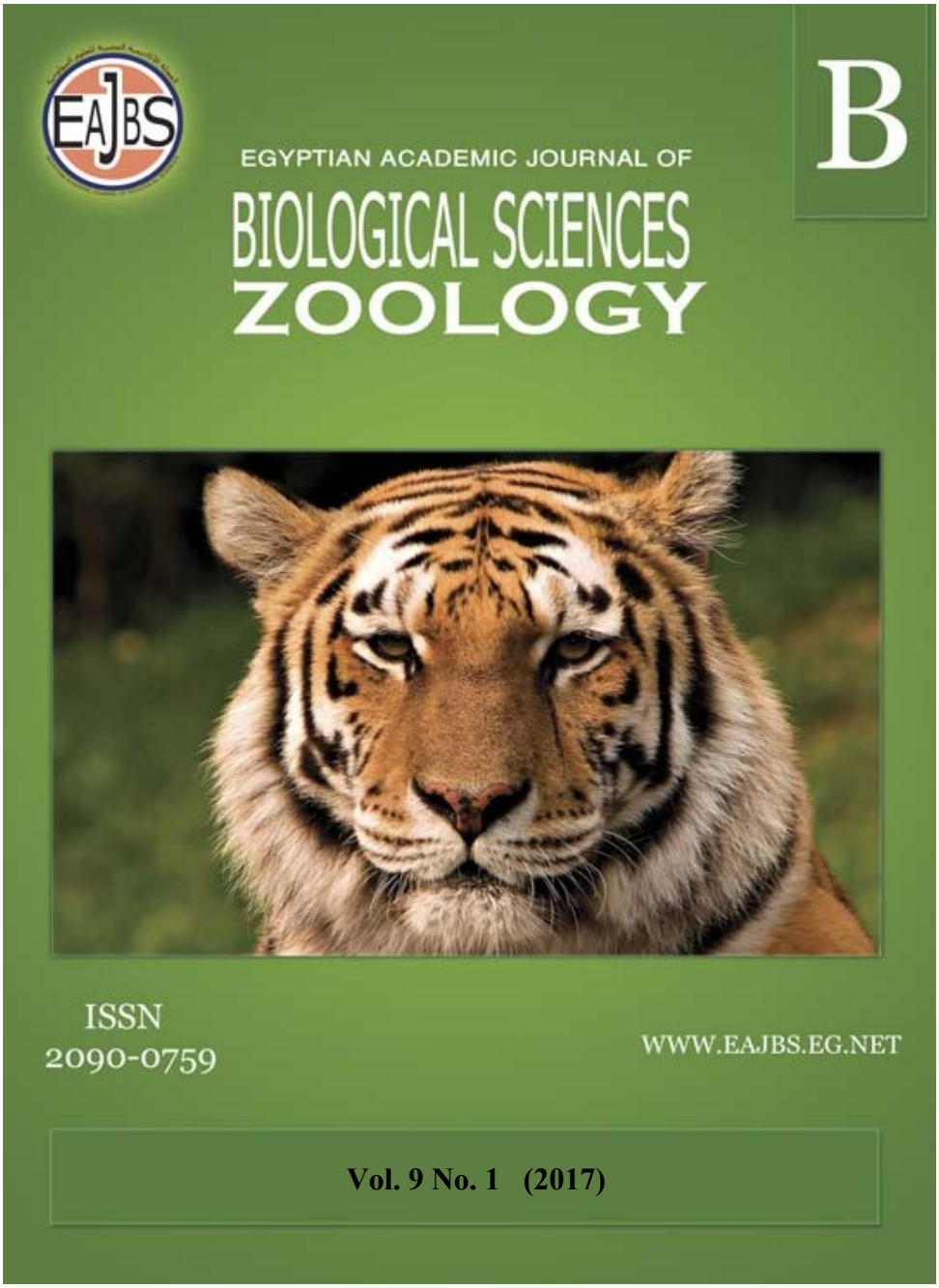


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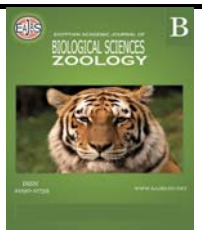


# Morphological and Anatomical Characteristics of the Two Taxa *Eremina desertorum desertorum* (Forskål, 1775) and *Eremina desertorum irregularis* (Férussac, 1821) (Gastropoda: Helicidae) of the Northern Deserts of Egypt

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**ABSTRACT**

The characteristic differentiation of the shell morphology and genitalia organs of the two native desert terrestrial snails *Eremina desertorum desertorum* (Forskål, 1775) and *Eremina desertorum irregularis* (Férussac, 1821) had been discussed in this article, showing the main characteristic aspects of the two taxa through the previous and recent literatures and studies of this genus. The two species are common widespread land snails that inhabit the desert of North Coast region of northern part of Egypt along the Mediterranean Sea, and considered as part of the natural ecosystem. These two taxa are different local subspecies where their morphological and anatomical descriptions are presented in this study.

## INTRODUCTION

*Eremina* is very confined genus to many countries of North Africa region (Pallary, 1909 &1924; Schileyko, 2006) such as the entire desert northern region of Egypt and the desert of north Sinai, in addition to southern Tunisia, shores of the Red Sea and the Atlantic to Rio of Oro, which is a southern geographic region of Western Sahara in northwest of Africa (Pallary, 1909 & 1924) and in other closer area such as southern Syria, Petrea and Akabah in Jordon (Pallary, 1924).

This recent article has a comprehensive description of the morphological and anatomical characteristics of the two native deserts terrestrial snails *Eremina desertorum desertorum* (Forskål, 1775) and *Eremina desertorum irregularis* (Férussac, 1821) (Gastropoda: Helicidae). It also clarifies the distribution of these species through the previous and recent studies.

The two species are widespread terrestrial snails in the north coast deserts that occurred in many different locations along the Mediterranean region, between Alexandria till EL Sallum village in the border of Egypt with Libya (Kaltenbach, 1934 & 1942; Ali *et al.* 2016). The desert snails were found in arid environment with little rainfall throughout the year on wild vegetation that considered as part of the natural ecosystem and common species.

The shell morphology and anatomical characteristics had been described in previous literature (Pallary, 1909; Hesse, 1920; Kaltenbach, 1934; Biggs, 1959;

Schileyko, 2006), but with no much recent investigation and dearth of studies with less adequate attention for their life cycle and habitat in the last few years.

These two taxa are considered different local subspecies with regard to the shell size and shape in addition to the mitochondrial haplotypes that support their classification as subspecies rather than distinct species (Ali *et al.,* 2016).

## MATERIALS AND METHODS

*Eremina* populations of this research were sampled previously in the activity season between March and April 2014 along the Mediterranean coast region of Egyptian deserts. The snails were found in large numbers on the dry and arid surfaces of hot deserts where fully exposed to sun and heat, which feed and shad under wild vegetation.

The collected specimens from each location were killed in boiling water and preserved in 70% ethanol and were dissected under a binocular microscope in the laboratory of the Zoological Museum of Hamburg University in Germany.

The species were determined first according to the shell morphology to *E. d. desertorum* and *E. desertorum irregularis*. The genital system structure was dissecting then photographed using microscopic camera recording the differences between the both species. The shell morphology and genitalia was described and illustrated in this article.

## RESULTS

**Distribution of genus *Eremina:***

Genus *Eremina* distribution is restricted mainly to North Africa such as Egypt, Libya and Tunis. *E. desertorum* was common for Egypt and the adjoining southern part of Palestine; in addition to southern parts of Tunis that they are on the northern shore along the Sahara (Hesse, 1920). The same author mentioned that the species *E. desertella* was first on the west coast of the Red Sea, near Suakin and had been discovered in Habab as well, but later also found in Egypt. The land snail *Eremina* is of predominantly Saharan distribution.

Previously, the only recognized species in Israel was *Eremina desertorum* that a sand dweller of the western Negev in Israel (Heller, 1993).

The distribution area of *Eremina desertorum mariuti*, as geographical race, was near Abukir and Mariout, both cities in Alexandria, till the end coast of the Mediterranean (Blume, 1952) in addition to other locations that *E. desertorum* had been found there i.e. the 15 to 40 km southwest the sea of Alexandria.

*Eremina desertorum* was spread in Sinai desert till the Libyan Desert, also South to the frontier of Upper Egypt in addition to some regions in east Cairo such as Petrified Forest, Gebel Chashab, Wadi Liblabe and Suez.

Wadi Natrun west of the Nile Valley, Beni Salame north of Fayum and Abu Roach north Giza Pyramids are other locations that the species was found there as well (Kaltenbach, 1934).

*Eremina desertella*, as one of the species belong to the same genus, has been recorded from a narrow zone along the coast of the Red Sea and the Gulf of Aden southwards to Cape Guardafui in Somalia with many records of this species from Arabian Peninsula (Neubert, 1998).

In the study of Ali *et al.* 2016, the samples were collected of many locations along the north coast of Egypt start from Alexandria till El Sallum village. *E. d. desertorum* was found mainly in south of El Alamein (Figs. 1 and 2) while *E. d.*

*irregularis* start to show in El Hammam village, north Coast Figure 3 (A – B) and in many locations till El Sallum village.

**Shell morphology description**

Genus *Eremina* L. Pfeiffer, 1855 is known as Medium-sized to large depressed shells with thick walls, the surface is smooth to heavily rib and widespread genus in arid areas from Morocco to Somalia. (Neubert, 1998)

The Shell of *Eremina* is subglobose, quite solid, opaque about 5 convex whorls, with shouldered whorls. Last whorl rounded or scarcely angulated, slightly, gradually deflected. Color whitish to yellowish-corneous, with reddish bands or yellowish streaks with irregular radial striation. Aperture rounded, sometimes slightly angulated, moderately oblique, with thickened, straight or a little reflexed margin. Umbilicus is very small or absent. The shell height is 14-26 mm, with 22-35 mm in diameter (Blume, 1952)

**Shell description of *Eremina desertorum desertorum***, Figure 4 (A – B)

The shell of *Eremina desertorum* is dirty-white, shiny, coarse irregularly radial striped with indistinct interrupted spiral strips, at first windings hints of faded light brown spiral bandages with diameter from 29-32 mm (Hesse, 1920).

The shell surface is shiny, glossy and pale white. The umbilicus is narrow; the lip is reflected, more rounded aperture with no growers. The suture of the shell is more deeply impressed. The spire is slightly higher. The shell also shows very light browns tones, which become too darker (Kaltenbach, 1934 & 1942).

The shell's wall is thick and strong of the specimens that were found in petrified forests east of Cairo, east of the Wadi Liblabe, the area of Suez, in east Sinai, as well as some places in the area east of the Wadi Natrun west of the Nile Valley.

It had been a noticeable conspicuous of uniformity in the shape of the shells from Palestine across the Sinai into the Libyan Desert and also South to the frontier of Upper Egypt. The diameter ranged from 19.93 to 25.56 mm while the height ranged 13.44 to 17.75 mm with 3.66-4.0 whorls. The shells are finely ribbed; The Color is deep black-brown, sometimes in spots, or in bands, which is more common around the shell (Kaltenbach, 1934).

The shells diameter averaged 27.53 ± 1.44 mm, while the shell height was 20.84 ± 1.44 mm in the location the road to El Alamein 125 km, south El Alamein 30°29'12. 17"N 30°9'51.87"E in northern part of Egypt.

The shell is usually smaller and more depressed comparing to *E. desertorum irregularis* (Biggs, 1959; Ali *et al*., 2016).

**Shell description of *Eremina desertorum irregularis*,** Figure 5 (A – B)

The shells of *E. desertorum irregularis* are irregularly wrinkled. The umbilicus is closed, almost no umbilicus and the lip reflected above.

The shell is white with some creamy to brown bands in some populations such as specimens found on the road from Marsa Matrouh to El Sallum 183 km 31°18'24.24 "N 26°57'19.76"E and El Hammam village 30°50'01.32"N 29°23'49.99"E north coast, Egypt.

Some specimens in some other population have white creamy shell without any darker bands or dots.

Some *Eremina populations,* the lip has or has not growers on the shell aperture lip which according to the specimen's location, humidity, temperature degree and nature of each spot, the lip is reflected. The bands are ranged from 4 to 5 bands. The specimens' shells of El Dabbah village, north coast are white in background with no bands and other shells with light creamy bands and white shells with growers on the lip.

Kaltenbach, 1934 mentioned that the *Eremina d. irregularis* shells are smooth, often wrinkled with wider one rib, which appear on the last whorls. The shell colors varying from a shiny white, dirty white to gray or brown.

Also a typical character for *Eremina d. irregularis* is the additional ring at the aperture opening, which is considered these supplementary rings as a general typical feature of this type of species, what makes the aperture tighter, while it is usually round and wide. In general, the shells are spherical; the height is greater than the diameter.

The shell diameter was 34.37 ± 2.1 mm, while shell height was 25.77 ± 1.88 mm.

**Genitalia description**

**Genitalia of *Eremina desertorum desertorum*** (Figs. 6 and 7)

The genital system structure of *Eremina d. desertorum* was having similarities with this one of *Eremina desertorum irregularis*.

The fundamental organs of the genital system for the both subspecies are start with genital atrium then the rest of the reproductive organs which are albumen gland, bursa copulatrix, bursa tract, dart sac, epiphallus, flagellum, hermaphroditic duct, mucus glands, oviduct, ovotestis, penis, penis retractor muscle, spermoviduct, vagina and vas deferens.

It was noted the presence or absence of a rudimentary flagellum. According to Schileyko, 2006, *E. d. desertorum* has flagellum as genital characteristic but in Ali *et al.* 2016 many of the dissected specimens has no flagellum. Ali *et al.* 2016 added as well other measurements items for giving broader view of the differentiation between the two subspecies i.e. vagina distal of the insertion of the mucus glands, epiphallus distal of the insertion of the penial retractor, epiphallus proximal of the insertion of the penial retractor, vagina proximal of the insertion of the mucus glands.

The penis was longer, and broader at its apical part. The vagina was longer and S-shaped. The bursa copulatrix was highly situated.

**Genitalia *Eremina desertorum irregularis*** (Figs. 8 and 9)

The genital system is similar to this one had been described before of *Eremina desertorum desertorum.* There is a lack of differences in the genitalia in the two species *E. d. desertorum* and *E. d. irregularis*, which small difference but that strong distinguish between them and the genital variation had been described in Ali *et al.* 2016. The authors mentioned that the genitalia of 141 (more than 100) individuals from six populations of *E. d. desertorum* and 14 populations of *E. d. irregularis* were analyzed according to some measurements to some organs such as the length of the penis, the distal epiphallus, the proximal epiphallus, the vagina distal of the insertion of mucus glands, the vagina proximal of the insertion of the mucus glands, the dart sac and the oviduct.

The analysis of this study shows that a rudimentary flagellum was found in 16.1% of the studied *E. d. desertorum* individuals and in 5.5% of the studied *E. desertorum irregularis* individuals.

The structure of the reproductive system is strictly hermaphroditic. From the gonads, a hermaphrodite duct, a duct that is designed to transport both sperm and eggs, leads to a portion of the reproductive tract where the duct splits into a strictly male and strictly female portion (Morton, 1955).

Hesse, 1920 mentioned that the flagellum might be rudimentary or entirely absent and the mucus glands are numerous delicate branches and the kind of branching considerably characteristic of this genus. The hermaphroditic gland of *Eremina desertorum* is a pale yellowish-white in color, and with 7-8 mm long gland. The volume and a length of albumen gland is 18-21 mm. The sperm oviduct has a

length of 25-30 mm and composed of a narrow band-like. The two expeditions of the mucus glands open close together on the inside of the beginning of the dart sack. The author added as well that the vagina is provided with longitudinal folds with 30 mm long thread-like, undivided channel, which in a spherical suture of 1.8 mm diameter. Retractor muscle is around from 6 to 6.5 mm long spindle-shaped. The vas deference is 16-28 mm long and the rudimentary flagellum was present in most cases as in a similar in *Theba pisana* but it was sometimes entirely absent in two specimens of population of Cairo. The penis is very variable; it is often spindle-shaped, rarely cylindrical, such the specimens he collected from El Ramleh, Alexandria. The two mucus glands are usually split into two branches; the branches are divided into numerous delicate branches (Hesse, 1920).

As in all Helicids, the hermaphrodite gland of the desert snail lies embedded in the tissue of the liver, at the apex of the visceral hump. The ovotestis of the desert snail is constituted of elongated branched diverticula, opening into the hermaphrodite duct (Fahmy, 1949).

Vas deferens rather short enters epiphallus sub terminally leaving conic, rudimentary flagellum. Epiphallus is not long, sharply bent at its boundary with penis. Proximal chamber of penis has a large axial fold, with small flagellum. Distal chamber of penis contains strongly muscularized, transversely folded verge having apical pore. Penial retractor attached to penis/epiphallus junction. Free oviduct is moderately long and vagina is slightly longer. Each of two mucus glands branches consists of short common duct, from which 2 or 3 secondary arms branched out. Spermathecal stalk slender, long and reservoir lies on albumen gland (Schileyko, 2006).

## DISCUSSION

In this article, the morphological differentiation had been examined of the two main taxa of this complex *E. d. desertorum* and *E. desertorum irregularis*.

*Eremina d. desertorum* differs from *E. desertorum irregularis* in several characters (Kaltenbach, 1934).

However, according to Hesse (1915) has not found anatomical differences before between *E. d. desertorum* from Cairo and *E. desertorum irregularis* from El Ramleh in Alexandria.

The mitochondrial haplotypes of the two taxa, which are different local subspecies, support their classification as subspecies rather than distinct species regardless to the size and shape of their shells (Ali *et al.,* 2016). The authors mentioned as well that the genitalia of some specimens of six populations of *E. d. desertorum* and other specimens of 14 populations of *E. d. irregularis* were analyzed according to some measurements genital organs and according to this analysis shows that a rudimentary flagellum was found in 16.1% of the studied *E. d. desertorum* individuals and in 5.5% of the studied *E. desertorum irregularis* individuals.

## ACKNOWLEDGEMENTS

The author is grateful to Prof. Dr. Bernhard Hausdorf, Center of Natural History, Zoological Museum University of Hamburg, Germany for the identification of these species and his providing for the laboratory equipment and assistance in dissecting and photographing the specimens' genitalia.

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Fig. 1: *Eremina desertorum desertorum* in its natural ecosystem in South El Alamein at North Coast of Egypt.

Fig. 2: *Eremina desertorum desertorum* in its natural ecosystem in South El Alamein at North Coast of Egypt


Fig. 3(A – B): A, *Eremina desertorum irregularis* in its natural ecosystem in El Hammam village at North Coast of Egypt; the shell is bright white with no bands. B, The shell with brown bands on the shell.


Fig. 4(A – B): Shell of *Eremina desertorum desertorum*, showing the different patterns of the shells. A, the shell is without brown bands, specimens from South El Alamein at North Coast of Egypt. B, the shell is with dark brown bands on the shell from the same location.


Fig. 5(A – B): Shell of *Eremina desertorum irregularis*. A, The shell is with no bands showing the grower rings on the aperture; the specimen from the road from Marsa Matrouh to El Sallum at North Coast of Egypt. B, The shell is with brown bands; the specimen from El Hammam village at North Coast of Egypt.

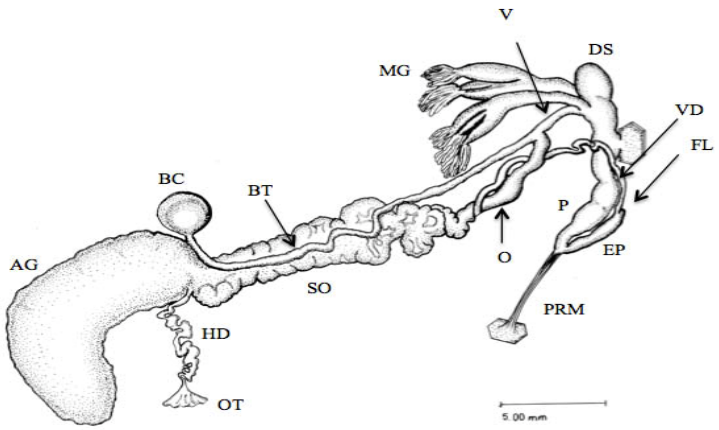


Fig. 6: Schematic drawing of the reproductive system in *Eremina desertorum desertorum* . AG, albumen gland; BC, bursa copulatrix; BT, bursa tract; DS, dart sac; EP, epiphallus; FL, flagellum; HD, hermaphroditic duct; MG, mucus glands; O, oviduct; OT, ovotestis; P, penis and epiphallus distal of the insertion of the penial retractor; PRM, penis retractor muscle; SO, sperm oviduct; V, vagina; VD, vas deferens.


Fig. 7: Genitalia of dissecting specimen of *Eremina desertorum desertorum* showing the reproductive organs.

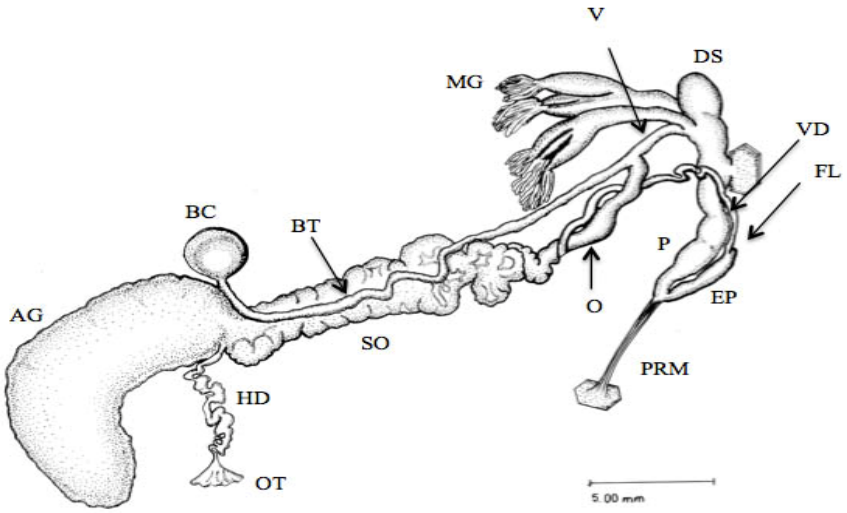


Fig. 8: Schematic drawing of the reproductive system in *Eremina desertorum irregularis* with no flagellum.
AG, albumen gland; BC, bursa copulatrix; BT, bursa tract; DS, dart sac; EP, epiphallus; HD, hermaphroditic duct; MG, mucus glands; O, oviduct; OT, ovotestis; P, penis; PRM, penis retractor muscle; SO, spermoviduct; V, vagina; VD, vas deferens.


Fig. 9: Genitalia of dissecting specimen of *Eremina desertorum irregularis* showing the reproductive organs.

## ARABIC SUMMERY

**الخصائص المورفولوجية و التشريحية للنوعين اريمينا ديسرتورم ديسرتورم (فورسكال، ١٧٧٥) و النوع اريمينا ديسرتورم اريجيورالس (فيروساك، ١٨٢١) (جاستروبودا: هيليسيداي) للصحاري الشمالية في مصر**

**رهام فتحي علي**
قسم الحيوان و النيماتولوجيا الزراعية، كلية الزراعة، جامعة القاهرة، الجيزة، ١٢٦١٣ شارع الجامعة، جمهورية مصر العربية

قد تم كتابة هذا المرجع البحثي للتعريف و التمييز بين الصفات المورفولوجية المميزة لشكل الصدفة الخارجية و الأعضاء التناسلية لنوعين من القواقع الأرضية و الصحرواية النوع اريمينا ديسرتورم ديسرتورم (فورسكال، ١٧٧٥) و النوع اريمينا ديسرتورم اريجيورالس (فيروساك، ١٨٢١). هذه الدراسة تبين الجوانب الرئيسية المميزة للنوعين من خلال الدراسات القديمة و الحديثة لهذا الجنس من البطنقدميات.

هذين النوعين من القواقع البرية شائعة الانتشار و تابعين لصف البطنقدميات الأرضية و لقبيلة الرخويات و المنتشرة في صحراء الساحل الشمالي شمال جمهورية مصر العربية و التي تتواجد علي امتداد البحر الأبيض المتوسط كما إنها تشكل جزءا من النظام البيئي الطبيعي. هذان النوعان هما نوعان محليان مختلفان حيث يتم عرض وصفهم المورفولوجي و التشريحي من خلال هذه الدراسة.