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First record of morphological malformations in the blue swimming crab, *Portunus segnis* (Portunidae: Brachyura) from the Timsah Lake, Suez Canal, Egypt

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ABSTRACT

The objective of this study is to document the presence of external morphological malformations in the blue swimming crab *Portunus segnis* (Forskal, 1775) (= *Portunus pelagicus*), from the Timsah Lake, Suez Canal. A total of 269 specimens were collected, out of which 28 individuals (19 males and 9 females, 7% and 3.4 % respectively) showed malformations with different percentages in chelipeds, swimming legs, carapace and abdomen. The presence of malformations was different between sexes. In males, the malformations were observed principally in the chelipeds, while in females were in the chelipeds and swimming legs. The cause of the malformation could be related to wound healing processes after an injury or molting artifacts, and perhaps developmental disorders based on toxic substances.

INTRODUCTION

Morphological malformations are changes that appear through development in the form of random deviations from perfect bilateral symmetry **(Tomkins and Kotiaho, 2001)**. Malformations produce body parts of disproportionate sizes, irregularly shaped body segments and/or additional appendages **(Araújo and Calado, 2012)**. Morphological malformations have been reported in embryos, larvae, and adult crustaceans mainly related to loss and modifications of the appendages. These show various degrees of loss, fusion, or multiplications of branches or appendage segments **(Nakatani *et al*., 1997; Hoch and Yuen, 2009)**.

Morphological changes arise naturally as a result of ecdysis **(Zanata *et al*., 2008)**, or produced by factors such as abnormal regeneration **(Rasheed *et al*., 2014; Purohit and Vachhrajani, 2016)**, parasitic infestations, mutations **(Von Vaupel Klein and Koomen, 1993)** or exposure to extreme environmental conditions **(Kurihara, 2008; Pandourski and Evtimova, 2009)**.

Morphological malformations have been reported for several groups of crustaceans, such as Copepoda **(Dias, 1999)**, Decapoda **(Mariappan *et al*., 2000)** and Cladocera **(Elmoor- Loureiro, 2004)**. As for the Infraorder Brachyura, **Gamo (1964)** described anomalies in the abdomen, pleopods, pereiopods and carapace of several species in Japan. **Okamoto (1991)** reported that abnormalities found in the chelipeds of

the red crab, *Geryon affinis*, inhibiting Suruga Bay, Shizuoka Prefecture, Japan are due to abnormal wound healing. **Mantelatto *et al*. (2000)** described anomalies in the abdomen of the swimming crab, *Callinectes ornatus*, whose specific causes could not be determined from Ubatuba Bay, Brazil. **Zou and Fingerman (2000)** reported an intersex individual of the fiddler crab, *Uca pugilator*, from Louisiana, U.S.A. and explained that it could be due to endocrine problems. **Zambrano (2017)** recorded the first case of malformation in the mangrove crab, *Ucides occidentalis*, in 11 specimens from the Gulf of Guayaquil, Ecuador.

The blue swimming crab, *Portunus segnis* (Forskål, 1775) (= *Portunus pelagicus*, according to **Lai, *et al*., 2010**) is an edible species fished by local fishermen in Egypt. This crab grows to a considerable size and weight and is considered one of the important commodities all over the world **(Rasheed *et al*., 2014)**. The biology and ecology of *P. segnis* have been studied in the Suez Canal by **Fox (1924)**. However, the previous studies including **Arshad *et al*.(2006)**, **El-Serehy(2018)** and **Abdel Razek *et al*.(2019)** did not report malformation in this species.

The present work aims at report and describe, for the first time, the occurrence of external malformations observed during an investigation on the biology of edible crab *P. segnis* and suggest reasons that might have caused these malformations.

MATERIALS AND METHODS

1. Study area:

Timsah Lake is one of the three lakes that constitute the Suez Canal **(Saad *et al*., 2016)**, and it is located to the south of Ismailia City (**Fig. 1**). It has an area of about 8 km^2 and an average depth of 10 m. The lake receives fresh water from the River through the Ismailia Canal, thereby reducing salinity **(Abd El Samie *et al*., 2008)**.

2. Collection and processing of samples:

Samples were collected between April 2021 and July 2021. Random samples of *Portunus segnis* were taken from the commercial catches. Trammel nets (locally known as Dabba and Dahabana) were employed by fishermen instead of bottom trawlers (Kalsa). The total catch was collected and stored in plastic buckets before being transferred to a laboratory for analysis at Marine Department, Faculty of Science of Suez Canal University. Measurements of carapace length (CL) and carapace width (CW) were obtained using a digital Vernier caliper. All collected specimens were adults. Adult mature males and females over 75.4 and 79.2 mm CW respectively were considered. Morphological malformations were recognized by examining specimens and comparing them with the typically normal individuals. Photographs were taken with Samsung Galaxy Note 8 Camera, and then edited by Adobe Photoshop for Windows.

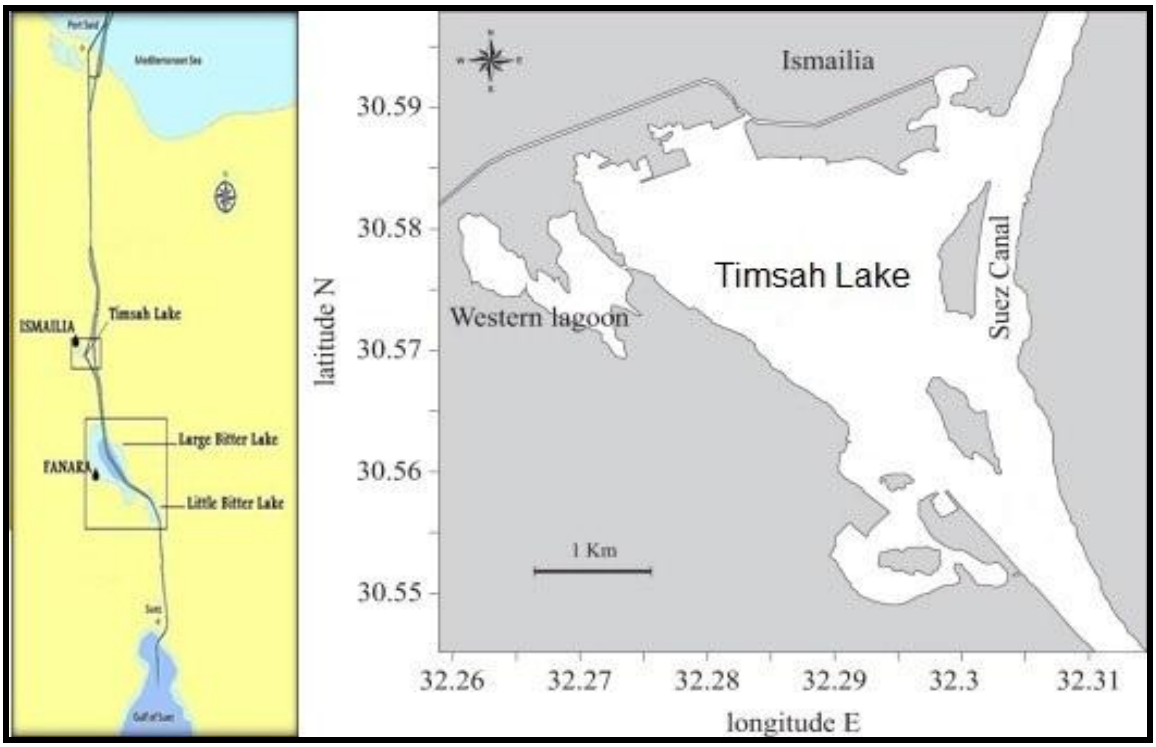

Fig.1. Map showing the location of Timsah Lake at the south of Ismailia City, Egypt.

RESULTS

Out of the 269 specimens collected (174 males and 95 females), 28 (19 males and 9 females), represent 10.40 % (7.06 % and 3.35 % males and females, respectively) were observed to have different types of malformations. The presence of malformations was different between sexes. In males, the malformations were observed principally in the chelipeds, while in the females were in the chelipeds and swimming legs (**Table 1**).

Table 1. Types of malformations observed among specimens (n= 269).

Type of abnormality	Specimens		% of all examined specimens	Sex			
	No.	% of all affected		♂	%	♀	%
Cheliped malformation	15	53.57	5.6	11	4.1	4	1.5
Swimming leg malformation	7	25.0	2.6	3	1.1	4	1.5
Abdomen malformation	4	14.29	1.5	3	1.1	1	0.4
Carapace malformation	2	7.14	0.7	2	0.7	0	0
Total	**28**		**10.41**	**19**	**7**.06	**9**	**3.35**

n= Total no. of examined specimens.

1.1. Cheliped malformation:

Fifteen abnormal specimens (11 males and 4 females) were identified (**Fig. 2**). They had an anomaly in the left and right meri of chelipeds consisting of: an extra spine (**Fig. 2 A and B**) or a missing spine (**Fig. 2 C**), bifurcated spine (**Fig. 2 D**), different spaces between spines (**Fig. 2 E**), a small extra spine emerging from one of the merus's spine (**Fig. 2 F**) and the existence of a lesion between two spines (**Fig. 2 G**). The most common malformation was an additional spine on the right merus (**Table 2**).

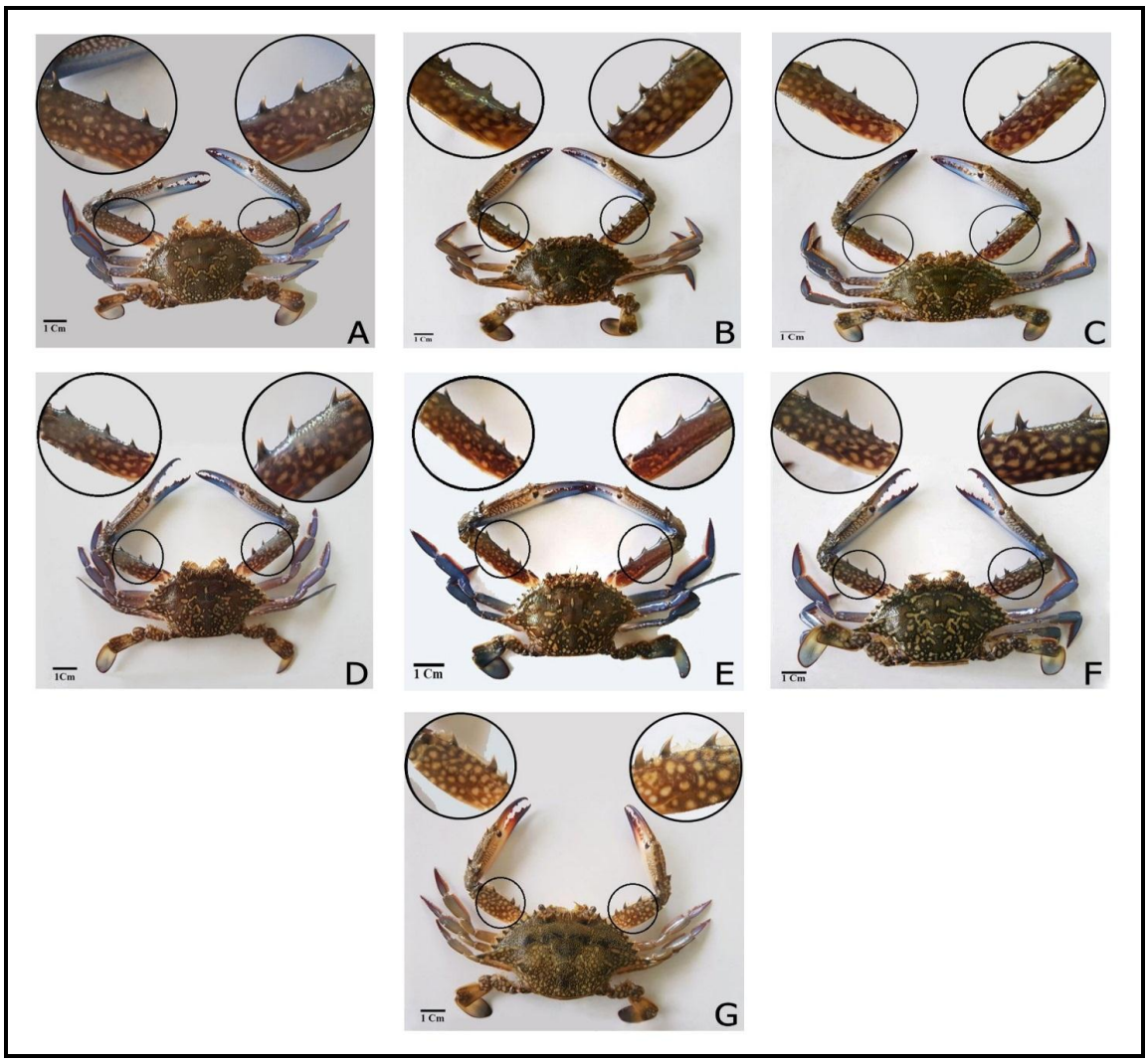

Fig. 2. Morphological malformations of *Portunus segnis* showing: abnormal an extra spine on the left and right meri of chelipeds (A &B) or missing spine (C), bifurcated spine (D), different spaces between spines (E), small spine emerging from one of the merus's spine (F), a lesion between two spines (G).

Table 2. Chelipeds defects observed among specimens (**n=269** individuals).

Chelipeds malformation		No. of specimens	Sex			
			♂	%	♀	%
An extra spine	4 spines on right merus	7	5	1.8	2	0.7
	4 spines on left merus	2	2	0.7	0	0
Missing spine (2 spines on left merus)		2	1	0.4	1	0.4
Bifurcated spine		1	1	0.4	0	0
Different spaces between spines of right and left merus		1	1	0.4	0	0
Small spine emerges from one of merus's spine		1	1	0.4	0	0
Existence of lesion between two spines		1	0	0	1	0.4

1.2. Swimming leg malformation:

The fifth walking leg was abnormal in three males and four females in which the last segment, the dactylus, of the left (**n= 4**) or right (**n= 3**) swimming leg was malformed, by having a notch (**Fig. 3**).

Fig. 3. *Portunus segnis* showing the dactylus of right swimming leg shows notch abnormality compared with the normal left dactylus.

1.3. Abdominal malformations:

Three types of malformations were observed in three males (**Fig. 4**). They were represented by the articulation of the telson with the 6th abdominal segment (**Fig. 4a**), gap between sternite (**Fig. 4a**) and depressed tip of abdomen (**Fig. 4b**). In females, only one

female crab has no or missing telson and the 6th segment fissured at the distal end, the edges folded internally then merged together leaving a small rounded elevated area (**Fig. 4c**).

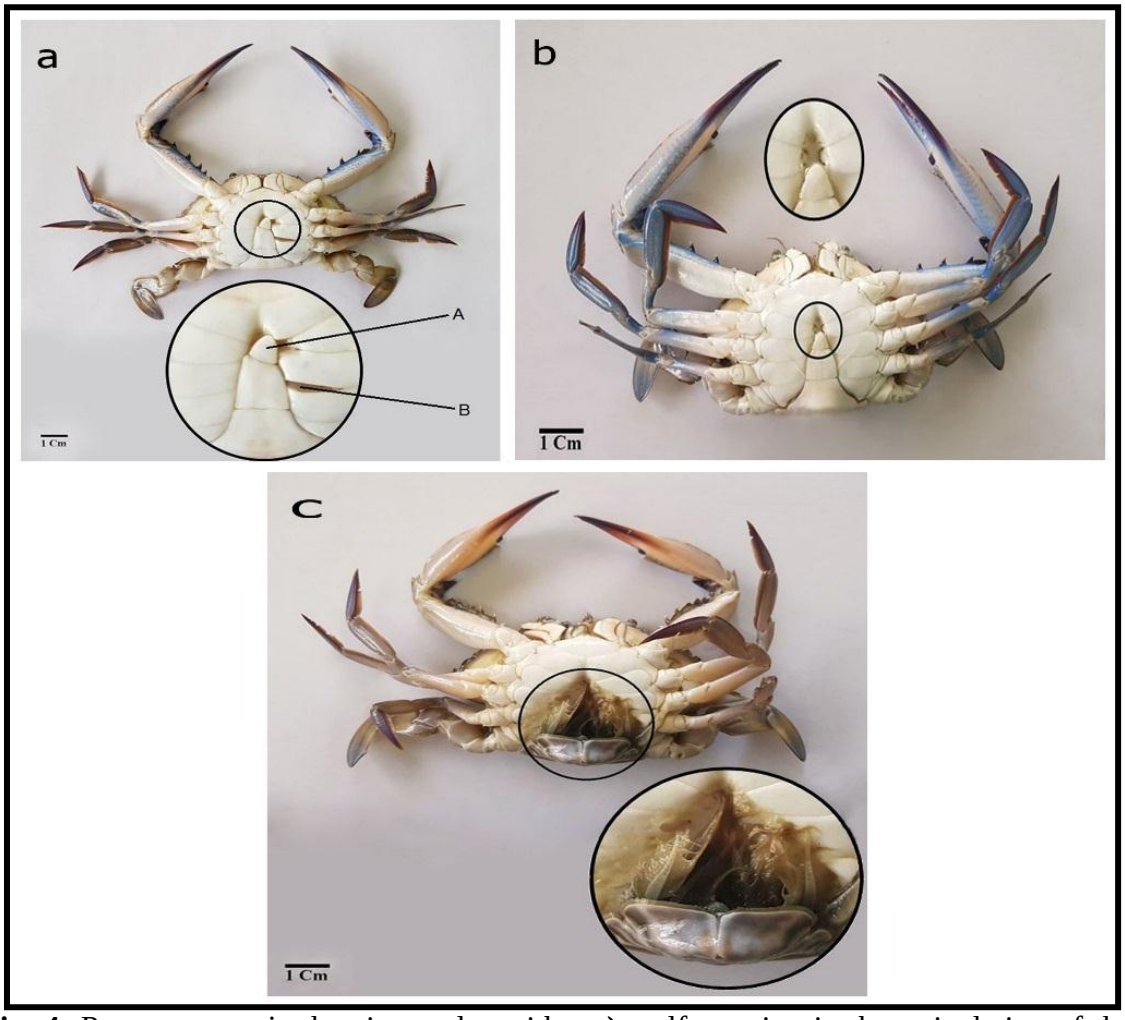

Fig. 4. *Portunus segnis* showing males with: **a)** malformation in the articulation of the telson with the 6th abdominal segment, **(b)** gap between sternites with depressed tip of abdomen**;** and **c)** abnormal abdominal segments in females.

1.4. Carapace malformation:

Two male crabs had malformations in the anterolateral teeth on the right side of the carapace (**Fig. 5**). The third and fourth anterolateral teeth were attached together (arising from the same origin, while the left side of the carapace had normal anterolateral teeth.

Fig. 5. Male of *Portunus segnis* has right 3rd and 4th anterolateral teeth attached together.

DISCUSSION

Over 10% of the examined specimens of *Portuns segnis* (Linnaeus) had malformations, with males exhibiting a higher incidence than females. The majority of the malformations were observed in the chelipeds. The chelipeds may be prone to develop malformations as a result of their greater possibility of injuries from fighting and for being shed in the later stages of molting **(Shelton *et al*., 1981)**. Malformation in the chelipeds of the blue swimming crab has been reported by several authors **(Noble, 1964; James, 1968; Ameer-Hamsa, 1973; Nakatani *et al*., 1992; Rasheed *et al*., 2014)**. In the present work, values for malformations in general and particularly for the chelipeds exceeded greatly those reported for the same species in other parts of the world **(Ramirez- Rodríguez and Félix-Pico, 2010; Rasheed *et al*., 2014; Hajjej *et al*., 2019)**.

Malformation in the swimming legs was noted in the examined specimens with relatively equal percentages for both sexes. **Lawler and Van Engel (1973)** reported that the most common abnormalities in crustaceans reported in the literature are modifications on periopods. **Rasheed *et al*. (2014)** reported a malformation in the swimming leg of one of the two species of the genus *Portunus* in Karatchi, Pakistan and attributed the cause of malformation to an accident during the molting process. On the other hand, **Šaganović *et al*. (2019)** stated that the alteration was may be externally induced, originating from injuries caused by predators and/or conspecifics competition.

In the present study, one type of abdominal malformations was observed in females and three in males. The malformation observed in the female crab is recorded for the first time. Apparently, this anomaly impeded the normal closure of the abdomen and left the abdominal setae exposed. Therefore, the vulnerability of this female during egg carrying

could be increased in terms of not being able to provide the required protection to all the spawn. A malformation in females' abdomen was reported in *Portunus pelagicus* by **Rasheed *et al*. (2014)** where the fourth and fifth abdominal segments in an immature female were fused together in the right half of the abdomen. On the other hand, the malformations observed in male crabs (the articulation of telson with 6th abdominal segment, the depressed abdominal tip and the gap between sternites) were reported by other authors for the portunid *Callinectes ornatus* from Ubattuba Bay, Brazil **(Mantelatto *et al*., 2003)** and **Araújo and Calado (2012)** for *Ucides cordatus* from a Brazilian coast. Unlike females, it can be assumed that the abnormalities of the males do not seem to influence their reproductive function or behavior.

Malformation found in carapace was related to the shape of the anterolateral teeth. The carapace malformation is less frequently observed than the chelipeds, swimming legs and abdomen. Similar results were reported by **Rasheed *et al*. (2014)** where all malformations found in carapace of edible crabs, *Portunus pelagicus* and *P. sanguinolentus* of Pakistan were related to the number and shape of the anterolateral teeth.

According to **Møller and Swaddle (1997)**, malformation represents an unusual expression of a trait that essentially differs from the typical phenotype and usually appears in fewer than 4% of the population. However, in the present study the percentage of malformations in the examined specimens is more than double the percentage recorded in other studies.

The possible consequences of these exoskeletal malformations are unknown. It may be assume that stress and exposure to severe environmental conditions are basic causes. This was suggested by **Pandourski and Evtimova (2009)** in explaining teratologies in copepods and branchiopods in circumpolar areas, and contaminants with teratogenic effects on crustaceans. This fact is maximized in El-Timsah Lake because it is very close to tons of residues that are derived from many different sources. The organic and chemical pollution generated from the huge agricultural drainage water from El Forsan drain in the north and waste water discharges from El Mahsama drains (industrial, agricultural, and sewage effluent) to the western lagoon which connected to the lake **(ICED, 1998)** are mostly capable of originating malformations. Causal factors of morphological alterations in Crustacea are pollutants **(Weis *et al*., 1992)**. Persistent organic pollutants can induce morphological malformations in crabs **(Betancourt-Lozano *et al*., 2006)**. Heavy metals could also induce malformations in brachyuran larvae **(Lavolpe *et al*., 2004)**.

It is therefore necessary to expand the survey of malformations, first to detect the causal factors and test the biological effects on the selected species; then to evaluate the possible uses as a bioindicator of pollution of that species.

In the author's opinion, malformation is attributed to several reasons such as errors in morphogenetic processes, moulting, pollution, injuries, and parasitic infections. Therefore, there is a need of studies related to effective population size and genetic diversity in this population, as well as further efforts to preserve the environment in the Suez Canal.

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الملخص العربي

أول تسجيل للتشوهات المورفولوجية في السلطعون الأزرق السابح *Portunus segnis* (Portunidae: Brachyura) من بحيرة التمساح ، قناة السويس ، مصر

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تهدف هذه الدراسة إلى توثيق وجود تشوهات شكلية خارجية في بعض أفراد السلطعون الأزرق السابح ***Portunus segnis***، المجمعة من بحيرة التمساح ، قناة السويس. فقد تم جمع ٢٦٩ عينة ، منها ٢٨ عينة (١٩ ذكور و ٩ إناث بنسبة ٧٪ و ٣.٤٪ على التوالي) أظهرت تشوهات في المخلّب ، والأرجل السابحة ، والدرقة و البطن. وقد أوضحت الفحوصات وجود اختلاف فى التشوهات بين الشقين، حيث لوحظت التشوهات في الذكور بشكل رئيسي في المخلب ، بينما ظهرت في الإناث في المخلب وأرجل السباحة. ويمكن أن يكون سبب ظهور تلك التشوه مرتبطًا بعمليات التئام الجروح بعد الإصابة أو انسلاخ القطع الأثرية ، كما قد يعزى السبب أيضا إلى اضطراب النمو بسبب المواد السامة الموجودة في بيئة السرطان.