered. I would be agreeable to accept junion authorship on the work if the Department will publish it.

As you will note when you read the thesis, Mohammad not only has put together the first original, authoratative and comprehensive work on the freshwater fishes of the country, but has made some incisive conslusions on past climatic and hydrographic conditions in the country based on the evidence of fish, zoogeography and speciation. Thus, the thesis will have a much greater potential interest to a wider audience than if it were strictly a taxonomic work.

Brian Coad, a Canadian teaching at Pahlavi University, has also been working on the freshwater fishes of Iran. Brian is a fine person and, I believe, is quite competent, but we have put together much more data and examined many more specimens from more areas than Brian was able to do. Since Mohammad is a Departmental employee and I was employed by the Department, it seems only logical that the Department should get credit for our work before a similar, but less comprehensive work is published (Neil Armantrout is again planning museum visits this year, but I really don't believe Neil will ever put it all together).

I have just received a manuscript by Coad to review for Copeia. The paper is entitled: "Alburnoides gunni, a new species of cyprinid fish from southern Iran." Enclosed is a carbon of my review. The type specimens are deposited in the National Museum of Canada; all acknowledgements are to

Canadians. There is no mention of the paper in reference to Iranians or Iranian agencies in relation to fish collections and ichthyological studies.

It would be agreeable with Mohammad and I for you to participate in assisting with maps, illustrations, editing, etc., in which case, you could become a co-author of the proposed book. As you will note, there are several areas where you could participate. Several new taxa must be named, from a new genus to several new species and subspecies. We need names, type specimens and in some areas, additional collections. The Department could put a price on the book to recoup some of the costs. I believe with reviews in international journals, the demand would be moderately high.

Another point for consideration concerns Mohammad's future employment with the Department. He has received a fine education here, both in general fisheries biology and in systematics-taxonomy. Could an arrangement be worked out so that he could be assigned at least half time to the museum, perhaps as "Curator of Fishes"? His education and research experience has been far more rigorous than any Iranian has yet received in fisheries from a foreign school. His expertise should certainly have input to the Department's fisheries program, but his in-depth knowledge of systematics, zoogeography and taxonomy would be most valuable to the Museum and there are still some collections we need to answer certain questions posed in the thesis.

Thanks for your thoughtful card and let me wish you a happy and productive New Year.

Sincerely,

Robert Behnke
Asc. Prof. Fish. Biol.

14 March 1978

Dr. P. Bianco
Instituto di Zoologia
Universita Degli Studi di L'Aguila
Piazza Regina Margherita, 7
L'Aquila, Italy

Dear Dr. Bianco:

In 1974 I was employed by the Iranian Department of the Environment as a fisheries consultant. Part of my duties concerned making collections of fishes from all of the separate drainage basins of the country and to assist in the education of Iranian fishery students. I selected Mr. Mohammad Saadati, an employee of the Department of Environment, to return to Colorado State University with me to study the collection of Iranian fishes and write a thesis for his graduate study. Mr. Saadati has recently completed this work and returned to Tehran in January. I have written to the Department of the Environment requesting that they publish Mr. Saadati's thesis as a book and make the information available. My collection is, by far, the most comprehensive collection made from the interior of Iran and includes the drainages of the Persian Gulf from the Tigres-Euphrates system to the Minab River (east of Bandar Abbas). We discovered many new species and much of zoogeographical significance. I would here mention an undescribed species (and probably representing a new genus related to the Tilapia group) of cichlid fish which occurs in coastal rivers east of the Tigres-Euphrates. In the coastal drainages, we found the genus Varicorhinus was found only in the Mond River drainage and in the headwaters of the Minab R.). How little is known about the fish fauna of the region can be exemplified by our collections from the Tigres basin. The genus Alburnoides has not been previously reported from the entire Tigres-Euphrates system. We identified 5 species of Alburnoides--one appears to be A. bipunctatus and four are undescribed.

I plan to make a summary of our findings for Professor Kosswig and Dr. Villawock of the Hamburg Museum. When I do, I will make copies for you and Dr. Banister.

I do not have plans to return to Iran in 1978, but would suggest you contact Mr. Saadati at the Department of Environment, P.O. Box 1430, Tehran, Iran, regarding fish collections to see if any plans for further collections are being made in which you might participate. I would also suggest you contact Dr. Frian Coad, Biology Department, Pahlavi University, Shiraz, Iran. Coad, a Canadian ichthyologist, has been teaching at Pahlavi University and has made several fish collecting trips.

I was wondering who you worked with in Iran in 1975, 76, 77. Evidently, Mr. Saadati and people in the Department of Environment are unaware of your Iranian fish study.

There is certainly much to be learned about Iranian freshwater fishes. My collections were aimed at samples from each separate basin. We moved around the country in Landrover vehicles and emphasized spot samples from many diverse areas rather than intensive sampling in any particular drainage basin. Undoubtedly there is much we overlooked.

I would appreciate it if you could send me your identification (to genus) of your fishes and the drainage basins from which you collected them. From this I should be able to tell you what species you have and which ones are likely to represent undescribed species.

Sincerely,

Robert Behnke

VOLUME 2 NUMBER 4 JANUARY, FEBRUARY, MARCH 1978

PARKS

AN INTERNATIONAL JOURNAL FOR MANAGERS OF NATIONAL PARKS, HISTORIC SITES, AND OTHER PROTECTED AREAS



PARKS

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Cover: Perforated stone stupas containing statues of Buddha grace the ancient Temple of Borobudur in Central Java. The stupa which originally protected the statue in the foreground has not been reconstructed. Photo: UNESCO/ David Davies. Back cover: Bicycle path through climax beech and red maple forest on stable dunes, Cape Cod National Seashore, Photo: Paul J. Godfrey.

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W. Brown Morton III

The Preservation of Borobudur, Indonesia

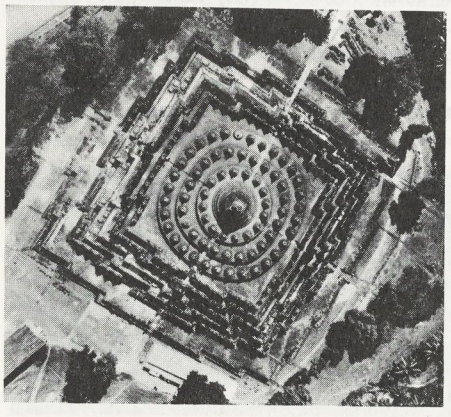
There is a folk tradition in Indonesia that the island of Java had to be nailed in place to fix its location in the ocean and that the head of the nail is the hill in south central Java known today as Tidar. The countryside around "The nail of Java" is renowned for its lush beauty, its fertility, and for its four volcanoes. One of these volcanoes, the Merapi, rises to a height of 2911 meters and is still active. Fifteen kilometers south of Tidar hill in a dramatic setting of jagged mountains, rice paddies, and forest is located the extraordinary stone pyramid known as Candi Borobudur, built in the 9th century A.D. (Figure 1).

In 1971, the Government of Indonesia and the United Nations Educational, Scientific and Cultural Organization (UNESCO) began an ambitious U.S. 7.75 million dollar preservation program to stabilize and preserve Borobudur. The program is now well under way and the technical methods being developed and used here deserve our notice and careful study.

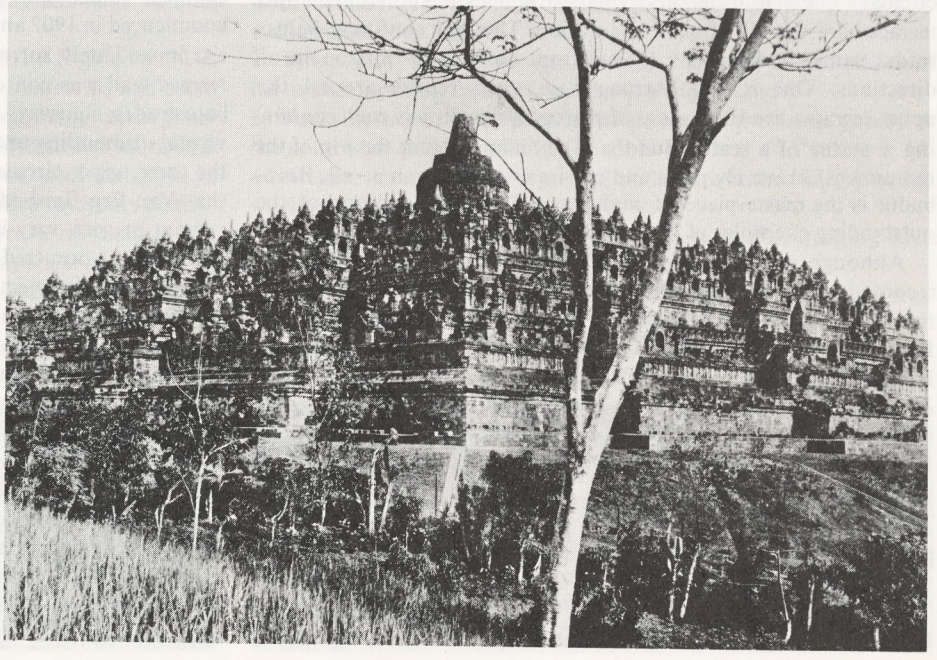
In Indonesia, the word Candi refers to an ancient religious monument but does not necessarily designate a temple. The origin of the word Borobudur itself is obscure. There is general agreement, however, that the monument was constructed beginning in the mid-9th century and formed the central feature of a Buddhist monastery complex. Borobudur is essentially a stepped dry stone pyramid built on the rise of a low hill. The structure is composed of nine stone terraces rising to a bell shaped stupa at the top (Figure 2). The first six terraces are square in plan. The balustrades and walls of the square terraces are covered with 1460 panels of exquisite bas-relief sculpture representing scenes from sacred Buddhist texts. The topmost three terraces are circular in plan. The first terrace is 123 meters square at the base and the monument rises to a height of 35 meters above grade. Borobudur is built of dressed grey-brown volcanic stone constructed around a core of earth fill. It is laid up without mortar in an intricate interlocking pattern to permit slight movement without danger of collapse in the case of seismic activity or minor settlement. Borobudur is oriented on a north-south, east-west axis and access to the top is provided by steep stairs in the center of each face. These four stairs also provide access to the nine terraces. The monument has no interior space and therefore is not, strictly speaking, a place of worship; it functions as a Buddhist holy place of pilgrimage and symbolizes through its form and plan the Buddhist concept of the organization of the cosmos and the path man must take through it to achieve union with God. (Figure 3).

In the 9th century, the builders of Borobudur conceived of it as a





Left, Figure 1. Borobudur: Site plan of Candi Borobudur showing village to the east and project working area to the southwest. (Photo: Japan International Cooperation Agency) Below, Figure 2. Borobudur: General view showing condition in 1969. (Photo: BPCB) Below left, Figure 3. Borobudur: Aerial View showing transition from square to circle. (Photo: BPCB)



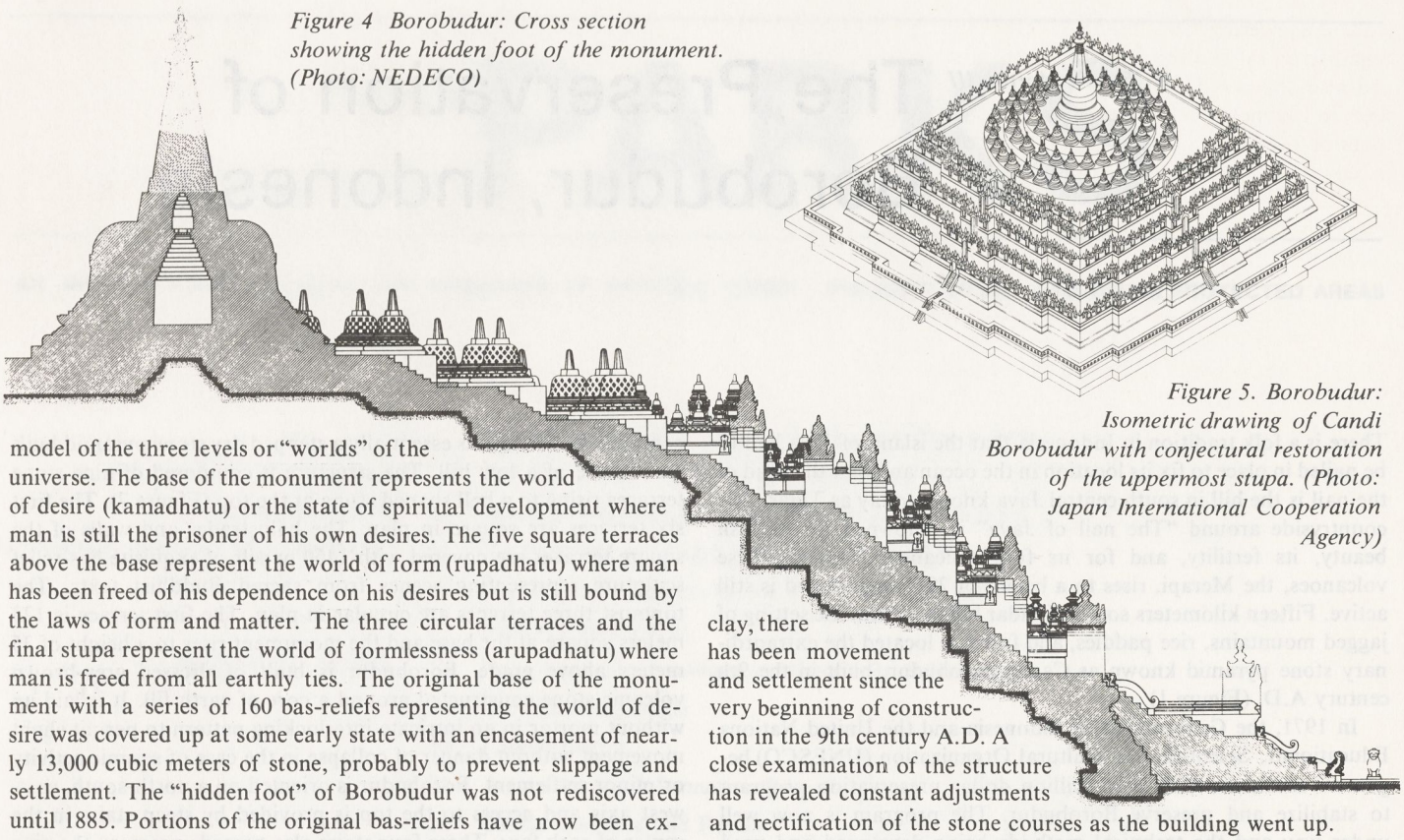


Figure 4 Borobudur: Cross section showing the hidden foot of the monument. (Photo: NEDECO)

Figure 5. Borobudur: Isometric drawing of Candi Borobudur with conjectural restoration of the uppermost stupa. (Photo: Japan International Cooperation Agency)

model of the three levels or "worlds" of the universe. The base of the monument represents the world of desire (kamadhatu) or the state of spiritual development where man is still the prisoner of his own desires. The five square terraces above the base represent the world of form (rupadhatu) where man has been freed of his dependence on his desires but is still bound by the laws of form and matter. The three circular terraces and the final stupa represent the world of formlessness (arupadhatu) where man is freed from all earthly ties. The original base of the monument with a series of 160 bas-reliefs representing the world of desire was covered up at some early state with an encasement of nearly 13,000 cubic meters of stone, probably to prevent slippage and settlement. The "hidden foot" of Borobudur was not rediscovered until 1885. Portions of the original bas-reliefs have now been exposed to view (Figure 4). The square terraces of the world of form have narrow walkways encircling the pyramid. These walkways are flanked by high ornate stone balustrades which carry the sculptured panels and support hundreds of niches, each containing a statue of a seated Buddha. The ornate decoration of these terraces and the visual and physical confinement of the terrace walkways reinforce the symbolism of "rupadhatu" and give Borobudur its essential character when seen from a distance. At the sixth level, the visitor passes through a small cramped archway and emerges out onto the three upper levels of the monument, into the world of formlessness. The actual experience of this transition is as dramatic as a clap of thunder. The plan of the monument changes from square to circular. The elaborate carved panels and niches cease. The upper terraces are virtually free of decoration. The high confining balustrades vanish and one can see out from horizon to horizon in all directions. One is free. Arranged in quiet repose around the upper terraces are three rings of pierced stone stupas each containing a statue of a seated Buddha. The main stupa at the top of the monument is severely plain and carries no decoration at all. Borobudur is the masterpiece of mahayana Buddhism and one of the outstanding examples of objective religious art (Figure 5).

Although the early history of Candi Borobudur is not well recorded, it is probable that the monument fell into disuse in the 15th century when the people of Java were converted to Islam. Borobudur was rediscovered in 1814 during the brief period of British occupation of Java. The Lieutenant Governor-General of Java, Sir Thomas Raffles, had a report of the structure prepared by Cornelius, a Dutch engineer. The first scholarly monograph on Borobudur was published in 1873. When the 'hidden foot' was uncovered in 1885, this discovery sparked wide public interest in Borobudur which in turn led to a decision by the Dutch colonial government to stabilize and restore damaged sections of the structure.

Because Borobudur is built of cut and fitted volcanic stone blocks assembled without mortar around a central core of sandy clay, there has been movement and settlement since the very beginning of construction in the 9th century A.D. A close examination of the structure has revealed constant adjustments and rectification of the stone courses as the building went up.

Over the centuries intermittent seismic activity, water penetration, the uncontrolled growth of vegetation, vandalism, and neglect had taken their toll of this proud "cosmic mountain." Walls had cracked and leaned badly out of plumb. The upper stupa and most of the smaller perforated stupas on the upper terraces had collapsed and many of the statues were missing in whole or in part (Figure 6). The movement of the walls had caused major damage to bas-relief sculptured panels. Uncontrolled water seepage had weakened the clay fill and encouraged deterioration of the surface of the stones, both plain and sculptured.

A Commission was appointed by the Government in 1900 to prepare preservation and consolidation plans. A Dutch army engineer named Van Erp was put in charge of the project. Work commenced in 1907 and was completed in 1911. Under Van Erp, the site immediately surrounding the Candi was excavated, the lower terrace wall was consolidated, extensive repairs were made to the balustrades, stairways, arches, and niches. The major work was the virtual dismantling and reassembling of the fifth terrace balustrade, the three upper circular terraces, and the top stupa. From the time that Van Erp finished his work in 1911 until the beginning of the current project, very little conservation activity other than routine maintenance occurred at Borobudur.

The present project began to take shape in 1955, a few years after the Republic of Indonesia became a member State of UNESCO. At that time the first of a series of UNESCO consultant experts travelled to Borobudur to advise the government's Archeological Institute. The outcome of the consultations was the decision to undertake a massive restoration and stabilization program to rectify the severe structural problems due to continued settlement and water damage and to try to reduce the alarming deterioration of the sculpture and carved decoration (Figures 7 and 8). From 1971 to 1973, the organization of the final project took shape. The government formed the Badan Pemugaran Candi Borobudur (BPCB), the Agency for the Restoration of Candi Borobudur, and also approved a comprehensive preservation project developed by The Nether-

lands Engineering Consultants (NEDECO). UNESCO agreed to organize an international campaign to raise funds for the project and also appointed a UNESCO Coordinator for Monuments and Sites in Indonesia to work as counterpart staff with the BPCB. To monitor the work in progress and modify the work program if necessary, the Government of Indonesia formed a Consultative Committee for the Safeguarding of Borobudur. The members appointed to the Committee were Professor Roosseno, Chairman of the BPCP; Dr. D. Chihara, Japan; Dr. K. Siegler, West Germany; Dr. R. M. Lemaire, Belgium; and Mr. J. E. N. Jensen, United States. In 1975, Mr. Jensen retired from the committee and was replaced by Mr. W. Brown Morton III.

The interim preservation project report, "The Restoration of Borobudur" issued by NEDECO in 1972, identified three principal causes of deterioration:

1. Dramatic acceleration in the rate of deterioration of the bas-relief sculptures, the statues, and the other surface stones caused by physio-chemical and micro-biological attack;
2. Inadequate drainage;
3. Severe settlement cracking and subsidence, especially of the first, second, third, and fourth terraces and balustrades, caused by insufficient bearing capacity of the soil beneath the monument and uncontrolled washing away of the soil fill in the center of the monument.

The NEDECO report called for a series of preservation measures to stabilize Borobudur and to reduce further deterioration to a minimum. These measures included the following:

1. Installation of a drainage system to provide rapid run-off for rainwater.
2. Introduction of waterproof layers to prevent further water infiltration and seepage.
3. Introduction of reinforced concrete slabs under areas of heavy compressive load to distribute the compressive load evenly over a wider area.
4. Cleaning, consolidation, and repair of bas-relief panels, statues, and other stone decoration.

It was decided that the preservation work would include the four square terraces and their balustrades, and the plateau between the fourth square terrace and the first circular terrace, but would not include major work to the ground level encasement surrounding the hidden foot or work on the three circular upper terraces and the final stupa. The Van Erp work at these areas has held up adequately.

The basic preservation scheme is shown in Figure 9. The execution of this work requires the removal, treatment, and eventual replacement of all of the outer stones and many of the inner stones of the areas affected. Over 300,000 outer stones alone will be identified and handled individually in the course of the work. In addition to the reinforced concrete slabs installed to evenly distribute the compressive loads, the scheme calls for the installation of a sophisticated series of waterproof layers. Layer A is a layer of Araldite-tar-epoxy painted over the surface of reset inner stones to prevent seepage between the filled earth core of the monument and the outer stones. Layer B is a vertical layer of treated inner stones covered with Araldite-tar-epoxy set two courses behind the outer decorated stones to prevent moisture moving through the decorated stones by means of capillary action. Layer C is a layer of asphalt on the underside of the new reinforced concrete slabs. There is also a system of hidden drain pipes installed flush with the concrete slabs and beneath the open joints of the relaid terrace floors to carry away rainwater run-off. A filter layer of volcanic sand to aid in drainage is also provided within the wall at each terrace level.

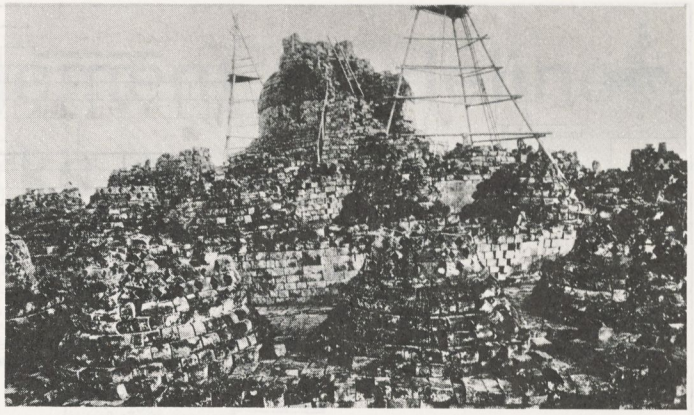


Figure 6. Borobudur: Upper terraces and stupa prior to restoration in 1907. (Photo: BPCB).

In order to achieve the work the following breakdown of tasks was developed by NEDECO:

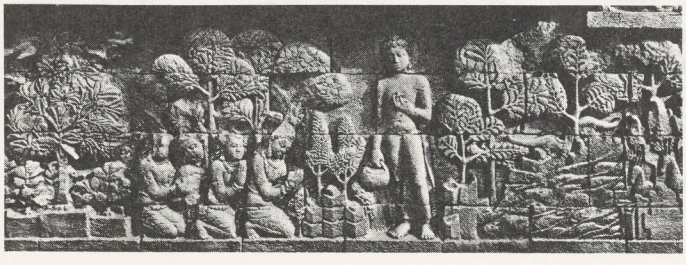
(a) dismantling, transport, and storage of outer stones;
(b) cleaning, repair, and treatment of outer stones;
(c) construction of the reinforced concrete foundation slabs;
(d) transport and treatment of the inner stones;
(e) insertion of the filter layer and waterproof layers;
(f) replacement and reconstruction of the stones of the terraces and balustrades.

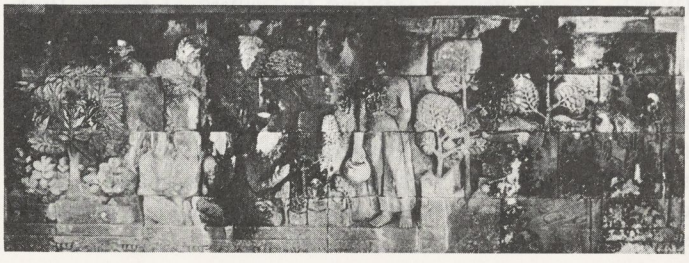
NEDECO also devised an ingenious transportation system to transport the stones from the monument itself to the work area southwest of the hill on which the pyramid is built. The system includes:

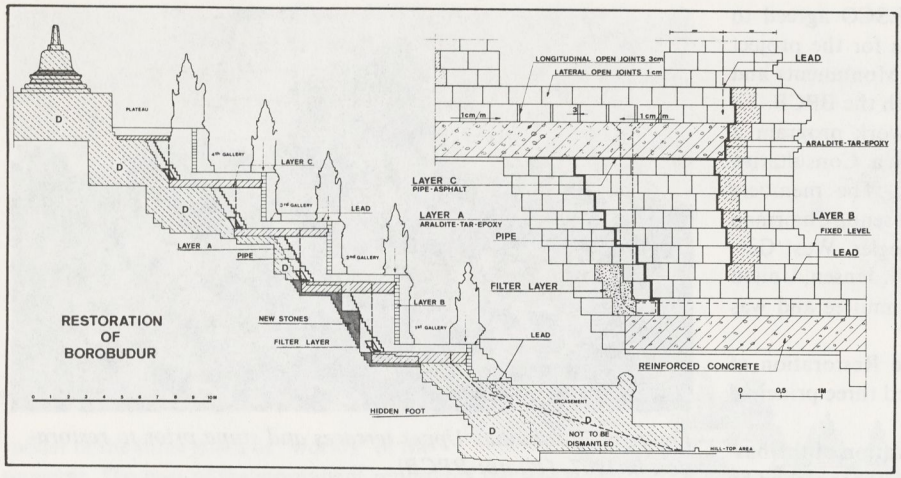
1. A series of small hand-operated cranes at all levels for transport of individual stones from their original location to specially designed wooden pallets.
2. Tower cranes on tracks for vertical transport of the stones in the wooden pallets from the terraces to the ground.
3. Fork lift trucks for transport of pallets to the crane gantry at the southwest side of the hill.
4. A crane gantry for transport of pallets from the hill top to the working area at the foot of the hill.
5. Fork lift trucks for transport of pallets in the working area and to the temporary and final storage areas.

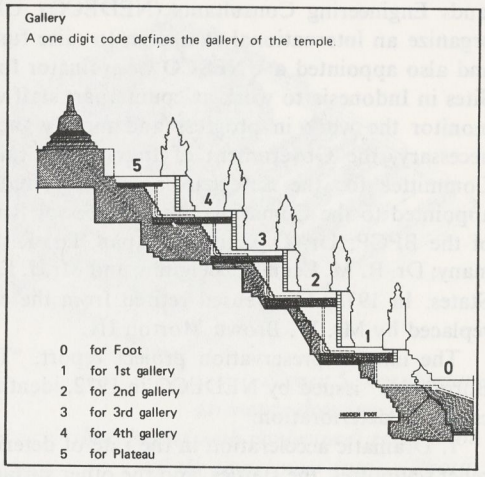
The dismantling of the stones is achieved by working simul-

Left, Figure 7. Borobudur: Bas relief sculptured panel showing condition in 1911. (Photo: BPCB) Right, Figure 8. Borobudur: Bas relief sculptured panel showing deteriorated condition in 1969. (Photo: BPCB)









Left, Figure 9. Borobudur: Cross section showing preservation work to be carried out. (Photo: NEDECO). Right, Figure 10. Borobudur: IBM code numbering system for the galleries. (Photo: BPCB).

taneously on opposite faces of the pyramid so as not to disturb the equilibrium of the monument. The balustrades are taken down first, then the inside terrace walls and floors, and finally the inner stones. Each outer stone is numbered, moved, inspected, cleaned, disinfected, treated, repaired, and stored for eventual replacement on the monument.

In order to achieve this work all stones were recorded by conventional photography and by stereophotogrammetry and then an innovative computer program was devised to number and track the path of each stone through the entire complicated preservation sequence.

The development of this computer program is the single most outstanding technological achievement of the Borobudur project. The program was developed by IBM in cooperation with the Government of Indonesia. A detailed report, "Computerized Stone Registration System for the Restoration Candi Borobudur" by V.K. Khandelwal and M. Soepardi, was published by the Badan Pemugaran Candi Borobudur in 1977.

Some of the problems to be solved by computer were:

(a) numbering and recording of over 400,000 stones;
(b) numbering of pallets;
(c) keeping track of each stone as it moves through the preservation process. Not all stones require the same treatment in the same order, but all stones require some treatment;
(d) organizing temporary storage space before treatment and final storage after treatment but before rebuilding. This is complicated by the fact that dismantling is carried out from the top down and rebuilding is carried out from the bottom up. Also dismantling areas on the monument are not in the same sequence as rebuilding areas;
(e) the number of wooden pallets is limited and they must be efficiently used.

The code used for the stone registration system can be outlined as follows:

A one character code denotes the side of the monument: U=Utara (North), S=Selatan (South), T=Timur (East), and B=Barat (West). A one digit code defines the gallery or terrace level. Each terrace is subdivided into sections: for the main wall sections A to J; for the balustrades A1 to J1 on the inner side, and A2 to J2 on the outer side; for stairways T and for archways Y for the right side and Z for the left side. Then a different number is given for each stone layer of the balustrade and for each stone layer of the main wall. Finally, each wooden pallet is designated by a five digit number based on the side of the monument and the level the stone came from.

Once the numbering and identification of stones and pallets is achieved, various input data are assembled. The input data provided on the input data forms for each pallet of numbered stone, for example, are as follows:

(a) dismantling date
(b) buffer (temporary) storage check-in
(c) buffer storage check-out
(d) treatment order
(e) cleaning
(f) drying
(g) repairing
(h) treatment
(i) final storage check-in
(j) final storage check-out
(k) rebuilding date

The data input is done daily and the data output can be called for at any time. The major benefits of the computer program for Borobudur are:

(a) ensuring the proper and timely treatment of stones;
(b) analysing the efficiency of the overall project operation;
(c) ensuring property coordination between different project phases and identifying and correcting delays;
(d) planning for rebuilding when sufficient stones are ready;
(e) providing adequate project documentation;
(f) checking errors, duplication, and losses.

The development of the computer program for Borobudur has revolutionized large scale preservation project planning and will most certainly have a significant impact throughout the world when other projects of a similar complexity are undertaken.

The first stage of dismantling began simultaneously on the north and south faces of Borobudur on April 24, 1974. The last stage of dismantling was completed on April 21, 1977. The rebuilding of the north and south faces is scheduled to be completed by July 14, 1979. At that time work on the east and west faces will be commenced. By working on only two faces at a time, the overall structural stability of the monument is safeguarded and visitation to the site is at no time interrupted.

When the work is completed in its entirety the Government of Indonesia and UNESCO will have achieved a milestone in historic preservation and made a lasting contribution to the cultural heritage of all mankind.

W. Brown Morton III is Departmental Consultant for Historic Architecture and Chief, Technical Preservation Services Division, Office of Archeology and Historic Preservation, National Park Service, U.S. Department of the Interior, Washington, D.C. 20240/USA. Mr. Morton is also Chairman of the United States National Committee for the International Council on Monuments and Sites (US/ICOMOS) and a member of the Consultative Committee for the Safeguarding of Borobudur.

Paul J. Godfrey

Management Guidelines for Parks on Barrier Beaches

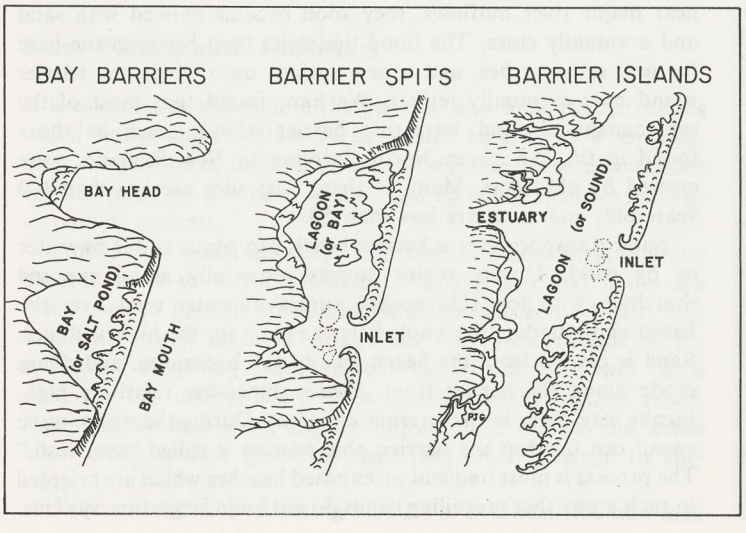
People have long used the seacoast as a source of livelihood and recreation, but only in recent decades have major pressures come to bear on the shoreline. Increasing demands for coastal recreation, as well as the need to protect the remaining undeveloped coastline, have come into direct conflict with development interests. Management approaches to these coastal areas vary considerably around the world, yet certain similarities and lessons can be perceived by looking at the problems faced by the U.S. National Park Service.

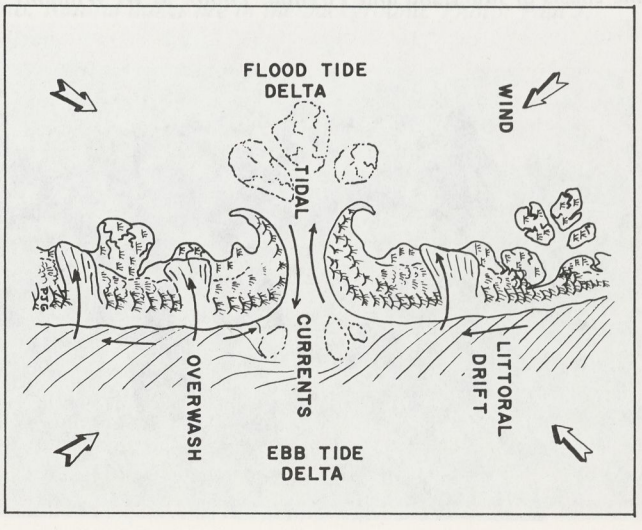
The U.S. NPS now manages 12 park areas along the U.S. east coast, two on the west coast and in Alaska, all of which contain sand beaches and dunes, the main subject of concern in this paper. With such a large section of the coast under its management, most of which came into its charge during the past 15 years, the NPS should have a wide array of management options and experiences from which to draw when it comes to making recommendations to others. While this is true in part, the NPS is still coming to terms with the problems of coastal management and is still looking back at past mistakes which often were made because of lack of information. After years of battling the sea, the NPS is now developing a sounder approach to coastal management. Research and experience gained at various National Seashores, such as Cape Lookout and Cape Hatteras in North Carolina, Fire Island in New York, and others, have provided the background for this change.

What Are Barrier Beaches?

A barrier beach refers to a sandy structure of beaches and dunes which protects a marsh and/or lagoon system from attack by oceanic waves (Figure 1). The key words here are "protect a marsh and/or lagoon" and this function separates the barrier beach from other types of beaches, such as those found at the base of glacial deposits or rocky cliffs. Within this basic form, three sub-types can be identified: bay barrier, spit, and barrier island. Of the three, the spit type barrier beach is most common in the glaciated regions of North America, and other similar coasts, while barrier islands are common south of that region. The best examples of barrier islands in the world can be found along the U.S. east and Gulf coasts from the south shore of Long Island, New York, to Mexico. Barrier spits are attached to a mainland or large island from which the sand that makes up the spit was derived by wave action, and wave-induced sand movement called "littoral drift". The bay barrier is a rather small barrier that forms between two rocky headlands or other land masses extending into the sea. These beaches are often at the head of a fiord, or bay, and usually form as waves move sand up to the head. They often have streams and marshes behind them, and thus fit the criteria of a barrier beach. Such beaches are found along rocky, indented shores. The best example in the NP System is "Sand Beach" in Acadia National Park, Maine.

Left, Figure 1. Types of barrier beaches showing the three basic ways sand, gravel, or other wave-transported sediments are deposited to form barriers which protect a lagoon and/or marsh system from direct ocean wave attack. Bay barriers are connected at each end *to the mainland; barrier spits are attached at* one end *with an inlet at the opposite end, or grow across open water; barrier islands are separated from each other by inlets at* both ends. *Right, Figure 2. Movement of sand along a barrier beach, and through it or over it, is caused by waves (littoral drift), tides (tidal currents), or storm surges (overwash). Wind also moves sand.*





Spit type barriers are rather common features along many coastal areas of the world, with some of the best examples found in the northeastern United States (particularly in Cape Cod National Seashore), the Canadian Maritime Provinces, the British Isles, many parts of the European Coast, Australia, and elsewhere. Barrier spits can grow right across a bay and connect other portions of the mainland, or source of sediment. In some cases, inlets are not regular features, and these barriers show a continuous beach from one sand source to another. Such beaches are referred to as "bay mouth barriers". The lagoons formed behind are often called "salt ponds." Good examples of beaches which connect eroding headlands are found on Martha's Vineyard and Nantucket Island, Massachusetts, and along the Rhode Island shore.

In most cases, however, inlets eventually cause barrier spits to break into separate barrier islands. This frequently happens during major storms, and inlets thus formed may become important features of the environment, although they usually close some time after the storm. Barriers of this type show few differences from the spits of which they are basically a part. The barrier islands along the Long Island shore, New York, which include Fire Island National Seashore; Monomoy Island, Massachusetts; the barriers off the coast of Prince Edward Island, Canada, which includes Prince Edward Island National Park; Holkham Beach, Scolt Head Island and Blakeney Point on the Norfolk Coast of England, and others, appear to be barriers of this category. The general pattern of sand movement is in the same direction as the dominant wave approach, and one can expect such barriers to continue migrating in that direction.

The formation of barrier islands, other than by spits, involves several alternative methods, some of which are not fully understood. Certain barrier islands are clearly sections of a low, gradually sloping coastal plain which have been cut off from the mainland by the rising sea. These islands are made up of typical coastal plain sediments and have a modern beach "welded" onto the front of the island. In general, these islands are relatively high and flat. The dunes present are usually restricted to the seaward portion. Islands of this type often are quite large, and irregularly shaped except for the ocean beach which is smoothed off by wave action. They have been called "sea islands" after the large barrier islands found off the coast of Georgia and South Carolina, USA. Cumberland Island National Seashore is a splendid example of a large sea island.

Stumps of an ancient forest protrude from the shifting sands of a beach in Assateague National Seashore, a barrier island off the coasts of Maryland and Virginia. Photo: M.W. Williams.



Other barrier islands along gradually sloping coastal plains undergoing submergence may have formed initially as sea islands, which are now completely reworked, or by other means. One hypothesis considered by geologists suggests that dune ridges were formed along these mainland shores some 6,000 years ago when the rate of sea level rise slowed. As the sea level continued to rise, these dune ridges were isolated from the mainland, and the low portions behind the dunes were flooded, thus creating the lagoons and bays. As sea level continued to rise, the barriers were pushed back toward the mainland, and regularly broken by inlets. Many islands along the central gulf coast of the U.S. seem to have formed in this manner. Good examples are found in Cape Lookout, Cape Hatteras, and Assateague Island National Seashores.

Natural Forces

The barrier beaches we see today, regardless of how they formed initially, are the products of a complex array of physical forces that develop between the land and the sea. Some of these forces have already been mentioned and they include: sea level change, waves, storm surges and floods, and wind (Figure 2).

Waves play a continuous role in the movement of sand in water. The waves create currents along the shore which move sand in the general direction of the wave approach. The greater the wave energy and angle of wave approach at breaking, the greater is the sand movement. The process is continuous, and as long as waves break on the beach, the sand will move downdrift. Even as waves can move sand up and down a beach, they move the sand on and off. During periods of heavy wave attack, such as in storms or during the winter months, sand is carried offshore into deeper waters to form bars. After the storms, or in summer, the sand is moved back up onto the beach. This cycle of onshore and offshore transport results in beaches which are wide during summer, or quiet non-storm times, and narrow during winter or stormy periods.

Waves can also move sand into inlets where other forces add to their effect. Inlets serve as a means by which sand moves under water to the regions behind a barrier beach. As the tide floods into the inlet, and waves move sand along the beach, shoals are created on the inside of the inlet—the "flood tide delta." When the tide ebbs, currents carry sand from the inner shoals back out into the sea where an ebb tide delta forms. Sand can thus move down the beach, into an inlet, out of the inlet, along the ebb tide delta, and then onto the beach on the other side of the inlet. When inlets are temporary, as most are except near major river outflows, they soon become choked with sand and eventually close. The flood tide delta then becomes the base for new salt marshes, and a new surface onto which the barrier island may eventually retreat. We have found that most of the salt marshes behind retreating barrier islands, such as those found in the U.S. from North Carolina to New England, were created by old inlets. Many of these inlet sites are less than 100 years old, and most are less than 50.

Sand transport over a barrier beach can occur either by water or by wind. During major storms, especially along exposed shorelines with low tide ranges, surges of water crest over the beach and inundate the whole barrier except for the highest dunes. Sand is carried from the beach face to the backshore, and dunes erode along the barrier front. Where dunes are relatively high, breaks may occur in the intermittent areas. During the storm, wave swash can overtop the barrier; this process is called "overwash." The process is most frequent on exposed beaches which are oriented in such a way that prevailing winds do not build large dune systems.

It is also most common where tide ranges are relatively narrow and thus a storm surge can rise over the beach at any tide stage. Where tide ranges are wide, storm surges have to arrive at high tide in order to crest the beach. Where overwash transport is a major factor in the environment, barrier beaches are relatively low and flat, with scattered dune systems.

We have found that certain barrier islands which experience regular overwash have vegetation that is highly adapted to this process, with grasses and other plants which grow right up through the new deposits of sand that are laid down on the backshore. The Outer Banks of North Carolina have excellent examples of overwash adapted grasslands. Where overwash is not a major factor these grass species are not present. We have found that overwashes which occur occasionally on northern beaches are recolonized by dune strand species which are carried in during the flood, deposited in drift lines, and then regenerate to create a new dune system further back from the earlier dunes. Whatever the mechanisms of vegetative recovery, overwash is a major means by which certain barrier beach systems retreat, while in other areas it is only a minor process that occurs during the most severe storms.

Wind transport is the process which has received the greatest attention by ecologists. Where exposed beaches can be crossed by winds that exceed 4 metres/sec, sand will be moved off the beach. The winds move the sand roughly in proportion to their velocity cubed: low wind speeds move the sand grain by grain along the surface while higher winds can actually pick the sand up and move it through the air. Strong winds also can move wet sand off a beach, even when it is raining. The sand will move until the wind reaches an object or series of objects which slow it and allow the grains to fall out. The most effective sand trap on beaches and dunes is beach grass or other similar plants.

When vegetation is present, the dunes become stabilized and are held where formed unless some event breaks the plant cover and exposes the sand to further wind transport. In some cases, formerly stabilized dunes may begin migrating more rapidly than natural grass growth can keep up with, and this can lead to large, open dunes that migrate over the barrier beach, burying anything in their paths and exposing the remains of older habitats once they move on. Examples of migrating dunes can be found on almost every sandy coast, with good examples to be found in Oregon and parts of California, the Nags Head region of the North Carolina Outer Banks, the Province Lands of Cape Cod, portions of the English coast, a few regions in Holland, Doñana in Spain, and along the Australian coast.

Some Management Guidelines

It is essential to understand the physical and biological processes which create and maintain barrier beach ecosystems when planning for any form of human use. Oftentimes these connections are not made by planners, and we end up with expensive damage to natural systems.

Any action which interferes with the movement of sand along beaches leads to major problems. While groins and jetties are often used to prevent erosion and stabilize a beach or inlet, they frequently result in more erosion on the downdrift side of the structures. Anything placed across the littoral drift will catch sand on the updrift side, while the downdrift regions erode. Examples abound along any developed shore. Groins and jetties often create greater problems than they were designed to alleviate.

Where islands are retreating because of overwash and new inlet formation, attempts to stop such retreat have been expensive and especially hazardous. Overwash flooding, when it occurs, is a necessary part of the system, and building dune dikes to protect permanent installations only postpones the inevitable flood, which then results in great losses of property and often lives. Nothing can really stop those shorelines which are retreating, unless the existing oceanic environment changes, and any structures placed in the way are doomed to eventual destruction. Millions of dollars have been spent in the U.S. to stabilize and prevent shoreline retreat, yet the problem still exists and, in many areas, is much worse in spite of the engineering attempts. Preventing the formation of new inlets can also jeopardize the continued redevelopment of new tidal marshes and a general widening of the islands that usually results where barriers are retreating.

Of course, not all shorelines experience the same patterns of retreat, as mentioned earlier. When developing management programs for barrier beaches it is essential to keep in mind that one policy may not be applicable to all types of situations. Management plans should be made according to geological and ecological conditions, the anticipated use patterns, and the past human history of the areas being considered. For most purposes, it is better to let the natural processes operate than to interfere with them, but while "working with the system" is the best overall approach to planning for a coastal park, certain specific recommendations can be made that relate to erosion changes and human impact.

For Problems Relating to Beach Erosion

1. If at all possible, complete islands, or spits and associated uplands, should be included within the boundaries of the park, rather than bits and pieces. The best management program can be made when the boundaries of a coastal park include as complete a geological system as possible. In complete systems erosion on one part is usually compensated for by accretion in another. Natural forces can work without hindrance if the whole barrier beach is contained within a single unit and managed as a system. Developed inholdings, e.g., private facilities predating the park, always lead to difficult management problems.

2. Any necessary developments such as management structures or recreational facilities should be minimal, easily replaced,

Dune stabilization projects at the Kennemerduinen National Park in The Netherlands are visible at the left and center of this photo. Natural dunes are in the background. Photo: Paul J. Godfrey



and located in geologically stable areas. The beach front should be avoided wherever evidence shows that the areas have a history of change. Major park facilities for barrier islands are best located on the mainland, or the uplands well back from any eroding shore and migrating spit, or be built on pilings if in a flood-prone area. Detailed geological studies should be made, particularly dealing with erosion trends, before any plans are made.

3. No structures should be placed in the path of littoral currents and sand movement along the beach. Groins, jetties and sea walls will create major problems in those areas where sand transport along the beach is important to the existence of the barrier. Where inlets are stablized, or designs for doing so are promoted, provisions must be made for sand transport around the structures. Such plans will necessarily involve a type of "beach nourishment" program for the beaches downdrift of the jetties. Sand could be obtained from maintenance dredging that might be needed in the inlet, or on the updrift side of the jetties. However, such operations are costly and will have to continue as long as the structures exist.

4. Whenever possible, avoid developing parks in areas that are severely affected by outside influences such as distant groins and jetties unless some agreements are made with appropriate agencies to help alleviate these outside problems. Otherwise, the program and budget of the park may be severely taxed by attempting to correct the problems inherited from outside developments.

5. Avoid any erosion control projects that will tend to create a false sense of security—either for private inholdings behind the project, or visitors in the park. The greatest problem caused by erosion control programs over the years at Cape Hatteras National Seashore, for instance, was not so much the geological and ecological changes that resulted, but the false security created in areas outside the park boundaries. Dune building projects were done on park land after the Seashore was given management authority for the beach in front of many privately-owned areas. The dunes that resulted allowed developers to move seaward with permanent houses and communities, something which old time residents knew was folly. Yet even with the dunes eroding in many places, developers and home buyers (many from inland areas) still think the man-made dunes will stop the sea and that their investment is safe. Every effort must be made in public relations and education to point out that any erosion control project is only a temporary solution at best and can only slow down the inevitable retreat of the beach.

Certain projects which are designed to alleviate man-made problems, such as dune destabilization, can restore natural stability and therefore security from sand burial. However, these programs can only restore security where the natural system and historic development of the site allow stability to exist.

6. Certain forms of erosion control—whether designed to control beach retreat, dune migration, or other major forms of instability—can be successful to varying degrees when natural methods are used. In those areas that are currently in a stage of accretion and dune building, fostering the process by planting dune grasses, and some initial sand fencing and fertilization, has been shown to be a very successful management tool. Such natural methods are especially valuable where human disturbance has resulted in massive dune migration problems.

Besides planting dune grasses, other native plants can be used to restore vegetated regions where needed or desired. Those areas which are presently barren of natural plant communities which could prevent or slow down sand loss might be planted with appropriate species. The early development of man-made dunes across many formerly barren areas of Cape Hatteras National Seashore led to the formation of natural plant communities which are tolerant of and adapted to overwash flooding and burial. In some cases, the appropriate species (particularly salt meadow cordgrass, *Spartina patens*) were planted on the barren flats, and have led to more or less natural grassland.

Intertidal grass species can be planted on dredge spoil islands, or along lagoon shores where erosion is a problem. Stabilization of spoil islands prevents redistribution of the sand back into channels. Such activities can lead to viable salt marshes which add greatly to the stability and productivity of lagoon habitats.

For Problems Relating to Pedestrians

Many large areas of migrating dunes which subsequently bury other habitats of concern are the result of human misuse. Studies of the migrating dunes of Province Lands on Cape Cod have shown that these classic examples of parabolic dunes were destablized by human activities following settlement in the 1600's. This area was once well-forested. Cutting of timber, creation of open grazing land, wild fires, and related influences, broke the vegetative cover, and caused massive blowouts which released the dunes. Continued use by large numbers of people and off-road vehicles contribute to the instability of these dunes.

Heavy pedestrian traffic can lead to significant deterioration of stabilizing dune vegetation. Studies done on Cape Cod, the British Isles, Denmark and elsewhere have been directed toward assessing this impact.

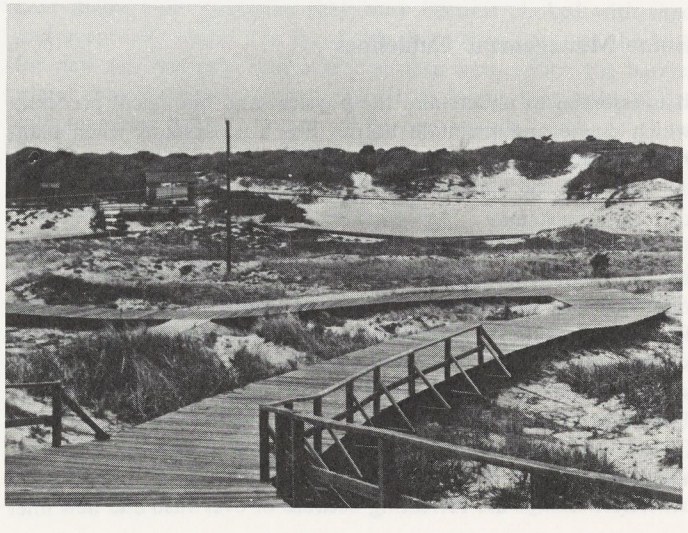
Suggestions:

1. In areas of moderate dune use, mark trails clearly and use native shrubs to create borders which can discourage people from widening the path. Roses, bayberry, and other rather impenetrable shrubs make good and often attractive trail borders.

2. Where heavy use is likely, wooden walkways and bridges over sensitive dune vegetation should be built over the dunes to the beach. Such elevated walkways are essential in wetland and salt marsh habitats. Good examples of elevated trail systems can be found on Fire Island National Seashore and parts of Cape Cod National Seashore. Most other parks which have heavy trail use are turning to elevated paths made of wood.

3. Most people climb high dunes to get a view, and hence

A boardwalk built over the dunes at Fire Island National Seashore, New York, U.S.A. Where use is heavy, boardwalks will help control damage. Photo: Paul J. Godfrey





Open dunes and an off-road vehicle track at Cape Cod National Seashore, Massachusetts. Pilgrim Lake appears at the right. Photo: Paul J. Godfrey

increase the instability of these high spots, often causing severe damage. A few wooden platforms and access steps in heavy use areas can significantly reduce this problem.

4. Maintain public information programs, explaining why heavy traffic on dunes creates problems.

For Problems Relating to Off-Road Vehicles

The uncontrolled and increasing use of beaches and dunes by visitors with off-road (four-wheel drive) vehicles can lead to major destabilization problems. Dune vegetation has a low tolerance to vehicle impact and when the plants are killed by vehicles, blowouts soon result. Recent studies done by the University of Massachusetts/National Park Service Cooperative Research Unit on Cape Cod show that fewer than 50 vehicle passes are sufficient to kill beach grass vegetation and lead to an open track. Traffic on beaches where new dunes normally form can prevent the development of new dune lines which ordinarily provide more stability. We also determined that intertidal salt marshes and the organisms of sand flats have a very low tolerance to vehicle impacts. The intertidal ocean beach showed the greatest tolerance of all the habitats we experimentally impacted, but other considerations must be taken into account when evaluating these results. Our studies were done on a northern beach where intertidal organisms are rather few. Similar beaches farther south, which have large populations of intertidal marine animals, can be severely affected by traffic.

Where birds use beaches for nesting and feeding, vehicle impacts can be very significant, especially where beaches are narrow. Nesting-bird colonies can be badly affected. Heavy traffic in vacant nesting sites can prevent birds from returning at nesting time, especially where the traffic is widespread over the beach. For more information regarding the management of coastal birds, refer to Buckley (1976).

Suggestions:

1. The best management approach to solving vehicle problems is not to open areas that have been closed or have previously been inaccessible. Provide controlled, public transportation to inaccessible areas, if really necessary, or encourage visitors to walk.

2. Where vehicles must be allowed for any compelling reason, certain management procedures can be followed:

a. Prevent indiscriminate traffic on dunes.

b. Restrict traffic to marked routes along which borders of cable, or dense shrubs, are established after careful study.

c. Vehicle tracks must be controlled and maintained. Deterioration of the track (such as development of washboard ruts) often will spur drivers to go off the established path and create new ones.

d. Restrict traffic to intertidal ocean beaches where surveys show relatively few marine animal populations are present. Where possible a marked route should be established on the berm to prevent indiscriminate driving over the beach zone.

e. Route traffic on the beach around sites of significant dune formation, particularly where driftlines and seeds accumulate.

f. Prevent all traffic across salt marshes and intertidal flats, or along the borders between marshes and sand dunes.

g. Close off overwash passes between dunes and prevent vehicle use of these openings. Such passes eventually close and develop new dune systems. Vehicle traffic will prevent the natural processes from closing the gaps.

h. Ramps should be built over dunes where access to the beach is desired. Once built, such ramps will require periodic maintenance, especially following storms.

i. Close off bird and marine turtle nesting sites and important feeding areas. Appropriate signs which explain the need for protection should be erected at some distance from the actual nesting sites. People on foot, leaving a vehicle to read a small sign near a nesting area, can cause more disturbance than a vehicle passing in front of the colony.

j. Close beaches to vehicles during periods of exceptionally high tides, which would force drivers to run up the face of dunes, often through nesting sites and incipient dune areas.

Basic Research and Management

Applying basic research to the needs of park management can be a very important exercise for both the researcher and the manager, although they often have different objectives. It is almost axiomatic that one needs to know how a natural system, such as a barrier beach, operates before one can manage it, yet the reverse has often been more common. However, today it has become quite clear that research and management should move together and that continuous dialogue and information transfer between managers and scientists is of mutual benefit. Our basic understanding of how the vegetation of barrier islands is adapted to overwash and migration, and the significance of the migration processes, has come from basic research supported by the National Park Service. In these projects, which were carried out through the NPS Cooperative Research Unit at the University of Massachusetts, and now in other institutions as well, new information was gathered, and new models were created to determine how the natural system operates. That process is still under way. Yet the main impetus of the research was management oriented. For example, the work we did on the Outer Banks was directed towards developing a basic understanding of barrier island ecology so that a new park, Cape Lookout National Seashore, one that is basically wild and undeveloped, could be better managed on the basis of research and experience.

Each year there are more scientists interested in coastal areas and their management problems. A recently held conference at the University of East Anglia in Norwich, England, brought together for the first time ecologists from Europe, Australia, New Zealand, Canada, the United States, and other countries to consider ecological research in coastal areas. Much of the research was basic in nature, but a considerable portion dealt specifically with management problems. As a result of this meeting, an international group of scientists concerned with human impacts on sand dunes was formed. In 1976, the NPS sponsored a conference on research in the

National Parks that was attended by both researchers and managers. A conference sponsored by the Georgia Conservancy and Barrier Island Coalition was held in early December, 1977. Scientific- and management-related problems of dealing with barrier islands were considered at this meeting attended by scientists, lawyers, Park Service, as well as other federal, state and private resource managers, interested lay people, and others who are involved with coastal problems. Such interaction is essential for effective programs for managing coastal resources.

Governments that are now creating coastal parks might follow a similar approach and include local scientists in planning operations for these parks. By doing so early in the process, management mistakes might be avoided, while at the same time improving research programs. Such interaction can lead to a much sounder program for management of an increasingly threatened resource, the barrier beaches of the world.

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Dr. Paul Godfrey is Associate Professor of Botany at the University of Massachusetts, Amherst, and Director of the U.S. National Park Service-University of Massachusetts Coastal Research Laboratory at Cape Cod National Seashore, Massachusetts.

Hans Köpp and Ali Yachkaschi

Development and Status of Protected Areas in Iran

The second edition of the *United Nations List of National Parks and Equivalent Reserves* of 1971 still contained no actual names of protected areas in Iran but there were a number of important indications as to their status.

At that time "Protected Regions" were mentioned in which agricultural activity was restricted but in principle not excluded. Thus hunting and fishing were allowed with the permission of the then Game and Fish Department in Tehran, and also agriculture, grazing and timber felling, with the permission of the Ministry of Agriculture and the Department of Hunting. At the end of 1965 there were 11 such protected regions with a total area of 600,000 ha.

Furthermore, legislation of that period envisaged the creation of "Wildlife Parks", areas which, in contrast to the Protected Regions, were exclusively owned by public authorities, in this case the Game and Fish Department. Here farming and stockbreeding were forbidden, but hunting and fishing were allowed under certain conditions.

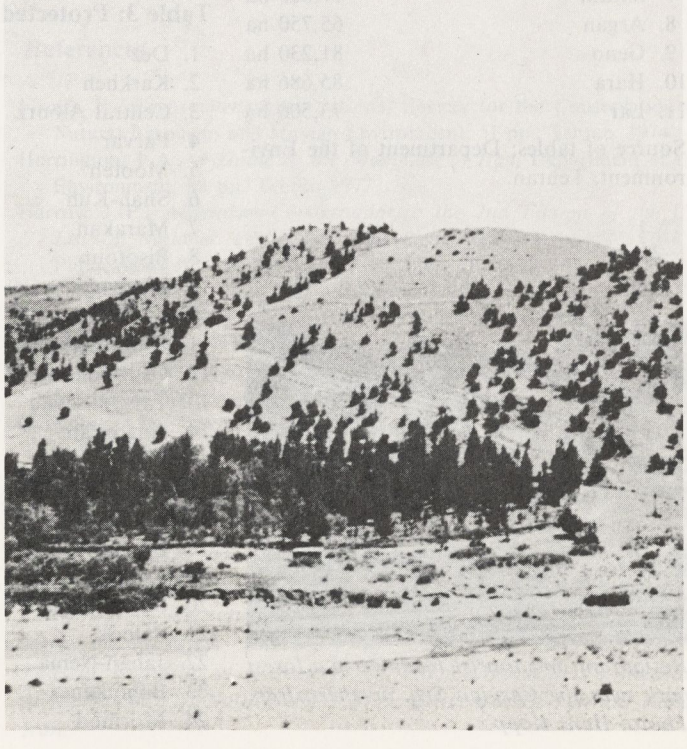
In 1965 there was only one such reserve. This was the Mohammed Reza Shah Wildlife Park in northeastern Iran, covering an area of about 100,000 ha of mainly mountainous and partly wooded country. There, together with a wide variety of bird life, were to be found a species of wild pig *(Sus scrofa)*, Urial sheep *(Ovis ammon arkal)*, Persian ibex *(Capra aegagrus)*, leopard (*Panthera pardus*), brown bear (*Ursus arctos*), goitered gazelle (*Gazella subgutturosa*) and maral (*Cervus elaphus*), a regional race related to the European red deer. Also until 20 years ago, the Caspian tiger was present in very small numbers. It must be regarded as extinct in Iran as no occurrence of it has since been reported. Changing habitat and illegal trapping, particularly the use of poisoned bait, by the local populace were factors which also led to the extinction of that great cat long after the disappearance of the Persian lion (*Panthera leo persica*). Other species, which have not been able to stand up to the pressure of hunting and changed agricultural methods, have been brought to the verge of extinction. These include above all the cheetah (*Acinonyx jubatus*), the Persian fallow deer (*Dama mesopotamica)*, the black bear (*Selenarctos thibetanus*) and *Equus hemionus*, the Persian wild ass. (Harrington 1977).

"Hunting Centres" were founded in the first instance on the initiative of a very few hunters for the protection of endangered species. The idea was that, in order to be able to control hunting, the possession of a hunting license should be made compulsory. In 1966, following this private initiative, the Game and Fish Department was then established and this organization declared certain areas as national parks and as equivalent reserves for the protection of flora and fauna. Because of the increase in population—at the moment Iran has about 34 million inhabitants and steadily growing high density areas, particularly in Tehran and in the north of the country—and because of the rapid development of industry, the tasks of that organization were considerably expanded, and in 1971 the Game and Fish Department was enlarged to become the Department of the Environment (Yachkaschi 1976).

The supplement to the second edition of the *United Nations List of National Parks and Equivalent Reserves* (Harroy 1972) lists five Wildlife Parks, covering a total of 211,700 ha. These are (1) Mohammed Reza Shah W.P., 91,890 ha; (2) Tandoureh W.P., 73,435 ha; (3) Kolah Ghazi W.P., 41,000 ha; (4) Dez W.P., 3,837 ha; and (5) Karkheh W.P., 1,538 ha. Meanwhile the first two of these five parks have been declared National Parks and the second two have been considerably enlarged in area. At the time of its publication two further Wildlife Parks already existed but because of their small area they were not included in the UN list: (1) Dash-i-Naz W.P., 55 ha, (2) Khoshkedaran W.P., 227 ha. The latter park in North Iran has since been officially declared as one of the four "National Nature Monuments."

At that time four important wetlands were already included in

Overgrazed and overexploited, the devastated cupressus forests in the Central Alborz Protected Region, North Iran, are now strictly protected. Photo: A. Yachkaschi.





Central Alborz National Park. Vegetation and minor settlements are mainly limited to valleys having streams or rivers. Photo: A. Yachkaschi.

the Protected Regions. With a few exceptions, hunting in the wetlands is forbidden. However, a limited degree of settlement and agriculture was permitted, in each case subject to a strict but not easily enforceable control.

Wildlife Parks (meanwhile renamed "Wildlife Refuges") enjoy in the main the same degree of protection as the National Parks but for them a restricted measure of hunting based on the principles of modern scientific wildlife management is explicitly planned under state control and limited to specially authorized persons. While hunting in these protected areas can be more or less controlled, outside the reserves more game continues to be killed than is authorized by law.

The rapid development and expansion of protected areas in Iran are shown by the *1974 United Nations List of National Parks and Equivalent Reserves* (UN 1974), in which are registered 12 Protected Regions—4 National Parks and 8 Wildlife Refuges—with a total area of over 1 million ha, of which, however, two are of purely provisional character. These figures reflect the development from 1962 to the beginning of the 1970's.

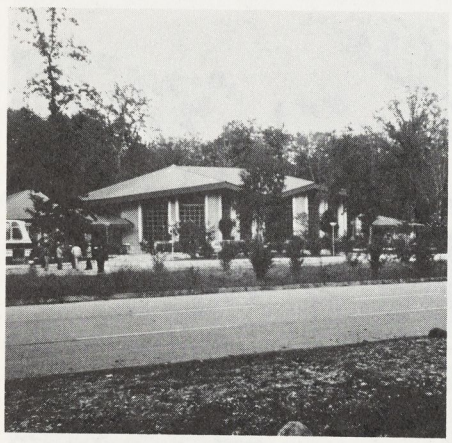
Iran attracted the attention of the world on the occasion of the United Nations Conference on the Human Environment (Stockholm 1972). In order to encourage international co-operation in the field of nature conservation, the Iranian government offered to cede its sovereignty in the "international" park Sashte Argan, an area of 65,750 ha west of Shiraz in South Iran, in favor of an international control.

Just as there has been tremendous economic and industrial growth, accompanied by serious problems of environmental

Table I: National Parks (1977)

1.	Mohammed Reza Shah	125,895 ha
2.	Lake Rezaiyeh	463,600 ha
3.	Central Alborz	56,250 ha
4.	Bamou	48,075 ha
5.	Kavir	790,625 ha
6.	Tandoureh	53,780 ha
7.	Sarani	17,800 ha
8.	Argan	65,750 ha
9.	Geno	81,230 ha
10.	Hara	85,686 ha
11.	Lar	73,500 ha

Source of tables: Department of the Environment, Tehran.



Restaurant and tourist facilities in a forest park near the Caspian Sea, northern Iran. Photo: Hans Köpp.

Table 2: National Nature Monuments (1977)

1.	Central Alborz	11,000 ha
2.	Khoshkedaran	227 ha
3.	Dehloran	1,400 ha
4.	Lilium Ledebourii	0.6 ha

Table 3: Protected Regions (1977)

1.	Dez	10,633 ha
2.	Karkheh	9,427 ha
3.	Central Alborz	332,126 ha
4.	Parvar	59,840 ha
5.	Mooteh	159,200 ha
6.	Shah-Kuh	26,600 ha
7.	Marakan	92,715 ha
8.	Bisotoun	50,850 ha
9.	Bazman	324,688 ha
10.	Lisar	31,250 ha
11.	Haftad-Gholle	82,125 ha
12.	Oshtrankooh	93,950 ha
13.	Tang-e-Sayad	27,000 ha
14.	Angouran	96,130 ha
15.	Bijar	72,640 ha
16.	Bahukalat	382,430 ha
17.	Arasbaran	34,145 ha
18.	Bahram-e-Gour	385,000 ha
19.	Touran	1,295,400 ha
20.	Shah-Jahan	28,000 ha
21.	Salook	16,000 ha
22.	Jahan-Nema	30,650 ha
23.	Babolkenar	1,133 ha
24.	Mormod	151,284 ha

Table 4: Wildlife Refuges (1977)

1.	Kharko	312 ha
2.	Dez	5,240 ha
3.	Karkheh	3,600 ha
4.	Khosh-Yeilagh	166,880 ha
5.	Dash-i-Naz	55 ha
6.	Mooteh	132,720 ha
7.	Bisotoun	31,250 ha
8.	Siahkesheem	6,701 ha
9.	Hamoun	193,500 ha
10.	Bakhtegan	327,820 ha
11.	Miankaleh	68,800 ha
12.	Kolah Ghazi	48,683 ha
13.	Selke	360 ha
14.	Amirkelayeh	1,230 ha
15.	Angouran	28,600 ha
16.	Khabr-va-Rouchoon	173,750 ha
17.	Mehrouyeh	7,468 ha
18.	Ghamishloo	49,250 ha
19.	Sheedvar	160 ha
20.	Arasbaran	38,320 ha
21.	Touran	515,000 ha
22.	Shadegan	296,000 ha
23.	Kiamaki	84,400 ha
24.	Semeskandeh	937 ha
25.	Miandasht	52,000 ha
26.	Fereidoonkenar	148 ha
27.	Astara	949 ha
28.	Dodangeh	6,700 ha
29.	Mond	46,700 ha
30.	Helleh	42,600 ha
31.	Latian*	110 ha

* Area approved, but not yet announced.

pollution and socio-economic changes, so also has there been in recent years a considerable extension in the work on protected areas, and it has been possible, above all, to safeguard the endangered species (Ovington 1972).

Because of its wide variety of geological, geomorphological, topographical and climatic conditions, and a total surface area of 1.6 million sq. km, Iran can boast of an equally wide variety of flora and fauna and their ecological communities, and natural resources in general. With the exception of the desert regions of central Iran and the eastern regions on the Afghanistan frontier, the present system of regional protection, which is in the process of being expanded, does its best to safeguard representative biotopes and habitats of threatened and endangered species, particularly fauna (Firouz 1974).

At the present there are 69 protected areas covering a total of almost 8 million ha (7,998,168) or 5 percent of the land surface. This does not include protected and recreational woodlands of the Forest Service and other jurisdictions, for instance those on the coast, which are maintained exclusively for leisure time activities, such as recreation and tourism. The protected areas are divided into 4 categories:

1. National Parks: 11 with a total of 1.8 million ha
2. National Nature Monuments: 4 with a total of only 12,267 ha.
3. Protected Regions: 24 with a total of 3.8 million ha
4. Wildlife Refuges: 30 with a total of 2.3 million ha

The majority of the protected areas fall into only one of the categories; 7 of them include both Protected Regions and Wildlife Refuges in the area they cover. In one case, namely that of the Central Alborz between Tehran and the Caspian Sea, categories 1, 2 and 4 are represented.

To date there are no bi-laterally protected areas although, particularly with Pakistan and Turkey, nature conservation projects are being agreed upon on the basis of joint conferences and there already exist protected areas which border on the neighboring countries of Pakistan, Afghanistan, USSR and Iraq.

It is still too early to provide a time schedule for the final and complete establishment of all the above mentioned protected areas. Some still have not been alloted fixed boundaries. It will take some years before they are classified according to the present system, zoned and effectively protected. In order to accelerate this work, Iran is taking steps, with some assistance from the UN, to train sufficient staff experts. This is an essential measure if the many nature conservation targets are to be met. It has become evident that the adoption of specific foreign models has its limitations; in the selection of protected areas the typical and characteristic development of the country must be taken into consideration. Also a national park without the possibility of access for the public by zoning is as out of date as the attempt to evacuate the resident peasant population in the protected areas. Meanwhile the first plans for national parks based on these principles are available.

In addition to protected land surface areas, the rivers Chalus, Sardab, Karaj, Jairud, Car and Harraz as well as all wetlands (marshes, lagoons and bays) on the Caspian Sea are protected as are also the rivers in the provinces of Gilan and Mazandaran which flow through lagoons or directly into the Caspian Sea. Furthermore, hunting is forbidden in three districts with a total area of 130,000 ha in the provinces of Eastern Azerbaijan and Hamadan.

Iran is still far from being able to achieve the aims she has laid down for herself. Nevertheless, in recent times the responsible authorities have shown themselves increasingly determined to implement all the measures that are within their power to accomplish.



Demawand, an ancient volcano located northeast of Tehran, is in the Central Alborz Protected Region some 150 km south of the Caspian Sea. It is always covered by snow and ice and at 5,774 m is the highest peak in Eurasia west of the Hindu Kush. Photo: A. Yachkaschi.

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Dr. Hans Köpp served as an FAO consultant on national park planning and management at the Faculty For Natural Resources, University of Tehran in 1977. His permanent address is Department of Forestry, University of Göttingen, 3400 Göttingen, Federal Republic of Germany. Dr. Ali Yachkaschi is a member of the Faculty of Natural Resources, University of Tehran, Karaj, Iran.

Criteria for Inclusion in the World Heritage Lists

The following criteria were adopted by the World Heritage Committee at its first meeting last June. These paragraphs were extracted from the document entitled "Operational Guidelines for the World Heritage Committee" and are reprinted on these pages as a service to the readers of PARKS Magazine.

Criteria for the inclusion of cultural properties

9. Outstanding universal value will be recognized when a cultural property, as defined in Article 1,* submitted for inclusion in the World Heritage List is found to meet one or more of the following criteria. Therefore each property should:

(i) represent a *unique artistic* or *aesthetic* achievement, as a masterpiece of the human creative spirit;

(ii) be of *outstanding importance* owing to its influence, over a span of time or within a cultural area of the world, on subsequent developments in architecture, monumental sculpture, garden and landscape design, or human settlements;

(iii) be *unique, extremely rare* or of *great antiquity*;

(iv) be among the *most characteristic* examples of a type of structure, the type representing an important cultural, social, artistic, technological or industrial development;

(v) be a *characteristic example of a significant* traditional style of architecture, method of construction, or human settlement, that is fragile by nature or has become vulnerable under the impact of irreversible socio-cultural or economic change;

(vi) be *most importantly* associated with ideas or beliefs, with events or with persons, of outstanding historical importance or significance.

10. (a) In every case, consideration should be given to the state of preservation of the property (which should be evaluated relatively, that is, in relation to property dating from the same period and of the same type and category).

(b) In addition, the property should meet the test of *authenticity* in design, materials, workmanship, and setting; authenticity does not limit consideration to original form and structure but includes all subsequent modifications and additions, over the course of time, which in themselves possess artistic or historical values.

Criteria for the inclusion of natural properties

11. Outstanding universal value will be recognized when a natural heritage property as defined in Article 2*, submitted for inclusion in the World Heritage List is found to meet one or more of the following criteria. Therefore properties should:

(i) be outstanding examples representing the *major stages of the earth's evolutionary history*. This would include sites which represent the major "eras" of geological history such as "the age of reptiles" where the development of the planet's natural diversity can well be demonstrated and as the "ice age" where early man and his environment underwent major changes;

(ii) be outstanding examples representing significant on-going *geological processes, biological evolution and man's interaction with his natural environment*. As distinct from the periods of the earth's development, this focuses upon on-going processes in the development of communities of plants and animals, landforms and marine and fresh water bodies. They would include, for example, a) as geological processes, glaciation and volcanism, b) as biological evolution, biomes such as tropical rainforests, deserts and tundra, c) as interaction between man and his natural environment, terraced agricultural landscapes.

(iii) contain *unique, rare or superlative natural phenomena, formations or features or areas of exceptional natural beauty*, such as superlative examples of the most important ecosystems to man, natural features (rivers, mountains, waterfalls), spectacles presented by great concentrations of animals, sweeping vistas covered by natural vegetation and exceptional combinations of natural and cultural elements,

(iv) *be habitats where populations of rare or endangered species of plants and animals still survive*. This would include those areas where concentrations of plants and animals of universal interest and significance are found.

It should be realized that individual sites may not possess the most spectacular or outstanding single example of the above, but when the sites are viewed in a broader perspective with a complex of many surrounding features of significance, the entire area may qualify to demonstrate an array of features of global significance.

12. In addition to the above criteria, the sites should also meet the conditions of *integrity*.

(i) the areas described in 11. (i) should contain all or most of the key interrelated and interdependent elements in their natural relationships; for example, an "ice age" area would be expected to include the snow field, the glacier itself and samples of cutting patterns, deposition and colonization (striations, moraines, pioneer stages of plant succession, etc.),

(ii) the areas described in 11. (ii) should have sufficient size and contain the necessary elements to demonstrate the key aspects of the process and to be self-perpetuating. For example, an area of "tropical rain forest" may be expected to include some variation in elevation above sea level, changes in topography and soil types, river banks or oxbow lakes, to demonstrate the diversity and complexity of the systems,

(iii) the areas described in 11. (iii) should contain those ecosystem components required for the continuity of the species or of the objects to be conserved. This will vary according to individual cases; for example, the protected area for a waterfall would include all, or as much as possible, of the supporting upstream watershed; or a coral reef area would be provided with control over siltation or pollution through the stream flow or ocean currents which provide its nutrients,

(iv) the areas described in 11. (iv) should be of sufficient size and contain the necessary habitat requirements for the survival of the species.

For earlier publications on this subject see PARKS Vol. 1, No. 1 (April, May, June 1976) and PARKS Vol. 2, No. 3 (October, November, December 1977). Additional information, nominating forms and instructions can be obtained by Members States from the Division of Cultural Heritage, UNESCO, 7 place de Fontenoy, 75700 Paris, France.

* of the Convention.

PARK PRACTICE

Repointing Mortar Joints in Historic Brick Buildings

Robert C. Mack, A.I.A.

The following material is reprinted from Preservations Brief No. 2, *Interagency Historical Architectural Services Program, Office of Archeology and Historic Preservation, U.S. National Park Service. It serves as a model that could be adapted by other countries for their own cultures and geographic locations.—Ed.*

Repointing, also known as "tuck pointing" or simply "pointing," is the process of removing deteriorated mortar from the joints of a masonry wall and replacing it with new mortar. The selection of improper techniques or materials in the repointing of historic buildings not only can alter the visual aspects of a building but also can lead to further deterioration of the masonry. The purpose of this publication is to provide general guidance on the methods and materials for the repointing of historic brick buildings, for the benefit of building owners, architects and craftsmen.

Identifying the Problems

The decision to repoint usually is related to some perceptible problem, such as falling mortar, loose bricks or damp walls. The actual cause of the problem, however, may be unrelated to the visible effects, and for this reason *the services of an architect or preservation consultant should be obtained at the earliest planning stages to prevent both visual and physical damage to the building.*

The first step in planning a repointing project is to ascertain the true causes of problems which need attention. If the reason for repointing is to stop water penetration, the consultant should thoroughly investigate all possible sources of water. Damp walls may be caused by leaks from parapets, flashing, or roofs, and such leaks may show up some distance below in the masonry walls. Another source is rising capillary moisture which can cause dampness several feet above the ground. In either of these cases, repointing the outer masonry wall will not cure the problem. Similarly, if open joints or loose bricks are caused by foundation settlement or deterioration of materials, such structural problems should be corrected before beginning masonry work. After such an investigation, the consultant can inform the owner of necessary remedial actions and their costs, possibly including additional technical advice from foundation or soil engineers.

Logistical planning: It is important to recognize that repointing will be an expensive and time-consuming task due to the large amount of handwork and special materials required. Work cannot begin immediately, because research is required and some materials such as handmade bricks may have a long delivery time. Scaffolding will be in place for an extended period, possibly interfering with normal circulation patterns. The owner should remember that many communities will require a building permit before work can begin.

The architect/consultant also must recognize logistical considerations and the relationship of the repointing to other proposed work. For example, if paint is to be removed or gutters replaced, it may be logistically advisable to conduct research relating to these items before beginning to repoint. If water penetration is to be corrected, the repointing work probably should come early in the preservation project; if the building is watertight, it may be better to wait until after completion of exterior cleaning so that the existing and new mortars will weather simultaneously. Related projects, such as installing downspouts or painting (possibly separate contracts) should be scheduled to avoid conflict with the repointing work but at the same time to take maximum advantage of the scaffolding. Contractors should be made aware of these various architectural and logistical relationships in the early stages of project planning.



Research

The repointing work will possibly involve analysis not only of the mortar but also of the bricks and the techniques originally used in striking the joints.

Mortar study or analysis is necessary if the repointing mortar is to match the original mortar in color, texture, and other properties. The identification of the major constituents is relatively simple; it may be possible to arrive at an approximation of the mortar's composition by observation (using low magnification) of an unweathered sample. (A more accurate method for performing this analysis is presented by E. Blaine Cliver in "Tests for the Analysis of Mortar Samples" in the *Bulletin* of the Association for Preservation Technology, Volume VI, Number 1, 1974. This article describes a methodology for separating a mortar sample into its various components.) Once the constituents have been separated and identified, the same can be examined for the range of color, size and shape of the grains. Other insoluble materials also should be identified for inclusion in the repointing mortar.

Pointing styles and the methods of producing them should be studied (Fig. 1). It is important to examine both the hori-

zontal and vertical joints to determine which were struck first and whether they are the same style. Some buildings, for example, have horizontal joints which were tooled concave while the vertical joints were finished flush with the surface of the brick, then stained to match the brick, creating the illusion of horizontal bands. This technique was used extensively in late 19th and early 20th century architecture.

Bricks should be studied so that any replacements which may be necessary will match the originals. Within a wall there may be a surprisingly wide range of colors, textures, and even sizes. Replacement bricks should match this range rather than a specific brick. Potential sources for replacement bricks should be considered at the first stages because of the length of time required for the manufacture of special bricks. It may be possible to obtain suitable bricks from salvage building materials suppliers, or, if of comparable hardness and color, bricks may be moved from unexposed areas in the building to exposed areas.

Planning the Work

Properties of mortar: In general, repointing mortars should match the original mortar in constituent composition and proportions as well as in color and texture. The importance of matching the composition frequently is overlooked, yet this match is necessary if the new and old mortars are to have the same physical characteristics.

It is a common error to assume that hardness or high strength is a measure of durability. Stresses within a wall caused by expansion and contraction or by settlement must be accommodated in some manner; in a masonry wall these stresses should be relieved by the mortar rather than the brick. A mortar which is stronger and harder than the masonry units will not "give," thus causing the stresses to be relieved by the masonry units, usually in the form of cracking and spalling (Fig. 2). Uneven movement in the masonry also can break the bond between the mortar and the brick, opening hairline cracks to water penetration. Mortars with a high percentage of portland cement can have the above described deleterious effects. Additional information on this problem is contained in *Studies of Stone-Setting Mortars; Building Materials and Structures Report 139*, published by the National Bureau of Standards in 1953. Porous mortar permits water within the wall to migrate and escape. Mortar with a high cement content does not permit this movement, and the water trapped within the wall may be subjected to freeze-thaw cycles which can spall soft, older brick.

"Workability" or plasticity of the mortar also is important. The new mortar should have both cohesive and adhesive qualities to make complete physical contact with the masonry and old mortar.

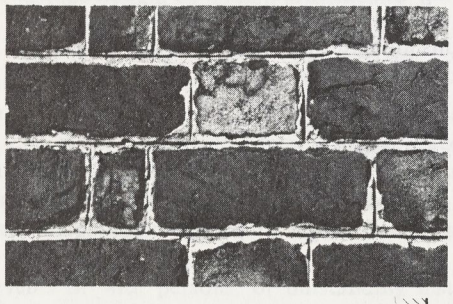
It should have the maximum amount of sand consistent with such workability to help reduce shrinkage while drying. The mortar must not be sticky or gummy and must handle readily on the pointing tool. Finally, the newly applied mortar must have good water retention to resist rapid loss of water through absorption by the brick or old mortar while setting.

Advantages of using high lime mortar: These facts lead to the conclusion that a high lime mortar generally is best for most historic structures, even those originally constructed with cement mortars. High lime mortar is soft and porous, and has the lowest volume change due to climatic condition. In addition, lime mortar is slightly soluble in water and able to self-seal small cracks and voids that may develop. In this phenomenon, a slight amount of the mortar dissolves in rain water and is precipitated in the void during the drying process, thus sealing the crack. Even straight lime mortar is more durable than generally recognized as long as the wall is protected from water penetration with sound roofing, gutters, flashing, etc. A small amount of white portland cement may be desirable, however, to accelerate setting.

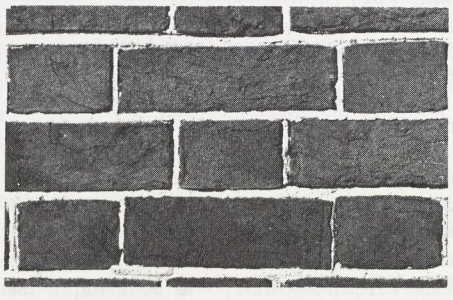
Even if the building originally was constructed with cement mortar, it usually is best to use a high lime mortar rather than match the original. High lime mortar will reduce potential stresses at the edges of the masonry and also help minimize shrinkage, which leads to hairline cracking.

Matching color and texture: Although the use of proper materials and techniques will give a watertight job, appearance is

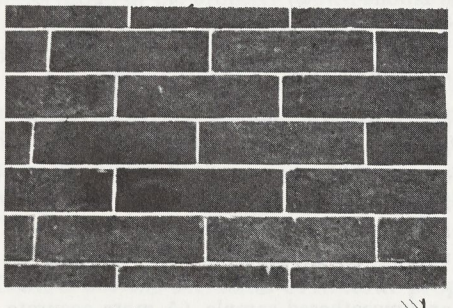
Figure 1. A variety of joint types and brick bonding patterns are illustrated here. Note the difference in uniformity of the bricks in A and B, which are handmade, and those from C through F, which are machinemade. It is evident in A, B, and F that the vertical joints were struck before the horizontal joints. Also note in B and E that the vertical joints are narrower than the horizontals.



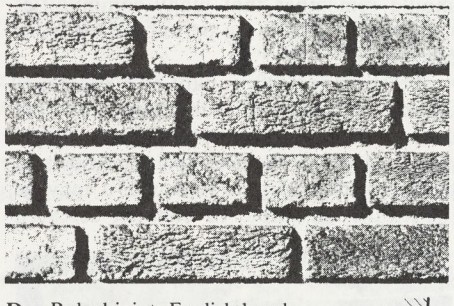
A Colonial grapevine joint, Flemish Bond ca. 1720.



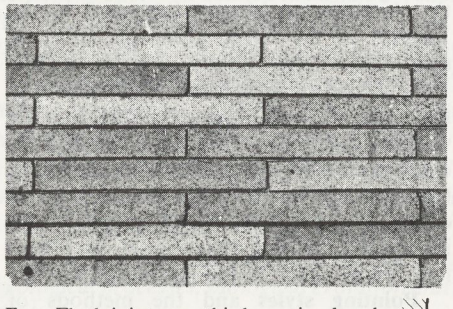
B Beaded joint, Flemish bond. ca. 1809.



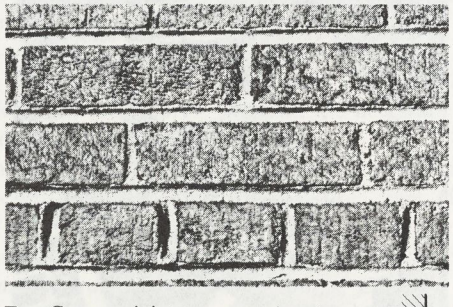
C Flush joint, common bond. mid-19th century



D Raked joint, English bond. early 20th century.



E Flush joint, one-third running bond. early 20th century.



F Concave joint, common bond. early 20th century.

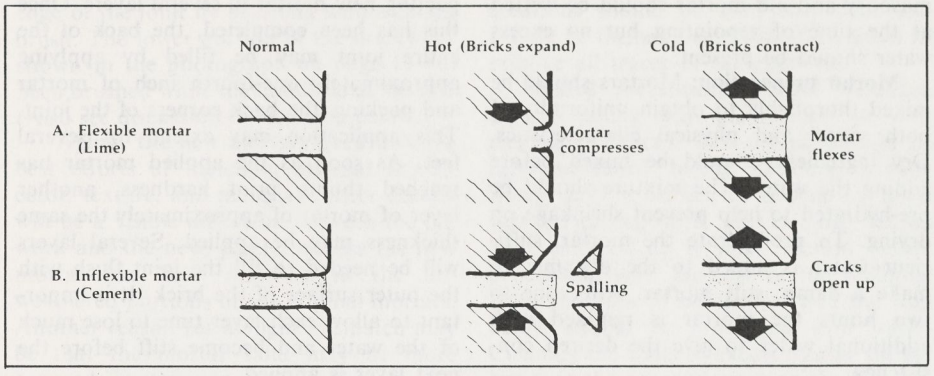


Figure 2. Diagrammatic sketches showing effects of temperature change upon masonry. Flexible mortar (A) expands and contracts with temperature changes. Bricks bonded by inflexible mortar (B) tend to spall at the edges (the area of greatest stress) in hot weather and separate from the mortar when it is cold. This latter condition opens cracks, permitting the entry of water and causing additional deterioration. Adapted from Maintenance of Old Buildings, *Document D 10; National Swedish Institute for Building Research, Stockholm, 1975.*

also important. Both color and texture most often can be matched through the careful selection of lime and sand or other aggregates. Every reasonable effort should be made to use these natural sources of color and texture in matching the mortar. If the original sand borrow pit is no longer available, the masonry contractor may know of similar sand available in the region.

If it is not possible to obtain a proper match through the use of natural materials, it may be necessary to use a mortar pigment. Of course, some late 19th and early 20th century mortars contained such colors. These pigments are available as a separate ingredient or already mixed with mortar cement and lime; the premixed mortars usually are not suitable for use on older structures due to the high portland cement content. Only chemically pure mineral oxides that are alkaliproof and sun-fast should be used; natural earths have low tinting values, organically based colors fade in direct sunlight, and carbon black dissolves out of mortars which are not impervious to moisture.

Texture of the mortar also affects the visual characteristics. Modern mortars are finely ground and thus present a uniform texture as well as color; early mortars were not as finely ground, however, and may contain lumps of oyster shell or incompletely burned lime. The size, color, and composition of these lumps should be determined as part of the mortar analysis, and they should be duplicated in the repointing mortar. These particles can be duplicated in kind with new oyster shells or lumps of lime, or they can be made by grinding the older mortar removed during the joint preparation and adding it to the new mortar.

Materials Specifications

Modern materials specified for use in repointing mortar should conform to specifications of the American Society for Testing and Materials (ASTM) or comparable Federal specifications.

Lime should conform to ASTM C 207, Type S, Hydrated Lime for Masonry Purposes, or Federal spec SS-L-351B. This lime is designed to assure high plasticity and water retention with a safe degree of strength. The use of quicklime with the necessity of slaking and soaking does not provide better results.

Cement should conform to ASTM C 150, Type I or II, or Federal spec SS-C-192G(3). It should have not more than 0.60% alkali (expressed as sodium oxide) or not more than 0.15% water soluble alkali by weight (in the combination of lime and cement). This low alkali content is necessary to help avoid efflorescence. Non-staining white cement is quite expensive but frequently will be required in lieu of the usual grey cement to provide the proper color.

Sand should conform to ASTM C 144, or Federal spec SS-A-281B(1) para. 3.1, to assure proper gradation and freedom from impurities. Sand color, size, and texture should match the original as closely as possible to provide the proper visual characteristics without other additives. A sample of the sand is necessary for comparison to the original, and should be approved by the consultant before beginning repointing work.

Water should be clean and free from deleterious amounts of acids, alkalis, or organic materials.

Special additives will require writing new specifications for each project. If possible, suggested sources for the special materials should be included. For example, crushed oyster shells frequently can be obtained in a variety of sizes from poultry supply dealers.

Mortar mix: As mentioned previously, the new mortar usually should match the existing mortar as closely as possible, and the best way to insure a match is through careful analysis of the existing mortar. If an accurate chemical match of the original mortar is not feasible, or if the original mortar is too hard for repointing work, the following mixes may provide a *starting point for the development of a mortar which is visually and physically acceptable*. If the original mortar was nearly all lime and sand, try by starting with the following mix:

1 bag hydrated lime
¼ bag white portland cement
3 cubic feet of sand to match the original
(note: 1 bag is equivalent to 1 cubic foot)

If the mortar originally contained cement, or for extreme weather exposures such as parapet walls, try:

1 to 1½ bags hydrated lime
1 bag portland cement
5 to 6½ cubic feet of sand

Keep in mind that the above mixes are only given to suggest the basic range of lime-to-cement ratios. It is likely they will require modification or additional constituents before they produce a mortar that matches the visual and physical character of the original.

Execution Of The Work

Supervision: Repointing work on historic structures will require significantly more supervision than work on contemporary buildings in order to prevent unintentional damage to the brick. Craftsmen, contractors, and job supervisors should understand the reasons for the repointing work and the damage which can arise from improper techniques. Craftsmen must realize that the preservation of the bricks is more important than strong mortar or rapid progress, and that a great deal of hand labor will be required. Contractors should be aware that some materials may require long delivery periods while others may not be available through builders' supply companies at all. Contractors must also understand that "stop orders" may be authorized by the owner to permit further

Figure 3. Comparison of incorrect and correct preparation of mortar joints for repointing.

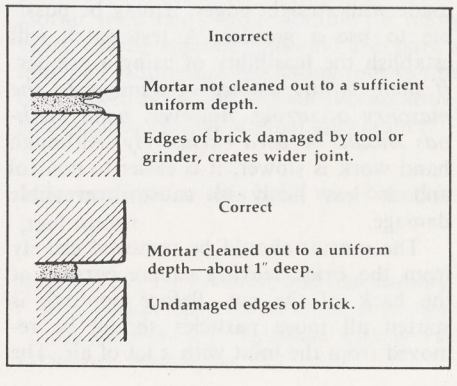




Figure 4. The damage to the edges and corners of these bricks was caused by using a power grinder in cleaning the joints. Extensive hand work is required to prevent damage to the bricks during joint preparation.

architectural research should unexpected conditions be revealed during the course of the project. Only after considering these factors will contractors be able to submit accurate bids which will afford a reasonable profit without pushing the craftsmen to produce a hasty job.

Joint preparation: Generally old mortar should be cut out to a minimum depth of one inch (2.54 cm) to insure an adequate bond between the new mortar and the existing masonry and to prevent mortar "pop-outs." For joints less than three-eighths (1 cm) of an inch thick, cutting the mortar back one-half inch (1.27 cm) usually is sufficient if the mortar behind that point is in good condition. Any loose or disintegrated mortar beyond this minimum depth should be removed (Fig. 3). Unless the mason is unusually skilled and extremely careful, the use of power tools for mortar removal inevitably will damage the brick (Fig. 4). Damage to the edges of the brick will significantly affect the character of the brickwork; in addition, absorption of water is increased since the softer inside of the brick is no longer protected by the hard burned outer surface. Where joints are uniform and fairly wide, and the bricks were machine-made with straight edges, it may be possible to use a grinder. A test patch will establish the feasibility of using a grinder. *If there is any chance of damage to the masonry occurring, however, hand methods should be used exclusively.* Although hand work is slower, it is easier to control and is less likely to cause irreversible damage.

The mortar should be removed cleanly from the brick leaving square corners at the back of the cut. Before pointing is started all loose particles should be removed from the joint with a jet of air. The masonry and old mortar should be wetted at the time of repointing but no excess water should be present.

Mortar preparation: Mortars should be mixed thoroughly to obtain uniformity of both visual and physical characteristics. Dry ingredients should be mixed before adding the water. The mixture should be pre-hydrated to help prevent shrinkage on drying. To pre-hydrate the mortar, sufficient water is added to the dry mix to make a damp, stiff mortar. After one to two hours the mortar is remixed with additional water to give the desired consistency.

The use of anti-freeze compounds during cold weather is not recommended. Their effectiveness with high lime mortars is questionable. Furthermore, they may contain salts which would be a source of later efflorescence. A better practice is to heat the water and sand, with care taken to prevent scorching of the sand. The masonry then should be protected from freezing.

The use of air entraining agents also is discouraged. These agents are used with concrete to resist frost action and increase plasticity. The air which these agents incorporate into mortar, however, has a detrimental effect on both bond and strength of repointing mortar. Air entraining agents are considered unnecessary in high lime mortars because of their natural plasticity. Air entrainment of 10 to 16 percent, however, may be desirable in areas of extreme exposure where high strength mortars are used.

Use of bonding agents: The use of chemical agents to increase the bond of the new mortar to the old mortar and masonry units should be avoided. These agents generally are unnecessary and can be harmful.

If the joint is properly prepared and moistened prior to placing the new mortar and if the mortar is properly prepared and applied, there will be a good bond between the new mortar and the adjacent surfaces; chemical agents will not significantly improve this bond. If chemical agents are used, there may be a tendency to neglect proper joint preparation in the thought that the agent will make adequate bonding. In actuality, deteriorated mortar or dirt may remain in the joint, and bonding to these materials will not keep the mortar from coming loose. *Chemical agents cannot substitute for adequate joint preparation and proper mortar mixing.* In addition, some of the chemical agent inevitably will become smeared on the exposed face of the masonry and, due to the nature of the material, its removal will be difficult. This situation is especially likely on walls with thin mortar joints.

Filling the joints: Where existing mortar has been removed (or has fallen out) to a depth greater than one inch, these deeper places should be filled first, compacting new mortar in several layers. Once this has been completed, the back of the entire joint may be filled by applying approximately one-fourth inch of mortar and packing the back corners of the joint. This application may extend for several feet. As soon as the applied mortar has reached thumb print hardness, another layer of mortar of approximately the same thickness may be applied. Several layers will be needed to fill the joint flush with the outer surface of the brick. It is important to allow each layer time to lose much of the water and become stiff before the next layer is applied.

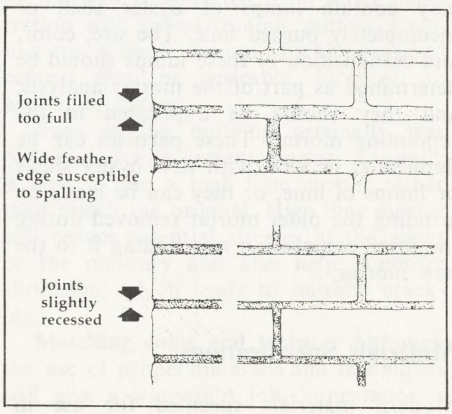
The rate of stiffening can be controlled by dampening the brick and old mortar before beginning to fill the joint. Free water or excessive dampness in the joint must be avoided; too much water will delay the tooling or cause excess shrinkage. If the joint is too dry, water will be absorbed from the mortar before it is properly set, thus reducing bond strength and increasing the probability of leaks.

When the final layer of mortar is thumb print hard, the joint is tooled in a manner to match the appearance of the old mortar. Tooling the finished joint at the right stage of firmness is important for uniform color. If finished while too soft, the color will be lighter than expected and hairline shrinkage cracks are likely to occur. If tooled when too hard, there may be dark streaks called tool burning, and good closure of the mortar against the brick will not be achieved.

If the old bricks have worn, rounded corners, it usually is best to *recess the final mortar surface slightly* to avoid leaving a joint which is visually wider than the actual historical appearance; it also will avoid creation of a large, thin, featheredge which is easily damaged, thus admitting water (Figs. 5 and 6).

Following tooling, it frequently is necessary to remove excess mortar from the

Figure 5. Comparison of visual effect of full mortar joints vs. slightly recessed joints. Filling joints too full hides the actual joint thickness and changes the character of the original brickwork.



edge of the joint by brushing with a bristle brush. The lower portion of the brickwork shown in the photograph on page 15 has been brushed while the middle area has not. (Also see discussion on cleaning below.)

"Aging" the new mortar: Even with the best efforts at matching original mortar color, texture, and materials, there usually will be a visible difference between the old work and the new, partly because the new mortar has been matched to the unweathered portions of the original mortars. Another reason for a slight mismatch may be that the mortar sand may be more exposed in the old mortar due to the slight erosion of the lime or cement. Several methods of treatment have been attempted in an effort to overcome these differences. As with all work, however, any proposed treatment should be carefully considered and tested prior to implementation.

One method of aging the new mortar is a light brushing with a stiff natural brush immediately after tooling. This brushing will roughen the surface slightly, thus producing a weathered look.

Another relatively safe treatment is to fine spray the mortar with low pressure water after completion of tooling. This spray will wash away part of the cement and lime before it is fully hardened, leaving the grains of sand more exposed on the outer surface of the joint as in natural weathering.

Efforts to artificially stain the new mortar may give an initial color match but can cause the new and old mortars to change color at a different rate during the natural aging process. In addition, the mixtures used to stain the mortar may be dangerous to the masonry; some mixtures, for example, can introduce salts into the masonry which then can cause efflorescence. If the mortars have been properly matched, the best treatment for surface color differences is to let the mortars age naturally.

Cleaning: *If repointing work is carefully executed, there will be little excess mortar to clean from the walls.* A conscientious mason will remove most extraneous mortar particles with a bristle brush after the mortar dries but before it hardens. Hardened mortar can be removed with a wooden paddle or, if necessary, a chisel.

Further cleaning is best accomplished with the use of plain water and bristle brushes. If chemicals must be used, the selection must be made with extreme caution to avoid damage to *either the mortar or the masonry*. Selection of an improper cleaner can lead to deterioration of the masonry units or the mortar, mortar smear, and efflorescence. *The use of acid or any agent containing acid should be a last resort*, for acid can destroy the featheredge closure between the finished mortar joint and the brick. Chemical solutions should be used only once and should be flushed freely with plain water to remove all traces of the chemicals.

Several precautions should be taken when cleaning with plain water or with cleaning solutions. The mortar should be fully hardened before cleaning; usually thirty days is sufficient, depending upon weather or exposure. Test cleaning should be conducted on a small section before proceeding with the rest of the building. Both the area to be cleaned and the wall below should be *presoaked with water.* Cleaning the walls of excess mortar should begin at the top and work to the bottom. As the cleaning proceeds, it is important to flush the area with water. Stiff natural brushes should be used for all surfaces except glazed or polished surfaces, for which only soft cloths should be used.

New construction "bloom" or efflorescence occasionally appears within the first few months after repointing and generally disappears through the normal process of weathering. If efflorescence is not removed by natural processes, the safest way to remove it is by dry brushing with bristle brushes followed with a brief water rinse. Chemical cleaners, especially muriatic acid, should be avoided in the removal of efflorescence since the chemicals can create additional salts which may lead to added efflorescence.

Further information on cleaning is contained in Preservation Briefs: No. 1, "The Cleaning and Waterproof Coating of Masonry Buildings," available from the Interagency Historic Architectural Services Program, Office of Archeology and Historic Preservation, National Park Service, Washington, D.C. 20240.

Summary

For the owner: It is important for the owner or administrator of an historic building to be aware that repointing is likely to be a slow and expensive project. Schedules for both the repointing work and other activities will require careful coordination in order to avoid unanticipated conflicts. The work cannot be rushed or overly economized if the building is to retain the proper visual characteristics and if the job is to be durable and watertight.

For the architect/consultant: The architect must assist the owner with planning for the logistical problems relating to research and construction. The architect also must realize that older buildings have special problems not usually encountered in modern construction, so extra research will be required, and other than standard materials and procedures will need to be specified. The qualifications of potential contractors must be carefully evaluated based on previous experience with historic structures, and the contractor must be given special instructions prior to starting the work.



Figure 6. This photograph shows the significant visual changes which can result from improper repointing procedures. Note the increased thickness of the joints, the color variation, and the difference in the method of tooling, all noticeable even from a distance.

For the contractor/craftsman: The requirement for large amounts of slow handwork must be recognized if the contractor is to submit a bid which will reflect these expensive methods. The contractor must explain the special nature of the project to the craftsmen so they will not rush the project. Understanding the potential problems will not only help the contractor in evaluating the project but will also help the masons to understand the reasons that specific methods should or should not be used.

While careful preservation, restoration and maintenance can hold back deterioration, it is important to understand that repointing work probably will not last the life of the structure. Nevertheless, if the first mortar joint has proved durable for many years, careful repointing should also have a long life. Additional repointing jobs can be undertaken as needed without altering structural soundness and original appearance.

Information for this brief was based in part upon:

Rogers, Percy L. "Restoration of Old Masonry," unpublished report for the Office of Archeology and Historic Preservation, National Park Service, Washington, D.C., 1973.

Hartshorne, Penelope. "Repointing of Brick Mortar Joints in Historic Buildings," *Early American Brick Masonry and Restoration of Exterior Brick Walls,* Third Annual Historic Structures Training Conference, National Park Service, Philadelphia, 1963.

Brick Institute of America. "Cleaning Clay Products Masonry," *Technical Notes on Brick Construction*, Number 20 (revised), 1964. [1750 Old Meadowbrook Road, McLean, Virginia, USA]

Additional readings on the subject of repointing are listed below:

Cleaning—Removal of Mortar and Mortar Stains on the Wall Surfaces of New Construction. Chicago: Portland Cement Association, 1963. [Old Orchard Road, Skokie, Illinois, 60076/USA]

Cliver, E. Blaine. "Tests for the Analysis of Mortar Samples," *Bulletin* of the Association for Preservation Technology, Volume VI, Number 1, 1974, pp. 68-73. [Box 2487, Station D, Ottawa, Ontario, K1P 5W6, Canada]

Connor, C.C. and W.E. Okerson. "Recent Disintegration of Mortar in Brick Wall," *ASTM Proceedings, (American Association for Testing and Materials)* Volume 57, 1957.

Kessler, Daniel W. and Ross E. Anderson. *Studies of Stone-Setting Mortar; Building Materials and Structures Report 139.* Washington, D.C.: National Bureau of Standards, U.S. Department of Commerce, 1953.

Loth, Calder. "Notes on the Evolution of Virginia Brickwork from the Seventeenth Century to the Late Nineteenth Century," *Bulletin* of the Association for Preservation Technology, Volume VI, Number 2, 1974, pp. 82-120.

McBurney, John W. "The Effect of Weathering on Certain Mortars Exposed in Brick Masonry With and Without Caps and Flashings," *ASTM Proceedings,* Volume 56, 1956.

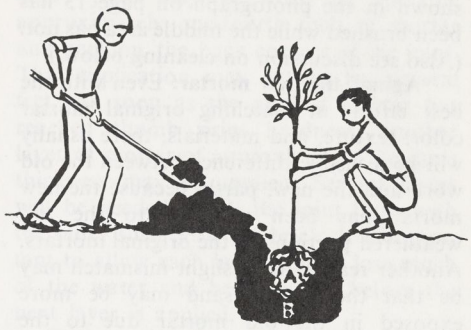
McKee, Harley J. *Introduction to Early American Masonry.* Washington, D.C.: National Trust for Historic Preservation/Columbia University, 1973.

National Lime Association, (5010 Wisconsin Ave., N.W., Washington, D.C. 20016 USA) "Tuck Pointing of Masonry Walls," *Limeographs*, Volume 8, Number 9, 1942.

Phillips, Morgan. "SPNEA—APT Conference on Mortar," *Bulletin* of the Association of Preservation Technology, Volume VI, Number 1, 1974, pp. 9-39.

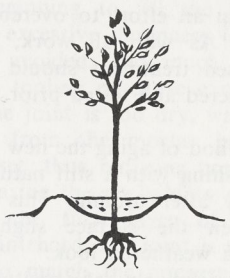
Preservations Brief No. 2 *was developed under the technical editorship of Lee H. Nelson, A.I.A., Technical Preservation Services Division, Office of Archeology and Historic Preservation, National Park Service, U.S. Department of the Interior, Washington, D.C. 20240. April 1976. The line illustrations for this brief were prepared by Robert C. Mack and David W. Look. Photographs by Calder Loth.*

Planting a Tree



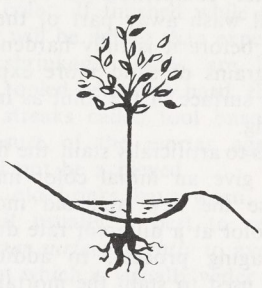
Φύτευσι. Α: μπάλλα. Β: μίγμα χώματος

1. Planting: A. ball of roots B. soil mixture.



Λεκάνη ποτίσματος. Τομή σὲ ἐπίπεδο ἔδαφος.

2. Pool for water—on level surface.



Λεκάνη ποτίσματος. Τομὴ σὲ ἐπικλινὲς ἔδαφος.

3. Pool for water—on a slope.



Σχέδια Μαρίας Βουδούρογλου

Πλάγια στήριξι

4. Support for the newly planted tree.

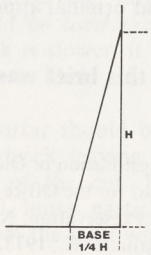
From Nature and Life, *a quarterly journal published by the Athens Society of Friends of the Trees, Winter 1977.*

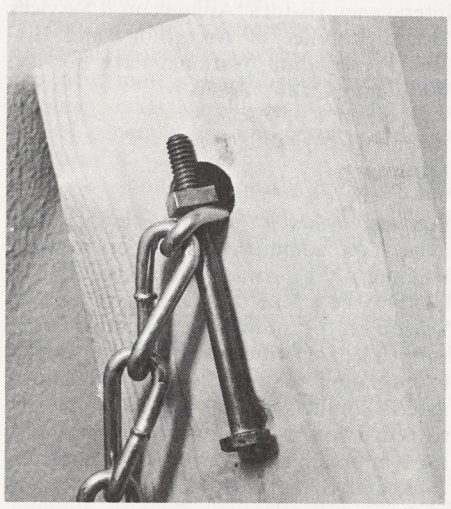
Chain Crosspiece for Ladder Safety

Good safety practice demands that when a ladder is in use its siderails, or legs, be firmly positioned on a stable surface, that the steps or crosspieces be level, and that it rest solidly against the wall or other working surface. This latter requirement can be very difficult when attempting to use a ladder against a round pole or tree trunk.

An easy way to increase ladder stability for tree work is to add a crosspiece of chain at the top. The chain will take the form of the tree and grip the bark firmly.

The chain can be affixed in a number of ways but perhaps the simplest is to secure each end through holes in the siderails. These should be no larger than necessary to take the chain. The chain can be kept in place with a bolt (and nut!) fastened through a link in each end. Length of the chain, or play, can be varied to suit by moving one bolt a link or two one way or another.





In a simple variation, a stout manila rope could be substituted for the chain. A figure-of-eight knot is made in each end of the rope on the outer sides of the siderails.

Remember not to lean any ladder too steeply against a work surface. The base should be at least one quarter of its height.

Be certain that any ladder you use is structurally sound, has no broken or missing rungs (crosspieces), or split parts. Never use a ladder where it could come into contact with electrical wires or fixtures.

And never paint a wooden ladder. Paint can conceal cracks or flaws and, in certain circumstances, it may contribute to rot.

When not in use, ladders should be stored horizontally, hung on good solid supports above ground and in a dry place.—R.I. Standish

An Automatic Information Box

Visitor centers, museums, signs, booklets, leaflets and notice boards all have their place in parks, but often these are not enough. There are special situations where nothing is quite as good as the spoken word. This can be presented in various ways, including recorded messages that are available whenever visitors require them at the points of interest.

In 1975 an automatic information box, based on my own design, was constructed for use in the Kennemerduinen National Park. It has the advantage of being virtually invulnerable to vandalism and appears to be very useful.

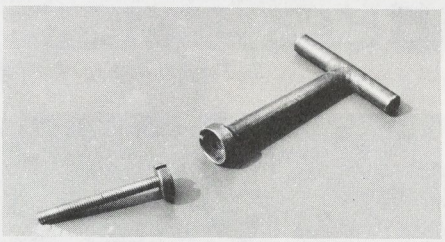
It is a sort of closet made of steel plate and covered with a facing of halved logs. It contains a very simple tape player and a battery to power it. The player uses an endless tape on which is recorded a short lecture on what is to be seen and heard in the vicinity. The lecture lasts approximately six minutes and then repeats. The recorder is activated when someone steps on a footplate in front of the box and it will run as long as the footplate is depressed.

Construction is on a concrete foundation. Bolt-ends are hammered flat to prevent the nuts from being unscrewed.

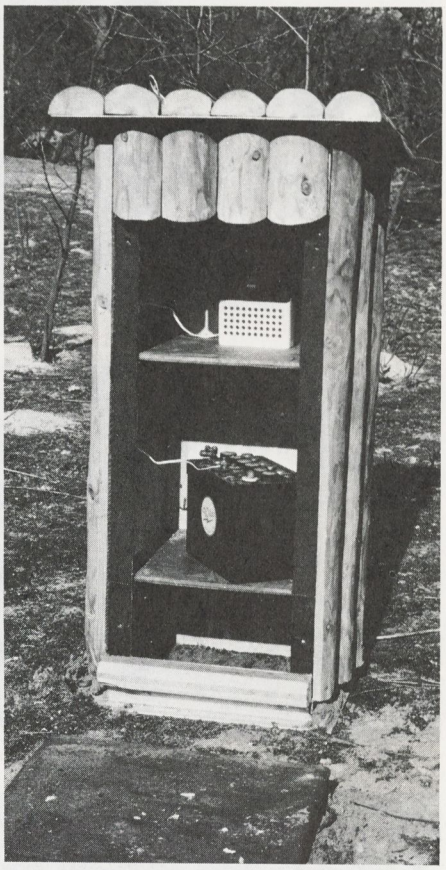
The door is fastened in the closed position by four round-headed bolts. When they are screwed tight, the heads are at the bottom of iron tubes. Unscrewing is possible only with the help of a special key: an iron tube with a cam welded on the inside that fits into a groove in the bolthead. Without that key it is impossible to open the door.



Information Box, ready for "use."



Bolt (one of 4) and special key wrench used to close and open the door.



The Box with door removed to show battery and tape equipment.

The sound aperture at the front is closed by an iron plate with holes in it. The wood facing both above and below the aperture is cut off obliquely, so it is not possible to reach the recorder with a twig or piece of wire poked horizontally through the holes.

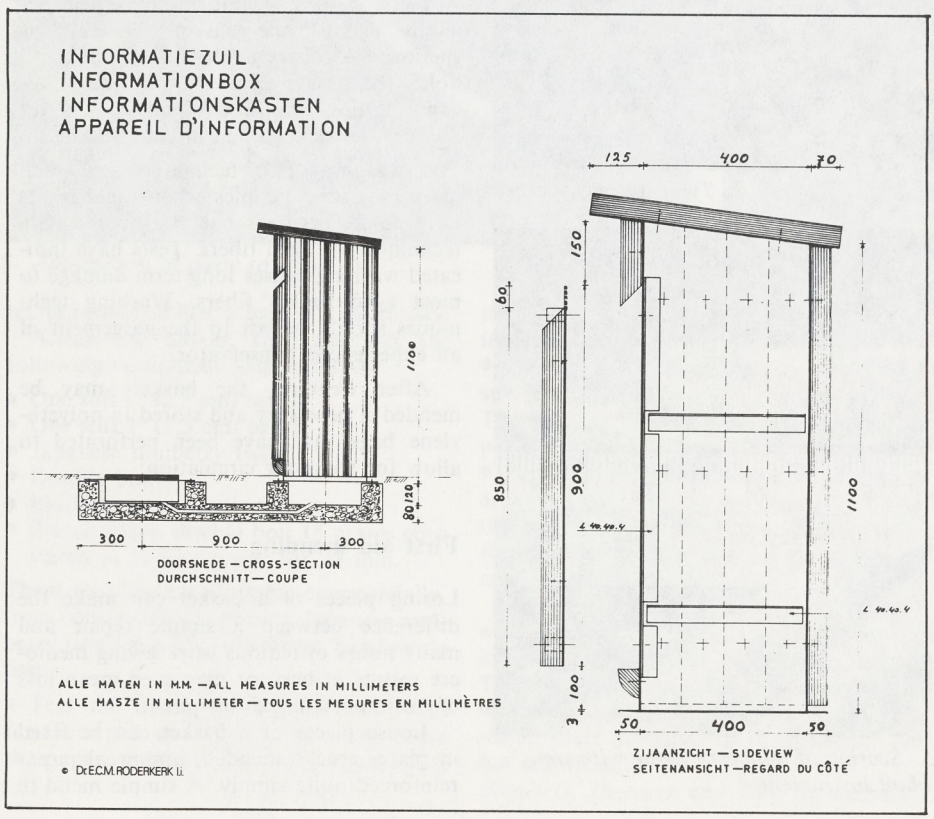
The recorder is enclosed in a plastic bag for protection against dust, sand and moisture.

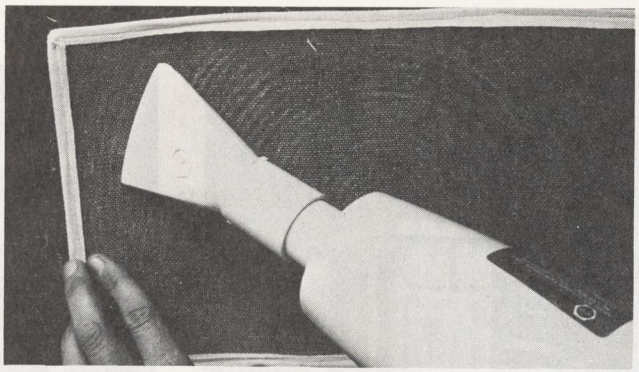
Springs under the footplate are adjusted so that contact requires a weight of at least 50 kilogrammes (about 110 lbs). Thus the recorder will not go on running if somebody puts a stone or a piece of wood on the footplate.

Space between the footplate and the foundation are closed with soft rubber seals to protect the contact plate against moisture. Moreover, the footplate is covered by a hard rubber sheet whose sides are dug into the ground.

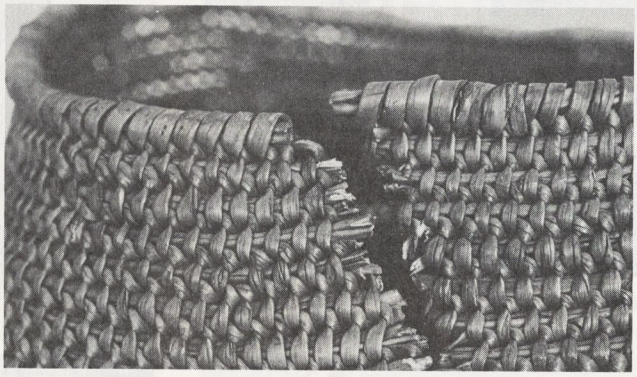
This information box can be placed where many visitors pass by or at an overlook or place of special interest. It appeals to the curiosity of the people, and most certainly will be heavily used.—Dr. E.C.M. Roderkerk

Dr. Roderkerk was Director of the Kennemerduinen National Park until he retired in 1976. He now lives at Pernambucolaan 15, Overeen, The Netherlands.—Ed.

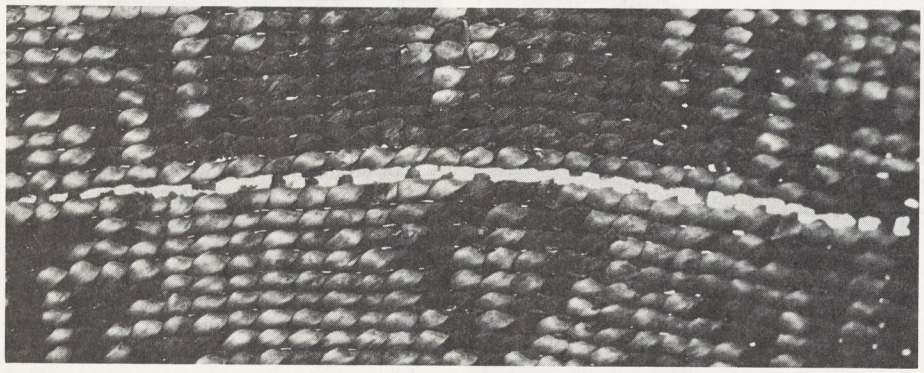




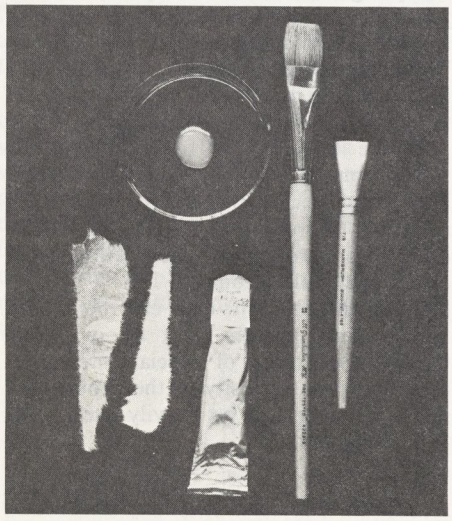
1. Recommended temporary cleaning procedure



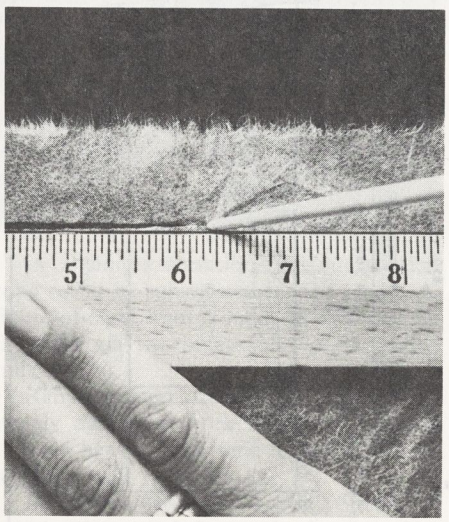
2. Typical damage-break



3. Typical damage-crack



4. Equipment and materials for temporary repair process



5. Scoring of mulberry tissue with wet, blunt instrument

Basket Cleaning and Repair

Park museum collections often contain baskets which are important elements of the cultural heritage of native peoples or other inhabitants of the park area. The following brief guides to their cleaning and first aid mending are taken from the CONSERVE-O-GRAM publications issued by the Division of Museum Services, Harpers Ferry Center, US National Park Service.

Cleaning

Dust on baskets is a serious problem. Dust obscures decoration, destroying the identity of the basket. Dust also acts as a nucleus for attracting moisture droplets which in turn attract moulds, dissolve pollutants, and catalyze decomposition reactions. All of this hastens the deterioration of the basket.

Once dust gets into a basket it is almost impossible to completely remove. Techniques used include:

Brushing with a soft brush—The dust acts as an abrasive. Each time the basket is brushed surface materials are removed. Brushing also increases the danger of knocking off loose pieces.

Blowing with a jet of air—This must be done outside or dust is just moved around. Again, caution must be taken against blowing off loose pieces.

Vacuum cleaning—This is the safest system of cleaning baskets if done properly. A piece of fine plastic mesh is held securely against the basket. The dirt is suctioned off through the mesh. The mesh holds the basket fibers in place and prevents "lifting" them. CAUTION: Do not abrade the basket when moving the mesh.

Wet washing—This technique was often used by native peoples when the baskets were new. This does not mean it is a safe technique for aged fibers. Tests have indicated washing causes long term damage to most aged basket fibers. Washing techniques should be left to the judgement of an experienced conservator.

After cleaning, the baskets may be mended if necessary and stored in polyethylene bags that have been perforated to allow for some air circulation.

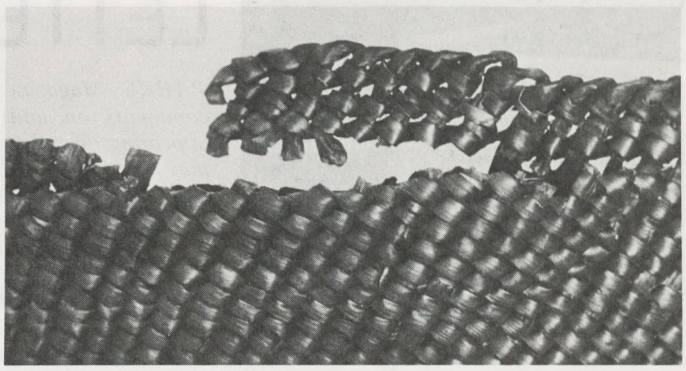
First aid mending

Losing pieces of a basket can make the difference between a simple repair and many hours of tedious work giving mediocre results at best, or may even mean loss of an important exhibit piece.

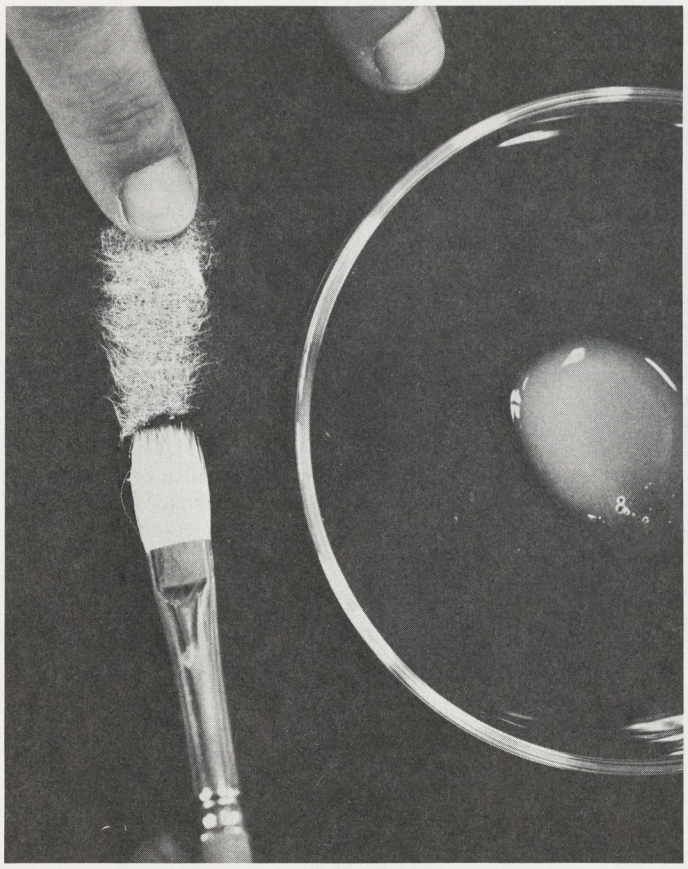
Loose pieces of a basket can be fixed in place, cracks mended, and weak areas reinforced quite simply. A simple mend to



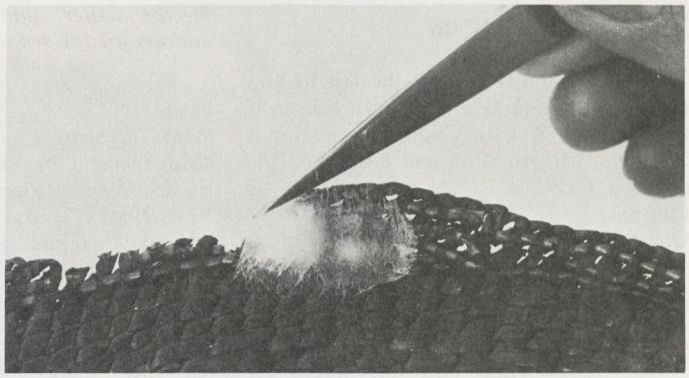
6. Proper tearing action of tissue



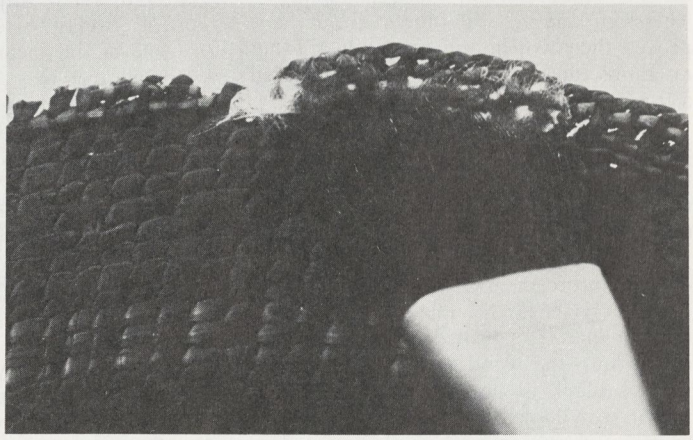
8. Weak area to be mended



7. Application of paste to tissue



9. Application of moist tissue



10. Tapping into place of tissue fibers with soft, dry brush

temporarily stabilize a basket is as follows:

Clean the basket, then assemble the following equipment and materials:

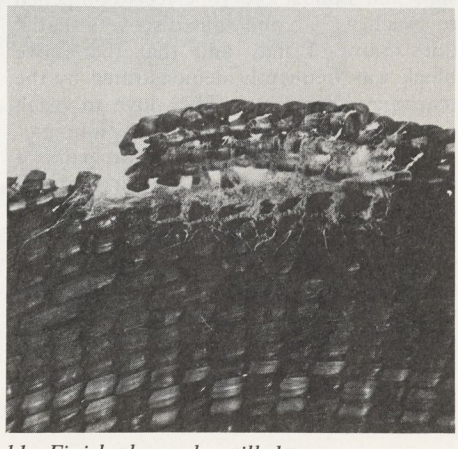
- One soft 1″ (2.5 cm) brush
- One stiff 1″ (2.5 cm) brush
- Japanese mulberry tissue
- Double boiler
- Blotting paper (optional)
- Starch paste: double boil 15 grams corn starch in ¼ litre water for 45 min.

These supplies are available commercially, from conservation suppliers. Japanese mulberry tissue is a thin, long fiber, hand made tissue.

- Tear the tissue into suitable size strips for the repair as follows: Wet a line down the paper, then pull the paper apart along that line. This type of tear leaves a soft feathered edge.
- Put a strip of tissue on the blotter and spread starch paste over the entire surface. The blotter removes excess water from the paste.
- Place the pasted strip over the damaged area and tap the paper fibers down into the basket fibers with the soft dry brush. Repeat this technique until the damaged area is stabilized.

This repair is not invisible unless done with fine pieces of paper, so mend on the inside of the basket if it is to be exhibited. The repair is meant to be temporary but will hold baskets intact for years. Use only starch paste adhesive—it is reversible. **Do not substitute!**

Fonda G. Thomsen and Toby J. Raphael



11. Finished mend—still damp
Photos: Hali Taylor



Revolving Signs

This "sign" stands next to the langur and macaque enclosures at the Nature Education Center Kahao Chong, in southern Thailand. The question and answer on the exposed faces of the block translates as follows:

Question: *How can you tell which monkeys stay mainly on the ground and which ones stay in the trees?*

Answer: *Look at their tails. The ones with short tails stay mainly on the ground and the long tailed ones stay in the trees.*

This sign and several others like it have proved their worth, and proved again that anything that can be moved or handled attracts visitors' attention.

These blocks can be spun around their axis thereby alternately revealing a question and its answer. All it consists of is a rectangular, wooden block of equal sides (solid or assembled from boards, hardwood for outdoor use), a length of concrete reinforcement steel, and two supports. It is cheap to make and virtually maintenance free, provided the lettering is routed into the wood.

This block is within easy reach of the visitor who looks down on it. Two of its faces are always at least partly exposed to view and it is so unlike any conventional sign that almost everyone feels compelled to touch it . . . and thus discovers that it does move. I may add that the above block was frequently demonstrated by the macaques themselves. They love to reach out from their cage and set it spinning.

Messages are arranged in two pairs of question/answer units. It does happen, of course, that one reads an answer first or in incorrect sequence because the block spins either way. This, however, is not a serious drawback since anyone who is able to read will make sense out of it all the same.—Klaus Berkmüller

LETTERS

PARKS Magazine welcomes thoughtful comments on and criticisms of material appearing in its issues. These comments may represent conflicting interpretations of policy and philosophy. They may provide additional information, and occasionally they will correct errors. Selected letters will be printed here as a service to our readers, and as a forum for constructive dissent. However, we reserve the right to edit and shorten contributions when necessary. Letters should be in English, French or Spanish, be signed with the full name of the writer, and include a complete address for the sender—Ed.

Dear Sir,

While agreeing generally with the article "Management of Red Deer in the Bayerischer Wald National Park" in PARKS, Vol. 2/1/1977, by Mr. Ulrich Wotschikowsky, there are some points on which I disagree:

1) In the Swiss Canton of Graubünden the lack of adjustment of the hunting season is not due to traditional hunting patterns, but to public resistance to killing "park game"—even outside the park.

2) I disagree with the author's definition of "today's Hege". In my opinion *Hege* never did mean to:

- prevent trophy stags from migrating to neighboring hunting grounds. This may have been a silent hope of a trophy hunter as a side effect, but had nothing to do with *Hege*;
- change the natural population structure by selective shooting of age and sex classes. It is intended to reduce the numbers in such a way that the natural population structure is maintained;
- ensure a high level of desired harvest, but to preserve wildlife by keeping their populations at level compatible with the interests of forestry, agriculture and nature conservation. This does not reflect a hunter's rancor, but is what I believe the law considers to be necessary.

"Today's Hege", as defined, is the "preservation of the biosphere for wildlife, including the adaptation of numbers of wildlife to the ecosystem and the adaptation of the environment to the needs of wildlife by consequent management". In my opinion, this kind of management is compatible with national park management, even by excluding any manipulation by man: In this sense it provides for the adaptation of numbers and social structure of deer populations, when necessary, for the benefit of the park's ecosystem. And this is the kind of management which I believe is compatible with the New Delhi principles.

I am perfectly in agreement with Mr. Wotschikowski's suggestions that the red deer which remain during summer in a park which is in higher altitude should, as far as possible, be allowed in winter to wander into the lower levels. I would even go as far as to say that one should try, with the help of winter conditions, to disaccustom the deer from staying in such a park. Many things, of course, have to be done outside the park in order to ensure that undesirable concentrations of deer causing much damage are avoided.

W.E. Burhenne, Bonn.

Dear Sir:

I have just read "Use of Chemical Restraints in Handling Wildlife" by Roy D. Hugie in PARKS, Volume 2, No. 3.

The following points and ideas might have been given greater emphasis or added.

I think the point should have been made that SCC (Succinylcholine Chloride) deteriorates quite rapidly in solution and on heating. The practical implication of this is that fresh solutions should be made up each day and these should be kept out of the sun and away from the engine heat of a vehicle. Also, loaded darts and the dart gun must not get hot if dosages are to maintain their potency.

SCC is a positive killer on some species! (e.g. Zebra) because there is an almost non-existent tolerance band between an underdose and an overdose.

Other systems for firing projectiles that could be mentioned are:

a) Paxarmus Ltd.
P.O. Box 317
Timaru, New Zealand
This system uses blank .22 cartridges as the propellant and has an array of accessories including telescopic sights, etc. The dart velocity, and thus impact, can be adjusted.

b) Tele-Narco-Technik
c/o Behr Chemie
73 Brack
2 Hamburg, West Germany
This system uses a modified 12 gauge shotgun with special optical sights and sound suppressors.

Two further practical hints are:

a) Blindfold animals that are immobilized with substances that leave them fully conscious (such as SCC) to reduce the traumatic effects of being approached and handled.

b) Wherever possible, a wildlife veterinarian should be involved in the immobilisation. *This is a must when dealing with rare or endangered species.*

Finally, one important reference that Mr. Hugie appears to have overlooked is the book "The Capture and Care of Wild Animals"—Editor Dr. E. Young, published by Human and Rousseau, Pretoria, 1973.

G.S. Child, FAO/ROME



Migrating dunes, Doñana National Park, Spain, (1977). Photo: Rollin D. Sparrowe.

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April 3, 1979

Dr. R. J. Behnke
Fishery Unit
Colorado State University
Fort Collins
Colorado 80521
U.S.A.

Dear Bob,

You must be wondering what happened to me! I finally left Iran on 6 February when the university strongly advised all foreign faculty to leave. Luckily I managed to take out all my fish collections, save a few minor items, though I had to leave all my books and papers behind. These should be sent on to me when the mail begins to function again (if they weren't looted).

The National Museum is employing me to work up these collections on a temporary contract basis. Unfortunately the political situation in Iran prevented me from going up to Tehran to visit MMTT and your former student last fall. I still haven't seen a copy of his thesis. Would it be possible to obtain a photocopy of this work either from you or from the Colorado University library? I am also naturally curious as to what you and your student have published or are working on, so that I can avoid unncessary duplication of effort.

At the moment I am busy with the mundane task of unpacking, sorting, and identifying my collection. When this is completed in a few weeks I can then start some projects on the systematics of the less well known cyprinids and cobitids. The Museum is keen on me writing up my collections in book form but I have an idea this might clash with MMTT's plans or does the revolution change this?

.../2

Ottawa
K1A 0M8

I have completed a paper on "Conservation of Iranian Freshwater Fishes" based on my own observations and published works. This has been accepted by Biological Conservation. However, I think it could be improved. One part of my aborted trip to Tehran was to have been a sweep through MMTT's library to dig out manuscript reports on Iran's fish fauna. If you do have any unpublished material of this kind which might be relevant I would be most grateful for a copy. (I would of course pay any expenses involved.)

If I can be of any help to you in your studies on Iranian fishes (eg. loan of specimens) please let me know.

Yours sincerely,

Brian W. Coad

Brian W. Coad, Ph.D.

P.S. Do you have a name and description for the cichlid from Iran?



National Museums Canada
Musées Nationaux Canada

Brian W. Coad
Ichthyology Section
Ottawa Ontario
K1A OM8

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Dr. R. J. Behnke
Fishery Unit
Colorado State University
Fort Collins
Colorado, 80521
U.S.A.

Air Mail Par avion

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14 May, 1979

Dr. R. J. Behnke,
Dept. of Fishery and Wildlife Biology,
Colorado State University,
Fort Collins, Colorado 80523

Dear Bob:

Thanks for your letter. I hope Saadati maintains a "low profile", being overtly anti-Islam right now is not very wise.

As you suggested I have requested a loan from the library of Saadati's thesis. I gave them your name in case they need your permission as supervisor.

A rough draft of my conservation paper is enclosed. Any comments scribbled on it will be most gratefully accepted.

I am currently examining the Aphanius of Iran but any publication on them is some way off since I would have to examine Jenkins' types. Do you have any A. mento from Iran? My collections also contain Glyptothorax kurdistanicus from two sites and I was thinking of writing them up as a note since Berg described the species from only one specimen. I'm waiting for a paper by Kuru who seems to have found this species in Anatolia. Did you also collect this species? I have sent out requests for comparative material of Indian and "Palestinian" cichlids for comparative osteological studies with the species from Iran. These will take some time to arrive but I'm staining up several Iranian cichlid specimens ready for this study.

Any contributions you could offer would be most gratefully accepted and I would be happy to pool complementary data for co-authorship.

Take care,

Yours sincerely,

Brian

Brian W. Coad, Ph.D.
Research Associate

Ottawa
K1A 0M8

du Canada
Research Associate
OTTAWA CANADA K1A OM8

DR. R. J. BEHNKE,
DEPT. OF FISHERY AND WILDLIFE BIOLOGY,
COLORADO STATE UNIVERSITY,
FORT COLLINS, COLORADO 80523

Bob,

This is a rough draft. Your information on Pimephales has not been included; nor have data from papers and MS reports which I am waiting to receive from Peter Wałczak and our library. The check-list of gobies is also being rewritten to conform with revisions by Pinchuk; many of the cyprinids and of the cobitids listed will prove to be synonyms I don't doubt, but until they have been studied in detail I have just listed names.

CONSERVATION OF FRESHWATER FISHES OF IRAN

BRIAN W. COAD

Ichthyology Section, National Museum of Natural Sciences, Ottawa, Ontario, Canada. K1A 0M8

Formerly of Department of Biology, Pahlavi University, Shiraz, Iran.

ABSTRACT

Factors affecting the distribution and abundance of freshwater fishes in Iran are described. These include climate, devegation, irrigation, and natural water level fluctuations which may be termed pre-industrial and such factors related to industrialization and population increase as devegetation, water abstraction, fishing, pollution, and faunal introductions. Conservation schemes are outlined and commented on and a list of threatened fishes is given.

INTRODUCTION

The purpose of this paper is to describe those factors, both man-made and natural, which affect the distribution and abundance of Iranian freshwater fishes and to record and suggest measures for the conservation of this fauna.

Fishes, particularly those of no economic value, do not receive the amount of attention from conservationists as do birds and mammals since they are not as readily observed and perhaps have less aesthetic appeal. The amateur ichthyologist is a rarity compared to the amateur ornithologist and mammalogist. A responsibility lies therefore with the professional ichthyologist to write about rare and endangered fishes. This is particularly true in a country like Iran which is rapidly industrializing, with consequent dangers to the fauna, and which in addition lacks an extended tradition of concerned amateur naturalists (Scott et al., 1975) and where there have been few studies on fish ecology. Factors affecting distribution and abundance of fishes can therefore only be outlined in general terms and it is hoped that more specific studies will be forthcoming from the responsible government agencies charged with environmental protection.

Reasons for conservation of fishes need hardly be argued; fishes are important for scientific, cultural, aesthetic, recreational, economic, and educational purposes.

A. PRE-INDUSTRIAL FACTORS

This section deals with those factors affecting distribution and abundance of fishes from about 8000 B.C. up until the present day. It is important to emphasize that the contemporary fish fauna has suffered from environmental degradation in prehistorical and historical times and that industrial factors are having an exacerbating effect.

a) Climate

Pluvial conditions in Iran ceased well before the end of the Pleistocene about 8000 B.C. (Butzer, 1972). Since that time there have been no major climatic fluctuations comparable to pluvials and interpluvials but even so minor fluctuations were of sufficient magnitude to have had an influence on the fish fauna. Butzer (1961) summarizes evidence for a minor subpluvial in southwest Asia after a post-Pleistocene arid period. This subpluvial lasted from circa 5500-2350 B.C. and was characterized by higher humidity and rainfall with luxuriant flora able to thrive in areas where it is too dry today. Distribution of fishes was probably facilitated by permanent rivers and streams which today are intermittent or dry. Inland lakes would have a greater volume of water and perhaps would be connected to adjacent basins further facilitating fish dispersals and distribution. A more luxuriant flora would reduce surface runoff so that flow regimes of rivers would be more stable, erosion and its destructive effects on watercourses would be reduced and shaded water would have lower temperatures such that stenothermal fishes would disperse more widely through lower parts of drainage basins which today are too warm. The subpluvial was followed by a period more arid at times than today although this improved towards the end of the last millennium B.C. and since then there have been only short term variations in the climate. The onset of dryer conditions might well have limited the distribution of the fish fauna and led to the loss or isolation of certain minor drainages.

Ice-melt from the Fennoscandian ice-cap, as late as 4000 B.C., contributed large volumes of water to the Caspian Sea which could not be evaporated. An overflow to the Black Sea was then possible (Raikes, 1967). Berg (1948-49) maintains that the silverside (Atherina mochon pontica var. caspia) and the pipefish (Syngnathus nigrolineatus caspius) entered the Caspian from the Black Sea in post-glacial times while most other fishes are relicts of earlier transgressions or are migrants from northern waters.

b) Devegetation

The influence of the climate is difficult to assess because of the disturbance of the delicate equilibrium between climate, vegetation and soil by man. The influence of man on the environment has been the major destabilizing factor.

The hunter or food collector burnt sections of the forest to clear the environment. Fire was also used to drive animals. The grazier burnt to stimulate new growth and reduce scrub and shifting cultivation used the slash and burn technique. Even the scorched earth policy of war contributed to degradation of the environment. Domestication of sheep and goats occurred in Iran in about 6000B.C. or even a little earlier and these animals prevent recovery of land devegetated by man through overgrazing. The pig and cattle, domesticated later, also contributed to devegetation by man through overgrazing, and to deforestation on the basis of feeding and pasturage requirements. The Przewalski horse was domesticated in Iran around 4000 B.C. and the modern horse was introduced in the second millennium B.C., both these animals greatly facilitating land clearance (Whyte, 1961). Dorst (1970) moreover states that forest was often identified with savagery so clearance had a psychological as well as economic basis. Introduction of iron and the plough in the first millennium B.C. also resulted in a more effective and a greater rate of clearance.

Wood was cut for domestic fuel, for charcoal, for pottery, brick and metal production and for building houses and ships. In time not only trees but also shrubs and finally perennial and annual vegetation was consumed. The extent of deforestation in Iran since the end of the Neolithic (circa 5000 B.C.) has been summarized by Whyte (1961). The following proportions have been destroyed: - three-quarters of the Caspian coast humid forest, one-half of the Caspian mountain humid forest (much of the remainder severely degraded), up to five-sixths of the Zagros oak and oak-juniper forests, and nineteen-twentieths of the Elburz and Khorasan juniper forest. Heavy depletion of the open Pistacia amygdalus stands, which once covered almost the entire central plateau outside the true desert, is also recorded. Nomads or semi-nomads have been responsible for destruction of plant cover because of extensive grazing, dry farming and charcoal burning.

Devegetation severely affects the hydrological regime with consequent destruction of fish habitats. It reduces rainfall and hence stream flow and desert encroachment results. Reduction in plant cover affects retention of rainfall; only about 20% of total rainfall can usually be measured as runoff but in deforested and devegetated areas of the Zagros 70-80% can be assumed (Whyte, 1961). Torrential flow and flash floods result with deleterious effects on the fish populations at certain times of the year. Only species able to cope with such unstable conditions survive. Lower reaches of rivers, which may not even be in the devegetated zone, experience a change in flow to seasonal instead of year round. Spawning occurs in the spring for many species when abnormal runoff is often high and eggs may be washed away, smothered by silt or subjected to desiccation on recession of high water levels. Devegetated areas are more susceptible to the action of wind. Rivers and streams of the Seistan basin are often blocked by sand blown by the Wind of 120 Days such that they change course with major effects on the fish fauna (Anon., 1966). Increased surface runoff causes greater erosion destroying stream habitats and the fauna and flora on which fish depend by washing them away, by siltation and abrasion. Direct effects on the fish themselves of turbid waters will also limit species and abundance in streams subject to excessive erosion. Certain species are not able to respire effectively locate food or mates, or carry out reproductive behavior under such conditions. Erosion also lowers the water table so that springs, marshes and their associated streams dry up. This is a particularly serious loss of habitat for those fishes which use such waters as refuges from the torrential regimes of larger streams and rivers. Lowered water tables cause rivers to be intermittent for part or most of the year. Personal observations have shown that this severely restricts the abundance of fishes in a river system and survivors in isolated pools are typically emaciated.

c) Irrigation

Extensive irrigation projects were undertaken in many parts of Iran under various dynasties and date back as early as the third millennium B.C., forming extensive habitats for fishes and perhaps replacing to some extent the swamp habitats first drained and settled as early as Babylonian times in Mesopotamia. However, wars, invasions such as that of the Mongols in the mid-thirteenth century, and neglect perhaps aggravated by variations in flow of

rivers resulted in destruction of these irrigation networks and although many were reconstructed they can not be regarded as stable habitats.

Khuzistan has long been characterized as a desolate waste largely taken over by silt from river floods and wind erosion but remains of ancient irrigation canals and dams can be seen in this province. Irrigation brings with it the danger of soil salinisation through surplus water infiltered into the soil causing a rise in saline groundwater or through slightly saline water evaporating when dammed. Many freshwater fishes have a low tolerance of salinity and runoff from such soils might well increase salinity in smaller water bodies to critical levels. Records of soil salinity problems in southern Mesopotamia date from 2400 B.C. (Whyte, 1961).

An important source of irrigation and general purpose water throughout much of Iran for more than twenty-five centuries has been the qanat or ghanat, described in detail by Smith (1953) and Beaumont (1974). A qanat is basically a gently sloping tunnel located in alluvial fans of foothill regions where it taps the water table at a depth of 20 to 250 metres to provide a continuous discharge by gravity flow at the lower end of the tunnel. Vahidi (1963) maintains that there are 50,000 qanats in Iran, ranging in length from a few hundred metres to as much as 50 kilometres, and with a total discharge exceeding Iran's largest river. Construction of qanats is expensive and time consuming and both maintenance and the initial construction process are dangerous because of the unstable nature of alluvial fan material. The qanat and its stream are an important refuge for fishes providing a constant flow of water of consistent temperature and within the qanat itself protection from insolation and predators. In some areas of Iran there is little surface water or fishes, apart from the qanat. "Mining" of groundwater by qanats often led to a reduction in flow such that they had to be lengthened thus penetrating deeper into the alluvial fan. Eventually longer qanats were abandoned for economic reasons as were those that collapsed or were destroyed in wars. Although qanats provide habitats for fishes they do lower the water table so that nearby springs and streams dry up. Subsequent loss of a series of qanats for the reasons outlined above would then eliminate the fish fauna of an area.

d) Natural water level fluctuations

There are historical records of water level fluctuations in such basins as the Caspian and Seistan which are not explicable solely on the basis of devegetation since there have been both rises and falls in water level. These basins receive much of their water from large catchment areas in other regions with a different topography and/or climate. Their water levels were therefore dependent on rainfall levels outside their immediate surroundings. Dunin-Barkovsky (1977) records level fluctuations of up to 50 metres in the Caspian Sea for the Holocene period due to variations in the general moistening of Eurasia and intermittent warming and cooling variously associated with changes in precipitation and evaporation. Brooks (1949) contends that the Oxus (Amu-darya River) flowed into the Caspian in the fourteenth century instead of into the Aral Sea. Shnitnikov (1969) records flow along the Uzboi channel into the Caspian from the Aral Sea at several periods, namely at the end of the third millennium B.C., at the turn of the second millennium B.C., in the end of the first millennium B.C., and in the fourteenth to sixteenth centuries A.D. Glubb (1967) however maintains that the Oxus changed its course in 1220 A.D. discharging into the Caspian Sea when the Mongols cut its banks after the capture of Urganj. Brooks (1949) also records high lake levels in Seistan about 900 A.D. Gholizadeh (1963) records drought years from 1957-62 for Tigris, Euphrates and Karun Rivers and their tributaries and such conditions no doubt occurred in pre-industrial times. Variations in rainfall, snow cover and insolation are marked in many parts of Iran. Several 'wet' or several 'dry' years in succession can affect surface water levels and groundwater recharge.

B. INDUSTRIAL FACTORS

This section covers those factors affecting fish distribution and abundance which have become most prominent in the last 50 years as concomitants of industrialization and a burgeoning population.

a) Devegetation

Although devegetation is a process of prehistorical and historical

age it still continues today. Perennial and annual vegetation is cut and carried by hand for fuel and Whyte (1961) has recorded motor vehicles radiating out from Tehran in a search for fuel making devegetation more extensive and complete. It is calculated that 10,500 hectares of plants numbering perhaps 105 million shrubs were uprooted in 1977 for Chahar-Shanbeh Suri, when these plants are burned as part of the Persian New Year celebrations (Kayhan International, 9 May, 1978).

Dorst (1970) reports statistics for Iran based on data published in 1960 that cite 27 million sheep, 12 million goats and 5.24 million cattle while the carrying capacity of the country was then equivalent to 26 million sheep. For administrative, social and economic reasons it was not possible to reduce the numbers of animals with any rapidity.

Firouz (1974) writing on the Zagros and other forests outside the Caspian area states that less than one-tenth remains compared to pre-World War II levels.

The consequence of vegetation and forest destruction and excessive numbers of grazing animals for the environment including fish habitats need not be reiterated.

b) Water abstraction

A burgeoning population, construction of many industrial complexes and the needs of agriculture have led to a greatly increased demand for water. Evaporative coolers are now widespread household fixtures and these consume very large quantities of water (Beaumont et al., 1976). Deepwell pump installations now compete directly with qanats for limited groundwater (Vahidi, 1963) and owners of qanats prefer to drill wells rather than maintain or extend drying qanats (Mandel, 1975) and perhaps 25% of qanats in Iran are now non-functional. Unlike qanats wells do not support a fish fauna. Excessive demands on groundwater of a region by numerous wells might also lead to drying up of marsh and spring habitats. Channelization of rivers converts a natural environment replete with vegetation cover and food organisms to an artificial environment with few of these essential requirements for maintenance for fish populations.

Construction of dams has been a feature of the Iranian industrial-

ization programme, twelve having been completed and a further six being under construction or at the planning stage (Beaumont, 1974) (Fig. 1). Dam construction affects fish populations in many ways. Even before completion the construction of a dam may cause heavy loads of silt to be transported down river with adverse affects on the fish fauna (Anon., 1972). Dams may accelerate the fall of the water table by blocking recharge of groundwater through the absence of floodwaters. Fishes which normally breed in flooded areas each spring can no longer do so. The river below the dam has its flow regime altered by power and irrigation requirements and large quantities of deoxygenated, hot surface or cold bottom water may be poured abruptly into the river from the dam. Construction of the Dorudsan dam on the Kor River near Shiraz has led to the loss or reduction of marshes down river (Cornwallis, 1968). Gas-bubble disease may occur in down river fishes which ingest water supersaturated in gases caused by turbines or when air bubbles are carried to great depths over a spillway where pressure forces gas into solution. Migration is physically prevented by dams even though fish ladders are constructed (Dorst, 1970). Migrating fish become delayed by dams and this leads to degeneration of eggs so entry into a fish passing device occurs with reduced or lost fecundity. Also the concentration of fish, eggs and larvae in reservoirs or below dams leads to loss by predators. Reduction of flow will also interfere with migrations. Vladykov (1964) has noted that dam construction on the Sefid River made no allowance for requirements of spawning sturgeon from the Caspian Sea. Water flow was reduced and shallow river water became overheated leading to the death of such food items as aquatic insects and crustaceans on which young sturgeon depend. Many adult sturgeon were attracted into irrigation channels by their strong water flow and ultimately perished. Still water in the dam caused silt deposition and increased river water transparency. Silt particles in the river water are an essential condition for successful reproduction of sturgeons. Also predators are more effective in clear water (Baxter, 1977). Dams often trap sediments and nutrients to the detriment of the down river environment. In a devegetated country like Iran, dams rapidly silt up because of erosion on the bare surrounding hills. Life

expectancy of such dams as the Shahbanou Farah and Mohammed Reza are low (Beaumont, 1974). The reservoir which forms behind a dam alters the aquatic environment from a stream or river to a lake, and fishes are often ill-adapted for such a change. Construction of a large earthfill dam on the Lar River in northern Iran will convert 40 kilometres of stream habitat ideal for trout spawning into still water and end fishing there in 1978.

Introduction of new species to exploit the sport fishery potential of the reservoir brings with it certain dangers for native species throughout the river basin. These dangers are outlined more fully later but certain points can be given here. The newly stocked reservoir initially shows high yields based on cover and food supply provided by drowned vegetation but several decades of poor yields occur as the vegetation is exhausted or covered by silt until settling of plankton produces a new organic layer. The reservoir is subject to abrupt fluctuations in water level according to the needs of water or electricity consumers and under such conditions rooted aquatic plants and stable shore habitats for reproduction and growth of fishes cannot develop. Parasite infestations can become high in reservoirs because more zooplankters are available as intermediate hosts (Baxter, 1977)

Certain areas of Iran depend on water supplies from neighboring countries. The prime examples are the endorheic basins of the Caspian Sea, which receives 76% of its water from the Volga River in the U.S.S.R. (Zenkevitch, 1963), and the Seistan lakes fed by rivers, principally the Helmand or Hirmand, which flow from the mountains of Afghanistan. Fifty per cent of the waters of the Volga are controlled by dams resulting in a serious fall in the level of the Caspian Sea with profound repercussions on fish habitats. In addition an increase in salinity has occurred, notably in northern sections, adversely affecting the biomass of benthos which constitutes a substantial part of fish food (Vladykov, 1964). The Russian sturgeon fisheries have declined by 50% since 1913 (Dorst, 1970). However it is principally the shallow northern Russian parts of the Caspian which are affected and the steeper Iranian shore offers some protection against habitat loss if the fall in level is gradual giving time for new areas to develop. Prehistorical and historical natural water level fluctuations

have been noted above which the fish fauna appears to have survived. In modern times there is additional pressure on the fauna from fishing and pollution and the decline in level is likely to be continuous unless corrective measures are taken. While species survival is probable there is a definite decline in catches of commercially important species which Vladykov (1964) attributes to a falling Caspian Sea level. In the 1930's the Pahlavi Mordab, a lagoon area of the Iranian Caspian shore, was 4-8 metres deep but in the 1960's it was only 1 metre deep, muddy and weed choked. Such conditions led to oxygen deficiencies through plant respiration and fish mortalities occurred. Spawning areas were rendered unsuitable and migratory fishes were obstructed. Catches for four commercial species declined from 6,682 tons in 1933/34 to 319 kilogrammes in 1961/62. Fall in Caspian Sea level has drained marshes along the whole length of the Caspian lowlands and many areas have been drained for agriculture resulting in a loss of aquatic habitats. The Gulf of Karabugas concentrates Caspian Sea salt by evaporation, preventing a rise in salinity despite a daily input to the Sea of 17.7×10^7 kilogrammes of salt. If the level of the Caspian falls too low to maintain flow into the Gulf then the Caspian salinity will rise to harmful levels.

Two of the Seistan lakes, Hamun-e-Hirmand and the Hamun-e-Sabari were largely dry in the winter of 1976 because their main water source, the Helmand River, was restricted by the Kajaki dam in Afghanistan. Hamun-e-Pazak, fed by the Khash River, was in good condition at this time. These Seistan lakes retain a freshwater character despite being an endorheic basin because floods and the seiche resulting from the Wind of 120 Days spill water through a channel to the Gaud-e-Zirreh, a salt flat in Afghanistan. The Kojaki dam and the Kohak and Zehak barrages in Iran, if they do not lead to complete drying up of these lakes, may well lead to an increase in salinity in the absence of a flushing effect with eventual deleterious effects on the fish fauna.

Many areas of Iran are threatened by water loss, ironically because of irrigation schemes, e.g. Lake Kobi and the Ghara Gheshlaq marshes of Azarbaijan, which understandably take priority over preservation of habitats when there is a burgeoning population to feed. Discharge of the Tigris-Euphrates system decreased in 1957-62 in part because of increased use of

water for irrigation in Iraq (Gholizadeh, 1963). In addition lack of proper drainage of irrigation water and inadequate drainage of flood waters, coupled with high evaporation, have increased soil and water salinity (Anon., 1961), e.g. salt content of Iraq drainage channels into the Arvand River (=Shatt-el-Arab) on the border with Iran was recorded as 40,000 p.p.m. of which 70% was sodium chloride (Gholizadeh, 1969). Water abstraction from many Caspian streams for rice growing helped to severely deplete stocks of the Caspian "salmon" or mahi azad, Salmo trutta caspius, which requires a fast current for spawning. The streams became shallow and weed choked, the current slowed and water temperatures rose above the tolerance level for mahi azad. Sefid mahi, Rutilus frisii kutum, the most popular Iranian food fish, is also susceptible to such changes in the environment, particularly in spawning areas (Vladykov, 1964).

c) Fishing

Sport fishing is still of only minor importance in Iran outside high, cool mountain trout streams and lakes. Certain cyprinid species are caught by local people using extensive gill nets but this is not carried out on a commercial scale except to a minor degree in some rivers of Khuzistan, Guilan, Mazanderan and the Seistan lakes where fish are sold locally.

The once commercially important Caspian "salmon" was almost driven to extinction by excessive use of nets, traps and even dynamite in the late 1950's (Firouz 1974). The introduction of synthetic fibre gill nets in 1957 led to an increased yield of Caspian Sea sturgeons while the fall in Sea level apparently did not have a great effect on sturgeon fisheries (Vladykov, 1964). Yearly catches by seines of non-sturgeon species in the Iranian part of the Caspian Sea, such as Rutilus frisii kutum, Rutilus rutilus caspius, Cyprinus carpio, Caspialosa species, Mugil and Liza sp., Stizostedion luciopera and Silurus glanis, have declined drastically, the 1961-62 catch being less than one-tenth that of the 1956-57 catch. The average production for the years 1927/28 - 1931/32 was 9,497 tons, declining to 4,469 tons in 1952/53 - 1956/57 and to only 821 tons in 1957/58 - 1961/62. This may be due in part to overfishing but changes in the environment are undoubtedly major factors. Fall in Caspian Sea level severely affected the major fisheries in the Pahlavi Mordab as was outlined above.

d) Pollution

Pollution of freshwaters in Iran is not a new concept since the Zend Avesta contains precepts guiding the disposal of waste. However, as Yazdani

(1973) has pointed out water pollution was not a major problem before 1960 because of the underdeveloped state of industry and agriculture. Visual (and nasal) evidence of water pollution is now apparent in many parts of Iran. Human wastes are discharged untreated into the ground or into the nearest water course in many cities. The effects of sediment from erosion of unprotected soils and overgrazed pastures have been noted above as have the dangers of salinity and choking of habitats by aquatic vegetation. Dorst (1970) has briefly reviewed in general pollutants and their effects on freshwater and fishes. A few examples from Iran will here suffice to delineate the problem.

The prime cause of pollution in the coastal Caspian region is urban waste. There are about 70 towns in this area out of a total of about 240 in Iran, many of them are on the waterfront and almost all lack a proper sewage system (Kayhan International, 8 March 1978). Pesticides used in agriculture, industrial wastes, and petroleum and oil from the oilfield of Baku Bay, U.S.S.R. are also a problem in this region (Firouz, 1974; Hollis, 1978). A fish kill in the Gorgan River in 1978 was attributed to careless insecticide spraying on adjacent fields according to local informants. Savage and Firouz (1968) have reported that marshes along the Atrek River of this region were polluted and also the river systems feeding the Khuzistan marshes in southern Iran.

The jube system, a series of channels carrying water along the streets of most Iranian towns and cities, is also a source of pollution. It functions to irrigate roadside trees but also serves to carry away detergents and other pollutants which may be poured into the nearest river or stream. The Khoshk River in Shiraz is little more than an open sewer in the summer and autumn receiving jube water and other untreated urban wastes.

A fish kill, numbering in the many thousands, occurred in the Mand River near Shiraz in 1977 and was attributed to chemicals used in spraying against malarial mosquitos. The people hired to spray village houses either dumped quantities of the chemical into the river to reduce their work load or washed out containers in the river. The Pulvar River, north of Shiraz, was polluted in 1978 with wastes from a food factory and other buildings and a fish kill was reported. The Barm-e-Dalak marsh near Shiraz has recently been used as a dumping ground for various industrial wastes depleting the fish population

by habitat destruction and water pollution. Fertilizers were first used in Iran on a large scale in 1956 when 3000 tons were imported. By 1969 250,000 tons were being used and must have affected the aquatic environment through runoff.

e) Introductions

Introductions or faunal supplementations using fishes can be of great utility but may also be hazardous undertaking for a number of reasons. Exotic fishes from another continent or from a different drainage basin may introduce a disease or parasite to which native fishes are ill-adapted thus causing a drastic reduction in the population. Exotics may prove to be serious predators or competitors of indigenous fishes. They may become distributed outside their carefully chosen river or lake, through the agency of anglers, into areas where their potential effects have not been gauged. Adequate studies to determine that the proposed introduction will be beneficial can be very expensive (Hubbs, 1977) and are seldom carried out by cost conscious authorities. There are several active and completed introduction programmes for fishes in Iranian waters and some of these are discussed individually by species below. However before describing these deliberate introductions the danger of accidental introductions by water diversion schemes should be outlined.

The headwater streams of the Karun River system (draining to the Persian Gulf) have been diverted into the headwaters of the Zayendeh River (an endorheic basin) for industrial expansion and the needs of agriculture in the Isfahan area since 1953. The headwaters of the Lar River, a Caspian tributary, may be diverted into the Jaji River via a tunnel beneath the Elburz mountains to augment Tehran's water supply. Fishes might not survive tunnel travel but diseases or other unsuitable organisms might become established outside their normal range. So little is known about the ecology of freshwater organisms in Iran that the dangers, or lack of them, cannot be assessed. Continued economic growth in Iran will depend on large scale transfer of water in this fashion since abundant water is concentrated in the north and west of the country (Beaumont, 1974).

Diversionary schemes and transport canals outside Iran may affect the Iranian fish fauna. The Volga-Don canal connecting the Caspian Sea and Azov Sea was completed in 1954-55 and may well result in Mediterranean euryhaline elements reaching the Caspian Sea. Fish populations are not only threatened by exotic fishes but also by introduction of other organisms. Zenkevitch (1963), for example, has described how a bivalve mollusc, Mytilaster lineatus, was accidentally introduced overland into the Caspian Sea from the Black Sea on the underside of small boats during the civil war (it can survive transport out of water with its valves closed). It was first recorded in 1928, by 1933 on the eastern shore of the southern Caspian it comprised 18% of the total benthos biomass and is now more than 90%. It suppresses development of fish food items, in particular another bivalve Dreissenia, but also forms part of the diet of such commercially important species of fish as uzun burun (Acipenser stellatus) and sefid mahi (Rutilus frisii kutum).

The projected diversion of Arctic flowing rivers, and the use of water from Lakes Ladoga and Onega and from the Sea of Azov to renew and stabilize Caspian Sea water level may well introduce predators, parasites, diseases or habitat destroyers (Zenkevitch, 1963; Kovda, 1961; Hollis, 1978).

The following are the principal supplementations in the fish fauna of Iran: -

1) Gambusia affinis

The mosquito fish has been actively distributed throughout Iran as part of a successful effort to combat malaria. It has the dubious distinction of being the most widely distributed and one of the most numerous fish species in Iran. Gambusia eat the larval mosquitos which develop in fresh and brackish waters and which as adults are vectors of malaria. There are two subspecies of Gambusia, G. affinis holbrooki which is found throughout Iran, and G. a. affinis which is said to be limited to Caspian drainages. Gambusia was first imported to the Ghazian marshes of the Caspian littoral from Italy during 1922-30. Its original distribution is in southern North America and Central America. An extensive campaign was mounted, starting in 1966, to distribute G. a. holbrooki throughout Iran to over 3000 permanent water bodies (Tabibzadeh et al., no date). The original source was the Ghazian marsh but natural waters in other parts of Iran are being used as reservoirs

for stocking surrounding areas. It is quite possible that young, indigenous fishes may be inadvertently distributed outside their natural range along with Gambusia.

Observations in other countries have shown that introduction of Gambusia is destructive not only to fish of similar and smaller sizes but also to larger fishes as Gambusia will eat their eggs and young (Berg, 1948-49; Menon, 1965). Gambusia should not be introduced to newly constructed reservoirs because it competes for food with various cyprinids (Nikol'skii, 1961) which are of potential economic and recreational importance throughout Iran. Competition and predatory activity between Gambusia and native Iranian fishes has not been investigated and it is now ineradicable from Iranian waters. Its effectiveness against mosquito larvae is not disputed when used in conjunction with insecticides but there are several, native Iranian species whose effectiveness as mosquito destroyers could have been tested. These include the cyprinodont fishes of the genus Aphanius which has four species in Iran. Two of these, A. dispar and A. sophiae, have been shown to eat mosquito larvae, at least under experimental conditions (Al-Daham et al., 1977), have an annual life cycle, a high tolerance of temperatures and salinities and are widely distributed in diverse fresh and brackish waters over southern Iran (personal observations, 1976-78), making them suitable candidates for introduction to control mosquitos. In more northerly waters other native species would conceivably be used for malaria eradication programmes. Berg (1948-49), for example, has noted that Cyprinus carpio fry regularly consume mosquito larvae. However care must be exercised in introducing such a species outside its normal range as adult C. carpio destroy water plants, eat the eggs of other fishes and muddy the water rendering it unsuitable for other more sensitive species.
Species of Phoxinus, Gobio, Alburnoides, Varicorhinus, Alburnus, Noemachilus and Pungitius are also reported to be useful in mosquito control and these genera are found in Iranian waters (Dubitskiy and Rusinov, 1971; Dubitskiy and Abdil'dayev, 1975).

2) Salmo gairdneri and Salmo trutta

The rainbow trout, S. gairdneri, has been introduced extensively into suitable, high, cool, lakes and streams of the Elburz and Zagros mountain ranges since about 1966 (Firouz, 1974; MacCrimmon, 1972). Since 1973 almost

two million fingerlings have been introduced into 20 location, many of which were previously fishless. This species is native to western North America.

The brown trout, S. trutta, is found chiefly in the Lar and Lighvanchai Rivers. Stocks in the former may well disappear or be severely depleted by construction of a dam. Some introductions to other suitable habitats have been made. The Lighvanchai brown trout, possibly a subspecies distinct from the European brown trout, is isolated in the Lake Reza'iyeh basin and attempts are being made to transplant breeding stocks to other parts of Iran to prevent its extinction. In 1975, 500 specimens were introduced into the Ab-e-Bazaft River near Shiraz.

The chum salmon, O. keta, is found in the Caspian Sea, fry having been released from the Samur Fish Farm in Dagestan, U.S.S.R. during 1962-1967 (Magomedov, 1970).

Large trout and salmon are potential predators on other fishes as well as being possible disease or parasite carriers. Particularly dangerous from the infestation angle are exotic species like S. gairdneri from another continent. Introduced trout and salmon may also compete for food and spawning grounds with native salmonids and with other fish species. MacCrimmon (1972) reports the rainbow trout from the Ligran-chay River (?=Lighvanchai) of Azarbaijan and from Caspian Sea rivers which have native populations of brown trout.

3) Mugil and Liza species and Pleuronectes flesus luscus

Between 1930 and 1934 three species of mullet (L. auratus chiefly but also L. saliens and M. cephalus) were transplanted from the Black Sea to the Caspian Sea by Russian authorities and are now caught in commercial quantities (Berg, 1948-49; Vladykov, 1964). Deleterious effects of these species, and of Pleuronectes introduced in 1902 and 1931, on local fishes have not been reported. Large Pleuronectes feed on fish however.

4) Stizostedion lucioperca and Esox lucius

These two predatory sport fishes are native to Caspian drainages but are being introduced into reservoirs and lakes outside their normal range, e.g. Valasht Lake near Marzanabad in Mazanderan, Evan Lake near Qazvin, Ghorigol Lake near Tabriz, Marivan Lake in Kurdistan and the Haft Barm Lakes west of

Shiraz among others. Both these fishes feed almost exclusively on other fishes when adult. They also carry Diphyllobothrium latum, a tapeworm, as cysticerci in their muscle tissue. Diphyllobothrium attains its adult form in man through consumption of poorly cooked fish (Nikolsky, 1963; Bykhovskaya-Pavlovskaya, 1964).

5) Ctenopharyngodon idella

The grass carp may become established in Iran where experimental stations are testing its utility in pond fish farming and for excess aquatic vegetation control. It was introduced into the Pahlavi Mordab on the Caspian littoral and survived until at least 1967 but did not appear to be reproducing (Armantrout, 1969). The native range of grass carp is the Amur River basin of the far eastern U.S.S.R. and there is danger of introduction of exotic diseases and parasites. A tapeworm, Borhriocephalus gowkongensis, has become a serious problem in European cyprinids which became infested via introduced grass carp. (Courtenay and Robins, 1975). Reduction of submerged vegetation, while initially helpful in overgrown areas, can increase vulnerability of other species to predators and deprive them of spawning or feeding habitats.

Both this species and Hypophthalmichthys molitrix, another far eastern cyprinid, are being introduced into Russian Azarbaijan and Turkmenia which has drainages in common with Iranian Azarbaijan (Abdurakhmanov and Abbasov, 1973; Aliev and Sukhanova, 1974). Any attendant dangers are not therefore under the immediate control of Iranian authorities.

6) Carassius auratus

The goldfish has become established in certain Iranian waters, notably the Hamun-e-Seistan, presumably as discarded aquarium fish. This species tends to muddy waters which may then be of less than optimum condition for other species.

7) Micropterus salmoides

The large-mouth bass is a North American predatory fish introduced into certain Iranian waters, e.g. the Ardakan-Yasuj area of the southern Zagros north of Shiraz (A. Shiralipour, pers. comm. 1978). Apart from dangers of truly exotic diseases and parasites this species is a marked predator on other fishes.

C. CONSERVATION SCHEMES

The freshwater ecosystems of Iran are endangered because of rapid industrialization, an increasing population and an environment degraded since prehistorical and historical times coupled with a shortage of water. As noted in the Introduction there is no tradition of concerned naturalists to agitate for environmental protection and such protection devolves on a government committed to massive industrial expansion. Mass-communication is being used to inform the public of environmental problems and appropriate methods of utilization of natural resources. This is undoubtedly hampered by a high illiteracy rate particularly in rural areas. Implementation of conservation schemes is held back by a lack of skilled, responsible and concerned workers. Training programmes are being used to alleviate this shortage but without widespread popular concern for conservation of natural resources trained manpower will remain overextended. Very few Iranians can be aware of the "Pahlavi Environmental Prize" ($50,000) awarded annually on an international basis by the Government of Iran for the most outstanding contribution in the field of the environment. Many efforts are being made however and some of these are outlined below:-

a) Biotic reserves and legislation

Iran has 70 biotic reserves aggregating to a total area near to 8 million hectares (Anon., 1977-78). Firouz (1976) and Firouz and Harrington (1976) give details of general conservation schemes in Iran which will benefit the fish fauna. Emphasis has been shifted from protection of individual species to protection of the different types of ecosystems to be found in the country. While this is undoubtedly a valid idea for such comparatively well known vertebrates as mammals and birds, the fishes are not well enough known to ensure that all species and lower taxonomic categories are adequately protected. A detailed survey, with special emphasis on endangered waters, should be made to ascertain the distribution and status of the fishes. Taxonomic revisions should also be made to clarify the systematics of Iranian fishes so that a proper appreciation of the species content of the fish fauna is available. At the moment there are not even keys for identification of Iranian freshwater fishes outside the Caspian basin.

Fines of 10,000 rials (approx. U.S. $140) are levied for illegal capture

of mahi azad (Salmo trutta caspius) and cave fishes (Iranocypris typhlops and Noemachilus smithi) and fines and terms of imprisonment are penalties for fishing during unlawful seasons or hours, for fishing by unlawful methods or without a licence, and for destruction of vegetation in a biotic reserve. It would require a considerable expansion of staff for the Department of the Environment to patrol all waters effectively however, given the size of the country.

The government has banned all private well drilling in the Varamin plain without a permit to control the drain on groundwater resources.

b) Afforestation, soil stabilization and grazing management

Afforestation programmes are being carried out in many parts of the country although these are hampered by a lack of water on dry mountain slopes. Since 1967, 12,000 hectares of forest plantation have been established and almost 70,000 hectares of desert land seeded or planted (Mehdizadeh, 1971a). These figures should be compared to the area set aside as biotic reserves.

Research is being carried out in the field of soil stabilization by mulch, 2-3,000 hectares having been stabilized in this manner, as well as selection of appropriate species of vegetation to prevent erosion. Watershed management is being undertaken over the catchment area of dams to prevent excessive erosion and siltation. Extensive studies have been made on selection of shrubs for burning at New Year celebrations and on cost evaluation for marketing cultivated and wild shrubs in an effort to reduce devegetation.

Substitution of petroleum fuels, such as kerosene, is helping to prevent devegetation. The number of cooperatives for distribution of fuels rose from 28 in 1964 to 8000 in 1970. New methods are being used for more efficient charcoal production (Anon., 1961).

Research on management of grazing is being undertaken to best meet the needs of vegetation, soil, animals and owner (Mehdizadeh, 1971b).

c) Water quality

In 1967 Iran passed a law nationalizing the water resources of the country and regulations exist for limiting discharge of pollutants into natural waters (Yazdani, 1973). The effective enforcement of such regulations could be improved considerably however.

Research and practical measures in a number of fields related to water quality are being carried out in Iran. These include siltation studies in most Iranian rivers, snow surveys to gauge runoff, rainfall and river gauging, flood control by dam construction, e.g. the Reza Shah Kabir dam on the Karun River has been used to regulate flow so there is more freshwater in the river during the dry season and this assists in combating salt intrusion (Gholizadeh, 1969), rehabilitation and expansion of irrigation canals, surveys of underground water, and river retention dykes (Anon., 1961). In addition loans are made available for qanat construction and maintenance and deep wells are dug in qanats to tap artesian water thus prolonging use of the qanat.

Pesticides, industrial effluents and mining residues are being studied as to their effects of pesticides on fish reproduction are under study (Firouz, 1974).

Research on synthesis of biodegradable detergents is being carried out by the National Iranian Oil Company in an effort to prevent surface and groundwater pollution. Sewage systems are being constructed in many parts of Iran and are now compulsory for all towns on the Caspian littoral, for example.

A joint agreement was signed with the U.S.S.R. in 1973 to combat pollution in the Caspian Sea (Firouz, 1974), and the U.S.S.R. authorities have issued a special directive on "Measures to prevent pollution of the Caspian Sea" which may aid the protection of fish stocks shared between the two countries.

d) Measures for fish conservation

A number of measures have been taken which directly help to conserve fishes in Iran. Fishing is controlled in an 8,000 hectare area of the Pahlavi Mordab set aside as a refuge (Firouz, 1968). Fishing operations in the Sefid River area were suspended in 1962 for a five year period in an effort to increase the spawning stock of sturgeons, mahi azad and sefid mahi. In Iranian waters since 1952 baiting of hooks with oil cloth or fish has been prohibited. These methods took large numbers of immature sturgeons (Vladykov, 1964).

An expected loss of 90% of the trout in the Lar River after construction of a dam at Polur is to be offset by provision of artificial spawning grounds and introduction of cold water fish which could give an annual catch of 50 tons.

The Shah Ismail reservoir was stocked with edible fish to replace coarse fish.

The United Nations has given advice on a series of fish culture stations and hatcheries and on a National Centre for Fish Culture and Research.

Mahi azad has been studied in a majority of Caspian streams to assess its status. Plans for artificial propagation have been implemented by the Northern Fisheries Company at Bandar Pahlavi. A number of streams with populations of this species were declared Protected Rivers and maintenance of the whole watershed attempted (Firouz, 1974). The Lighvanchai brown trout has been transplanted, e.g. to the Ab-e-Bazaft River near Shiraz, in an attempt to prevent its extinction.

Conservation measures have been carried out in Russian waters of the Caspian Sea and these may contribute to an increase or maintenance of stocks and species in Iranian waters. In 1967, for example, the Volga fish farms produced 32,079 million sturgeon fry and the Kura farms 13,035 million sturgeon fry (Mil'shteyn, 1969). Iranian waters may benefit in particular from the product of the Kura farms which lie in Russian Azarbaijan across the border from Iranian Guilan. Artificial propagation of beluga (Huso huso) is being carried out in Russian waters to offset the unfavourable spawning conditions engendered by the regulation of the Volga discharge. Tagging at fish hatcheries in the Volga-Caspian region showed that 21.1% of the total number of yearlings were recaptured in the south Caspian Sea as opposed to only 6% in the north Caspian Sea. Older fish reared in Volga hatcheries have also been caught in the southern Caspian Sea. A considerable number of beluga fished in Iranian territorial waters belong to stocks reproducing in U.S.S.R. rivers (Filippov, 1976). Artificial propagation is also undertaken for Stizostedion marinum which is commercially fished off the Turkmenian coast adjacent to Iranian Mazanderan (Guseva, 1975) and for Salmo trutta caspius in the Kura River adjacent to Iranian Guilan (Kyazimov and Alekperov, 1975).

D. THREATENED FISHES

It is difficult to assess the status of certain Iranian freshwater fishes since they are known only from their original descriptions based on a few specimens from one locality. They may well prove to be synonymous with more

widely distributed and better known species (Coad, 1979a). Other species, presumed or known to be valid, are known only from a single river system or lake but this may be due to poor field data. Species restricted to a single river system or lake are more susceptible to extinction through habitat destruction or pollution than more widely distributed species, particularly in Iran where lakes and rivers can be quite small but of immense value as a water source for industry and domestic consumption. These limitations on status assessment apply particularly to the speciose families Cyprinidae, Cobitidae and Gobiidae.

Miller (1972) has classified fish populations from a conservation standpoint and the following definitions are based on this work.

Endangered - actively threatened with extinction. Continued survival unlikely without the implementation of special protective measures.

Rare - not under immediate threat of extinction, but occurring in such small numbers and/or in such a restricted or specialized habitat that it could quickly disappear. Requires careful watching.

Depleted - although still occuring in numbers adequate for survival, the species has been heavily depleted.

Indeterminate - apparently threatened on the criteria above but insufficient data currently available on which to base a reliable assessment of status.

The status of each species is assessed for Iranian waters only and species may be common elsewhere. A check-list of Iranian freshwater fishes is given in Table 1 so that the threatened fishes can be placed in context.

Family 2. Acipenseridae

2. Acipenser güldenstädti. Depleted.
3. Acipenser nudiventris. Depleted.
4. Acipenser persicus. (regarded as a subspecies of A. guldenstadti by some authors). Depleted.
5. Acipenser stellatus stellatus natio cyrensis. Depleted.
6. Huso huso caspicus. Depleted.

These five species of sturgeons are found in the south Caspian Sea and tributary rivers. Overfishing (adults taken in spawning condition for their

eggs which constitute caviar), pollution and habitat destruction particularly of spawning grounds in rivers have caused a decline, at least on a commercial scale, of these species (Vladykov, 1964).

Hardly any rivers on the Iranian coast suitable for ~~beluga~~ Huso spawning have been preserved apart from the Gorgan and Sefid Rivers which are now regulated. Conditions are generally unfavourable for natural reproduction of ~~beluga~~ Huso (Filippov, 1976).

Family 3. Clupeidae

7.	Alosa brashnikovi.	Depleted.
8.	Alosa caspia.	Depleted.
9.	Alosa curensis.	Indeterminate.
10.	Alosa kessleri.	Depleted.
11.	Alosa saposhnikovii.	Depleted.
12.	Clupeonella delicatula	Depleted.
13.	Clupeonella engrauliformis.	Depleted.
14.	Clupeonella grimmi.	Depleted.

These eight species of herrings are fished commercially in the Caspian Sea in varying degrees. They are, therefore, subject to depletion through overfishing and, in addition, river dams and the fall in Caspian Sea level affect spawning migrations and spawning grounds respectively. Assessment of threatened status is complicated by lack of information on the subspecies and stocks encountered and fished in Iranian waters. Eight subspecies of A. brashnikovi alone are said to be found in the south Caspian Sea (Berg, 1948-49; Svetovidov, 1952), for example. Herrings also migrate seasonally for spawning and to avoid harsh winter conditions so that species and stocks encountered in the Iranian waters may be subject to overfishing or environmental degradation in Russian waters. Vodovskaya (1977) reported that catches of A. kessleri throughout the Caspian Sea in 1965-73 constituted 2-4% of the catch in 1938-43. Winter aggregations in the south of the Caspian had also decreased as had the already small migrations to the Azarbaijan coasts. Mamulyan (1969) stated that the spawning area of A. kessleri volgensis was greatly reduced by construction of the Volga dam in 1958 but a fish ladder, beginning to function in August 1961, enabled this species of herring to reproduce in the river section of the Volgograd

Reservoir and progeny went down river to supplement Caspian Sea stocks. However, Vodovskaya (1977) reported that A. kessleri volgensis, once the main form of herring caught, is now encountered rarely so the fish ladder apparently did not alleviate the loss of spawning areas caused by the Volga dam. A. curensis is a poorly studied species with a more restricted distribution than other herrings in the southern part of the Caspian Sea in the region of the Kura estuary and Lenkoran coast to the south near Iranian Guilan. It may prove to be a subspecies of A. brashnikovi.

Family 6. Salmonidae

20. Salmo trutta. Endangered.

S. trutta caspius, mahi azad, of Caspian rivers has been severely depleted by overfishing, poaching with dynamite, and deterioration of spawning grounds. The Lighvanchai brown trout is restricted to the Lighvanchai River of the Lake Reza'iyeh basin. Development of agriculture and domestication of sheep and goats have destroyed the range and watersheds. Formerly it is believed to have occupied all the streams of the Lake Reza'iyeh basin. S. trutta macrostigma was mentioned by Berg (1948-49) as occurring in the Karadj River. This may well have been the European brown trout, S. trutta fario, (Vladykov, 1964) which is also reported from the Lar River. All populations or subspecies of brown trout are threatened in Iran by habitat destruction.

Family 4. Anguillidae

16. Anguilla anguilla. Rare.

Occasionally caught in the south Caspian Sea in Iranian waters (P. Walczak, pers. comm. 1978), and reported from Russian Azarbaijan by Abdurakhmanov and Kuliev (1968). Common elsewhere in Eurasia.

Family 7. Cyprinidae.

46. Barilius mesopotamicus. Rare.

Reported from the Tigris River basin in Iran at two localities, 33° 20' N, 46° 20' E and 33° 42'N, (Berg, 1949). Further collecting may show it to be more widespread.

74. Iranocypris typhlops. Rare.

A "cave" fish restricted to a natural well or cave outlet of a subterranean water system at Kaaje-Ru near Bag-e-Loveh in the Zagros mountains of southwestern Iran. Since specimens near the surface may represent strays

from a main subterranean population and the cave is in a remote area, this species and its habitat are unlikely to be threatened. It is however a rarity and only a few specimens have been caught (Bruun and Kaiser, 1950; Greenwood, 1976).

80. Pelecus cultratus. Rare.

A species encountered on rare occasions in the Sefid River (Berg, 1948-49) but common elsewhere in Eurasia.

21. Abramis brama. Depleted.

66. Cyprinus carpio. Depleted.

82. Rutilus frisii kutum. Depleted.

83. Rutilus rutilus caspicus. Depleted.

These four species are found in the Caspian Sea and tributary rivers. They are commercially important species whose numbers have declined through overfishing and destruction or modification of spawning habitats (Vladykov, 1964; Roux, 1961).

A number of other cyprinid species may be classified as Indeterminate in that they are species of restricted distribution according to the literature and are thus susceptible to unfavourable environmental modifications although they may ultimately prove to be more widespread with better field collection data, e.g. species 26, 27, 47, 48, 50, 60, 76, 79; or are species, often of restricted distribution according to the literature, which may prove to be synonyms of more widely distributed species, e.g. 29, 31, 32, 33, 35, 36. So little is known about the ecological requirements of non-commercial Iranian freshwater fishes that any species in Caspian rivers may be threatened with environmental degradation and fishes like the Schizocypris, Schizopygopsis and Schizothorax species found in the Seistan basin may be threatened in some degree by water level fluctuations.

94. Cobitis linea. Rare.

Description based on a single much-damaged specimen of doubtful taxonomic validity. Reported from the Pulvar River near Persepolis in Fars Province.

109. Noemachilus smithi. Rare.

Restricted to a "cave" habitat with the cyprinid Iranocypris typhlops (q.v.).

As in Cyprinidae a number of Cobitidae must be classified as Indeterminate until more data on the taxonomy, distribution and ecological requirements are available, e.g. species 101, 103, 105, 108, 112.

Family 9. Bagridae

115. Mystus pelusius. Rare.

Apparently in the Karun River but rarely collected perhaps through inadequate field work.

Family 10. Siluridae

116. Silurus glanis. Depleted.

A commercially important species of Caspian Sea and Lake Reza'-iyeh rivers whose numbers have declined through overfishing and habitat degradation (Vladykov, 1964).

Family 11. Sisoridae

117. Glyptothorax kurdistanicus. Rare.

One specimen reported from the Iran-Iraq border in the upper Tigris River basin at 36° N (Berg, 1949). Appears to be rare in Iran or at least poorly collected.

Family 14. Gadidae

120. Lota lota. Rare.

Recorded from Sefid River by Berg (1948-49) but Armantrout (1969) states that reports are uncertain. Common elsewhere in Eurasia and North America.

Family 15. Cyprinodontidae

122. Aphanius ginaonis. Rare.

Restricted to a hot spring at Ginao near Bandar Abbas in southern Iran (Coad, 1979b). Threatened by being limited to a single habitat subject to some human interference.

123. Aphanius mento. Rare.

Reported from the Shatt-el-Arab on the Iran-Iraq border in Khuzistan (Al-Daham et al., 1977). Appears to be rare in Iran but further collecting may reveal it to be distributed throughout Khuzistan in favourable habitats. Common elsewhere in the Middle East.

Family 21. Percidae

131. Acerina cernua. Rare.

Reported by Ladiges and Vogt (1965) from south Caspian Sea drainages on a map but no other records. Common elsewhere in Eurasia.

132. Stizostedion lucioperca. Depleted.

This species is found in Caspian Sea rivers and numbers have been depleted there by overfishing and destruction of spawning habitats (Vladykov, 1964; Roux, 1961).

133. Stizostedion marinum. Depleted.

Guseva (1975) reports that catches and stocks of this species have declined off the Turkmenian coast in the Caspian Sea where it is commercially fished.

Family 24. Gobiidae

140. Asra turcomana. Rare.

145. Benthophilus leptocephalus Rare.

152. Mesogobius nonultimus. Rare.

161. Proteorhinus semipellucidus Rare.

These four species are known from only one or two specimens taken in the Caspian Sea. P. semipellucidus may be a synonym for the more widespread species P. marmoratus (Berg, 1948-49). Further collecting may show these species to be widely distributed.

Family 25. Channidae

162. Ophiocephalus gachua. Rare.

Recorded from the Bampur River in Baluchistan (4 specimens; Nikolsky, 1899) and the Haliri River in Kerman (1 specimen; Coad, 1978). Appears to be rare perhaps because of a lack of suitable habitats but may be inadequate collecting. Common in Pakistan.

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Table 1. A check-list of Iranian freshwater fishes including brackish-water species of the Caspian Sea. Classification follows Nelson (1976). Species marked with an asterisk (*) are exotic species and those marked with a plus sign (+) are naturally restricted to the Caspian Sea basin within Iran.

Family 1. Petromyzonidae

1. Caspiomyzon wagneri +

Family 2. Acipenseridae

2. Acipenser güldenstädti +

3. Acipenser nudiventris +

4. Acipenser persicus +

5. Acipenser stellatus +

6. Huso huso +

Family 3. Clupeidae

7. Alosa brashnikovi +

8. Alosa caspia +

9. Alosa curensis +

10. Alosa kessleri +

11. Alosa saposhnikovii +

12. Clupeonella delicatula +

13. Clupeonella engrauliformis +

.../2

14. Clupeonella grimmi +

15. Hilsa ilisha

Family 4. Anguillidae

16. Anguilla anguilla +

Family 5. Esocidae

17. Esox lucius +

Family 6. Salmonidae

18. Oncorhynchus keta *

19. Salmo gairdneri *

20. Salmo trutta C. Izvornik

Family 7. Cyprinidae

21. Abramis brama +

22. Abramis sapa +

23. Acanthalburnus microlepis +

24. Alburnoides bipunctatus

25. Alburnoides urmiamus

26. Alburnus atropatenae

27. Alburnus caudimacula

28. Alburnus charusini +

29. Alburnus doriae

30. Alburnus filippi

31. Alburnus iblis

32. Alburnus maculatus

33. Alburnus megacephalus

34. Alburnus orontis

35. Alburnus schejtan

36. Alburnus striatus +

37. Aspidoparia morar

38. Aspius aspius +

39. Aspius vorax

40. Barbus brachycephalus +

41. Barbus capito

42. Barbus mursa

43. Barbus plebejus

44. Barbus rajanorum

45. Barbus xanthopterus

46. Barilius mesopotamicus

47. Bertinius longiceps

48. Bertinius subquincunciatus

49. Blicca bjoerkora +

50. Capoeta barroisi
51. Capoeta buhsei
52. Capoeta capoeta
53. Capoeta fusca
54. Capoeta trutta
55. Carasobarbus luteus
56. Carassius auratus *
57. Chalcalburnus chalcoides +
58. Chalcalburnus mossulensis
59. Chondrostroma cyri +
60. Chondrostoma regium
61. Crossochilus adiscus
62. Crossochilus latius
63. Ctenopharyngodon idella *
64. Cyprinion macrostomus
65. Cyprinion watsoni
66. Cyprinus carpio +
67. Garra rossica
68. Garra rufa
69. Garra variabilis
70. Gobio gobio
71. Gobio persa
72. Hemigarra elegans
73. Hemigrammocapoeta nanus
74. Iranocypris typhlops Hypothalmichthys
75. Leuciscus cephalus
76. Leuciscus gaderanus
77. Leuciscus latus
78. Leuciscus lepidus
79. Leuciscus ulanus
80. Pelecus cultratus +
81. Rhodeus sericeus +
82. Rutilus frisii
83. Rutilus rutilus +
84. Scardinius erythrophthalmus +
85. Schizocypris brucei

86. Schizopygopsis stoliczkai

87. Schizothorax anjac

88. Schizothorax pelzami

89. Schizothorax schumacheri

90. Schizothorax zarudnyi

91. Tinca tinca +

92. Tor grypus

93. Vimba vimba +

Family 8. Cobitidae

94. Cobitis linea

95. Cobitis taenia

96. Noemachilus angorae

97. Noemachilus baluchiorum

98. Noemachilus bampurensis

99. Noemachilus brandti

100. Noemachilus cristatus

101. Noemachilus kermanshahensis

102. Noemachilus kessleri

103. Noemachilus longicauda

104. Noemachilus malapterurus

105. Noemachilus merga +

106. Noemachilus persa

107. Noemachilus rhadineus

108. Noemachilus sargadensis

109. Noemachilus smithi

110. Noemachilus stoliczkai

111. Noemachilus tenuis

112. Noemachilus tigris

113. Sabanejewia aurata

114. Sabanejewia caspia +

Family 9. Bagridae

115. Mystus pelusius

Family 10. Siluridae

116. Silurus glanis

Family 11. Sisoridae

117. Glyptothorax kurdistanicus

Family 12. Heteropneustidae

118. Hesteropneustes fossilis

Family 13. Ariidae

119. Arius thalassinus

Family 14. Gadidae

120. Lota lota +

Family 15. Cyprinodontidae

121. Aphanius dispar

122. Aphanius ginaonis

123. Aphanius mento

124. Aphanius sophiae

Family 16. Poeciliidae

125. Gambusia affinis *

Family 17. Atherinidae

126. Atherina mochon +

Family 18. Syngnathidae

127. Syngnathus nigrolineatus +

Family 19. Gasterosteidae

128. Pungitius platygaster +

Family 20. Centrarchidae

129. Micropterus salmoides *

Family 21. Percidae

130. ~~Acerina cernua +~~ Gymnocephalus cernua +

131. Perca fluviatilis +

132. Stizostedion lucioperca +

133. Stizostedion marinum +

Family 22. Cichlidae

134. Species undescribed

Family 23. Mugilidae

135. Mugil abu

136. Mugil cephalus *

137. Mugil oligolepis

138. Liza auratus *

139. Liza saliens *

Family 24. Gobiidae

140. Asra turcomana +

141. Benthophilus baeri +

142. Benthophilus ctenolepidus +

143. Benthophilus granulosus +

144. Benthophilus grimmi +

145. Benthophilus leptocephalus +

146. Benthophilus macrocephalus +

147. Benthophilus stellatus +

148. Boleophthalmus dussumieri

149. Hyrcanogobius bergi +

150. Knipowitschia longicaudata +

151. Mesogobius gymnotrachelus +

152. Mesogobius nonultimus +

153. Neogobius caspius +

154. Neogobius cephalarges +

155. Neogobius fluviatilus +

156. Neogobius kessleri+

157. Neogobius melanostomus +

158. Periophthalmus koelreuteri

159. Pomatoschistus caucasicus +

160. Proteorhinus marmoratus +

161. Proteorhinus semipellucidus +

Family 25 Channidae

162. Ophiocephalus gachua

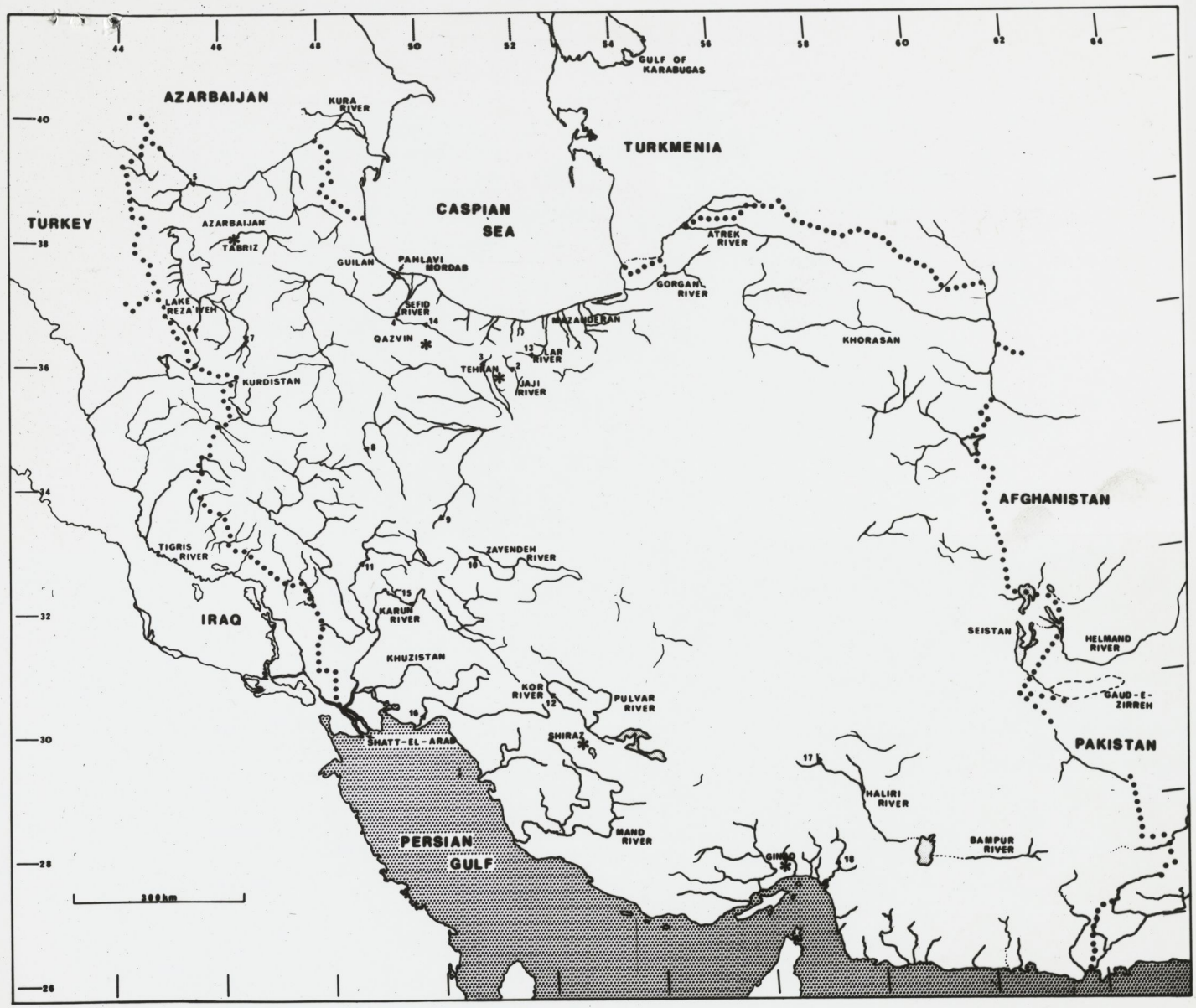
Family 26. Mastacembelidae

163. Mastacembelus mastacembelus

Family 27. Pleuronectidae

164. Pleuronectes flesus *

Figure 1. Map of Iran to show major drainages and dams. Dams are numbered 1 - 18, the first 12 are completed and the last 6 are proposed or under construction (1 = Sangarsavar on the Gorgan river, 2 = Farahnaz on the Jaji River, 3 = Amir Kabir on the Karadj River, 4 = Shahbanou Farah on the Sefid River, 5 = Aras on the Aras River, 6 = Shapur Aval on the Mahabad River, 7 = Kourush Kabir on the Zamreh River, 8 = Shahnaz on the Karachai River, 9 = Shah Esmail on the Qom River, 10 = Shah Abbas Kabir on the Zayendeh River, 11 = Mohammad Reza Shah on the Dez River, 12 = Dariush Kabir on the Kor River, 13 = Lar on the Lar River, 14 = Talegan on the Shah River, 15 = Reza Shah Kabir on the Karun River, 16 = Nader Shah on the Marun River, 17 = Minab on the Minab River, 18 = Jiroft on the Haliri River.


AZARBAIJAN
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GULF OF KARABUGAS
TURKMENIA
CASPIAN SEA
TURKEY
AZARBAIJAN
TABRIZ
GUILAN
PAHLAVI MORDAB
ATREK RIVER
GORGAN RIVER
LAKE REZA'IYEH
SEFID RIVER
MAZANDERAN
QAZVIN
KHORASAN
LAR RIVER
TEHRAN
KURDISTAN
QAJI RIVER
AFGHANISTAN
TIGRIS RIVER
ZAYENDEH RIVER
IRAQ
KARUN RIVER
SEISTAN
HELMAND RIVER
KHUZISTAN
KOR RIVER
PULVAR RIVER
GAUD-E-ZIRREH
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16 May, 1979

Dr. R. J. Behnke,
Dept. of Fishery & Wildlife Biology,
Colorado State University,
Fort Collins, Colorado 80523

Dear Bob:

I'm just dropping you a line to see if you collected any Barilius mesopotamicus in Iran. In sorting my collections I found 3 specimens from the Dalaki River, north of Bushire as well as from rivers in Khuzistan. If you do have any on hand I would be grateful for a loan so I can expand on Berg's original description.

Thanks for your help,

Yours sincerely,

Brian

Brian W. Coad, Ph.D.
Research Associate

Ottawa
K1A 0M8

Brian W. Coad, Ph.D
National Museums Canada / Musées Nationaux Canada
Research Assoc., Ichthyology,
OTTAWA CANADA K1A 0M8

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Dr. R.J. Behnke,
Dept. of Fishery and Wildlife Biology,
Colorado State University,
Fort Collins, Colorado 80523

Department of Fishery and Wildlife Biology

Colorado State University
Fort Collins, Colorado
80523

Dec. 10, 79

Dear Brian:

I didn't realize it until I received your letter, but pg. 21 is missing from all of the copies of Saadati's thesis. I will check the library with the possibility that the original thesis is there, but I suspect That Saadati has the original and no one has heard from him since the summer of 1978. He went to Hammadan Univ. at that time. I note pg. 21 must discuss the Rezaiyeh basin Alburnoid fishes. As I recall, we didn't have much in the way of Rezaiyeh basin alburnoids except for the species ~~uriam~~. urmianus which is an Acanthalburnus, so the discussion was probably based on my notes from Hamburg specimens. - I don't know what can be done about the missing pg. 21, I'll let you know if the library has original, if not, only copies made from Saadati's original would have it. There should be copies

at Dept. in Tehran made from the thesis Saadati brought back, but I don't believe we've had any recent communications. I'll ask Barry Nehring. I saw Barry and Bruce Sanford, the last American in the Iranian Conservation Dept. to leave the country, last week. They told me they heard that Firouz, the former director, was first imprisoned and now works as a tea boy.

I would be agreeable to coauthor a paper describing the Iranian cichlid, but you have much more material. I have only a relatively few specimens from the Sol and Mehran drainages. Are your collections also from these rivers? If so, I doubt ~~that you~~ that my specimens can add anything to the description, but if you want to borrow them, let me know. In any event, I don't believe anyone will be collecting more fishes from Iran for scientific study for awhile. Remember when the greatest threat to Americans was from the traffic and the crazy drivers?

Sincerely,

Bob Behnke

National Museums Canada
Musées nationaux Canada

19 May 1980

Dear Bob,

As you can see from the enclosed I went ahead and described the Iranian cichlid. Before I send it off to "Copeia" I want to make sure I'm not stepping on any toes, and to get your comments on the draft. Reading your last letter (10 Dec. '79) I interpreted it as a go-ahead since you had only a few specimens at hand. However you and Saadati do have first dibs on this species, as I acknowledge on p. 1, and I don't want to "steal" the description if you had planned to do one yourself.

In other areas I am ploughing on with Iranian fishes - this summer with an assistant - but by next summer I will be looking for a job! A checklist of fishes of Afghanistan is to be published by the National Museum, and I have submitted papers on a new species of sisorid catfish and various non-Iranian material. I'm also compiling an annotated list of fishes from the Tigris-Euphrates basin based on literature, some museum material (Beckman's Syrian and Trewavas' Iraqi identifications) and my own collections. I would particularly like to get from you your list of stations which are mostly indicated by numbers in Saadati, if at all possible.

Ottawa
K1A 0M8

I have'nt heard from anyone in Shiraz for some months now but last reports indicated (in a round about way) that the students were not all satisfied with a theocracy and more trouble can be expected. There will probably be a lot more turmoil when Khomeini dies - Iranians can't seem to operate without an autocratic father-figure.

Best wishes,

Brian W. Coad

A New Genus and Species of Cichlid Endemic to Southern Iran

Brian W. Coad

A new cichlid, Iranocichla hormuzensis, is described from Iranian waters draining to the Persian Gulf at the Straits of Hormuz. Its closest relatives appear to be members of the Levant genus Tristramella with which it shares three derived characters. The new species is endemic to southern Iran and the absence of cichlids from the Arabian Peninsula and the Tigris-Euphrates basin is attributed to a combination of desiccation and limiting temperature conditions. Iranocichla is an inhabitant of small streams and rivers characterised by high temperatures and salinities.

"Si terrarum Orbis, quaqua patet, Annulus esset,
Illius Ormusium gemma, decusque foret."

1975 AISH meeting
Arabian Sea

The presence of an endemic cichlid in southern Iran was first noted by Saadati (1977) in a MS thesis based on 9 specimens collected by R.J. Behnke, Colorado State University, in 1974. A formal description has not been published. I first collected this species in 1976 unaware of Behnke's material, and made subsequent collections in 1977-1978 totalling 221 specimens. These specimens form the basis for the present description.

Counts and measurements followed Hubbs and Lagler (1958). Measurements were taken to the nearest 0.1 mm with dial calipers on 23 adults of each sex greater than 50 mm standard length (SL) to minimize ontogenetic variation.

For comparison 20 juvenile specimens, 20.2 - 32.3 mm SL were also measured. Head depth was taken at the posterior edge of the preoperculum and caudal peduncle length was taken in a straight line from the anal fin insertion to the hypural fold. Scales in the upper lateral line were counted to the last pored scale, even if this was preceded by one or more unpored scales, or to the last scale row preceding the first pored scale of the lower lateral line. Pored scales in the lower lateral line overlapping with the upper lateral line were omitted from the count. The lower lateral line count extended to the last pored scale. Small scales on the caudal fin base were not counted. Overlap between the two lateral lines was minimal, one scale in 4 specimens and two scales in 4 specimens. The first caudal vertebra was taken to be the one lying immediately posterior to the first anal proximal pterygiophore since the first complete haemal spine was not readily distinguishable on radiographs. Meristic data was based on combined adult and juvenile material except that the two lateral line counts could not be distinguished because scales were incompletely pored in juveniles.

Abbreviation: NMC, National Museum of Natural Sciences, National Museum of Canada, Ottawa.

Iranocichla new genus

Type species - Iranocichla hormuzensis new species

Diagnosis.- A small, distinctive cichlid of the Tilapia lineage characterised by posteriorly rounded dorsal and anal fins; short pectoral fins not reaching the vent; cycloid scales with granular posterior ciculi bearing rounded or

irregular protuberances, cheek, operculum, belly, isthmus and area between pectoral and pelvic fin bases naked or poorly scaled; teeth of lower pharyngeal bone of uniform size, not enlarged medially; inferior apophyses for support of swimbladder centred around fourth vertebra (Fig. 2); mesethmoid not meeting vomer; modal vertebral count 29; median length of lower pharyngeal bone 31.8 - 49.9% ($\bar{x}$ = 35%) length of head; and pharyngeal blade/median length toothed area 0.6 - 1.0 ($\bar{x}$ = 0.8).

Etymology.- The genus name is a feminine compound word indicating the country of origin of this endemic genus and the family to which it belongs.

Iranocichla hormuzensis n. sp.

Fig. 1

Holotype.- NMC79-0408A, 94.2 mm SL, female with eggs in mouth, Mehran River at 27° 04'N, 54° 35'E, Hormozdgan Province; 18 March 1978, B.W. Coad and R.E. Lee.

Paratypes.- NMC79-0408B, 15 specimens (24.3 - 86.5 mm SL), same collection as holotype.

Nontype material.- NMC79-0138, 17 specimens (25.6 - 97.3 mm SL), stream in Rasul River drainage between Chahar Berkeh and Tang-e Dalan, ca. 27° 32'N, 54° 58-1/2'E, Fars-Hormozdgan border; 26 November 1976, B.W. Coad and H. Assadi. NMC79-0139, 35 (29.6 - 95.2 mm SL), stream in Rasul River drainage between Chahar Berkeh and Tang-e Dalan, ca. 27° 25-1/2'N, 54° 59'E, Fars-Hormozdgan border; 26 November 1976, B.W. Coad and H. Assadi. NMC79-0140, 48 (24.2 - 59.4 mm SL), stream east of Kichal, Kul River drainage, 27° 14'N, 55° 46-1/2'E, Hormozdgan; 26 November 1976, B.W. Coad

and H. Assadi. NMC79-0141, 5 (15.0 - 21.0 mm SL), Kul River at road bridge, 27° 17-1/2'N, 56° 03-1/2'E, Hormozdgan; 26 November 1976, B.W. Coad and H. Assadi. NMC79-0142, 65 (21.3 - 82.8 mm SL), Baghu River at road bridge, 27° 17'N, 56° 28'E, Hormozdgan; 27 November 1976, B.W. Coad and H. Assadi. NMC79-0143, 3 (25.0 - 26.7 mm SL), marshy area on Bandar Abbas to Minab road, Hasan Langi River drainage, 27° 21'N, 56° 50-1/2'E, Hormozdgan; 27 November 1976, B.W. Coad and H. Assadi. NMC79-0148, 5 (33.2 - 92.7 mm SL), Sarzeh River 46 km by road north of Bandar-e Abbas, 27° 30-1/2'N, 56° 15-1/2'E, Hormozdgan; 29 November 1976, B.W. Coad and H. Assadi. NMC79-0181, 1 (40.8 mm SL), Kul River at road bridge, 27° 17-1/2'N, 56° 03-1/2'E, Hormozdgan; 28 January 1977, B.W. Coad, Sh. Mansoorabadi and A. Shirazi. NMC79-0184,12 (31.4 - 50.4 mm SL), effluent of Rasul River, 27° 11'N, 55° 42' E, Hormozdgan, 28 January 1977, B.W. Coad, Sh. Mansoorabadi and A. Shirazi. NMC79-0185, 7 (26.1 - 59.8 mm SL), stream in Rasul River drainage near confluence of Rasul and Kul Rivers, 27° 06'N, 55° 45'E, Hormozdgan; 28 January 1977, B.W. Coad, Sh. Mansoorabadi and A. Shirazi. NMC79-0187, 2 (63.9 - 64.6 mm SL), stream at Sar Khun in Sarzeh River drainage, 27° 23-1/2'N, 56° 26'E, Hormozdgan; 29 January 1977, B.W. Coad, Sh. Mansoorabadi and A. Shirazi. NMC79-0406, 5 (33.4 - 59.2 mm SL) stream 7 km north of turnoff to Bandar-e Charak, 26° 48'N, 54° 18'E, Hormozdgan; 17 March 1978, B.W. Coad.

Diagnosis.- As for genus.

Description.- General body shape of mature female shown in Fig. 1. The buccal region was enlarged ventrally to accomodate eggs. The upper and lower jaws were equal, neither projecting and the mouth was slightly oblique. The snout profile was slightly to obviously convex and the maxilla extended

posteriorly to or just past a level with the nostril. The caudal fin was sub-truncate to slightly rounded. The pectoral and pelvic fins were short not reaching the vent, and in the pectoral fin branched ray 3 was usually the longest forming the point of the fin apex while in the pelvic fin a less pronounced apex was formed by the first branched ray. The soft dorsal and anal fins were rounded without a pronounced apex although in the largest fish a weak apex was present.

Meristic data is summarised in Table 1. There were no significant differences ($P > 0.05$) between males and females and between adults and juveniles for any meristic character using t-tests except for total scales in lateral series which was less in juveniles ($\bar{x} = 31.0$, SD = 1.21) than in adults ($\bar{x} = 32.4$, SD = 2.21) because some large adults had additional small scales interspersed with regular scale rows.

There were no significant differences ($P > 0.05$) between males and females for any morphometric character except last dorsal spine length which was significantly larger ($P < 0.05 > 0.02$) in males than in females, as were longest dorsal soft ray ($P < 0.01 > 0.001$) and longest anal soft ray ($P < 0.05 > 0.02$).

Similarities and differences between adults (combined male and female data) and juveniles are summarised in Table 2. Pectoral and pelvic fins were shorter in juveniles, the eye was larger at the expense of snout length, the preorbital bone and the caudal peduncle were not as deep and the predorsal length was longer than in adults.

Scales on flanks regularly arranged except in some larger specimens regular scale rows interspersed with irregularly distributed smaller scales particularly on upper flank. Scales may be absent entirely from the head, sparse above the upper lateral line anteriorly and on the belly posterior

to the pelvic fins, absent from the dorsal and anal fin bases, absent from between the pectoral and pelvic fin bases and on the belly and isthmus anterior to the pelvic fin. However, in other specimens the head may be dorsally scaled to above the eyes with scales variably imbricate, 2 - 3 rows containing 4 - 7 scales may be present on the cheek but it was never completely scaled and these scales were miminally or non-imbricate, the upper margin of the opercle may have 2 large scales next to each other and a single scale may be present over the centre of the subopercle bone. Scales may be found on the whole belly, isthmus and between the pectoral and pelvic fin bases but these were minute, embedded, and non-imbricate. Their extent and number varied between individuals. Small to minute scales were found on the caudal fin base extending distally on to the fin membranes for more than half the fin ray length in some specimens, numbering up to about 20 scales.

Flank scales taken from below the mid-point of the spiny dorsal fin beneath the upper lateral line were cycloid or occasionally very weakly ctenoid. The focus was central and there were 9-14 ($\bar{x}$ = 12.4) radii (based on 5 scales from each of 7 adult specimens 59.2 - 87.1 mm SL) on the anterior field. Posterior circuli became granular so that the exposed scale surface had rows of rounded or irregular protuberances.

The peritoneum was black and the gut a tightly coiled spiral with its apex ventral. Gut length in 5 specimens (59.2 - 90.5 mm SL) was 6.8 - 8.3 ($\bar{x}$ = 7.6) times longer than standard length. Gill rakers were short and rounded.

The pharyngeal apophysis was of the Tilapia type (Greenwood, 1978). The mesethmoid did not meet the vomer, the intervening space being cartilaginous. Pores at the openings of the cephalic lateral line canals on the

preorbital and preoperculum were single, not multiple. The inferior apophyses for support of the anterior end of the swimbladder were examined on 10 alizarin preparations and were found to involve vertebrae 2 to 5 (Table 3). The contribution of left and right halves were often unequal but involved the fourth vertebra in 8 out of 10 specimens. Two vertebrae were involved in 8 specimens and only one vertebra in 2 specimens. Fig. 2 shows the variation in development that may be encountered in a single individual and effectively summarises the degree of development seen in different specimens. The apophyses may be as weakly developed as that on the right side of the third vertebra or as massive and fused as the left side of the third and fourth vertebrae.

The median length of the lower pharyngeal bone in the 10 alizarin preparations was 31.8 - 40.9% ($\bar{x}$=35%) length of head. Pharyngeal bone blade length was 0.6 - 1.0 ($\bar{x}$ = 0.8) of median length of toothed area. Pharyngeal bone width was 27.4 - 31.5% ($\bar{x}$ = 29.7%) length of head. Medial pharyngeal bone teeth were not enlarged (Fig. 3).

Teeth in the jaws were often irregularly arranged so that 4 rows were found at some places in both jaws. In some individuals where teeth were regularly arranged there were 3 rows in the upper jaw and 4 in the lower jaw. Number of rows decreased laterally in each jaw to one row at mouth corners. The outer row of teeth were bicuspid with the lateral cusp the smallest while inner rows were tricuspid with the central cusp the most prominent in both jaws. Accurate tooth count of the outer series in both jaws were difficult to make since some teeth were missing in all specimens. In general there were more teeth in the upper jaw than in the lower jaw.

Live specimens were not brightly coloured even when spawning. Overall body colour was a light lime green, with an iridescent tinge to the posterior

edge of the operculum and on the back. The dorsal fin had light, lime-green, oblique bars, the last one or two black-edged and spot-like. In a breeding male, the pelvic fins, belly anterior to the pelvics and the ventral surface of the head were black.

Pigmentation in specimens preserved in 45% iso-propyl alcohol was as follows. Juveniles had a distinct tilapia-mark on the soft rays of the dorsal fin. This mark was a black spot with surrounding fin rays and membranes hyaline. Occasionally a second spot was found posterior to the first spot. The spot was frequently retained in adult specimens. Juveniles also had 7 - 11 vertical bars along the flanks which were also present in adults but less distinct. In adults the dorsal fin rays and membranes were covered with melanophores interspersed with hyaline spots and irregular blotches. Wavy, oblique bars were found posteriorly on the soft dorsal fin in some specimens. The caudal fin had a series of about 7 thin vertical bars in some male specimens while females were uniformly grey. The anal fin was thinly barred with up to 6 vertical to oblique bars in some specimens, in others uniformly pigmented grey proximally fading to hyaline distally. Pectoral and pelvic fins were not barred and were lightly pigmented, the pelvics being the darker. The head and body were more heavily pigmented including the belly to give an overall brown colour, lightest on the belly anterior to the pelvic fins in females. Scales were not pigmented on their free margins.

Relationships.- Iranocichla can be excluded from relationship with the only genus found to the east, Etroplus of southern India and Sri Lanka, on gross morphological grounds. In particular there are 12 or more anal fin spines in Etroplus species while Iranocichla has only 3.

The closest relative of Iranocichla appeared to be the endemic genus Tristramella which has two or three species in the Levant Rift Valley and waters around Damascus (Lortet, 1883; Trewavas, 1972; Steinitz and Ben-Tuvia, 1960; Beckman, 1962). This proposed relationship was based on three shared derived characters. The inferior apophyses for support of the anterior end of the swimbladder centred on the fourth vertebra, the posterior scale circuli became granular such that the exposed scale surface had rows of rounded or irregular protuberances in both genera and the modal vertebral count was 29. Iranocichla may be distinguished from Tristramella by the absence of enlarged teeth medially on the lower pharyngeal bone, small size - up to 121 mm TL for Iranocichla compared to 250 - 280 mm TL for Tristramella species, naked or poorly scaled cheek, operculum, belly, isthmus and area between pectoral and pelvic fin bases, the short pectoral fins not reaching the vent, posteriorly rounded dorsal and anal fins (values for longest dorsal fin branched ray in HL for 3 Tristramella simonis and 2 T. sacra were 1.6 - 1.9 for 4 males and 2.2 for a female and for longest anal fin branched ray in HL 1.7 - 1.9 and 2.1 respectively, cf. Table 2 for Iranocichla), and the mesethmoid not meeting the vomer.

In other respects Iranocichla, like Tristramella, showed evident affinities with the Tilapia s.l. lineage (Trewavas, 1973) in such characters as possession of a tilapia-mark, roman cycloid scales (the granular posterior scale field made the distinction of circuli form difficult but they appeared to be roman), bicuspid outer and tricuspid inner jaw teeth, long intestine, few and short epibranchial gill rakers, and high vertebral count, modally 29. In the median length of the lower pharyngeal bone, the mesethmoid not meeting the vomer and mouth-brooding Iranocichla resembles Sarotherodon rather than Tilapia s.s. as defined by Trewavas (1973) with

such characters as gill raker number and pharyngeal blade/median length toothed area overlapping figures for the two genera.

Distribution and zoogeography.- Iranocichla hormuzensis is known from 13 localities in 11 streams and rivers draining to the Persian Gulf at the Straits of Hormuz (Fig. 4). Major river basins to the east (Minab River drainage and the Jaz Murian basin) and the northwest (Mand River drainage) have been sampled by me but the cichlid has not been found there or elsewhere in Iran (see also Saadati, 1977). Peninsular Arabia has been poorly sampled for fishes but there are no reports of extant cichlids (Trewavas, 1941; Banister and Clarke, 1975). The fish faunas of Pakistan, Northern India, and the Tigris-Euphrates basin of Iraq and Syria are better known and cichlids are absent (Mirza, 1975; Jayaram, 1974; Khalaf, 1961; Beckman, 1962).

The present distribution of Iranocichla is regarded as a relict of a once wider distribution across Peninsular Arabia and/or the Tigris-Euphrates basin, representing the easternmost extent of the African Tilapia lineage. Kosswig (1965, 1973) has suggested that connections between Levant rivers and the river systems of Mesopotamia were close during various periods of the late Pliocene and Pleistocene. Even today there is only a narrow divide between the Amanus River, a headwater of Lake Antakya in the north of the Levant Rift Valley, and the Sacur River, an affluent of the Euphrates River (Por, 1975). Banister and Clarke (1975) consider that there were periods up to at least 10,000 B.P. when migrations were feasible across the Arabian peninsula because the onset of arid conditions is fairly recent. Hotzl and Zotl (1978) record extensive erosion of large west-east running river systems in central and eastern Saudi Arabia during the late Pliocene and

early Pleistocene. It is also pertinent to note that Tristramella magdalenae is found around Damascus outside the Levant Rift Valley indicating that this deep rift has not been an insupperable obstacle to cichlids.

The absence of cichlids from the Arabian Peninsula and the Tigris-Euphrates basin may be due to the limiting factors of low temperatures combined with desiccation in the Pleistocene and Recent periods. The effects of low temperature on Tristramella and Iranocichla are not known but Chervinski and Lahav (1976) have shown that fingerlings of Tilapia aurea, which occurs naturally in the southern Levant Rift Valley, ceases all motion of temperatures below 10°C and begin to die at 11°C. The 10°C isotherm for January encompasses the southern Rift Valley, southern Iraq, and the Iranian coast of the Persian Gulf but most of Syria, northern Saudi Arabia and northern Iraq have temperatures below 10°C in winter (Beaumont et al., 1976). Spot temperatures from southern Iraq and the northern Persian Gulf coast of Iran are about 12 - 13°C in January compared to 18 - 20°C for the area at the Straits of Hormuz where Iranocichla occurs. In addition Chervinski and Lahav (1976) have shown that death rate of Tilapia aurea in freshwater is twice that in saltwater at low temperatures. It may be pertinent that Iranocichla is found in salt rivers and streams.

The Persian Gulf would not present a barrier to a salt-tolerant species and in any event its modern form dates to about 10,000 B.P. Prior to this time for about 90,000 years the Gulf was a large river valley for the Tigris-Euphrates drainage which emptied into the Sea of Oman in the region of the Straits of Hormuz (Kassler, 1973).

Steinitz (1954) has suggested that Tilapia s.l. species of the Levant are immigrants of late Tertiary age. — I'm waiting for this reference; presumably Tristramella and Iranocichla are late Tertiary.

Habitat and biology.- Iranocichla hormuzensis was found in an area of southern Iran rich in salt domes (Booth, 1977) and as a consequence most surface water was saline. An exception was the stream at Sar Khun (NMC79-0187) which was fresh with a conductivity of 1.6 millimhos. Other localities were salt to taste and conductivity range was 1.25-80 millimhos (mean 29.3 millimhos). Water quality varied from cloudy to clear and colourless. Water temperatures in winter (November to March) ranged from 15°C to 33°C and would be high in summer (July) when air temperatures in this region may reach 45°C. There was no riparian shade. Each stream or river consisted of alternating riffle and pool stretches with occasional backwaters. Width varied from 1 to 50 m. Cichlids were found in pools and backwaters and caught at depths from 5 cm to 1 m over pebbles, sand or mud. Aquatic vegetation was restricted to encrusting algae. The highest collection was made at 480 m.

A mouth brooding female and a breeding male were caught on March 18 in a backwater of the Mehran River (the type series). This backwater was 1-5 m wide, maximum depth was 40 cm over a mud bottom, the water was cloudy and highly saline (conductivity 40 millimhos) and temperature ranged from 26°C at the backwater's mouth to 33°C at its head. Eggs in the ovaries of females taken in November and January at other localities were small so the breeding season for this species in the Iranian spring centred around March. Five eggs from the mouth brooding female had a length range of 3.2 - 3.8 mm (mean 3.6 mm) and a width range of 2.4 - 2.7 mm (mean 2.5 mm). Total number of eggs taken from both ovaries of 2 females, 59.0 - 59.2 mm SL, (NMC79-0406) was low, 36 and 38 respectively. Eggs in preserved specimens are orange-yellow in colour.

Examination of stomach contents of 5 specimens (41.2 - 90.5 mm SL) revealed only algae and diatoms suggesting that diet consisted of aufwuchs and bottom deposits. This suggestion is consistent with an elongate intestine and black peritoneum. The failure of the mesethmoid to meet the vomer has been attributed to a microphagous habit which exerts fewer stresses and strains on the jaw apparatus than in predators enabling the ethmoid region to broaden for the passage of large quantities of food-laden water (Trewavas, 1973).

Other species associated with the cichlid were the goby Boleophthalmus boddarti, the cyprinodont Aphanius dispar, the milkfish Chanos chanos, and the cyprinids Cyprinion watsoni and Garra cf. persica.

The saline waters comprising the cichlid's habitat cannot be utilised for irrigation or industry and the species is not endangered by man. No aquatic predators were observed but piscivorous birds were seen in the general area. Sudden, heavy winter rainfall over the large, vegetation barren drainage basins of these shallow rivers often result in disastrous scouring flash floods which must cause mortality in the cichlid populations. Mouth brooding would afford protection to the eggs from floods and from associated species, several of which are substrate feeders.

Etymology.- The specific name hormuzensis refers to Hormuz, once a famous emporium at the mouth of the Persian Gulf, from which is derived Hormozdgan the province in which Iranocichla is endemic.

Other material examined.- Tristramella sacra: NMC80-0406, 2, 162.0-187.2 mm SL, Yam Kinneret, Israel. 2 March 1977. T. simonis simonis: NMC79-0694, 183.5 mm SL, Yam Kinneret, Israel. T. simonis intermedia: NMC80-0405, 2, 146.0-150.8 mm SL, Yam Kinneret, Israel.

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TABLE 1. FREQUENCY DISTRIBUTIONS OF MERISTIC DATA FOR *IRANOCICHLA HORMUZENSIS*. N = 66 EXCEPT FOR LATERAL LINE COUNTS WHERE N = 46 AND GILL RAKER COUNT WHERE N = 65.

Scales in upper lateral line

17	18	19	20	21	22	23	24	25	26 - 29	$\bar{x}$	SD
1	1	2	8	9	10	7	4	2	1	21.8	2.13

Scales in lower lateral line

9	10	11	12	$\bar{x}$	SD
6	17	14	9	10.6	0.96

Total scales in lateral series

28	29	30	31	32	33	34	35	36 - 40	$\bar{x}$	SD
1	2	4	9	13	5	4	4	3	1	32.4	2.22

Scales around caudal peduncle

16	17	18	19	20	$\bar{x}$	SD
15	13	15	2	1	17.2	1.01

Precaudal vertebrae

14	15	16	$\bar{x}$	SD
2	53	11	15.1	0.43

Caudal vertebrae

13	14	15	$\bar{x}$	SD
26	35	5	13.7	0.61

Total vertebrae

23	29	30	$\bar{x}$	SD
19	40	7	28.8	0.61

Dorsal fin spines

xiv	xv	xvi	$\bar{x}$	SD
6	46	14	15.2	0.58

Dorsal fin branched rays

9	10	11	$\bar{x}$	SD
2	36	28	10.3	0.51

Anal fin branched rays

6	7	8	9	$\bar{x}$	SD
7	20	38	1	7.5	0.66

Pectoral fin branched rays

11	12	$\bar{x}$	SD
42	24	11.3	0.47

Caudal fin branched rays

12	13	14	15	$\bar{x}$	SD
1	4	60	1	13.9	0.36

Gill rakers

14	15	16	17	18	19	x	SD
6	9	24	19	6	1	16.2	1.13

TABLE 2. MORPHOMETRIC DATA FOR ADULT AND JUVENILE *IRANOCICHLA HORMUZENSIS* WITH MEAN ($\bar{x}$), STANDARD DEVIATION (SD) AND RANGE IN PARENTHESES, AND PROBABILITIES (P) BASED ON t-TESTS. DATA FOR MALE AND FEMALE ADULTS COMBINED EXCEPT WHERE SIGNIFICANTLY DIFFERENT (SIGNIFICANCE LEVELS GIVEN IN TEXT).

Character	Holotype	Adult	Juvenile	P
N		46	20	
SL(mm)	94.2			
		$\bar{x}$ SD	$\bar{x}$ SD	
SL / Head length (HL)	2.6	2.7 0.09 (2.6 - 3.1)	2.7 0.09 (2.5 - 2.8)	>0.05
SL / Head depth	3.2	3.5 0.16 (3.2 - 4.0)	3.5 0.14 (3.3 - 3.9)	>0.05
SL / Body depth	2.8	2.9 0.18 (2.5 - 3.4)	3.0 0.10 (2.8 - 3.2)	>0.05
SL / Pectoral fin length	3.9	3.5 0.22 (2.9 - 4.1)	4.0 0.29 (3.5 - 4.4)	<0.001
SL / Pelvic fin length	5.2	4.8 0.33 (4.0 - 5.5)	5.7 0.26 (5.3 - 6.2)	<0.001
SL / Caudal peduncle length	5.6	6.0 0.31 (5.4 - 6.8)	5.7 0.42 (5.1 - 6.4)	>0.05
SL / Predorsal length	2.6	2.6 0.07 (2.5 - 2.8)	2.4 0.05 (2.3 - 2.5)	<0.02 >0.01
HL / Orbit width	4.8	4.3 0.35 (3.6 - 5.1)	3.3 0.17 (3.1 - 3.8)	<0.001
HL / Interorbital width	3.7	3.8 0.17 (3.5 - 4.1)	3.8 0.19 (3.5 - 4.2)	>0.05
HL / Snout length	2.3	2.5 0.11 (2.2 - 2.8)	2.9 0.17 (2.7 - 3.3)	<0.001

TABLE 2. (cont'd)

Character	Holotype	Adult	Juvenile	P
HL / Postorbital length	2.3	2.3 0.08 (2.2 - 2.6)	2.5 0.07 (2.3 - 2.6)	>0.05
HL / Preorbital bone depth	7.9	8.0 0.55 (6.5 - 8.9)	6.7 0.51 (5.9 - 7.5)	<0.001
HL / Premaxillary pedicels length	4.7	4.6 0.25 (4.1 - 5.2)	4.5 0.14 (4.3 - 4.8)	>0.05
HL / Length of lower jaw	2.9	3.1 0.20 (2.7 - 3.5)	3.2 0.16 (2.9 - 3.5)	>0.05
HL / Caudal peduncle length	2.1	2.2 0.13 (2.0 - 2.6)	2.1 0.15 (1.9 - 2.4)	>0.05
HL / Pectoral fin length	1.5	1.3 0.10 (1.1 - 1.6)	1.5 0.13 (1.3 - 1.7)	<0.05 >0.02
HL / Pelvic fin length	2.0	1.8 0.15 (1.5 - 2.1)	2.1 0.12 (2.0 - 2.4)	<0.01 >0.001
HL / Last dorsal fin spine length	2.9	2.4 0.16 (2.2 - 2.8) 2.7 0.17 (2.3 - 3.0)	3.5 0.31* (3.1 - 4.2)	<0.001+
HL / Longest dorsal fin branched ray	2.3	2.2 0.15 (1.9 - 2.4) 2.5 0.13 (2.2 - 2.7)	3.0 0.34 (2.2 - 3.7)	<0.001+
HL / Longest anal fin branched ray	2.5	2.3 0.18 (1.9 - 2.7) 2.5 0.12 (2.2 - 2.8)	2.9 0.36 (2.2 - 4.0)	<0.05+
Snout length / Orbit width	2.1	1.7 0.20 (1.3 - 2.1)	1.1 0.09 (1.0 - 1.3)	<0.001
Orbit width / Preorbital depth	1.7	1.9 0.18 (1.5 - 2.4)	2.0 0.14 (1.8 - 2.3)	>0.05

TABLE 2. (cont'd)

Character	Holotype	Adult	Juvenile	P
Last dorsal fin spine length / Last anal fin spine length	1.2	1.1 0.08 (1.0 - 1.4)	1.0 0.07 (0.9 - 1.1)	<0.05 > 0.02
Caudal peduncle length / Caudal peduncle depth	1.3	1.2 0.07 (1.1 - 1.4)	1.4 0.11 (1.2 - 1.6)	<0.01 > 0.001

* n = 16, dorsal fin spines damaged in four specimens.

+ Minimum significant difference between males and juveniles, females and juveniles and combined males with females and juveniles.

TABLE 3. VERTEBRAE COMBINING TO FORM APOPHYSIS IN 10 SPECIMENS (36.7 - 87.1 mm SL) OF IRANOCICHLA HORMUZENSIS.

Vertebrae / Specimen	2/3		3		3/4		4		4/5	
	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT
1	+	+								
2							+	+		
3				+	+					
4						+	+			
5			+	+						
6									+	+
7					+	+				
8			+			+				
9						+	+			
10								+	+	

Fig. 1. Iranocichla hormuzensis. Holotype (NMC79-0408A), female with eggs in mouth (94.2 mm SL).

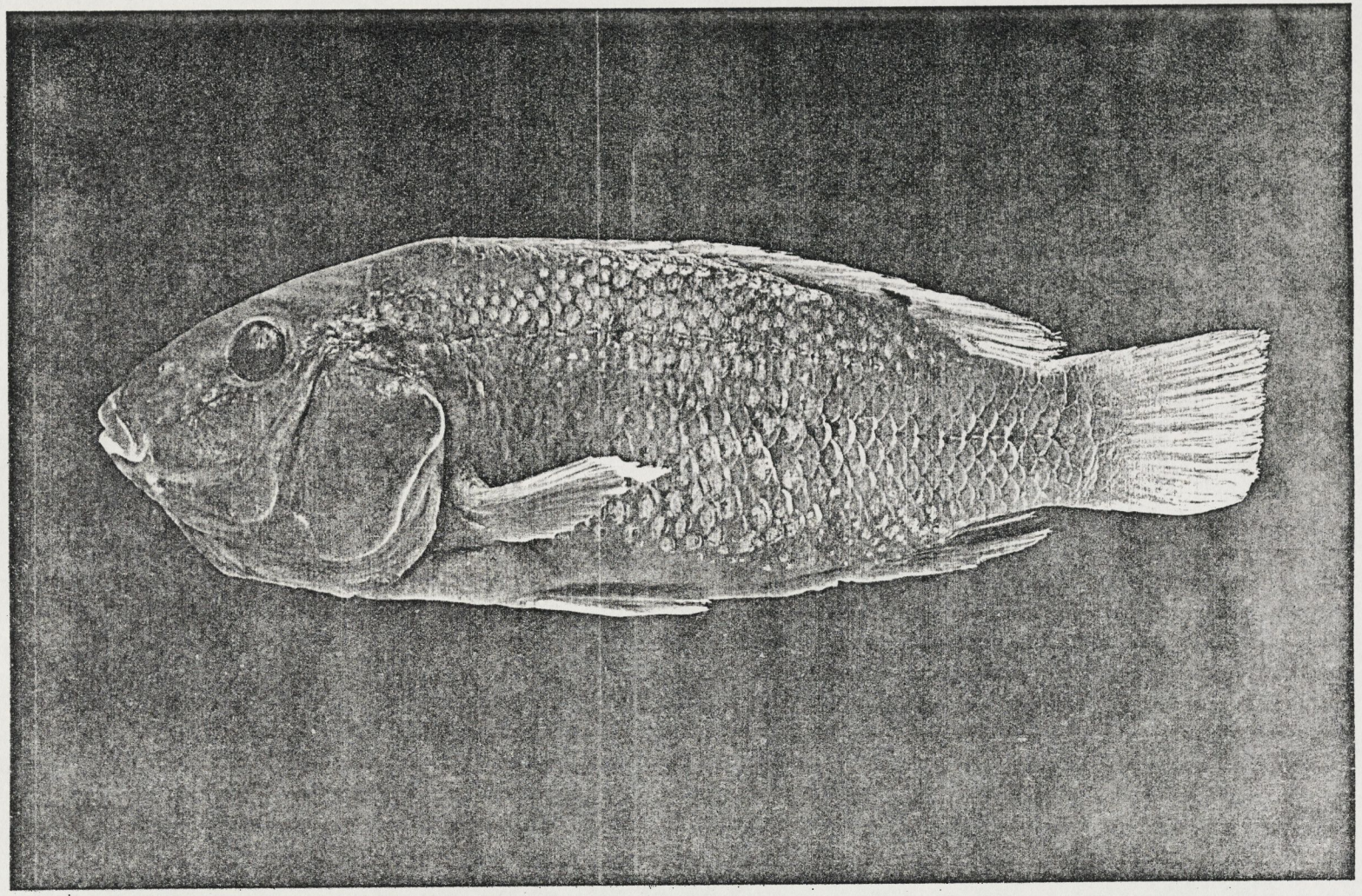


Fig. 2. Right lateral view of inferior apophyses of 87.1 mm SL *Iranocichla hormuzensis*, NMC79-0148. Scale = 1 mm.

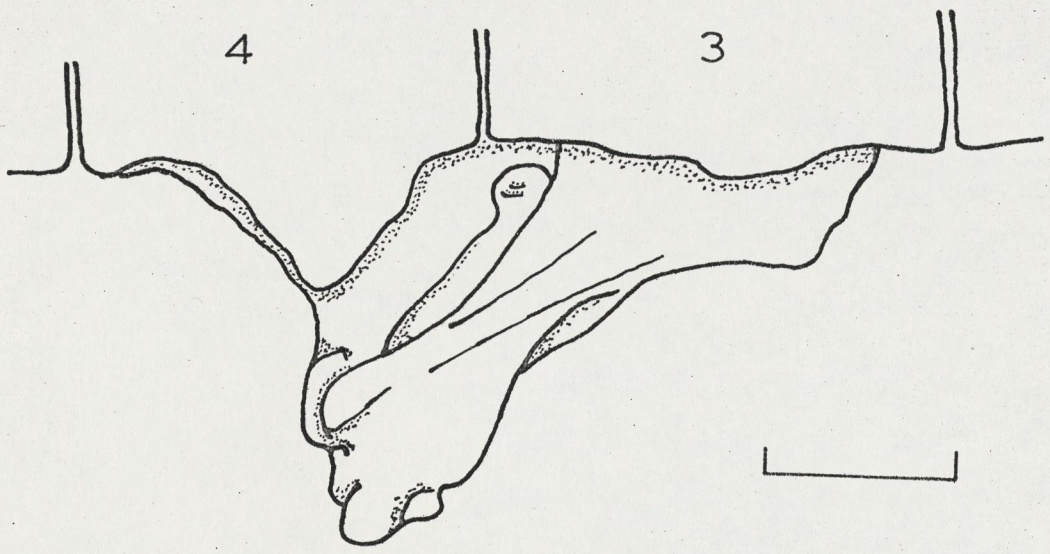

4
3

Fig. 3. Dorsal view of lower pharyngeal bone of 62.0 mm SL Iranocichla hormuzensis, NMC79-0142. Scale = 1 mm.

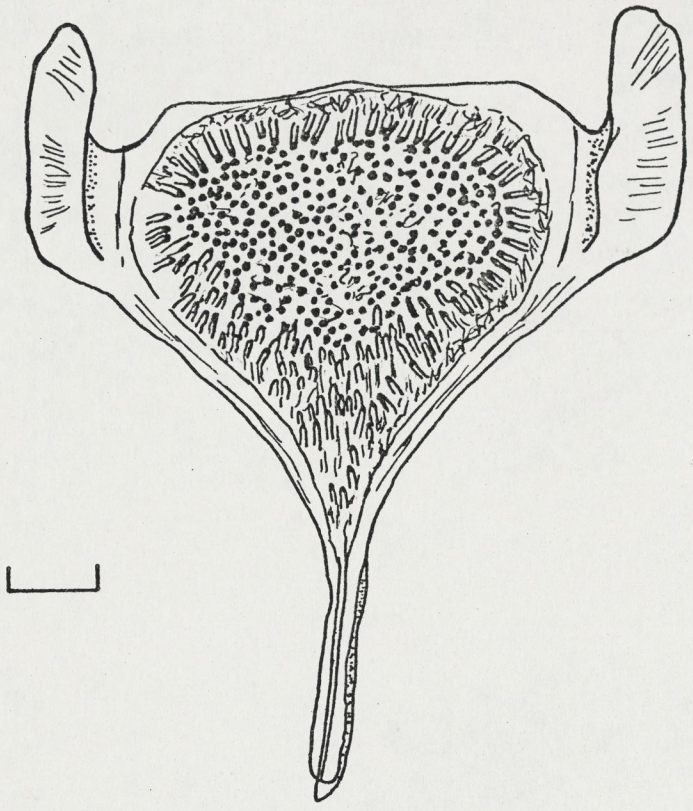
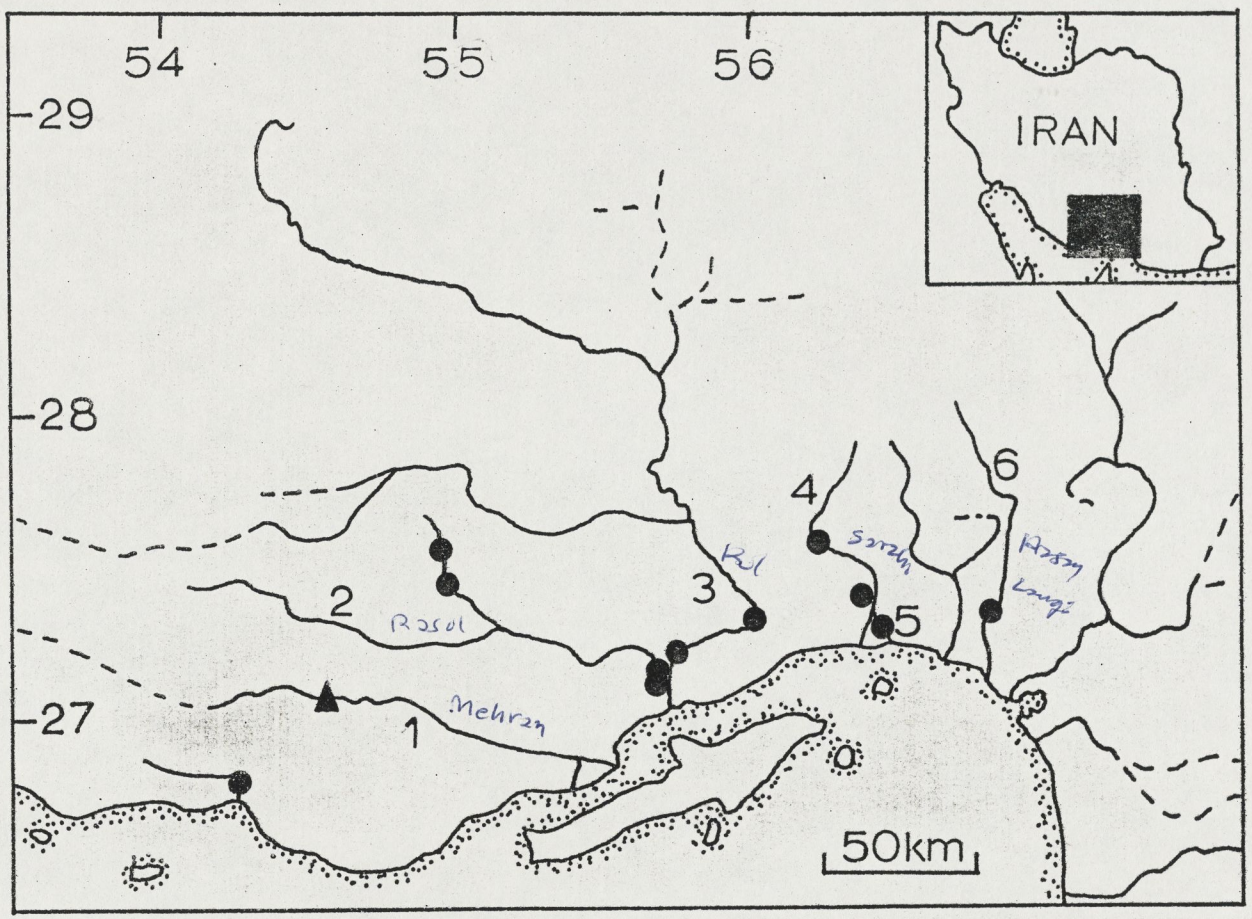


Fig. 4. Distribution of Iranocichla hormuzensis in southern Iran. ▲ = Type locale; ● = other collections; 1 = Mehran River, 2 = Rasul River, 3 = Kul River, 4 = Sarzeh River, 5 = Baghu River, 6 = Hasan Langi River.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National Museums
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Natural Sciences

Musées nationaux
Canada

Musée des Sciences
naturelles

July 4, 1980

Dr. R.J. Behnke,
Department of Fishery and
Wildlife Biology,
Colorado State University,
Fort Collins, Colorado,
U.S.A. 80523

Dear Bob,

Many thanks for your letter and field notes. I have a copy of Wossughi's thesis and as you say it is really poor.

I haven't seen my checklist on Iranian fishes yet but will send a reprint when they come through. I'm working up a revised version which will correct errors and add new information.

Karaman is a nuisance, isn't he? I don't agree with much of his stuff, but feel that too many people advance ideas without proof and thus merely add to the confusion. Until I can disprove his statements I just include them.

Enclosed is my bibliography on SW Asian fishes — any additions you can make would be most welcome; I have about 100 more references to add.

Thanks again for the field notes.

Sincerely,

Brian

Brian W. Coad, Ph.D.

Encl.

Ottawa
K1A 0M8

Dear Dr. Behnke Sept. 8th, 1980

I, Behrooz Dehdashti, am an international Graduate student in biology, from Iran.

Last summer, I had the opportunity to study at Marine Science Center, Oregon State University.

I visited Dr. Richard Tubb, the director of the Dept. of Fisheries & Wildlife, to ask for some literature about Iranian fishes. Dr. Tubb kindly mentioned you to get in touch with. Therefore, I would like to ask for your help with respect to Iranian fishes and fisheries. My primary interest is on inland fish culture on the northern part of Iran (nearby the Caspian Sea). But I am totally ignorant of the kind of species that might be apt for that environment or whether to pursue an extensive or intensive culture. I also don't know if in Iran balanced

fish diet is made or not.

Unfortunately, due to the special situations in Iran nowadays, I have not been able to receive any information from Iranian fisheries authorities.

Hence, your contributions in this regard will be fully appreciated. Needless to say any expenses on the xerox copies or manuals are also welcomed.

Thank you for your time

Cordially

Behrooz Dehdashti
C.U. Box 12002 N.A.U.
Flagstaff. Az. 86011

Behrooz Dehdashti
C. U. Box 12002 N. A. U.
Flagstaff, Az. 86011

FLAGSTAFF, AZ
SEP 8
1980



Dr. Robert J. Behnke
Colorado State University
Cooperative Fishery Unit
Fort Collins, Colorado
80521

Coad, B.W. 1980. Environmental changes and its impact on the freshwater fishes of Iran. Biol. Conservation. 19(1):51-80.

Gambusia introd. - may inadvertantly bring other sp. (Aphanoides in Helmand basin)

Todd-Smith zenithicus - Can. F. - 37(12)

JOURNAL OF NATURAL HISTORY, 1980, 14:33–40

A re-description of *Aphanius ginaonis* (Holly, 1929) from southern Iran (Osteichthyes: Cyprinodontiformes)

BRIAN W. COAD†
Department of Biology, Pahlavi University, Shiraz, Iran

Introduction

A new species of cyprinodont fish, *Cyprinodon ginaonis*, was described from a hot spring at Ginao‡ near Bandar Abbas in southern Iran by Holly (1929). This description was based on only three specimens. The species has been placed tentatively in *Aphanius dispar* by Berg (1949) who apparently did not examine any new material. A re-description is given here based on 77 specimens to resolve the systematic status of the species.

It should be noted that Miller (1948) has restricted the use of the genus name *Cyprinodon* to Central American and southern North American cyprinodonts while Middle Eastern cyprinodonts are referred to the genus *Aphanius*.

Materials and methods

The study is based on the following specimens of *A. ginaonis* and comparative material of *A. dispar*:

A. ginaonis

BWC 77–11 (personal collection catalogue number), 77 specimens, 15·1–39·9 mm total length, Iran, Hormozdgan, hot spring at Ginao, 38 km north of Bandar Abbas and slightly more than 2 km west from the Bandar Abbas to Sirjan road, 27° 26′ N, 56° 20′ E. B. W. Coad, Sh. Mansoorabadi, A. Shirazi. 27 January 1977.

A. dispar

BWC 76–128, 14 specimens, 26·6–36·8 mm total length, Iran, Hormozdgan, marshy area by Bandar Abbas to Minab road, about 56 km from Bandar Abbas, Shirin River drainage, ca. 27° 21′ N, 56° 47′ E. B. W. Coad, H. Assadi. 27 November 1976.

BWC 77–13, 5 specimens 30·7–47·0 mm total length, Iran, Hormozdgan, stream 50 km north of Bandar Abbas on Bandar Abbas to Sirjan road, Sarzeh River drainage, 27° 31′ N, 56° 15′ E. B. W. Coad, Sh. Mansoorabadi, A. Shirazi. 27 January 1977.

BWC 77–15, 5 specimens, 35·0–43·3 mm total length, Iran, Hormozdgan, stream 55 km north of Bandar Abbas on Bandar Abbas to Sirjan road, Sarzeh River drainage, 27° 34′ N, 56° 14′ E. B. W. Coad, Sh. Mansoorabadi, A. Shirazi. 27 January 1977.

BWC 77–18, 6 specimens, 36·8–43·3 mm total length, Iran, Hormozdgan, stream 63 km west of turnoff from Bandar Abbas to Sirjan road, en route to Bandar-e-

† Present address: Ichthyology Section, National Museum of Natural Sciences, Ottawa, Ontario, Canada K1A OM8.

‡ The translation of the Farsi word گینائو into various European languages has given the following other variants which appear on maps of the region: Ginau, Genu, Genow, Gueno, Geno.

 0022–2933/80/1401 0033 $02·00 © 1980 Taylor & Francis Ltd

Lengeh, Kul River drainage, 27° 14′ N, 55° 46′ E. B. W. Coad, Sh. Mansoorabadi, A. Shirazi. 28 January 1977.

Counts and measurements were made on 15 male and 15 female adult specimens of each species except where stated. The range in total length for *A. ginaonis* was 26·8–39·9 mm and for *A. dispar* 26·6–47·0 mm. Five males and five females of each species were stained in 2% potassium hydroxide and alizarin red S to confirm accuracy of scale and fin ray counts and for vertebral numbers. All dorsal, anal, pectoral and ventral rays were recorded as separate even when proximally close together. Only branched caudal fin rays were counted. Counts on pectoral rays were restricted to 10 alizarin preparations of each species because of the difficulty in making accurate counts of the smaller ventral rays in unstained specimens. Scales were counted in lateral series from the one touching the postero-dorsal corner of the operculum to the last large scale on the caudal peduncle (a number of small scales at the caudal fin base were not included in the count). The number of scales around the narrowest part of the caudal peduncle were counted and the number around the body just anterior to the ventral fins. The vertebral count includes the hypural plate as one vertebra.

The following measurements were taken to the nearest 0·1 mm using dial calipers. Total length: tip of lower jaw (anteriormost part of fish when jaw is closed) to end of caudal fin. Head length: tip of lower jaw to posteriormost part of operculum including fleshy membrane. Head depth: taken at a level with the posterior edge of the operculum. Body depth: maximum depth exclusive of fins. Caudal peduncle depth: minimum depth of this region. Eye width: maximum width of bony margin of eye. Snout length: from mid-point of tip of snout to anterior bony margin of eye. Interorbital distance: bony distance between orbits. Dorsal fin height: length of longest ray from base to fleshy tip. Anal fin height: length of longest ray from base to fleshy tip. Pectoral fin length: length of longest ray from base to fleshy tip. Ventral fin length: length from base of anteriormost ray to posteriormost fleshy tip.

Values for head length, head depth, body depth and caudal peduncle depth were entered into total length and eye width, snout length, interorbital distance, dorsal fin height, anal fin height, pectoral fin length and ventral fin length were entered into head length. It is these values which are discussed in the results.

Results

Description of the Ginao hot spring (*Ab-e-Garm*).

The unique environment of the hot spring which supports a single endemic species of cyprinodont warrants a description.

The site of emergence of the hot spring was partially enclosed by brick-work forming a hammam or bath-house for the local people when visited in 1977. The altitude of the spring is about 400 m. Its stream was about 10–15 m wide near the source and the bed of the stream was composed of stones and pebbles. These were covered by a lime-green alga. Fish were not found in the main flow of the stream or close to the source but along the stream margins and in many minor subsidiary springs which emerged a few metres from the main spring. These minor springs had a mud bottom, were as shallow as 1 cm and had soap and food debris pollution.

On the 27 January 1977 shade air temperature at 1400 hours was 20°C; spring water was 41°C and this appears to be constant (Joneidi *et al.* ?1971). Side springs at this time were slightly cooler, 37–40°C. The water of the spring is clear and colour-

less but there is a strong smell of sulphur. Joneidi *et al.* (?1971) gave the following data for this spring: pH = 6·2, conductivity = 14 000 μmhos, dry residue at 180°C = 9933 mg/litre, flow = 30 litres/s, traces of carbon dioxide, no measurable Fe, NO_2 or CO_3, H_2S = 34 (no units given ? p.p.b.), r (reacting value) Ca = 22·4, r Mg = 9·9, r Na + K = 6·1, total cations = 162·1 (sic), r Cl = 147, r SO_4 = 15·4, r HCO_3 = 4·6, total anions = 166 (sic), SiO_2 = 10 mg/litre, NH_4 = 0·7 (no units given), NO_3 = 22 (no units given).

Comparison of meristic and morphometric characters for A. ginaonis *and* A. dispar.

Meristic and certain other characters are summarized in tables 1 and 2. *t*-tests were used to compare sexes within a species and to compare the two species. There

Table 1. Comparison of some meristic characters for *A. ginaonis* and *A. dispar* (S.D. = standard deviation, *p* = probability between species—see text for *p* values between sexes).

Total dorsal fin rays ($p < 0{\cdot}001$)

	5	6	7	8	9	10	Mean	S.D.
A. ginaonis	2	24	4				6·07	0·4498
A. dispar					23	7	9·23	0·4302

Total anal fin rays ($p < 0{\cdot}001$)

		7	8	9	10	11	Mean	S.D.
A. ginaonis	♂	1	8	6			8·33	0·6172
	♀		4	9	2		8·87	0·6399
A. dispar	♂				13	2	10·13	0·3519
	♀			2	11	2	10·00	0·5345

Total ventral fin rays ($p < 0{\cdot}001$)

	6	7	Mean	S.D.
A. ginaonis	17	13	6·43	0·5040
A. dispar	3	27	6·90	0·3051

Total pectoral fin rays ($p < 0{\cdot}001$)

	14	15	16	17	18	Mean	S.D.
A. ginaonis	2	3	4	1		15·40	0·9661
A. dispar		2	6	1	1	16·10	0·8756

Branched caudal fin rays ($p < 0{\cdot}001$)

	9	10	11	12	13	14	15	16	Mean	S.D.
A. ginaonis	1	1	1	14	13				12·23	0·9353
A. dispar				2	6	11	10	1	14·07	0·9803

Total vertebrae ($p < 0{\cdot}001$)

		26	27	28	29	Mean	S.D.
A. ginaonis	♂	3	2			26·40	0·5477
	♀		3	2		27·40	0·5477
A. dispar	♂			4	1	28·20	0·4472
	♀		1	3	1	28·00	0·7071

Table 2. Comparison of scale characters and flank bars for *A. ginaonis* and *A. dispar* (n = number of specimens).

		n	Range	Mean	S.D.
		Lateral line scales ($p<0{\cdot}005>0{\cdot}001$)			
A. ginaonis		30	22–28	25·87	1·3322
A. dispar		30	24–35	27·73	2·7156
		Scales around body ($p<0{\cdot}01>0{\cdot}005$)			
A. ginaonis		24	22–26	24·17	1·1293
A. dispar		24	22–32	25·83	2·5651
		Scales around caudal peduncle ($p>0{\cdot}05$)			
A. ginaonis		28	14–17	16·04	0·7927
A. dispar		28	14–18	15·86	0·9315
		Total scale radii ($p>0{\cdot}05$)			
A. ginaonis		24	10–17	13·88	1·8252
A. dispar		24	10–20	14·79	1·9777
		Total flank bars ($p>0{\cdot}05$)			
A. ginaonis	♂	13	10–20	14·15	2·7642
	♀	13	13–21	17·46	2·8756
A. dispar	♂	13	12–21	15·15	2·7339
	♀	13	10–22	17·77	3·7673

were significant differences between the two species in all characters except number of scales around caudal peduncle, total scale radii and total number of flank bars ($p>0{\cdot}05$). There were no significant differences ($p>0{\cdot}05$) between male and female *A. ginaonis* for total numbers of dorsal fin rays, branched caudal fin rays, pectoral fin rays, ventral fin rays, lateral line scales, scales around caudal peduncle, scales around body and total scale radii. Total number of anal fin rays was higher in females (mean 8·87) than in males (8·33) ($p<0{\cdot}05>0{\cdot}025$), total number of vertebrae was higher in females (27·4) than in males (26·4)($p<0{\cdot}025>0{\cdot}01$) and total number of flank bars was higher in females (17·46) than in males (14·15)($p<0{\cdot}001$). There were no significant differences between sexes of *A. dispar* for the first two characters ($p>0{\cdot}05$) but for total number of flank bars male *A. dispar* had a mean of 15·15 and females 17·77 ($p<0{\cdot}05>0{\cdot}025$). There were significant differences ($p<0{\cdot}001$) between males of the two species and between females of the two species for anal fin rays and total vertebrae. There were no significant differences ($p>0{\cdot}05$) between sexes of the two species for total number of flank bars.

Morphometric characters are summarized in table 3 and significant differences were found in all characters except body depth in total length, interorbital distance

Table 3. Comparison of morphometric characters for *A. ginaonis* and *A. dispar* ($n=30$ for each species and character).

	Total length/body depth ($p>0{\cdot}05$)		
	Range	Mean	S.D.
A. ginaonis	3·92–5·47	4·77	0·3000
A. dispar	4·12–6·02	4·87	0·4218
	Total length/head length ($p<0{\cdot}001$)		
	Range	Mean	S.D.
A. ginaonis	3·33–3·78	3·58	0·0997
A. dispar	3·51–4·29	4·00	0·1723
	Total length/head depth ($p<0{\cdot}005>0{\cdot}001$)		
	Range	Mean	S.D.
A. ginaonis	4·75–6·02	5·32	0·2496
A. dispar	5·11–6·14	5·55	0·3099
	Total length/caudal peduncle depth ($p<0{\cdot}001$)		
	Range	Mean	S.D.
A. ginaonis	7·05–9·00	8·12	0·3799
A. dispar	7·73–9·91	8·77	0·4765
	Head length/eye width ($p<0{\cdot}001$)		
	Range	Mean	S.D.
A. ginaonis	3·80–5·14	4·31	0·3198
A. dispar	2·74–3·94	3·39	0·3031
	Head length/snout length ($p>0{\cdot}05$)		
	Range	Mean	S.D.
A. ginaonis	3·09–4·00	3·45	0·2208
A. dispar	2·70–4·05	3·46	0·2841
	Head length/interorbital distance ($p>0{\cdot}05$)		
	Range	Mean	S.D.
A. ginaonis	2·24–2·93	2·66	0·1319
A. dispar	2·26–2·92	2·59	0·1735
	Head length/dorsal fin height ($p<0{\cdot}001$)		
	Range	Mean	S.D.
A. ginaonis	2·29–3·83	2·91	0·3171
A. dispar	1·55–2·31	2·04	0·1991

		Head length/anal fin height ($p<0{\cdot}001$)		
		Range	Mean	S.D.
A. ginaonis		2·05–3·12	2·53	0·2543
A. dispar		1·34–2·13	1·88	0·1587
		Head length/pectoral fin length ($p<0{\cdot}001$)		
		Range	Mean	S.D.
A. ginaonis		1·71–2·46	2·07	0·1616
A. dispar		1·33–1·93	1·66	0·1282
		Head length/ventral fin length ($p<0{\cdot}001$)		
		Range	Mean	S.D.
A. ginaonis	♂	3·03–4·91	3·82	0·4622
	♀	2·94–4·00	3·51	0·3336
A. dispar	♂	2·30–3·41	2·86	0·3318
	♀	2·80–4·26	3·26	0·3893

in head length and snout length in head length ($p>0{\cdot}05$). There were no significant differences ($p>0{\cdot}05$) between male and female *A. ginaonis* for morphometric characters except for ventral fin length in head length where in males mean value was 3·82 and in females 3·51 ($p<0{\cdot}05>0{\cdot}025$) i.e. the ventral fin was longer in females. Curiously in *A. dispar* this difference was reversed and females had a higher mean value (3·26) than males (2·86) ($p<0{\cdot}01>0{\cdot}005$). There was no significant difference between female *A. ginaonis* and female *A. dispar* ($p>0{\cdot}05$) but male *A. ginaonis* had shorter ventral fins than male *A. dispar* ($p<0{\cdot}001$).

Pigmentation

Pigmentation in specimens preserved in 5% formalin was as follows. The peritoneum was black in both species. Males of both species had two black vertical bars on the caudal fin with the posterior margin hyaline. These bars were usually straight but occasionally were wavy. Some specimens had one or three bars or a forked bar assuming a 'Y' shape. These bars were not present in females where the caudal fin rays were lightly speckled in both species. The dorsal fin in males of both species carried 4–5 horizontal rows of spots, fading dorsally. These were not always well developed and then consisted of irregular, black pigmentation on the rays and membranes of the dorsal fin. The dorsal fin rays and membranes of female *A. ginaonis* and female *A. dispar* were weakly pigmented. Horizontal rows of spots were also seen on the anal fin of some male *A. dispar* but confined to the last three rays. Otherwise this fin, like the ventral fins, had little or no pigment in both species and both sexes. The pectoral fins carried black pigment on the rays and membranes of some male *A. dispar* and concentrated on the rays of *A. ginaonis*. Pectoral fin rays were weakly speckled in females of both species. Vertical bars on the flank of female *A. ginaonis* and *A. dispar* varied from weak to obvious. The light intermediate bars were not as highly coloured as in males nor as well defined. Black bars in males of both species were better defined than in females.

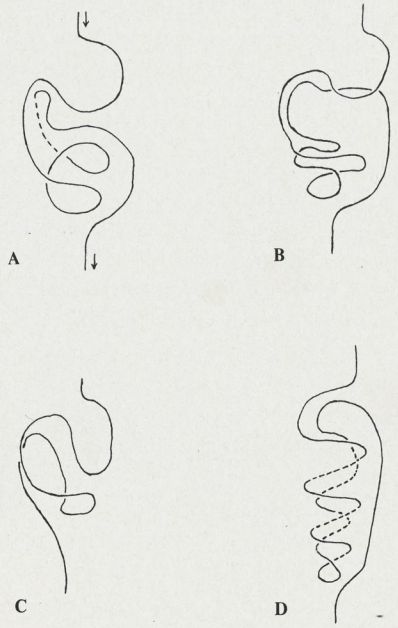
A milky-white colour was developed in some *A. dispar* of both sexes around the base of the anal fin, on the caudal peduncle posterior to this fin and antero-ventrally from the pectoral fins on the belly and onto the isthmus. In one male this milky-white colour extended onto the lower jaw and the lower half of the head. This type of coloration was not observed in *A. ginaonis*.

Pigmentation in live *A. ginaonis* and *A. dispar* was brighter in males than in females although colour intensity also varied individually within sexes. The dorsal, anal, pectoral and ventral fins in *A. ginaonis* were a light orange colour. Flank bars were alternately black tinged with orange and grey-white, light blue or light orange. The side of the head was anteriorly iridescent light blue to green and the opercle was dorsally orange, postero-ventrally blue. The iris of the eye was iridescent green and the anterior ventral surface of the head was light blue. In *A. dispar* the fin colour was usually a lemon yellow but some individuals showed an orange tinge. Body bars were black and light orange and there was an orange spot dorsally on the opercle of some fish.

Other characteristics

The gut pattern in *A. ginaonis* varied between individuals and three examples are given in the figure. In *A. dispar* the pattern was a constant spiral as shown in the figure.

Scales were absent from the belly between the pectoral fins and posteriorly to the ventral fins in some specimens of *A. dispar*. The isthmus was also variably scaled. In *A. ginaonis* these areas were scaled.



Ventral views of gut patterns in *A. ginaonis* (A, B and C) and *A. dispar* (D) (anterior end of gut at top of page, dotted lines indicate portions of gut overlain by other sections in ventral view).

Discussion

A. ginaonis exhibits many meristic, morphometric and other characters which separate it from *A. dispar* the only other cyprinodont found in adjacent drainages. In addition it lives in a unique, isolated environment, a hot spring. These factors are considered sufficient to re-affirm *A. ginaonis* as a species distinct from *A. dispar*.

Summary

Aphanius ginaonis, a cyprinodont fish from a hot spring in southern Iran, is redescribed and compared with *A. dispar*. Its specific status is re-affirmed.

Acknowledgments

The author is indebted to Dr. B. Kholdebarin, Chairman of the Biology Department, Pahlavi University for his assistance in arranging field trips on which the material studied was collected. Mr. B. Rostami, Mr. A. Shirazi, Mr. H. Assadi and Mr. Sh. Mansoorabadi acted as drivers and field assistants and their energetic help is gratefully acknowledged. This research was financed by a Pahlavi University Research Council grant number 35-A5-149-172.

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ANTHONY SMITH

9 STEELE'S ROAD, LONDON N.W.3

February 3rd, 1981

Dr Robert Behnke,
Dept. of Fishery and Wildlife,
Colorado State University,
Co. 80523, U.S.A.

Dear Dr. Behnke,

I was delighted to receive your letter, not only for its bits and pieces of news but because of your statement that there are 18 Noemacheilus smithi at Colorado. This brings to 19 the known numbers of this fish! But of course I am full of more questions. Are these specimens to be anatomically investigated? Has any work been done on them yet? What plans are there? As you know the holotype exists in London but, being just a single specimen, nothing has been done about its internal structure. You mention an Iranian student who made the collection with you - has he published anything yet?

I would also be keen to know the whereabouts of Barry Nehring. We met in Tehran and I would like to keep in touch.

So far as the new Iraqi blind fish is concerned, that was written up in the Bulletin Brit. Mus. Nat. Hist. (Zool.), 38 (3), pp. 151-158 by K.E.Banister and M.K.Bunni. Dr Banister lives in London, and tells me he certainly see a re-print to you. So obviously the U.S. mail is behaving erratically somewhat like our own. The newest blind fish from that area, a cyprinid found in an Omani sink-hole, is also being described by Dr Banister, but this work has not yet been published. The blind noemacheiline from China is also - so Dr P.H.Greenwood discovered on a recent visit there - living in association with a blind cyprinid. So the parallel between the Chinese situation and that of the Zagros mountains (where I found my fish) is even closer than we at first believed.

Please write back when you can with more news. I find the whole blind fish story so continuously fascinating. Do you ever visit London ?

Yours sincerely,

Anthony Smith.

01-722-4928

By air mail
Par avion



Dr Robert Bahnke,

Dept. of Fishery and Wildlife Biology,

Colorado State University,

Fort Collins,

Co. 80523, U.S.A.

E5 48

February 16, 1981

Dear Keith:

Under separate cover I have posted three specimens of Noemacheilus-smithi (topotypes) and also a specimen of the unnamed species of Cyprinion, designated as "undescribed species no. 1" in Mr. Al Kahem's thesis. This specimen is from the Wadi Mahala near Abha. You may keep the copy of Al Kahem's thesis. He plans to return to Saudi Arabia this summer and should be able to collect more specimens from diverse localities.

Thanks for the reprint describing Caecocypris basimi. As you note, it seems to have no congeners or logical progenitors in the Tigres-Euphrates basin.

I would very much appreciate a reprint of your paper on the fishes of the Tigres-Euphrates. In my Iranian collections, many new genera and species were recorded from the Tigres drainage (in comparison to genera and species listed by L. S. Berg). I found 4 new species of Alburnus and Alburnoides, Cobitis taenia, new species of Chondrostoma and Phoxinellus, etc. Obviously, many undescribed species are yet to be discovered in such an enormous basin with such diverse habitats and with so little collecting.

I also noted that the Mond River (first major drainage to the east of Tigres-Euphrates draining into Persian Gulf) has a distinct fauna with several endemic species (mainly undescribed or previously unrecognized). The other rivers draining into the Gulf in Iran lack Barbus and Varicorhinus with Cyprinion being the most ubiquitous species -- and these rivers have the cichlid in the lower reaches.

If you were not able to make a trip to Oman, I hope that at least the London winter has moderated by now.

Sincerely,

Dr. Keith Banister
British Museum (Natural History)
London, SW7 5BD
ENGLAND

(self-contained air mail envelope)

February 23, 1981

Dear Mr. Smith:

On the day I received your letter, I had just posted three specimens of Noemacheilus smithi to Keith Banister.

My Iranian fish collection was used by Mr. Mohamad Saadati to write a thesis on the fishes of Iran. Mr. Saadati was a biologist with the Iranian Department of Conservation. He returned to Iran in January, 1978. Our plan was to have the Conservation Department's Museum of Natural History fund a book on Iranian fishes, but as you know, nothing goes according to plan in Iran. I have heard indirectly that Mr. Saadati has been appointed Director of the Museum, but I doubt that any book on fishes will be forthcoming for some time.

I have received Keith Banister's reprint on the new Iraqi cavefish and I've requested his recent paper on Tigres-Euphrates fishes. I notdd in a recent issue of the journal Biological Conservation 19(1) that Brian Coad (formerly at Pahlavi University in Shvioz) published a paper on conservation of Iranian fishes.

Barry Nehring now works for the Colorado Division of Wildlife, Montrose, Colorado. I see him frequently and showed him your letter.

I assume that you are writing an article on blind fishes for the popular media. Have you ever been in contact with Dr. Nicolaus Peters and his wife Babrielle at the University of Hamburg? The Peterss are good friends of mine and they have done considerable research on eyeless fishes and published papers, including popularized versions (in German).

I spent a few weeks in London in 1960 when I examined specimens at the British Museum. I have pleasant memories of associations and afternoon teas with Ethylwynn Trewavas, N. B. Marshall, and PH.H. Greewood, and of a visit to Lake Windemere with E. D. LeCren. I stopped by for a quick visit in 1965 on my return from the USSR, but haven't been back since. I look forward to an opportunity for another visit.

Sincerely,

Robert Behnke

Mr. Anthony Smith
9 Steele's Road
London N.W. 3
England

Biological Conservation **19** (1980–81) 51–80

ENVIRONMENTAL CHANGE AND ITS IMPACT ON THE FRESHWATER FISHES OF IRAN

BRIAN W. COAD†

Department of Biology, Pahlavi University, Shiraz, Iran

ABSTRACT

Factors affecting the distribution and abundance of freshwater fishes in Iran are described. These include climate, devegetation, irrigation, and natural water level fluctuations (termed pre-industrial) and such factors related to industrialisation and population increase as devegetation, water abstraction, fishing, pollution, and faunal introductions. Conservation schemes are outlined and commented on and a list of threatened fishes is given.

INTRODUCTION

The purpose of this paper is to describe those factors, both man-made and natural, which affect the distribution and abundance of Iranian freshwater fishes and to record and suggest measures for the conservation of this fauna.

Fishes, particularly those of no economic value, do not receive the amount of attention from conservationists as do birds and mammals since they are not as readily observed and perhaps have less aesthetic appeal. The amateur ichthyologist is a rarity compared with the amateur ornithologist and mammalogist. A responsibility therefore lies with the professional ichthyologist to write about rare and endangered fishes. This is particularly true in a country like Iran which is rapidly becoming industrialised, with consequent dangers to the fauna, and which in addition lacks an extended tradition of concerned amateur naturalists (Scott *et al.*, 1975) and where there have been few studies on fish ecology. Factors affecting distribution and abundance of fishes can therefore only be outlined in general terms

† Present address: Ichthyology Section, National Museum of Natural Sciences, Ottawa, Ontario, Canada K1A OM8.

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and it is hoped that more specific studies will be forthcoming from the responsible government agencies charged with environmental protection.

Reasons for conservation of fishes need hardly be argued; fishes are important for scientific, cultural, aesthetic, recreational, economic, and educational purposes.

PRE-INDUSTRIAL FACTORS

This section deals with those factors affecting distribution and abundance of fishes from about 8000 BC until the present day. It is important to emphasize that the contemporary fish fauna has suffered from environmental degradation in prehistoric and historical times and that industrial factors are having an exacerbating effect.

Climate

Pluvial conditions in Iran ceased well before the end of the Pleistocene about 8000 BC (Butzer, 1972). Since that time there have been no major climatic fluctuations comparable with pluvials and interpluvials but even so minor fluctuations were of sufficient magnitude to have had an influence on the fish fauna. Butzer (1961) summarises evidence for a minor subpluvial in southwest Asia after a post-Pleistocene arid period. This subpluvial lasted from c. 5500–2350 BC and was characterised by higher humidity and rainfall with luxuriant flora able to thrive in areas where it is too dry today. Distribution of fishes was probably facilitated by permanent rivers and streams which today are intermittent or dry. Inland lakes would have a greater volume of water and perhaps would be connected to adjacent basins, further facilitating fish dispersals and distribution. A more luxuriant flora would reduce surface runoff so that flow regimes of rivers would be more stable, erosion and its destructive effects on watercourses would be reduced and shaded water would have lower temperatures such that stenothermal fishes would disperse more widely through lower parts of drainage basins which today are too warm. The subpluvial was followed by a period more arid at times than today, although this improved towards the end of the last millennium BC and since then there have been only short-term variations in the climate. The onset of drier conditions might well have limited the distribution of the fish fauna and led to the loss or isolation of certain minor drainages.

Ice-melt from the Fennoscandian ice-cap, as late as 4000 BC, contributed large volumes of water to the Caspian Sea which could not be evaporated. An overflow to the Black Sea was then possible (Raikes, 1967). Berg (1948–49) maintains that the silverside *Atherina mochon pontica* var. *caspia* and the pipefish *Syngnathus nigrolineatus caspius* entered the Caspian from the Black Sea in post-glacial times while most other fishes are relicts of earlier transgressions or are migrants from northern waters.

National Museums of Canada | Musées nationaux du Canada
National Museum of Natural Sciences | Musée national des sciences naturelles

February 26, 1982

Dr. R.J.Behnke
Dept. of Fishery and Wildlife Biology
Colorado State University
Fort Collins
Colorado 80523
U.S.A.

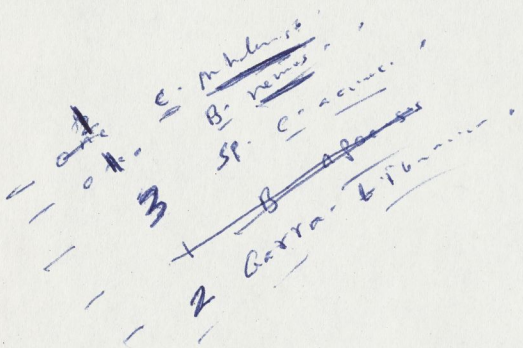
Dear Bob,

Enclosed is a draft on Alburnus doriae which is self-explanatory. The only qualm I have is the lower (7) branched dorsal ray count for De Filippi's material; he may have hit on a population we didn't sample. I am quite convinced he was describing L. lepidus although it may have been a distinct subspecies. This point can never be resolved because his locality is so vague.

Yours sincerely,

Brian

Brian W. Coad,
Associate Curator of Fishes



Ottawa, Canada
K1A 0M8

Canada

Comments on manuscript by Brian Coad describing a new species of Alburnoides from Iran

Anything discussed below can be cited by the author as personal communication from R. J. Behnke (Colorado State University) and M. Saadati (Department of Environment, Tehran). It is based on our study of Iranian fishes. Mr. Saadati has just completed a graduate thesis: "Taxonomy and distribution of the freshwater fishes of Iran," Colorado State University. 212 p. (January 1978).

We would consider the new species, A. gunni, as a subspecies of A. bipunctatus. We have data on 9 specimens from 5 localities in the Tigres basin of Iran which appear essentially identical to A. gunni and are treated as A. bipunctatus in Saadati's thesis. This matter of specific vs. subspecific recognition for gunni is, of course, a judgment to be made by the author, but the only difference between gunni and bipunctatus (Berg's literature description) is the scaleless vs. scaled keel--a character we find to be variable in alburnoid fishes. Our Tigres basin specimens (identified as A. bipunctatus) have 6-8 gill rakers, 41-50 l.l. scales, 8 branched dorsal rays, 11-12 branched anal rays, and 8 ventral rays.

More detailed discussion on the taxonomy and distribution of Alburnoides and on the type locality of gunni would be desirable.

Most European literature treats Alburnoides as part of Alburnus. Berg recognized three genera of alburnoid fishes--Alburnus, Chalcalburnus and Alburnoides. These groups do represent three natural phylogenies but the generic distinctions used by Berg--morphology of pharyngeal teeth and of the keel is not as clear-cut as stated by Berg. A conservative course would be to recognize three subgenera of the genus Alburnus.

The type locality of gunni is the Kor River or Neyriz Lake basin. The Neyriz basin is contiguous with the Tigres basin in the west and its fish fauna

is little differentiated from the nearest relatives in the Tigres. We could find no trenchant differences in Chalcalburnus mossulensis, Varichorhinus macrolepis and Noemacheilus persa from the Neyriz basin and from the Tigres basin. Thus it is likely that A. gunni (or A. bipunctatus) is found in both the Tigres basin and Neyriz basin and is not endemic to the Neyriz basin. As mentioned, it appears that all of the fishes of the Neyriz basin have been derived from the Tigres basin (by headwater cutting of the Kor River) in relatively recent geological times. A problem, based on the literature would be: From whence came the ancestral Alburnoides to invade the Neyriz basin? There has never been a published account of Alburnoides from the entire Tigres-Euphrates system. This is due, however, to a lack of detailed collections and studies of the fish fauna of this large drainage area. We have identified five species of Alburnoides in the Tigres basin (three from our Iranian collections and two from Turkish specimens in the Zoological Museum of the University of Hamburg). One of these Tigres species, which, as mentioned above, appears very similar to A. gunni, we have identified as A. bipunctatus. The other four clearly represent undescribed species.

A few additional notes on Alburnoides taxonomy and distribution pertinent to the manuscript may be in order. A. bipunctatus occurs in the Namak Lake basin and the Tedzhan-Murgab basin in Iran, but the most surprising find was a specimen we have identified as A. bipunctatus from the Helmand (Hamum) basin in Iran. From Lake Rezaiyeh (Urmia) basin, Berg listed A. bipunctatus, but our Rezaiyeh specimens of Alburnoides represent an undescribed species (9-10 branched anal rays). The Rezaiyeh basin species named Abramis urmianus by Günther and revised to Alburnoides urmianus by Berg actually is in the genus Acanthalburnus. Until now, Acanthalburnus has been considered a monotypic genus for A. microlepis of the Kura-Araks drainage.

We consider Alburmus iblis, A. megacephalus and A. schejtan described from the Neyriz basin as synonyms of Chalcalburnus mossulensis. A. caudimacula is Chalcalburnus caudimacula and evidently is endemic to the Mond River basin. A. doriae of Shiraz is unknown but may be the same species as Alburnus maculatus (a primary homonym) of the Zayanderud basin.

make 2 carbons

Comments on manuscript by Brian Coad describing a new species of alburnoides from Iran.

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A. ganni, a new species of cyprinid fish from southern Iran (Cypriniformes: Cyprinidae)

Brian W. Coad

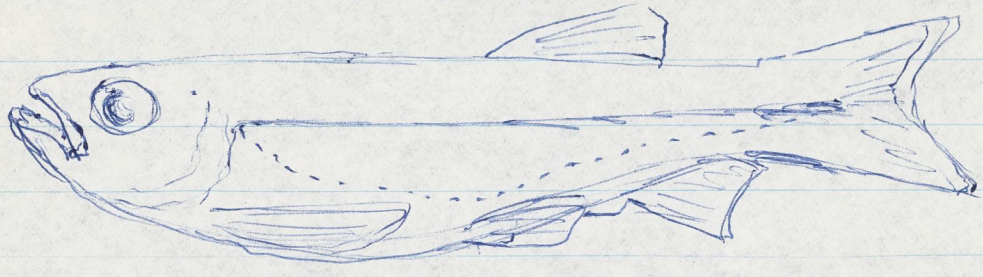
last 2 rays in D & A. fins were counted separately even when proximally close together. Counts of radii from 3 scales of each specimen made, scales taken fm. caudal peduncle above l. l. & incl. primary & 2nd ary radii

Types: Source & stream of qanat, at Naqsh-e-Rostam Pulvar R. drainage, 30° 00' N, 52° 54' E. Oct. 6, 76,

Holotype + 16♂ paratype - 34-92 mm. T.L.

keel covered w/ scales, extend over base of anal fin

D 9 A 13 V 8 ll 46 9 above



2-5-4,2 one ~ 2,4-4,0 hooked, not serrated

gut shape simple "S" peritoneum light white-~~gray~~-light brown w/ black spots, seldom dark brown

bases of lower fins red-orange; orange band above anal fin, faint orange, yellow spots along flanks.

	A. b. b.	A. b. e.	A. ganni	A. oblongus	A. tzenatus
l. l.	41-51	44-54	41-49	50-54	37-43
naken	7-9	8	6-9	11-13	17-18
keel	scaleless	scaleless	scaled	scaled	scaled or not
D	7-8(9)	7-8(9)	(8)~~9~~	8	7-9
A	12-17	16	13	11	9-12
V.	9	8	8	8	?8
Vert.	38-40	?	40-41	?	38-39

select few to send specimens to Coad.

Example of how to make comparisons (corrections to Saadati's work)

ALBURNUS DORIAE DE FILIPPI, 1864 A SYNONYM OF LEUCISCUS LEPIDUS (HECKEL, 1843)(OSTEICHTHYES: CYPRINIDAE).

Alburnus doriae was described by De Filippi (1864) from Shiraz in southern Iran based on material collected by the Marchese Giacomo Doria in 1862. The original description viz. "Rassomigliante all Alb. iblis Hek, ma distinto per squame assai più grande. Squam 53 8/4 D. 3-7 A. 3-9" leaves something to be desired and a subsequent description (De Filippi, 1865:360) hardly amplifies it. Tortonese (1934) briefly re-described the holotype from the Museo di Torino and gave the first illustration of this species. He later (Tortonese, 1940) indicated some other type material was to be found in the Museo Civico di Genova.

This species has not been collected again and its identity has remained unresolved (Berg, 1949; Saadati, 1977; Armantrout, 1980). Through the courtesy of Dr. Orsetta Elter, Conservatore, Museo ed Istituto di Zoologia Sistematico della Università, Torino and Dr. Gianna Arbocco, Conservatore, Museo Civico di Storia Naturale "Giacomo Doria", Genova, I have been able to re-examine the type material of A. doriae consisting of, respectively, the holotype (catalogue number P1110(720)) and six specimens listed as lecto-paratypes (catalogue number C.E. 9102). Five of the lectotypes have an evident, naked, ventral keel and lateral line scale counts greater than 66. These specimens do not conform with descriptions of A. doriae. They belong to the genus Chalcalburnus, the Iranian species of which are in need

generic character (not Leuciscus)

but

of revision.

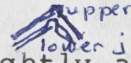
The following observations are based, therefore, on the holotype and the second lectotype, both of which are females. The range, mean (or mode for meristic characters) for 50 Leuciscus lepidus from central Iran are given in parentheses.

comparing type specimens of "Alburnus doriae" w/ 50 specimens of L. leuciscus lepidus

Dorsal fin rays III7 (III7-9, III8), anal fin rays III10 (III9-12, III10), ventral fin rays I8 (I7-9, I8), pectoral fin rays I15 (I13-16, I15), caudal fin branched rays 16-17 (17), total gill rakers on first arch 15 (12-18, 15), pharyngeal teeth (in lectotype) 2,5-4,2 (2,5-4,2), lateral line scales to hypural fold 46-50 (45-55, 51), scales above lateral line 9 (9-12, 9), scales below lateral line 4 (4-6, 4), scales between lateral line and ventral fin origin 4 (4-6, 4), predorsal scale rows 23-25 (20-28, 25), caudal peduncle scale rows 14 (13-17, 15), total vertebrae 41 (41-43, 41).

Head length (HL) in standard length (SL) 4.1-4.5 (3.7-4.6, 4.1), head depth in SL 5.7-5.8 (4.1-5.9, 5.3), body depth in SL 3.9-4.0 (3.6-4.5, 3.9), predorsal length in SL 1.8 (1.7-1.9, 1.8), preventral length in SL 2.2 (1.9-2.2, 2.1), snout length in HL 3.7-4.2 (3.5-4.2, 3.9), orbit diameter in HL 3.3-3.5 (3.1-3.8, 3.5), interorbital width in HL 3.1-3.4 (2.9-3.7, 3.3), postorbital length in HL 2.0-2.1 (1.9-2.3, 2.1), longest dorsal fin ray length in HL 1.4 (1.2-1.7, 1.5), longest anal fin ray length in HL 1.8-2.1 (1.6-2.3, 2.0), orbit diameter in interorbital width 0.9-1.0 (0.8-1.3, 1.1), orbit diameter in postorbital length 1.6-1.7 (1.3-1.9, 1.6), caudal peduncle depth in caudal peduncle length 2.1 (1.8-2.3, 2.1), pectoral fin length in

pectoral-ventral fin origin distance 1.2-1.5 (1.0-1.7, 1.3), ventral fin length in ventral-anal fin origin distance 1.5 (1.0-1.6, 1.3).



The lower jaw projects slightly and bears a symphysial knob which fits into a depression on the upper jaw. The mouth is oblique and extends to a level with the anterior eye margin. The opercular membrane is attached to the isthmus at a level between the posterior eye margin and the anterior margin of the vertical ramus of the preopercle. The dorsal fin origin lies behind a level with the ventral fin origin. The dorsal and anal fin margins are rounded to truncate. The caudal fin is moderately forked. Scales are regularly arranged, the lateral line is moderately decurved and complete, a ventral fin axillary scale is present, a sheath of scales surrounds the anal papilla and the bases of the anterior rays of the anal fin, and scales bear radii on both the anterior and posterior fields. There is no naked, ventral keel. The intestine is a simple S-shape, the peritoneum is silvery-brown, pharyngeal teeth are hooked with obvious serrations below the hook, and gill rakers are close together and short to moderate in length. The specimens are bleached but flanks are silvery and the back brown. Light melanophores are found on dorsal and caudal fin rays and membranes and on or near pectoral fin rays. The anal and ventral fins are hyaline.

This description agrees with that of De Filippi (1864, 1865) except that my lateral line scale counts are lower (probably attributable to different counting methods) and anal fin branched rays are definitely 10 as opposed to the 9 reported by De Filippi.

As noted above Alburnus doriae has not been re-collected despite recent field work in the Shiraz area and examination of museum specimens by R. J. Behnke (see Saadati, 1977), Armantrout (1980), P. G. Bianco (pers. comm. 1981) and my own collections during a three-year residence in Shiraz (1976-1979). The locality for all Giacomo Doria's freshwater collections in southern Iran is given as Shiraz but he travelled from Tehran to Shiraz and it is suggested here that he collected some of his specimens, including A. doriae, on the journey south.

In all respects, save branched dorsal fin ray number, A. doriae agrees with Leuciscus lepidus (Heckel, 1843), a species known from the Tigris River basin in Iran and the Qom and Esfahan endorheic drainage basins on the route between Tehran and Shiraz. A. doriae has a branched dorsal fin ray number of 7 based on the two available specimens examined by De Filippi. Leuciscus lepidus shows a strong mode of 8 for this character with rarer counts of 7 (5%) or 9 (2%). This variation is not considered sufficient to warrant distinction of A. doriae from L. lepidus.

Material of Leuciscus lepidus examined:-

NMC (National Museums of Canada) 79-0244, 3 specimens, 60.6-74.6 mm SL, Shahrestan-e Bakhtiari va Chahar Mahall, spring at Shahr Kord, 32*19'N, 50*52'E, 9 June 1977, B. W. Coad and Sh. Mansoorabadi. NMC 79-0245, 125 (26 specimens used for counts and measurements), 31.6-100.6 mm SL, Shahrestan-e Bakhtiari va Chahar Mahall, stream in Ab-e

Shalamzar drainage, 32*08´N, 50*51´E, 9 June 1977, B. W. Coad and Sh. Mansoorabadi. NMC 79-0249, 1, 106.7 mm SL, Esfahan Province, stream at Dizaj, 31*55´N, 51*30´E, 9 June 1977, B. W. Coad and Sh. Mansoorabadi. NMC 79-0250, 28 (5), 26.2-88.4 mm SL, Esfahan Province, stream tributary to Pelasegan River, 33*01´N, 50*29´E, 10 June 1977, B. W. Coad and Sh. Mansoorabadi. NMC 79-0251, 134 (9), 22.1-83.7 mm SL, Esfahan Province, stream tributary to Pelasegan River, 32*59´N, 50*26´E, 10 June 1977, B. W. Coad and Sh. Mansoorabadi. Saadati´s specimens:- 15 (6), 55.6-84.0 mm SL, Esfahan Province, "Paherahneh" qanat, 100 km east of Esfahan, ca. 32*43´N, 52*40´E, 29 November 1974, R. J. Behnke.

I am grateful to the Research Council of Pahlavi (now Shiraz) University, Shiraz, Iran for grants 35-A5-149-172 and 37-AS-251-238 which funded field work. I would like to thank drivers and field assistants who made collections possible, Dr. Bahman Kholdebarin, former Chairman, Biology Department, Pahlavi University, for arranging field trips, and Drs. R. J. Behnke, Orsetta Elter and Gianna Arbocco for loan of specimens.

BRIAN W. COAD

Ichthyology Section,

National Museum of Natural Sciences,

Ottawa, Ontario, Canada. K1A 0M8.

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GARRA PERSICA BERG, 1913, A VALID SPECIES OF CYPRINID FISH FROM SOUTH-EASTERN IRAN

by

Brian W. COAD (1)

RÉSUMÉ. – La validité de *Garra persica*, un cyprinidé retrouvé dans les provinces du Baluchistan et d'Hormozdgan dans le sud-est de l'Iran, est réaffirmée. Cette espèce était considérée comme synonyme de *Garra rufa* (Heckel). On donne une description fondée sur des exemplaires provenant de la localité-type ainsi que sur du matériel comparatif couvrant l'aire de répartition de l'espèce, qui est étendue plus de 500 km vers l'ouest jusqu'aux drainages du golfe Persique.

SUMMARY. – The validity of *Garra persica*, a cyprinid fish from the provinces of Baluchestan and Hormozdgan in southeastern Iran, is reaffirmed. This species has been regarded as a synonym of *Garra rufa* (Heckel). A description is given based on topotypes and comparative material from the whole range of species which is extended over 500 km westward to Persian Gulf drainages.

Garra persica was briefly described as a new species by Berg (1913) from seven specimens collected by N.A. Zarudnyi in south-eastern Iran. A more detailed description was given by Berg (1914) based on the same material but a holotype was not designated. The seven specimens were identified incorrectly as *Discognathus lamta* (Hamilton, 1822) by Nikolsky (1899). Six of the specimens were listed as from the Bampur River, Baluchestan in Nikolsky (1899) and Berg (1913, 1914) but Berg (1949) cited ten specimens as the type-series from this locality under the same collection number, possibly an error. The seventh specimen was collected at Kiabad in the Zirkuh region of eastern Khorasan. This locality is obscure but may be near Zir-e Kuh, a mountain at 32°48'N, 59°50'E West of the Sistan basin as Zarudnyi's (1898) itinerary indicates he was en route to Sistan on the collection date given by Nikolsky (1899) and Berg (1913) for the specimen. *Garra persica* has not been recollected in this area.

Menon (1964), in a monograph on the genus *Garra*, placed *G. persica* in the synonymy of *G. rufa obtusa* (Heckel, 1843). Saadati (1977) provisionally recognised *G. persica* as a valid species. Saadati's two specimens and a specimen from the Oregon State University, Corvallis collections examined by Armantrout (1980) differ in a number of respects from the material collected by me, particularly in scale counts, and are excluded from the present description. Saadati (1977) and Armantrout (1980) incorrectly regard the specimen from Zirkuh as the holotype but Berg's specimens are syntypes (Berg, 1949).

(1) Ichthyology Section, National Museum of Natural Sciences, Ottawa, Ontario, Canada, KIA OM8.

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The description given below is based on 12 small recently collected specimens from the type-locality and comparative material from the provinces of Hormozdgan and eastern Fars comprising 110 specimens thus extending the distribution of *G. persica* westwards to include the basins of rivers draining to the eastern Persian Gulf at the Straits of Hormoz (see Coad, 1982 for map).

Dorsal fin rays IV-7 ; anal fin rays III-4 (3 specimens), III-5 (9) ; ventral fin rays I-6 (1), I-7 (11) ; pectoral fin rays I-12 (1), I-13 (6), I-14 (4) (one specimen too small to count accurately) ; branched caudal fin rays 15 (1), 16 (10), 17 (1) ; lateral line scales to hypural fold 29 (2), 30 (1), 31 (1), 32 (2), 33 (2), 34 (2), 35 (2) ; scales above lateral line 4 (7), 5 (5) ; scales below lateral line 4 (12) ; scales between lateral line and ventral fin 3 (1), 4 (11) ; predorsal rows 11 (1), 12 (2), 13 (2), 14 (7) ; scales around caudal peduncle 12 (11), 13 (1) ; total vertebrae including urostylar centrum 34 (9), 35 (3) ; gill rakers on whole first arch 15 (in 6 specimens) ; pharyngeal teeth 2, 4, 5-5, 4, 2 (in 5 specimens).

Head length in standard length 3.7 - 4.0 (mean 3.8), body depth in standard length 4.6 - 5.2 (4.9), head depth in standard length 5.6 - 6.1 (5.9), predorsal length in standard length 1.9 - 2.1 (2.0), pectoral fin length in standard length 3.8 - 4.9 (4.4), prepelvic length in standard length 1.8 - 1.9 (1.9), head width in head length 1.4 - 1.5 (1.4), head depth in head length 1.5 - 1.6 (1.5), snout length in head length 2.3 - 2.7 (2.4), orbit diameter in head length 3.4 - 3.9 (3.6), interorbital width in head length 2.3 - 2.6 (2.5), caudal peduncle length in head length 1.4 - 1.8 (1.6), mouth width in head length, 2.4 - 3.2 (2.7), orbit diameter in interorbital width, 1.3 - 1.7 (1.4), disc length in head length 2.7 - 4.1 (3.3), disc width in head width 1.4 - 2.0 (1.6), disc length in disc width 1.4 - 1.5 (1.4), caudal peduncle depth in caudal peduncle length 1.1 - 1.7 (1.4), pectoral fin length in pectoral - ventral fin distance 1.1 - 1.6 (1.3), ventral fin length in ventral - anal fin distance 1.1 - 1.4 (1.2), anal papilla to anal fin length in ventral - anal fin distance 6.3 - 8.7 (7.3), length longest anal fin ray in longest dorsal fin ray 1.1 - 1.4 (1.2), and anal papilla to anal fin length as a percentage of ventral - anal fin distance 11.5 - 15.8 (13.9).

Dorsal fin origin well in advance of ventral fin origin. Caudal fin moderately forked, dorsal fin emarginate and anal fin rounded. Gill membranes are attached to isthmus at or behind a level with the preopercular bone. Peritoneum black and gut greatly coiled. The pharyngeal teeth bear flattened crowns. Disc and rostral fold greatly papillose. Centre of disc not as papillose as margins. Rostral fold margin weakly fringed. Scales regularly arranged except on anterior portion of isthmus where absent. Pelvic axillary scale present but not always well developed. Radii numerous on all fields, focus broken up into a network of lines. Tuberculate males have a transverse depression anterior to the nostrils. Tubercles are found between the eye and nostril, around the margins of the transverse depression, below the nostril and very weakly on anterior head surface between the eyes. Not developed elsewhere.

There is a large dark spot at or just below the beginning of the lateral line on the flank behind the postero-dorsal corner of the operculum. In life this spot has a dark blue tinge. The bases of the pectoral fins are also tinged blue. The flanks are orange-brown and the fins pink. In preserved specimens there are elongate blotches lining the posterior half of each dorsal fin membrane and fading dorsally. In some fish these blotches occupy the whole membrane and are developed dorsally. Ventrally there is a gap between these blotches and 3-5 bars which originate at the posterior edge of the base of branched ray three and succeeding rays, and extend dorsally across the ray and then along the ray and the membrane to the gap. These bars are much more heavily pigmented than the dorsal blotches. The pigmentation on the caudal fin varies with the individual. Some are blotched irregularly on both rays and membranes, in others there is a trace of a band in mid-fin extending from the dorsal to the ventral margin following the posterior outline of the fin, while others have pigment heavily concentrated only in the mid-fin clear of the margins. The ventral fin has little or no pigment and the anal fin has a very few irregular light blotches on both rays and membranes. The pectoral fin is pigmented near the base dorsally with some pigment on anterior rays and membranes.

This species is clearly distinguished from other *Garra* s.s. of Iran seen by me in having a mode of 7, as opposed to 8, branched rays in the dorsal fin and a mode of 16 branched rays in the caudal fin as opposed to 17. Comparative material of *G. persica* from Persian Gulf and Hamun- e Jaz Murian drainages had 6 dorsal fin branched rays in 2 fish, 7 (106), or 8 (1) (one specimen excluded because fin was abnormally developed) and 15 branched rays in the caudal fin in 6 fish, 16 (97), 17 (3) or 18 (1) (three specimens damaged).

Material examined. – All specimens examined are deposited at the National Museum of Natural Sciences, National Museums of Canada, Ottawa (NMC) and further details are on file. From the type-locality : NMC 79-0312, 10 specimens, 26.6 - 35.6 mm standard length (SL), Rampur River, 8 km west of Iranshahr, 27°11'N, 60°36'E, Baluchestan ; 1 December 1977, B.W. Coad, A. Tofangdar and A. Shirazi. NMC 79-0315, 23.8 mm SL, Rampur River, 2 km north of Karvandar, 27°51'N, 60°46'E, Baluchestan ; 1 December 1977, B.W. Coad, A. Tofangdar and Shirazi. NMC 79-0324, 29.6 mm SL, Rampur River at Qasemabad, 27°11'N, 60°22'E, Baluchestan ; 4 December 1977, B.W. Coad, A. Tofangdar and A. Shirazi.

Comparative material from Hormozdgan and Baluchestan : NMC 79-0138 (1 specimen), 27°32'N, 54°58 1/2'E ; NMC 79-0139 (1), ca. 27°25 1/2'N, 54°59'E ; NMC 79-0144 (1), 27°09 1/2'N, 57°04'E ; NMC 79-0145 (4), 26°55'N, 57°01 1/2'E ; NMC 79-0149 (7), 27°36'N, 56°14'E ; NMC 79-0152 (1), 28°09'N, 55°43'E ; NMC 79-0178 (25), 27°36'N, 56°15'E ; NMC 79-0180 (1), 27°19'N, 56°17 1/2'E ; NMC 79-0181 (1), 27°17 1/2'N, 56°03 1/2'E ; NMC 79-0186 (8), 27°24 1/2'N, ca. 56° 25'E ; NMC 79-0187 (9), 27°23 1/2'N, 56°26'E ; NMC 79-329 (2), 27°02'N, 61°20'E ; NMC 79-0411 (1), 27°24'N, 57°12'E ; NMC 79-0412 (9), 27°30'N, 57°34'E ; NMC 79-0416 (39), 27°27'N, 56°18'E.

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CONCLUSION

Avec ces nouvelles collections, la connaissance des Cyprinodontidés ivoiriens a notablement progressé. Il a été possible de préciser les distributions des différentes espèces en fonction des contraintes biogéographiques et de proposer une nomenclature à peu près satisfaisante.

Il reste un besoin impérieux de matériel vivant de manière à entreprendre l'étude des caryotypes, des croisements jusqu'en F3 vérifiés par des caryotypes sur les hybrides et de la variabilité des types de coloration, le tout permettant de mieux connaître les relations interspécifiques et surtout les rapports des espèces ivoiriennes avec les autres groupes évolutifs en particulier chez les Procatopodinés.

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A CONTRIBUTION TO THE KNOWLEDGE OF THE CYPRINIDAE OF IRAN (PISCES, CYPRINIFORMES) (3)

by

Pier Giorgio BIANCO (1) and Petru BANARESCU (2)

ABSTRACT.– A total amount of 23 species and subspecies, mainly from southern Iran, are described. Among them, there is a new species and three new subspecies. *Schizocypris altidorsalis*, from Seistan, is the third species of the genus. *Chondrostoma cyri orientalis*, from Pulwar River (Kor River basin) near Persepolis belong, apparently, to the *nasus* group. *Capoeta capoeta intermedia*, from Mand and Hablehrud rivers, is intermediate between *C.c. umbla* and *C.c. macrolepis*. *Capoeta barroisi mandica* is another new subspecies from Mand River, Besides, almost all other species deserve some remarks concerning their systematic status.

RESUME.– Une collection de 23 espèces et sous-espèces provenant surtout du sud de l'Iran est décrite dans ce travail. Parmi elles, les auteurs décrivent une nouvelle espèce et trois nouvelles sous-espèces. *Schizocypris altidorsalis*, provenant de Seistan, est la troisième espèce du genre. *Chondrostoma cyri orientalis*, de la rivière Pulwar (bassin du Kor) près de Persépolis, appartient, semble-t-il, au groupe *nasus*. *Capoeta intermedia*, des rivières Mand et Hablehrud, est intermédiaire entre *C. c. umbla* et *C. c. macrolepis*. *Capoeta barroisi mandica* est une autre nouvelle sous-espèce provenant de la rivière Mand. Presque toutes les autres espèces citées permettent de fournir des compléments d'information sur leur statut systématique.

The first author made a zoological trip in several areas of Iran during the months June-July 1975 and May-June 1976 collecting fish specimens from localities illustrated in Tab. I. Further fish specimens were collected by Prof. Augusto Vigna (Zoological Institute of Rome) from the outskirts of Zabol, Seistan Province, SE Iran on November 1977.

This paper deals only with Cyprinidae collected during the above mentioned trips ; this family, the largest in the fish fauna of the world (Nelson, 1976) and, undoubtedly the largest in the fresh waters of the Holoarctic and Sino-Indian regions, is represented in the collection under study by a total amount of 23 species and subspecies, among which there are a new species and three new subspecies, while almost all other species deserve some remarks concerning their systematic status. The collection is mainly represented by fishes collected from the southern areas of Iran and it is but natural that it includes only a small part of the rather rich and incompletely known Cyprinid fauna of Iran.

(1) Istituto di Zoologia dell'Università di L'Aquila, Italy.
(2) Institutul de Stiinte Biologice, Bucuresti, Romania.

(3) Contribution n° 92, Researches on Near East Faunas, Institute of Zoology, Roma University, CNR Grant n° 74.00279.04.

Tab. I. Collecting localities of Cyprinidae in Iran during two (1975 and 1976) Italian Zoological expeditions. Temperature in parenthesis are from banks, the others from the middle of the rivers ; h = altitude ; S = salinity.

Rivers	Locality	Date	h (m)	T (°C)	pH	S ‰
Trib. to Araxes	Maku	29/6/1975	1300	18	7.5	–
Qezel-owzan	Mivaneh	30/6/1975	1250	27	8.0	–
Qom	Qom	6/7/1975	950	33	8.0	–
Pulwar	Persepolis	8/7/1975	1800	21 (17)	8.2	–
Mand	Akbar	10/7/1975	1600	24 (18)	–	–
Mand	Dasht-e-Arzhan	11/7/1975	1900	23 (17)	8.5	–
Hablehrud	Borazjan	14/7/1975	100	30	8.2	–
Mand	Dasht-e-Arzhan	25/5/1976	1900	18 (16)	–	–
Mand	Akbar	27/5/1976	1450	23 (16)	7.3	0.7
Hablehrud	Borazjan	28/5/1976	170	25 (28)	7.6	2.5
Pulwar	Persepolis	30/5/1976	1800	21	8.0	0.5
Springs of Kul River	Darab	1/6/1976	1750	23	7.5	0.2
Qom	Qom	5/6/1976	950	23	8.3	3.5

Barilius mesopotamicus (Berg, 1932)

Hablehrud River, southern Iran, Persian Gulf drainage, near Borazjan, 28.5.1976, P. Bianco and S. Zerunian coll., 4 spec. 43.2-49.0 mm standard length (SL), two are deposited in first author's collection (I.Z.A.) cat. number 7858 and two in the Institute of Biological Sciences, Bucarest (I.S.B.B.) uncatalogued.

This species was described by Berg (1932), from Tigris River near the border between Turkey and Iran, after a single specimen Z.I.A.N. 23955, 36.0 mm SL. The second author examined the type specimen in Leningrad. It has : D 3/8, A 2/13, an incomplete lateral line, a single pair of barbels (the rostral), pharyngeal teeth on two rows. The four Hablehrud specimens are similar to the holotype of *mesopotamicus* in all respects, except the lateral line that is complete. Doubts could therefore be raised about the identity of the Hablehrud specimens. But we obtained five other specimens from the upper Tigris in Turkey, e.g. near the type-locality, collected by Mr. A. Kelle in Kiyarbakir and deposited in I.S.B.B. These are identical to the Hablehrud specimens and have complete lateral line, with 47-53 scales. It seems quite improbable that two distinct species, similar in all respects, but one with incomplete and one with complete lateral line, occur sympatrically in the upper Tigris River. We, therefore, consider that the length of the lateral line is subject to individual variation and there is a single species, with apparently no distinct subspecies, that extends from the Tigris to Hablehrud River.

Doubts were raised concerning the generical position of this species by G.J. Howes in his valuable paper on the anatomy and phylogeny of Bariliinae minnows (1980) : he considers that *mesopotamicus* does not belong to *Barilius* and that it shares apomorph characters with some species presently assigned to *Leucaspius*.

We have no possibility to study the osteology of this species. Yet we found a single external character in which it differs from the other *Barilius* : pharyngeal teeth on two rows. It resembles several other *Barilius* in having barbels, a low lateral line, rather broad suborbitals, transversal stripes, very similar to those in some species such as *B. vagra*. *Leucaspius*, actually includes a single species, the central european *L. delineatus*. This species has a quite short lateral line running on the middle of the sides, no barbels, no stripes, three circum-anal papillae. None of these characters occurs in *mesopotamicus*. Several other species from southern Europa and the Near East, included by some earlier authors within *Leucaspius* (some of them within *Rutilus*), actually represent a distinct genus, *Pseudophoxinus* (= *Phoxinellus* auct. *nec* Heckel) (Trewavas, 1971) ; these have a deeper body, darkened body sides (but no lateral stripes), a blackish peritoneum, pharyngeal teeth on a single row, short dorsal and anal fins, no barbels, complete or incomplete lateral line running on the middle of the side.

Hence the species *mesopotamicus* may be generically distinct from the true South-Asian *Barilius*, but we cannot accept it is closer either with *Leucaspius* or with *Pseudophoxinus*.

Leuciscus cephalus orientalis Nordmann, 1840

Qom River, inner drainage from northern Iran, near Qom town, 6/7/1975, P. Bianco coll., three spec. 109-111 mm SL (two I.Z.A. 7815 and one I.S.B.B. uncat.).

D 3/8 ; A 2/8-9 ; LL 43-44

The species *L. cephalus* has a wide range throughout most of Europe, Anatolia, the Tigris-Euphrat system, Transcaucasia and northern Iran (Caspian Sea basin and inner drainages). Several subspecies are recognized, but the differences between them are slight and there is no critical revision of them. According to Berg (1912, 1949 a, 1949 b) the populations from West Asia and the northern slope of Caucasus represent a distinct subspecies, that differs from the central european nominal subspecies in having a dark stripe on the operculum and statistically fewer scales and anal rays, but with overlap of extreme values.

L.c. cephalus : A 3/ (8) 9 (10), LL (43) 44-46 (47)

L.c. orientalis : A 3/ (7) 8 (9), LL (38) 41-46 (47)

The few specimens from Qom River basin (and others from upper Tigris) have the formula indicated by Berg as typical for *orientalis*, while those from the Danube River in Romania have usually 44-46 scales in lateral line, but eight, rarely nine or ten branched anal rays.

These few data actually suggest the subspecifical independence of *orientalis*, but a statistical study on much more specimens is necessary in order to decide this problem.

Chalcalburnus mossulensis (Heckel, 1843)

Pulwar River, inner drainage east of Shiraz, near Persepolis, 30/5/1976 and 8/7/1975, 111 spec. 48-147 mm SL, I.Z.A. 7818 ; Mand River near Dasht E Arzhan, 25/5/1976, 47 spec. 38-78 mm SL, I.Z.A. 7895 ; Mand River near Akbar, 27/5/1976, 13 spec. 51-118 mm SL, I.Z.A. 7819 ; springs of a tributary of Kul River near Darab, 1/6/1976, 2 spec. 92 and 111 mm SL ; I.Z.A. 788. All collected by P, Bianco and S. Zerunian.

This species was described from Tigris River at Mossul under the name *Alburnus mossulensis* ; it was later on assigned to *Chalcalburnus* (Berg, 1933, 1949 b), a genus that differs from *Alburnus* above all in having the postventral keel partially covered by scales, usually fewer anal rays, more scales and a thicker body. Four species are presently ascribed to *Chalcalburnus :*

– *chalcoides* (Güldenstädt), including several subspecies in the basins of the Black, Caspian, Aral and Egean seas;

– *tarichi* (Pallas) in Lake Van, eastern Turkey ;

– *sellal* (Heckel) in western Syria (Orontes and Kueik Rivers) ;

– *mossulensis* (Heckel) in the Tigris-Euphrat basin. Berg (1949 b) believes that three nominal species described from lake Niris, southern Iran, are synonyms of *mossulensis.*

The three last-named species have blackish peritoneum, *Chalcoides* a silvery one.

The comparision of our numerous specimens from the three river basins in Iran with the few available specimens from the upper Tigris in Turkey (not far from Mossul, the type locality) and with data by other authors, reveals a wide range of variation for three important characters : number of branched rays in the anal fin, number of scales in lateral line and gill rakers. We found following values in the Iranian specimens and in the available upper Tigris ones :

	A (branch.)	LL	G.R.
upper Tigris	11-12 (11.75)	69-80 (74.2)	11-15 (14.5)
Pulwar River	10-12 (11.24)	66-82 (75.98)	12-16 (13.82)
Mand R. (Dasht.)	10-12 (10.89)	61-74 (68.29)	12-14 (12.91)
Mand R. (Akbar)	10-12 (11.00)	65-72 (68.00)	12-14 (12.50)
Kul R. springs	10-12 (11.00)	65-72 (68.00)	12-13 (12.50)

Those data demonstate there is a more or less gradual decrease of the number of anal rays, scales and gill rakers from the north-west to the south-east. The Pulwar River (Kor R. basin) specimens are intermediate in respect of the number of anal rays and gill rakers (but not of scales) between those from the upper Tigris and from the Mand and Kul basins, being much closer to the Tigris specimens. One is justified to include the Pulwar River population within the same subspecies as the Tigris-Euphrat specimens, and to separate those from Mand and Kul basins in a distinct subspecies. There are four available specific names based on specimens belonging to *Ch. mossulensis* in a wide sense : *Alburnus capito* Heckel, 1843 (type locality : Kurdistan, e.g. Tigris basin) ; *A. iblis* Heckel, 1846 ; *A. schejtan* Heckel, 1846 ; *A. megacephalus* Heckel 1846. These three are from Kor River basin near Persepolis (Heckel, 1846 gives as locality Araxes R. bei Persepolis ; this is surely an older name for Pulwar R., a tributary of Kor, the only river that flows in the immediate vicinity of Persepolis ; it has nothing to do with the true Araxes, the main tributary of Kura River, Caspian Sea basin).

Hence the four available names refer to localities within the range of the same subspecies ; basins of Tigris and Kor rivers. A new subspecifical name has to be proposed for populations from the basins of Mand and Kul rivers. Yet we think it is better not yet to describe a new subspecies, since the problem of the general geographical variation of *Ch. mossulensis* is far from being clear : Berg (1949 b) gives for specimens from the Tigris, scale counts within a much wider range of variation as found by us (65-84) and for specimens from the Euphrat 76-86 ; *Ch. sellal* from Orontes and Kueik rivers, usually considered as a distinct species, has A 3/13, LL 66-70, G.R. ± 14 according to Berg (1949 b), but in seven specimens from Kueik R., Aleppo (M.N.H.N. A 3905 and A 3906) the second author found LL 71-77 (-84), G.R. 10-14, e.g. values within the range of variation of *mossulensis.* Besides this, the temperature of the water is quite variable in the upper reach of the three Iranian rivers where the species was collected and it is known that the number of vertebrae and scales, sometimes depend of the environmental conditions being not determined genetically.

Alburnoides bipunctatus eichwaldi (de Filippi, 1863)

Small tributary to Araxes River near Maku, northern Iran, 29/6/1975, 4 specimens 43-70 mm SL, I.Z.A. 7814, P. Bianco coll.

D 3/8 ; A 3/12 (13) ; LL 45-48 ; G.B. 7.

This subspecies, spread in rivers flowing in southern Caspian Sea, Euphrat River in Anatolia, Karadj River and lake Rezaiyeh, differs from the nominal subspecies in having less branched rays in the anal fin, and a much deeper body, head and caudal peduncle.

Carasobarbus luteus (Heckel, 1843)

Springs of a tributary of Kul River near Darab, southern Iran, 9 spec. 67-326 mm SL, 9 I.Z.A. 8168 and 3 I.S.B.B. uncat., 1/6/1976, P. Bianco and S. Zerunian coll.

D 4/10 ; A 3/6 ; LL (26) 28-30 (31) ; G.R. 8-12 ; circumpeduncular scales 12.

We compared these specimens with twelve (I.S.B.B. uncat.) from the Tigris-Euphrat basin and found no significant differences between them.

Chondrostoma cyri orientalis subsp. nova (Fig. 1A and 2A)

Holotype : I.Z.A. 8170, 92 mm SL, Pulwar River near Persepolis, 30/5/1976, P. Bianco and S. Zerunian coll. Paratypes : I.Z.A. 7833, 75 spec. 34-90 mm SL, (ten more specimens are deposited in I.S.B.B. uncat.), same locality as holotype.

Derivatio nominis. - *orientalis* = eastern, this being the easternmost form of the genus *Chondrostoma.*

Diagnosis.— A *Chondrostoma* with transverse mouth, usually 8 branched rays in the dorsal, nine or ten in the anal fin, 47-55 scales in lateral line, 23-28 gill rakers.

Description. — D 3/(7) 8 (9), M = 7.98 ; A 2/ 9 (10), M = 9.31 ; LL 47-55. M = 50.8 ; G.R. 22-28, M = 25.3 ; Phar. teeth 6-6, more rarely 6-5 or 7-5.

In % of SL : body depth 24.1-29.2 (M = 25.9) ; least depth 9.9-12.3 (11.0) ; caudal peduncle length 18.1-23.7 (20.0) ; predorsal distance 47.7-52.0 (50.0) ; preventral distance 51.2-54.5 (52.3) ; pectoral-ventral distance 27.7-29.3 (28.7) ; preanal distance 68.5-71.7 (69.7) ; length of pectorals 17.6-22.1 (19.1) ; length of pelvics 18.7-22.5 (20.4) ; height of dorsal 21.7-23.9 (22.6) ; base of dorsal 12.0-14.4 (13.1) ; height of anal 14.0-16.0 (14.9) ; base of anal 10.9-13.1 (11.8) ; head length 22.7-27.7 (24.3) ; length of snout 5.5-7.1 (6.2) ; eye diameter 5.4-6.6 (6.0).

In % of head length : snout 23.8-27.6 (26.2) ; eye diameter 23.8-26.1 (25.0). (Values in ten specimens, 69-92 mm SL, M = 82 mm).

Comparative remarks and discussion.— The genus *Chondrostoma* includes 11 species ranging throughout Europe, Anatolia, Transcaucasia, western Syria and the Tigris-Euphrat basin. Berg (1932), who includes within the genus a few more species, that later on prove to be either synonyms, hybrids *(Ch. reiseri)* or to belong to other genera, ascribes them to two distinct groups : *nasus*, characterized by an almost transversal mouth, and *toxostoma* with a strongly arched mouth.

Actually the differences between the two groups are not as sharp as accepted by Berg. Only two species have a strongly arched mouth : *phoxinus*, from Adriatic slope of the Balkan Peninsula and *toxostoma* from south France (with a distinct subspecies, *arrigonis*, on the Atlantic slope of Spain and Portugal). In some other species the mouth is not as arched as in these two species, but neither as transverse as in *nasus : kneri*, from the west Balkan, the two Italian species *genei* (usually included within the *toxostoma* group) and *soetta* (included in the *nasus* group) and apparently *cyri* from the Kura-Araxes basin in Transcaucasia. More difficulties raise from the fact that in the young the mouth is usually more arched than in adult specimens and the character is also subject to some individual variability (and also it cannot be measured).

The Pulwar River (Kor R. basin) form, here described as new, is represented in our collections only by young specimens (largest 92,0 mm SL), in which the mouth is slightly arched (but it may be transverse in adult specimens).

Two species range in the proximity of Kor River basin : *regium* in the Tigris-Euphrat, western Syria and most of Anatolia, that has a transversal mouth, and *cyri* in the Kura-Araxes basin, in which is rather slightly arched. The formulae of these two species are :

regium : D 3/(8) 9 ; A 2/(9) 10-11 ; LL 62-69 ; G.R. 24-31 ; Phar. teeth 7-7; 6-7 or, rarely, 6-5.

cyri : D 3/(7) 8 (9) ; A 2/(8) 9 (10) ; LL 52-64 ; G.R. 21-24 ; Phar. teeth 5-5, 6-5 or 6-6.

By comparing these figures with those of *orientalis*, it becomes evident that the last-named is more similar to *cyri* in respect of number of dorsal and anal rays, scales, to a certain degree of pharyngeal teeth formula, too, being intermediate in respect of the number of gill rakers. We therefore, consider it closer to *Ch. cyri* and include in it, as a new subspecies, within the last named.

Crossocheilus latius diplocheilus (Heckel, 1838)

Synonyms : *Barbus diplocheilus* Heckel, 1838 (Indus drainage, Kashmeer) ; *Crossocheilus latius punjabensis* Mukerji, 1934 (Indus drainage, Punjab) ; *Discognathus adiscus* Annandale, 1919 (Seistan, Iran).

Nahr-taheri, near Zabol, Seistan, 16 spec. 39-41 mm SL, I.S.B.B. uncat., 263 spec. 29-60 mm SL, I.Z.A. 7840, 1/10/1977 Prof. A. Vigna coll. ; Rud-Sistan, near Zabol, Seistan, 35 spec. 35-78 mm SL, I.Z.A. 7820, 10/1977 A. Vigna coll.

The species *C. latius* has a wide range over whole North India-Pakistan, also ranging in parts of Central India and of Afghanistan extending west to Seistan Province in Iran. It is presently accepted by most authors that there are two subspecies in North India : the nominal one in the Gange-Brahmaputra basin, characterized by 39-42 scales in lateral line, and *diplocheilus* (= *punjabensis)* in the Indus River basin, with 36-39 scales. The Seistan form was described as *adiscus ;* it has 35-39 scales (usually 36) ; Berg (1949 b) considers it a distinct species that differs from *diplocheilus* in having rostral barbels and quite reduced papillae on the lower lip. Actually several *diplocheilus* specimens have rostral barbels too and we found no differences between the specimens from the Indus basin, Afghanistan (Arghandab R., U.S.N.M. 182278) and Seistan in respect of the development of the lower lip papillae. Since the number of scales is practically the same, we do not find any reason for recognizing *adiscus* as a distinct species or subspecies.

Karaman (1971) considers *D. adiscus* to be a subspecies of *Tylognathus*

elegans, for which he raised the new genus *Hemigarra* ; it seems he had no available *adiscus* specimens, since he mentions none. We examined several syntypes of *T. elegans* and found they actually represent a distinct genus, for which the name *Hemigarra* Karaman is justified ; but *adiscus* differs strongly from it, being a typical *Crossocheilus*.

Garra rufa crenulata (Heckel, 1844)

Hablehrud River, near Borazjan, 10 spec. 39-88 mm SL, I.S.B.B. uncat., 7 spec. 41-60 mm SL, I.Z.A. 7860, 14/7/1975 and 28/5/1976, P. Bianco and S. Zerunian coll. Mand River near Akbar, 5 spec. 39-66 mm SL, I.S.B.B. uncat., 4 spec. 39-68 mm SL, I.Z.A. 7861, 10/7/1975 and 27/5/1976, P. Bianco and S. Zerunian coll.

D 4/8 ; LL 29-34 ; G.R. 15-21

Heckel (1844) described *Discognathus crenulatus* from Shiraz. In the last revision of the genus (Menon, 1964) this nominal species is included within the synonymy of *G. rufa obtusa* (Heckel), a subspecies ranging in the Tigris-Euphrat basin. Actually the specimens from Hablehrud and Mand rivers differ from those of the Tigris-Euphrat basin in having much fewer scales and fewer gill rakers ; the second author examined 18 specimens from the Tigris-Euphrat and found 35-37, rarely 38 scales and 25-26, rarely 27 gill rakers. In respect of the number of scales, there are differences also between our Iranian specimens : those from Mand river have 29-32 (M = 30,7), those from Hablehrud 33-34 (M = 33). We also examined three specimens from the type locality, Shiraz (M.N.H.N. 1632, received from Vienna Museum, perhaps syntypes of *crenulata)* and found 31-34 scales, e.g. rather intermediate values between those in Hablehrud and Mand rivers. Possibly the populations from these rivers, all lying in the basin of the Persian Gulf, will be in the future ascribed to several subspecies ; presently we include them in *Garra rufa crenulata* that is evidently distinct from *G. r. obtusa*.

Garra rufa persica (Berg, 1913)

Darab, springs of Kul River, south-western Iran, 10 spec. 51-80 mm SL, I.S.B.B. uncat., 54 spec. 16-82 mm SL, I.Z.A. 7859, 1/6/1976, P. Bianco and S. Zerunian coll.

D 4/7 ; LL 33-37 ; G.R. 18-22.

The species was described by Berg (1913) after six specimens from Bampur River, southern Iran (type locality) and one from Sirkuch in the eastern Khorasan. The river Bampur, that ends in the desert, lies east and not far from the Kul River basin ; Khorassan Province is much more distant, in north-eastern Iran. The subspecies may have a wide range in the whole eastern half of Iran.

Berg (1913, 1914) mentions 7 branched rays and 35-37 scales in lateral line, e.g. the range of variation of the last character is wider in our specimens.

There are some differences in respect of body proportions between the data given by Berg in the original description (1913) and those we found in ten specimens (51-80 mm SL) from Darab.

	after Berg	Darab specimens
Body depth (% SL)	20.0-21.8	21.8-26.0 (23.5)
Least depth (% SL)	–	12.6-14.9 (13.8)
Head length (% SL)	22.1-23.2	23.8-25.4 (24.8)
Snout length (% head L)	–	34.2-46.0 (40.9)
Eye diameter (% head L)	24.4-25.0	15.0-22.8 (21.8)
Eye diameter (% interorbital distance)	± 55.5	30.2-55.0 (43.5)

All these meristic characters are partially allometric and since Berg does not mention the size of his specimens, no definitive conclusion can be derived from these data about the differences between the specimens from the two localities.

A further difference between the description and especially the illustration of *Garra rufa* by Berg (1914, fig. 93) from Bampur River and our Darab specimens, concerns the colour pattern : the Bampur specimens have a dark bar near the base of the caudal, that has about the same width and extends from the dorsal to the ventral side of the caudal peduncle, while in most Darab specimens there is a rather roundish, unsharply delimited spot (but in a few of them a quite unsharply delimited vertical bar, more or less similar to that in the illustration of the type specimen by Berg).

We consider these differences are too small to justify the separation of the Darab population in a distinct subspecies.

This is the only subspecies of the polytypic *G. rufa* that has seven branched dorsal rays, the three others (*rufa, obtusa, crenulata*) having but eight. One important character, that justifies the inclusion of *persica* within *rufa*, is the presence of blackish spots on the base of the dorsal fin ; according to Menon (1964) the only *Garra* species sharing this character are : *rufa* sensu lato, *barreimiae* from Oman, *tibanica* from the Arabian Peninsula, the six African species and a single south-east Asian one (*notata*, from Tenasserin and Burma).

Menon (1964) includes *persica* within the synonym of the Tigris-Euphrat subspecies *obtusa* ; actually *obtusa* constantly has eight branched dorsal rays, as against seven in *persica*.

Cyprinion tenuiradius Heckel, 1846)

Hablehrud River near Borazjan, 14 spec. 62-103 mm SL (6, I.S.B.B. uncat, and 8, I.Z.A. 7862), 14/7/1975 and 28/5/1976, P. Bianco and S. Zerunian coll.

D 4/13-15 ; A 3/7 ; LL 35-38 ; G.R. 12-16.

This species is very close to *Cyprinion macrostomum* from the upper Tigris-Euphrat and Kueik rivers, Aleppo, both species having a wide, transverse mouth, contrary of *C. kais*, that occurs sympatrically with *macrostomum* and was wrongly considered a synonym of the last named even by some recent authors such as Berg (1949) and Karaman (1971) and in which the mouth opening is much narrower and arched. In *tenuiradius* the dorsal spine is more slender than in *macrostomum* (yet this character cannot be measured) and there are fewer dorsal rays (the last named species has 40-44, rarely 39 or 45). Both may prove to be subspecies of a polytypic species ; but we hesitate in lumping them, since *tenuiradius* is said by Berg to occur also in the lower Tigris, and one must verify if an intergradation of the two forms takes place in the middle reach of this river, or if they occur sympatrically.

Cyprinion watsoni (Day, 1872)

Synonyms : *Scaphiodon watsoni* Day, 1872 (Indus basin in Sind and Punjab ; *S. irregulare* Day, 1872(Sind) ; *S. microphthalmus* Day, 1880 (Quetta, inner drainage of Baluchistan, west of the Indus basin) ; *Cirrhina afghana* Günther, 1881 (Kush, inner drainage of Afghanistan) ; *Cirrhina afghana* var. *nikolskii* Berg, 1905 (Bampur River, south-eastern Iran) ; *Cyprinion kirmanense* Nikolski, 1900 (Kirman, central Iran) ; *Scaphiodon macmahoni* Regan, 1905 (delta of Helmand River, inner drainage between Iran and Afghanistan) ; *S. baluchiorum* Iandrins, 1910 (Nihnir R., Indian Ocean slope of southern Iran) ; *S. watsoni belense* Zugmayer, 1912 (Jhelum, Indus drainage in Punjab) : *S. readingi* Hora 1923.

Darab, Kul River basin, 70 spec. 32-138 mm SL, I.Z.A. 7857 (6 I.S.B.B. uncat.), 1/6/1976, P. Bianco and S. Zerunian coll.

D 4/10-12 ; A 2/(6) 7 (8) ; LL 34-40 ; G.R. (9) 10-12 (13).

This is a quite variable species, the range of which includes the middle part of the Indus basin in Pakistan (and probably in India too), many rivers of the inner drainages of Afghanistan and Iran, the rivers flowing into the Indian Ocean (Persian Gulf) in Iran and also Oman (Muscat) in the eastern corner of the Arabia Peninsula. This is a quite variable species, in respect of many characters such as number of dorsal rays, scales, body proportions, extension of scales on the ventral side and on the back (there is a either sharply marked or a quite slight scaleless stripe), even colour pattern. Several subspecies, most of them connected by intergrades will surely be recognized in the future and most of the numerous names, listed above as synonyms, will be valid for the subspecies. In spite of the fact that the second author could study, besides the Darab specimens, several others from various areas in Iran, Afghanistan and Pakistan (including for example, syntypes of *Cirrhina afghana)*, it is not yet possible to delimite subspecies within the area extending from the Persian Gulf to the Indus basin ; the only well delimited subspecies is *C. watsoni muscatensis* (Boulenger, 1887) from Oman, south eastern Arabian Peninsula, that usually has 10, rarely 9 or 11 branched dorsal rays and 39-41 scales

in lateral line (in 11 examined specimens), as against 34-39 rarely up to 41 in the Middle East area (1).

The Darab population is characterized by : 10-12 branched dorsal rays (Mean : 11), 36-39, rarely 34 or 35 and 40 scales in lateral line (M. : 37.1) ; body depth in % SL 24.6-28.8 (M : 26.48) ; least depth in % SL 9.7-10.7 (10.4) ; caudal peduncle length in % SL 14.3-18.5 (16.9) ; predorsal distance % SL 46.4-52.3 (48.2) ; head length in % SL 24.8-27.6 (26.0) ; snout length in %SL 6.7-8.7 (8.1) ; eye diameter in %SL 5.1-6.3 (5.8).

Of all these characters, the most significant is the number of dorsal rays, that varies in the other populations within the subspecies between 9 and 11 and the average values between 9.1 (Khost, Afghanistan) and 10.2 (the syntypes of *C. afghana ;* Kushk, northern Afghanistan). In no other population did we find specimens with 12 branched dorsal rays, or average values higher than 10.2.

The number of scales varies, in most populations, between the same range as in the Darab population. Only a few specimens from Waziristan and from Pakistan, have 40 scales ; the average values vary between 36.5 (Kirman, probably inner drainage of SE Iran) and 37.9 (Waziristan, NW Pakistan).

Since none of the specific names, here included within the synonymies of the species, apply to specimens from Darab or other locality within Kul River basin, this population will be assigned in the future (when a comprehensive study of the variation of *C. watsoni* will be undertaken) to a new subspecies.

Capoeta capoeta aculeata (Valenciennes, 1844)

Qom River, near Qom, inner drainage of northern Iran, 13 spec. 72-102 mm SL, I.S.B.B. uncat, and 170 spec. 33-104 mm SL I.Z.A. 7887, 5/6/1976 and 6/7/1975, P. Bianco and S. Zerunian coll.

Other available specimens : syntypes of *Chondrostoma aculeatum*, M.N.H.N. 2357, Iran (with no mention of locality), 6 spec. 105-210 mm SL ; M.N.H.N. 1960. 611, no locality, 2 spec. 149 and 136 mm SL ; B.M.N.H. 1975.1.17 : 255-258, Isfahan, 2 spec. 166 and 132 mm SL.

D 4/8 (9) ; LL 37-45 ; G.R. 17-23 ; circumpeduncular scales 16, 18 or 20.

Mouth opening smaller than in other subspecies of the same species and quite slightly arched, almost straight. In about one third of the specimens there are two slightly marked longitudinal rows of small spots above the lateral line.

Among the numerous subspecies of *C. capoeta, aculeata* has the largest scales. Its range includes the inner drainage of northern Iran, south of Elburntz mountain, not reaching the Caspian Sea.

(1) Banister and Clarke (1975) record from Oman *C. microphthalmus* (Day) mentioning *muscatensis* as synonym and give 33-39 scales in lateral line.

Capoeta capoeta macrolepis (Heckel, 1846)

Pulwar River (Kor R. basin) near Persepolis, 19 spec. 48-177 mm SL, I.S.B.B. uncat. and 21 spec. 47-235 mm SL, I.Z.A. 7888, 30/5/1976, P. Bianco and S. Zerunian coll.

Other available specimens : Z.M.H. 2527, Karasu-Gamasia, southern eastern Iran, one 179 mm SL.

D 4/8 (9) ; LL 41-47 (M : 44.0) ; G.R. 18-20 (18.9) ; Circum-ped. scales 16 or 18.

There are five longitudinal series of small spots above and two below the lateral line, better marked in large-sized specimens. Our specimens are from the type-locality. The range of the subspecies seems to be restricted to Kor River Basin ; it is closed to *Capoeta capoeta aculeata,* differing from it in having smaller scales.

Capoeta capoeta gracilis (Keyserling, 1861)

Quezel-Ouzan River, tributary to Sefid-Rud near Mianeh (Caspian Sea drainage), 6 spec. 64-129 mm SL (3 deposited in I.S.B.B. uncat. and 3 I.Z.A. 7886), 30/6/1975 P. Bianco coll.

D 4/8 ; LL 53-59 ; G.R. 20-22 ; Circum-ped. scales 20. Body proportion expressed as % of SL : body depth 21.2-24 . least depth 10.1-11.9 ; caudal peduncle length 15.9-19.0 ; head length 23.8-26.5 ; eye diameter 4.7-6.6 ; mouth opening 6.7-8.5. Mouth large, transverse (almost straight). Colour darker than in other subspecies, no longitudinal rows of spots.

This is a variable subspecies, the range of which includes the southern slope of the Caspian Sea, between Sefid-Rud and Atrek, but not the Kura-Araxes drainage, where lives another subspecies, *C. capoeta capoeta* (Güldenstaedt), characterized by : LL 53-61 ; G.R. 18-23, colour lighter, mouth less arched and other body proportions.

Since its range includes several distinct river basins, *C.c. gracilis* is a variable subspecies. The above mentioned values refer to the Quezel-Ouzan specimens ; other available specimens, from other rivers, have : LL 48-53 (56), a deeper body, longer caudal peduncle, shorter head, smaller eye.

Capoeta capoeta intermedia subspecies nova (fig. 1B and 2B)

Holotype : I.Z.A. 7892, Mand River near Akbar, southern Iran, 92.5 mm SL ; paratypes, 13 specs. 68-86 mm SL I.S.B.B. uncat. and 62 specs. 36-87 mm SL, I.Z.A. 7893, same locality, 27/5/1976, P. Bianco and S. Zerunian coll.

Other specimens (not included as paratypes) : Hablehrud River near Borazjan, two specs. 90 and 103 mm SL. I.Z.A. 7894, 28/5/1976, P. Bianco and S. Zerunian coll.

Derivatio nominis.– intermedia : intermediate, the subspecies being intermediate between *C.c. umbla* and *C.c macrolepis.*

Diagnosis.– A subspecies of *C. capoeta,* intermediate between *C.c. umbla* and *C.c. macrolepis,* characterized by 62-70 scales in lateral line (M : 66.2), 19-24 gill rakers (M : 21.3), transversal mouth (but smaller than in *C.c. umbla*) and a rather light coloration.

D 4/8 ; LL 62-70 ; G.R. 19-24 ; Circum-ped. scales usually 26, rarely 24 or 28.

In larger specimens (73-92 mm SL) following body proportions expressed as in % of the SL : body depth 23.4-26.3 (M : 24.8) ; least depth 10.8-12.6 (11.7) ; caudal peduncle length 14.1-18.1 (16.6) ; predorsal distance 46.5-51.0 (49.8) ; preventral distance 53.0-56.0 (54.5) ; preanal distance 75.0-79.0 ; pectoral-ventral distance 26.8-33.0 (30.0) ; ventral-anal distance 22.6-26.3 (24.2) ; length of pectoral 18.6-22.2 (20.8) ; length of ventral 16.0-20.0 (18.3) ; height of dorsal 20.4-22.5 (21.2) , dorsal base length 15.2-20.6 (18.4) ; height of anal 15.1-19.0 (17.2) ; anal base length 7.5-8.7 (8.2) ; head length 24.8-26.7 (25.5) ; snout length 6.5-8.2 (7.4); eye diameter 4.8-6.6 (5.7) ; barbel length 3.6-5.3 (4.6). In % of head length : snout length 27.6-34.6 (31.8) ; eye diameter 19.6-24.5 (21.7) ; barbel length 14.3-20.0 (17.6) ; mouth opening 15.6-28.6. Postdorsal distance 100-122 % of the predorsal. Eye diameter 51.0-71.0 of interorbital width.

Colour apparently lighter, the margin of lateral scales not as darkened as in other subspecies (the specimens are not quite well preserved and we are not sure about this character).

Remarks.– This subspecies from Mand River, flowing into the Persian Gulf, is characterized by 62-70 scales in lateral line (M = 66.2), being intermediate between the subspecies *umbla* from the Tigris-Euphrat basin (LL 81-98 in the available specimens, 87-99 according to Karaman, 1969) and *macrolepis* from Kor River basin, inner drainage (LL 41-47). The two spec. from Hablehrud River, that lies slightly north-east from Mand River, have 61-65 scales in lateral line, being intermediate in this character slightly between *intermedia* and *macrolepis,* but evidently much closer to the first named. An intergradation between *macrolepis* and *umbla,* may occur in the rivers of south-western Iran flowing into the Persian Gulf between the lower Euphrat and Hablehrud River.

Following other subspecies of *Capoeta capoeta,* not represented in the collection under report, range in Iran :

C.c.umbla in the Tigris-Euphrat drainage : D 4/8-10 ; LL 81-99 ; G.R. 18-21 ; Circum-ped. scales 32, 34 or 36 ; mouth opening large and quite straight.

C.c. capoeta in the Kura-Araxes drainage : D 4/8 (9) ; LL 55-61 ; G.R. (16) 18-23 (24) ; Circum ped. scales 20 rarely 22 ; mouth large, almost straight or slightly arched ; colour light.

C.c. heratensis in Tedgen, Murgab and Artchman rivers which drain north-

western Afghanistan, Turkmenistan. The first-named also reaching the north-western corner of Iran ; D 4/ 8 ; LL (50-) 55-60 ; G.R. 19-21 ; circum-ped. scales 24 or 26 ; mouth slightly arched ; constantly two pairs of barbels.

Of the remaining five subspecies of *C. capoeta,* one, *steindachneri* Kessler, 1872 occurs in Syr and Amur Dar ja basins, e.g. east of the range of *heratensis,* from which it differs in having slightly fewer gill rakers (G.R. 17-21) and in having usually a single pair of barbels ; the four others range west of the Tigris-Euphrat.

There is apparently no subspecies of *C. capoeta* in Kul River basin, where another, very distinct species occurs : *C. saadi.*

Capoeta buhsei (Kessler, 1877)

Springs of Kul River basin near Darab, one spec. 86 mm SL, I.Z.A. 7889, 1/6/1976 P. Bianco and S. Zerunian coll.

Further available specimens were borrowed by various museums. Most of them are from inner drainage of northern Iran (near Teheran, Isfahan and Djodje), others from the vicinity of Kirman (e.g. north of Darab), e.g. all from the area including several inner drainages east of the rivers flowing into the Persian Gulf.

The species is characterized by : D 4/8 (9) ; LL 73-92 ; G.R. 11-19 ; mouth opening arched. In the single specimen from Darab : D 4/9 ; LL 76-79 ; G.R. 13 ; depth of the body 21.3 % of SL. The differences between the various populations of *C. buhsei,* in comparison with the closely related *C. saadi,* are given in tabl. II.

Capoeta saadi (Heckel, 1846)

Examined material : Pulwar River near Persepolis, 10 spec. 61-108 mm SL, I.S.B.B. uncat. and 24 spec. 44-122 mm SL, I.Z.A. 7882, 8/7/1975 and 30/5/1976 P. Bianco and S. Zerunian coll. ; Mand River near Akbar, 8 spec. 56-107 mm SL, I.S.B.B. uncat. and 21 spec. 31-78 mm SL. I.Z.A. 7884, 10/7/1975 and 27/5/1976, P. Bianco and S. Zerunian coll. ; Mand River near Dasht -e- Arzhan, 4 spec. 74-80 mm SL, I.S.B.B. uncat. and 7 spec, 63-105 mm SL, I.Z.A. 7883, 11/7/1975 and 25/5/1976, P. Bianco and S. Zerunian coll. ; springs of Kul River basin near Darab, one 72 mm SL, I.S.B.B. uncat, and 2 spec. 74 and 78 mm SL, I.Z.A. 7885, 1/6/1976 P. Bianco and S. Zerunian coll. Other available specimens : one syntype of *Scaphiodon saadi* R.M.N.H. 3166, 82 mm SL, Persepolis.

This is one of the least known species of the genus ; it is not mentioned in the revision of the genus by Karaman (1969) who had no specimen available. We had rather many specimens at our disposal, most from the type-locality (Persepolis, Pulwar River, Kor R. basin) ; this enabled us to point out its position within the genus.

This species is close to *C. buhsei,* having an arched mouth (as against transverse in most subspecies of *C. capoeta),* with slightly developped horny cover, feebly ossified dorsal spine and 13-17 gill rakers. The formula is :

D 4/8 (9) ; LL 53-76 ; G.R. 13-17 ; Circum-ped. scales 24-28.

Table II. Main characters of various populations of *Capoeta saadi* and *C. buhsei*

Spec.	Locality	n	LL	GR	Stand.length mm	Depth % st length	Least depth % st. length
Capoeta saadi	Kur R., Persep.	10	53-74 (65.5)	13-17 (14.5)	61.5-108.0	25.0-27.3 (26.4)	10.7-13.0 (11.68)
	Kur R., paratype	1	?	14	82.0	21.9	9.8
	Shur R., Shiraz	4	62-69 (65.3)	14-17 (15.0)	74.0-80.0	21.9-25.0 (23.17)	9.5-11.8 (10.9)
	Mand River	8	66-76 (69.5)	13-16 (14.3)	56.0-107.0	22.2-28.2 (24.4)	11.1-12.0 (11.6)
	Darab	3	63-69 (65.3)	13	72.-78.2	22.2-24.0 (23.2)	11.3-11-8 (11.5)
	Aucher Eloy	3	65-73 (67.6)	14-17 (15.5)	91.0-120.0	19.8-21.1 (20.3)	10.2-11.5 (10.86)
Capoeta buhsei	Darab	1	76-79 (77.5)	13	86.0	21.3	9.3
	Jupa. S. Kirman	6	73-82 (77.0)	12-16 (13.5)	95.0-153.0	18.4-25.8 (20.8)	8.7-9.8 (9.3)
	Isfahan	2	76-77 (76.5)	15-19 (17.5)	136.0-145.0	23.5-24.6 (24.01)	9.6-11.2 (10.42)
	Djodje	2	80-85 (82.5)	12-13 (12.5)	126.0-150.0	24.1-24.6 (24.35)	10.5-11.0 (10.75)
	Teheran	6	79-92 (84.65)	11-14 (13.0)	141.0-208.0	21.5-24.8 (22.97)	9.9-11.0 (10.63)
	Iran M.N.H.M.	9	70-80 (74.5)	12-15 (13.3)	92.0-177.0	18.9-23.4 (21.4)	9.6-11.2 (10.42)

Body proportions in % of SL : body depth 21.8-27.6 ; least depth 9.9-13.0 ; caudal peduncle lenght 14.5-18.0 ; predorsal distance 50.5-56.2 ; preventral distance 54.0-59.0 ; pectoral-ventral distance 27.6-34.4 ; ventral-anal distance 19.5-23.3 ; pectoral length 18.5-22.8 ; ventral length 14.6-20.3 ; dorsal height 16.3-21.1 ; head length 24.6-31.2 ; snout length 7.6-10.5 ; eye diameter 4.5-6.8 ; barbel length 4.8-7.6.

Table II shows the differences, in respect of number of scales, gill rakers, body depth and least body depth between the specimens of *C. buhsei* and *C. saadi* from all localities. One remarks how strong is the individual variability even within the same locality (e.g. number of scales in *C. saadi* from Pulwar River, Persepolis), even the intra-individual variability is strong (in some specimens there are up to five scales more on one body side than on the other).

In spite of this strong intraspecifical variability, the differences between the two species remain evident : *buhsei* has 70-92 scales in lateral line and 26-36 circum-ped. scales, *saadi* has 53-74 in lateral line and 24-28 circum-ped. scales ; besides this, the maximum and minimum body depth have both higher values in *saadi.* The ranges of both forms are rather representative : *buhsei* lives above all in the inner drainages lying east of the Persian Gulf slope, while *saadi* occurs mainly in the basin of the rivers flowing into the Persian Gulf (Mand and Kul R.) and also in Pulwar River (Kor River basin) near Persepolis, western part of the inner drainage close to the Persian Gulf slope ; yet both species occur sympatrically at least in one locality : Darab on Kul River, that flows into the Persian Gulf. From the four specimens collected in this locality, one is *buhsei* (the specimen has 79 scales on the right, 76 on the left sides, body depth 21.3 % of SL ; least depth 9.3 % of SL), three are *saadi* (they have LL 63-69 ; G.R. 13 ; body depth 22.1-24 % SL ; least depth 11.3-11.8 % SL). The difference is sharp and cannot be considered as representing individual variability. It seems evident there are two, reproductively isolated species.

The sympatrical occurrence of *buhsei* and *saadi* in Kul River basin, is an argument for considering them distinct species and not subspecies.

There are two more species of the group *buhsei* in Iran that are no represented in the collection under study : *fusca* Nikolski, 1897 from eastern Iran, characterized by D 4/7 ; LL 49-59 ; G.R. 13-17 ; Circum-ped. scales 20-24 ; body rather low (body depth 17.9-25.5 % of SL, M = 21.4 in the available specimens, mouth arched) and *gibbosa* Nikolski, 1897, in Korassan, with D 4/7 ; LL 44-45 ; G.R. 15-17 ; Circum-ped. scales 20, mouth arched.

Capoeta barroisi mandica subspecies nova (fig. 1C and 2C)

Holotype ; I.Z.A. 7890, 107 mm SL, Mand River near Dasht-e-Arzhan, 11/7/1975, P. Bianco coll. Paratypes : 5 spec. I.S.B.B. 3123 and 95 spec. I.Z.A. 7891, 34-86 mm SL, same locality, 25/5/1976, P. Bianco and S. Zerunian coll.

Derivatio nominis.– after type locality.

Diagnosis.– A subspecies of *C. barroisi* having usually eight branched dorsal rays, 61-68 scales in lateral line, 21-24 gill rakers and a transverse mouth.

D 4/8 (9) ; A 3/5 ; LL 61-68 ; G.R. 21-24 ; Circum-ped. scales 30 or 32.

Body proportion in % of the SL : body depth 24.2-27.3 ; least depth 11.9-13.4 ; caudal peduncle length 15.3-17.1 ; predorsal distance 50.0-54.5 ; preventral distance 51.5-58.0 ; preanal distance 69.5-77.0 ; pectoral-ventral distance 28.0-31.0 ; ventral-anal distance 22.0-26.2 ; length of pectoral 16.7-19.4 ; length of ventral 15.8-18.0 ; height of dorsal 15.8-21.3 ; length of dorsal base 15.0-17.9 ; height of anal 14,8-16.4 ; head length 23.4-29.5 ; length of snout 7.2-8.3 ; eye diameter 4.6-6.2 ; length of barbel 2.8-5.0 ; width of mouth 5.8-7.0. Snout 30,5-32.2 % of head ; eye diameter 20.0-22.5 % of head and 50.0-64.5 % of interorbital width. Mouth opening transverse, almost straight. Postdorsal distance usually larger than the predorsal : 100-108 % of this. Edge of dorsal fin almost straight.

Sides with brownish spots irregularly arranged in the upper half of the body.

Remarks.– The nominal subspecies *C. barroisi barroisi* ranges mainly in lake Orontes basin, western Syria, and also in the Tigris-Euphrat. The second author examined 15 specimens, 106-109 mm SL. They are characterized by : D 4/ (8) 9 ; LL 69-82 ; G.R. 27-31 ; body depth 21.2-28.4 % of SL ; edge of dorsal slightly concave, mouth transversal (as in the new subspecies). Another subspecies, *C. barroisi persica,* was described by Karaman (1969) after a single specimen from lake Zariwar at Mariwan, 120 km west of Sanandaj (north-western Iran). The second author examined the holotype of this species (Z.M.H. 4119) 183 mm SL. It has : D 4/ 8 ; LL 78-79 ; G.R. 18 ; Circum-ped. scales 44 ; mouth arched and somewhat larger spots than in our new subspecies.

Hence the specimens from Mand River basin differ either from the nominal subspecies or from *persica* in respect of number of scales and gill rakers. From *persica* also in having an almost straight mouth. One is justified to include them in a new subspecies.

Barbus cyclolepis cyri Filippi, 1865

Tributary of Araxes River near Maku (Caspian Sea drainage), 5 spec. 45-68 mm SL (2 I.S.B.B. uncat. and 3 I.Z.A. 7849), 19/6/1975, P. Bianco coll.

D 4/8 ; A 2/5 ; LL 59-64.

We consider *B. cyri* from the southern tributaries of the Caspian Sea, together with *B. lacerta* from Aleppo and the Tigris-Euphrat *B. escherichi* from northern Anatolia and western Transcaucasia, *B. euboicus* from Eubea island, off eastern Greece, *B. cyclolepis* from the south Bulgarian rivers, *B. tauricus* from Crimea and perhaps other *Barbus* from adjacent areas to be only subspecies of a rather widely ranging species that inhabited the former Aegean mainland. The differences between them are above all statistical.

Barbus miliaris Filippi, 1862

Qom River near Qom, inner drainage of northern Iran, 12 spec. 42-77 mm SL (6 I.S.B.B. uncat. and 6 I.Z.A. 7850), 5/6/1976 P. Bianco and S. Zerunian coll.

D 4/8 ; A. 2/5 ; LL 74-87.

This species is similar and probably closed related to *B. cyclolepis,* the colour pattern, shape of anal fin, etc. being the same. It differs from all available specimens of the various subspecies of *cyclolepis* not only in having more scales, but also a more pointed and longer snout. We therefore consider it for the moment as specifically distinct, althought it may be only a subspecies of *cyclolepis.*

Barbus capito (Güldenstaedt, 1773)

Qezel Owzan (Sefid-Rud R. basin), near Mivaneh, one spec. 60 mm SL, I.Z.A. 7854, 30/6/1975, P. Bianco coll.

D 4/8 ; A 2/5 ; LL 58-59.

Hablehrud River, drainage of Persian Gulf, one spec. 67 mm SL, I.Z.A. 7853, 28/5/1976 P. Bianco and S. Zerunian coll.

D 4/8 ; A 2/5 ; LL 52-52 ; G.R. 18.

Kul River basin at Darab, drainage of the Persian Gulf one spec. 125 mm SL, I.Z.A. 7851, 1/6/1976 P. Bianco and S. Zerunian coll.

D 4/8 ; A 2/5 ; LL 52 ; G.R. 19.

While the identity of the first specimen raises no doubts, the two others differ from *B. capito* as defined by Berg (1949 a) in having fewer scales in the lateral line. *B. capito*, that is native in southern part of the Caspian Sea drainage, has LL 58-65 (rarely 57 up to 68). In other respects (shape of snout and dorsal fin, colour pattern) the Hablehrud and Kul rivers specimens are similar to *B. capito*. They probably belong to a distinct, still undescribed subspecies, but we hesitate in describing it on only two specimens a single of which is fully mature and also having to few specimens of the true *B. capito*.

Schizopyge zarudny (Nikolski, 1897)

Synonyms : *Aspiostoma zarudny* Nikolski, 1897 (Seistan) ; *Schizothorax zarudny*, Berg, 1949 b : 406 (Seistan).

Rud-Seistan. 8 km from Zabol, 8 spec. 59-171 mm SL, I.Z.A. 7842 (3 are deposited in I.S.B.B. uncat.), 2/10/1977 Prof. Augusto Vigna coll.

D 4/8 ; A 2/5 ; LL 103 $\frac{26\text{-}30}{18\text{-}23}$ 113 ; G.R. 32-37 ; Phar. teeth 5.3.2-2.3.5, more rarely 5.3.2-1.3.5.

Body rather elongate, its depth 15.3-20.2 in % of SL ; least depth 7.4-10.5 ; caudal peduncle length 16.2-20.8 ; predorsal distance 49.0-52.5 ; preventral distance 50.0-55.5 ; pectoral-ventral distance 24.0-29.0 ; length of pectoral 16.7-17.6 ; length of ventral 14.6-16.3 ; height of dorsal 19.3-24.0 ; length of dorsal base 11.5-14.6 ; height of anal 14.9-15.4 ; length of head 26.6-27.1 ; length of snout 6.9-9.0 (and 27.2-29.3 % of head length) ; eye diameter 4.1-4.8 (and 15.2-18.2 of head length). Eye diameter 49.5-65.0 in % of interorbital width (values in seven large specimens 137-171 mm SL).

Remarks.— *Schizopyge* Heckel, 1843 (type species *Schizothorax curvifrons* Heckel, 1838 as designed by Bleeker, 1861), synonym *Schizothoraichthys*, Misra 1959, is the right generical name for the High Asian snow-barbs without suctorial discus. These species were listed until recently as *Schizothorax* Heckel 1838 ; but the type species of the last genus is *S. plagiostomus* Heckel, as fixed by Bleeker, 1861 ; this is a species with a suctorial disc, from the group usually recorded as *Oreinus* Mc Clelland, 1839. The last generical name becomes a synonym of *Schizothorax*.

Schizopyge is above all a High Asian genus, including quite few species in Iran. *S. zarudnyi* is the only one from Seistan ; *S. pelzami* occurs in the drainages of Tedjen and Murghab rivers (Turkmania and North-Iran) ; a subspecies of it *S.p. iranicus* was recently described from near Teheran (Karaman, 1969).

We have some hesitations in ascribing our specimens to *S. zarudnyi* as described by A. Nikolski, (1899) and Annandale & Hora (1920), since they have a much slenderer body. But they were captured in almost drying pools, full with starving fish, the low body being not the usual one.

Schizocypris altidorsalis species nova (fig. 1D)

Holotype : I.Z.A. 8169, 74 mm SL, Nahr-Taheri near Zabol, Seistan, 1/10/1977, A. Vigna coll. Paratypes : I.Z.A. 7841, 5 spec. 35-65 mm SL (further specimens I.S.B.B. 3136), locality as holotype ; I.Z.A. 7844, 3 spec. 68-73 mm SL, Rud-Sistan, 8 km. from Zabol, Seistan, 2/10/1977, A. Vigna coll. (further specimens I.S.B.B. 3137).

Derivatio nominis. - After *altus* : high and *dorsalis* : dorsal, because of the high dorsal fin.

Diagnosis.— a *Schizocypris* species with very high dorsal fin, provided with a strong denticulated spine, 87-96 scales in lateral line, most of the body scaled, except the anterior part of the breast. They are embedded on most of the body, except the caudal peduncle and the lateral line.

Description.— D 4/8 ; A 2/6 ; LL 87-96.

Body proportion in % of SL : Body depth 18.9-24.6 ; least depth 8.8-11 ; length of caudal peduncle 15.2-19.4 (16.9-21.4 if measured to the end of the skin and scales) ; predorsal distance 48.0-53.0 ; preventral distance 50.2-55.2 ; preanal distance 73.0-78.0 ; distance from pectoral to ventral insertion 25.4-30.2 ; distance from ventral to anal insertion 20.4-26.3 ; length of pectoral 18.8-22.0 ; length of ventral 14.8-19.4 ; height of dorsal 24.4-29.8 ; length of dorsal base 13.9-17.1 ; height of anal 17.6-20.2 ; length of head 24.3-27.2 ; length of snout 5.6-7.4 ; eye diameter 5.1-7.0. Snout 22.2-29.0 % of head length ; eye diameter 21.6-27.4 % of head and 56.0-73.0 % of interorbital width.

Mouth inferior, transverse, slightly arched ; lower lip developped only laterally ; lower jaw covered in some specimens by a horny sheat that probably periodically falls. No barbels.

Origin of dorsal, in some spec., equally distant between tip of snout and caudal base, in others nearer either snout tip or caudal. Origin of pelvics behind that of dorsal. Last simple ray of the dorsal strongly ossified, denticulated and long, the fin being much higher than in the two other species of the genus ; posterior edge of dorsal straight, almost vertical.

The scales cover most of the body, except the breast ; there is no scaleless stripe on the back, in front of the dorsal, as in *S. brucei*. They are well developped and imbricated on the caudal peduncle and also along lateral line ; on the other parts of the body, they are embedded and gradually become smaller ; on the ventral side they are excessively small and hardly visible ; in most specimens the limit between the scaled and the scaleless part of the belly, cannot be determined. A raw of enlarged scales surround the base of the anal and the anus.

Colour pattern.— In preserved specimens : upper half of body greyish, with very numerous brown spots ; lower half white-yellowish. Fins length greyish ; the brownish punctuations extend on the spinified rays and on the base of the dorsal, and also on the out caudal rays.

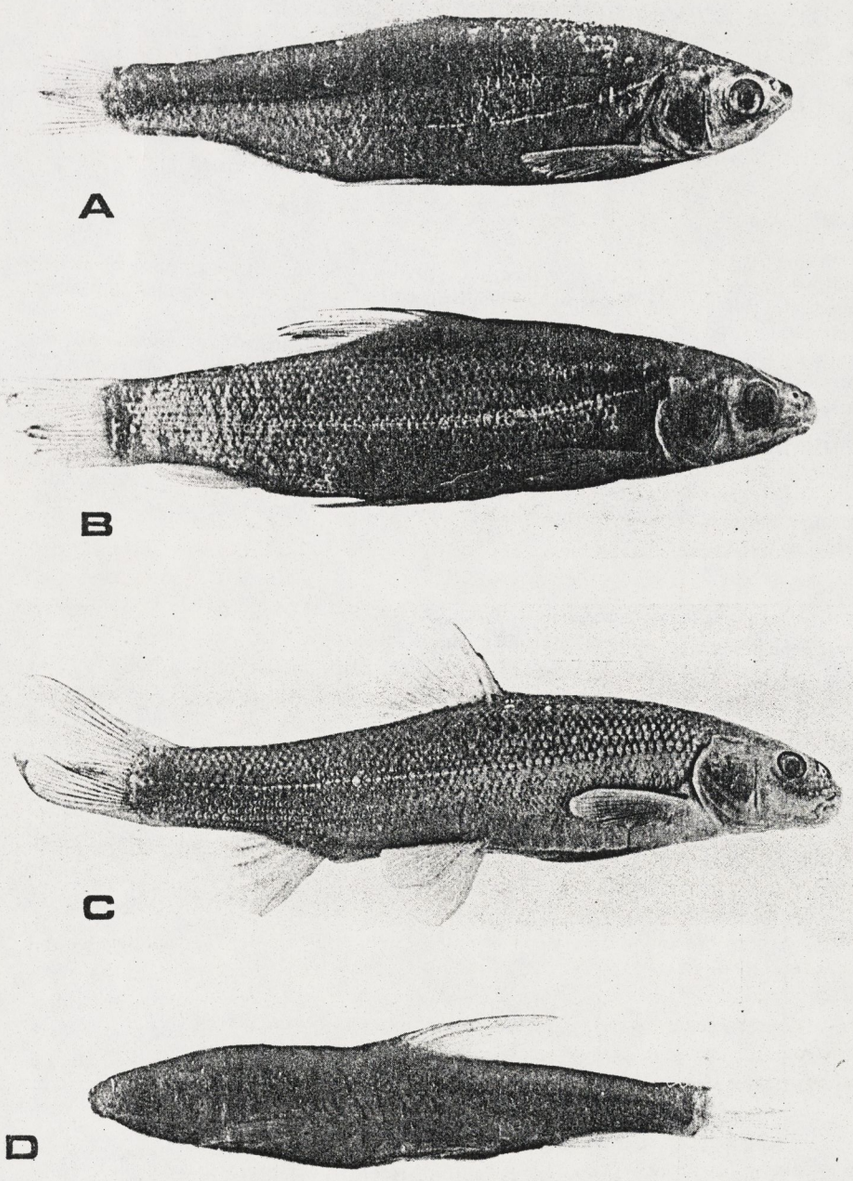

Fig. 1. Lateral view of new forms of Cyprinidae from Iran :
A *Chondrostoma cyri orientalis* n. ssp., holotype, 92 mm SL ;
B *Capoeta capoeta intermedia* n. ssp., holotype 92.5 mm SL ;
C *Capoeta barroisi mandica* n. ssp., holotype 107 mm SL ;
D *Schizocypris altidorsalis* n. sp., holotype 74 mm SL.

Comparative remarks.– The genus *Schizocypris* Regan, 1914 includes two more species : *S. brucei* Regan, 1914 form the basin of Gomal River, a right tributary of the Indus in the present day Pakistan (Baluchistan Province) and *S. ladigesi* Karaman 1969 from Kankai River, that belongs to the basin of Kabul River, another right tributary of the Indus.

The main differences between the three species are :

	brucei	*ladigesi*	*altidorsalis*
LL	74-81	78-88	87-96
Dorsal height %SL	19.4-20.4	14.7-19.5	24.4-29.8
Scales on body sides	embedded	well developped	well developped on caudal peduncle embedded on the rest of the body
Top of back in front of dorsal fin	naked	scaled	scaled

One remarks that the new species has more scales and a much higher dorsal fin than the two others (*S. ladigesi* being intermediate in respect of the first character, *S. brucei* in respect of the second), while in the disposition of the scales, *S. altidorsalis* is intermediate, being closer to *S. ladigesi*. The reduction of the scales being a derived character, *brucei* is in this respect the most apomorphic and *ladigesi* the most plesiomorphic species.

The genus *Schizocypris* belongs to the tribe Schizothoracini ; its main differential characters against the other genera of the tribe are : the inferior transversal mouth, absence of barbels, six (as against five) branched anal rays. While all other Schizothoracini genera, except the South Indian *Lepidopygopsis* have a High Asian range, *Schizocypris* is West Asian. Its three species have representative ranges : two inhabit distinct rivers in the western part of the Indus basin, *altidorsalis* occurs in the inner drainages of eastern Iran.

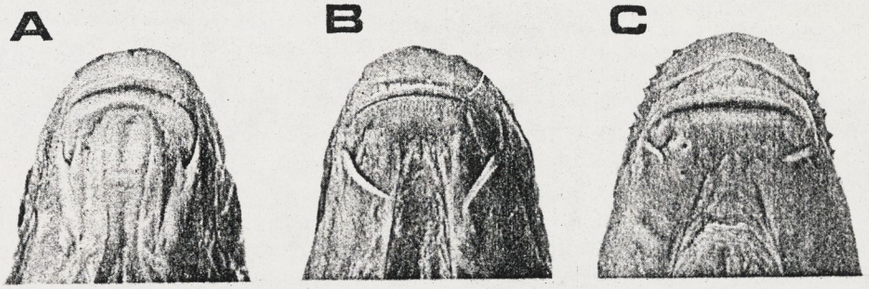

Fig. 2.– Mouth conformation of : A *Chondrostoma cyri orientalis* ; B *Capoeta capoeta intermedia* ; C *Capoeta barroisi mandica*. From holotypes.

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GARRA PERSICA BERG, 1913, A VALID SPECIES OF CYPRINID FISH FROM SOUTH-EASTERN IRAN

by

Brian W. COAD (1)

RÉSUMÉ. – La validité de *Garra persica*, un cyprinidé retrouvé dans les provinces du Baluchistan et d'Hormozdgan dans le sud-est de l'Iran, est réaffirmée. Cette espèce était considérée comme synonyme de *Garra rufa* (Heckel). On donne une description fondée sur des exemplaires provenant de la localité-type ainsi que sur du matériel comparatif couvrant l'aire de répartition de l'espèce, qui est étendue plus de 500 km vers l'ouest jusqu'aux drainages du golfe Persique.

SUMMARY. – The validity of *Garra persica*, a cyprinid fish from the provinces of Baluchestan and Hormozdgan in southeastern Iran, is reaffirmed. This species has been regarded as a synonym of *Garra rufa* (Heckel). A description is given based on topotypes and comparative material from the whole range of species which is extended over 500 km westward to Persian Gulf drainages.

Garra persica was briefly described as a new species by Berg (1913) from seven specimens collected by N.A. Zarudnyi in south-eastern Iran. A more detailed description was given by Berg (1914) based on the same material but a holotype was not designated. The seven specimens were identified incorrectly as *Discognathus lamta* (Hamilton, 1822) by Nikolsky (1899). Six of the specimens were listed as from the Bampur River, Baluchestan in Nikolsky (1899) and Berg (1913, 1914) but Berg (1949) cited ten specimens as the type-series from this locality under the same collection number, possibly an error. The seventh specimen was collected at Kiabad in the Zirkuh region of eastern Khorasan. This locality is obscure but may be near Zir-e Kuh, a mountain at 32°48'N, 59°50'E West of the Sistan basin as Zarudnyi's (1898) itinerary indicates he was en route to Sistan on the collection date given by Nikolsky (1899) and Berg (1913) for the specimen. *Garra persica* has not been recollected in this area.

Menon (1964), in a monograph on the genus *Garra*, placed *G. persica* in the synonymy of *G. rufa obtusa* (Heckel, 1843). Saadati (1977) provisionally recognised *G. persica* as a valid species. Saadati's two specimens and a specimen from the Oregon State University, Corvallis collections examined by Armantrout (1980) differ in a number of respects from the material collected by me, particularly in scale counts, and are excluded from the present description. Saadati (1977) and Armantrout (1980) incorrectly regard the specimen from Zirkuh as the holotype but Berg's specimens are syntypes (Berg, 1949).

(1) Ichthyology Section, National Museum of Natural Sciences, Ottawa, Ontario, Canada. KIA OM8.

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Brian W. Coad
Associate Curator of Fishes
National Museums of Canada
Musées nationaux du Canada

Ottawa, Canada
K1A 0M8

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Dr. R. J. Behnke,

Dept. of Fisheries and Wildlife Biology,
COLORADO STATE UNIVERSITY,
Fort Collins,

Colorado 80523

U.S.A.

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