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Morphological variation of longspine scraper (*Paracapoeta trutta*) in Iranian sub-basins of the Persian Gulf

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Introduction

The longspine scraper, *Paracapoeta trutta*, is found in the Quwayq, Orontes, and Persian Gulf basins including the Euphrates-Tigris River system, and Zohreh River in the countries of Iran, Turkey, Syria, and Iraq. This species inhabits a wide range of habitats, including streams, rivers, lakes, and wetlands. The longspine scraper size reaches up to 48 cm having small size scales, an inferior mouth transversed with a strong horny cover to the lower jaw, and an elongated gut with numerous anterior and posterior loops (Keivany et al., 2016).

Fish body shape is directly related to their nutritional, swimming, and reproductive characteristics (Mouludi-Saleh et al., 2020; Mouludi-Saleh and Keivany, 2018). Therefore, the study of morphological differences between populations of fish species is an important tool for understanding how morphological diversity, evolutionary biology, and diversity of organisms evolved (Seçer et al., 2020; Mouludi-Saleh et al., 2020). The morphology of an organism changes under the influence of environmental and habitat factors (Mouludi-Saleh et al., 2020) and is known as phenotypic plasticity. In addition, understanding morphological differences can be used as a tool for the degree of differentiation of populations, ecological adaptations, habitat selection, genetic diversity, and evaluation of the relationship between morphology and habitat factors (Radkhah et al., 2015; Abbasi et al., 2021). Therefore, this study aimed to investigate the morphological variation of *P. trutta* in seven populations in the Iranian sub-basins of the Persian Gulf basin.

Materials & Methods

A total of 161 specimens of Longspine scraper were sampled from seven populations in the Iranian sub-basins of the Persian Gulf basin, including Sirvan, Little Zab, Karun, Gamasiab, Zemkan, Godarkhosh, and Zohreh using cast-net and electrofishing device. The specimens were fixed in 10% buffered formalin. To extract morphological data in the geometric morphometric method, photographs were taken from the left side of the fish, and then 18 landmark points were digitized on their 2D images using tpsDig2 software. The landmark data was submitted to a generalized Procrustes analysis to remove non-shape data including scale, direction, and position. The landmark data were analyzed using Principal Components Analysis (PCA), Canonical Variate Analysis (CVA), Cluster Analysis (CA), and MANOVA to explore the patterns of variation and differences in their body shape. All multivariate analysis was computed using PAST software (Hammer et al., 2001). The consensus configuration of populations was visualized using the wireframe graphs in MorphoJ (Klingenberg, 1998) to compare their shape differences.

Results & discussion

The results of the Canonical Variate Analysis showed that Godarkhosh and Little Zab populations are separated from other populations. Also, MANOVA showed significant differences between the body shape of the studied populations (Wilks lambda = 0.01242, f = 4.184; P<1.668E-44). Based on the results of Mahalanobis distances between the studied populations, the maximum and minimum distances were found between the Zohreh and Godarkhosh populations (6.1016) and the Sirvan and Zemkan populations (2.3963), respectively. The cluster analysis of the studied populations based on body shape had a Copernicus coefficient of 0.93, which indicates the high correlation of the analysis. Based on the Cluster analysis, the populations of Gamasiab, Karun, Sirvan, Zemkan, and Zohreh were clustered together, and Godarkhosh and Little Zab in another one.

The results also showed the phenotypic plasticity of this species in adapting to different habitats in traits, including depth of head, trunk, and tail as well as head length, based on habitat conditions. The results also showed the differentiation of the body shape of different populations of longspine scraper in the Iranian sub-basins of the Persian Gulf using the geometric morphometric method, which indicates the high flexibility of this species to the environmental conditions of their habitats.

Conclusion

As a general conclusion, *P. trutta* can adapt to environmental conditions in different habitats due to phenotypic plasticity in traits, including head, trunk, tail depth, head length, and positions of the pelvic and pectoral fins. Therefore, the use of these morphological features as taxonomic characters can cause problems in their taxonomic studies. In addition, it is suggested that the populations of this species in each sub-basin be studied along with the effective environmental factors to better understand the effect of environmental parameters on their morphological changes.

Keywords: *Phenotypic plasticity, Cluster analysis, Morphometric, Mesopotamian scraper*

Declaration of conflict of interest

The authors declare that they have no conflicts of interest.