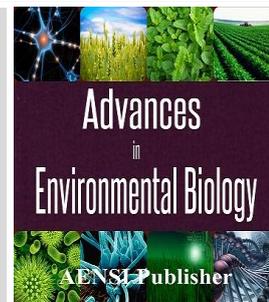




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## Comparison of Caudal Skeleton Between Three Populations of *Rutilus rutilus caspicus* from Southern Caspian Sea

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### ABSTRACT

This study was aimed to survey some osteological differences in caudal skeleton of *Rutilus rutilus caspicus* from southern Caspian Sea. totally 15 specimens of roach were caught from Bandar-e-Turkmen shore, Anzali wetland and Aras River. Fifteen fishes (Five specimens from each station) were cleared and stained using alcian blue and Alizarin red S. the hypural plate skeleton were imaged using an Epson v700 scanner equipped with Glycerin bath at 2400 dpi. The details of osteological structures were controlled using an MS5Leica stereomicroscope. Based on the present study the three studied population of *Rutilus* genus can be recognized based on: There are 5-6 (mode 6) hypurals in *R. r. caspicus* natio *kurensis* but 6 (100%) in other two populations, the rudimentary neural arch in *R. r. caspicus* is bifurcated but in others it is unifurcated. The rudimentary neural arch in *R. r. caspicus* natio *knipowitsch* is astute but fragile in *R. r. caspicus* natio *kurensis*. The epural in *R. r. caspicus* natio *knipowitsch* is more elongated and touching posterior border of the rudimentary neural arch but in other populations it placed apart from the rudimentary neural arch and there is a gap between them.

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### INTRODUCTION

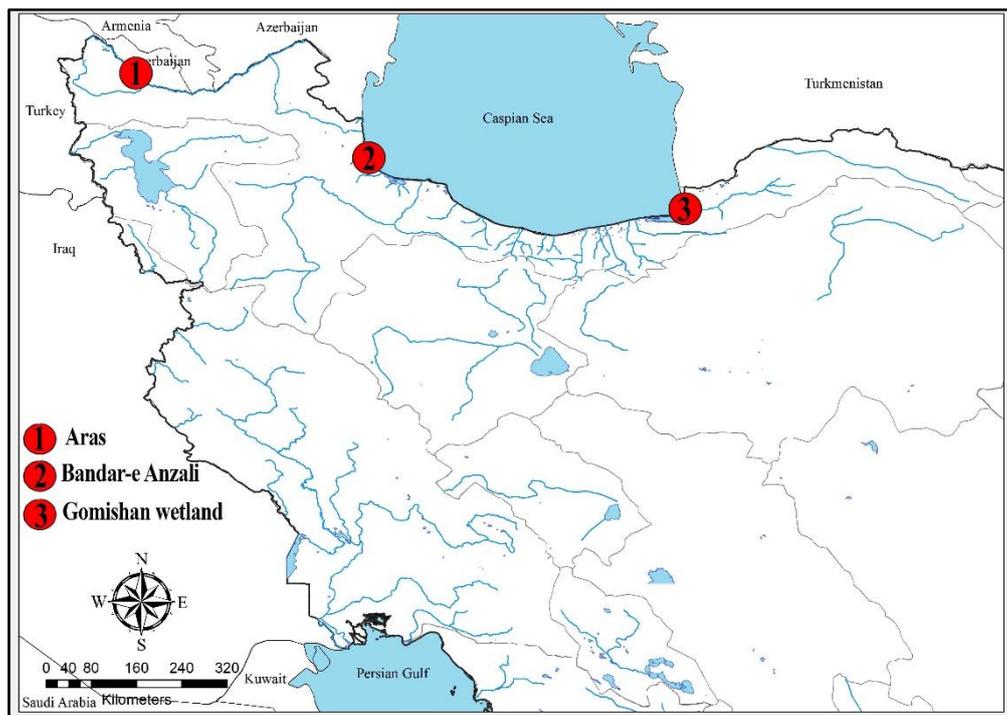
The Caspian roach (*Rutilus rutilus caspicus*) have a wide distribution in southern Caspian Sea [4] and showing morphological variation among populations [19,20,17,22]. Hence, the populations of this species are recognized as the morpho migratorius, perhaps a first steps toward speciation [11,4]. Various populations of this species considered as a distinct species i.e. *R. r. caspicus* with three varieties including the Astrakhan or Northern, Turkmenian (natio *knipowitschi*, Pravadin [26]) and Kura (natio *Kurensis*, Berg, [2]) Caspian roach based on morphometric and meristic characteristics [18,4].

The caudal complex is a complex of vertebral centra, vertebral accessories, and fin rays that have been modified during evolution. There are some osteological variations in external and internal anatomy of caudal complex skeleton among fishes [9]. It can provide a variety of useful information about swimming patterns [10] and fish phylogeny [13]. Skeleton in bony fishes had been ignored as a source of systematic characters until Monod [21] examined the caudal skeleton in a wide range of bony fishes and he prepared a coherent terminology. Schultze and Arratia [32] reaffirmed the value of caudal skeleton in the classification of bony fishes. Based on Various studies, there are some morphological differences among various populations of Caspian roach based on traditional morphometrics [19,20,17,22,26,27]. In addition, the molecular studies using microsatellite markers revealed controversial results [15,16,29], displaying a high gen flow and non-significant differences among the southern population of Caspian roach. Therefore, despite genetic similarities, the morphological differences may be considered as phenotype plasticity responding to various environmental conditions [17].

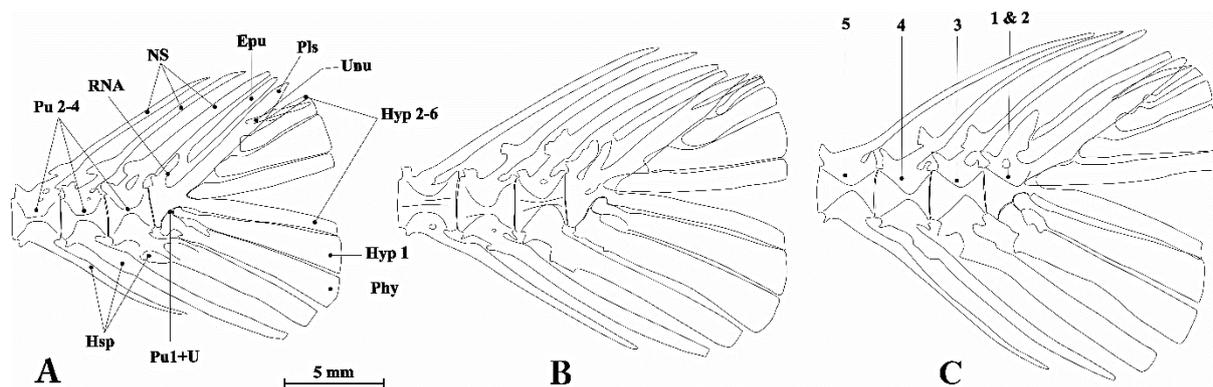
There is no osteological information on roaches. So the present study was done to evaluate the potential diversity in hypural complex of roach in southern Caspian Sea. This study was done to reveal some novel potential phylogenetic and taxonomic relationships among southern Caspian roaches.

## MATERIALS AND METHODS

For this study, 15 specimens of roach, including 5 samples of *R. rutilus caspicus* natio *knipowitsch* from Gomishan wetland in the south eastern Caspian sea, 5 samples of *R. rutilus caspicus* natio *kurensis* from Bandar-e Anzali and 5 samples of Aras *R.rutilus caspicus* were bought from the local fisherman (Figure 1). Fishes were fixed in 10% buffered formalin and transported to the laboratory. The fixative solution was replaced after 48 hours. The fish were cleaned and colored using [34] with some modifications. An Epson v700 scanner equipped of glycerin bath used for photographing the caudal complex at 2400 dpi resolution. The skeletal elements were identified using an MS5Leica stereomicroscope. The nomenclature of bones were flowed [30,6]. The skeletal elements were depicted using CorelDraw X5 software.



**Fig. 1:** Sampling stations in southern Caspian Sea (Iran).



**Fig. 2:** Caudal complexes of the roach populations (A) *R. r caspicus* natio *kurensis* (B) *R. r caspicus* (C) *R. r caspicus* natio *knipowitsch*. (1-5- Vertebrae 1 to 5; Epu- Epural; Hsp- Hemal spine; Hyp- Hypural; NS- Neural Spine; Phy- Parhypural; Pls- Pleurostyle; Pu- preural; Pu1+U- preural1+Urostyle; RNA- Rudimentary neural arch; Unu- Uroneural).

### Results:

In present study there are five vertebrae in caudal complex of *Rutilus*. In all specimens the last four vertebrae were directly supporting the caudal fin rays but the vertebrae 4 supporting the precurent caudal fin

rays (Figure 2). There are 5-6 (mode 6) hypurals in *R. r. caspicus natio kurensis* (Turkman population) but 6 (100%) in other two populations. The rudimentary neural arch is differs among populations, in *R. r. caspicus* it is biforkated and in others it is uniforkated. The rudimentary neural arch in *R. r. caspicus natio knipowitsch* is astute but fragile in *R. r. caspicus natio kurensis*. The epural in *R. r. caspicus natio knipowitsch* is more elongated and touching posterior border of the rudimentary neural arch but in other populations it placed apart from the rudimentary neural arch and there is a gap between them.

#### Discussion:

Caudal complex in cyprinid fishes includes the last four or five vertebrae of the vertebral column that support the caudal fin rays [7,24]. Presence of four hypurals in the upper lobe of caudal fin is common in Cyprinidae family and in the studied populations, the situation is the same. Presence of a thin uroneural along the pleurostyle is one of the homogenous features in all species of carp fishes [12]. The fish tail includes vertebral centra, vertebral accessories, and fin rays that have been modified through evolution to propel the fish forward in a linear fashion [9]. In early bony fishes, caudal fin made of a number of hypurals (enlarged blood thorns) supporting many main radius of caudal [7]. Epural (modified neural thorns) and the last blood thorn support the radius of small tail fin (procurrent). The hypural skeleton is phylogenetically important [8,25]. It may also be considered as tool to distinguish fish species [6]. Epurals are cartilages or perichondrally ossified bones found in the epaxial region of the caudal fins of actinopterygian fishes and their phylogeny and homology is under question [5]. Molids fishes considered as the most modern bony fishes due to their specialized osteological features of their caudal skeleton [13]. There are six hypurals in Cyprinid fishes that four of them placed on upper half of caudal plate [33,3]. Eastman [6] stated that in some fish species, the sixth hypural is present and it may be placed backward or fused to the fifth hypural. Irfan [12] noted that parhypural is an important element in caudal complex concerning to swimming ability. So the lack of differences in this character can be related to their similar need for swimming performance. Uroneural may have a protective role for the distal part of spinal cord and also it plays as helm [28]. Finally based on the present study it can be noted that the three studied population of *Rutilus* can be recognized based on: There are 5-6 (mode 6) hypurals in *R. r. caspicus natio kurensis* but 6 (100%) in other two populations, the rudimentary neural arch in *R. r. caspicus* is biforkated but in others it is uniforkated. The rudimentary neural arch in *R. r. caspicus natio knipowitsch* is astute but fragile in *R. r. caspicus natio kurensis*. The epural in *R. r. caspicus natio knipowitsch* is more elongated and touching posterior border of the rudimentary neural arch but in other populations it placed apart from the rudimentary neural arch and there is a gap between them.

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