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Sea urchins (Echinoidea: Echinodermata) from Gulf of Aqaba, Red Sea, Egypt

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ABSTRACT

A total of 16 species of echinoids (sea urchins), belonging to 13 genera lie under 6 families and 4 orders,were collected (during period from January to November 2015) from Gulf of Aqaba, Red Sea, Egypt. Among them, 13 species were recorded before from Gulf of Aqaba and *Heterocentrotus trigonarius* was recorded for the first time from the study area. On the other hand, 2 species, *Astropyga radiata* and *Diadema savignyi* were recorded for the first time from the entire Red Sea. Based on the present data and other studies, a key for all recorded species was constructed and expandable when possible. In addition, notes on the geographical distribution and ecology of these echinoids were discussed.

Key words: Echinodermata, Echinoidea, Sea urchins, Red Sea, Gulf of Aqaba, Egypt**.**

INTRODUCTION

Echinoidea (sea urchins) is one of the most important entities of the global marine ecosystems because of its medical, nutritional and ecological importance. Ecologically, Echinoidea play an important role as cleaners of the ocean bottom. The regular sea urchinseasily distinguished from irregular ones by spherical to ovate calcareous test[(1)]. They are also important due to their role in the food chain and to the change of the substrata [(2)]. Sea urchins considered as a keystone animals because of their ability to alter the composition and the dynamics of algal resources by their grazing [(3)]. Echinodermata are characterized by polychromatism. Such color polymorphism is displayed in the sea urchins (Echinoidea) such as *Echinometra* sp., *Tripneustes* sp., *Paracentrotus* sp.[(4)] and *Heterocentrotus mammillatus*[(5)].

Echinoids records in Red Sea started with the France Scholars after the Military Campaign to Egypt in 1798, where numerous new records of species[(6)]. In the past two centuries many expeditions conducted to the Red Sea resulting in a large collection of many echinoid species, monographs and catalogues[(7, 8, 9, 10, 11, 12)].

Some literatures stated that it is difficult to identify variant species within the same genus as: *Diadema* sp.[(13)] and *Echinometra* sp.[(14)].Not only new species of echinoids have introduced to the Red Sea[(13, 15,16)] , but also new echinoid records introduced to the Red Sea[(17, 18, 19,20,21,22,23,24)].

According to the continuous introducing of new species from the Mediterranean Sea to the Red Sea through Suez Canal resulted in inaccuracy of the biogeography as a result of uncertainty of geographical extent[(13)]. Studies on the status of echinoid populations of the Red Sea are scarce including such basic data as their phylogenetics, population structure, distribution, population dynamics and fisheries status[(3)]. In order to have well management of resources, the monitoring of biodiversity considered as an effective role[(25)].

Goal of the present study is to provide a clear comprehensive study of shallow water Echinoidea from the western bank of the Gulf of Aqaba, showing their occurrence and distribution within the study area. Furthermore, this work is supported with an identification key to all recorded Echinoidea species from Gulf of Aqaba.

MATERIALS ANDMETHODS

Several field trips were made along Gulf Aqaba Egyptian cost began with Ras Muhamad Protected area (27° 43' 27.21") at Southern part and ended with Taba (29° 29' 24.01") at Northern part (Fig. 1), during the period from January 2015 till November 2015. The survey included monitoring and collection of individuals belonging to phylum Echinodermata class Echinoidea from both tidal and sub-tidal habitats (rocky, sandy, dead coral and live coral) at 9 main sites and many interval ones covering the study area. Survey was done at the high and low tide levels using both snorkeling and SCUBA diving.

Collected samples were fixed and preserved in the field in sea water formalin (10%) by injecting the solution into the body of the urchin through the peristome membrane, then the samples were held in jars and transported to the Laboratory of Marine Invertebrates at Faculty of Science, Al-Azhar University for further examination. Morphological examinations were done; diagnostic features and characters were carried out mainly by using the key of Clark and Raw **(26)** and other literatures[20, 22,27, 28]. All recorded species from Red Sea and adjacent waters were compiled using data from[18,20, 23, 26, 27].

The following terms are used in identification and description of Echinoids species (Fig. 2):

Test or corona: the usually rigid main part of the series of five pairs of ambulacral plates and five pairs of interambulacra, extending from the peristome up to the apical system.

Apical system: the upper part of the regular sea urchin which is placed opposite side to the oral system and composed of double ring of five radially situated ocular plates(opposite the apical ends of the ambulacral series of plates) and five interradial genital plates,together with the periproct which they encircled. Some or all ocular plates may make contact with periproct, in such case they called inserted alternatively if they are exclude by adjoining genital plates they called exerted in this case.

Periproct: the circular or oval extensible area immediately surrounding the anus bearing a variable number of small plates embedded in the skin.

Ambitus: the broadest part of the test, through which horizontal measures is measured.

Peristome: the area of the skin between the mouth and the test; usually with only a few widely spaced plated embedded in it but sometimes with articulated plates.

Horizontal diameter: the largest diameter from the interambulacral area to the opposite ambulacral one.

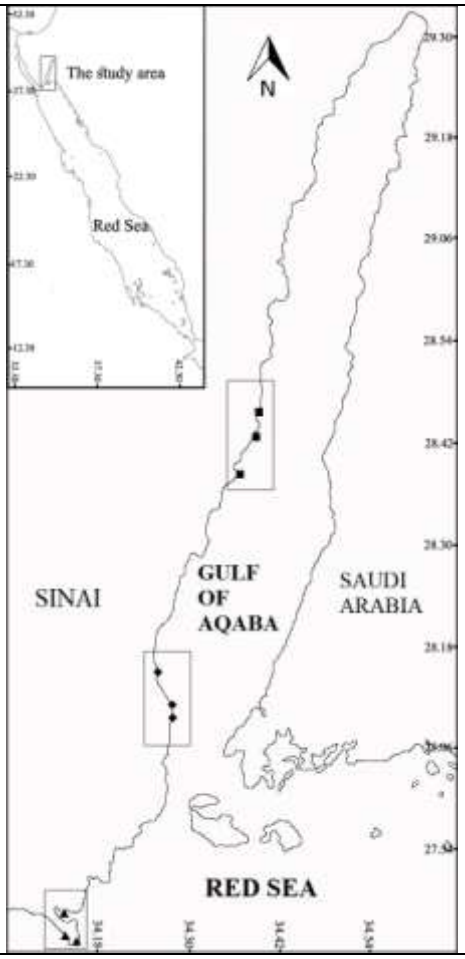


Fig. (1): Map of the study area, showing the nine sampling sites in three different protectorates from south to north (Ras Muhamed Protectorate, Nabq Protectorate and AbouGalom Protectorate).

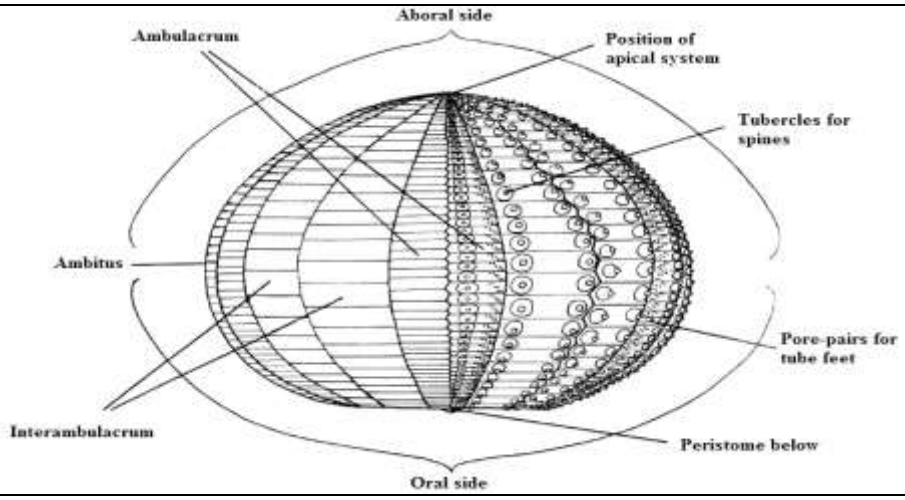


Fig. (2): Introductory drawing of regular echinoid test (side view), after Clark and Row[26].

RESULTS

I. Key to the families, genera and species recorded in the present study.

1 -Interambulacral plates high, each with a single massive primary spine, usually ringed by much smaller, often spatulate, secondary spines; the mature primary spines naked and often encrusted with epizoic organisms; ambulacral plates simple so that the pore-pairs form single vertical series, sometimes sinuous; peristome covered with both ambulacral and interambulacral series of over- lapping plates but the main part of test rigid……**Cidaridae**……...**2**

-Interambulacral plates low, the ambital ones at least usually with several primary spines, which are rarely massive, the secondary spines not arranged in rings but scattered among the primaries; spines covered with very thin barely perceptible skin, which prevents the settling of encrusting organisms; ambulacral plates compound, three or more fused together and the pore-pairs correspondingly forming more or less staggered series, rarely a single one; peristome covered with soft skin, or if with plates then these are only ambulacral ones the whole test is very flexible……..……..**4**

2(1) -Ambulacralpores non-conjugate (no furrow linking the two pores of each pair), a knob between the two pores in larger specimen; apical system bare but for a scattering of minute miliaryspinelets and marginal fringe of larger petaloid ones together with small cluster on the periproct; the plates of the apical system covered with minute glassy bumps, visible on denuding size not known to exceed 30 mm h.d. ……..……...***Eucidaris metularia*** (Lamarck, 1816).

-Ambulacral pores conjugate, sunk in common furrow; apical system with a more or less dense covering of spinelets, or of tubercles visible when denuded; adult size usually exceeding 30 mm h.h. ……..……..**3**

3(2) -In the apical system, the ocular plates exsert (Fig.3. 1b); no limb on the stalk of the globiferouspedicellariae; primary spines smooth, each with 18 or more very fine longitudinal ridges or series of granules; six to seven interambulacral plates; oral primary spines more or less clavate.….***Phyllacanthus imperialis*** (Lamarck, 1816).

-Ocular plates usually nearly all insert (Fig.3. 1a); large globiferouspedicellariae usually with a "limb" or frill of rods on the stalk close to the head; primary spines have smooth purple spotted basal collar and longitudinal series of thorns which are sometimes arranged in incomplete whorls (Fig.3. 2a, b)…..……..…. ……..….***Prionocidaris baculosa*** (Lamarck, 1816).

4(1) -Test very flexible, in life more or less hemispherical in shape but usually collapsing into a flat pancake on preservation; ambulacral plates continuing over peristome to the mouth. .....**Echinothuriidae**.....…. ……***Asthenoso mavarium*** Grube, 1868.

-Test rigid, rarely somewhat flexible but then undergoing little if any flattening when preserved; peristomeskin covered……...**5**

5(4) -Primary tubercles perforate and often also crenulate (Fig.3.3a); spines usually hollow, long, cylindrical and very slender and breakable….**Diadematidae**…….. **6**
-Primary tubercles imperforate (Fig.3.3b), though sometimes crenulate; spines solid. ……..…….……11

6(5) -Primary tubercles of oral side abruptly reduced in size from close below the ambitus and pore-pairs correspondingly becoming widely spaced into a single almost straight series without arcs; test somewhat flexible……..... ……..……***Chaetodiadema granulatum*** Mortensen, 1903.
-Primary tubercles as well-developed on the oral side as at the ambitus and aborally; pore-pairs arranged in arcs throughout; spines completely hollow, long and very slender……...……..**7**

7(6) -Genital plates conspicuously elongated into the ambulacra between the aborally bulging ambulacra (Fig.3.4a), except in immature specimens h.d. < 60 mm; periproct flat or low conical; adult size very large, up to 180 mm h.d……..... ……..……..***Astropygaradiata*** (Leske, 1778).
-Genital plates not longer than wide (Fig.3.4b); if the ambulacra bulge conspicuously aborally then the slender primary ambulacral spines are distinctly barbed terminally, not smooth; periproct often with a tubular extension……..…**8**

8(7) -Ambulacral spines of the aboral side very fine and needle-like, with backwardly-directed barbs near to the tip contrasting with other spines (Fig.3.5a)……. ……***Echinothrix***……..…….**9**
-Aporal spines not conspicuously different, the barbs on the ambulacral ones directed backwards (Fig.3.5b); no spines on buccal plates; globiferouspedicellariae absent. ……...***Diadema***…….……..**10**

9(8) -Ambulacra distinctly bulging aborally, with naked interambulacral areas between them apically; cavity of primary spines large, spines with transverse series of thorns, though longitudinal ridging may also be evident; naked test aborally usually greenish in colour……...……***Echinothrix calamaris*** (Pallas, 1774).
-Ambulacra not distinctly bulging and no naked interambulacral areas aborally; cavity of primary spines very small, their surfaces with fine longitudinal ridges only; no green colour on the naked test aborally..... ……..……..***Echinothrix diadema***(Linnaeus, 1758)**.**

10(8) -Large tridentate pedicellariae mostly with narrow blades only meeting at the tip, the ratio of total length of the valve to breadth of the blade 20:1 (unfortunately these pedicellariae are never numerous and sometimes lacking); a red ring around the anus……...***Diadema setosum*** (Leske, 1778).
-Tridentate pedicellariae leaf or spoon shaped, tapering slightly to a rounded distal end, length : breadth 3-5 : 1; no anal red ring...***Diadema savignyi*** (Audouin, 1809)**.**

11(5) -Tubercles usually crenulate; test usually with distinct pits, troughs or pores at the angles of the sutures; naked aboral areas of the test dark purple, forming zigzag

pattern when the test is clean……..**Temnopleuridae**……
.....***Microcyphus rousseaui*** Agassiz in Agassiz & Desor, 1846.
-Tubercles not crenulated; no angular pits or pores……**12**

12(1) -Gill slits sharp deep v-shaped (Fig.3.6a); test high, circular, almost globular; only one out of every two or four ambulacral plates with a primary tubercle; pore-pairs in horizontal arcs and spaced to form three distinct vertical series in large specimen. ……..**Toxopneustidae**…….***Tripneustes gratilla*** (Linnaeus, 1758).
-Gill slits shallow (Fig.3.6b); test often more or less ovate…….**Echinometridae**.**13**

13(1) -Maximum h.d. of test at about half the total height or below; test arched aborally; four to sixteen pore-pairs in each arc; longest spines projecting horizontally or only diagonally upwards; lives exposed or in shallow hollows……..**14**
-Test high, maximum h.d. near the aboral side, which almost flat; only three pore-pairs in each arc; longest spines projecting vertically in an aboral tuft; inhabits deep burrows…….…….***Echinostrephus molaris*** (Blainville, 1825).

14(1) -Long axis of the test through ambulacrum I and interambulacrum 3 (Fig.3.7a); spines short, slender and acute, all circular in cross section; usually only four pore-pairs per arc aborally; spines not banded……..
…….……..***Echinometra mathaei*** (Blainville, 1825).
-Long axis through ambulacrum II and interambulacrum 4 (Fig.3.7b); primary spines massive very long, all either rounded and very thick but somewhat flattened towards the tip, or triangular in cross section and slightly tapering; eight or more pore-pairs per arc aborally; spines more or less banded……***Heterocentrotus***…..**15**

15(1) -Usually 9-11 pore-pairs in each arc at the ambital region; primary ambulacral tubercles rather abruptly smaller above the ambitus and their spines truncated like the secondary ones; tridentate pedicellariae with narrow valves meeting only at the tip……..***Heterocentrotus mamillatus*** (Linnaeus, 1758).
-Usually 15-16 pore-pairs in each arc at the ambital region; primary ambulacraltubercles gradually decreasing in size aborally and their spines correspondingly only gradually shorter and not truncated; tridentate pedicellariae with leaf-shaped valves, contiguous for their whole lengths……..……...
……..***Heterocentrotus trigonarius*** (Lamarck, 1816).

II. Systematic account of recorded Echinoidea

Class: Echinoidea
Subclass: Cidaroidea
Order: Cidaroida
Superfamily: Cidaroidea Gray, 1825
Family: Cidaridae Gray, 1825
Subfamily: Cidarinae Gray, 1825

***Eucidaris metularia* (Lamarck, 1816)** (PLATE I, A)

Synonymized names:
Cidaris (Dorocidaris) metularia(Lamarck, 1816)

Cidaris (Eucidaris) metularia(Lamarck, 1816), Peters, 1854: 101-109; Bell, 1909: 12-22; Tortonese, 1933: 104; Clark, 1952: 204; Clark and Spencer, 1966: 597-612; Clark,1967: 51.56; Clark and Rowe, 1971: 140,150; Dolfus and Roman, 1981: 23-25; Price, 1982: 9.
Cidaris (Gymnocidaris) metularia(Lamarck, 1816), Agassiz, A., 1863: 17.
Cidaris mauri Lambert &Thiery, 1910, 141.
Cidaris metularia(Lamarck, 1816), Blainville, 1834: 232.
Cidarites metularia Lamarck, 1816: 56.
Gymnocidari smetularia (Lamarck, 1816), Agassiz, A., 1863: 17.
Gymnocidaris minor A. Agassiz, 1863: 17

Global distribution: South Africa, Somalia, Indian Ocean, Kenya, Madagascar, Mozambique, Red Sea, Republic of Mauritius, Seychelles, Eastern Africa and Tanzania**.**

Tribe: Phyllacanthina Smith & Wright, 1989

***Phyllacanthus imperialis* (Lamarck, 1816)** (PLATE I, B)

Synonymized names:

Cidaris (Phyllacanthus)imperialis (Lamarck, 1816)
Cidaris fustigera (A. Agassiz, 1863)
Cidaris imperialis (Lamarck, 1816)
Cidaris imperialis fustigera (A. Agassiz, 1863)
Cidarites imperialis Lamarck, 1816
Leiocidaris imperialis(Lamarck, 1816)
Phyllacanthus fustigera A. Agassiz, 1863
*Phyllacanthus fustiger*us A. Agassiz, 1863
Rhabdocidaris imperialis (A. Agassiz, 1863)

Global distribution: South Africa, Indian Ocean, Indonesia, Kenya, Madagascar, Mozambique, New Zealand, Red Sea, Republic of Mauritius, Seychelles, Eastern Africa, Tanzania and United States.

Subfamily: Stylcidarinae Mortensen, 1903

***Prionocidaris baculosa* (Lamarck, 1816)**

Synonymized names:

Cidaris (Cidaris) baculosa(Lamarck, 1816)
Cidaris (Leiocidaris) baculosa(Lamarck, 1816)
Cidaris (Rhabdocidaris) baculosa(Lamarck, 1816)
Cidaris baculosa(Lamarck, 1816)
*Cidaris Krohnii*L. Agassiz in L.Agassiz&Desor, 1846
Cidaris lima Valenciennes, 1847
Cidaris ornate Gray, 1855
Cidaris baculosa Lamarck, 1816
Leiocidaris baculosa (Lamarck, 1816)
Leiocidaris cidaris Lambert &Thiery, 1910
Phyllacanthus baculosa (Lamarck, 1816)
*Rhabdocidaris baculos*us(Lamarck, 1816)
Schleinitzia crenularis Studer, 1876

Global distribution: Mediterranean Sea-eastern basin, North Pacific Ocean, Indian Ocean, Kenya, Madagascar, Mozambique, Red Sea, Republic of Mauritius, Seychelles, Eastern Africa and Tanzania.

Order: Echinothurioida
Family: Echinothuriidae Thomson, 1872
Subfamily: Echinothuriinae Thomson, 1872

***Asthenoso mavarium* Grube, 1868** (PLATE I, C)

Synonymized names:

Asthenoso mavarium Grube , 1868 : 42-44; Bell , 1902 : 222-233; Mortensen, 1938 :45; Clark, 1967 : 26-58; Clark and Rowe, 1971 : 140,148,152; Totonese , 1977 : 286; Dolfus and Roman ,1981 : 28-30; Price, 1982 : 9.
Asthenoso magrubii Agassiz A., 1881:321.
Asthenoso maheteractis Bedford, 1900: 274,278,280.
Cyanosoma urens Sarsin and Sarsin , 1886 : 80-81.

Global distribution: Red sea; Indian Ocean; Ceylon and Maldives; Bay of Bengal; East India; Phillipine; China and Japan; and Java.

Order: Diadematoida
Family: Diadematidae Gray, 1855

***Astropyga radiata*(Leske, 1778)** (PLATE I, D)

Synonymized names:

Asteropyga radiata
Astropygae lastica Bell, 1876
Astropyga freudenbergi Sarasin, 1887
Astropyga major (Seba, 1734)
Astropyga mossambica Peters, 1853
Cidaris radiata Leske, 1778
Cidarite sradiata (Leske, 1778)
Diadema radiata (Leske, 1778)
Echinus radiate (Leske, 1778)
Echionanthus major Seba, 1734

Global distribution: South Africa, Indian Ocean, Kenya, Mozambique, Republic of Mauritius, Seychelles, Eastern Africa and Tanzania as well as Red Sea (new record in the study area, Gulf of Aqaba).

***Chaetodiadema granulatum* Mortensen, 1903**

Synonymized names:

Chaetodiadema sundararaji Devanesen, 1930

Global distribution: Maldives, Australia, Bay of Bengal, East Indies, Philippine, China, South Japan and Red Sea.

***Diadema savignyi* (Audouin, 1809)** (PLATE I, E)

Synonymized names:

Centrechinus savignyi (Audouin, 1809)
Centrostephanus savignyi (Audouin, 1809)

Cidarites savignyi Audouin, 1809
Diadema globulsum A. Agassiz, 1863

Global distribution: Republic of Mauritius, Red Sea (new record in the study area, Gulf of Aqaba, confirmed material), Kenya, Madagascar, Mozambique, Seychelles, South Africa, Tanzania and Eastern Africa.

***Diadema setosum* (Leske, 1778)** (PLATE I, F)

Synonymized names:

Echinometra setosa Rumphius,1705: 35-36; Leske,1778: 36.
Diadema setosum Agassize A.,1872b: 103-104,234,235;Fourtau, 1900: 540;Tortonese,1936b: 226;Tortonese,1955: 35-36; Clark,1967: 49-50,56;James and Pears,1969:92-93;Clark and Rowe,1971: 140,153;Tortones, 1977: 286; Price, 1981: 8; Dolfus and Roman, 1981: 34-38; Price, 1982: 9.
Echinus diadema Gemlin,1788: 3173 (non diadema L.,1778).
Cidarites diadema Lamarck, 1816: 58-59.
Diadema setosa Gray,1825: 426.
Cidarites savignyi Audouin, 1826: 210.
Diadema lamarckii Agassiz and Desor,1846: 349.
Diadema nudum Agassiz A., 1863: 353-354.
Diadema saxatile Loven, 1887: 129-137.
Centrostephanus setosus Lambert and Thiery, 1909: 58-59.
Centrostephanu slongispinus Russo, 1931: 4 (non C.longispinusPhillipi)
Centrichinus setosus Jackson, 1912: 28; Clark H.L.,1921: 146,220.
Aspidodiadema annulatum Koehler,1927: 61.
Diadema savignyi Totonese,1936b: 225.

Global distribution: Red sea; East Africa and Madagascar; Mascarene; Persian gulf; Maldives; India; Bay of Bengal; Philippine; China and Japan; North Australia; South pacific and South sea.

***Echinothrix calamaris* (Pallas, 1774)** (PLATE I, G)

Synonymized names:

Astropyga clamaria (Pallas, 1774)
Astropyga desorii L. Agassiz in L. Agassiz &Desor, 1846
Cidaris calamaria (Pallas, 1774)
Cidaris calamaris (Pallas, 1774)
Cidarites calamaria (Pallas, 1774)
*Diadema calamar*e (Pallas, 1774)
*Diadema calamar*ia (Pallas, 1774)
*Diadema calamar*ium (Pallas, 1774)
Diadema desor i(L. Agassiz in L. Agassiz &Desor, 1846)
Diadema frappieri (Michelin, 1862)
Echinothrix aequalis (Gray, 1855)
*Echinothrix annellata*Peters, 1853
Echinothrix aperta A. Agassiz, 1863
Echinothrix clavata (Gray, 1855)
Echinothrix desori (L. Agassiz in L. Agassiz &Desor, 1846)
Echinothrix desorii (L. Agassiz in L. Agassiz &Desor, 1846)
Echinothrix scutata A. Agassiz, 1863

Echinotrix calamaris (Pallas, 1774)
Echinus calamaris Pallas, 1774
Echinus calamarus Pallas, 1774
Garelia aequalis Gray, 1855
Garelia clavata Gray, 1855
Savigny afrappieri Michelin, 1862

Global distribution: East India, Somalia, Indian Ocean, Maldives, Kenya, Madagascar, Mozambique, Red Sea, Republic of Mauritius, Seychelles, South Africa, Tanzania and Eastern Africa.

***Echinothrix diadema* (Linnaeus, 1758)** (PLATE I, H)

Synonymized names:
Astropyga spinosissima (Lamarck, 1816)
Astropyga subularis (Lamarck, 1816)
Centrostephanus subularis (Lamarck, 1816)
Cidaris araneiformis Leske,1778
Cidaris coronalis Leske,1778
Cidarites spinosissima Lamarck, 1816
Cidarites subularis Lamarck, 1816
Diadema desjardinsii Michelin, 1845
Diadema spinosissimum (Lamarck, 1816)
Diadema subulare (Lamarck, 1816)
Echinothrix cincta (A. Agassiz, 1863)
Echinothrix petersii Bolsche, 1865
Echinothrix spinosissima (Lamarck, 1816)
Echinothrix spinosissimum (Lamarck, 1816)
Echinothrix subularis (Lamarck, 1816)
Echinothrix turcarum Peters, 1853
Echinus coronalis (Leske,1778)
Echinus diadema Linnaeus, 1758
Garelia cincta A. Agassiz, 1863
Garelia subularis (Lamarck, 1816)

Global distribution: Republic of Mauritius, Somalia, Indian Ocean, Maldives, Kenya, Madagascar, Mozambique, Red Sea, Seychelles, South Africa, Tanzania and Eastern Africa.

Order: Camarodonta
Infreorder: Temnopleurdea
Family: Temnopleuridae A. Agassiz, 1872

***Microcyphus rousseaui* Agassize and Desor, 1846**(PLATE II, A)

Synonymized names:
Microcyphus rousseaui Agassiz and Desor,1846: 358; Martens,1869: 131; Mortensen, 1904: 99; Mortensen, 1943a: 155-159; Clark, 1967: 51;Clark and Rowe, 1971: 140,148,156; Dolfus and Roman,1981: 52-54;Price,1982: 9.

Global distribution: Red Sea, Federal Republic of Somalia, Kenya, Madagascar, Tanzania and East Africa.

Infraorder: EchinideaKroh& Smith, 2010
Suberfamily: OdontophoraKroh& Smith, 2010
Family: ToxopneustidaeTroschel, 1872

***Tripneustes gratilla* (Linnaeus, 1758)** (PLATE II, B)

Synonymized names:

Cidaris angulosa Leske, 1778: 28-29.
Cidaris variegata Leske, 1778: 85.
Echinus faciatus Lamarck, 1816: 45.
Echinus gratilla Linnaeus, 1758: 664.
Echinus inflatus Blainville, 1825: 92-93.
Echinus pentagonus Lamarck, 1816: 46.
Echinus sardicus Lamarck, 1816: 45.
Echinus subcaeruleus Lamarck, 1816: 49.
Echinus varigatus Lamarck, 1816: 44.
Hipponoe nigicans Agassiz A., 1863: 24-25.
Hipponoe variegate Agassiz A., 1872b: 135-136.
Hipponoe violaccea Agassiz A., 1863: 24.
Tripneustes angulosus Bell, 1884: 121.
Tripneustes bicolor Perrier, 1869: 156-157,187.
Tripneustes fuscus Michelin, 1863: 1,5.
Tripneustes gratilla Loven,1887: 77; Bell, 1909: 17-22; Clark H.L.,1921: 148; Tortonese,1933: 126; Tortonese,1949: 39; Clark, 1952: 204,211; Clark, 1967: 51-52; James and pearse, 1969: 94-95; Clark and Rowe, 1971: 142,153,156; Tortonese,1977: 286; Dolfus and Roman,1981: 65-67; Pears,1982: 1-13; Price,1982: 9.
Tripneustes pentagonus Martens, 1869: 131.
Tripneustes sardicus Martens, 1869: 128.
Tripneustes variegates Doderlein, 1888: 838.
Tripneustes zigzag Michelin, 1863: 1,5.

Global distribution: Egypt, Maldives, Red Sea, Indian Ocean, Federal Repuplic of Somalia, Kenya, Madagascar, Mozambique, New Zealand, Mauritius, Seychelles, South Africa and Tanzania.

Family: Echinometridae Gray, 1855

***Echinostrephus molaris* (Blainville, 1825)** (PLATE II, C)

Synonymized names:

Echinometra molare Studer, 1881: 872.
Echinostrephus molaris Mortensen, 1943: 311-316; Clark and Rowe, 1971: 142,157.
*Echinostrephus pentagonus*Yoshiwara, 1898: 59.
Echinus laganoides Aggasiz and Desor, 1846: 370.
Echinus lezaroides Perrier, 1869: 146.
Echinus mola Blainville, 1834:228.
Echinus molaris Blainville, 1825:88-89.
Ecinostrephus molare Agassiz, 1872: 119.
Raphidechinus molaris Lambert and Thiery, 1914: 214.

Global distribution: Red Sea, Indian Ocean, Kenya, Mozambique, Seychelles, South and Eastern Africa and Tanzania.

***Echinometra mathaei* (Blainville, 1825)** (Plate II, D)

Synonymized names:

Echinometra heteropora Agassiz and Desor, 1846: 372.
Echinometra lucunter Gray, 1872: 121.
Echinometra mathaei Blainville,1830: 206; Clark H.L., 1921: 151; Tortonese, 1933: 135-136; Clark, 1952: 204; Tortonese, 1955: 37; Clark, 1967: 52,56; James and Pears,1969: 95-97; Clark and Rowe,1971: 142; Tortonese,1977: 286; Price,1981: 8; Dolfus and Roman,1981: 72-74; Price,1982: 9;Pears,1982: 8-13; Lawrence,1982: 2-15.
Echinometra subangularis Dreyfuss, 1931: 316.
Echinometra viridis Russo, 1894: 159 (non *virdis* in Atlantic).
Echinus mathei Blainville, 1825: 94.
Ellipcechinus decaryi Lambert, 1933: 47.

Global distribution: Egypt, Gulf of Mexico, Maldives, Red Sea, Indian Ocean, Federal Repuplic of Somalia, Kenya, Madagascar, Mozambique, New Zealand, Republic of Mauritius, Seychelles, South and Eastern Africa and Tanzania.

***Heterocentrotus mamillatus*(Linnaeus, 1758)** (PLATE II, E)

Synonymized names:

Acrocladia blainvillei Dujardin and Hupe, 1862: 540.
Acrocladia hastifera Agassiz and Desor, 1846: 373.
Acrocladia mamillata Agassiz L., 1840: 19.
Acrocladia planispina Martens, 1866: 381-382.
*Cidarisma millatus*Leske, 1778: 121-122.
Echinometra blainvillei Desmoulins, 1837: 264.
*Echinometra mamillatus*Blainville, 1830: 206.
Echinus mamillatus Linnaeus 1758:664; Brandt, 1835: 66.
Heterocentroutus mamillatus Agassiz A., 1873: 428; Clark H.L.,1921: 151;Tortonese, 1933:138-139; Clark, 1952: 204; Clark, 1967: 52,56; James and Pearse, 1969: 97;Clark and Rowe, 1971: 142,158; Totonese, 1977: 286; Dolfus and Roman, 1981: 74-76; pearse, 1982: 5; Price,1982: 9.

Global distribution: Jordan, Maldives, Red Sea, Indian Ocean, Kenya, Madagascar, Republic of Mauritius, Seychelles and South and Eastern Africa.

***Heterocentrotus trigonarius* (Lamarck, 1816)** (PLATE II, F)

Synonymized names:

Acrocladia trigonaria Agassiz and Desor, 1846: 373.
Echinometra trigonarius Blainville, 1830: 206.
Echinus trigonarius Lamarck, 1816
Heterocentroutus trigonarius Brant, 1835: 66; Mortensen, 1943b: 420-425;Tortonese, 1951: 30-42; Clark and Rowe, 1971: 142,158; Dolfus and Roman, 1981: 77;price,1982: 9.

Global distribution: South Andaman Islands, Red Sea (new record in the study area, Gulf of Aqaba), Indian Ocean, Federal Repuplic of Somalia, Kenya, Madagascar, Republic of Mauritius, Seychelles, South and Eastern Africa and Tanzania.

III. Occurrence and spatial distribution of Red Sea Echinoidae:

The regular sea urchins are representing in the Gulf of Aqaba, Red Sea by sixteen species belonging to four orders. Orders; Diadematoida and Camarodonta occupy 75% of the total recorded species, while Echinothurioida is represented only by *Asthenoso mavarium* Grube, 1868. On the other hand, family Diadematidae was represented by six species 37.5% of total recorded species as a largest family of Echinoidae from the Gulf of Aqaba with adding two new records for this family; *Astropyga radiate* (Leske, 1778) and *Diadema savignyi* (Audouin, 1809). While, family Echinometridae has 25% of recorded species out of which *Heterocentrotus trigonarius* (Lamarck,1816)is a new record from the Gulf of Aqaba. Families Echinothuridae, Temnopleuridae and Toxopneustidae, each of them was represented by only one species.

The results of this work showed the occurrence of recorded species in comparison with other adjacent localities listed from literatures **(Table, 1)**. *Prionocidarisbaculosa* (Lamarck,1816), *Diadema setosum* (Leske, 1778) and *Echinometra mathaei* (Blainville, 1825) were occurred in the Red Sea and all adjacent waters showing 100% of occurrence in all seven tabulated sites. On the other side, sixteen echinoid species were representing 100% of faunal distribution from the Gulf of Aqaba and 50% of these species were recorded from the Gulf of Suez, while in the Arabian Gulf only five species of these echinoids were listed. Furthermore, more than 93% of the studied species were recorded from East Africa coast, while 68% of that species were recorded from South East Arabian coast.

Table (1): List of regular echinoids recorded from The Gulf of Aqaba and adjacent areas.

Taxa			Geographical distribution						
			Red sea				Adjacent waters		
Order	family	species	Gulf of Aqaba	Gulf of Suez	Northern part	Southern part	S. East Arabia	Arabian Gulf	East Africa
Cidaroida	Cidaridae	*Eucidaris metularia*	+	+	+	+			+
		Phyllacanthus imperialis	+		+	+			+
		Prionocidaris baculosa	+	+	+	+	+	+	+
Echinothurioida	Echinothuriidae	*Asthenosoma varium*	+	+		+	+		
Diadematoida	Diadematidae	*Astropyga radiata* *	+				+		+
		Chaetodiadema granulatum	+		+	+			+
		Diadema savignyi *	+	+			+	+	+
		Diadema setosum	+	+	+	+	+	+	+
		Echinothrix calamaris	+	+	+	+	+		+
		Echinothrix diadema	+		+	+	+		+
Camarodonta	Temnopleuridae	*Microcyphus rousseaui*	+		+	+	+		+
	Toxopneustidae	*Tripneustes gratilla*	+	+	+	+	+		+
	Echinometridae	*Echinometra mathaei*	+	+	+	+	+	+	+
		Echinostrephus molaris	+			+		+	+
		Heterocentrotus mamillatus	+		+	+	+		+
		Heterocentrotus trigonarius *	+			+			+
Total number of species			**16**	**8**	**11**	**14**	**11**	**5**	**15**
Percentage			100.0	50.0	68.8	87.5	68.8	31.3	93.8
* New record in Gulf of Aqaba									

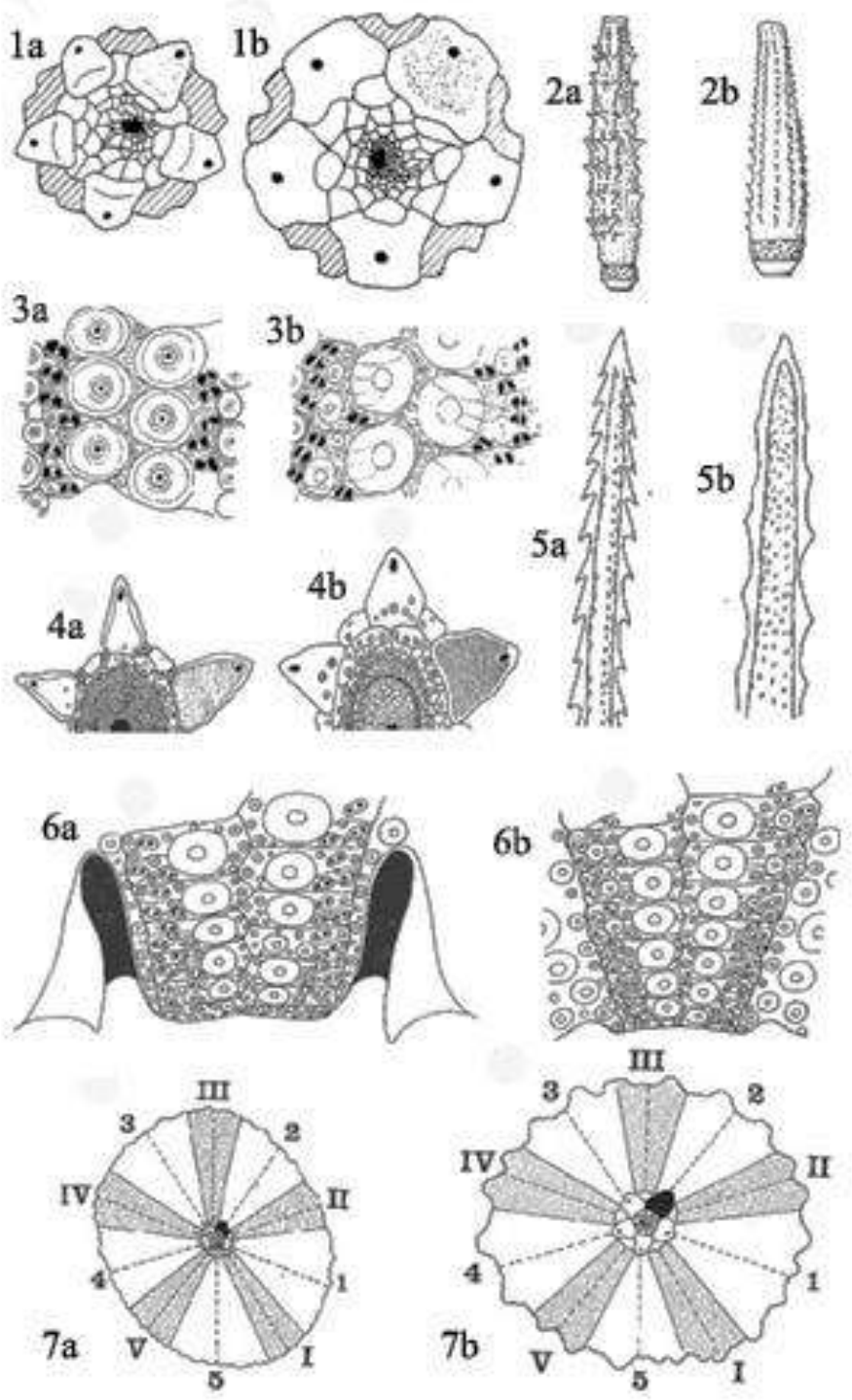
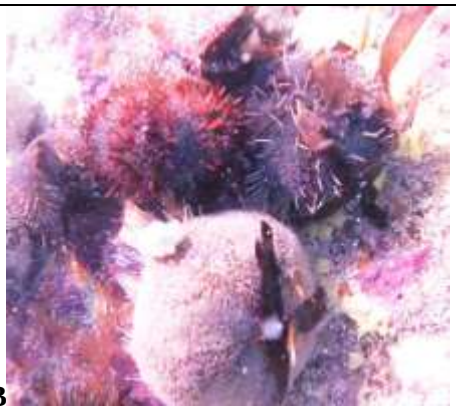


Fig. (3): pencil drawing of some diagnostic characters of Echinoids after Clark and Row (1971); 1- Apical system of: a. *Prionocidarisbaculosa* with insert ocular plates and b. *Phyllacanthusimperialis* with exsert ocular plates, 2- Primary spines of: a. *Prionocidarisbaculosa* semi-verticillate spine and b. more usual spine with smaller thorns in longitudinal series, 3- Tubercles of: a. *Diademasetosum*and b. *Echinometramathaei*, 4- Parts of apical system of: a. *Astropygaradiata* and b. *Echinothrixcalamaris*, 5- Tips of aboralambulacral spines of: a. *Echinothrixdiadema* and b. *Diademasetosum*, 6- Gill slits of: a. Toxopneustidsand b. *Echinometramathaei* and 7- Orientation of long axis of test in: a. *Echinometramathaei* and b. *Heterocentrotusmammillatus*

A 	B 
Eucidarismetularia	*Phyllacanthusimperialis*
C 	D 
Asthenosomavarium	***Astropygaradiata***
E 	F 
Diademasavignyi	***Diademasetosum***
G 	H 
Echinothrixcalamaris	***Echinothrixdiadema***
PLATE I	

A 	B 
Microcyphusrousseaui	***Tripneustesgratilla***
C 	D 
Echinostrephusmolaris	***Echinometramathaei***
E 	F 
Heterocentroutusmamillatus	***Heterocentroutustrigonarius***
PLATE II	

DISCUSSION

Echinoids are key stone species by that they are play an important role in marine organisms life style also in the food chain [1, 2], although they are not as rich in speciesin Red Sea as Ophiuroids 49 species[29]; asteroids 36 species[30];holothuroids28-38 species[31,32, 33]; or brachyuran crabs 361 species[34] and bivalves 180 species[35].

The output of the current study, which uniquely covered the whole Gulf of Aqaba, was 16 regular echinoid species. This number is higher than that recorded by Price [23] (13 species), but lower than that recorded by Hellal *et al.* [36] (18 species). The results obtained in the present study reflect clearly the lower diversity of echinoids in the Gulf of Aqaba, in

agreement with[36 ,37]. Such pattern coincide the general opinion that the Red Sea fauna is impoverished compared to that with the fauna of the Indo-Pacific in general[31 38].

The present study recorded *Diademasavignyi*(Audouin, 1809) for the first time from the Gulf of Aqaba, and subsequently from the entire Red Sea. This species was mixed with *Diademasetosum* (Leske, 1778), but differ from it in the absence of the red anal ring and having leaf like tridentate pedicellariae. Also, *Heterocentrotustrigonarius* (Lamarck, 1816) recorded for the first time from the Gulf of Aqaba and confused with their alleles *H. mammillatus* (Linnaeus, 1758), but differs from it in the number of pore-pairs per arc (15-16) at the ambital region and primary ambulacral tubercles gradually decreasing in size aborally.

Although the northern part of the Red Sea comprised 16 echinoid species and considered more diverse than other adjacent areas such as South East Arabia (11 species) and Arabian Gulf (5 species) it still has lower diversity if compared with other biogeographic Indo-Pacific areas. The distribution pattern can be attributed to several factors, a) Physical environments in the Red Sea differ from that those in the Indian Ocean, where conditions unfavorable to species originating from adjacent waters of the Indian Ocean, as a result (16 species) compared with that recorded in the Indian Ocean and other Indo-Pacific areas; b) The constricted and shallow entrance of the Red Sea is thought to be a geological barrier preventing influx of many species; c) Indian Ocean being geologically older than the Red Sea[39], it might be expected to contain more species for historical and evolutionary reasons and d) The reflection of sampling thoroughness and the collection methods used. Subsequent collections in the study areas could alter the existing picture.

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القنافذ البحرية (القنفذانيات: الجلدشوكيات) من خليج العقبة، البحر الأحمر، مصر

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الملخص
تم تجميع 16 نوعاً من القنفذانيات (القنافذ البحرية)- تنتمي الى 13 جنساً تنحدر من 6 عائلات لأربعة رتب تصنيفية- من الشاطئ المصري لخليج العقبة بالبحر الأحمر؛ وذلك خلال الفترة من يناير الي نوفمبر 2015. وقد أظهرت النتائج أن 13 نوعاً من هذه القنافذ قد سجلت بالفعل من قبل بخليج العقبة وأن نوع *هتيروسنتروتس تريجوناريس* قد تم تسجيله لأول مرة من مكان الدراسة. و علي الجانب الآخر، فقد تم تسجيل نوعي *أستروبيجا رادياتا* و *ديادیما سافيني* لأول مرة من البحر الأحمر كاملاً. و بناء علي النتائج الحالية و الدراسات السابقة تم عمل مفتاح تصنيفي لجميع الأنواع المسجلة و الأنواع المحتملة. بالإضافة الي إجراء مناقشة للتوزيع الجغرافي و البيئي لها.