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Short Communication

Length-Weight Relationship of the Invasive Mosquitofish

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ABSTRACT

This study presents 49 length-weight relationships gathered from literature and our investigation pertaining to *Gambusia affinis* and *G. holbrooki*. The value of the slope *b* ranged from 2.44 for male *G. holbrooki* in Tajan River (Iran) to 3.81 for combined *G. holbrooki* in reservoirs of Segura River basin (Spain). The mean value of *b* was 3.11 (SD =0.30), which significantly higher than 3 (t-test, $p<0.05$). The median value of *b* was 3.15 and 50% of the b values ranged between 2.95 and 3.31.

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Authors' Contribution
WX performed the experiments, designed the research and wrote the paper. QZ and DG analyzed the data. YH conducted the research.

Key words
Invasive, Mosquitofish, Length-weight relationship, *Gambusia affinis*, Growth parameter

Length-weight relationships (LWRs) are an important tool for fish biology and fisheries management (Froese, 2006; Froese *et al*., 2011). Researchers can determine fish weight from length or vice versa (Sasi and Ozay, 2017; Xiong *et al*., 2018a, b). Thus, understanding LWRS can be very useful tool for ichthyologists because of limited by resources and time.

Mosquitofish (including *Gambusia holbrooki* and *Gambusia affinis*) are small fish native to the North America and have been introduced to all continents except Antarctia (Pyke, 2005). They are probably the most widely distributed freshwater fish in the world (Pyke, 2008) and western mosquitofish (*Gambusia affinis*) were listed in the world's 100 worst invasive alien species by IUCN (Global Invasive Species Programme, http://www.issg.org/database). Western mosquitofish was introduced into China Taiwan in 1911, and into China mainland in 1924 (Cheng *et al*., 2018) and now occurred and widespread wetlands in southern China (Xiong *et al*., 2015a, 2019). Many studies have shown that western mosquitofish negatively affect native amphibians in native (Zelber and Sutton, 2008) and non-native habitat (Gamradt and Kats, 1996; Goodsell and kats, 1999; Segev *et al*., 2009; Shulse and Semlitsch, 2014). In China, western mosquitofish has been implicated in the decline of native endangered fish (Li and Xie, 2002; Xiong *et al*., 2018c) and amphibian (Dudgeon and Corlett, 1994).

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A large amount of literature exists with regard to two mosquitofish. However, our knowledge of western mosquitofish (*Gambusia affinis*) and Eastern mosquitofish (*G. holbrooki*) biology is also surprisingly patchy and limited because of complex distributions and difficult to separate with certainty (Pyke, 2008). In this study, length-weight relationships were estimated for western mosquitofish from wetlands of the central Yangtze River, and we gathered 46 length-weight relationships from literature for western mosquitofish and eastern mosquitofish from world.

Materials and methods

The study was carried out in some wetlands along side Donghu Lake (30°31′-30°36′N, 114°21′-114°28′E) in Wuhan, Hubei Province, central of the Yangtze River. West mosquitofish specimens were caught periodically every season from May 2012 to January 2013 (20-27 May, 15-22 August, 11-19 November 2012, and 22-30 January 2013). Captured by dip nets, they were measured to the nearest 0.1 cm (total length, L) and weighed to the nearest 0.01g (Weight, W). For detailed sampling methods see Xiong *et al*. (2015b). West mosquitofish were classified as males if they possessed any evidence of a gonopodium, and as females in the case of the absence of gonopodium. When this was not possible (usually TL<13mm), sex was determined by the direct observation of gonads. Length-weight relationship was calculated using the expression: $W= aL^b$, where the W is the weight (g) and L the length (cm), the parameters *a* and *b* is the intercept (coefficient related to body

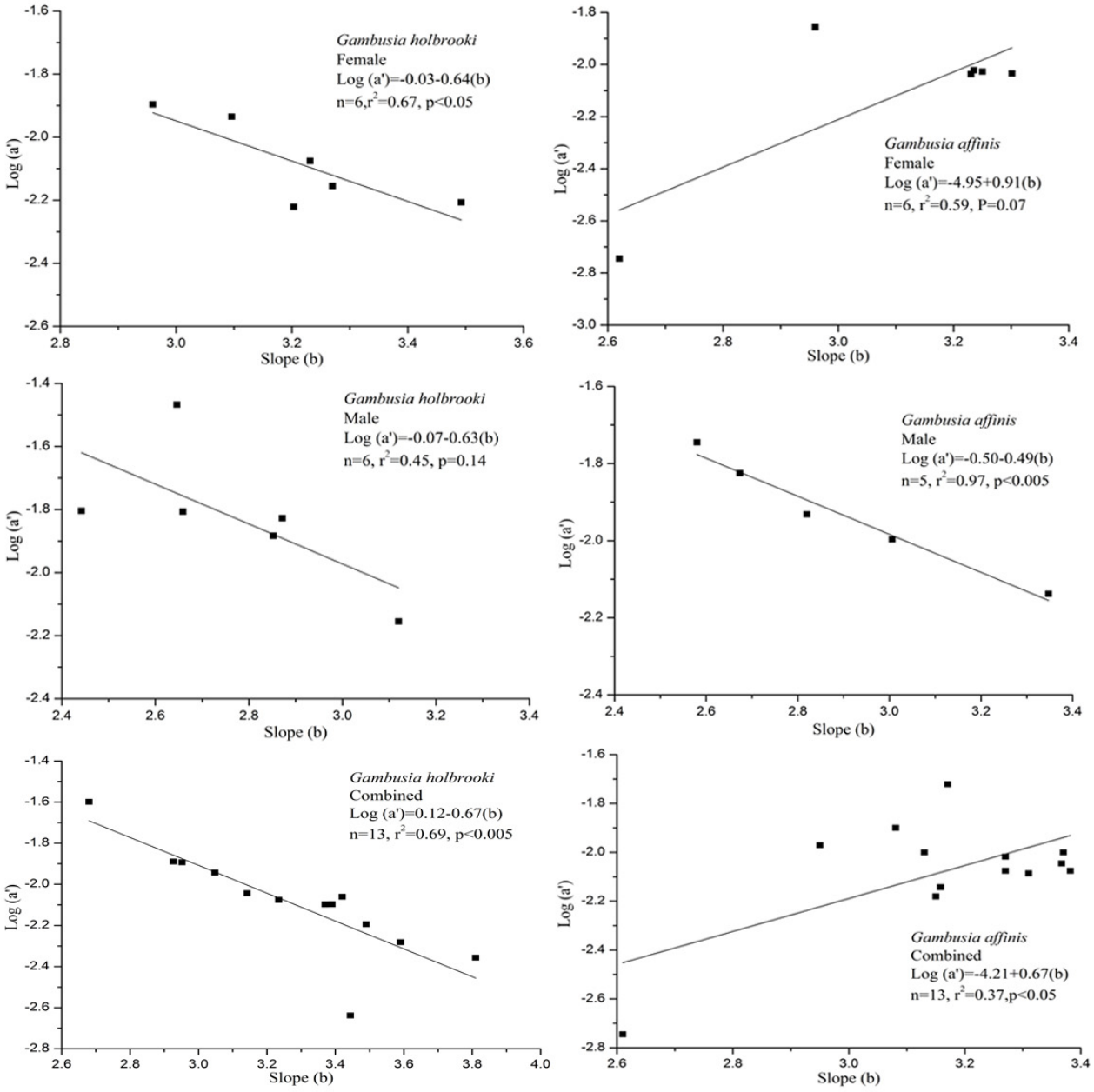

Fig. 1. Plots of Log (a') vs b for all available length-weight relationships of mosquitofish (*G. holbrooki* and *G. affinis*) in the world. Outliers are marked by number '3' in Supplementary Table 1.

form) and the slope, respectively (Froese, 2006). The 95% confidence of limits of *a* and *b* were determined.

All length-weight relationships of two mosquitofish are the product of field studies conducted during 2004-2013 in freshwater and estuary of the world. For the majority of the original length-weight relationships ($w=aL^b$), length was in cm and weight in g (43 relationships out 49; 88%), whereas for 6 (12%), length and weight were expressed in mm and g. For all length-weight relationships presented here, length has been expressed in cm and weight in g. Based on our field investigations and literature review, this study is the first report on preliminary length-weight relationship of mosquitofish in the world (Supplementary Table I).

Results and discussion

Overall, 49 length-weight relationships (Supplementary Table 1) were gathered from literature and our investigation, referring to two mosquitofish, including female, male and combined. Thereinto, 25 length-weight relationships refer to *G. holbrooki* (6 females, 6male, and 13 combined), other 24 to *G. affinis* (6 females, 5 males and 13 combined).

The value of the slope *b* in the plot of Log *W* against Log *L* ranged from 2.44 for male *G. holbrooki* in Tajan River (Iran) to 3.81 for combined *G. holbrooki* in reservoirs of Segura River basin (Spain). The mean value of *b* was 3.11 (SD =0.30), which significantly higher than 3 (t-test, $p<0.05$). The median value of b was 3.15 and 50% of the b values ranged between 2.95 and 3.31.

The plot of log *a* vs *b* for all known length-weight relationships of s species results in a species results in a linear relationship, and that this relationship can be used to identify outliers (Froese, 2000). We have applied this method to two mosquitofish (Fig. 1). This method led to the detection of outliers, where the respective point deviated more than two standard deviations from the regression line. These length-weight relationships were marked as "questionable" in Supplementary Table I.

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Supplementary material

There is supplementary material associated with this article. Access the material online at: https://dx.doi.org/10.17582/journal.pjz/20190422150443

Statement of conflict of interest

The authors report no conflicts of interest. The authors alone are responsible for the content and writing of the paper.

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