Indian J. Fish., 71 (1): 150-154, 2024 doi:10.21077/ijf.2024.71.1.136805-18

Available online at: epubs.icar.org.in/index.php/IJF

Note

Morphometry and length-weight relationships of the freshwater pearl mussel *Parreysia corrugata* (Muller 1774) (Bivalvia: Unionidae) from Daya River, Odisha, India

E. M. Chhandaprajnadarsini, Shailesh Saurabh* and Pankaj Kumar Tiwari

ICAR-Central Institute of Freshwater Aquaculture, Kausalyaganga, Bhubaneswar - 751 002, Odisha, India

Abstract

Allometry in the freshwater mussel *Parreysia corrugata* was studied from east-flowing river Daya, Bhubaneswar, India. The results indicated that shell length (SL)-shell height (SH) and shell length-shell width (SW) relationships for *P. corrugata* were SH = 0.876 + 0.932SL and SW = 0.625 + 0.898SL. Greater correlation was found between SL and SW than between SL and SH. The length-weight, height-weight and width-weight relationships of *P. corrugata* were established as $TW = 0.00038SL^{2.80}$, $TW = 0.0006SH^{2.95}$ and $TW = 0.0023SW^{2.97}$ respectively. The t-test value of b indicated an isometric growth pattern in the width-weight and the height-weight relationships. The highest r^2 value was obtained for shell length-total weight and shell height-total weight equations. Present study will be helpful in strengthening the knowledge on interrelationship between the morphometric variables of *P. corrugata* and also in comparing with the earlier studies to know the existence of spatial or temporal variability in the morphometry of this species. This information can also be used to better understand the biology of *P. corrugata* and to improve the management of this species.

*Correspondence e-mail:
ssaurabh02@rediffmail.com

Keywords:
Conservation, Daya River, Length-weight relationships, Morphometry

Received : 24.05.2023
Accepted : 27.01.2024

The study of shell dimension (shell length, shell width and shell height) and body weight provides basic information on the biology of the bivalves *i.e.,* morphological development, growth pattern, general well-being, habitat condition and morphological characteristics of the species at individual and population level (Anderson and Gutreuter, 1983; Gosling, 2003). In bivalves, growth is estimated by measuring the shell dimension or weight of the animal as this is a simple and non-destructive method (Hibbert, 1977; Bailey and Green, 1988). Allometry *i.e.,* relationship between two measurable variables is the most reliable and precise method to study the growth pattern in bivalves (Nahar *et al.,* 2019) and when this information is available, shell dimension is sufficient to estimate the biomass of the resources (Hibbert, 1977). Allometric information on bivalves is a valuable tool for understanding bivalve biology as well as ecology and it is useful in efficient resource management and understanding the environmental condition (Palmer, 1990). Further, the information also aids in understanding the ideal condition of the bivalve and the optimum harvestable size for maximising production. Though this type of studies have been carried out extensively in fishes; only very few studies have been undertaken in freshwater mussels (Palmer, 1990; Boulding and Hay, 1993; Caceres-Martinez *et. al*., 2003).

Daya River, a branch of the Kuakhai River and part of Mahanadi River is home to a great variety of flora and fauna. This river holds great importance in maintaining the rural and urban ecosystems in and around Bhubaneswar, Odisha, India. The freshwater mussel *Parreysia corrugata* (Muller 1774), an important candidate species for pearl culture inhabits this river. The species is widely distributed in several states like Odisha, Punjab, Bihar, Madhya Pradesh, Maharashtra and Karnataka (Rao, 1989).

© 2024 Indian Council of Agricultural Research

Freshwater pearl culture emerges as a promising avenue for boosting the aqua-economy by providing employment and ensuring food security. In India, large scale production of freshwater pearl relies on 3 species *Lamellidens marginalis*, *L. corrianus* and *P. corrugata.* Most of the farmers depend on the wild caught populations due to lack of standardised seed production technology. Indiscriminate exploitation of the natural resources can lead to decline in the fishery. In many parts of the world, freshwater bivalves are facing a high rate of extinction due to overexploitation, habitat degradation, pollution, climate change, lack of proper management and many other factors which can threaten the long-term sustainability of the freshwater pearl farming sector (Strayer *et al.,* 2004; Walker *et al.*, 2014; Lopes-Lima *et al.,* 2018). Considering the rising interest in freshwater pearl farming, the present investigation was carried out to study the morphometric and length-weight relationships of *P. corrugata* inhabiting the Daya River.

In total, 200 specimens were collected from Daya River (20.2095°N, 85.8512°E) near Bhubaneswar during the period from June 2021 to February 2023. The specimens were collected by hand picking and transported to the laboratory in live condition with utmost care. The specimens were cleaned gently with tap water to remove the sand particles and epifauna, and wiped with dry cotton cloth to remove moisture around the shell. Shell length (maximum antero-posterior distance), width (maximum distance between two valves' outer edges) and height (maximum distance from hinge to ventral edge) of the specimens were recorded using a digital Vernier caliper with 0.01 mm accuracy. The individual weight of each specimen was taken on an electronic balance with accuracy of 0.1 g.

Dimensional relationship was established using linear regression equation (Ricker, 1973) log Y = a + bX; where Y is shell height or width and X is the shell length while a is the intercept and b is the slope. The degree of association between the variables was estimated by coefficient of determination (r^2). Student's t- test (H_0, b=1) was carried out to test the statistical significance in the variation of slope 'b' from the isometric value b=1 with 95% confidence level (negative allometry b<1 or positive allometry b>1) and expressed by equation given by Sokal and Rohlf (1987):

$t_s = (b-1)/S_b$

where t_s = t-test value; b = Slope; S_b = Standard error of the slope

The length-weight relationship was estimated using non-linear regression equation ($W=aL^b$), where W is total wet weight of the mussel, a (intercept) and b (slope) are constants and 'L' is the shell dimensional measurement (length, height or width). Student's t-test was also carried out to determine statistical significance in the variation of slope b from the isometric value 'b=3 (negative allometry b<3 or positive allometry b>3) (Sokal and Rohlf, 1987). All the statistical analyses were carried out using Microsoft Excel Programme.

The present study is the first report on allometric relationship in the freshwater pearl mussel *P. corrugata* from Daya River, Odisha, India. The shell length of the sampled mussels ranged from 15.72 to 46.67 mm and the average length was 28.90 mm. The shell width and shell height of the mussels ranged from 7.37 to 19.92 mm and 11.12 to 30.77 mm respectively. The average shell width and the shell height were 12.82 and 20.06 mm respectively. A linear relationship was observed between shell length-shell width and shell length-shell height in the present study indicating the gradual increase in the shell width and shell height with the increase in the shell length (Fig. 1). However, variations were observed in the shell height and shell width in some individuals of the same shell length. Such variations lead to shape distinction in mussels. Similar observations were reported in *P. favidens* population in river Seeta (Ramesha and Sophia, 2015) and in other organisms like painted turtle, *Chrysemys picta marginata* (Jolicoeur and Mosimann, 1960).

The regression equations derived for length-width and length-height relationships in the present study are :

$SW = 0.625 + 0.898SL$ (R^2 =0.96);

$SH = 0.876 + 0.932SL$ (R^2=0.898)

The estimated 't- test' value for b showed a significant difference at 95% confidence level indicating negative allometric growth. Gaspar *et al.* (2002) noted a negative allometric pattern in the length-width and length-height relationships of shell morphometrics in a majority of bivalves. They ascribed this pattern to the characteristics of the bottom substrate in their habitat and the burrowing behaviour exhibited by the bivalves. The allometry observed in bivalves represents an adaptive strategy aimed at improving burrowing efficiency and preventing dislodgement from the bottom substrate in response to local hydrodynamics (Thomas, 2013). The morphometric relationship is useful for comparison between dimensional growth of same species or related species in different geographical regions (Hemachandra and Thippeswamy, 2008). Ramesha and Thippeswamy (2009) reported the 'b' value for length-width and length-height relationship in *P. corrugata* as 0.585 and 0.333, respectively. Ramesha and Sophia (2015) estimated

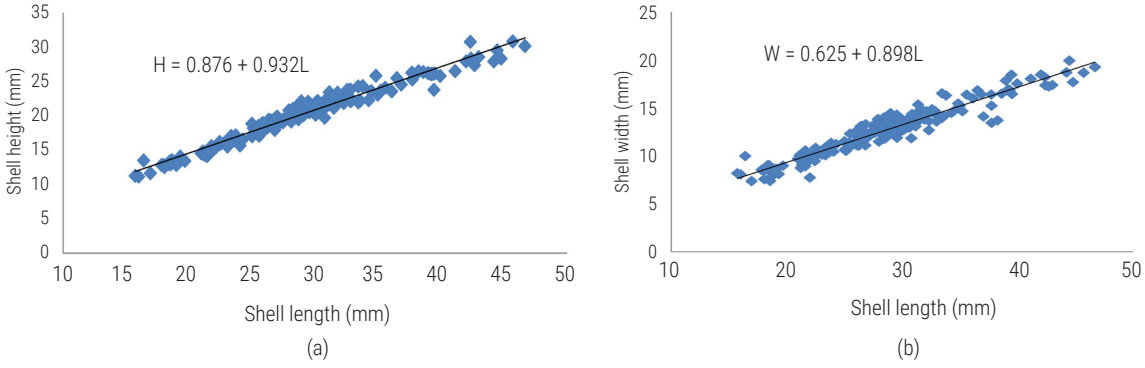

Fig.1. Shell length relationship of *P. corrugata.* (a). Shell length-shell height and (b). Shell length-shell width

the b value for length-width and length-height relationships in *P. favidens* as 0.4561 and 0.674, respectively. However, the present estimated values are higher than in the above-mentioned studies which may be due to variation in the geographical location. In addition to genetic make-up, several environmental factors also affect the morphological variation in organisms (Bravi *et al*., 2013; Caillon *et al., 2018)*. In bivalves, environmental factors influence shell formation and fluctuations in the ambient temperature in the bottom water affects the shell size more than the shell shape (Wilbur and Owen, 1964; Seed, 1968). Hence in bivalves, rather than shell size, shell shape presents accurate insights into dimensional relationships (Hemachandra and Thippeswamy, 2008).

The equations for relationship between different morphometric variables and weight in *P. corrugata* derived are as follows:

$TW = 0.00038SL^{2.80}$

$TW = 0.0023SW^{2.97}$

$TW = 0.0006SH^{2.95}$

All the morphometric variables showed a strong functional relationship with total weight (co-efficient of determination r2 ≥ 0.95). However lower co-efficient of determination ($r^2 = 0.95$) was observed for shell width–total weight as compared to the other two morphometric variables (shell length and shell width) with total weight. The skewed relationship in the allometric relationship suggests that smaller individuals are short while the bigger ones are heavier (Fig. 2). Generally, with increase in age, weight also increases, however in some individuals of the same length, difference in weight was observed which can be due to the environmental variables and reproductive strategies (Bauer,1983; Haag and Staton, 2003; Ravera *et al.,* 2007).

In the allometric length-weight relationship, the equilibrium constant 'b' is the important component as the variation of this hypothetical unity suggests physiological deviations in general well-being of an animal. In the present study, the estimated 'b' value for SL-TW, SW-TW and SH-TW are 2.80, 2.95 and 2.97 respectively which is similar to the range reported for most of the bivalves by Wilbur and Owen (1964) and Shafee (1978). However, Isham *et al.* (1951) reported b-value of 1 in the ship-worm teredo.

The present estimated value of 'b' for SL-TW, SW-TW and SH-TW indicates negative allometric growth pattern in *P. corrugata* as b value is less than 3. Student's t-test indicated that except SL-TW, other two relationships did not show any significant difference (p>0.05), indicating isometric growth pattern. It further indicated that there is an equal proportion of growth in shell width and total weight as well as shell height and total weight. Negative allometric growth is indicated between shell length and shell weight.

The length-weight relationship is an important indicator for identifying the condition of bivalves across different life stages; and it also helps in comparing the condition in the context of environmental variations in same species or between related species. The result of the present study has been compared with earlier studies on *P. corrugata* and with related species (Table 1). The change in growth coefficient 'b' may be due to many factors such as variation of the habitat, food availability and seasonal growth changes. As per the earlier reports by Williams and McMahon (1989), the bivalves showed significant variations in weight and biochemical content of meat because of seasonal changes. However, we could not collect the samples during rainy season to corroborate these findings, because of increase in water level in the river. The estimated growth co-efficient value for shell length-weight in the present study was found to be less than 3, which suggests that the mussels are of lighter weight and in relatively poor growth conditions.

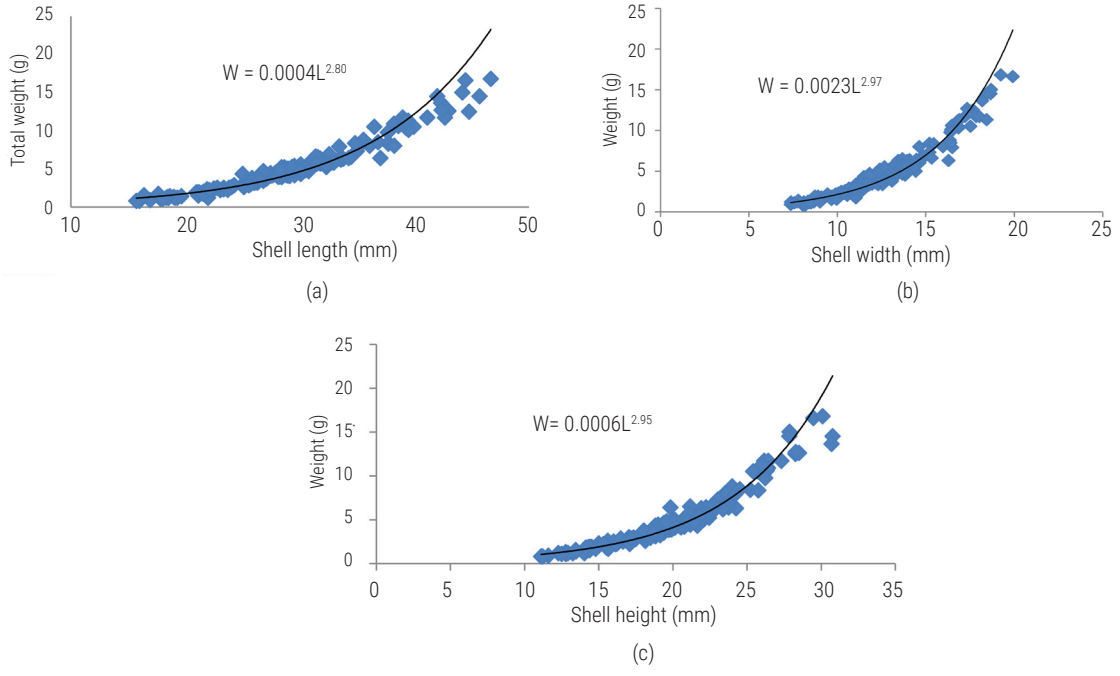

Fig. 2. Length-total weight relationship of *P. corrugata.* (a) Length-weight, (b) Width-weight and (c) Height-weight

Table 1. Comparison of length (total shell length)-weight (total weight) relationship of *P. corrugata* with earlier studies in same species and related species

Authors	Species	a	b	Location
Desai and Borkar (1989)	*Lamellidens carrians*	-1.9009	1.6105	Khandepar river basin of Goa, India
Ramesha and Sophia (2015)	*Parreysia favidens* (Benson, 1862)	0.000385	3.066	River Seeta, Western Ghats
Kovitvadhi *et al.* (2008)	*Hyriopsis (Limnoscapha) myersiana*			Thailand (Laboratory condition)
	120-270 mm length group	-3.747	2.674	
	270-360 mm length group	-4.149	2.976	
Ramesha and Thippeswammy (2009)	*Parreysia corrugata* (Mullar)	0.000342	2.777	River Kempuhole, India
Malathi and Thippeswamy (2011)	*Parreysia corrugata* (Mullar)	0.0007	3.0266	River Malthi, Western Ghats, India
Mondol *et al.* (2016)	*Lamellidens corrianus*	0.1756	2.6775	Freshwater Lake in North-west Bangladesh
Pradhan *et al.* (2020)	*Lamellidens marginalis* (Lamarck, 1819)	0.0003	2.712	Cultured environment, India
Hossain *et al.* (2022)	*Lamellidens marginalis* (Lamarck, 1819)	−0.83	2.75	Ratargul freshwater swamp forest, Bangladesh

The current investigation furnishes critical insights into the morphometry of *P. corrugata* in the Daya River, Odisha. The results obtained from this study will be of use in further comprehensive studies on the growth, biology and stock assessment of the species paving the way for sustainable management practices. The study will help not only fisheries experts but also pearl growers seeking to cultivate this species for freshwater pearl production.

Acknowledgements

Authors are thankful to the Director, ICAR-CIFA, Bhubaneswar for providing necessary facilities to carry out the work.

References

Anderson, R. O. and Gutreuter, S. J. 1983. Length, weight and associated structural indices. In: Nielsen, L. A. and Johnson, D. L. (Eds), *Fisheries techniques*. American Fisheries Society, USA, 300 p.

Bailey, R. C. and Green, R. H. 1988. Within-basin variation in the shell morphology and growth rate of freshwater mussel. *Can. J. Zool*., 66: 1704-1708. https://doi.org/10.1139/z88-246.

Bauer, G. 1983. Age structure, age specific mortality rates and population trends of the freshwater pearl mussel (*Margaritifera margaritifera*) in north Bavaria. *Arch. Hydrobiol.*, 98: 523-532.

Boulding, E. G. and Hay, T. K. 1993. Quantitative genetics of shell form of an intertidal snail: Constraints on short-term response to selection. *Evolution*, 47(2): 576-592. https://doi.org/10.1111/j.1558-5646.1993.tb02114.x.

Bravi, R., Ruffini, M. and Scalici, M. 2013. Morphological variation in riverine cyprinids: A geometric morphometric contribution. *Ital. J. Zool.,* 80: 4536-4546.

Caceres-Martinez, J., Rio-Portilla, M. A., Gutierrez, S. C. R. and Humaran, I. M. G. 2003. Phenotypes of the California mussel, *Mytilus californianus*, Conrad (1837). *J. Shellfish Res*., 22: 135-140.

Caillon, F., Bonhomme, V., McCollmann, C. and Frelat, R. 2018. A morphometric dive into fish diversity. *Ecosphere*, 9: e02220, 10.1002/ecs2.2220.

Desai, P. V. and Borkar, M. R. 1989. A study of allometric relationship in *Lamellidens carrians*. *Indian J. Fish.,* 36: 180-182.

Gaspar, M. B., Santos, M. N., Vasconcelos, P. and Monterio, C. C. 2002. Shell morphometric relationships of the most common bivalve species (Mollusca: Bivalvia) of the Algarve coast (southern Portugal). *Hydrobiologia,* 477: 73-80. https://doi.org/10.1023/A:1021009031717.

Gosling, E. 2003. *Bivalve molluscs: biology, ecology and culture*. Fishing News Books, Oxford, UK, 455 p.

Haag, W. R. and Staton, J. L. 2003. Variation in fecundity and other reproductive traits in freshwater mussels. *Freshwat. Biol.,* 48: 2118-2130. https://doi.org/10.1046/j.1365-2427.2003.01155.x.

Hemachandra, A. and Thippeswamy, S. 2008. Allometry and condition index in green mussel *Perna viridis* (L) from St. Mary Island off Malpe, near Udupi, India. *Aquac. Res*., 39: 1747-1758. https://doi.org/10.1111/j.1365-2109.2008.02051.x.

Hibbert, C. J. 1977. Growth and survivorship in a tidal flat population of the bivalve *Mercenaria mercenaria* from South Hampton waters. *Mar. Biol.,* 44: 71-76.

Hossain, M. A., Hussain, M., Sarker, T. R., Saha, S. and Iqbal, M. M. 2022. Reproductive and morphometric traits of freshwater mussel *Lamellidens marginalis* and associated hydrology in the Ratargul Freshwater Swamp Forest, Bangladesh. *Egypt. J. Aquat. Res*., 49(2): 161-170. https://doi.org/10.1016/j.ejar.2022.11.004.

Isham, L. D., Moore, H. B. and Smith, F. G. W. 1951. Growth rate measurement of shipworms. *Bull. Mar. Sci. Gulf. Caribb*., 1: 136-147.

Jolicoeur, P. and Mosimann, J. E. 1960. Size and shape variation in the painted turtle. A principal component analysis. *Growth*, 24: 339-354.

Kovitvadhi, S., Kovitvadhi, U., Sawangwong, P., Trisaranuwatana, P. and Machado, J. 2008. Morphometric relationship of weight and size of cultured freshwater pearl mussel, *Hyriopsis (Limnoscapha) myersiana*, under laboratory conditions and earthen pond phases. *Aquac. Int.,* 17: 57-67. https://doi.org/10.1007/s10499-008-9180-z.

Lopes-Lima, M., Burlakova, L. E., Karatayev, A. Y., Mehler, K., Seddon, M. and Sousa, R. 2018. Conservation of freshwater bivalves at the global scale: diversity, threats and research needs. *Hydrobiologia,* 810: 1-14. https://doi.org/10.1007/s10750-017-3486-7.

Malathi, S. and Thippeswamy, S. 2011. Morphometry, length-weight, and condition in *Parreysia corrugata* (Muller 1774) (Bivalvia: Unionidae) from river Malathi in the Western Ghats, India. *Int. J. Biol. Sci.,* 2(1): 43-52.

Mondol, M. R., Nasrin, F. and Nahar, D. A. 2016. Length-weight relationships, condition index and sex ratio of mussel *Lamellidens corrianus* (Lea, 1834) in a freshwater lake, Northwest Bangladesh. *Croat. J. Fish*., 7: 172-178.

Nahar, D., Islam, M. R., Islam, M. S., Jasmine, S. and Mondol, M. 2019. Growth pattern of freshwater bivalve mollusk *Lamellidens marginalis* (Lamarck, 1819) from the northwest Bangladesh. *J. Biosci*., 27: 121-132. https://doi.org/10.3329/jbs.v27i0.44677.

Palmer, A. R. 1990. Effect of crab effluent and scent of damaged conspecifics on feeding, growth and shell morphology of the Atlantic dogwhelk *Nucella lapillus* (L.). *Hydrobiologia*, 193: 155-182.

Pradhan, S., Saurabh, S., Padhi, N., Kumar, T., Kumar, R., Mohanty, U. L. and Sundaray, J. K. 2020. Length-weight, width-weight and height-weight relationships of cultured freshwater pearl mussel, *Lamellidens marginalis* (Lamarck, 1819). *Indian J. Fish*., 67: 157-160.

Ramesha, M. M. and Sophia, S. 2015. Morphometry, length-weight relationships and condition index of *Parreysia favidens* (Benson, 1862) (Bivalvia: Unionidae) from river Seeta in the Western Ghats, India. *Indian J Fish.*, 62(1): 18-24.

Ramesha, M. M. and Thippeswamy, S. 2009. Allometry and condition index in the freshwater bivalve *Parreysia corrugata* (Muller) from river Kempuhole, India. *Asian Fish. Sci.,* 22: 203-214. https://doi.org/10.33997/j.afs.2009.22.1.019.

Rao, S. N. V. 1989. *Handbook of freshwater mollusc of India*, Zoological Survey of India, Calcutta, India, 194 p.

Ravera, O., Frediani, A. and Riccardi, N. 2007. Seasonal variation in population dynamics and biomass of two *Unio pictorum mancus* (Mollusca, Unionidae) population of two lakes of different trophic state. *J. Limnol.*, 66: 15-27. https://doi.org/10.4081/jlimnol.2007.15.

Seed, R. 1968. Factors influencing shell shape in the mussel *Mytilus edulis*. *J. Mar. Biol. Ass. UK*, 48: 561-584. https://doi.org/10.1017/S0025315400019159.

Shafee, M. S. 1978. Studies on various allometric relationships in intertidal green mussel *Perna viridis* Linnaeus of Ennore estuary, Madras. *Indian J. Fish.,* 23(1&2): 1-9.

Sokal, R. R. and Rohlf, F. J. 1987. *Introduction to biostatistics*, 2nd edn. W.H. Freeman and Co., New York, USA, 394 p.

Strayer, D. L., Downing J. A., Haag, W. R., King, T. L., Layzer, J. B., Newton, T. J. and Nichols, S. J. 2004. Changing perspectives on pearly mussels, North America's most imperiled animals. *Bioscience*, 54: 429-439.

Thomas, S. 2013. Allometric relationship of short neck clam *Paphia malabarica* from Dharmadom Estuary, Kerela. *J. Mar. Biol. Ass. India*, 55(1): 50-54. https://doi.org/10.6024/jmbai.2013.55.1.01755-08.

Walker, K. F., Jones, H. A. and Klunzinger, M. W. 2014. Bivalves in a bottleneck: Taxonomy, phylogeography and conservation of freshwater mussels (Bivalvia: Unionoida) in Australasia *Hydrobiologi*a, 735: 61-79. https://doi.org/10.1007/s10750-013-1522-9.

Wilbur, K. M. and Owen, G. 1964. Growth. In: Wilbur, K. M. and Yonge, C. M. (Eds.), *Physiology of mollusca*, Vol 1, Academic Press, New York, USA, pp. 211-242.

Williams, C. J. and McMahon, R. F. 1989. Annual variation in the tissue biomass and carbon and nitrogen content in the freshwater bivalve *Corbicula luminea* relative to downstream dispersal. *Can. J. Zool.*, 67: 82-90. https://doi.org/10.1139/z89-013.