Morphometry of gastropod snails in desert wetlands of Bikaner district, Rajasthan

Nayab hasan, Yogender singh

Research scholar, Professor

Laboratory of Environmental Biology, Department of Zoology

Govt. Dungar college, Bikaner, Rajasthan

nayabhasan29@gmail.com, dryogenderskush@gmail.com

Abstract

The present work focuses on the morphometry of gastropod snails found in the two desert wetlands of Bikaner. Four identified freshwater snail species namely, *Bellamya bengalensis, Digoniostoma pulchella, Indoplanorbis exustus and lymnaea acuminata. Bellamya bengalensis* and *Digoniostoma pulchella* were prosobranch snails while *Indoplanorbis exustus* and *Lymnaea acuminata* were pulmonate snails. In this study, measured the number of whorls, freshwater snail's height, diameter and Aperture length and width. The biometry of freshwater snails is varying from species to species. In Darbari and Kodamdesar ponds, *Bellamya bengalensis* is generally larger in size compared to the other three species present in both ponds. Height and diameter of snails and Aperture length or width are calculated by vernier caliper.

Keywords: morphometry, desert, wetlands, freshwater, prosobranch, pulmonate, size of snails, vernier caliper.

Introduction

The morphometry of freshwater snails was varied in Darbari and Kodamdesar ponds of Bikaner. Snails are among the few animals that provide a direct measurable connection to their individual lives, even after death, through their shell studies on morphology (i.e. size and shape) has been an important aspect in many biological field's palaeontology, anatomy, ecology, systematic and to study phylogeny tree (Madan *et. al.* 2015). Some studies have been carried out earlier on its length-frequency distribution, morphometry, length-weight relationship and condition factor from India and adjacent countries (Saha *et. al.* 2016; Panda *et. al.* 2021). Length – weight relationship of intertidal molluscs from Mumbai, India was studied by Jaiswar and Kulkarni (2002). Prosobranchia as the majority type gastropods and its shells usually consists of a circular and spiral tube increases with diameter growth, and opening only at the end of the growing ventral, called aperture. The axis may be vacant shells or columella, organize the opening of the shell, umbilicus (Strong *et. al.* 2008). Basic shell formed by the largest spiral or body whorl, while the other whorls, which closer to the top or apex, is spire (Tracey, 2010). Mantle *et. al.* (2018) worked on the length – weight relationship of freshwater pulmonate snail *Indoplanorbis exsutus* at local pond near Aurangabad, Maharashtra. In recent years, limited attention has been given to the study of malacofauna and its morphometric significance for understanding the diversity of gastropods of desert wetlands in Darbari and Kodamdesar ponds. Therefore, this morphometric study on prosobranch and pulmonate snails carried out in desert wetlands.

The study site

India is located on the continent of Asia. Geographically, it lies entirely in the northern and eastern hemispheres, stretching between the latitudes of 8°4' and 37°6'N, and the longitudes of 68°7'E and 97°25'E. Rajasthan occupies the North Western region of India. The state extends from 23°3'N to 30°12'N latitude and from 69°30'E to 78°17'E longitude. Situated in the North Western part of Rajasthan, Bikaner is one of the desert districts in the region. The geographical coordinates of Bikaner are approximately 28.0229°N latitude and 73.3119°E longitude. About 26 km from Bikaner lies the Kodamdesar pond, while the Darbari Pond is located around 33 km away along the Bikaner- Jaisalmer highway.

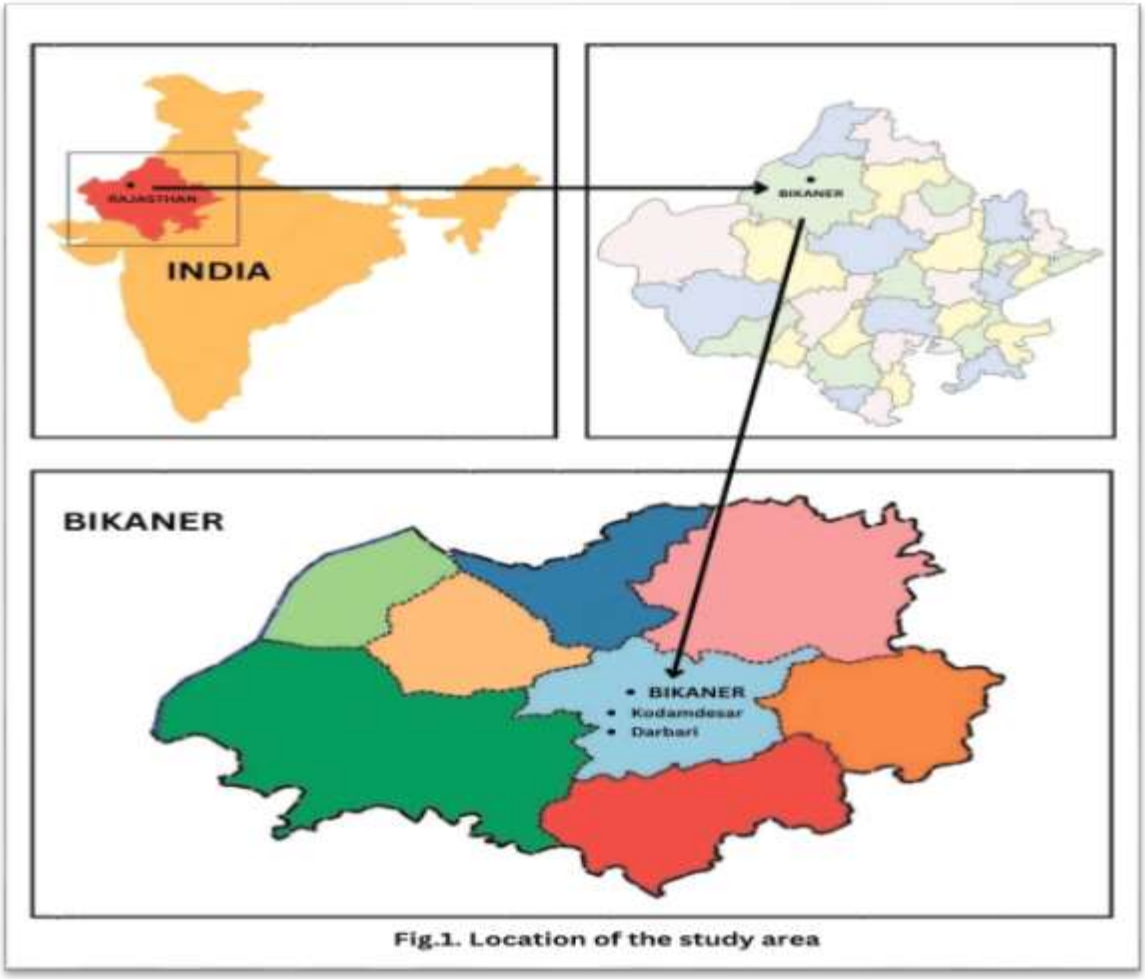

Fig.1. Location of the study area

Materials and methods

The sample was collected from Darbari and Kodamdesar ponds. Live snails and empty shells were collected from these ponds of desert wetlands in Bikaner district of Rajasthan. In these ponds four freshwater snail species were identified. After collection, the snails were brought to the laboratory, cleaned with water. Each sample was placed in a labelled container including the date, location and habitat information. Living snails were collected, shorted and described with accompanying notes on their occurrence in the desert wetland of Bikaner. Specimens were collected from February 2022 to January 2023. Living snails and mud samples were collected using a quadrat with a fixed area of 500 cm^2. Each specimen was thoroughly cleaned before tacking measurements. After cleaning, all specimens were photographed at the instrument room of the Environmental laboratory, Govt. Dungar college, Bikaner. Number of whorls and spirals of gastropods snails are also measured by naked eye with the help of stereoscopic binocular microscope or bull lens. By the use of vernier calliper we examine the snail height (H), snail diameter (D) and aperture length (AL) and its aperture width (AW). Various number of snails shell were considered for morphometry analysis.

Results

The specimens were found at both ponds, belong to subclasses prosobranchia and pulmonata. *Bellamya bengalensis* (Lamarck) and *Digoniostoma pulchella* (Benson) were prosobranch snails, while *Indoplanorbis exustus* (Deshayes) and *Lymnaea acuminata* (Lamarck) were pulmonate snails (Fig.2)

Prosobranch *Bellamya bengalensis* were the most common and wide spread in Darbari Pond and pulmonate *Indoplanorbis exustus* at Kodamdesar Pond. All gastropod species throughout the study period dwelling in sediments, and sticking with wooden twigs and other materials.

Fig.2(i) *Bellamya bengalensis*

Fig.2(ii) *Digoniostoma puichella*

Fig.2(iii) *Indoplanorbis exustus*

Fig.2(iv) *Lymnaea acuminata*

Table 1. Morphometry changes in gastropod species in Darbari Pond, Bikaner (February 2022-January 2023) values are means (mm) with ranges in parentheses.

Gastropod species	Morphometry Measurement (mm)	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan
Bellamya bengalensis	1.Whorls no.	6	5	5	5	6	7	6	5	6	6	5	6
	2. Height	31.2 (21.2-41.5)	24.6 (20.2-29.1)	25.8 (19.3-32.3)	20.2 (19.4-21.1)	32.2 (28.2-36.3)	37.2 (35.2-39.2)	39.8 (37.3-42.4)	32.7 (32.2-33.2)	37.7 (37.2-38.3)	36.7 (34.2-39.2)	24.2 (19.3-29.2)	25.7 (24.4-27.1)
	3. Diameter	22.9 (15.4-30.4)	17.2 (14.3-20.1)	17.2 (13.2-21.2)	14.3 (13.3-15.3)	22.1 (19.1-25.2)	26.8 (24.2-29.4)	28.7 (26.2-31.3)	21.6 (21.1-22.2)	26.6 (26.1-27.2)	26.2 (23.2-29.3)	16.7 (13.2-20.2)	17.1 (16.2-18.1)
	4. Aperture Length(l)	15.1 (11.2-19.1)	12.1 (10.2-14.1)	12.2 (9.2-15.3)	10.3 (9.4-11.2)	15.2 (13.2-17.3)	16.7 (16.3-17.2)	19.2 (18.3-20.2)	15.7 (15.2-16.3)	18.7 (18.2-19.3)	16.2 (15.3-17.2)	11.7 (9.3-14.1)	12.2 (12.2-12.2)
	5. Aperture width (w)	12.1 (8.2-16.1)	9.2 (7.3-11.2)	9.2 (6.3-12.2)	7.2 (6.4-8.1)	12.2 (13.2-14.2)	13.7 (13.2-14.2)	16.2 (15.2-17.2)	12.6 (12.1-13.2)	15.7 (15.2-16.2)	13.2 (12.3-14.2)	8.7 (6.2-11.2)	9.2 (9.2-9.3)
Digoniostoma pilchella	1. Whorls no.	5	4	5	_	_	5	4	5	4	_	4	4
	2. Height	5.3 (5.2-5.4)	5.1 (4.5-5.7)	4.6 (4.6-4.7)	_	_	6.0 (6.0-6.1)	5.7 (5.6-5.8)	5.9 (5.7-6.1)	5.7 (5.6-5.8)	_	4.6 (4.4-4.8)	5.7 (5.4-6.1)
	3. Diameter	4.1 (4.1-4.2)	4.1 (3.8-4.5)	3.7 (3.7-3.8)	_	_	4.2 (4.2-4.3)	4.3 (4.3-4.4)	4.2 (4.2-4.3)	4.3 (4.3-4.3)	_	3.6 (3.6-3.7)	4.3 (4.2-4.4)
	4. Aperture length(l)	3.3 (3.3-3.4)	3.3 (3.0-3.6)	3.1 (3.1-3.2)	_	_	3.2 (3.2-3.2)	3.3 (3.2-3.5)	3.2 (3.2-3.3)	3.1 (3.1-3.1)	_	3.0 (3.0-3.0)	3.3 (3.2-3.4)
	5. Aperture width(w)	1.3 (1.2-1.5)	2.3 (2.1-2.5)	2.1 (2.1-2.2)	_	_	1.2 (1.2-1.2)	2.3 (2.3-2.4)	2.2 (2.1-2.3)	2.1 (2.1-2.2)	_	2.1 (2.1-2.2)	1.3 (1.2-1.5)
Indoplanorbis exustus	1.Spirals	4	5	4	5	_	4	5	4	5	5	4	4
	2. Height	5 (4.5-5.5)	5.5 (5.4-5.6)	4.1 (4.1-4.2)	6.0 (6.0-6.1)	_	6.1 (6.0-6.1)	5.9 (5.7-6.2)	5.2 (4.3-6.2)	6.1 (6.1-6.2)	6.0 (5.8-6.3)	5.7 (5.7-5.8)	6.1 (6.1-6.2)
	3. Diameter	9.9 (9.1-10.7)	10.5 (10.5-10.6)	8.8 (8.7-9.0)	10.1 (10.1-10.2)	_	11.7 (10.2-13.2)	10.5 (10.2-10.8)	10.6 (9.0-12.2)	10.3 (10.2-10.4)	12.0 (10.9-13.2)	10.8 (10.8-10.9)	11.7 (10.3-13.1)
	4. Aperture length(l)	5.1 (4.8-5.5)	5.4 (5.3-5.6)	4.7 (4.7-4.8)	5.1 (5.1-5.2)	_	4.7 (4.3-5.2)	5.4 (5.3-5.6)	4.5 (4.2-4.8)	5.3 (5.2-5.4)	5.4 (5.2-5.7)	5.6 (5.6-5.6)	4.8 (4.2-5.4)
	5. Aperture width(w)	4.1 (3.6-4.6)	4.5 (4.4-4.7)	3.5 (3.5-3.6)	3.2 (3.2-3.3)	_	3.2 (3.2-3.2)	4.0 (3.4-4.7)	3.3 (3.1-3.6)	3.4 (3.3-3.6)	4.4 (4.2-4.6)	4.5 (4.5-4.5)	3.4 (3.2-3.6)
Lymnaea acuminata	1.Whorls no.	4	4	5	5	_	5	4	4	_	4	5	_
	2. Height	7.2 (7.2-7.3)	6.3 (6.3-6.4)	7.3 (6.5-8.2)	8.1 (0-8.1)	_	8.2 (8.2-8.3)	9.1 (9.1-9.1)	8.7 (8.4-9.1)	_	6.8 (6.4-7.4)	7.2 (6.2-8.3)	_
	3. Diameter	4.3 (4.2-4.4)	3.3 (3.3-3.4)	4.3 (3.5-5.2)	5.1 (0-5.1)	_	5.2 (5.2-5.3)	6.1 (6.1-6.2)	5.8 (5.4-6.2)	_	3.9 (3.4-4.5)	4.2 (3.2-5.2)	_
	4. Aperture Length(l)	4.1 (4.1-4.2)	3.2 (3.2-3.2)	4.2 (3.4-5.1)	5.2 (0-5.2)	_	5.1 (5.1-5.2)	6.1 (6.1-6.2)	5.7 (5.3-6.1)	_	3.8 (3.3-4.3)	4.1 (3.1-5.1)	_
	5. Aperture Width (w)	1.1 (1.1-1.2)	1.1 (1.1-1.1)	1.7 (1.3-2.1)	2.1 (0-2.1)	_	2.1 (2.1-2.1)	2.1 (2.1-2.2)	2.1 (2.1-2.2)	_	1.3 (1.3-1.4)	1.6 (1.1-2.1)	_

Table 2. Morphometry changes in gastropod species in Kodamdesar Pond, Bikaner (February 2022-January 2023) values are means (mm) ranges in parentheses.

Gastropod species	Morphometry Measurement (mm)	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan
Bellamya bengalensis	1.Whorls no.	6	7	_	_	_	6	5	7	6	5	6	_
	2. Height	38.2 (37.2-39.2)	39.3 (38.2-40.4)	_	_	_	39.2 (0-39.2)	34.8 (33.2-36.4)	41.2 (40.2-42.3)	39.2 (38.2-40.3)	37.7 (36.2-39.3)	36.8 (36.4-37.3)	_
	3. Diameter	27.7 (26.2-29.2)	28.8 (28.3-29.3)	_	_	_	29.3 (0-29.3)	23.8 (22.3-25.3)	30.7 (30.3-31.2)	28.8 (27.2-30.4)	27.3 (25.3-29.4)	25.8 (25.3-26.3)	_
	4. Aperture Length(l)	17.7 (17.2-18.3)	17.2 (16.3-18.2)	_	_	_	17.2 (0-17.2)	16.7 (16.2-17.2)	19.2 (18.2-20.3)	18.7 (18.2-19.3)	17.2 (17.2-17.3)	18.2 (18.2-18.2)	_
	5. Aperture width (w)	14.7 (14.2-15.2)	14.2 (13.2-15.2)	_	_	_	14.3 (0-14.3)	13.7 (13.2-14.3)	16.2 (15.2-17.2)	15.7 (15.2-16.3)	14.2 (14.2-14.2)	15.1 (15.1-15.2)	_
Digoniostoma pilchella	1. Whorls no.	4	5	4	_	_	5	4	5	4	4	5	4
	2. Height	5.5 (5.4-5.7)	5.5 (5.5-5.6)	5.0 (4.6-5.5)	_	_	5.8 (5.7-5.9)	6.0 (5.9-6.1)	5.9 (5.8-6.0)	5.4 (4.7-6.1)	4.8 (0-4.8)	5.8 (5.5-6.1)	5.8 (5.7-5.9)
	3. Diameter	4.3 (4.3-4.3)	4.2 (4.2-4.3)	3.9 (3.6-4.2)	_	_	4.3 (4.2-4.4)	4.3 (4.3-4.3)	4.3 (4.2-4.4)	4.1 (3.8-4.4)	3.5 (0-3.5)	4.2 (4.2-4.2)	4.3 (4.3-4.4)
	4. Aperture length(l)	3.4 (3.3-3.5)	3.1 (3.1-3.2)	3.3 (3.2-3.5)	_	_	3.1 (3.1-3.2)	3.1 (3.1-3.2)	3.4 (3.3-3.5)	3.2 (3.2-3.2)	3.1 (0-3.1)	3.1 (3.1-3.1)	3.2 (3.2-3.3)
	5. Aperture width(w)	1.9 (1.4-2.4)	2.1 (2.1-2.2)	2.3 (2.2-2.4)	_	_	2.2 (2.1-2.3)	1.7 (1.2-2.2)	1.2 (1.2-1.3)	1.6 (1.2-2.1)	2.2 (0-2.2)	1.6 (1.1-2.2)	2.1 (2.1-2.2)
Indoplanorbis exustus	1.Spirals	5	5	5	5	4	4	4	5	5	4	4	4
	2. Height	5.2 (4.2-6.2)	5.3 (4.5-6.1)	6.2 (6.2-6.2)	6.1 (0-6.1)	6.2 (6.2-6.2)	6.1 (6.1-6.2)	5.6 (5.6-5.7)	6.2 (6.1-6.3)	6.0 (5.8-6.2)	6.1 (6.1-6.2)	5.7 (5.7-5.8)	5.9 (5.5-6.3)
	3. Diameter	11.1 (9.1-13.1)	9.7 (9.1-10.3)	11.8 (10.3-13.3)	10.3 (0-10.3)	11.3 (10.4-12.2)	11.7 (10.3-13.1)	10.5 (10.5-10.6)	11.7 (10.2-13.3)	11.3 (10.4-12.3)	11.2 (10.3-12.2)	10.6 (10.4-10.9)	11.8 (10.4-13.3)
	4. Aperture length(l)	4.4 (4.3-4.6)	5.0 (4.7-5.3)	5.3 (5.3-5.3)	5.2 (0-5.2)	4.7 (4.2-5.3)	5.2 (5.1-5.4)	5.5 (5.5-5.6)	5.1 (5.1-5.2)	4.7 (4.2-5.2)	4.2 (3.3-5.2)	5.5 (5.4-5.7)	5.2 (5.2-5.3)
	5. Aperture width(w)	3.3 (3.2-3.4)	3.3 (3.2-3.5)	3.8 (3.5-4.2)	3.3 (0-3.3)	3.3 (3.2-3.4)	3.8 (3.4-4.2)	4.6 (4.6-4.7)	3.7 (3.2-4.3)	3.7 (3.2-4.3)	2.7 (2.2-3.2)	4.5 (4.5-4.6)	4.2 (4.1-4.3)
Lymnaea acuminata	1.Whorls no.	4	4	_	4	_	5	4	5	4	4	4	4
	2. Height	6.9 (6.4-7.4)	6.3 (6.3-6.4)	_	7.1 (0-7.1)	_	8.7 (8.2-9.2)	7.7 (7.3-8.1)	9.1 (9.1-9.1)	6.3 (0-6.3)	9.3 (9.2-9.4)	7.2 (6.2-8.2)	6.4 (0-6.4)
	3. Diameter	3.9 (3.4-4.5)	3.3 (3.3-3.3)	_	4.2 (0-4.2)	_	5.7 (5.2-6.2)	4.7 (4.3-5.2)	6.1 (6.1-6.2)	3.4 (0-3.4)	6.3 (6.3-6.4)	3.8 (2.5-5.1)	2.6 (0-2.6)
	4. Aperture Length(l)	3.8 (3.3-4.3)	3.1 (3.1-3.2)	_	4.1 (0-4.1)	_	5.6 (5.1-6.1)	4.6 (4.2-5.1)	6.1 (6.1-6.2)	3.2 (0-3.2)	6.2 (6.2-6.3)	4.2 (3.3-5.2)	3.6 (0-3.6)
	5. Aperture Width (w)	1.2 (1.2-1.3)	1.1 (1.1-1.2)	_	1.1 (0-1.1)	_	2.1 (2.1-2.2)	1.6 (1.2-2.1)	2.1 (2.1-2.1)	1.1 (0-1.1)	2.2 (2.2-2.3)	1.6 (1.1-2.1)	1.1 (0-1.1)

The systematic accounts of the four recorded gastropods species based mainly on Subba Rao (1989), goes as below:

Class – Gastropoda

Subclass - Prosobranchia

Family – Viviparidae

Genus – *Bellamya* Jousseaume

Species – *B. bengalensis* (Lamarck)

Description: The number of whorls ranged between 5-7, while Shell height ranges between 20.2 - 41.2 mm and shell diameter ranges between 14.3 - 30.7 mm with a thick brown and banded conical shell (globose). The aperture length ranges from 10.3 - 19.2 mm and aperture width ranged between 7.2 - 16.2 mm (Table 1,2). The teleoconch whorls are nearly cylindrical and display very fine axial riblets. Regular spiral groove may interrupt the axial sculpture. The aperture is subquadrate with thickened peristome (Fig. 2, i). This species is wide spread with high abundance at both study site.

Class – Gastropoda

Subclass - Prosobranchia

Family – Bithyniidae

Genus – *Digoniostoma* Annandale

Species – *D. pulchella* (Benson)

Description: *Digoniostoma pulchella* exhibited 4 to 5 whorls, with shell height varying from 4.6 - 6 mm and shell diameter measuring between 3.5 - 4.3 mm. The aperture length ranged between 3 - 3.4 mm, while its aperture width varied from 1.2 - 2.3 mm (Table 1,2). The shell of *Digoniostoma pulchella* is generally thin, exhibiting a conical to globose shape, last and large whorls shell exhibit a diagonal line. The aperture is oval to slightly rounded and operculum is well developed, fitting securely within the aperture (Fig. 2, ii).

Class – Gastropoda

Subclass - Pulmonata

Family – Planorbidae

Genus – *Indoplanorbis* Annandale and Parshad

Species – *I. exustus* (Deshayes)

Description: The shell is white and discoid (planispiral / discoidal) with a low conical spire. The number of spirals ranged between 4 to 5, while shell height ranged between 4.1- 6.2 mm and the maximum shell diameter was 8.8 - 12 mm, much broader then long. The aperture length ranged between 4.2 - 5.6 mm and the aperture width varies between 2.7 - 4.6 mm (Table 1,2). The whorls are narrowly coiled and shed by a deep suture (Fig. 2, iii).

Class – Gastropoda

Subclass - Pulmonata

Family – Lymnaeidae

Genus – *Lymnaea* Lamarck

Species – *L. acuminata* (Lamarck)

Description: The shell of *Lymnaea acuminata* consisted of 4 to 5 whorls. Its shell height ranged between 6.3 - 9.3 mm, while the diameter spanned from 2.6 - 6.3 mm. The aperture length was observed to vary between 3.1 - 6.2 mm, with its aperture width measuring from 1.1 - 2.2 mm (Table 1,2). The shell of *Lymnaea acuminata* is conical elongated. The shell height is typically greater than its width, giving it a conical appearance. The aperture generally long and fits the shells opening. Both shell dimensions and aperture size can vary depending on environmental conditions such as habitat type, availability of calcium and the age of the snail (Fig.2, iv).

Discussion

Singh, Y. (2000) reported biometric measurements of freshwater snails at Harsolao Pond in their malacological study. AL-KHAYAT Jassim A (2010) recorded five terrestrial gastropods at Qatar. He also described their morphometry like whorls number, shell height, shell diameter and aperture size. Khanam (2012) reported average measurements of different prosobranch snail species in different season at desert water in Bikaner. Khanam Y. and Singh Y. (2012) Study the biometry of some prosobranch snail in desert water at Bikaner, Rajasthan. Mantale A. *et. al*. (2018) describes the length – weight relationship of freshwater pulmonate snail *Indoplanorbis exustus* at local pond of Aurangabad (Maharashtra). They show length – weight relationship as an allometric growth. Khanam Y. (2024) reported local dispersal of land snail *Zootecus insularis* (Ehrenberg,1831) shell in Hanumangarh district, Rajasthan (India). She also recorded biometry of the snail. The *Zootecus insularis* shell height ranged between 7 mm to 10 mm and shell diameter 5 mm to 7mm and whorls number 3 to 6. She also recorded aperture length and width with ratio. In *Bellamya bengalensis*, the shell has 5 to 7 number of whorls. The shell height varies from 20.2 - 41.2 mm, while the shell diameter ranges between 14.3 – 30.7 mm. The aperture length is between 10.3 – 19.2 mm and the aperture width vary from 7.2 – 16.2 mm. whereas in *Digoniostoma pulchella*, the number of whorls ranged between 4-5, while shell height ranges between 4.6 – 6 mm and shell diameter ranges between 3.5 – 4.3 mm. The aperture length ranges from 3 – 3.4 mm and aperture width ranged between 1.2 – 2.3 mm. *Indoplanorbis exustus* exhibited, the number of spirals ranged between 4 to 5, while shell height ranged between 4.1 – 6.2 mm and the maximum shell diameter was 8.8 – 12 mm. The aperture length ranged between 4.2 – 5.6 mm and the aperture width vary between 2.7 – 4.6 mm. The shell of *lymnaea acuminata* consisted 4 to 5 whorls. Its shell height ranged between 6.3 – 9.3 mm, while the shell diameter ranged between 2.6 – 6.3 mm. The aperture length was observed to vary between 3.1 – 6.2 mm, with its aperture width measuring from 1.1 – 2.2 mm. These morphometric parameters are useful for faunal ecology, phylogeny and systematic studies in desert wetlands.

Acknowledgment

The authors gratefully acknowledge the University Grants Commission (UGC), New Delhi, India, for awarding the UGC- JRF fellowship. We also extend our sincere thanks to the Principal and the Head of the Department of Zoology, Government Dungar College, Bikaner (Rajasthan), for providing the essential laboratory facilities.

References

1. Al – KAYAT, Jassim A. 2010. "first record of five terrestrial snails in the state of Qatar,'' Turkish Journal of Zoology Vol. 34: No. 4, Article 12.
2. Jaiswar, A.K. and Kulkarni, B.G. 2002. Length- Weight relationship of intertidal molluscs from Mumbai, India. *Journal of the Indian Fisheries Association*, 29, pp. 55-63.
3. Khanam Y. 2012. *A study on prosobranch snail fauna and its Ecology in some desert waters*. Ph.D. thesis, MGSU, Bikaner (India) pp 141.
4. Khanam Y. & Singh Y. 2012. A study on biometry of some prosobranch snails in Desert waters at Bikaner, Rajasthan. Vol. 14 (4), December, *Bio notes*.
5. Khanam Y., Singh Y. 2024 "Local dispersal of land snail *zootecus insularis* (Ehrenberg, 1831) shell in north west region of Rajasthan (India)". *Int. J. Scien. dev. rese*. (IJSDR), Volume 9, Issue 7, pp 1050-1058.
6. Madan S, Singh S, Jauhari RK. 2015. Morphometric Analysis of Freshwater Snails Along with Associated Planktonic Community at Dudhlee in Doon Valley (Uttarakhand). *Journal of Global Biosciences*. 6(4):2604-2610.
7. Mantale A, Patil M, Shaikh M, Lakwal V. 2018. "Analysis of Length – Weight Relationship of Fresh Water Pulmonate Snail *Indoplanorbis exustus*", *JETIR*, Dec. 2018, Volume 5, Issue 12, pp. 168 – 173.
8. Panda, F., Pati, S. G., Bal, A., Mathur, S., Nirmaladevi, R. and Paital, B. 2021. Temporal morphometric analyses of Pila globosa in India for its use in aquaculture and food industry. *J. Basic Appl. Zool*., 82: 17.
9. Saha, B. K., Jahan, M. S. and Hossain, M. A. 2016. Morphometric, length-weight relationship and ecological factors affecting the habitat of Pila globosa (Swainson, 1822) located in Rajshahi University campus. Bangladesh *J. Sci. Ind. Res*., 51(2): 121-128. DOI: 10.3329/bjsir.v51i2.28098.
10. Singh, Y. 2000. *A malacological study on a freshwater pond in the Indian desert*. Ph.D. Thesis, M.D.S. University Ajmer (India) pp 123.
11. Strong EE, Gargominy O, Ponder WF, Bouchet P. 2008. Global diversity of gastropods (Gastropoda; Mollusca) in freshwater. *Hydrobiologia*. ;595:149–166.
12. Subba Rao, N. V. 1989. *Handbook of freshwater molluscs of India*. ZSI, Calcutta. 289 pp.
13. Tracey S. 2010. Gastropoda. Natural history Museum, London, United Kingdom.