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Length-weight relationship and morphological studies in the Kashgarian loach *Triplophysa yarkandensis* (Day, 1877) from the Tarim River, Tarim River Basin, North-West China

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ABSTRACT

The Kashgarian loach *Triplophysa yarkandensis* is one of the rare freshwater species distributed in the Tarim River basin of Xinjiang Uygur Autonomous Region in north-west China. Biological information on this species is scarce. As a species caught in the traditional fisheries, the natural resources are nearly exhausted. Attempt to breed this species in captivity has not yet succeeded. The present study was undertaken to investigate selected biological aspects of the species. Truss morphometric measurements were used to assess the principal shape components of different sized *T. yarkandensis*. A total of 102 numbers of *T. yarkandensis* were collected from Alaer reach of Tarim River, Tarim River Basin. Wet weight (*Wt*) and body length (*BL*) were measured in the laboratory and the length-weight relationship was expressed as $Wt = 0.0594 \times BL^{2.1669}$. Our study provides first biological reference to this species in Alaer Reach of Tarim River and the results will provide fundamental information for resource assessment as well as for taking up further aquaculture practices of this species.

Keywords: Length-weight relationship, Morphometry, *Triplophysa yarkandensis*, Truss network

Introduction

Triplophysa yarkandensis (Day, 1877) belonging to the family cobitidae is one of the native freshwater species widely distributed in the Tarim River Basin. This is an important species in commercial fishery. The growth of *T. yarkandensis* is faster and the size is bigger as compared to other indigenous species of cobitidae family, in this area (Chen *et al.*, 2008). However, recent evidence indicates that the population of *T. yarkandensis* in the wild has declined dramatically in consequence to overfishing and the introduction of exotic species such as common carp and silver carp (Yuan, 1991; Feng, 1995). Though a series of studies have been conducted on this species (Ren *et al.*, 2004; Chen *et al.*, 2010), biological as well as ecological information on this species is scarce, and also the breeding of this species in artificial environment has not yet been successful.

The present study was undertaken recognising the need to gather information on selected biological aspects of *T. yarkandensis,* aimed at evolving strategies to conserve the natural resource of the species in Tarim River. The use of length-weight relationship of a fish species in fishery ecology and stock assessment has been comprehensively studied (Erzini, 1994; Petrakis and Stergiou, 1995; Goncalves *et al.*, 1997; Lamprakis *et al.*, 2003). For instance, when calculating the production over biomass ratio (P/B) between different functional groups, this relationship can provide more accurate weight estimation (Moutopoulos and Stergiou, 2002; Torres *et al.*, 2012). Apart from this, the length-weight relationship can also be used for deriving comparisons between different fish species in life history and morphology or between fish populations from regions or habitat groups (Maguire and Mace, 1993; Petrakis and Stergiou, 1995; Goncalves *et al.*, 1997) and tracking seasonal variations in fish growth (Safran, 1992; Richter *et al.*, 2000).

Morphometric traits are frequently used for the purpose of stock identification as compared to other methods such as otolith chemistry, traditional tags, parasites as natural tags, electronic tags and molecular genetics (Sajina *et al.*, 2011). Truss network analysis of morphometric measurements used for the purposes of stock identification (Booke, 1981) is a powerful tool for the analysis of shape, and is generally designed to cover the animal's body (Strauss and Bookstein, 1982). Ideally, the truss lengths measured between desired landmarks points should be curved vectors, since they lie on curved surfaces (Humphries *et al.*, 1981). In order to simplify the method, Hockaday *et al.* (2000) assumed that all the distances measured represent straight lines lying on the same plane.

Materials and methods

Fish

In April 2010, a total of 102 numbers of *T. yarkandensis* were collected from Alaer Reach of Tarim River, Tarim River Basin (40° 26' 22.8" N, 81° 09' 16.3" E) and transported to the School of Animal Sciences, Tarim University, P. R. China. The fish were maintained in three 100 l fiberglass tanks and after 3 h of recovery period, morphological studies were conducted.

Measurement procedure

Fish were anaesthetised with MS-222 (tricaine methane suphonate) using the recommended dose according to the manufactorer's instructions, before being weighed and measured. The lengths were measured using vernier calipers (accurate to ± 0.2 mm) and wet weights were taken using an electronic balance (accurate to ± 0.01 g). Body length (*BL*) was taken from the tip of the upper jaw to the end of the caudal peduncle. Total length (*TL*) was measured from the tip of the jaw to the end of the caudal fin tip.

An Olympus (SP-565UZ) digital camera was used to capture the images of the 102 samples with a calibration ruler placed in left-side view, in each image. The image analysis software, Matlab, R2011a was used to perform the morphometric data analyses. The truss network was constructed by 10 landmarks which can describe the major features of *T. yarkandensis* (Fig. 1), including (1) origin of pectoral fin, (2) tip of snout, (3) origin of pelvic fin, (4) top of operculum, (5) origin of anal fin, (6) origin of dorsal fin, (7) end of anal fin, (8) end of dorsal fin, (9) ventral attachment of the caudal fin to the tail, and (10) dorsal attachment of the caudal fin to the tail. The selection criteria for these landmarks are as follows: a) the landmarks were linked closely to the skeletal structure of *T. yarkandensis*; b) can be easily observed and assessed by eye. The truss lengths' between these landmarks were measured as described by Hockaday *et al*. (2000), where all the distances measured were assumed to represent straight lines lying in the same plane.

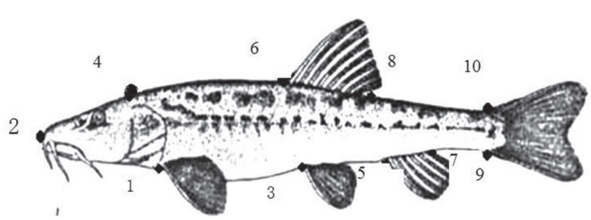

Fig. 1. Landmarks used in the analysis of morphometric comparison of *T. yarkandensis*
Fish image from Ren *et al.* (2004) re-marked with landmarks used in the present study. (1) origin of pectoral fin, (2) tip of snout, (3) origin of pelvic fin, (4) top of operculum, (5) origin of anal fin, (6) origin of dorsal fin, (7) end of anal fin, (8) end of dorsal fin, (9) ventral attachment of the caudal fin to the tail, and (10) dorsal attachment of the caudal fin to the tail.

Statistical analyses

The relationship between body length (*BL*) and wet weight (*Wt*) were calculated by the power regression $Wt = a \times BL^b$ (PASW Statistics 19.0). Values of the exponent b provide information on fish growth. When $b = 3$, the increase in weight was isometric. When the value of b was > 3, the weight increase was allometric (positive if $b > 3$, negative if $b < 3$) (Morey *et al.*, 2003). All the truss measurements were log transformed and tested for normality using the SPSS 19.0.

Significant correlations between body size and truss measurements were found in this study. The absolute measurements made were transformed into size-independent shape variable to perform further analysis. The transformation method was done following Sajina *et al*. (2011), using the equation:

$$\text{Dtrans} = \quad D \times \left(\frac{\text{BL mean}}{\text{BL}}\right)^b$$

where, *Dtrans* is the transformed truss measurement, *D* is the original truss measurement, *BL* is the body length of fish, *BL mean* is the overall mean of the body length, and *b* is the within-group slope of the geometric mean regression calculated with log-transformed variables, *D* and *BL*.

Results and discussion

Morphological observations

The body of *T. yarkandensis* is fusiform, compressed at the sides, tapering more towards the tail region than the head. The height-length ratio of the caudal peduncle is < 0.5 (Fig. 2). The head is short, thick and compressed dorsoventrally. The body is scaleless and covered with smooth skin. The dorsal fin is located anteriorly on the body. The location of the pelvic fin is opposite to the first and second branched rays of the dorsal fin. *T. yarkandensis* has a small pectoral fin with the 2nd and 3rd branched rays being slightly longer than the rest. There is also a slight difference between female and male. The pectoral fin of female has soft branched rays, while in the male it is harder and the 2nd and 3rd branched rays are significantly longer than in the female. *T. yarkandensis* can change its body color according to the environment.The color of the back and sides of the body is normally earthy-yellow with black spots, while the belly area is yellow-white.

Fig. 2. *Triplophysa yarkandensis*

Length-weight relationship

The relationship between fish body length (*BL*) and wet weight (*Wt*) was derived as $Wt = 0.08 \times BL^{2.04}$ ($r^2 = 0.78$, $n = 102$, Fig. 3), $a = 0.08$, and $b = 2.04$. The value of $b < 3$, obtained in the present study indicates that the growth of *T. yarkandensis* follows negative allometric trend. This result is consistent with the findings of Ren *et al*. (2004). The value of *a* in our study, however was greater than that reported by Ren *et al*. (2004). Several factors may be attributed to this difference, as Bagenal and Tesch (1978) suggested that the parameters of *a* in length-weight relationships can vary daily, seasonally, and/ or between habits. In our study, all the samples were collected from Alaer Reach of Tarim River, during April, while the samples for the previous study (Ren *et al*., 2004) were collected from different regions and they have not clearly indicated the sampling period

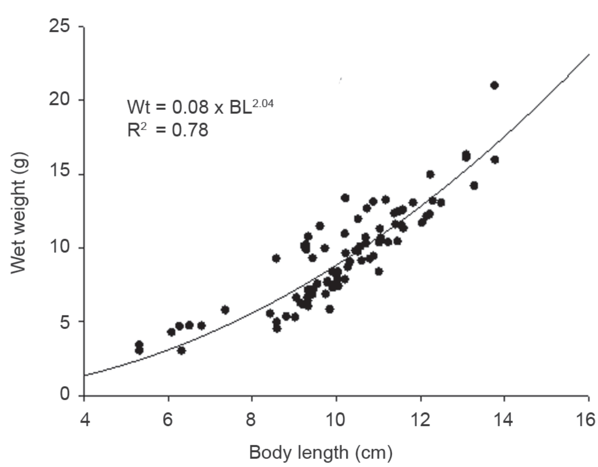

Fig. 3. Length-weight relationship for *Triplophysa yarkandensis*

Truss network analysis

In the truss network measurement, the testing size in terms of body length was between 5.32 and 13.77 cm, and nearly 92% of sample size (body length) was distributed between 8 and 13 cm. The length measurements between selected landmarks are presented in Table 1, and the models of truss networks are presented in Fig. 4. As a powerful measurement tool, morphometric trait has been employed for the identification of fish stock units (Cadrin and Friedland, 1999). Cadrin (2000) suggests that morphometric variations can be used for the discrimination of stock units as the result may be different when locations are changed. Poulet *et al*. (2005) observed that the interactive effects of environment, selection, and genetics on individual ontogenies, produce morphometric differences within a species. Furthermore, several studies have demonstrated that phenotypical characters may be more useful than purely genetic studies (Lear and Wells, 1984; Kinsey *et al*., 1994; Swain and Foote, 1999), as a gene flow of small magnitude may prevent the detection of significant genetical

Table 1. Truss network of distance measurements of *T. yarkandensis* (cm)

Two framework sites	Ratio range	Mean±SD
2~1	1.190~3.476	2.323±0.411
1~3	2.016~4.062	2.803±0.363
3~5	0.400~2.890	1.921±0.372
5~7	0.470~1.248	0.795±0.164
7~9	0.696~2.334	1.193±0.294
9~10	0.404~1.110	0.744±0.139
4~1	1.020~2.728	1.684±0.398
4~2	0.542~2.900	1.098±0.471
4~3	2.534~4.988	3.362±0.457
4~5	3.180~7.334	5.142±0.723
10~8	1.604~4.180	2.808±0.482
8~6	0.716~1.590	1.179±0.201
6~5	0.904~2.046	1.543±0.237
6~4	2.026~4.530	2.994±0.533
6~3	0.998~2.608	1.548±0.283
6~7	1.218~4.124	3.001±0.480
7~10	0.846~2.714	1.451±0.333
8~9	1.110~4.178	2.847±0.548
8~7	1.276~2.648	1.909±0.285
8~5	0.972~1.950	1.519±0.195

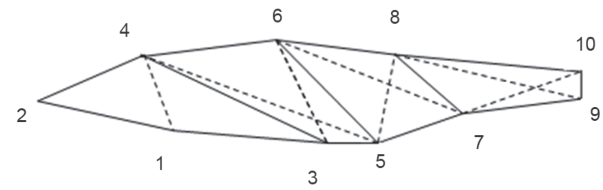

Fig. 4. The fitted truss network of *Triplophysa yarkandensis*. (Landmarks as given in Fig. 1)

differences (Murta *et al.*, 2008). Moreover, morphometric studies have been able to identify differences between fish populations and are helpful tools for the discrimination of fish populations (Bailey, 1997; Saborido-Rey and Nedreaas, 2000; Palma and Andrade, 2002). In the present study, only samples from Alaer Reach of Tarim River were used and no comparisons for morphometric variations could be made. However, the data presented can be used in future research programmmes.

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