Accouterments of organic pollution on autotomy and regeneration of *Sesarma boulengeri* (Calman, 1920) in Shatt al-Arab, Basrah, Iraq

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- Part of Ph.D. dissertation for the first author.
- Date of research received 26/10/2023 and accepted 31/12/ 2023.

Abstract

Sesarma boulangeri (Calman 1920), a type of freshwater invertebrate, was collected between January and December 2022 from three stations at the Shatt AL-Arab River, Basrah/ Iraq in order to conduct the research. The goal of the study was to determine the effect of organic pollution on autotomy in this species of crab. The organisms were subjected to varying levels of organic contamination in the river that came from sewage, farming activities, boat traffic, and transportation of products and oil derivatives using the organic pollution index (OPI). The left fifth leg's object was the reason for the autotomy. According to the characteristics of the water quality impacted by the oscillation, the cut creatures have varied indicators in response to the aquatic species. As a result, an extended period of growth for the regenerated portions is caused by the rise in organic contaminants in the water. Thus, the present findings indicate that *S. boulengeri* exposed to high amounts of organic pollution has a slower rate of replacing the cut component than control animals, that the growing bud is more vulnerable to distortion, and that the period of compensating for the cut part is longer. According to the OPI result shows that the first station has significant difference ($P<0.05$) as compared to the sconed and third stations wish did not difference.

Key words Autotomy, Sesarma boulangeri, R- Value, OPI, Regeneration, Shatt AL-Arab
Citation: Al-Kanani, H., Al-Hejuje, M., & Sultan, E. (2024). Accouterments of organic pollution on autotomy and regeneration of Sesarma boulengeri (Calman, 1920) in Shatt al-Arab, Basrah, Iraq. *Kirkuk University Journal For Agricultural Sciences*, 14(4), 235-242. doi: 10.58928/ku23.14421
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Introduction

Invertebrates are defined as organisms that can be observed without the aid of a microscope and are typically found in water bodies close to sediments and bottoms [1]. Invertebrates are found in a variety of habitats; some are terrestrial, others are aquatic, and some spend part of their lives in one environment and the remainder in another [2]. Large-sized invertebrates are used as a tool in biomonitoring programs all over the world and are frequently regarded as crucial in determining the quality of water [3]. The diversity of big invertebrates is a result of the environment's degradation and its ability to tolerate toxins, making it a useful indicator of pollution. Other species can survive in a contaminated environment and can withstand the harshest circumstances, including a rise in water temperature, an oxygen shortage, and the admission of pollutants [4].

The ability of some animals to disassemble specific body parts in reaction to stress is known as autotomy. Therefore, Autotomy may increase an organism's chance of surviving in challenging circumstances. Numerous organisms possess this characteristic, including numerous vertebrates, arachnids, and echinoderms [5]. A decapod can be autotomized by removing any one of its ten pereopods (limbs), including its walking limbs (chelipeds) and swimming legs in those that have them. The extent to which an individual who has autotomized one or more limbs may continue "normal" physiological or ecological functions is unknown for the majority of animals [6]. In spite of the fact that these limbs undoubtedly have a function, individuals with a high number of autotomized limbs are more likely to have issues with growth, survival from additional predatory attacks, competitive ability, feeding rate or behavior, movement (including the ability to swim), mating behavior, or energy allocation during limb regeneration. For instance, Taylor and Jackson [7] found that jumping spiders with high autotomy levels were less likely to have successful intrasexual relationships.

Despite the terminology used above, the term "autotomy" is still frequently used to describe the self-harm phenomenon. It is defined as the removal of an appendix or appendages of the body, regardless of the reason or method for cutting [8]. One of the creatures that has expanded to the Shatt al-Arab's intertidal waters is the crab *S. boulengeri* (Calman, 1920). *S. boulengeri* was initially found by Calman [9], who recognized it as a new species of the *genus Sesarma*. The research done by Ali [10] on the biological traits and behavior of the animal *S. boulengeri* in its natural habitat is regarded as the country of Iraq's first environmental study. Therefore, this study was designed to investigate the effect of organic pollutants on autotomy in one species of freshwater crab (*S. boulangeri*).

Materials and methods

Samples were collected monthly from the three-study station from the intertidal zone of Shatt Al-Arab River (Sindibad Island, Abi al-Khasib, and Al-Siba) (**Fig. 1**.), starting from January to December 2022, randomly. Male and female *S. boulengeri* animals of various sizes were taken from the study locations and put in plastic troughs (60 x 30 x 30 cm) with three aquarium for each area and five animals in each aquarium contained polluted river water with a small amount of fine gravel at a laboratory temperature of 27±3 °C. They were brought to the lab and left there for three days in order to acclimate.

Figure 1. The study area

Utilizing the organic pollution index (OPI), determine how much the process of regeneration and restoration of cut parts in S. boulengeri is affected by organic pollution by using some of water variables including, nitrate (NO_3), phosphate (PO_4), ammonia (NH_4), and the biochemical oxygen demand (BOD_5).

The regeneration index (R-Value), which is determined by Waterman [11], was calculated from the lengths of the buds produced throughout the regeneration process.

$$R=L/W\times100$$

Where: L= length of the new bud and W= Shield width

Picture 1. *Sesarma boulengeri* (Calman 1920)

Autonomy process

A single cutting of the fifth hind leg was performed on the *S. boulengeri* animal at the junction between the patella (trochanter) and the femur using a small, thin forceps to cut the animal precisely and without allowing bleeding. Every month, an electronic tool was used to measure the length of the growing shoots on the harvested legs, and the animals received enough food from the animal diet. The experiment used polluted water from the Shatt Al-Arab River.

Calculation of organic pollution index (OPI)

After determining the time period, variables, and criteria, the following equation and modified in accordance with the Shatt al-Arab to calculate the organic pollution index, as the equation was modified to a percentage scale to be more acceptable to decision makers and the general public, as shown in [12]: -

$$OPI=(\sum\ 〚Ci/Cmi)/n\times10〛$$

Where: Ci: the recorded value for each variable analyzed; Cmi: the maximum allowed of each variable (Table 1) and, n: the number of variables used to calculate the index.

Table (1): The maximum limits allowed for the variables of organic pollution index.

Pointers	The maximum allowable limits				Measuring unit
	Salim [13]	EPA [14]	EPA [15]	The Iraqi Standards and Metrology Organization	
BOD5	4	-	-	<5	mg/l
PO4	0.15	0.13*	0.04*	0.04	mg/l
NH4	0.4			1	mg/l
NO3	2	0.76**	0.9**	15	mg/l

* Total Phosphor ** Total Nitrogen

Results

The figure.3 shows the monthly changes in the values of the organic pollution index at the study stations. It is noted that the highest value was 72 in November at the third station, while the lowest value was 26 in October at the first station.

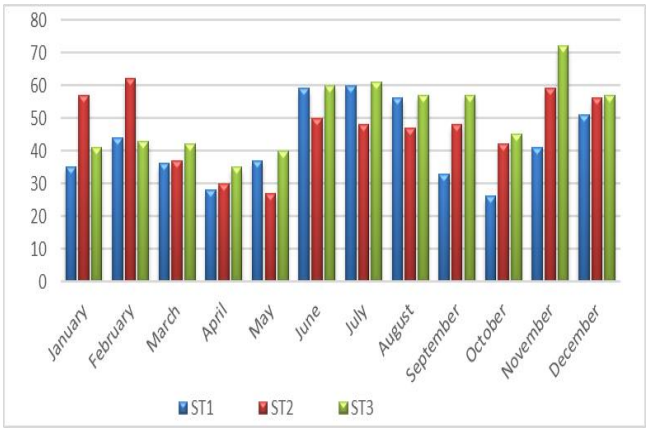
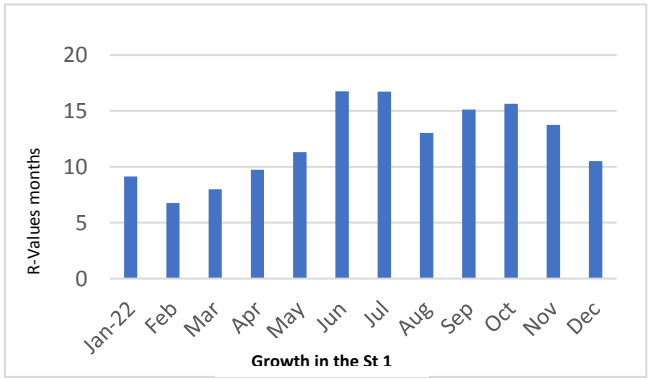
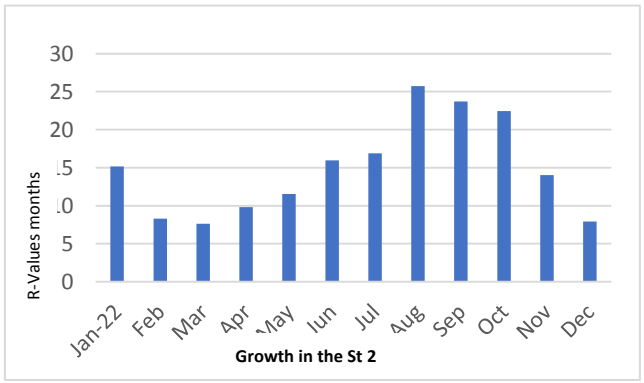
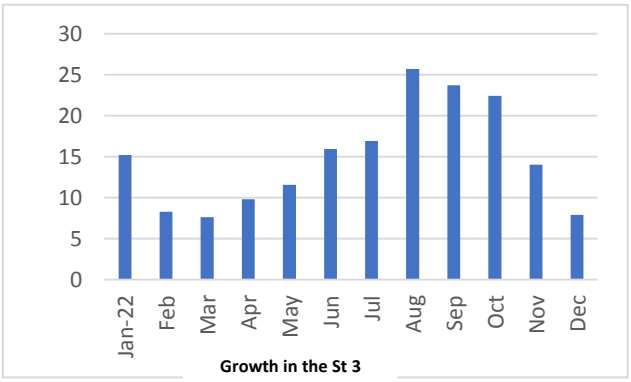


Figure. 3. Organic pollution levels in the study areas

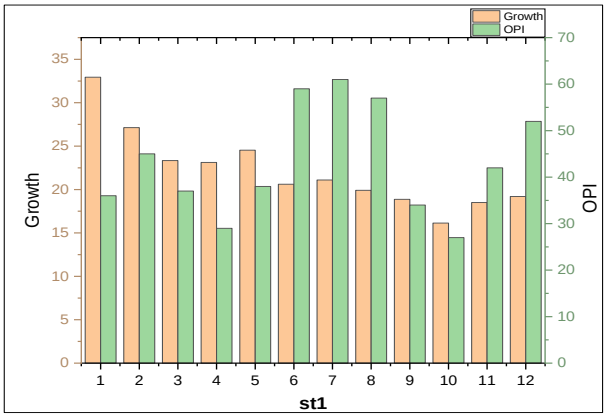
The results showed the length of the growth part that was cut during 12 months, up to the full foot of the animals that were cut in the laboratory and exposed to organic pollution during the study period, as in (Figures 3, 4, and 5).

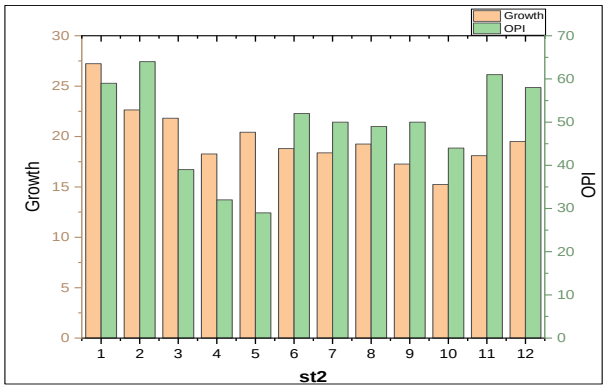


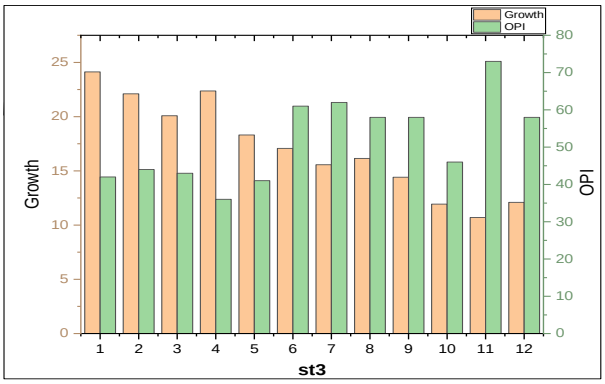




The results show the effect of organic pollution on the growth of the harvested parts of the crab during the study period, as shown in (Figures 6, 7 and 8).







Discussion

The present findings revealed regional and seasonal differences in the organic pollution index values, and it was discovered that the second station was more contaminated than the other stations as a result of the vast amounts of wastewater that were dumped into the Shatt al-Arab. The station is more exposed to untreated sewage water, agricultural waste laced with chemical fertilizers, and animal excrement that flows through the river because of its proximity to residential areas. All of these factors contribute to rising organic matter concentrations and high organic pollution index scores. The Karmat Ali River, which is known for having low concentrations of organic pollutants, brought in additional water from the east Al-Hammar marsh, which caused the organic matter concentration to be diluted, which led to a decrease in index values at the first station [16,17]. On other hand, the third station was located in an area with organic pollution brought on by ships and boats, as well as sewage and industrial water from Iranian refineries in Abadan and Muhammarah city that were tidally carried into the area. According to the study, spring levels were low and summer values were high. The increased consumption of nutrients by phytoplankton and aquatic plants throughout the summer, as well as the leaking of chemical fertilizers from nearby agricultural fields, are the causes of the elevated values in [18]. The increase in the rate of decomposition of organic matter during the Summer is caused by high temperatures, and the fall in values during the spring is linked to a decrease in nutrient concentrations and an increase in phytoplankton ingestion by aquatic organism. As a result, the contamination index values are low [19]. According to the present findings of the *S. boulengeri*, the regenerated component is softer and deeper in color than the autotomized original organ. It was discovered in the current study that crabs exposed to high levels of organic pollution have a slower rate of replacing the cut part compared to control animals and that the developing bud is more susceptible to deformation, as well as an increase in the period of compensation of the cut part, as confirmed by Weis & Weis [20]. This is because dyes are present in the cells of melanophores as a result of the pollutant in *S. boulengeri* limulus polyphemus. The present findings indicate that the length of the growing bud changes according to the size classes of *S. boulengeri*, we may find it longer during the exposure period in the small size classes than it is in the large. These results are in agreement with the studies of Jamall and Roque [21]; Itow et al. [22] and Weis et al. [23] as they attributed this to the fact that the speed of growth of missing parts in young animals is greater than it is in large animals.

The current results demonstrated that the length of the growing bud is influenced by the amount of pollutants that the animal is exposed to in its surroundings. This is supported by the fact that growth is reduced in the months when the OPI is at its highest levels. According to Ballarin et al. [24], stem cell abnormalities have a direct impact on an organism's functions and a secondary impact on how well it can adapt to environmental changes. Temperature plays a significant effect in the process of regenerating the cut sections, as Pushpalatha et al. [25] found in their study on the reaction to the cutting process in the freshwater crab (*Paratelphus hydrodromous*). Also, low temperatures affect the reduction of pain signals to the brain and thus affect the process of losing parts when exposed to predation. the length of the developing bud in Fiddler crabs is affected by increasing concentrations of pollutants in the water, as increasing the concentration of pollutants inhibits the germination process, causing deformities in the developing bud and delaying the speed of germination [26,27]. factors that slow down and prevent growth in the same strain of *S. boulengeri*. They explained this by stating that heavy elements prevent cell differentiation and that increasing the concentration of elements prevents the growth of developed internal cells in the developing bud. They also stated that the process of cell.

Division is stopped or obstructed by the

Disruption of the gland's endocrine system, with the cells being impacted by the rise in organic pollutants on the cut part. The present findings agree with the study of Itow [28] in that the number of cut parts affects the speed of growth in the developing part of horseshoe cancer. The study found that there were clear and significant differences between the study stations with regard to the speed of growth, as the second and third stations were close and there were no significant differences ($P<0.05$) between them due to the exposure of the two areas to approximately the same level of pollution. As for the first station, there were significant differences ($P>0.05$) in the growth process as well as in the level of pollution at the second and third stations.

Conclusion

This study indicates that harvested organisms have different markers in the response of aquatic organisms to water quality parameters affected by oscillation. Growth is affected by the increase of organic pollutants in the water, which leads to a long period of growth of renewable parts. And the impact of the organic pollution that is increasing in the waters of the Shatt al-Arab, which is the main water source for nearly four million people in Basra, Iraq.

Acknowledgement

Thanks, and appreciation to the Department of Fish and Marine Resources, College of Agriculture, and Department of Ecology, College of Science, University of Basra, for providing support.

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- جزء من اطروحة الدكتوراه للمؤلف الأول.
- تاريخ استلام البحث 2023/10/26 وقبوله 2023/12/31.

الملخص

صممت هذه الدراسة لدراسة تأثير التلوث العضوي على عملية القطع في أحد أنواع كائنات المياه العذبة السرطان النهري: *Sesarma boulangeri* (Calman 1920) والتي تم جمعها خلال فترة الدراسة (كانون الثاني إلى تشرين الثاني 2022) من ثلاثة مواقع في نهر شط العرب. وتعرضت الكائنات الحية لتراكيز مختلفة من التلوث العضوي في نهر شط العرب الناتج عن الصرف الصحي والأعمال الزراعية وحركة القوارب ووسائل نقل المشتقات النفطية والبضائع. تم إجراء القطع الذاتي لجسم الساق الخامسة اليسرى. تشير هذه الدراسة إلى أن الكائنات المقطوعة لها علامات مختلفة في الاستجابة في الكائنات المائية حسب معايير نوعية المياه المتأثرة بالتذبذب. ويتأثر النمو بزيادة الملوثات العضوية في الماء مما يؤدي إلى فترة طويلة من نمو الأجزاء المتجددة. وجد في الدراسة الحالية أن السرطانات المعرضة للتلوث العضوي بمستويات عالية لديها سرعة بطيئة في استبدال الجزء المقطوع مقارنة بالحيوانات المعرضة الى مستويات منخفضة من التلوث وأن البرعم النامي أكثر عرضة للتشوه، فضلا عن زيادة في فترة تعويض الجزء المقطوع أظهرت الدراسة وجود فروق معنوية ($P<0.05$) بين المحطات الأولى والثانية والثالثة. ولم تكن هناك فروق معنوية ($P<0.05$) بين المحطتين الثانية والثالثة.

الكلمات المفتاحية: القطع؛ السرطان النهري؛ دليل الاخلاف؛ دليل التلوث العضوي؛ التجديد؛ شط العرب