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Does global warming affect acclimatization of seawater snail *Planaxis sulcatus* and *Nerita undata*?

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This study aimed to detect the effect of temperature on wet weight, shell length and shell aperture of seawater snail *Planaxis sulcatus* and *Nerita undata*.This experimental study investigated 18 *Planaxis sulcatus* snails and 18 *Nerita undata* that were collected from the beach of Sharm Yanbu in western of Saudi Arabia. Samples were divided into 3 groups control, cure 1 and cure 2. Each group contained 6 snails. Group cure 1 was treated by increasing water temperature to be 28°C, while group cure 2 was treated by increasing water temperature to be 33°C.There were no significant differences in the weekly measures of the wet weight, shield length, and, shield aperture of *Planaxis sulcatus* between the studied groups, while there was a significant difference between control group and cure 1 group for the first and second weeks. There were no significant differences between weekly measures of the wet weight, shield length, and, shield aperture of *Nerita undata* between the three studied groups, while there was a significant difference between cure 1 group and both control group and cures 2 groups for the third week regarding shield aperture. Also, there was a significant difference between control group and cure 2 groups for the third week regarding wet weight.This study showed that there is no relationship between temperature elevation and the wet weight, shield length and shield aperture of *Planaxis sulcatus* and *Nerita undata* collected from the beach of Sharm Yanbu in western of Saudi Arabia.

Keywords: ***Planaxis sulcatus*, *Nerita undata*, temperature elevation**

INTRODUCTION

The most notable indicators of climate change are noticed in many climatic phenomena since 1950s, such as changes in temperature, the amount of precipitation, hurricanes, the resulting floods and high levels of saline seawater (S Binnaser, 2021a)- (Stocker, 2014) where the climate changes could be due to human activities or natural causes (S Binnaser, 2021a)- (S Binnaser, 2021b)- (Gravili et al. 2017). These climate changes lead to significant changes in natural habitats and ecosystems (S Binnaser, 2021a)- (Hanley et al. 2020) which may threten the biodiversity of organisms and human food security (S Binnaser, 2021a)- (Banerjee et al. 2018) where, the countinus increasing in the global warming by 1.5°C - 2.5°C it will cause the extinction of 30% of known biological species (S Binnaser, 2021a)- (S Binnaser, 2021b)- (Dow and Downing, 2016)

The global climate change is manifested by the global warming and sea level rise (Hereher, 2016)- (Williams, 2013). Recent investigations reported an increase in the global temperature by 0.7 °C and the rise of the sea level by 10–20 cm in the 20th century (Hereher, 2016)- (Parry et al. 2007) Global warming is expected to continue due to the emissions of carbon dioxide (CO_2) gas into the atmosphere (Hereher, 2016)- (Simas et al. 2001). It is expected that the sea level will rise about 60 cm by 2100 due to the thermal expansion of seawater and the melting of ice in the arctic glaciers (Hereher, 2016)-(Parry et al. 2007) . The dependence on the coastal zone is important worldwide as more than 60 % of the world population lives along shorelines (Hereher, 2016)- (Doukakis, 2005) and a wide range of socioeconomic activities occurs at or near coastlines. (Hereher, 2016)

Many organisms now live in temperatures close to their thermo tolerance limits (S Binnaser, 2021a)- (Somero, 2005). The increase in the behavioral activity of ectothermal marine organisms due to the rise in sea water temperature will lead to the high rate of oxygen consumption, and causes a decrease in the rate of energy stored in the body of the marine organisms, which may work to reduce the rate of physical growth (S Binnaser, 2021a)- (Levinton and Levinton, 1995). Therefore, it is expected that global warming causes a decrease in the body size of the organisms (S Binnaser, 2021a)-(Mazurkiewicz et al. 2020). Thus, global warming can reduce overall animal biomass by affecting the animal's interaction with the food web due to an increase in energy demand and an increase in metabolic processes (S Binnaser, 2021a)- (Bruno et al. 2015)

Gastropods are the largest class of mollusks including about 30,000 marine species. *Planaxis sulcatus* belong to the kingdom Anemalia, phylum Mollusca, class Gastropoda, snails order Neotaenioglossa, order, family Planaxis, Species Sulcatus (Born, 1978). The Furrowed Clusterwink (*Planaxis sulcatus*) is found commonly in the rocky intertidal environments. The conical shell, speckled with patterns of white spots on a greenish-brown background of P. sulcatus, grows up to a length of 35 mm in adult individuals. P. sulcatus are herbivorous, feeding primarily on microalgae growing on the substrates in the habiats that inhabit (Stocker, 2014)- (Houbrick, 1987). Females are usually larger than males (S Binnaser, 2021a)-(OHGAKI, 1997).

Nerita undata belong to the kingdom Anemalia, phylum Mollusca, class Gastropoda, snails order Neritoidea, order, family Neritidae, Species Undata (Linnaeus, 1758). It is a type of marine snail that has a wide distribution in the tropics and temperate regions. The Neritidae form a group of often very colorful small species of gastropods. They normally inhabit the intertidal zone in the marine environment or live in brackish or fresh water. The inner walls of the spire whorls are resorbed. The calcareous operculum is characteristic of the family. It is a semicircular disc with a deposit of calcareous material on a horny layer. This calcareous layer has one large apophysis and the outer surface is often sculptured. (DEKKER, 2000).

This study aimed to detect the effect of temperature on wet weight, shell length and shell aperture of seawater snail *Planaxis sulcatus* and *Nerita undata*.

MATERIALS AND METHODS

Materials used in this study included:

18 *Planaxis sulcatus* and *Nerita undata* snails

6 Aquaria (10 L to each one) to place snails in them

Cages to keep snails in the bottom of the aquarium

Digital thermometer (Aqua Medic with an accuracy of ± 1 º C) to measure water temperatures

Heaters (50W) to provide suitable temperatures for water

Measuring ruler cm to measure the snail aperture

Balance to measure the weight of the snail (DENSI (PC-100W))

Plastic tie to tie the cage

Caliper cm to measure the length of the snail

Air pump to provide oxygen the aquarium

Paint to classify and number the snail for easy identification

Collection of samples:

The samples were collected from the beach of Sharm Yanbu, the coordinates of the site (37.9409090.24.1423170), October 1, 2017 at five thirty in the evening at a temperature of 39 °C. The surface sea water temperature was measured at a depth of 20 cm using a thermometer and it was 34 °C.The first type, *Planaxis sulcatus*, with 18 animals and the second type, *Nerita undata*, with 18 animals. We sorted each type of snail in ponds. We set the appropriate environment for it from sea water and rocks, and it was transferred to the College of Science - Taibah University - in Madinah.

Study groups:

The two types of snails were sorted into two groups, and each group included 3 aquariums. Inside each aquarium, 6 snails were placed inside a mesh cage, numbered from No. 1 to No. 6, using paint. We installed air pumps to all aquariums and measured the temperatures of all aquariums.

The snails were divided into 6 aquariums, Basin No. 1 and Basin No. 4 are the control group, and Basin 2, 3, 5 and 6 are the ones we conducted the study on with an average temperature of 23, 28 and 33 for 4 weeks (Table 1).

Measurements:

Growth measurements included; wet weight, shield length and shield aperture were evaluated on all samples once per week.

Statistical analysis

The collected data were coded, processed and analyzed using Statistical Package of Social Science (SPSS) program for windows (version 22) (Chicago, IL, USA). Quantitative data were presented as mean and standard deviation (SD). To test significance between different groups, one way ANOVA test was used. Repeated measures ANOVA test was done to test significant difference throughout study period within each group. Bonferroni post hoc test was performed to detect pairwise significance throughout study period. A p-value of < 0.05 was considered statistically significant.

RESULTS

Two kinds of sea snails were included in the current study (*Planaxis sulcatus and Nerita undata*) 18 snails from each kind, where three measurements were assessed (length, aperture, and weight).

Regarding *Planaxis sulcatus*, changes in the weight of studied snails were reported. It was observed that in control group, the wet weight started at 1.1 ± 0.2 in the beginning of the study to reach 0.8 ± 0.2 by the end of 4^{th} week without any significant differences between weekly measures of the wet weight. Regarding cure 1 group the wet weight started at 1.3 ± 0.3 in the beginning of the study to reach 1.1 ± 0.2 by the end of 4^{th} week without any significant differences between weekly measures of the wet weight. In cure 2 group, the wet weight started at 1.2 ± 0.19 in the beginning of the study to reach 1.1 ± 0.2 by the end of 4^{th} week without any significant differences between weekly measures of the wet weight. Comparison between the three studied groups regarding the weekly assessed wet weight of snails revealed no significant difference in the wet weight at any station of the study (Table 2).

Changes in shield length of *Planaxis sulcatus* snails were reported. It was observed that in control group, the shield length started at 1.3 ± 0.1 in the beginning of the study to reach 1.2 ± 0.1 by the end of 4^{th} week without any significant differences between weekly measures of shield length. Regarding cure 1 group, the shield length started at 1.3 ± 0.1 in the beginning of the study and continue in the same measure 1.3 ± 0.1 by the end of 4^{th} week without any significant differences between weekly measures of shield length. Regarding cure 2 group the shield length started at 1.1 ± 0.1 in the beginning of the study to reach 1.3 ± 0.1 by the end of 4^{th} week without any significant differences between weekly measures of shield length. Regarding the shield length, comparison of the weekly assessment revealed no significant difference in the shield length at any station of the study (Table 3).

Changes in shield aperture of *Planaxis sulcatus* snails were reported. It was observed that in control group, the shield aperture started at 0.9 ± 0.04 in the beginning of the study and continue in the same measure 0.9 ± 0.1 by the end of 4^{th} week without any significant differences between weekly measures of shield opening. Regarding cure 1 group, the shield aperture started at 0.8 ± 0.1 in the beginning of the study to reach 1.00 ± 0.1 by the end of 4^{th} week without any significant differences between weekly measures of shield aperture. Regarding cure 2 group the shield aperture started at 0.9 ± 0.1 in the beginning of the study and continue in the same measure 0.9 ± 0.1 by the end of 4^{th} week without any significant differences between weekly measures of shield opening. Comparison between the three studied groups regarding their weekly assessed shield aperture of snails showed significant difference between control group and cure 1 group for the first and second weeks. On the other hand, no significant difference in the shield aperture was found for the rest stations of the study (Table 4).

Regarding the results of *Nerita undata* changes in the weight of studied snails were reported. It was observed that in control group, the wet weight started at 4.3 ± 0.9 in the beginning of the study and continue in the same measure 4.3 ± 0.9 by the end of 4^{th} week without any significant differences between weekly measures of the wet weight. Regarding cure 1 group the wet weight started at 5.4 ± 0.9 in the beginning of the study to reach 4.9 ± 0.9 by the end of 4^{th} week without any significant differences between weekly measures of the wet weight. In cure 2 group, the wet weight started at 5.5 ± 1.3 in the beginning of the study to reach 5.0 ± 1.3 by the end of 4th week without any significant differences between weekly measures of the wet weight. Comparison between the three studied groups regarding the weekly assessed wet weight of snails significant difference between control group and cure 2 group for the third week. On the other hand, no significant difference in the shield aperture was found for the rest stations of the study (Table 5).

Changes in shield length of *Nerita undata* snails were reported. It was observed that in control group, the shield length started at 2.0 ± 0.2 in the beginning of the study and continue in the same measure 2.0 ± 0.2 by the end of 4th week without any significant differences between weekly measures of shield length. Regarding cure 1 group, the shield length started at 2.2 ± 0.2 in the beginning of the study to reach 2.1 ± 0.2 by the end of 4th week without any significant differences between weekly measures of shield length. Regarding cure 2 group the shield length started at 2.2 ± 0.2 in the beginning of the study to reach 2.1 ± 0.2 by the end of 4th week without any significant differences between weekly measures of shield length. Regarding the shield length, comparison of the weekly assessment revealed no significant difference in the shield length at any station of the study (Table 6).

Changes in shield aperture of *Nerita undata* snails were reported. It was observed that in control group, the shield aperture started at 1.5 ± 0.1 in the beginning of the study study to reach 1.6 ± 0.04 by the end of 4th week without any significant differences between weekly measures of shield opening. Regarding cure 1 group, the shield aperture started at 1.6 ± 0.1 in the beginning of the study and continue in the same measure 1.6 ± 0.1 by the end of 4th week without any significant differences between weekly measures of shield aperture. Regarding cure 2 group the shield aperture started at 1.7 ± 0.1 in the beginning of the study to reach 1.6 ± 0.1 by the end of 4th week without any significant differences between weekly measures of shield opening. Comparison between the three studied groups regarding their weekly assessed shield aperture of snails showed significant difference between cure 1 group and both control group and cure 2 group for the third week. On the other hand, no significant difference in the shield aperture was found for the rest stations of the study (Table 7).

Table 1: Groups of snails included in this study

Aquariums No	Group	Snail	Temperature (°C)	Sample
1	Control group	*Planaxis sulcatus*	23	6
2	Cure 1 group	*Planaxis sulcatus*	28	6
3	Cure 2 group	*Planaxis sulcatus*	33	6
4	Control group	*Nerita undata*	23	6
5	Cure 1 group	*Nerita undata*	28	6
6	Cure 2 group	*Nerita undata*	33	6

Table 2: Comparison between the studied groups regarding the *Planaxis sulcatus* wet weight throughout study period (n = 18).

Study period	Wet weight			P value
	Control Mean ± SD	Cure 1 Mean ± SD	Cure 2 Mean ± SD	
Week 1	1.1 ±0.2	1.3 ± 0.3	1.2 ±0.2	P1= 0.684 P2= 0.999 P3= 0.684
Week 2	1.1 ±0.2	1.3 ± 0.2	1.1 ± 0.3	P1= 0.684 P2= 0.999 P3= 0.684
Week 3	1.3 ±0.3	1.3 ± 0.3	1.1 ± 0.2	P1= 0.999 P2= 0.814 P3= 0.814
Week 4	0.8 ±0.2	1.1 ± 0.2	1.1 ± 0.2	P1= 0.072 P2= 0.072 P3= 0.999

One way ANOVA test was used with Bonferroni post hoc test. A p-value of < 0.05 was considered statistically significant.
P1 compare control vs. cure 1
P2 compare control vs. cure 2
P3 compare cure 1 vs. cure 2

Table 3: Comparison between the studied groups regarding the shield length of *Planaxis sulcatus* throughout study period (n = 18).

Study period	Shield length			P value
	Control Mean ± SD	Cure 1 Mean ± SD	Cure 2 Mean ± SD	
Week 1	1.3 ±0.1	1.3 ± 0.1	1.2 ±0.1	P1= 0.999 P2= 0.999 P3= 0.806
Week 2	1.3 ±0.1	1.3 ± 0.1	1.2 ±0.1	P1= 0.999 P2= 0.999 P3= 0.806
Week 3	1.3 ±0.1	1.3 ± 0.1	1.3 ±0.1	P1= 0.999 P2= 0.999 P3= 0.999
Week 4	1.2 ±0.1	1.3 ± 0.1	1.3 ±0.1	P1= 0.248 P2= 0.999 P3= 0.999

One way ANOVA test was used with Bonferroni post hoc test. A p-value of < 0.05 was considered statistically significant.
P1 compare control versus cure 1
P2 compare control versus cure 2
P3 compare cure 1 versus cure 2

Table 4: Comparison between the studied groups regarding the *Planaxis sulcatus* shield aperture throughout study period (n = 18).

Study period	Shield aperture			P value
	Control Mean ± SD	Cure 1 Mean ± SD	Cure 2 Mean ± SD	
Week 1	0.9 ±0.04	0.8 ± 0.1	0.9 ±0.1	P1= 0.027* P2= 0.463 P3= 0.463
Week 2	0.9 ±0.04	0.8 ± 0.1	0.9 ±0.1	P1= 0.027* P2= 0.463 P3= 0.463
Week 3	0.9 ±0.1	0.9 ±0.1	0.9 ±0.1	P1= 0.999 P2= 0.999 P3= 0.999
Week 4	0.9 ±0.1	1.0 ±0.1	0.9 ±0.1	P1= 0.178 P2= 0.999 P3= 0.719

One way ANOVA test was used with Bonferroni post hoc test. A p-value of < 0.05 was considered statistically significant.
P1 compare control versus cure 1
P2 compare control versus cure 2
P3 compare cure 1 versus cure 2

Table 5: Comparison between the studied groups regarding the *Nerita undata* wet weight throughout study period (n = 18).

Study period	Wet weight			P value
	Control Mean ± SD	Cure 1 Mean ± SD	Cure 2 Mean ± SD	
Week 1	4.3 ±0.9	5.4 ± 0.9	5.5 ±1.3	P1= 0.245 P2= 0.192 P3= 0.999
Week 2	4.3 ±0.9	5.4 ± 0.9	5.5 ±1.3	P1= 0.082 P2= 0.064 P3= 0.896
Week 3	4.2 ±0.8	5.3 ± 0.9	6.0 ±1.4	P1= 0.091 P2= 0.16* P3= 0.278
Week 4	4.3 ±0.9	4.9 ± 0.9	5.0 ±1.3	P1= 0.352 P2= 0.384 P3= 0.912

One way ANOVA test was used with Bonferroni post hoc test. A p-value of < 0.05 was considered statistically significant.
P1 compare control versus cure 1
P2 compare control versus cure 2
P3 compare cure 1 versus cure 2

Table 6: Comparison between the studied groups regarding the shield length of *Nerita undata* throughout study period (n = 18).

Study period	Shield length			P value
	Control Mean ± SD	Cure 1 Mean ± SD	Cure 2 Mean ± SD	
Week 1	2.0 ±0.2	2.2 ± 0.2	2.2 ±0.2	P1= 0.265 P2= 0.349 P3= 0.999
Week 2	2.0 ±0.2	2.2 ± 0.2	2.2 ±0.2	P1= 0.088 P2= 0.115 P3= 0.881
Week 3	2.0 ±0.2	2.0 ± 0.1	2.2 ±0.2	P1= 0.347 P2= 0.048 P3= 0.213
Week 4	2.0 ±0.2	2.1 ± 0.1	2.1 ±0.2	P1= 0.189 P2= 0.144 P3= 0.677

One way ANOVA test was used with Bonferroni post hoc test. A p-value of < 0.05 was considered statistically significant.
P1 compare control vs. cure 1
P2 compare control vs. cure 2
P3 compare cure 1 vs. cure 2

Table 7: Comparison between the studied groups regarding the *Nerita undata* shield aperture throughout study period (n = 18).

Study period	Shield aperture			P value
	Control Mean ± SD	Cure 1 Mean ± SD	Cure 2 Mean ± SD	
Week 1	1.5 ±0.1	1.6 ± 0.1	1.7 ±0.1	P1= 0.030 P2= 0.015 P3= 0.999
Week 2	1.5 ±0.1	1.6 ± 0.1	1.7 ±0.1	P1= 0.010 P2= 0.005 P3= 0.748
Week 3	1.5 ±0.1	1.6 ± 0.1	1.7 ±0.1	P1= 0.256 P2= 0.001* P3= 0.010*
Week 4	1.6 ± 0.04	1.6 ± 0.1	1.6 ± 0.1	P1= 0.999 P2= 0.733 P3= 0.733

One way ANOVA test was used with Bonferroni post hoc test. A p-value of < 0.05 was considered statistically significant.
P1 compare control versus cure 1
P2 compare control versus cure 2
P3 compare cure 1 versus cure 2

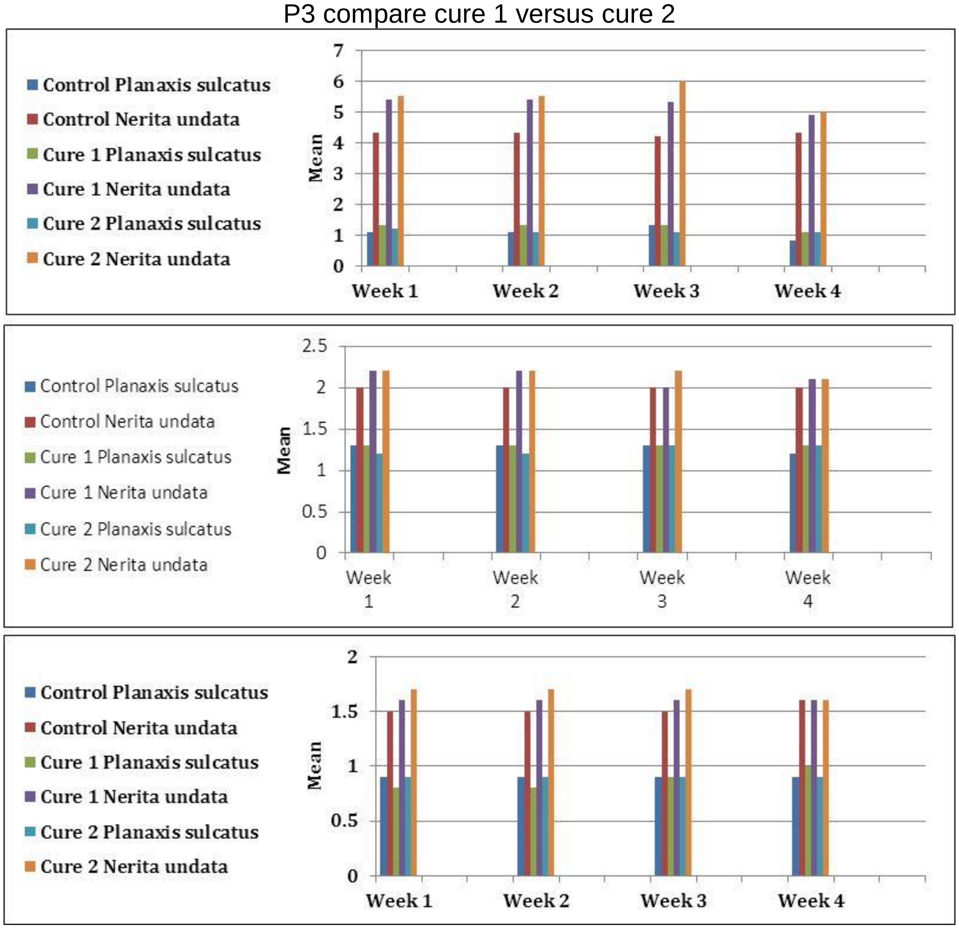

Figure 1: Comparison between the studied groups of *Planaxis sulcatus Nerita undata* regarding shield wet weight, length, aperture throughout study period.

The findings of the current study revealed that measurements of *Nerita undata* were changed more than the measurements of *Planaxis sulcatus*, indicating that *Nerita undata* is more adaptable than Planaxis sulcatus to the changes in their environment's temperature (Figures 1, 2 & 3).

DISCUSSION

Marine biodiversity, ecosystem health and fisheries are currently threatened by overfishing, but also by pollution and other anthropogenic impacts (Wabnitz et al. 2018)- (Pitcher and Cheung, 2013). Climate change further challenges the ability to devise sustainable management and conservation plans to preserve ecosystem services, as it has started to convert oceans and seas conditions, especially water temperature and various aspects of oceans and seas biogeochemistry (Wabnitz et al. 2018)- (Gattuso et al. 2015). Where, marine biodiversity reacts to shifting temperatures and other oceans and seas conditions through changes in organismal physiology and phenology, as well as population dynamics and allocations (Wabnitz et al. 2018) - (Pauly et al. 2010). These reactions to oceans and seas atmospheric changes have been projected to lead to varied patterns of species richness (Wabnitz et al. 2018)- (Chust et al. 2014)- (Jones and Cheung, 2015) variations in community structure (Wabnitz et al. 2018)- (MacNeil et al. 2010) and ecosystem functions (Wabnitz et al. 2018)- (Petchey et al. 1999) and consequential variations in marine merchandises and services (Wabnitz et al. 2018)- (Cheung et al. 2010) (Madin et al. 2012).

There is a high biodiversity in the Red Sea which is placed in one of the warmest areas in the world (S Binnaser, 2021a)- (Xiao et al. 2011). Although species found in it are of small size, it is still an marine ecosystem which has not been studied adequately if compared to other water ecosystems such as the Caribbean Sea and the Great Barrier Reef (S Binnaser, 2021a)- (Bruckner et al. 2012)- (Berumen et al. 2013). There were only few studies that examined the influence of temperature rising on sea snail in the Red Sea particularly at the coast of the kingdom of Saudi Arabia.

This study is an experimental animal study including 18 *Planaxis sulcatus* and 18 *Nerita undata* snails collected form the beach of Sharm Yanbu in the kingdom of Saudi. This study aimed to detect the physiological impact of near future temperature elevation due to climate change on sea snail growth at the coast of kingdom of Saudi on the Red Sea.

To summarize our findings, seawater measurements of temperature was increased gradually in group B and group C. Regarding *Planaxis sulcatus*, there were no significant differences between weekly measures of the wet weight, shield length, and, shield aperture. Also, there were no significant differences between the three studied groups (control, cure 1 and cure 2) regarding the weekly assessed wet weight and shield length of snails at any station of the study. On the other hand, there was a significant difference between control group and cure 1 group for the first and second weeks. While, no significant difference in the shield aperture was found for the rest stations of the study.

Similar results were reported in Binnaser YS study, where no significant differences between weekly measures of the wet weight and shield aperture in intragroup comparison of the three groups A, B and C. Also, when comparing the 3 groups, wet weight, shield length and shield aperture of studied snails also showed no significant differences. While, shield length increased at week 1 with pairwise comparison of weekly shield length records that showed only a significant difference between the 1st week reading and that of the onset of the study in group A; the control group. In group B, the shield length increased at week 6 with pairwise comparison of weekly shield length records showing only a significant difference between week 3 and that of the 6th week. (Stocker, 2014)

These results showing no differences between the control group and others with temperature elevation may be due to acclimation. Where, in accordance with a previous study which investigated acclimation temperature on thermal resistant at upper and lower lethal temperature. Snails adapted to 10, 20 and 30C showed reasonable heat and cold acclimation (Al-Khateeb, 2006) . This adaptation helps gastropods to survive in environments such as the intertidal zone where low tide temperature exceeds 52°C on coasts which are tropical and rocky (Stocker, 2014)- (Marshall et al. 2013).

According to *Nerita undata* there were no significant differences between weekly measures of the wet weight, shield length, and, shield aperture. Also, there was no significant differences between the three studied groups (control, cure 1 and cure 2) regarding the weekly assessed shield length of snails at any station of the study. On the other hand, there was a significant difference between cure 1 group and both control group and cure 2 group for the third week regarding shield aperture. Also, there was a significant difference between control group and cure 2 group for the third week regarding wet weight. While, no significant difference in the wet weight and shield aperture were found for the rest stations of the study.

This adaptation helps gastropods to survive in environments such as the intertidal zone where low tide temperature exceeds 52°C on coasts which are tropical and rocky (Stocker, 2014) - (Marshall et al. 2013). Organisms living in the low tide zone can tolerate higher temperature (Stocker, 2014)- (Knox, 2000). May be the reason for their survival in high temperature is due to their cone shaped high-spired shells (Stocker, 2014).

The current study was conducted in autumn, so the effects of different seasons didn't include or detect in the study. Water warming has many consequences. One of them is elevation of sea level. Water expands and water surface rise when its temperature is elevated. By now, this is limited to the surface layer which is only a few hundred meters deep (Stocker, 2014)- (Hotamisligil, 2006).

This heat diffuses overtime to more depth, leading to more expansion and higher sea level due to melting of inland glaciers and continental ice sheets as those resting on Antarctica.

CONCLUSION

The results of this study showed that there is no relationship between temperature elevation and the wet weight, shield length and shield aperture of *Planaxis sulcatus* and *Nerita undata* collected from the beach of Sharm Yanbu in western of Saudi Arabia. There is need for conducting further experimental studies in different seasons (winter, spring, summer, and autumn) to detect the effects of different climate factors such as high temperature, acidity and salinity.

CONFLICT OF INTEREST

The authors declared that present study was performed in absence of any conflict of interest.

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AUTHOR CONTRIBUTIONS

Y.B. have designed and performleed the study, collected the samples, analyzed the data and also wrote, revised and approved the final version of the manuscript.

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