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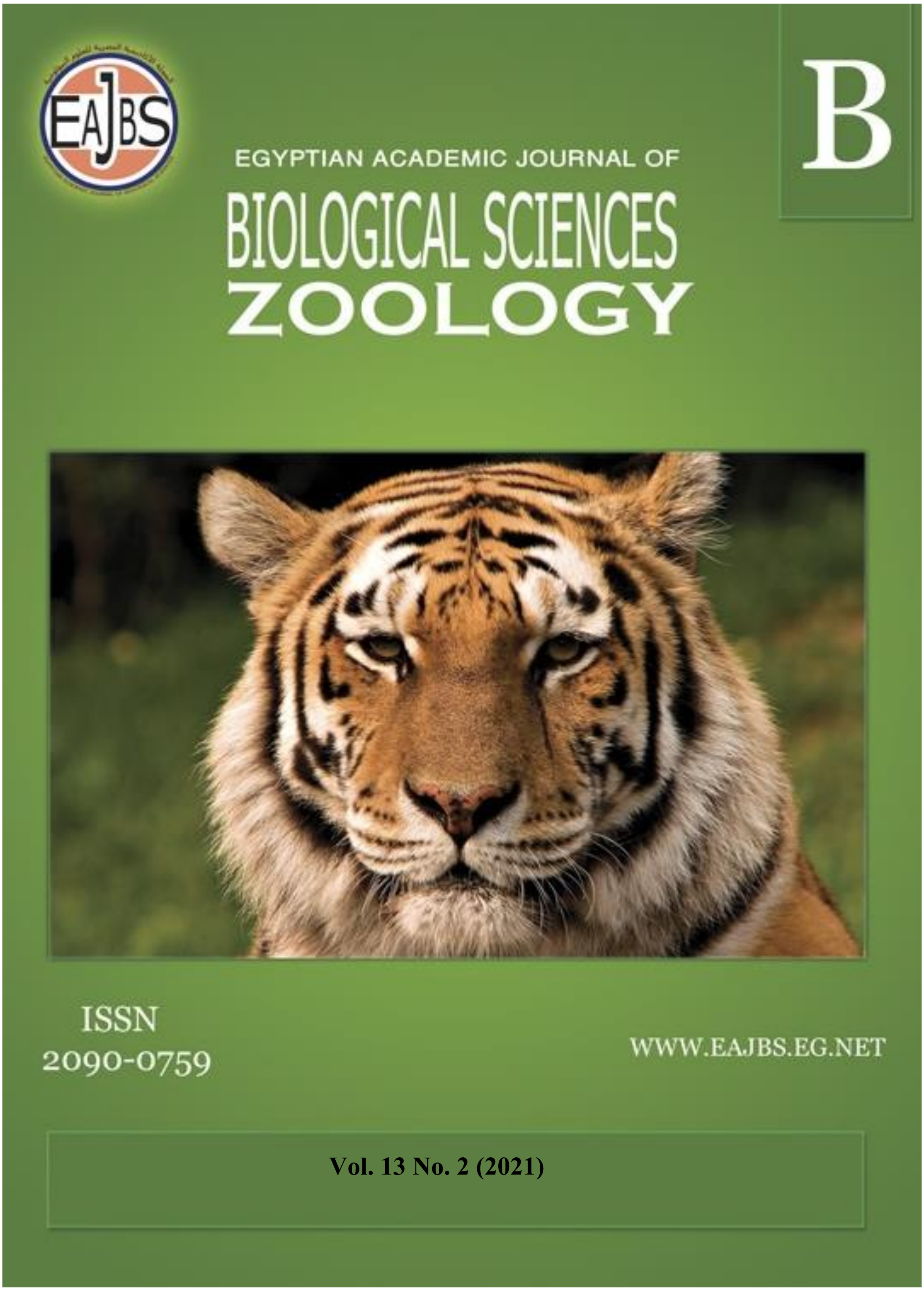

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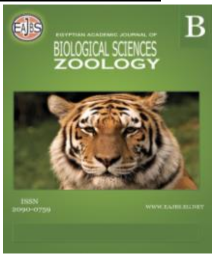

Ecological State in The Relationship Between Environmental Factors and Proximate Composition of *Squilla mantis* (Stomatopoda-Squillidae): as an Expected Indicator of The Impact of Climate Change

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ABSTRACT

Squilla mantis shrimp is extremely a good source of high nutritive value making them a very healthy choice for human food. Therefore, the objective of the present study is to examine the relationship between environmental factors and the proximate composition of *Squilla mantis* (stomatopoda - squillidae): as an indicator of the impact of climate change. Through measurement of the environmental factors (temperature, salinity, pH value, and dissolved oxygen) measured seasonally, at the same time of proximate composition and biochemical constituents were analyzed seasonally in the muscle tissue of *Squilla mantis*. The Crude protein, lipid, carbohydrate, calorific value, moisture and ash were quantified in *Squilla mantis*. The statistical analysis of the results showed that the values of the correlation coefficient for different biochemical composition parameters ranged between very strong positive correlation and very strong negative correlation, the relationships were different; the most influential factor is salinity, followed by dissolved oxygen, followed by temperature and pH. It was clear from this study that the ecological state of these constituents is affected by the alteration of environmental factors as a new indicator of the impact of climate change.

INTRODUCTION

In spite of the effects of environmental parameters on marine organisms had been studied before in several articles, but the field is still large and needs more innovative studies, especially after the emergence of the phenomenon of climate change. According to Posey (1986), these characteristics have a significant impact on marine creatures. Data on environmental influences on retentions aids in understanding not only the likely implications of ocean warming and acidification, but also seasonal and inter-annual fluctuations in fisheries production.

Whiteley (2011) investigated the physiological and ecological responses of crustaceans to ocean acidification, concluding that the species most vulnerable to ocean acidification are entirely marine and have limited physiological capacities to adapt to environmental change. As a result of these changes, species survival, range, and abundance may be impacted. According to Akram Ullah *et al*. (2020), the biochemical composition varies by species (*Scylla olivacea*). Despite the fact that no data on the elements that may influence it is collected.

In the South coast of Mediterranean Sea, Physico-chemical parameters were found to be unstable which affected by the disposal of mainly acidic sewage and industrial effluents (Mohamed, 2006). Community composition and structure are likely to be affected by numerous interacting environmental factors such as temperature, wave action and salinity (Underwood, 1981). Also, Davenport *et al*. (2009) found that temperature greatly affects marine organisms. Physical and chemical stress caused by climate changes in ecological parameters has had an impact on the physiology and distribution of marine creatures (Rico and Fredriksen, 1996; Snyder, 2004 and Davenport *et al*., 2009). A change in mean water temperature represents climate change projections over the next 50 years (IPCC, 2007).

We focus principally on the impacts of temperature, salinity, and oxygen on development and close with a summary of the implications of climate change, particularly ocean warming and acidification, which are fast-growing and rapidly changing fields of inquiry written (Bridget *et al*., 2014)

The pH of natural waterways is a significant component in their chemical and biological systems. The photosynthetic activity of aquatic flora, temperature, salinity, and the number of organic components all have a significant impact (Hutchinson, 1957 and Abd-Elaziz, 2009). Due to climatic change, the salinity of marine habitats can fluctuate both seasonally and seasonally (Johnson *et al*., 1991).

The findings of Velasco *et al*. (2019) investigations showed that global change is linked to variations in salinity and other significant abiotic stresses (such as temperature, pH, pollutants, etc.) Many physiological variables that determine the performance of aquatic organisms are studied at the organism level.

According to Vincent *et al*. (2008), high frequency dissolved oxygen measurements in Mediterranean coastal lagoons exhibit varied dynamics on different time scales, with this variance influenced by a variety of physical and chemical parameters. According to Whiteley (2011), the consequences of numerous ecological stressors on the survival of marine crustaceans have been understudied.

Understanding and anticipating the effects of numerous stressors in the face of global change is one of the most serious concerns in conservation and applied ecology (Cote *et al*., 2016 and Schafer & Piggott, 2018). These alterations at the organism level are the primary and most sensitive reactions to stress (Crain *et al*., 2008), but they may eventually affect community composition (Folt and Chen, 1999) and interfere with ecosystem processes and services that support human wellbeing (Folt & Chen, 1999 and Gutierrez-Canovas *et al*., 2019).

In recent years, several meta-analyses have synthesized the findings of studies that examined the combined effects of multiple stressors in marine ecosystems (Harvey *et al*., 2013; Przeslawski *et al*., 2015 and Berger *et al*., 2019) and freshwater ecosystems (Jackson *et al*., 2016), at many organisational levels, ranging from organisms to communities, and have produced disparate outcomes.

While numerous stressors have been demonstrated to have a synergistic effect on marine systems, there is needing for more study to specially examine the biological responses of inland aquatic species especially marine invertebrates

to the combined effects of salinity increases and other global change stressors. (Özyurt *et al*., 2005). Benedetta and Paul (2021) pointed out that there is evidence of a shortage that has been discovered to supplement scientific knowledge to changing environment about mantis shrimp (*Squilla mantis*),and can be used to assess long-term changes and habitat status. which we need it to improve the status of marine ecosystems.

As a result, the goal of this study is to identify changes in *Squilla mantis* proximate composition (crude protein, lipid, carbohydrate, calorific value, moisture, and ash) caused by environmental factors (temperature, salinity, pH value, and dissolved oxygen) as an indicator of the impact of climate change, by measuring and identifying these variables and statistically evaluating the relationships among them.

MATERIALS AND METHODS

A total of 108 specimens of *Squilla mantis* were collected seasonally from the Mediterranean Sea Southwestern coast of al max Bay, (Alexandriah Governorate). during the period from January 2014 to January 2015, specimens stated as XL size were collected fresh from the study area. The obtained specimens were preserved in iceboxes and transported to the laboratory of Marine Biology, Zoology Department, Faculty of Science, Al-Azhar University, Nasr City, Cairo, Egypt for later examinations. In the laboratory, crustacean species were examined and identified according to FAO species identification sheets for fishing purposes were used as a reference for identification (Anone, 1973). Total length was measured to the nearest millimetres and recorded and also weight-weighted in grams and the following studies were carried out.

Physico-Chemical Parameters:

The water samples were taken seasonally below the water surface (About 30 cm) and preserved immediately by a few drops of chloroform. The four environmental parameters (surface water temperature, salinity, pH, and dissolved oxygen) were assessed seasonally by the following:

1. Water temperature was monitored with a mercury thermometer set to 100 degrees Celsius.
2. Salinity was determined by using the gravimetric method (APHA, 1985).
3. The concentration of hydrogen ions (pH) was determined using a pH metre (pH ep3 pocket-sized microprocessor pH meter).
4. Dissolved oxygen was measured using Winkler's technique, which was modified by Parsons *et al*. (1984).

Proximate composition and biochemical constituent:

After the dissection of *Squilla mantis*, a known weight of the edible part was kept under the freezing condition at 4 ^{0}C until the biochemical determination. Total protein was determined using the Folin phenol reagent, which was described by Lowry *et al*. (1951), with a modification provided by Ansell and Lander (1967). Total lipid determination by the method of Knight *et al*. (1972). The carbohydrate content was determined by using the technique of Carrol *et al*. (1955).

Calculation of Calorific Value:

The calorific content of each sample (stage) was determined by multiplying each component by the relevant calorific equivalents for the biochemical composition in each example (4.2 kcal for carbohydrates; 9.45 kcal for lipids and 5.7 kcal for protein). The results were given in kcal/g (Phillips, 1969). Water Content was determined by measuring weight loss at 105°C until steady weight is achieved according to Ruiz-Roso *et al.* (1998). Ash content was determined by incineration at 450–500 degrees to a fixed weight in a muffle furnace according to AOAC (1990).

Statistical Analysis: Statistical tests were carried out using the statistic software, SPSS (2008) to determine (Mean: ẋ, Standard deviation: бx and Pearson’s correlation coefficient), Where the correlation values were explained after calculating them through the following table:

Explanation values of correlation factor

Value of Correlation factor	Meaning	Abbreviation
+1	perfect positive correlation	p. p. c.
From 0.9 to 0.99	Very strong positive correlation	V. s. p. c.
From 0.7 to 0.89	strong positive correlation	s. p. c.
From 0.5 to 0.69	medium positive correlation	m. p. c.
From 0.3 to 0.49	weak positive correlation	w. p. c.
From 0.01 to 0.29	Very weak positive correlation	V. w. p. c.
0	no correlation	no c.
From -0.01 to -0.29	Very weak negative correlation	V. w. n. c.
From -0.3 to -0.49	weak negative correlation	w. n. c.
From -0.5 to -0.69	medium negative correlation	m. n. c.
From -0.7 to -0.89	strong negative correlation	s. n. c.
From -0.9 to -0.99	Very strong negative correlation	V. s. n. c.

RESULTS AND DISCUSSION

Fluctuation of Environmental Factors:

Data in Table (1) showed that the minimum value of surface water temperature (17°C) was recorded during winter, but the maximum one was measured during summer (26.4°C) with an annual mean of 22.7 ± 3.5. While in spring and autumn seasons, the values of surface water temperature recorded means 21.4 and 24.7 °C, respectively.

At the same time, the general values of salinity (S %) showed that the lowest value (25.6 %) was recorded during winter, but the highest one was measured during summer (34.3 %) with an annual mean of 30.2 ± 3.6; while in spring and autumn seasons recorded means 33.2 and 27.8 % respectively (Table 1).

On the other hand, the minimum value of pH was recorded during spring (7.5), but the maximum one was measured during winter (8.1) with an annual mean of 7.8 ± 0.2; while in summer and autumn seasons recorded means were 7.8 and 7.9 respectively (Table 1).

Regarding dissolved oxygen, the general values of dissolved oxygen ranged from 5.3 mg/l recorded during winter to 6.2 mg/l measured during spring with an annual mean of 5.8 ± 0.3; while in summer and autumn seasons recorded means 6.1 and 5.9 mg/l respectively (Table 1).

Identifying factors that influence crustaceans is one of the keys focuses of crustacean ecologists. Due to the intricacy of the natural marine environment, this aim is challenging to attain (Lee, 2008). Understanding and anticipating the consequences of numerous stressors in the face of global change is one of the most serious concerns in conservation and applied ecology (Cote *et al*., 2016 and Scha & Piggott, 2018).

From a scientific standpoint, understanding the *Squilla mantis* (Stomatopoda - Squillidae) is critical. As a result, this species has a significant impact on the food chain, food web, marine ecosystem, as well as human diet and health. The state of the sea's environment is changing, which has an impact on all physical, chemical, and biological processes (Mohamed, 2006 and Snyder, 2004). Benedetta and Paul (2021) pointed out that there has been a significant decline in the perceived abundance of mantis shrimp (*Squilla mantis*), and evidence of a shortage has been discovered to supplement scientific knowledge, which we need and should improve in order to improve the status of marine ecosystems.

According to Abd-Elaziz (2009), changes in environmental elements in marine habitats have an impact on the biochemical makeup of marine creatures. Seasonal changes in crustaceans may be due not just to changes in water temperature, but also to indirect effects on their food sources (Rico and Fredriksen, 1996).

Proximate Composition:

Data in Table (1) demonstrates the protein, lipid and carbohydrate contents (g /100 g tissue) of *Squilla mantis* and revealed that the protein concentration varied from one season to the next. The maximum figure was recorded during the summer season (12.5 g/100 g). However, the lowest reading was 11g/100 g during the winter season. In the spring and fall, respectively, 12 and 11.3 g/100 g were reported.

In terms of lipid content, the highest value (2.9 g/100 g) was recorded during summer, while the lowest (1.8 g/100 g) occurred during winter; while, 2.3 and 2 g/100 g were found in the spring and autumn seasons respectively. The maximum carbohydrate value was found in the summer season (1.9 g/100 g), while the lowest was found in the winter season (1.2 g/100 g). For spring and fall, it registered 1.7 and 1.3 g/100 g, respectively (Table 1).

Simultaneously, data on Calorific Value (K.cal / 100g) revealed that values varied from season to season. During the summer season, the maximum value was 106 K.cal / 100g. However, the lowest value was 84.84 K.cal / 100g during the winter season. In the spring and fall, were reported 97.24 K.cal / 100g and 88.7 K.cal / 100g respectively (Table 1).

Table (1) demonstrates the water and ash contents (g /100 g) of *Squilla mantis*. In terms of water content, the maximum value was found in the summer season (83.5 g/100 g), while the lowest was found in the winter season (81 g/100 g). For spring and fall, it reported 81.2 and 81.4 g/100 g, respectively.

The maximum value of ash was measured in the summer season (1.8%/100 g), while the lowest was measured in the winter season (1.5 g/100 g); while 1.7 and 1.6 g/100 g were observed for spring and fall, respectively (Table 1).

The proximate makeup of the examined species was seen to be changed from season to season. Farina *et al*. (2003) agree, stating that the feeding of some species can have a significant impact on ecological processes. Temperature or salinity fluctuations cause these alterations (Sumpton and Greenwood, 1990). Changes in the dietary composition of the examined species, as well as other environmental factors, reflect changes in the availability of food type (Choy, 1986), which is also influenced by environmental factors.

The biochemical makeup of *Squilla mantis* edible component changed from one season to the next, according to the findings of this study. *Squilla mantis* with high total protein, total fat, and carbohydrate ratios was investigated. This is something that Amer *et al*. (1991); Hashem (1992); Abd-Elaziz (2009); and Nasef (2016) all agree on.

Protein content fluctuates from season to season, with the maximum value recorded in the summer and the lowest in the winter, according to data on the biochemical makeup of *Squilla mantis*. Moulting, reproductive activity, limb regeneration, and protein deposition in chitin, which creates the carapace, might all cause a reduction in protein levels.

This is consistent with the findings of Highnam and Hill (1979) and Subramoniam (1982). The latter was found to be the lowest when total protein and total fat levels in *Squilla mantis* were examined. This is consistent with the findings of

Hashem (1992) and Venugopal & Shahidi (1998); they showed crustaceans to have a low total lipid content.

During summer, the highest lipid content value was determined, while the lowest value was calculated during winter. The discrepancies in lipid levels might be due to morphological and physiological changes in the studied species. This is in line with the findings of Akpan (1997) and Abd-Elaziz (2009).

The maximum carbohydrate value was recorded in the summer, while the lowest value was obtained in the winter, which agrees with that recorded by Schmitt and Santos (1993). The increases in carbohydrate levels might be explained by increased activity (glycogenolysis) and carbohydrate buildup in the new tissues of moulted and post-moulted crabs. This is consistent with the findings of Siu-Ming Chan *et al*. (1988) and Abd-Elaziz (2009). Similarly, data on Calorific Value (K.cal / 100g tissue) found that values vary by season. The highest value was observed in the summer and the lowest in the winter.

The highest water content for *Squilla mantis* was discovered in the winter season, while the lowest was discovered in the summer season. The greatest levels of ash were detected in the summer, while the lowest levels were detected in the winter. This is in line with the findings of King *et al*. (1990), Naczk *et al*. (2004), and Nasef (2016), they stated that differences in species, diet nutrient composition (Fabris *et al*., 2006), surrounding medium (Kádár *et al*., 2006), and other environmental factors (e.g., season, location, substrate, depth, water salinity, temperature, and anthropogenic influence) (Aidos *et al*., 2002).

Changes in body chemical composition (protein, fat, carbohydrate moisture, and ash) determined by food type, composition, variations in environmental conditions such as temperature and salinity impact fish density and physiological processes (Jassim *et al*., 2014).

Table 1: The relationship between environmental factors and biochemical composition of *Squilla mantis*, collected from the coast of al max Bay, Mediterranean Sea, during the period from January 2014 to January 2015.

Measurements \ Seasons		Winter	Spring	Summer	Autumn	Annual Mean ±SD
Environmental factors	°C	17	21.4	26.4	24.7	22.4 ± 3.5
	‰S	25. 6	33. 2	34. 3	27. 8	30.2 ± 3.6
	PH	8.1	7. 5	7. 8	7.9	7.8 ± 0.2
	O2 mg/l	5. 3	6. 2	6. 1	5.9	5.8 ± 0.3
Proximate Composition	Protein (g/100g)	11	12	12.5	11.3	11.7 ± 0.6
	Lipid (g/100g)	1.8	2.3	2.9	2	2.25 ± 0.4
	Carbohydrate (g/100g)	1.2	1.7	1.9	1.3	1.52 ± 0.3
	Cal. Value (Cecil / 100g)	84.84	97.24	106.6	88.7	94.35 ± 8.4
	W. content (g/100g)	83.5	81.2	81	81.4	81.8 ± 1
	Ash (g/100g)	1.5	1.7	1.8	1.6	1.6 ± 0.1

Ecological State In The Relationship Between Environmental Factors And Biochemical Composition of *Squilla mantis* During This Study:

Data in **Table (1)** showed that the occurrence of *Squilla mantis* was affected by water temperature, pH value, salinity and dissolved oxygen, where the maximum values of protein, lipid, carbohydrate and calorific were recorded during summer with the highest water temperature and salinity and with increasing in dissolved oxygen and pH value, but their minimum values were recorded in winter with the lowest water temperature, salinity and dissolved oxygen; as well as with highest pH value. Seasonal effects on nutrient contents in marine creatures have been explored by Aidos *et al*. (2002) and Hamre *et al*. (2003), although interpretation is difficult and depends on a variety of conditions (Özyurt *et al*., 2005).

The swings in biochemical composition are mostly related to the dietary composition of marine organisms, which is highly influenced by changes in environmental conditions, particularly temperature, with food intake being lower during colder months **(**Suzuki & Shibrata, 1990 and Amer *et al*., 1991).

According to Fouda (2000), chemical composition differs slightly because of changes in size, age, and sampling season. In temperate climates, however, seasonal fluctuations in food items were more noticeable. Seasonal fluctuations in chemical composition may be due to human impacts, pollution, and extreme physical conditions (Amer *et al*., 1991; Fouda (2000) and Soundarapandian *et al*. (2013).

Banu *et al*. (2016) used proximate composition studies to evaluate the nutritional status of penaeid prawns, emphasising that all penaeid prawns are supposed to be a source of food for human consumption. Also, because enzyme activity during shellfish catching is normally minimal, the shift in biochemical composition could be related to this (Venugopal and Shahidi, 1998). Because the elements are numerous and overlap, this study attempted to determine the magnitude of their impact and which are more influential.

Statistical Analysis:

Data in Table (2) showed that the values of the correlation coefficient for different biochemical composition parameters relationships were very far to unity. Salinity exhibited a very significant correlation with protein, lipid, carbohydrate, calorific value, and ash, despite the fact that the values of the correlation coefficient for water content were very negatively correlated with salinity.

In addition, dissolved oxygen had a high positive correlation with protein, lipid, carbohydrate, calorie value, and ash, despite the fact that water content had a very negative correlation coefficient with dissolved oxygen.

At the same time, the temperature had a moderate positive association with protein and carbohydrate, but it had a significant positive correlation with lipid, calorific value and ash whereas temperature was strongly negatively correlated with water content.

On the other hand, pH had a moderate negative association with protein and carbohydrate, as well as calorific value and ash, and a weak negative correlation with lipid; nevertheless, pH had a substantial positive correlation with water content.

Table 2: The relationship between environmental factors and biochemical composition of *Squilla mantis* with statistical analysis**.**

Prox. Comp., / Envi. Factor	Pearson's correlation coefficient											
	Protein		Lipid		Carbohydrate		Calorific value		Water content		Ash	
	Correl-ation value	Correlation degree	C. value	C. Degree	C. value	C. Degree	C. value	C. degree	C. value	C. degree	C. value	C. degree
°C	0.68	m. p. c	0.73	s. p. c.	0.62	m. p. c	0.70	s. p. c.	-0.88	s. n. c.	0.77	s. p. c.
S	0.98	V. s. p. c.	0.90	V. s. p. c.	0.98	V. s. p. c.	0.95	V. s. p. c.	-0.81	s. n. c.	0.97	V. s. p. c.
PH	-0.66	m. n. c.	-0.48	w. n. c.	-0.69	m. n. c.	-0.59	m. n. c.	0.74	s. p. c.	-0.67	m. n. c.
O2	0.81	s. p. c.	0.71	s. p. c.	0.80	s. p. c.	0.77	s. p. c.	-0.96	V. s. n. c.	0.86	s. p. c.

The findings of statistical analysis revealed that the correlation coefficient values for several biochemical composition parameter relationships were different in this study.

Despite the fact that the study found a substantial association between salinity and biochemical composition, the results of the correlation coefficient for water content were very adversely correlated with salinity. Similarly, dissolved oxygen had a substantial positive correlation with biochemical composition, despite the fact that water content had a very negative correlation coefficient with dissolved oxygen.

At the same time, the temperature had a moderate positive correlation with protein and carbohydrate, as well as a significant positive correlation with lipid, calorie value and ash, and a high negative correlation with water content. On the other hand, pH had a moderate negative correlation with biochemical composition and a weak negative correlation with lipid, despite the fact that pH had a substantial positive correlation with water content.

This statistical study aims to determine the magnitude of the association between changes in environmental conditions and the biochemical composition of marine organisms; it becomes clear to us that the most influential factor is salinity, followed by dissolved oxygen, followed by temperature and pH. It is no secret that these factors are affected by environmental pollution and the resulting climate changes.

Global environmental change is having quantifiable consequences on the epipelagic realm in marine systems, according to Vicenç *et al*. (2021). According to Oliver *et al*. (2018) and Frölicher *et al*. (2018), the frequency and severity of maritime heat waves (MHWs) are rising as a result of climate change.

These effects have an influence on epipelagic ecosystem species, particularly those that sustain high-value commercial fisheries, either directly or through trophic interactions. Physiological changes have been used in the past to infer the ecological consequences of ocean acidification (Fabry *et al*., 2008; Guinotte & Fabry, 2008; Widdicombe & Spicer 2008 and Dupont *et al*., 2010).

As a result, crabs may be found in a wide range of aquatic environments with varying degrees of environmental fluctuation. Those who dwell in deep oceans and at high latitudes originate from environments that are relatively stable in terms of physical factors through time and space. Other habitats, such as the intertidal zone and estuaries, can experience enormous and rapidly changing oscillations in physical variables as a result of diurnal fluctuations in tide height. Variations in freshwater and fertilizer inputs cause seasonal changes in the physical properties of estuarine ecosystems.

Researchers may use crustacean studies to look at the link between environmental unpredictability and the capacity to withstand ocean acidification, which has recently been explored in the literature (Fabry *et al*., 2008 and Widdicombe & Spicer 2008).

According to Abd-Elaziz (2009), changes in salinity and other significant abiotic stressors are connected to global changes at the organism level on many of the physiological parameters that impact aquatic species' functioning?.

According to Vincent *et al*. (2008), high frequency dissolved oxygen measurements in Mediterranean coastal lagoons show distinct dynamics across time, with this variation driven by a range of physical and chemical characteristics. This is also in agreement with Underwood (1981) and Davenport *et al*. (2009), who found that temperature has a significant impact on marine organisms, while Crivelli (1982) stated that, despite rapid environmental changes; temperature is the most important environmental element influencing *Palaemon squilla* activity.

Temperature, salinity, and the number of organic components all have an influence on the photosynthetic activity of aquatic plants (Hutchinson, 1957 and Abd-Elaziz, 2009). Although the results of this study provide detailed information about the biochemical composition of *Squilla mantis*, the most common marine benthic crustacean in the Mediterranean Sea, they also reflect the impact of environmental factors on the biochemical composition of one marine benthic crustacean, which calls for more research and studies.

Finally, we need additional research into the effects of the environment on crustaceans utilising single and double variable trials.

These experiments are usually carried out to gain a better understanding of biological processes. It's time to take a more comprehensive approach to understand environmental variability and climate change, as well as their consequences, by putting large-scale, long-term datasets to work, as well as large-scale oceanographic and biophysical modelling, to start constructing a testable hypothesis.

Conclusion:

The results showed that the values of the correlation coefficient between environmental factors and biochemical composition parameters were different, the most influential factor is salinity, and the less influential factor was pH. It was clear from this study the ecological state affected by alteration of environmental factors is a new indicator of the impact of climate change.

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ARABIC SUMMARY

الحالة البيئية في العلاقة بين العوامل البيئية والمكونات البيوكيميائية لجمبري سكويللا مانتيس كمؤشر متوقع لتأثير تغير المناخ

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يعتبر جمبري سكويللا مانتيس مصدرًا جيدًا للغاية ذو قيمة غذائية عالية مما يجعله خيارًا صحيًا للغاية للطعام البشري. لذلك، فإن الهدف من هذه الدراسة هو فحص العلاقة بين العوامل البيئية والتركيب التقريبي للحيوان القشرى سكويللا مانتيس – فميات القدم: كمؤشر متوقع لتأثير تغير المناخ. وذلك من خلال قياس العوامل البيئية موسمياً (درجة الحرارة ، الملوحة ، قيمة الأس الهيدروجيني ، والأكسجين المذاب)، في نفس الوقت تم تحليل التركيب التقريبي والمكونات البيوكيميائية موسمياً في الأنسجة العضلية لسكويلا مانتيس ، تم قياس كمية البروتين الخام والدهون والكربوهيدرات والقيمة الحرارية والرطوبة والرماد في الكائن محل الدراسة ، أظهر التحليل الإحصائي للنتائج أن قيم معامل الارتباط لمختلف معاملات التركيب البيوكيميائي تراوحت بين ارتباط إيجابي قوي للغاية وارتباط سلبي قوي للغاية ، وكانت العلاقات متباينة ، وكان العامل الأكثر تأثيراً هو الملوحة ، يليها الأكسجين المذاب ، يليه درجة الحرارة ثم الرقم الهيدروجيني. وقد اتضح من هذه الدراسة أن هذه العناصر تتأثر بتغير العوامل البيئية كمؤشر جديد ومتوقع لتأثير تغير المناخ.