

The Echinoderm Fauna  
of Ascension Island,  
South Atlantic Ocean

DAVID L. PAWSON

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*David L. Pawson*



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## ABSTRACT

Pawson, David L. The Echinoderm Fauna of Ascension Island, South Atlantic Ocean. *Smithsonian Contributions to the Marine Sciences*, number 2, 31 pages, 11 figures, 1978.—Two recent intertidal collecting expeditions and existing museum collections have added much to knowledge of the Ascension Island echinoderm fauna. Twenty-five species are now known from Ascension; eight are new records. One new species, *Holothuria (Halodeima) manningi*, and one new subspecies, *Echinometra lucunter polypora*, are described. *Diadema ascensionis* Mortensen is regarded as a subspecies of *D. antillarum* Philippi, and *Pseudoboletia atlantica* H. L. Clark is regarded as a subspecies of *P. maculata* Troschel.

The echinoderm fauna of Ascension Island includes 8 ampho-Atlantic species, 3 western Atlantic species, 4 eastern Atlantic species, 5 circumtropical species, 4 species shared only with St. Helena, and 1 endemic species. There are in addition three endemic subspecies. Twelve species are shared with St. Helena, and both islands are closely similar in terms of numbers and relationships of their faunal components. Colonization of both islands by planktonic larval stages is suggested. Dendrochirotid holothurians, which lack such larval stages, are not represented at either St. Helena or Ascension. The structure of the Ascension fauna seems to have been determined by vagaries of ocean surface and sub-surface currents. In contrast, Bermuda, which sits astride the Gulf Stream, has a fauna that is entirely typical of the West Indian region to the south.

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# The Echinoderm Fauna of Ascension Island, South Atlantic Ocean

*David L. Pawson*

## Introduction

Ascension Island lies in the South Atlantic at 07°57'S, 14°22'W, approximately 150 kilometers west of the centerline of the mid-Atlantic Ridge (Wilson, 1963). It is an entirely volcanic island, comprising the uppermost part of a cone which rises from a depth of about 3000 meters below sea level (Atkins et al., 1964). Daly (1925) has noted that the only nonvolcanic material on the island are "some small patches of beach material thrown up by storm waves." Much of this material is calcareous, derived from calcareous algae and mollusk shells. The island is approximately circular, with an area of about 97 square kilometers (Figure 1). In the absence of fossils and other reliable indicators, it is difficult to determine the length of time that Ascension has stood above sea level. Estimates range from approximately 1.5 million years to considerably less than 1 million years (Sullivan, 1974; Daly, 1922; J. D. Bell (in litt.) in Chace and Manning, 1972).

The nearest large land masses are a considerable distance away; the coast of Brazil lies 2200 km to the west, West Africa is 1300 km to the northeast (Figure 2). To the south, 1100 km away, lies St. Helena, another volcanic island, but considerably older (20 million years; Wilson, 1963) than Ascension.

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Until very recently, no extensive collections of invertebrates have been made at Ascension, and our knowledge of the echinoderm fauna stems from one or two small collections made during the late 1800s, and visits by Antarctic research vessels during the first half of this century. Dr. R. B. Manning, National Museum of Natural History, visited Ascension in 1971 and made extensive collections of invertebrates. The interesting material obtained led to the organization of a second Smithsonian expedition in 1976. This paper is based upon material collected during those two expeditions: Asc. = collection stations for 1976 expedition; RBM = collection stations for 1971 expedition; USNM = catalog numbers using abbreviation for former United States National Museum, collections of which are in the National Museum of Natural History, Smithsonian Institution.

ACKNOWLEDGMENTS.—I am grateful to Dr. R. B. Manning for making a fine collection of echinoderms at Ascension in 1971. A second expedition to the island in 1976 by Dr. Manning, Dr. M. L. Jones, Dr. J. Rosewater and myself, of the National Museum of Natural History, and Dr. A. J. Provenzano, Jr., of the Old Dominion University, Norfolk, resulted in the amassing of an extensive series of shallow water marine invertebrates, among them numerous echinoderms. Mr. Ross Simons of the Office of the Assistant Secretary for Science, Smithsonian Institution, was especially helpful in making necessary arrangements with the U.S. Air Force and

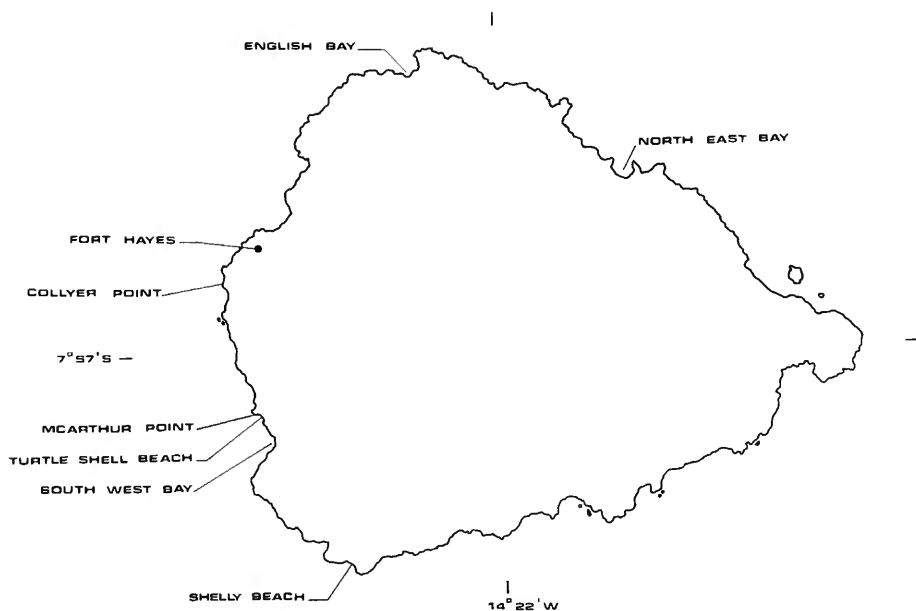


FIGURE 1.—Outline map of Ascension Island, showing collecting localities.

with the Administrator of Ascension Island. The Administrator, Mr. Jeffrey C. Guy, the U.S. base commanders Major Henry Spangler and Lieutenant Colonel Thomas Morris, and the head of the NASA tracking station, Mr. Jefferson Speck, were most helpful to us during our stay at Ascension. Our expenses were met by a grant from the Smithsonian's Fluid Research Fund; we are grateful to Mr. S. Dillon Ripley, Secretary of the Smithsonian Institution, for his support.

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#### PREVIOUS RECORDS OF ECHINODERMS FROM ASCENSION

The first record of an echinoderm from the island

was that of Cuninghame (1699:298), who made the following observations:

One small warted Barbadoes sea egg. *Echinus ovarious* Barbado. verrucis plurimis minoribus Mus. Petiver 123.

The spines of these are purplish, especially the tips, the largest I have yet seen, exceed not a crow-quill in thickness, and are scarce an inch long; they end pointed, and are finely striated if strictly viewed. The naked shell of this was somewhat more than six inches in circumference, and about 5 broadways and  $5\frac{1}{2}$  lengthways.

Bell (1881:437) suggested that this "small warted Barbadoes sea egg" was undoubtedly a specimen of *Echinometra subangularis* Leske (= *E. lucunter* (Linnaeus)); Cuninghame's description fits that species admirably. In the same paper Bell listed the following species from Ascension Island:

Bell's name	Currently accepted name
<i>Cidaris metularia</i> Lamarck	<i>Eucidaris clavata</i> Mortensen
<i>Diadema setosum</i> Gray	<i>Diadema antillarum</i> <i>ascensionis</i> Mortensen
<i>Tripneustes angulosus</i> Leske	<i>Tripneustes ventricosus</i> (Lamarck)
<i>Echinometra subangularis</i> Leske	<i>Echinometra lucunter</i> <i>polypora</i> Pawson
<i>Echinoneus cyclostomus</i> Leske	Same
<i>Rotula dentata</i> Leske	<i>Heliophora orbiculus</i> (Linnaeus)
<i>Linckia diplax</i> Müller and Troschel	<i>Linckia guildingi</i> Gray



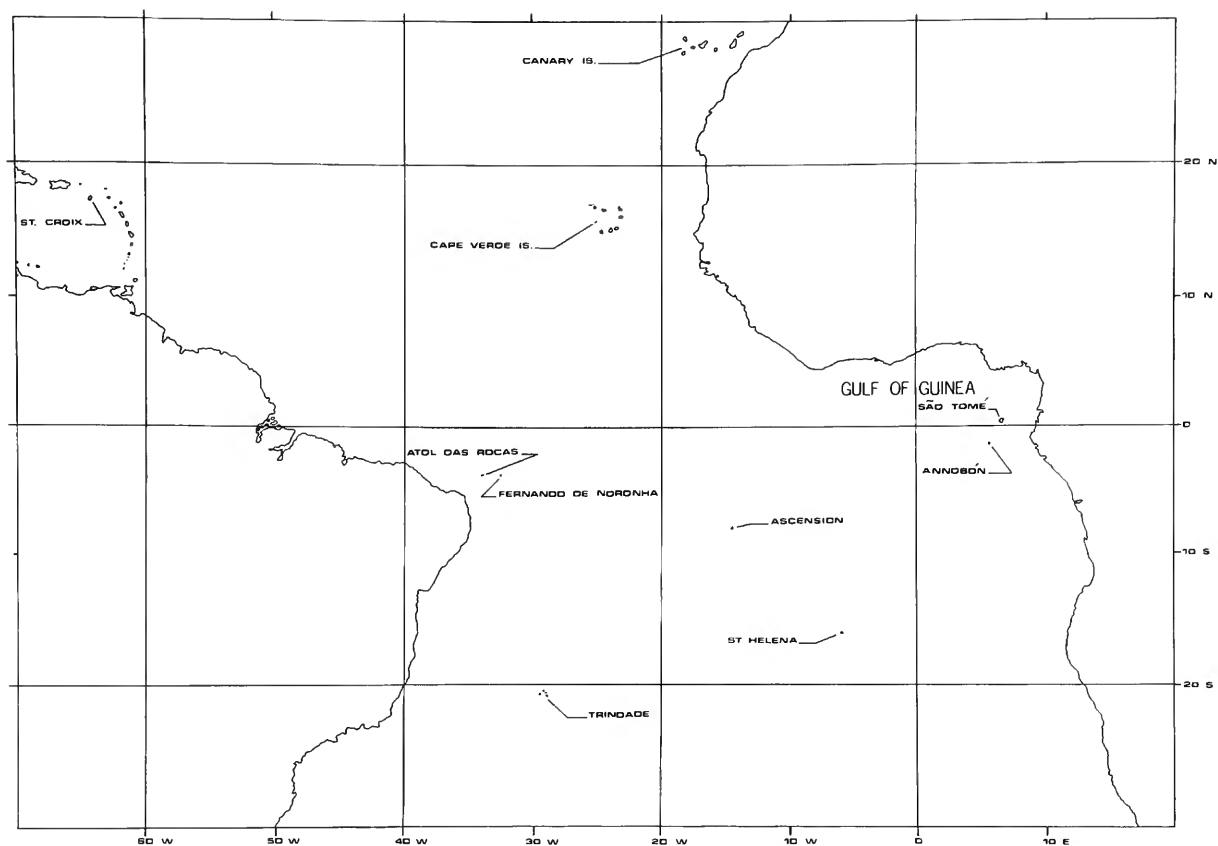


FIGURE 2.—Central Atlantic Ocean, showing principal islands.

During the early part of this century, several ships paused briefly at Ascension, when they were returning from expeditions in the southern oceans, and made collections, usually by dredging. Koehler (1908) reported the following species from Ascension, collected by the *Scotia*:

Koehler's name	Currently accepted name
<i>Moiraster magnificus</i> (Bell)	<i>Tethyaster magnificus</i> (Bell)
<i>Chaetaster longipes</i> (Retzius)	Same
<i>Amphiura capensis</i> Lyman	Same
<i>Tretocidarid spinosa</i> Mortensen	Same
<i>Cidarid minor</i> , new species	<i>Eucidaris clavata</i> Mortensen
? <i>Coelopleurus floridanus</i> Agassiz	Same
<i>Echinometra subangularis</i> (Leske)	<i>Echinometra lucunter</i> <i>polypora</i> Pawson
<i>Pseudoboletia maculata</i> Troschel	<i>Pseudoboletia maculata</i> <i>atlantica</i> Clark

The Deutsche Sudpolar-Expedition collected *Dia-*

*dema ascensionis* Mortensen (now *D. antillarum ascensionis*) at Ascension, according to Mortensen (1909).

As a result of a visit by the *Discovery*, Fisher (1940) noted the presence of *Ophidiaster guildingii* at Ascension, and Mortensen (1936) listed the following species:

Mortensen's name	Currently accepted name
<i>Ophiolithrix roseocaerulans</i> Grube	Same
<i>Ophiactis savignyi</i> (Müller and Troschel)	Same
<i>Ophiostigma abnorme</i> (Lyman)	Same
<i>Eucidaris tribuloides</i> (Lamarck)	<i>Eucidaris clavata</i> Mortensen
<i>Diadema antillarum</i> var. <i>ascensionis</i> Mortensen	<i>Diadema antillarum</i> <i>ascensionis</i> Mortensen
<i>Echinometra lucunter</i> (Linnaeus)	<i>Echinometra lucunter</i> <i>polypora</i> Pawson

Thus, at the time of writing of this paper, 17 species of echinoderms were known from Ascension. The following checklist lists all 25 known species in systematic order; new records are marked with an asterisk (\*).

## CHECKLIST OF ASCENSION ISLAND ECHINODERMS

- CRINOIDEA  
None
- ASTEROIDEA  
Family OPHIOTHRICIDAE  
*Tethyaster magnificus* (Bell)
- Family CHAETASTERIDAE  
*Chaetaster longipes* (Retzius)
- Family OPHIDIASTERIDAE  
*Ophidiaster guildingi* Gray  
*Linckia guildingi* Gray
- OPHIUROIDEA  
Family OPHIACTIDAE  
*Ophiactis savignyi* (Müller and Troschel)  
\**Ophiactis lymani* Ljungman
- Family AMPHIURIDAE  
? *Amphiura capensis* Lyman  
*Ophiostigma abnorme* (Lyman)
- Family OPHIOTHRICIDAE  
*Ophiothrix (Ophiothrix) roseocaerulans* Grube
- ECHINOIDEA  
Family CIDARIDAE  
*Eucidaris clavata* Mortensen  
*Tretocidaris spinosa* Mortensen
- Family DIAEMATIDAE  
*Diadema antillarum ascensionis* Mortensen
- Family ARBACIIDAE  
? *Coelopleurus floridanus* Agassiz
- Family TOXOPNEUSTIDAE  
*Pseudoboletia maculata atlantica* H. L. Clark  
*Tripneustes ventricosus* (Lamarck)
- Family ECHINOMETRIDAE  
*Echinometra lucunter polypora* Pawson
- Family ECHINONEIDAE  
*Echinoneus cyclostomus* Leske
- Family ROTULIDAE  
*Heliophora orbiculus* (Linnaeus)
- Family BRISSIDAE  
\**Brissus unicolor* (Leske)
- HOLOTHUROIDEA  
Family HOLOTHURIDAE  
\**Holothuria (Halodeima) grisea* Selenka  
\**Holothuria (Halodeima) manningi*, new species  
\**Holothuria (Thymiosycia) arenicola* Semper  
\**Holothuria (Platyperona) sanctori* Delle Chiaje
- Family STICHOPODIDAE  
\**Isostichopus badionotus* (Selenka)
- Family SYNAPTIDAE  
\**Euaпта lappa* (Müller)

The record of *Amphiura capensis* Lyman is doubt-

ful (see p. 11). The single juvenile specimen of *Coelopleurus* recorded from Ascension was identified by Koehler (1908) as *C. floridanus* Agassiz; this identification must remain in doubt until adult specimens are found.

## COMPOSITION OF THE ASCENSION ECHINODERM FAUNA

The fauna as it is known today comprises 25 species (Table 1), of which one, *Amphiura capensis*, is a doubtful record. The identity of *Coelopleurus floridanus* has yet to be confirmed. Eight species are reported from Ascension for the first time, but only one of these, *Holothuria manningi*, is new.

There are some notable absentees from the fauna. No members of the holothurian Order Dendrochirotida have yet been found, despite the fact that these "cucumaria-type" holothurians are common on both sides of the Atlantic Ocean (see below for discussion). No crinoids are known from Ascension. It is also surprising that many species that are amphi-Atlantic in distribution and can tolerate a variety of habitats are apparently absent from Ascension. These include such common shallow-water forms as *Linckia bouvieri* Perrier, *Axiognathus squamatus* (Delle Chiaje), *Ophiocoma pumila* Lütken, *Ophioderma appressum* (Say), and *Ophiolipsis paucispina* (Say).

## RELATIONSHIPS OF THE ASCENSION ECHINODERM FAUNA

As can be seen from Table 1, the relationships of the echinoderm fauna of Ascension are complex: 8 species (32%) are amphi-Atlantic; 1 species (4%) is restricted to Ascension; 3 species (12%) are also known from the western Atlantic only; 4 species (16%) are also known from the eastern Atlantic only; 5 species (20%) are circumtropical in distribution; 4 species (16%) are also known from St. Helena only; 12 species (48%) are shared by Ascension and St. Helena.

These figures are similar to those for the mollusks given by Rosewater (1975). The only notable difference lies in the fact that 5 of the 89 Ascension mollusk species (6%) occur at Ascension and St. Helena only, while 4 of the 25 echinoderms (16%) have this distribution pattern. There is some indication here that Ascension-St. Helena are more

TABLE 1.—Relationships of Ascension echinoderms (+ = present; O = present as species, but not as subspecies listed; ? = doubtful record)

Ascension echinoderms	Ascension	Amphi-Atlantic	Western Atlantic	Eastern Atlantic	Cosmopolitan-circumtropical	St. Helena	St. Helena and Ascension
<i>Tethyaster magnificus</i> .....						+	+
<i>Chaetaster longpipes</i> .....				+		+	
<i>Ophidiaster guildingi</i> .....			+				
<i>Linckia guildingi</i> .....					+		
<i>Ophiactis savignyi</i> .....					+	+	
<i>Ophiactis lymani</i> .....	+					+	
<i>Amphiura capensis</i> .....				+			
<i>Ophiostigma abnorme</i> .....	+						
<i>Ophiothrix</i> (O.) <i>roseocaerulans</i> .....						+	+
<i>Euclidaris clavata</i> .....						+	+
<i>Tretocidaris spinosa</i> .....						+	+
<i>Diadema antillarum ascensionis</i> .....	o	?				+	
<i>Coelopleurus floridanus</i> .....			+			?	
<i>Pseudoboletia maculata atlantica</i> .....					o	+	+
<i>Tripneustes ventricosus</i> .....	+					?	
<i>Echinometra lucunter polypora</i> .....	o					+	+
<i>Echinoneus cyclostomus</i> .....					+		
<i>Heliophora orbiculus</i> .....				+			
<i>Brissus unicolor</i> .....	+						
<i>Holothuria</i> ( <i>Halodeima</i> ) <i>grisea</i> .....	+						
<i>Holothuria</i> ( <i>Halodeima</i> ) <i>manningi</i> .....	+						
<i>Holothuria</i> ( <i>Thymiosycia</i> ) <i>arenicola</i> .....					+		
<i>Holothuria</i> ( <i>Platyperona</i> ) <i>sanctori</i> .....				+		+	
<i>Isostichopus badionotus</i> .....	+						
<i>Euapta lappa</i> .....			+			+	
Total species.....	1	8	3	4	5	12	6

“isolated” for the echinoderms than for the mollusks, but little weight can be attached to such slender evidence.

The relationships expressed in the above percentages imply that propagules have reached Ascension from the east and from the west. It seems likely that colonization of Ascension was mediated by surface and subsurface transport of planktonic larval stages.

Briggs (1974) has pointed out that Ascension lies on the “northern limb of the South Atlantic gyre where the water movement is relatively rapid and the direction of flow almost due west.” He notes that if this pattern of surface water flow were constant, then one would expect that for the fishes there would be a strong relationship with West Africa. But this is not so, and Briggs suspects that Ascension comes under the influence of the east-

ward-flowing Equatorial Countercurrent for at least part of the year.

The equatorial undercurrent, flowing eastward at velocities of around 0.8 to 2.9 knots (Metcalf et al., 1962; Sturm and Voigt, 1966; Voigt, 1975), with a core which may range from the surface to (usually) around 75 meters, has been suggested by Chesher (1966) as a likely route for transportation of larvae of echinoids across the Atlantic from west to east, thereby maintaining genetic continuity between populations of amphi-Atlantic species. Chesher calculated that larvae might make the trans-Atlantic trip in a minimum of 43 days and a maximum of 70 days. Scheltema (1968, 1971) suggested that the undercurrent would be a potent dispersal agent for his so-called teleplanic molluscan larvae. The true extent of the equatorial undercurrent is not known. Most authors estimate that it extends southwards to a latitude of around 2°S. Possibly then the current might not directly influence the fauna of Ascension, which lies at latitude 7°57'S, some 600 km away.

Some alternative mechanisms for trans-Atlantic transport of pelagic larval stages have been discussed by Scheltema (1968, 1971) for the North Atlantic; similar patterns of current flow exist for the South Atlantic. For successful transport of larvae in the North or South Atlantic gyres, the larvae must be eurythermal and long-lived. Six of the ten mollusk species discussed by Scheltema in 1971 have larval lives of at least three months; two others can reach the settling state in less than two months; these two, plus the remaining two species, can probably delay metamorphosis until conditions are suitable for settlement.

Regrettably, very little is known about the actual larval life span of echinoderms. The excellent investigations of Mortensen (1921, 1931, 1938) and others are mostly descriptive.

For Ascension Island species, the following information is available. *Linckia guildingi*: In the related *L. multifora* the late brachiolaria stage is reached after 27 days (Mortensen, 1938); in *L. laevigata* metamorphosis can take place after 22 days (Yamaguchi, 1973). *Ophiactis savignyi*: Late ophiopluteus is reached after 21 days (Mortensen, 1931). *Eucidaris clavata*: In the closely related *E. tribuloides* metamorphosis takes place after about 25 days (McPherson, 1968). *Tripneustes ventricosus*: Fully developed larva after 22 days (Mortensen, 1921). *Echinometra lucunter*: Metamorphosis takes

places after 19 days (Mortensen, 1921). *Holothuria* species: In *H. impatiens* metamorphosis can take place after 21 days, and in *H. difficilis* after 14 days (Mortensen, 1938).

Devaney (1973) extracted estimates of average lengths of larval life for tropical echinoderms from Thorson (1946) as follows:

Number of days	Percentage of species
0-9	7
10-20	33
21-30	26
31-40	17
41-50	13

While the figures given above provide some useful guidelines, it must always be borne in mind that metamorphosis can be delayed for considerable periods of time if proper food and/or proper substrate are not available, or if physical factors such as temperature and salinity are not optimal (Thorson, 1950).

The fact that Ascension appears to have received colonists from the east and from the west leads to the suggestion that the important surface and subsurface currents mentioned above are not exerting a continuous influence on the island's fauna. Latitudinal shifts in currents accompanied by extensive midocean eddies (Robinson, 1976) over the past one million years have no doubt had important effects upon composition of the Ascension fauna.

#### HOW "ISOLATED" IS ASCENSION?

Oceanic islands are useful natural laboratories for investigation of effects of isolation upon their resident populations of animals and plants. MacArthur and Wilson (1967) noted that new populations arriving on an island might pass through three overlapping evolutionary phases. During the first phase, genetic divergence from the "mother" population might take place (founder effect: see Mayr, 1963) because the colonizing population is small, and contains fewer genes than the "mother population" (the founder principle.) There is some experimental evidence in support of the founder principle (see MacArthur and Wilson, 1967) but some critics have suggested that many colonizations are made by successive waves of propagules, and that large fractions of the genetic variation of the mother population can be inserted into the founder popula-

tion, thus reducing genetic drift to a low level. During the second phase, adjustments are made to the new environment. The third phase comprises speciation, secondary emigration, and radiation.

It is assumed that Ascension has been available for colonization only within the past one million years or so. The Ascension fauna offers some excellent possibilities for exploration of the effects of isolation. Many of the Ascension echinoderm species are consistently different in a variety of ways from their conspecifics elsewhere. The reader is referred to the systematic section of this paper for details, but some species are worth mentioning here in this context.

*Ophiactis lymani*: Ventral arm plates with convex distal edges in St. Helena and Ascension forms. Specimens of this species from the eastern and western Atlantic do not have convex distal edges on ventral arm plates.

*Diadema antillarum ascensionis*: Tridentate pedicellariae in Ascension and St. Helena population (also Fernando de Noronha ?) with curved valves. Valves essentially straight in eastern and western Atlantic populations of this species (*Diadema antillarum antillarum*).

*Pseudoboletia maculata atlantica*: There are usually five pore-pairs to the arc in Ascension and St. Helena populations of this species. In *Pseudoboletia maculata maculata* there are typically four pore-pairs.

*Echinometra lucunter polypora*: Ascension and St. Helena populations have seven pore-pairs to the arc, and the test is purplish adapically. In *Echinometra lucunter lucunter* there are typically six pore-pairs, and the test is greenish or white adapically.

*Holothuria (Halodeima) grisea*: In comparison with West Indian specimens of this species, Ascension specimens have smaller buttons with more numerous larger perforations, and the ossicles in the tube feet are a different shape.

*Holothuria (Platyperona) sanctori*: In Ascension and St. Helena specimens of this species, the buttons have numerous small knobs. In contrast, specimens from the eastern Atlantic and Mediterranean have buttons with very few knobs or with none.

These striking and consistent differences from presumed "mother" populations prompt enquiry as to whether they might be environmentally or genetically induced. In the absence of experimental evidence (rearing of specimens from different At-

lantic localities in uniform environments would be most informative), it is almost impossible to answer the question. If the differences are genetic, one must presume that Ascension is genetically isolated from the eastern and western Atlantic, but not from St. Helena, and that recruitment of newly settling juveniles is entirely internal.

There is some evidence to indicate that Ascension is genetically isolated to a considerable degree. Amphi-Atlantic populations of many species are virtually identical morphologically, and a genetic continuity across the Atlantic has been postulated for the echinoids by Chesher (1966). But in the case of Ascension, it is notable that (1) several amphi-Atlantic species appear not to have been able to colonize this island, and that (2) many taxa, including *Eucidaris clavata*, *Diadema antillarum ascensionis*, and *Echinometra lucunter polypora* appear to have originated from populations elsewhere in the Atlantic, but have not been "swamped" by continuing recolonization, nor have populations of these taxa apparently become established in other parts of the Atlantic (Fernando de Noronha may be the exception; this area of the Atlantic requires further investigation).

It also seems evident that colonization by planktonic larval stages is the only method by which the Ascension echinoderms have reached the island. The absence of dendrochirotid holothurians is attributable to the fact that these animals generally lack planktotrophic larvae. Some dendrochirotids disperse by rafting on floating weed. In the tropics, and certainly in the case of Ascension, this method of colonization is not common.

The Ascension-St. Helena fauna might be interpreted as being in the third evolutionary phase in the sense of MacArthur and Wilson (1967). This is the phase of "speciation, secondary emigration, and radiation." The process of speciation is obviously slow, but establishment of subspecies, especially in the echinoids, is proceeding rather rapidly.

One might contrast the fauna of Ascension with that of Bermuda, another isolated island, which lies 1075 km away from the nearest land-mass. The known echinoderm fauna of Bermuda now comprises approximately 50 species (Pawson, in ms); none of these are endemic to Bermuda, and all are common in the West Indian region. Only one species, *Lytechinus variegatus* (Lamarck), shows slight but consistent differences from its West

Indian conspecifics. Bermuda is a relatively much older island than Ascension (36 million years), and thus might be expected to have developed some endemic species. The single overwhelming factor influencing the Bermuda fauna, however, is the Gulf Stream; this gigantic river must be rapidly transporting endless numbers of larval and early juvenile stages of echinoderms from the West Indies to Bermuda. No equivalent physical factor exists for Ascension.

#### MATERIAL EXAMINED

This report is based upon material from several sources. In 1970, Storrs Olson, National Museum of Natural History, took time from his search for fossil birds to make some shore collections; these included species of echinoderms. Stimulated by Dr. Olson's discoveries, R. B. Manning visited the island in May 1971, and made general collections of shallow-water marine invertebrates; these included an excellent series of echinoderms. Further material was obtained during a second visit in July 1976, to Ascension by a party comprising R. B. Manning, M. L. Jones, J. Rosewater, A. J. Provenzano, Jr., and me. A specimen of *Ophidiaster guildingii* collected at Ascension by Mr. A. Lovelidge, together with ophiuroids and asteroids collected by the U.S. *Eclipse* Expedition to West Africa in 1890 are described in this report. Some echinoderms collected a few years ago by Mrs. K. M. Hutchfield, a former resident of Ascension, and deposited in the British Museum (Natural History) were kindly sent to me for study by Miss Ailsa M. Clark. The small collection in the Ascension Historical Society Museum at Fort Hayes was examined during July 1976.

In the station list below only the 1971 Manning expedition and the 1976 expedition stations are listed. Miscellaneous records are given under the relevant species accounts. The number of specimens is indicated after the author of the species.

#### R. B. MANNING'S 1971 EXPEDITION TO ASCENSION

RBM 3: 18 May 1971, Turtle Shell Beach, beach and rocky point (MacArthur Point) at northern edge of South West Bay, coarse sand beach and rocky intertidal, 1900-2030, RBM and D. Rogers

*Holothuria grisea* Selenka, 1

RBM 5: 19 May 1971, North East Bay Beach and tidepools

on rocky point west of main beach, temperature 27°C, salinity 38‰, 0900-1100, RBM, D. Rogers, P. Kashulines

*Ophidiaster guildingi* Gray, 1

*Ophiothrix (Ophiothrix) roseocaerulans* Grube, 1

*Eucidaris clavata* Mortensen, 1 (found dry on beach, not represented in collections)

*Echinoneus cyclostomus* Leske, 2

RBM 9: 20 May 1971, Turtle Shell Beach (MacArthur Point), northern edge of South West Bay, tidepool with sand bottom in lava flow area, 0800-0930, RBM and P. Kashulines

*Isostichopus badionotus* (Selenka), 1

RBM 10: 20 May 1971, rocky point at northern edge of English Bay, intertidal pools and subtidal rocky shore, some coarse sand bottom, temperature 27°C, salinity 39‰, 1430-1900, RBM and P. Kashulines

*Eucidaris clavata* Mortensen, 1

*Holothuria (Halodeima) grisea* Selenka, 1

RBM 12: 21 May 1971, Turtle Shell Beach, northern edge of South West Bay (MacArthur Point), tidepool with sand bottom in lava flow area, 1200-1630

*Ophiothrix (Ophiothrix) roseocaerulans* Grube, 7

*Echinometra lucunter polypora* Pawson, 1

RBM 13: 22 May 1971, rocky point off Fort Hayes, Georgetown, algal mats in intertidal, 0800-1100, RBM and D. Rogers

*Holothuria (Thymiosycia) arenicola* Semper, 1

RBM 14: 22 May 1971, rocky flat near Collyer Point, rock surface at low tide with dense algal mat, area locally known as Cable and Wireless Beach, 1100-1130, RBM and D. Rogers

*Echinometra lucunter polypora* Pawson, 1

RBM 15: 22 May 1971, same locality as sta 10, but second tidepool from shore as well as more isolated tidepool, 1330-1600, RBM, D. Rogers, K. Double

*Ophiothrix (Ophiothrix) roseocaerulans* Grube, 1

*Eucidaris clavata* Mortensen, 1

*Echinoneus cyclostomus* Leske, 1

*Holothuria (Platyperona) sanctori* Delle Chiaje, 2

RBM 16: 22 May 1971, Shelly Beach, flat exposed at low tide on open beach proper, 1830-2330, RBM and D. Rogers

*Eucidaris clavata* Mortensen, 1

*Diadema antillarum ascensionis* Mortensen, 2

RBM 18: 23 May 1971, Shelly Beach, tidepools in flat exposed at low tide on open beach, temperature 27°C, salinity 40‰, 1000-1200, RBM, D. Rogers, K. Double

*Ophiothrix (Ophiothrix) roseocaerulans* Grube, 8

*Schinometra lucunter polypora* Pawson, 2

RBM 20: 23 May 1971, same as sta 14, 1900-2030, RBM

*Eucidaris clavata* Mortensen, 1

*Echinometra lucunter polypora* Pawson, 2

RBM 21: 24 May 1971, rocky point at northern edge of English Bay, tidepools on rocky flat, 0800-1200

*Ophiothrix (Ophiothrix) roseocaerulans* Grube, 4

*Ophiactis savignyi* Müller and Troschel, 2

*Isostichopus badionotus* (Selenka), 1

RBM 22: 24 May 1971, Turtle Shell Beach, northern edge of South West Bay (MacArthur Point), tidepool about 20 feet in diameter with clear, soft sand bottom, 1300-1700

*Ophiothrix (Ophiothrix) roseocaerulans* Grube, 1

*Eucidaris clavata* Mortensen, 1

*Diadema antillarum ascensionis* Mortensen, 1  
*Echinometra lucunter polypora* Pawson, 3  
*Holothuria (Thymiosycia) arenicola* Semper, 2

RBM 23: 25 May 1971, same as sta 22, 0800–1030, RBM, K. Double

*Eucidaris clavata* Mortensen, 1  
*Diadema antillarum ascensionis* Mortensen, 5

RBM 24: 25 May 1971, same as sta 14, 1030–1230, RBM and K. Double

*Diadema antillarum ascensionis* Mortensen, 7  
*Echinometra lucunter polypora* Pawson, 7

RBM 24: 25 May 1971, same as sta 14, temperature high pool 42°C, shore pool 38°C, salinity high pool 32‰, shore pool 28‰, 1300–1530

*Ophiothrix (Ophiothrix) roseocaerulans* Grube, 1

#### THE 1976 EXPEDITION TO ASCENSION

Asc. 1-76: 11 Jul 1976, MacArthur Point, temperature 25°C, salinity 34‰

1B, associated with rocks

*Ophiothrix (Ophiothrix) roseocaerulans* Grube, 12  
*Ophiactis savignyi* (Müller and Troschel), 2  
*Eucidaris clavata* Mortensen, 7  
*Echinometra lucunter polypora* Pawson, 27  
*Holothuria (Halodeima) grisea* Selenka, 8

1C, in clumps of coralline algae

*Ophiothrix (Ophiothrix) roseocaerulans* Grube, 12  
*Ophiactis savignyi* (Müller and Troschel), 1  
*Echinometra lucunter polypora* Pawson, 3

Asc. 3-76: 12 Jul 1976, English Bay, temperature 28°C (inner pool), 25°C (outer pool), salinity 34‰

3A, sand, inner tidepool

*Isostichopus badionotus* (Selenka), 1

3C, associated with rocks beyond outer pool

*Ophiothrix (Ophiothrix) roseocaerulans* Grube, 10  
*Ophiactis savignyi* (Müller and Troschel), 2  
*Eucidaris clavata* Mortensen, 1

3D, associated with rocks, outer pool

*Eucidaris clavata* Mortensen, 13  
*Holothuria (Halodeima) grisea* Selenka, 6  
*Holothuria (Platyperona) sanctori* Delle Chiaje, 3

3G, collected by snorkeling in 5–10 m beyond outer tide pool, calcareous sand and rock bottom

*Holothuria (Halodeima) manningi* Pawson, 3

Asc. 5-76: 13 Jul 1976, Shelly Beach, temperature 31°C, salinity 34‰

5A, isolated tide pools in back of open shore

*Ophiothrix (Ophiothrix) roseocaerulans* Grube, 2  
*Ophiactis savignyi* (Müller and Troschel), 6  
*Holothuria (Halodeima) grisea* Selenka, 1  
*Holothuria (Thymiosycia) arenicola* Semper, 2

Asc. 6-76: 14 Jul 1976, Collyer Point, temperature 26°C, salinity 34‰

6A, isolated tide pools

*Ophiothrix (Ophiothrix) roseocaerulans* Grube, 48  
*Ophiactis lymani* Ljungman, 1  
*Echinometra lucunter polypora* Pawson, 2  
*Echinoneus cyclostomus* Leske, 1

6B, associated with exposed rocks

*Ophiothrix (Ophiothrix) roseocaerulans* Grube, 3  
*Eucidaris clavata* Mortensen, 4  
*Diadema antillarum ascensionis* Mortensen, 4

Asc. 7-76: 14 July 1976, off Collyer Point, diving, collected by Mr. K. Jourdan

*Ophiaster guildingi* Gray, 1  
*Ophiothrix (Ophiothrix) roseocaerulans* Grube, 2  
*Echinometra lucunter polypora* Pawson, 1

Asc. 8-76: 15 Jul 1976, MacArthur Point, isolated tide pool  
*Ophiothrix (Ophiothrix) roseocaerulans* Grube, 3

Asc. 9-76: 16 Jul 1976, Northeast Bay, temperature 25°C, salinity 34‰

9C, isolated tide pool

*Ophiothrix (Ophiothrix) roseocaerulans* Grube, 7  
*Ophiactis savignyi* (Müller and Troschel), 1

9D, associated with rocks in the intertidal

*Holothuria (Platyperona) sanctori* Delle Chiaje, 1

### Class STELLEROIDEA

### Subclass ASTEROIDEA

### Order PAXILLOSIDA

### Family ASTROPECTINIDAE

#### *Tethyaster magnificus* (Bell)

*Archaster magnificus* Bell, 1882:440.

*Moiraster magnificus*.—Koehler, 1908:630, pl. 12: figs. 107–110.—Mortensen, 1933a:422, pl. 21: figs. 1–2, pl. 22: fig. 1.

*Tethyaster magnificus*.—A. M. Clark and A. H. Clark, 1954: 16, pls. 9, 10: figs. 2e–g.

MATERIAL EXAMINED.—None.

DISTRIBUTION.—This species is known only from St. Helena (40 meters) and Ascension Island (72 meters).

### Order VALVATIDA

### Family CHAETASTERIDAE

#### *Chaetaster longipes* (Retzius)

*Chaetaster longipes*.—Koehler, 1908:632.—Mortensen, 1933a: 431.

MATERIAL EXAMINED.—USNM 17473, Ascension Island, 77 m, collected by William Harvey Brown, 28 Mar 1890, U.S. Eclipse Expedition to West Africa, 4 specimens.

REMARKS.—The four specimens are typical of the species in all respects. Largest specimen has  $R = 52$  mm.

DISTRIBUTION.—Madsen (1950) gives the distribution of this species as western Mediterranean, European Atlantic coast as far north as Bretagne, off West Africa, Morocco and Cape Palmas, St. Helena, the Cape Verdes, the Canaries, and the Azores, in 30–1140 meters.

HABITAT AT ASCENSION.—Not known.

## Family OPHIDIASTERIDAE

### *Ophidiaster guildingi* Gray

#### FIGURE 3

*Ophidiaster guildingii*.—Clark, 1921a:79.—Fisher, 1940:269.

MATERIAL EXAMINED.—RBM 5, 1 specimen; Asc. 1B-76, 6 specimens; Asc. 3D-76, 1 specimen; Asc. 7-76, 1 specimen. Ascension Island, collected A. Loveridge, 31 Aug 1963, 1 specimen.

REMARKS.—The smallest specimen has  $R = 10$  mm (station RBM 5); the largest has  $R = 52$  mm. The ratio  $R/r =$  approximately 1:8. When alive, all specimens were mottled light and dark orange-brown, and none were unicolor red. The adambu-

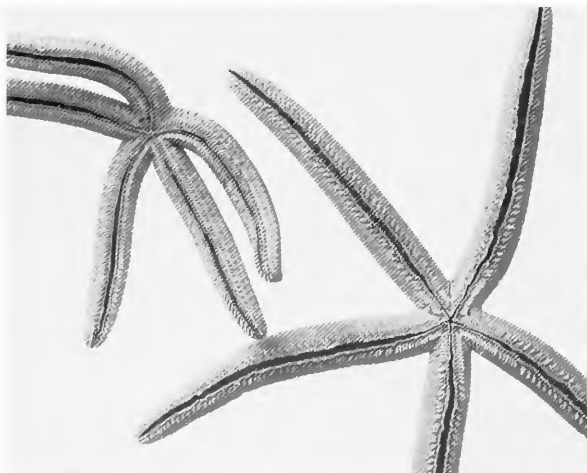


FIGURE 3.—Left, *Ophidiaster guildingi* Gray from Ascension. Right, *O. ophidianus* (Lamarck) from the Azores. Note conspicuous difference in shape of adambulacral spines.

lacral spines (see Figure 3) conform exactly to the description of H. L. Clark (1921a), and, thus, in all respects the Ascension specimens concur with Clark's concept of this species. Fisher (1940) was of the same opinion concerning a specimen collected at Ascension by the *Discovery*. Mortensen (1933a) recorded *O. ophidianus* (Lamarck) from St. Helena, noting that his specimens were either uniformly red or had mottled coloration; he doubted that the two species could be separated on the basis of color alone. Chapman (1955) records *O. ophidianus* from the Azores without comment, and this species also occurs at the Cape Verde Islands (see A. M. Clark, 1955). The question of the validity of the two species and their limits of variation can be settled only by a thorough study of several scattered populations.

DISTRIBUTION.—Common throughout the West Indies (Clark, 1921a), and recorded from Ascension by Fisher (1940). *O. ophidianus* is known from the Mediterranean, West Africa, and the islands mentioned above.

HABITAT AT ASCENSION.—On underside of rocks or exposed in intertidal zone. Also present subtidally (Asc. 7-76).

### *Linckia guildingi* Gray

*Linckia diplax*.—Bell, 1881:437.

*Linckia guildingii*.—Clark, 1921a:67.—Madsen, 1950:216.

MATERIAL EXAMINED.—British Museum (Natural History) Catalogue No. 1972.1.21.3, collected Mrs. K. Hutchfield, 1 specimen; Catalogue No. 81.10.27.15, collected T. Conry, 1 specimen.

REMARKS.—Both specimens undoubtedly represent this widespread species. One specimen (Catalogue No. 81.10.27.15) is that which was identified by Bell (1881) as *Linckia diplax*.

DISTRIBUTION.—As Clark (1921) points out, this seems to be "a truly tropicopolitan species of sea-star, absent only from the western coast of America." It has not been reported from St. Helena; according to Mortensen (1933a) another species which he named *Linckia formosa* occurs there. *L. formosa* is apparently most closely related to the amphiatlantic species, *L. bouvieri* Perrier.

HABITAT AT ASCENSION.—Not known. Probably same as for preceding species.



## Subclass OPHIUROIDEA

## Order OPHIURIDA

## Family OPHIACTIDAE

*Ophiactis savignyi* (Müller and Troschel)

*Ophiactis savignyi*.—Mortensen, 1933a:442; 1936:264.—Clark, 1955:36.—Madsen, 1970:207, fig. 33.

MATERIAL EXAMINED.—RBM 21, 4 specimens; Asc. 1B-76, 2 specimens; Asc. 1C-76, 1 specimen; Asc. 3C-76, 2 specimens; Asc. 5A-76, 6 specimens; Asc. 9C-76, 1 specimen.

REMARKS.—All specimens have six arms and all possess the very large radial shields that render this species readily recognizable.

DISTRIBUTION.—According to Madsen (1970) this species has a circumtropical distribution in littoral-sublittoral depths. It has been recorded from Ascension by Mortensen (1936) and also from St. Helena (Mortensen, 1933a).

HABITAT AT ASCENSION.—Under rocks in tide pools. Not uncommon in clumps of coralline algae.

*Ophiactis lymani* Ljungman

*Ophiactis lymani*.—Mortensen, 1933a:442, fig. 15.—Clark, 1955:35, fig. 12.—Madsen, 1970:208, fig. 34.

MATERIAL EXAMINED.—Asc. 6A-76, 1 specimen.

REMARKS.—This species has been well illustrated by all of the authors cited in the synonymy above. The single specimen from Ascension is typical in most respects. Disc spines are virtually absent, there being only one or two at the base of each arm. Mortensen (1933a) pointed out that in St. Helena specimens the ventral arm plates have convex distal margins, whereas in populations from elsewhere, the distal margins tend to be concave. In the present specimens the distal margins are convex on all ventral arm plates until approximately the 12th arm joint, where the margins become concave, and then they remain so throughout the length of the arm. In alcohol the disc is light and dark gray mottled, and the arms are light brown and dark gray mottled.

DISTRIBUTION.—Madsen (1970) described this

species as an amphi-Atlantic sublittoral form, known from several localities off tropical West Africa, from the Cape Verdes to northern Angola in 0–90 meters, from the Virgin Islands in the West Indies, and from St. Helena (10–110 meters). The present record from Ascension is therefore not unexpected.

HABITAT AT ASCENSION.—Under rock in isolated tide pool.

## Family AMPHIURIDAE

*Amphiura capensis* Lyman

*Amphiura capensis*.—Koehler, 1908:634.

MATERIAL EXAMINED.—None.

REMARKS.—Koehler recorded this species from Ascension Island, and it has not been collected there since. Mortensen (1933a) seriously doubted the validity of this record, and suggested that there had been a mistake with the locality labels. Further doubt is cast upon the validity of Koehler's identification by Mortensen's (1933b) restudy of Koehler's (1914) presumed *Amphiura capensis* from Angola and Senegal; Mortensen found that these specimens comprised two genera, neither of which was an *Amphiura*.

*Ophiostigma abnorme* (Lyman)

*Ophiostigma abnorme*.—Mortensen, 1936:293.—Clark, 1955:38.—Madsen, 1970:200, fig. 29.

MATERIAL EXAMINED.—USNM 17488 Ascension Island, 36–54 m, collected by William Harvey Brown, 25 Mar 1890, U.S. Eclipse Expedition to West Africa, 1 specimen; USNM 17489, as above, 72 m, 5 specimens.

REMARKS.—The six specimens are in fair condition; they are typical examples of this species. None have numerous spines on the upper surface of the disc; at best they are sparsely scattered.

DISTRIBUTION.—Madsen (1970) notes that this is an amphi-Atlantic sublittoral species. It is also known from the Cape Verdes. Mortensen (1936) first recorded *O. abnorme* from Ascension.

HABITAT AT ASCENSION.—Not known; has been taken at 16–27 m (Mortensen 1936) and at 36–72 m.

## Family OPHIOTHRICIDAE

*Ophiothrix (Ophiothrix) roseocaerulans* Grube

*Ophiothrix roseocaerulans*.—Koehler, 1904:97.—Mortensen, 1933a:440, pl. 22: figs. 5–7; 1936:2262.

*Ophiothrix (Ophiothrix) roseocaerulans*.—A. M. Clark, 1967: 647.

MATERIAL EXAMINED.—RBM 5, 1 specimen; RBM 12, 7 specimens; RBM 15, 1 specimen; RBM 18, 9 specimens; RBM 21, 5 specimens; RBM 22, 1 specimen; RBM 25, 1 specimen. Asc. 1B-76, 12 specimens; Asc. 1C-76, 12 specimens; Asc. 3C-76, 10 specimens; Asc. 5A-76, 2 specimens; Asc. 6A-76, 48 specimens; Asc. 6B-76, 3 specimens; Asc. 7-76, 2 specimens; Asc. 8-76, 3 specimens; Asc. 9C-76, 7 specimens. South West Bay (MacArthur Point), sandy bottom tide pool, collected by Storrs Olson, 12 Jul 1970, 2 specimens; Ascension Island, from dead *Cymatium* shell, collected K. Jourdan, Jul 1976, 1 specimen.

REMARKS.—These are typical specimens of this beautiful species. The color is highly variable, as Mortensen (1933a) had noted for his St. Helena material. Most commonly shades of blue to purple are represented, but light blue and even pink specimens were collected at Ascension. A. M. Clark (1967) in her revision of the family Ophiotrichidae referred this species to the typical subgenus *Ophiothrix (Ophiothrix)*.

DISTRIBUTION.—The species is known to occur only at St. Helena (see Mortensen, 1933a) and at Ascension.

HABITAT AT ASCENSION.—Almost ubiquitous in the intertidal, encountered in clumps of coralline algae, under rocks, and in crevices. It was common at all stations sampled.

## Class ECHINOIDEA

## Order Cidaroida

## Family Cidaridae

*Eucidaris clavata* Mortensen

FIGURES 4–7

*Cidaris metularia*.—Bell, 1881:436.

*Cidaris tribuloides* juv.—A. Agassiz, 1881:36, pl. 1: figs. 3, 5, 6.

*Cidaris minor* Koehler, 1908:638, pl. 16: figs. 136–138. [Although *C. minor* Koehler, 1908, seems to be the oldest available name for *E. clavata*, it is not available, as Mortensen (1928) has pointed out, because it is preoccupied by at least two earlier homonyms.]

*Eucidaris tribuloides*.—Clark, 1925:21 [in part]—Mortensen, 1936:213, pl. 1: figs. 13–15 [in part].

*Eucidaris clavata* Mortensen, 1928:408, pl. 42: figs. 1–4; pl. 67: figs. 10–11, pl. 73: fig. 2, pl. 86: fig. 15; 1932:169, pl. 4: figs. 3–5; 1933a:464.

Not *Cidaris minor* Koehler, 1914:217 [= *Eucidaris tribuloides africana*].

REMARKS.—The status of the species *E. clavata* has been in doubt for some time. On the basis of St. Helena material, Mortensen described his new species *E. clavata* in 1928, and later (1932, 1933a) reinforced his opinion of the validity of the species. Clark (1925) called attention to the clavate spines of his St. Helena specimens, but also noted that not all specimens had such spines. Later, Mortensen (1936) described some small specimens from Ascension as *E. tribuloides* and noted their similarity to specimens from Annobón, West Africa (now Pagalu, Equatorial Guinea), which he regarded as representing a “var. *africana*.” Comparative measurements made upon small numbers of specimens (2 from Annobón, 6 from Ascension, 4 from West Indies) of small size (largest specimen 18 mm h.d.) tended to support his contention. Examination of larger series of mature specimens for the present paper show that Mortensen’s conclusions were erroneous, that the Ascension *Eucidaris* is identical to the St. Helena form, and quite distinct from the West African–West Indian species.

A complete description of *E. clavata* is not included here; details can be found in Mortensen (1928, 1932). However, it is necessary to discuss those characters that are of apparent systematic importance.

*Relationship between Areole Width and Width of Median Area of Interamb:* Mortensen (1936) measured the width of a primary areole at the ambitus, and compared this with the width of the median area of the interamb. He found that in two West African species measured the areole width exceeded slightly the width of the median area; by contrast, in three West Indian specimens of *E. tribuloides* the areole width was less than the width of the median area. This supposed difference, together with some others of a minor nature, led Mortensen to erect a new variety, *E. tribuloides africana*, for the West African forms. I have made additional measurements of some “typical” West Indian *E. tribuloides*, and these are presented graphically herein (Figure 4). It is apparent that

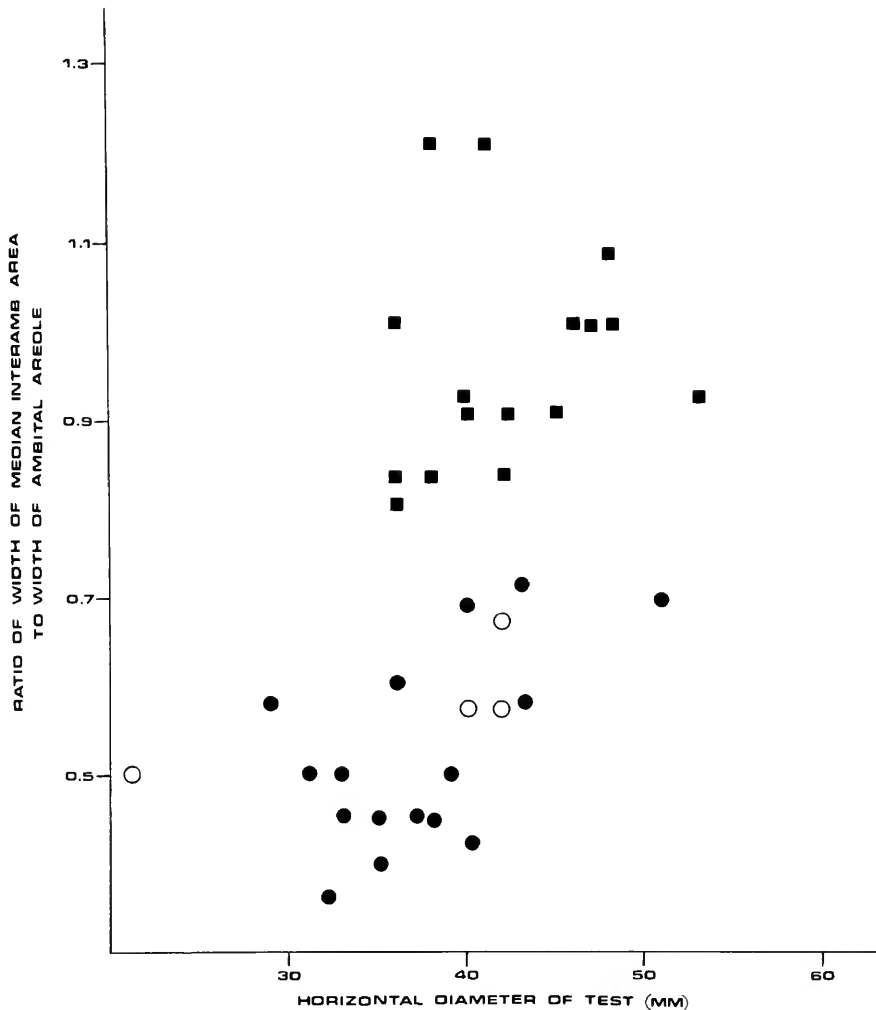


FIGURE 4.—Comparison of *Eucidaris tribuloides* (Lamarck) with *E. clavata* Mortensen (for details, see text).

*tribuloides* ■ *clavata* (Ascension) ● *clavata* (St. Helena) ○

the relationship between dimensions of median area and areole approaches unity (median area width as percentage of areole width: mean 97%) and that, in fact, Mortensen's use of this character to distinguish a new variety *africana* was not justifiable. Chesher (1972) has plotted the same parameters to distinguish *E. tribuloides* from *E. thourarsii*; his graph shows the same results for the relationship between areole and median interamb area in *E. tribuloides* sensu stricto as does Figure 4 herein. In the case of Ascension and St. Helena *Eucidaris*, the situation is somewhat different (see Figure 4).

Here, the areole is almost twice as wide as the median interamb area (interamb width as percentage of areole width: mean 51.5%). It is believed that this character is important in distinguishing *E. clavata* from *E. tribuloides*.

*Relationship between Diameter of Peristome and Diameter of Apical System:* As shown in Figure 5, for *E. tribuloides* from West Africa and from the West Indies area, the peristome and apical system have approximately the same diameter (apical system diameter as percentage of peristome diameter: mean 102%). The West African and West

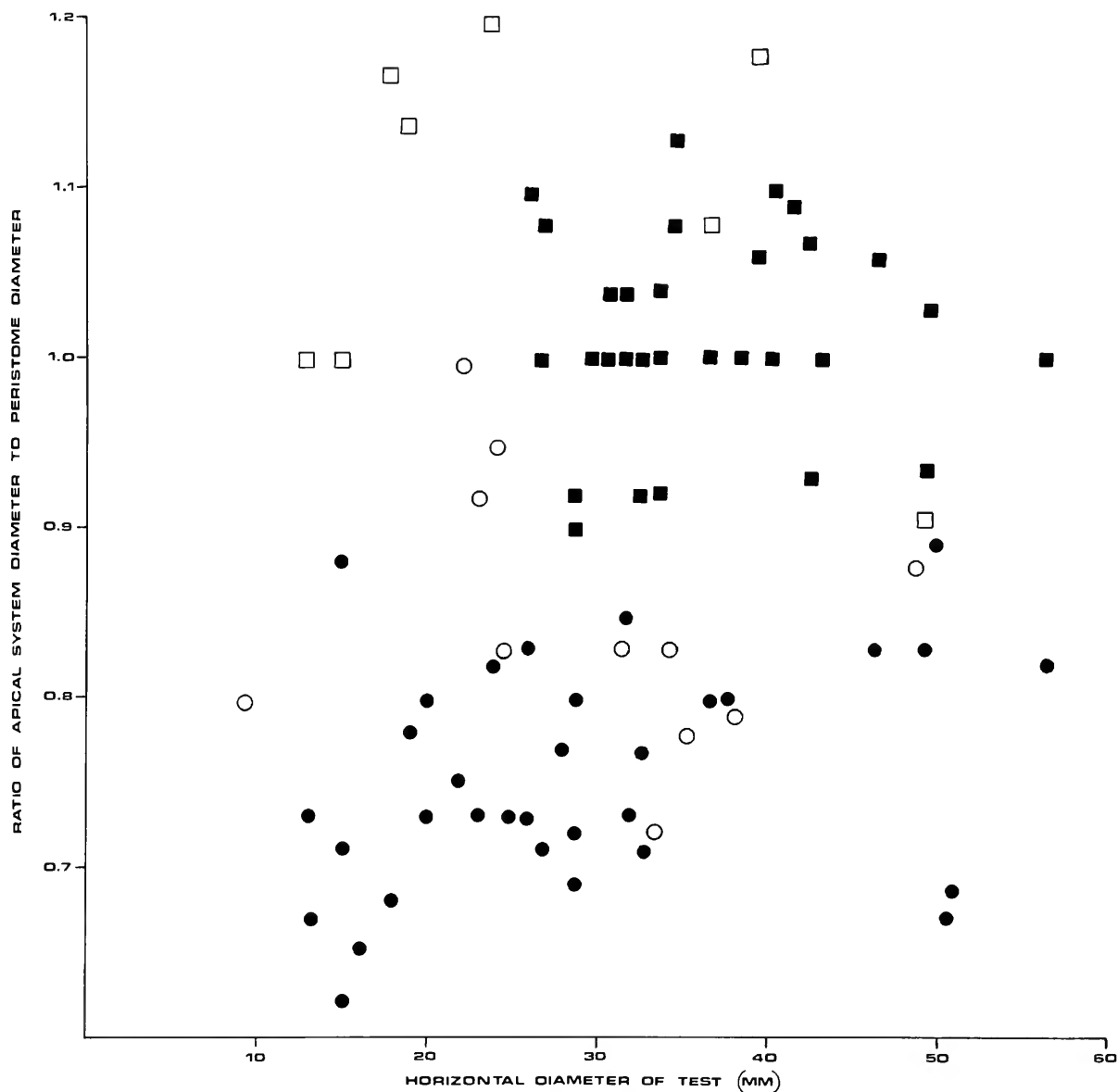


FIGURE 5.—Comparison of *Eucidaris tribuloides* (Lamarck) with *E. clavata* Mortensen (for details, see text).

*tribuloides* (West Indies) ■ (West Africa) □  
*clavata* (Ascension) ● (St. Helena) ○

Indian specimens are indistinguishable in respect to this relationship. In contrast, in Ascension and St. Helena *Eucidaris*, the peristome is considerably larger than the apical system diameter as percentage of peristome diameter: mean 77%). This character also is regarded as important in distinguishing Ascension-St. Helena *Eucidaris*

from its congeners on each side of the Atlantic.

*Shape of the Spines:* Mortensen (1928, 1932) regarded the shape of the spines as a feature of paramount importance in distinguishing *E. clavata* from *E. tribuloides*. He noted that while many of his St. Helena specimens had the club-shaped spines (such as those shown in Figure 6a-b herein) others,

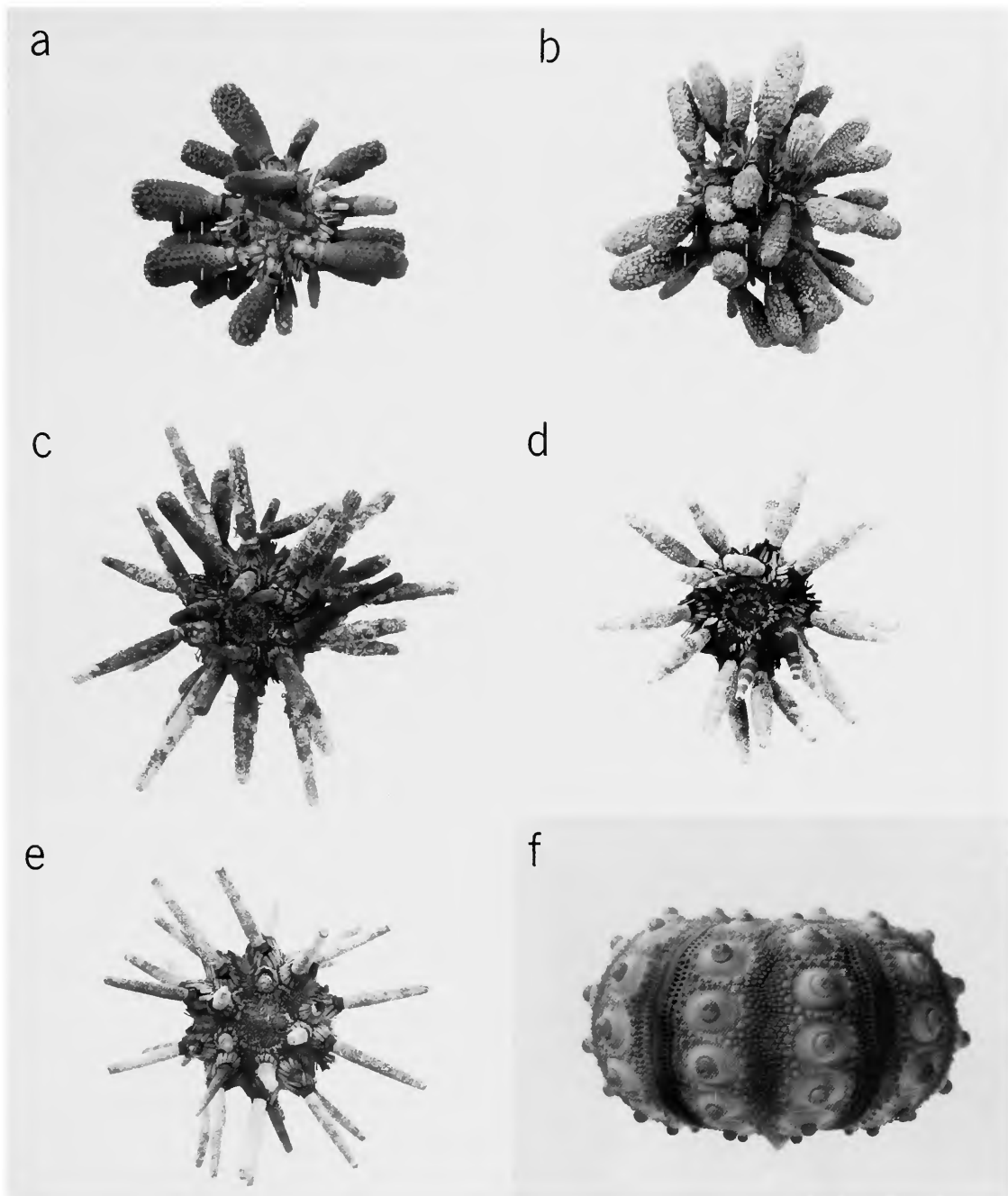


FIGURE 6.—*Eucidaris clavata* Mortensen: *a*, St. Helena, 20–30 meters; *b*, St. Helena, 20–30 meters; *c*, St. Helena, shore; *d*, Ascension, shore; *e*, Ascension, shore; *f*, St. Helena, 20–30 meters (Specimens *a*–*c*, *f* are in the Zoological Museum, Copenhagen.)

particularly from the intertidal area, had more slender, almost cylindrical, spines (Figures 6c-e, 7). In Ascension specimens the spines are almost invariably cylindrical (Figures 6e, 7); on occasional specimens a tendency towards clavate form is exhibited (Figure 6d), but in no case were specimens with truly club-shaped spines found. No deeper water specimens have yet been recovered at Ascension (apart from Koehler's (1908) *Cidaris minor*), so the true range of spine shape for the Ascension *Eucidaris* is not yet known. Examination of a great variety of specimens of western Atlantic *E. tribuloides* from a variety of habitats in the collections of the National Museum of Natural History revealed not one specimen with a tendency to form club-shaped spines similar to those from St. Helena.

It is believed that, while presence of club-shaped spines is a useful indicator of the identity of this species, this character is highly variable in its expression, and, consequently, is not completely reliable.

*Affinities of E. clavata:* *E. clavata* is readily distinguished from *E. tribuloides* on the basis of relationships between dimensions of peristome and periproct, relationships between width of ambital areoles and width of median interamb areas, and, to a lesser extent on the shape of the spines. McPherson (1968) measured some specimens of *Eucidaris* from Ascension to complement his study of shape and growth of *E. tribuloides*, and he regarded the Ascension forms as conspecific with *E. tribuloides sensu stricto*. He did not analyze his

data, however, in a way which would have indicated the obvious differences that exist, for such an analysis was not relevant to his study.

*E. clavata* may be derived from *E. tribuloides*, as has been suggested by Mortensen (1933a). The eastern Pacific species *E. thoursii* closely resembles *E. clavata* in terms of the relationship between diameter of peristome and apical system, and in relationship between areole width and width of median interamb area. The two species are distinctly separated on the basis of color alone. A form from the Galapagos Islands, often referred to as *E. galapagensis* (Doderlein) resembles *E. clavata* in having club-shaped spines. The interesting parallel was noted by Mortensen (1928), who commented in some detail upon the status of *E. galapagensis*.

The complex of taxa, *tribuloides-clavata-thoursii-galapagensis*, requires a thorough analysis, based upon large series of specimens. The present arrangement of the species is even now not completely satisfactory. The intriguing question about formation of club-shaped spines at isolated oceanic islands has yet to be investigated; a genetic basis is suggested by the slender evidence available.

**DISTRIBUTION.**—*E. clavata* is known only from Ascension and St. Helena, in depths of 0–60 meters.

**HABITAT AT ASCENSION.**—All specimens were found either lodged in rock crevices or under rocks, always on hard substrates. Mostly smaller specimens of up to 38 mm h.d. were found intertidally. Subtidally, within snorkel diving range, considerably larger specimens were found (50+ mm h.d.), usually wedged inextricably in deep crevices. Off St. Helena, Mortensen (1932) found numerous specimens lodged in holes and cavities of the sponge *Chondrosia plebeia* Schmidt at depths of 20–30 meters.

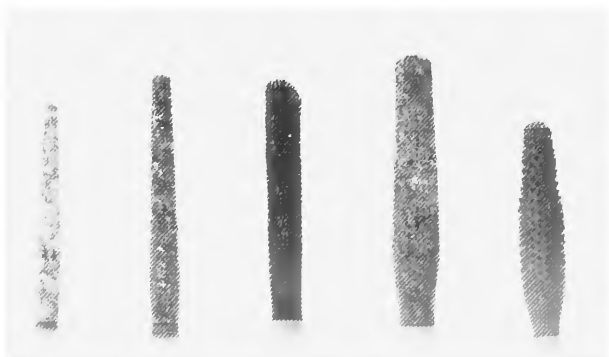


FIGURE 7.—Spines from specimens of *Eucidaris clavata* Mortensen, Ascension Island.

### *Tretocidaris spinosa* Mortensen

*Tretocidaris spinosa* Mortensen, 1903:17, 28, pl. 10: figs. 10, 11, 16.—Koehler, 1908:636, pl. 16: figs. 163, 164.—Mortensen, 1928:317, pls. 33: figs. 1–3, pl. 34: figs. 1–2, pl. 67: fig. 9, pl. 71: fig. 15, pl. 82: figs. 32–36; 1932:154, pl. 4: figs. 6–12, 15, pl. 13: fig. 3; 1933a:465.

**MATERIAL EXAMINED.**—None.

**DISTRIBUTION.**—Known from Ascension (72 meters) and St. Helena (50–60) meters.

## Order DIADEMATOIDA

## Family DIADEMATIDAE

*Diadema antillarum ascensionis* Mortensen

*Diadema setosum*—Bell, 1881:436.

*Diadema ascensionis* Mortensen, 1909:55, pl. 7: fig. 10, pl. 16: figs. 1, 4, 8, 16–17, 21–23; 1940:279, pl. 48: fig. 2, pl. 54: fig. 4, pl. 61: figs. 6–11, pl. 73: figs. 14–16.—Tommasi, 1966: 11, figs. 3–5.—Lima-Verde, 1969:10.—Brito, 1962:5; 1971: 264, fig. 1.

*Diadema antillarum*.—Clark, 1925:42 [in part].

*Diadema antillarum* var. *ascensionis*.—Mortensen, 1933a:465; 1936:216.

MATERIAL EXAMINED.—RBM 16, 2 specimens; RBM 22, 1 specimen; RBM 23, 5 specimens; RBM 24, 7 specimens; Asc. 6B-76, 4 specimens. Turtle Shell Beach (MacArthur Point), rocky tide pools, collected by Storrs Olson 18 Jun 1970, 1 specimen.

REMARKS.—The status of the Ascension–St. Helena populations of *Diadema* has been the subject of considerable discussion, mainly on the part of Mortensen (1909, 1933a, 1936, 1940). His final conclusion was that these populations should be regarded as a separate species from *D. antillarum* Philippi. The main character upon which the separation was based is the shape of the tridentate pedicellariae, the blades of which are distinctly curved in *D. ascensionis*, while they are more or less straight in typical *D. antillarum*. This character appears to be reasonably consistent, although a survey of USNM material of *D. antillarum* revealed that slightly curved tridentate pedicellariae are common. Mortensen (1940) also stated that in *D. ascensionis* the median series of primary tubercles in the interambis are arranged almost in a straight line, whereas in *D. antillensis* the series remain distinct; thus, in *D. ascensionis* there appear to be five series of tubercles in each interamb. Again, this character seems to be consistent for Ascension populations, but numerous specimens of *D. antillarum* in USNM collections show exactly the same type of tubercle arrangement. Mortensen (1940) also notes that the spines of St. Helena specimens are “somewhat coarser” than those of *D. antillarum*; this is not a reliable character, for the size of the spines can vary considerably within populations.

In view of the broad distribution of *D. antillarum* (see below), and the apparent restriction of *D. ascensionis* to Atlantic islands or island groups, it would seem wisest to regard *D. ascensionis* merely as a subspecies of *D. antillarum*.

DISTRIBUTION.—*D. a. antillarum* occurs on both sides of the Atlantic, in the west from Bermuda south to Brazil, perhaps to 23°S (Tommasi, 1966), and in the east from Cape Verde to the Gulf of Guinea (Angola) on the African coast, also the Azores, Canaries, and Madeira Islands. *D. a. ascensionis* is known from Ascension (Mortensen, 1909) and St. Helena (Mortensen, 1933a), Fernando de Noronha (Clark, 1925; Mortensen, 1940), also Isla Trindade (Brito, 1971) and Atol das Rocas (Lima-Verde, 1969). Atol das Rocas is only 200 km from the coast of Brazil, and possibly the *Diadema* there is *antillarum* rather than *ascensionis*. Bathymetric range is 0–360 meters.

HABITAT AT ASCENSION.—Common in tide pools, in rock crevices, and partially concealed under rocks.

## Order ARBACIOIDA

## Family ARBACIIDAE

? *Coelopleurus floridanus* Agassiz

*Coelopleurus floridanus*.—Koehler, 1908:640.—Mortensen, 1935:612, pl. 68: figs. 5–7, p. 88: figs. 17–18, 31–34.

MATERIAL EXAMINED.—None.

REMARKS.—The juvenile specimen, 9 mm in diameter, upon which Koehler (1908) based his identification is the only specimen of this genus so far known from Ascension. As Mortensen (1935) points out, only additional adult material will settle the question of the identity of the species. He also notes that the Ascension form may be *C. floridanus*, or the African species *C. interruptus* Döderlein, or perhaps a new species.

DISTRIBUTION.—Ascension Island, 72 meters (Koehler, 1908); western Atlantic from West Indies to Cape Hatteras, U.S.A., in 90–2380 meters (Mortensen, 1935).

## Order TEMNOPLEUROIDA

## Family TOXOPNEUSTIDAE

*Pseudoboletia maculata atlantica* Clark

*Pseudoboletia maculata*.—Koehler, 1908:641, pl. 15: figs. 139–142, pl. 16: fig. 165.

*Pseudoboletia atlantica*.—Clark, 1912:344; 1925:131.—Mortensen, 1933a:467; 1943:534, pl. 32: figs. 1–5, pl. 39: fig. 6, pl. 40: fig. 6, pl. 42: figs. 1–3, pl. 43: figs. 1–2, pl. 44: fig. 1, pl. 55: figs. 1, 3, 19, 20.

**MATERIAL EXAMINED.**—No specimens in collections being described here.

**REMARKS.**—Koehler (1908) was the first to record this species (as *P. maculata*) from Ascension, the two specimens being collected at a depth of 40 fathoms off Point Pyramid. Clark (1912) regarded the Ascension specimens as a new species, *P. atlantica*, and Mortensen (1933a) reported the species from St. Helena.

Study of the literature of this species and of another Atlantic Ocean species, *P. occidentalis* Clark, together with examination of specimens of both (Table 1), has led to the conclusion that *P. atlantica* should be regarded as subspecies of *P. maculata* Troschel and that *P. occidentalis* is a junior synonym of *P. maculata*. A brief analysis is given here of the features used in the past to distinguish these taxa.

*Pseudoboletia* **MATERIAL EXAMINED.**—*P. occidentalis* Clark: holotype (USNM E4531); 4 specimens (USNM E12353) from off Venezuela, 83–186 meters, diameters 63, 69, 78, 79 mm; 3 specimens (USNM E16203, E16204) from off Florida north of Miami, 19–21 meters, diameters 60, 76, 85 mm. *P. atlantica* Clark: 3 specimens (USNM E16096, diameter 71 mm; USNM E11732, diameter 82 mm; USNM E5953, diameter 89 mm) from St. Helena.

**Spicules in Gills:** In the gills of both *P. atlantica* and *P. occidentalis* spicules of the bihamate and C-shaped type are numerous. The C-shaped spicules appear to be more numerous than the bihamate type in *P. atlantica*, and the reverse might appear to be true in *P. occidentalis*, but it was found that the relative proportions of the types of spicules can depend to a great extent upon the area of gill that is being studied. The same is probably true for *P. maculata*. It is concluded that this character is unreliable. Mortensen (1943:537) referred to the "remarkable differences from [the Indo-Pacific species] *indiana* and *maculata* . . ." in the matter of the spicules of *P. atlantica*, but apparently did not regard a supposed difference as being important systematically.

**Number of Plates on the Periproct:** Clark (1921b: 116–117) noted that "In *maculata* the periproct is

covered by about 30 plates," and that in *P. occidentalis* there are "about 20 plates." In the four additional specimens of *P. occidentalis* examined there are more than 30 plates in the periproct, and the same situation applies in specimens of *P. atlantica*. Clearly, no reliance can be placed upon this character, as has already been pointed out by Mortensen (1943).

**Size and Shape of Primary Spines:** Clark (1921b) noted that the ambital primary spines of *P. occidentalis* are "about 12 mm long, terete basally, and becoming flattened only slightly near tip"; this situation he contrasted with that in *P. maculata*, where the spines are "markedly flattened, with bluntly chisel-shaped tips (though with a terminal concavity), and are 14–16 mm long." The primary spines of the additional specimens of *P. occidentalis* examined are typically 15 mm or more in length, often approaching 20 mm. They are terete basally, and the degree of flattening near the tip is highly variable. Ambital spines of *P. atlantica* are similar, but tend to be shorter, averaging approximately 14 mm in length.

**First Appearance of Inner Primary Tubercle:** Clark (1921:117) notes that in *P. maculata* the inner primary tubercle in the ambis appears first on the seventh, eighth, or ninth plate from the ocular plate in specimens 52–55 mm in diameter, whereas in his specimen of *P. occidentalis* it occurs first on the tenth–twelfth plate. In the additional specimens of *P. occidentalis*, the tubercles first appear on the eighth to the 14th plate from the ocular; the number of plates are correlated to some extent with size of the specimen. In a specimen of 63 mm h.d., the first tubercle appears on plates 8–9 from the ocular, while in a specimen of 78 mm h.d. it appears on plates 11–14. In *P. atlantica* the tubercles appear on plates 8–10 from the ocular. These figures confirm Clark's (1921b) own suggestion that this character is "inconstant and unreliable."

**Color of Test:** The dark brownish or greenish blotches which appear to characterize *P. maculata* are also present on the holotype of *P. occidentalis*. They are present and conspicuous in most specimens of the additional material of *P. occidentalis*. Mortensen (1943) notes that in *P. atlantica* the blotches may be absent, or that there may be some darker spots or bands in the median spaces aborally. It is



evident that in the Atlantic *Pseudoboletia* the test coloration is somewhat variable.

*Color of Spines:* In all specimens of *P. occidentalis* examined, the color of the spines has faded somewhat, but in most cases the spines are greenish basally and pale fawn elsewhere, or almost totally white. In the holotype and most non-type specimens, spines located on the greenish blotches on the test are mostly dark green, light only at the tips, a feature already noted by Clark (1921b) for the holotype. In *P. atlantica*, according to Mortensen (1943) the spines may be whitish, with green or brown basal areas, or they may be banded with dull green or brown. Clark (1921b) noted that in *P. maculata* the spines are "green at base and red-purple or reddish at tip . . . quite different from the pale colors of *occidentalis*."

*Pedicellariae:* In his original description of *P. occidentalis*, Clark (1921b) did not describe the pedicellariae in detail, and Mortensen (1943) expressed regret that Clark had not illustrated the tridentate pedicellariae he had described as "slender, with valves 1.25 mm long." I could find no such pedicellariae on the holotype or on the additional specimens of *P. occidentalis*. All of the tridentate pedicellariae found were of the broad-bladed type, none of them exceeding 1.1 mm in total length. In all features these pedicellariae closely resembled those of *P. maculata*, *P. atlantica*, and *P. indiana*. It is impossible to determine from Mortensen's (1943) figures of tridentate pedicellariae from these three species exactly how they differ from each other, although he mentions (p. 533, 537) that they are essentially the same in *P. atlantica* and *P. indiana*, and that those of *P. indiana* and *P. maculata* differ. I do not believe that these differences, whatever they might be, are significant.

The globiferous pedicellariae also present a confusing picture. Mortensen (1943:531) notes that the globiferous pedicellariae in *P. indiana* "are as in *P. maculata*," but two pages later (p. 533) he states that the smaller globiferous pedicellariae "differ rather conspicuously in the length of the blade, it being distinctly longer than the basal part in *maculata*, scarcely as long as the basal part in *indiana*." His figures show a conspicuous difference in the pedicellariae of these two species. The same type of pedicellariae in *P. atlantica* are virtually identical to those of *P. maculata*, and in *P. occiden-*

*talis* a condition resembling that in *P. maculata* was found, although the blade appears to be relatively shorter.

An extensive study of large series of pedicellariae from many parts of the world might settle the several problems that exist with regard to the pedicellariae in this genus, but on the basis of the admittedly scanty evidence now available, it would seem that they do not afford the best characters for distinction of species in *Pseudoboletia*.

*Number of Pore-Pairs to the Pore-Arc:* All species in the genus *Pseudoboletia* have four pore-pairs in each pore-arc, except *P. atlantica*, which has five. In this respect, *P. atlantica* forms an interesting parallel to *Echinometra* from Ascension (see p. 22). The presence of five pore-pairs has been noted by Mortensen (1943) in a large specimen of *P. indiana* 75 mm in diameter, and, conversely, *P. atlantica* frequently has arcs of four pore-pairs. Mortensen (1943) states:

The pore-pairs are in general arranged in arcs of 5 . . . . But this is by no means constantly so; some specimens have in the main only 4 pore-pairs, or there may be here and there a plate with only 4 pairs, most of the plates having 5 pore-pairs. This has nothing to do with age; thus the specimen of 94 mm h.d. . . has in the main 4-geminate plates, whereas the specimens of 62 and 68 mm have regularly 5-geminate plates.

In the present collection, all specimens of *P. occidentalis* have four pore-pairs to the arc, and all specimens of *P. atlantica* have five.

It is concluded that the only reasonably consistent difference between *P. atlantica* and other species in the genus is the presence of five pore-pairs in each pore-arc. There appears to be no evidence for maintaining *P. occidentalis* as a species distinct from *P. maculata*; all of the distinguishing features enumerated by Clark fall within the range of variation of *P. maculata*. Further, in view of the fact that some other echinoid species at Ascension Island have undergone some phenetic changes as a result of isolation, environment, or a combination of the influences of these factors, the presence of five pore-pairs would not appear to be sufficient to warrant maintenance of *P. atlantica* as a separate species, distinct from *P. maculata*, and it is here recognized as a subspecies of *P. maculata*. The status of *P. maculata* in relation to *P. indiana* cannot be determined here.

DISTRIBUTION.—*P. maculata atlantica* is so far known only from Ascension and St. Helena in 20–40 meters. *P. maculata maculata* is known from Ceylon, the Philippines and the Macclesfield Bank, and the Banda and Timor Sea in 20–70 meters (Mortensen, 1943), also southern Japan (Utinomi, 1954); in the western Atlantic, *P. m. maculata* is known from off Barbados (holotype of *P. occidentalis*), from off Venezuela in 83–186 meters, and from off southeastern Florida in 19–21 meters.

### *Tripneustes ventricosus* (Lamarck)

*Tripneustes angulosus*.—Bell, 1881:437.

*Tripneustes esculentus*.—Clark, 1925:124.

*Tripneustes ventricosus*.—Mortensen, 1943:490.

MATERIAL EXAMINED.—None.

REMARKS.—Bell (1881) first reported this species (as *T. angulosus*) from Ascension and Clark (1925) referred again to Bell's specimen, confirming its identity as *T. esculentus* (= *T. ventricosus*). No further specimens of the species have been taken at Ascension, in spite of assiduous intertidal and subtidal collecting in what would seem to be suitable habitats for the species.

Mortensen (1933a) was inclined to believe that the record of this species from St. Helena (Cunningham, 1910) was erroneous, for he found no further material in his collecting around that island. In fact, he suggested that the material of this species which was described by Cunningham may have been collected at Ascension.

DISTRIBUTION.—Common in the West Indies and the west coast of Africa (Mortensen, 1943). The records from Ascension and St. Helena must be regarded as questionable.

## Order ECHINOIDA

### Family ECHINOMETRIDAE

#### *Echinometra lucunter polypora*, new subspecies

FIGURES 8–10

*Echinometra acufera* Mellis, 1875:219.

*Echinometra subangularis*.—Bell, 1881:437.—Koehler, 1908:640.—Cunningham, 1910:125.

*Echinometra lucunter*.—Clark, 1925:143 [in part].—Mortensen,

1933a:468; 1936:224 [in part]; 1943:357, pl. 41: figs. 1–5, pl. 42: figs. 12–14, pl. 43: figs. 1–13, pl. 44: fig. 9, pl. 64: figs. 17, 20–24 [in part].

MATERIAL EXAMINED.—Holotype: USNM E16206, RBM 24, 25 May 1971, Ascension Island, rocky flat near Collyer Point, rock surface at low tide with dense algal mat, collected by R. B. Manning and K. Double. Paratypes: USNM E16190, RBM 24, 16 specimens (same data as holotype); USNM E16186, RBM 12, 1 specimen; USNM E16179 (4), USNM E16191 (1), RBM 14, 5 specimens; USNM E16184, RBM 18, 2 specimens; USNM E16185, RBM 20, 2 specimens; USNM E16187, RBM 22, 3 specimens; USNM E16180, Asc. 1B-76, 27 specimens; USNM E16181, Asc. 1C-76, 3 specimens; USNM E16189, Asc. 6A-76, 2 specimens; USNM E16182, Asc. 7, 1 specimen; USNM E16183, Turtle Shell Beach (MacArthur Point), rocky tide pools, collected Storrs Olson 18 Jun 1970, 3 specimens.

DIAGNOSIS.—Like *E. l. lucunter*, except that there are predominantly 7 pore-pairs to the arc, when greatest test diameter of approximately 32 mm is reached. Upper surface of test with conspicuous tinge of purple; no trace of green color adapically.

REMARKS.—While I am reluctant to erect subspecies in a group that is poorly known in so many ways, there seem to be excellent grounds for regarding the Ascension and St. Helena populations of *E. lucunter* (Linnaeus) as distinct from the "typical" ampho-Atlantic populations. Mortensen (1933a, 1943) has already called attention to differences that he noted in St. Helena specimens of this species, and my examination of larger samples of specimens from Ascension and elsewhere tend to confirm Mortensen's observation (for the St. Helena specimens) that they are "about to develop into a separate variety" (1943:366). Mortensen's observation (1943:366) that the Ascension *Echinometra* are different from St. Helena specimens in some respects are contradicted by my present findings, and I could find no morphological differences between Ascension and St. Helena.

DISTRIBUTION.—Ascension and St. Helena, intertidal and shallow subtidal.

HABITAT AT ASCENSION.—This is by far the most common intertidal species at Ascension. Specimens were found in great numbers in high splash pools, in pools between tidemarks, and in rock faces at and slightly below low tide level. While most were occupying shallow burrows in the volcanic rock, many were lodged in crevices or were exposed on the rock surface (Figure 8). Commonly, specimens were found in association with *Diadema antillarum*

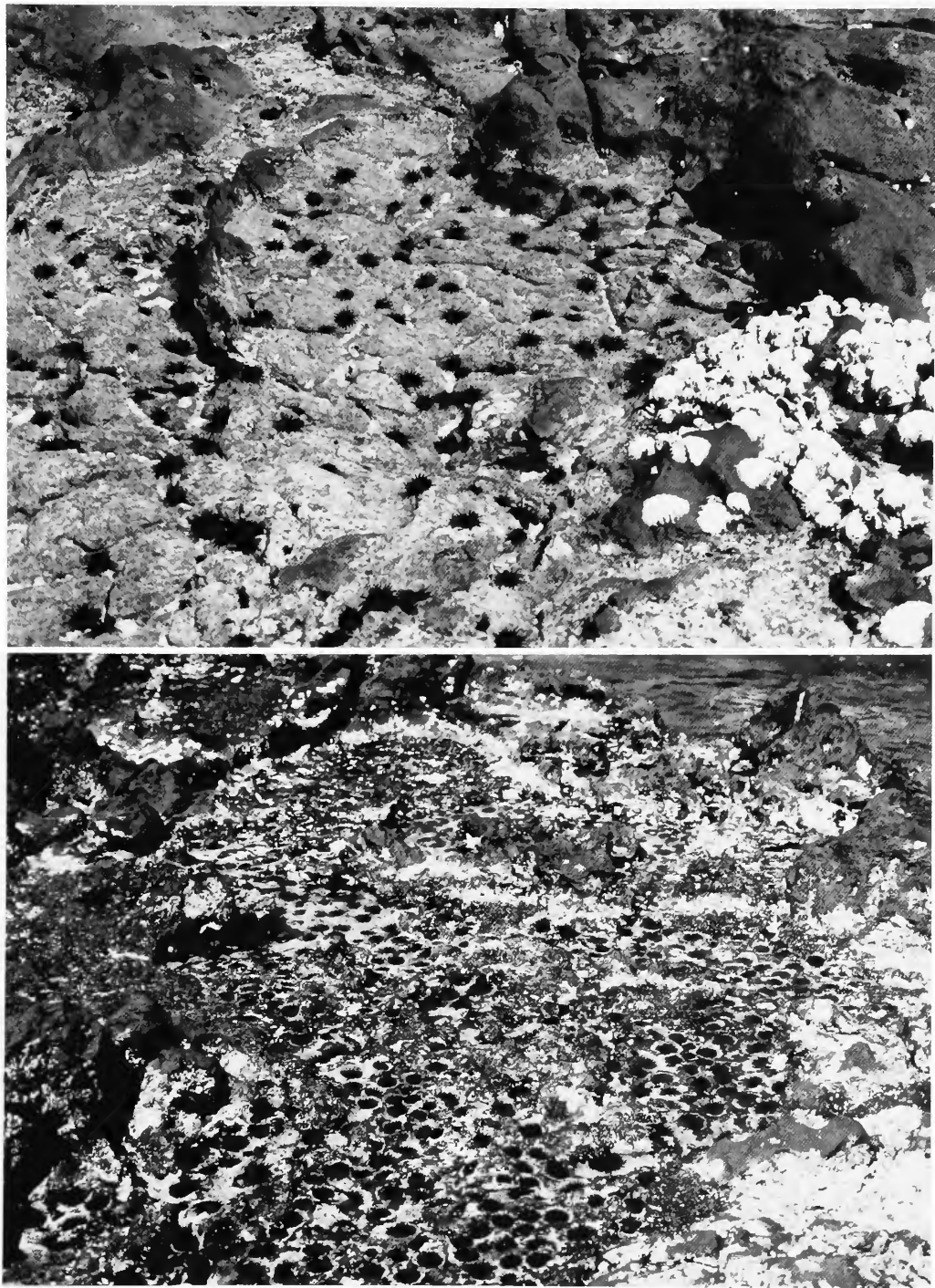


FIGURE 8.—Two contrasting habitats for *Echinometra lucunter polypora* at Collyer Point, Ascension Island: *upper*, specimens on surface of rock; *lower*, specimens occupying burrows. (Photos: R. B. Manning.)

*ascensionis*. J. Rosewater (pers. com.) found small clusters of the gastropod mollusk *Hipponyx anti-quatus* (Linnaeus) in the bottoms of several of the burrows after removal of *Echinometra*. This may be merely a fortuitous association, for numerous specimens of the gastropod were also found in other habitats, not associated with *Echinometra*. Approximately 20 specimens of *Echinometra* were washed in formaldehyde in search of commensals; none were found.

### *Echinometra* Specimens

**COLOR OF TEST.**—In all specimens from Ascension, the upper part of the cleaned test has a distinct purple tinge; the test is white elsewhere. By contrast, all specimens from the western Atlantic examined have the test either more or less white, or more often with a greenish tinge to the upper part of the test. Color of specimens from Annobón, off West Africa (now Pagalu, Equatorial Guinea) is variable; some specimens have greenish tests, some have a very pale purplish tinge, while others are virtually white. According to Koehler (1914), the West African specimens he examined are indistinguishable from the West Atlantic forms. Mortensen (1943) noted that West African specimens are "darker," but apparently he was referring to color of the spines.

Specimens from St. Helena are all purplish adapi-

cally (Mortensen, 1933a) as they are in USNM collections.

**COLOR OF SPINES.**—Mortensen (1943) noted that the spines "show all intermediates between wholly black and wholly white. . . . It is very noteworthy however that all the numerous specimens from St. Helena, Ascension, and West Africa that I have seen are black." The living specimens at Ascension appeared quite black upon superficial examination. Preserved and dried specimens have dark green spines with purplish tips. The same coloration can be found in specimens from Annobón, off West Africa (USNM E12263).

**NUMBER OF PORE-PAIRS.**—Mortensen (1943) noted that in West Indian specimens of *E. lucunter* the number of pore-pairs is "more generally 6 (though often 7) to each arc," while in St. Helena specimens there are "almost constantly 7 (or often 8. . . ." The number of pore-pairs in Ascension specimens were counted and results are given below, together with data gathered from series of *E. lucunter* from the eastern Atlantic (Annobón) and the western Atlantic (St. Croix, Virgin Islands; Key West, Florida; and Curaçao). The pore-pairs counted were those immediately above the ambitus. See Figure 9.

### Summary of *Echinometra* Morphometric Data

**ASCENSION ISLAND.**—Number of specimens examined, 56. Greatest length 9–64 mm, width 8–64 mm. Average width as percentage of length 90%. In 12 specimens the product of length  $\times$  width was less than 900, and 10 (84%) of these specimens have 6 pore-pairs to the arc. In the 44 specimens where length  $\times$  width exceeded 900, 24 (approximately 55%) have 7 pore-pairs to the arc, 3 (7%) have predominantly 7 pore-pairs and 10 (23%) have 6 and 7 pore-pairs present in approximately equal proportions. None of the latter specimens have 6 pore-pairs to the arc throughout.

**EASTERN ATLANTIC.**—Number of specimens examined, 15. Greatest length 10–60 mm, width 9–50 mm. Average width as percentage of length 91%. In 11 specimens the product of length  $\times$  width exceeded 900, and in all of these (100%) the number of pore-pairs to the arc is 6. No specimens have arcs with 7 pore-pairs.

**WESTERN ATLANTIC.**—*St. Croix Population*: Number of specimens examined, 110. Greatest length 25–62 mm, width 23–58 mm. Average width as per-

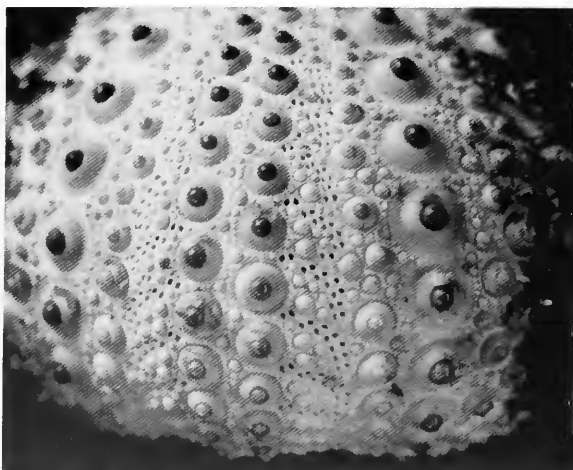


FIGURE 9.—Ambulacrum of *Echinometra lucunter polypora*, new subspecies, showing arcs of 7 pore-pairs.

centage of length 88%. In 74 specimens the product of length  $\times$  width exceeded 900, and in 66 (89%) of these there are 6 pore-pairs to the arc. One specimen had predominantly but not exclusively 7 pore-pairs, and in only 7 specimens (9%) arcs with 7 pore-pairs were present in equal numbers with arcs with 6. No specimens have 7 pore-pairs to the arc throughout.

*Key West and Curaçao Specimens:* Number of specimens examined, 30. Greatest length 19–62 mm, width 17–54 mm. In 23 specimens the product of length  $\times$  width exceeded 900, and in 15 specimens (65%) there are 6 pore-pairs to the arc. In 4 specimens (17%) there are 7 pore-pairs, and in 4 specimens (17%) 6 and 7 pore-pairs were present in approximately equal proportions.

SUMMARY OF DATA.—The data summarized above

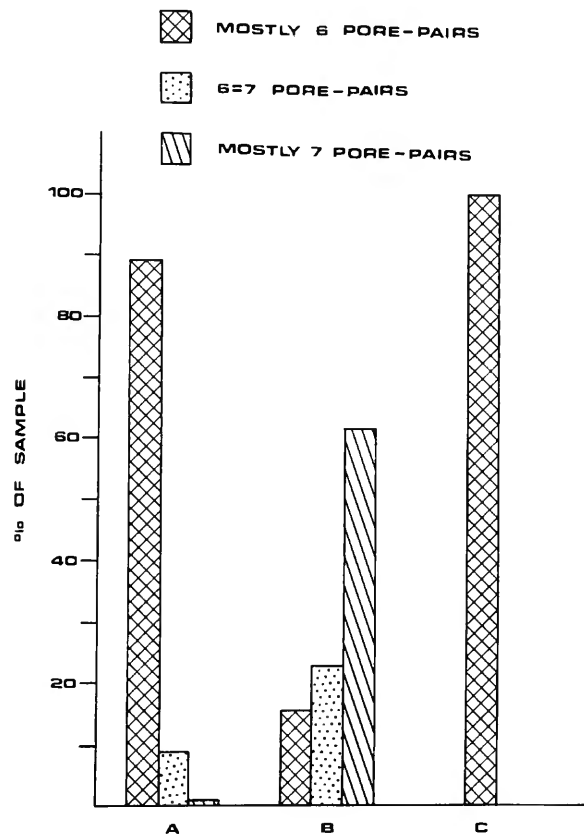


FIGURE 10.—Numbers of pore-pairs to the arc in three populations of *Echinometra lucunter* (Linnaeus): a, Western Atlantic (St. Croix); b, Ascension; c, Eastern Atlantic (Anno-bón). (For details, see text.)

and presented graphically in Figure 10 show that the populations of *E. lucunter* at Ascension are consistently different from those examined from the eastern and western Atlantic in terms of number of pore-pairs to the arc. After a length of approximately 32 mm is reached (at which point length  $\times$  width will approximate 900), the typical configuration for Ascension specimens is to have 7 pore-pairs, while eastern and western Atlantic forms typically have 6.

The combination of characters here regarded as taxonomically important (number of pore-pairs and color of test) warrant the erection of a new subspecies to accommodate the central Atlantic populations of the species.

## Order HOLECTYPOIDA

### Family ECHINONEIDAE

#### *Echinoneus cyclostomus* Leske

*Echinoneus cyclostomus*.—Bell, 1881:437.—Mortensen, 1948: 75, fig. 60, pl. 1: figs. 14, 26; pl. 12: figs. 21–23.

MATERIAL EXAMINED.—RBM 5, 2 specimens; RBM 15, 1 specimen; Asc. 6A-76, 1 specimen.

REMARKS.—The four specimens (total lengths 20, 26, 31, 41 mm) are typical of this well-known species, and need no further comment here.

DISTRIBUTION.—A truly "tropicopolitan" species, which ranges the Indo-Pacific and the western Atlantic; it has not yet been recorded from West Africa (Mortensen, 1948:79).

HABITAT AT ASCENSION.—Under rocks on hard or calcareous sand substrate.

## Order CLYPEASTEROIDA

### Family ROTULIDAE

#### *Heliophora orbiculus* (Linnaeus)

*Rotula dentata*.—Bell, 1881:436.

*Rotula orbiculus*.—Clark, 1925:175.—Mortensen, 1948:459, pl. 57: fig. 1, pl. 72: fig. 4; 1951b:298.—Cherbonnier, 1959: 49, pl. 7: fig. K; 1963:187.

*Heliophora orbiculus*.—Durham, 1955:185; 1966:U491, fig. 377, 4a-c.

MATERIAL EXAMINED.—None.

REMARKS.—The inclusion of this species in the faunal list for Ascension rests upon the record of Bell (1881) of two bare tests. No further specimens have been collected at Ascension. The species is not known from St. Helena.

DISTRIBUTION.—From Senegal to Angola (Mortensen, 1940), also Ascension Island (Bell, 1881) and the Cape Verdes (Mortensen, 1951b).

## Order SPATANGOIDA

### Family BRISSIDAE

#### *Brissus unicolor* (Leske)

*Brissus unicolor*.—Mortensen, 1951a:509, pl. 38: fig. 10.

MATERIAL EXAMINED.—Ascension Island, collected by divers, Ascension Historical Society, approximately 1972, specimen on display in Ascension Historical Society Museum, Fort Hayes, Ascension Island.

REMARK.—The single specimen of *Brissus unicolor* was apparently collected by diving at Ascension Island, and was initially identified by Ailsa M. Clark of the British Museum (Natural History). No other specimens of the species have been recorded from Ascension. The bare test was photographed, and approximate dimensions (based upon the photograph) are as follows: length 115 mm, greatest width 87 mm, greatest height 52 mm, height at level of apical system 42 mm, length of left posterolateral petal 44 mm, length of left anterolateral petal 29 mm.

DISTRIBUTION.—Mortensen (1951a) records the species from the "warmer regions of both the Western and Eastern Atlantic." The record from St. Helena (Clark, 1952) is exceedingly doubtful although, in the light of the known occurrence of the species at Ascension, it seems quite likely that it could also occur at St. Helena. Chesher (1972) notes that some specimens of *Brissus* from the Gulf of California cannot be distinguished from *B. unicolor*, and he considers that this species ranges into the eastern Pacific, where its relationships with *B. obesus* Verrill have yet to be determined.

## Class HOLOTHUROIDEA

### Order ASPIDOCHEIROTIDA

#### Family HOLOTHURIIDAE

#### *Holothuria (Halodeima) grisea* Selenka

FIGURE 11a-e

*Holothuria grisea*.—Deichmann, 1930:76, pl. 5: figs. 1-4.  
*Holothuria (Holothuria) grisea*.—Panning, 1934a:31, fig. 23.  
*Ludwigothuria grisea*.—Deichmann, 1958:311.  
*Holothuria (Halodeima) grisea*.—Rowe, 1969:138.

MATERIAL EXAMINED.—RBM 3, 1 specimen; RBM 10, 1 specimen. Asc. 1B-76, 8 specimens; Asc. 5A-76, 1 specimen; Asc. 6A-76, 6 specimens.

DISTRIBUTION.—In external features, specimens conform with previous descriptions. Color in life generally reddish ground color, with yellowish and brownish patches marking presence of dorsal tube feet. Color in alcohol mottled greyish. Ventral feet form conspicuous sole, light greenish-yellow in life, brownish in alcohol.

Ossicles in body wall numerous tables and buttons (rosettes). Tables (Figure 11a) with small disc carrying few perforations; generally four large central perforations surrounded by four to twelve smaller peripheral holes. Edge of disc with approximately 12 blunt projections. Spire short, with one crossbar, and terminating in 12 spines, of which four project more or less vertically. Dimensions: average diameter of disc 58  $\mu\text{m}$  (SD 6.75; SE 2.04); average height of spire 51  $\mu\text{m}$  (SD 4.28, SE 1.29). Buttons (rosettes) apparently derived from basic form with 4-6 larger holes and variable number of smaller holes (Figure 11d); edges of buttons indented. Length ranges from about 36 to about 45  $\mu\text{m}$ ; average length 39  $\mu\text{m}$  (SD 3.72, SE 1.24).

Ventral tube feet contain well developed end plates, together with rods (Figure 11b) with perforated ends; some rods develop four large lateral perforations as well. Rods average approximately 115  $\mu\text{m}$  in length.

Tentacles contain rods (Figure 11e) with perforated ends and with short spines near perforations. Tentacle rods greatly variable in size, up to maximum length of approximately 250  $\mu\text{m}$ .

REMARKS.—The ossicles of the Ascension representatives of this species show some consistent dif-

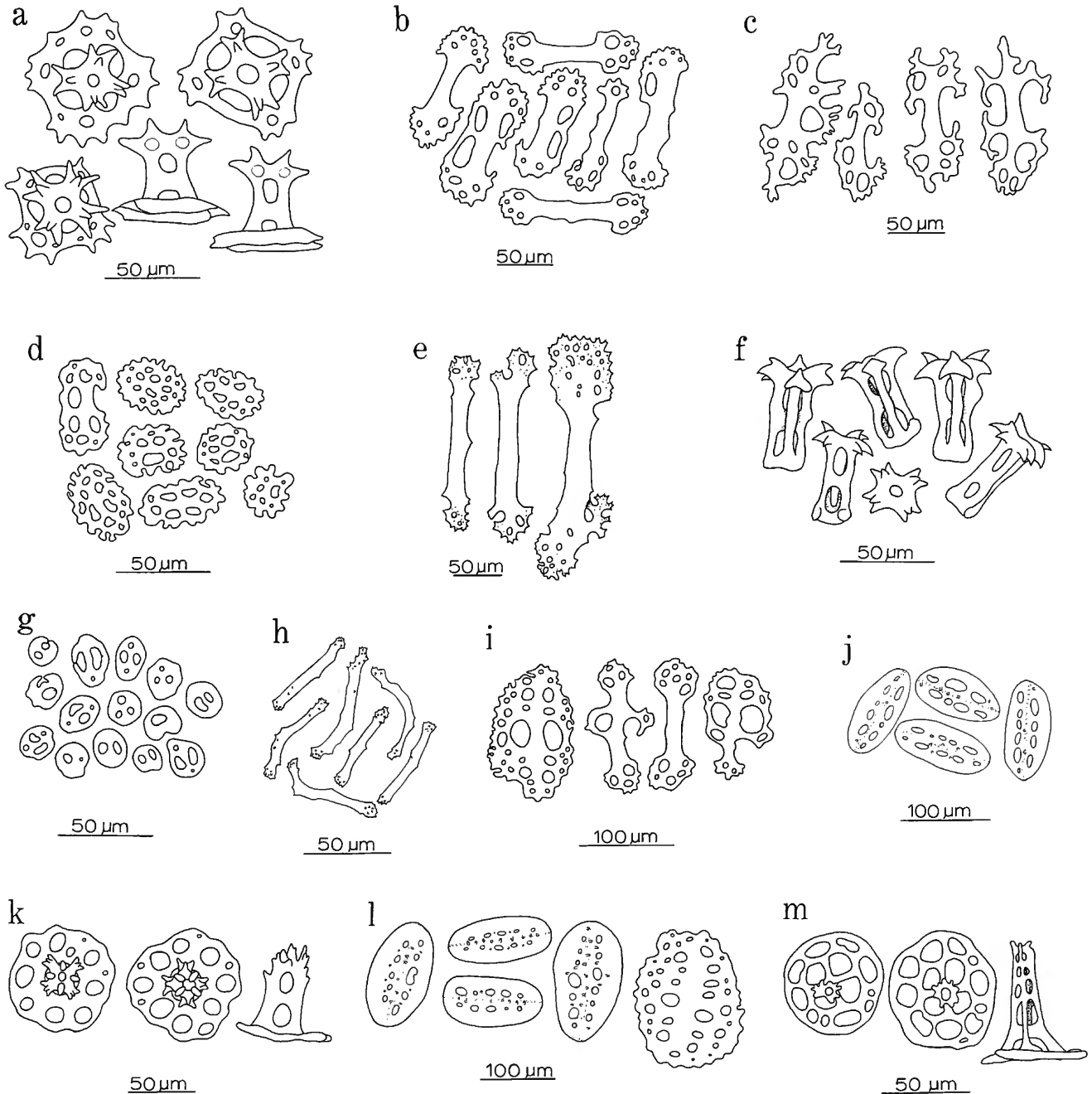


FIGURE 11.—*Holothuria (Halodeima) grisea* Selenka: *a*, tables from body wall; *b*, rods from ventral tube feet of Ascension specimens; *c*, rods from ventral tube feet of specimen from the Bahamas (USNM 32489); *d*, buttons from body wall; *e*, rods from tentacles. *Holothuria (Halodeima) manningi*, new species: *f*, tables from body wall; *g*, buttons from body wall; *h*, rods from tentacles; *i*, perforated plates from tube feet. *Holothuria (Platyperona) sanctori* Delle Chiaje: *j*, buttons from body wall of specimen from Naples (USNM 17025); *k*, tables from body wall; *l*, buttons from body wall. *Isostichopus badionotus* (Selenka): *m*, tables from body wall of juvenile specimens.

ferences from those of West Indian specimens. The tables are virtually identical, although those from Ascension may be slightly higher. The buttons or rosettes are smaller in the Ascension form (Deichmann, 1930:77, notes that they are about 50  $\mu\text{m}$  in diameter in West Indian forms), and appear to have more numerous larger holes. While very few of the ossicles illustrated by Deichmann (1930, pl. 5: fig. 1) can be found in the ventral tube feet, most are the shape shown in Figure 11*b*. By contrast, tube foot ossicles from USNM 32489, a specimen from Andros Island, Bahamas (Figure 11*c*), are quite different, with more irregular shape, and few complete perforations in the ends. It can be seen, however, that both of these ossicles follow the same basic pattern. The tentacle rods are quite variable in both populations, although the Ascension specimens tend to have rods with more numerous perforations.

**DISTRIBUTION.**—Common in the tropical western Atlantic (Deichmann, 1930), and also known from West Africa (Greef, 1882).

**HABITAT AT ASCENSION.**—Fairly common under rocks or on sand under rocky ledges. Despite bright coloration, difficult to see because of covering of particles of sand.

### *Holothuria (Halodeima) manningi*, new species

FIGURE 11*f-i*

**MATERIAL EXAMINED.**—Holotype: USNM E16167, total length 90 mm. Asc. 3G-76, 12 Jul 1976, English Bay, Ascension Island, collected by snorkeling from depths of approximately 5 m in broad surge channel; substrate rock or coarse coralline "sand." Water temperature 25°C, salinity 34‰. Paratypes: USNM E16168, total length 95 and 80 mm. Same locality data as holotype.

**ETYMOLOGY.**—The species is named for Dr. Raymond B. Manning, Department of Invertebrate Zoology, National Museum of Natural History, who has contributed so much to our knowledge of Ascension Island invertebrates by his assiduous collecting and who was the first to discover the specimens described herein.

**DIAGNOSIS.**—Deposits include tables of average height 54  $\mu\text{m}$  with completely reduced disk and with spire surmounted by 12 projections, and minute circular buttons of average diameter 22  $\mu\text{m}$ , typically with 2 large and 2 small perforations, but

nature and disposition of perforations highly variable.

**DESCRIPTION.**—Body cylindrical, lacking conspicuous tubercles dorsally. In life, dark brown dorsally, darker along mid-dorsal interradius, fading to lighter brown on flanks; ventral surface light brown. In alcohol, color similar. Tentacles olive green in life, yellowish green in alcohol. Skin slightly rough to touch due to presence of numerous ossicles. Dorsal and ventral tube feet identical. Dorsally, feet sparsely scattered; ventrally, feet much more numerous, but not forming conspicuous sole. Largest specimen with conspicuous naked band along mid-ventral radius, but naked area not obvious in smaller specimens.

Ossicles in dorsal and ventral body wall identical, consisting of tables and buttons. Tables with completely reduced disc; basal portion rounded (Figure 11*f*). Top of spire with "maltese cross" comprising 12 projections, none of which appear to point vertically. Spire with one crossbar. Average height of tables 54  $\mu\text{m}$  (SD 3.63). Buttons minute, tending to be circular. Typical form (Figure 11*g*) has four perforations, two larger and two smaller, but nature and disposition of perforations highly variable. Most buttons with only two perforations. Average diameter 22  $\mu\text{m}$  (SD 2.28).

Tube feet contain end plates, tables, buttons, and flat perforated plates (Figure 11*i*), usually with two larger perforations and numerous small perforations at ends. Developmental stages of these plates common.

Tentacles contain scattered minute straight or curved spinous rods (Figure 11*h*), averaging approximately 50  $\mu\text{m}$  in length.

**REMARKS.**—This species falls within the subgenus *Halodeima* of the genus *Holothuria* as defined by Rowe (1969). It is immediately distinguished from all species listed by Rowe, except *Holothuria (Halodeima) edulis* Lesson, in having tables with a completely reduced disc. This Indo-Pacific species has tables that closely resemble those of *Holothuria (Halodeima) manningi*, but the buttons in both species are very different, for in *H. (H.) edulis* the buttons tend to be elongate, have generally larger holes, and are frequently reduced to form X-shaped granules. Further, this latter species has distinctive coloration, being brown dorsally and rose red ventrally when alive (Clark, 1946); this color is quite consistent and distinctive.



While relationship with *H. (H.) edulis* might be postulated, *H. (H.) manningi* appears to bear no close relationship to any species of *Holothuria* in the Atlantic Ocean.

The species was found only at English Bay, and only in minimum depths of 3–4 meters. Further searching in the English Bay area revealed that the species is relatively common and conspicuous, lying exposed on rocks and calcareous sand.

### *Holothuria (Thymiosycia) arenicola* Semper

*Holothuria arenicola*.—Deichmann, 1930:66, pl. 4: figs. 1–9.

*Holothuria (Holothuria) arenicola*.—Panning, 1935:88 fig. 73.

*Bradtothuria arenicola*.—Deichmann, 1958:290.

*Holothuria (Thymiosycia) arenicola*.—Rowe, 1969:145.

MATERIAL EXAMINED.—RBM 13, 1 specimen; RBM 22, 2 specimens; Asc. 5A-76, 2 specimens.

DESCRIPTION.—Specimens typical of species. Specimen from RBM 13 is juvenile, with tables only in body wall; buttons absent. In adult specimens tables average 61.5  $\mu\text{m}$  in diameter (SD 2.70, SE 0.85) and buttons average 48.8  $\mu\text{m}$  in length (SD 1.69, SE 0.56).

REMARKS.—In all characters examined, specimens from Ascension conform well with descriptions of the species. Dimensions of ossicles fall within the range of variation for *H. arenicola*. Deichmann (1930) noted that there was surprisingly little variation in ossicle size throughout the geographic range of the species.

DISTRIBUTION.—This species is cosmopolitan in the tropics, generally living under rocks or burrowing into sandy substrates.

HABITAT AT ASCENSION.—R. B. Manning noted that the specimens collected at RBM 22 were found "burrowing deep in bottom of pool." The specimens from Asc. 5A-76 were found under rocks, burrowing into coarse calcareous rubble.

### *Holothuria (Platyperona) sanctori* Delle Chiaje

FIGURE 11j-l

*Holothuria farcimen*.—Mortensen, 1933a:471, fig. 29.

*Holothuria sanctori*.—Panning, 1934b:74, fig. 55.—Tortonese, 1965:61, figs. 21A, 22.

*Microthele sanctori*.—Deichmann, 1958:287.

*Holothuria (Platyperona) sanctori*.—Rowe, 1969:145.

MATERIAL EXAMINED.—RBM 15, 2 specimens; Asc. 30–76, 3 specimens; Asc. 90–76, 1 specimen.

DESCRIPTION.—Specimens typical of species in most respects, although ossicles show some differences. Tables apparently normal (Figure 11k), but buttons consistently possess several small knobs (Figure 11l).

REMARKS.—Most typical specimens of *H. sanctori* have smooth buttons, with no trace of knobs on their surface. A single specimen from Naples (USNM 17025) possesses buttons with few knobs (Figure 11j); approximately six knobs per button was the largest density observed. The presence of numerous knobs on the buttons was also observed by Mortensen (1933a) in the St. Helena specimens he described as *Holothuria farcimen* Selenka.

DISTRIBUTION.—Mediterranean Sea, Azores (Selenka, 1867; Chapman, 1955), St. Helena (Mortensen, 1933a). According to Tortonese (1965), the bathymetric range is 5–30 meters. At St. Helena the species was collected intertidally, and at a depth of 40 meters (Mortensen, 1933a). The Ascension records are all intertidal.

HABITAT AT ASCENSION.—Under rocks on rocky substrate.

## Family STICHOPODIDAE

### *Isostichopus badionotus* (Selenka)

FIGURE 11m

*Stichopus badionotus*.—Deichmann, 1930:80, pl. 5: figs. 30–36.

—Cherbonnier, 1976:631, pl. 1A–C: fig. 1A–C, fig. 2H–O.

*Isostichopus badionotus*.—Deichmann, 1958:280.

MATERIAL EXAMINED.—RBM 9, 1 specimen; RBM 21, 1 specimen; Asc. 3A-76, 1 specimen (juvenile).

DESCRIPTION.—Specimens from station RBM 9 and RBM 21 are typical of the species. Juvenile specimen from Asc. 3A-76, white alive and in alcohol, total length 10 mm. Body wall soft, with scattered tube feet. Ossicles exclusively tables (Figure 11m) with four central perforations, surrounded by eight or more marginal perforations. Spire tall, with four or more crossbars. Diameter of tables variable, usually 50–60  $\mu\text{m}$ ; spire with same dimensions.

REMARKS.—Clark (1922) described the ossicles of a juvenile 20 mm in length, and in that specimen the tables were 75  $\mu\text{m}$  across and the spire 50  $\mu\text{m}$  high, with two crossbars and with teeth on the top.

Differences from the ossicles of the Ascension specimen are obvious. However, Clark's specimen was approximately twice as long as the present one, and he noted (Clark, 1922:57) that growth changes in the ossicles can be quite dramatic. It does not seem likely that two species of *Isostichopus* occur at Ascension Island; thus the juvenile specimen is assigned to *I. badionotus*.

DISTRIBUTION.—Deichmann (1930) notes that this species is distributed over "most of the West Indian Seas, from Bermuda to Panama." Greef (1882) reported the species (as *Stichopus maculata*) from West Africa, as did Bell (1883) (as *S. assimilis*), and Cherbonnier (1975) confirmed that *I. badionotus* occurs in West African waters. No stichopodids are known from St. Helena.

HABITAT AT ASCENSION.—Exposed on sand or rock. Not common intertidally.

## Order APODIDA

### Family SYNAPTIDAE

#### *Euapta lappa* (Müller)

*Euapta lappa*.—Clark, 1924:464, pl. 1: figs. 5–7.—Heding, 1928:136, figs 8.2, 9.4, 10.5, 10.6.—Mortensen, 1933a:471.

MATERIAL EXAMINED.—British Museum, unregistered holothurian, English Bay, Ascension Island; Ascension Island Historical Society, Fort Hayes Museum, Dec 1972, one fragment, anterior end of body.

DESCRIPTION.—Specimen comprises anterior end of body approximately 220 mm in length. Tentacles 14. Color mottled brown. Ossicles comprise anchors and anchor plates, all of approximately the same size. Anchors average 368  $\mu$ m in length and 210  $\mu$ m in width, and plates average 233  $\mu$ m in length and 166  $\mu$ m in width.

REMARKS.—This is a typical specimen of *E. lappa*. The dimensions of the anchors and plates conform well with those given by Clark (1924) and Heding (1928).

The label with the specimen notes: "white sea slug apparently is never observed during daylight hours. This specimen was recovered during darkness." In spite of searching in a variety of habitats during the 1976 expedition, no further specimens were found. Apparently the species is not common in shallow water.

DISTRIBUTION.—*E. lappa* is common in the West Indies and the Caribbean area generally. Theel (1886) records the species or a close relative, from off Teneriffe in the Canary Islands, and Mortensen (1933a) described what was probably this species from St. Helena.

## Literature Cited

- Agassiz, A.  
1881. Report on the Echinoidea Dredged by H.M.S. *Challenger* during the Years 1873-76. *Report on the Scientific Results of the Voyage of H.M.S. Challenger, Zoology*, 3(9): 321 pages, 45 plates.
- Atkins, F. B., P. E. Baker, J. D. Bell, and D.G.W. Smith  
1964. Oxford Expedition to Ascension Island. *Nature*, 204:722-724.
- Bell, F. J.  
1881. Report of a Collection Made by Mr. T. Conry in Ascension Island: Echinodermata. *Annals and Magazine of Natural History*, series 5, 44:436-438.  
1882. Description of a New Species of the Genus *Archaster* from St. Helena. *Annals and Magazine of Natural History*, series 5, 48:440-441.  
1883. Studies on the Holothuroidea, II: Descriptions of New Species. *Proceedings of the Zoological Society of London 1883*:58-62, plate XV.
- Briggs, J. C.  
1974. *Marine Zoogeography*. x + 475 pages. New York: McGraw-Hill Book Company.
- Brito, I. M.  
1962. Ensaio de catalogo dos Equinodermas do Brasil. *Universidade do Brasil Faculdade Nacional de Filosofia, Centro de Estudos Zoológicos*, 13:1-10, 3 plates.  
1971. Contribuicao ao conhecimento dos Equinodermas de Ilha la Trindade, Brasil. *Archivos do Museu Nacional*, 54:261-265.
- Chace, F. A., Jr., and R. B. Manning  
1972. Two New Caridean Shrimps, One Representing a New Family, from Marine Pools on Ascension Island (Crustacea: Decapoda: Natantia). *Smithsonian Contributions to Zoology*, 131:1-18, 11 figures.
- Chapman, G.  
1955. Aspects of the Fauna and Flora of the Azores, IV: Echinodermata. *Annals and Magazine of Natural History*, series 12, 8:398-400.
- Cherbonnier, G.  
1959. Echinides. *Expedition Oceanographique Belge dans les Eaux Côtieres Africaines de l'Atlantique Sud (1948-1949)*, 3(6):35-59, plates I-X.  
1963. Echinodermes des cotes du Cameroun récoltés par A. Crosnier en Decembre 1962-Janvier 1963. *Bulletin du Muséum National d'Histoire Naturelle*, 35(2):179-193, 3 figures.  
1975. Note sur la presence dans la Golfe de Guinee, de l'Holothurie Aspidochirote *Stichopus badionotus* Selenka (= *St. maculatus* Greef). *Bulletin du Muséum national d'Histoire naturelle Zoologie*, 210: 631-638, 1 plate, 2 figures.
- Chesher, R. H.  
1966. The R/V *Pillsbury* Deep-Sea Biological Expedition to the Gulf of Guinea, 1964-65, 10: Report on the Echinoidea Collected by the R/V *Pillsbury* in the Gulf of Guinea. *Studies in Tropical Oceanography, Institute of Marine Sciences (University of Miami)*, 4(1):209-223.  
1972. The Status of Knowledge of Panamanian Echinoids, 1971, with Comments on Other Echinoderms. *Bulletin of the Biological Society of Washington*, 2: 139-158, figures 1-2.
- Clark, A. M.  
1955. Echinodermata of the Gold Coast. *Journal of the West African Science Association*, 1(2):16-56, figures 1-23.  
1967. Notes on the Family Ophiotrichidae (Ophiuroidea). *Annals and Magazine of Natural History*, series 13, 9:637-655.
- Clark, A. M., and A. H. Clark  
1954. A Revision of the Sea-Star of the Genus *Tethyaster*. *Smithsonian Miscellaneous Collections*, 122(11):1-27, 12 plates, 2 figures.
- Clark, H. L.  
1912. Hawaiian and Other Pacific Echini: The Pedinidae, Phymosomatidae, Stomopneustidae, Echinidae, Temnopleuridae, Strognylocentrotidae, and Echinometridae. *Memoirs of the Museum of Comparative Zoology*, 34(4):209-383, 32 plates.  
1921a. The Echinoderm Fauna of Torres Strait: Its Composition and Origin. *Carnegie Institution of Washington Publication*, 214(10): viii + 224 pages, 38 plates.  
1921b. Report on the Echinoidea of the Barbados-Antigua Expedition of 1918. *Bulletin from the Laboratory of Natural History of the University of Iowa* 9(5): 103-121, 2 plates.  
1922. The Holothurians of the Genus *Stichopus*. *Bulletin of the Museum of Comparative Zoology*, 65(3): 39-74, 2 plates.  
1924. The Holothurians of the Museum of Comparative Zoology: The Synaptinae. *Bulletin of the Museum of Comparative Zoology*, 65(13):459-501, 12 plates.  
1925. *A Catalogue of the Recent Sea-urchins (Echinoidea) in the Collection of the British Museum (Natural History)*. xxviii + 250 pages, 12 plates. London: British Museum (Natural History).  
1946. The Echinoderm Fauna of Australia: Its Composition and Origin. *Carnegie Institution of Washington Publication*, 566: iv + 567 pages.

- Cunninghame, J.  
1699. A Catalogue of Shells, etc., Gathered at the Island of Ascension by Mr. James Cunninghame Chirurgion, with What Plants He There Observed; Communicated to Mr. James Petiver, Apothecary, and Fellow of the Royal Society. *Philosophical Transactions of the Royal Society of London*, 21:295-300.
- Cunningham, J. T.  
1910. On the Marine Fishes and Invertebrates of St. Helena. *Proceedings of the Zoological Society of London*, 1910:86-131, plates IV-VII, figures 3-6.
- Daly, R. A.  
1922. The Geology of Ascension and St. Helena Islands. *Geological Magazine*, 59:146-156.  
1925. The Geology of Ascension Island. *Proceedings of the American Academy of Arts and Sciences*, 60(1): 1-80.
- Deichmann, E.  
1930. The Holothurians of the Western Part of the Atlantic Ocean. *Bulletin of the Museum of Comparative Zoology*, 71(3):43-226, 24 plates.  
1958. The Holothurioida Collected by the *Velero III* and IV during the Years 1932 to 1954, Part II: Aspidochirota. *Allan Hancock Pacific Expeditions*, 11:249-349, 9 plates.
- Devaney, D. L.  
1973. Zoogeography and Faunal Composition of South-eastern Polynesian Asterozoan Echinoderms. In R. Fraser, editor, *Oceanography of the South Pacific 1972*, pages 357-366. Wellington: New Zealand National Commission for UNESCO.
- Durham, J. W.  
1955. Classification of Clypeasteroid Echinoids. *University of California Publications in Geological Sciences*, 31(4):73-198, plates 3-4.  
1966. Clypeasteroids. In R. C. Moore, editor, *Treatise on Invertebrate Paleontology*, Part U (Echinodermata 3):U450-491. Lawrence, Kansas: University of Kansas Press.
- Fisher, W. K.  
1940. Asteroidea. "*Discovery*" Reports, 20:69-306, figures A-M, 23 plates.
- Greeff, R.  
1882. Echinodermen, beobachtet auf einer reise nach der Guinea-Insel Sao Thome. *Zoologischer Anzeiger*, 5:114-120, 135-139, 156-159.
- Heding, S. G.  
1928. Synaptidae. *Videnskabelige Meddelelser fra Dansk naturhistorisk Forening i Kjøbenhavn*, 85:105-323, 69 figures, plates II, III.
- Koehler, R.  
1904. Ophiures nouvelles ou peu connues. *Memoires Societe Zoologique Francaise*, 17:54-119.  
1908. Asteries, Ophiures et Echinides de l'expedition antarctique eocossaise. *Transactions of the Royal Society of Edinburgh*, 46:529-649, 18 plates.  
1914. Echinoderma, I: Asteroidea, Ophiuroidea et Echinoidea. *Beiträge zur Kenntnis der Meeresfauna Westafrikas* (Hamburg), 1(2):129-303, plates iv-xv.
- Lima-Verde, J. S.  
1969. Primeira contribuicao ao inventario dos Equinodermas do Nordeste Brasileiro. *Archivos de Ciencias do Mar*, 9(1):9-13.
- MacArthur, R. H., and E. O. Wilson  
1967. *The Theory of Island Biogeography*. xi + 203 pages, 60 figures. Princeton, New Jersey: Princeton University Press.
- McPherson, B. F.  
1968. Contributions to the Biology of the Sea Urchin *Eucidaris tribuloides* (Lamarck). *Bulletin of Marine Science*, 18(2):400-443, 26 figures.
- Madsen, F. J.  
1950. The Echinoderms Collected by the Atlantide-Expedition 1945-46, I: Asteroidea. "*Atlantide*" Report, 1:167-222, plates XIV-XVI, 11 figures.  
1970. West African Ophiuroids. "*Atlantide*" Report, 11: 151-243, 49 figures.
- Mayr, E.  
1963. *Animal Species and Evolution*. xiv + 797 pages. Cambridge: Belknap Press of Harvard University.
- Melliss, J. C.  
1875. *St. Helena: A Physical, Historical, and Topographical Description of the Island; Including Its Geology, Fauna, Flora, and Meteorology*. xiv + 426 pages, 62 plates, 1 map. London.
- Metcalf, W. G., A. D. Voorhis and M. C. Statcup  
1962. The Atlantic Equatorial Undercurrent. *Journal of Geophysical Research*, 67(6):2499-2508.
- Mortensen, T.  
1903. Echinoidea. *The Danish Ingolf-Expedition*, 4(1): 1-194, 21 plates, 12 figures. Copenhagen: Bianco Luno.  
1909. Die Echinoiden. *Deutsche Sudpolar-Expedition 1901-1903 XI* (Zoologie, 1): 113 pages, 19 plates.  
1921. *Studies of the Development and Larval Forms of Echinoderms*. 261 pages, 33 plates, 102 figures. Copenhagen: G.E.C. Gad.  
1928. *A Monograph of the Echinoidea, Cidaroida*. Volume 1, 551 pages, 88 plates, 173 figures. Copenhagen: Bianco Luno.  
1931. Contributions to the Study of the Development and Larval Forms of Echinoderms I-II. *Danske Videnskabelnes Selskabs Skrifter, Naturvidenskabelig og matematisk Afdeling*, series 9, 4(1):1-39, plates I-VII, 12 figures.  
1932. New Contributions to the Knowledge of the Cidarids I-II. *Danske Videnskabelnes Selskabs Skrifter, Naturvidenskabelig og matematisk Afdeling*, series 9, 4(4):145-182, 18 figures, 10 plates.  
1933a. The Echinoderms of St. Helena. *Videnskabelige Meddelelser fra Dansk naturhistorisk Forening i Kjøbenhavn*, 93:401-472, plates XX-XXII, 29 figures.  
1933b. Echinoderms of South Africa (Asteroidea and Ophiuroidea). *Videnskabelige Meddelelser fra Dansk naturhistorisk Forening i Kjøbenhavn*, 93:215-400.  
1935. *A Monograph of the Echinoidea, Bothriocidaroida, Melonechinoida, Lepidocentroida, and Strirodonta*. Volume 2, 647 pages, 377 figures, 89 plates. Copenhagen: Bianco Luno.

1936. Echinoidea and Ophiuroidea. "Discovery" Reports, 12:199-348, plates I-IX.
1938. Contributions to the Study of the Development and Larval Forms of Echinoderms, IV. *Danske Videnskabernes Selskabs Skrifter, Naturvidenskabelig og matematisk Afdeling*, series 9, 7(3):1-59, plates I-XII, 30 figures.
1940. *A Monograph of the Echinoidea: Aulodonta*. Volume 3, number 1, 370 pages, 197 figures, 77 plates. Copenhagen: Bianco Luno.
1943. *A Monograph of the Echinoidea: Camarodonta*, 1. Volume 3, number 2, 553 pages, 321 figures, 56 plates. Copenhagen: Bianco Luno.
1948. *A Monograph of the Echinoidea: Clypeastroida*. Volume 4, number 2, 471 pages, 258 figures, 72 plates. Copenhagen: Bianco Luno.
- 1951a. *A Monograph of the Echinoidea: Spatangoida*, 2. Volume 5, number 2, 593 pages, 286 figures, 64 plates. Copenhagen: Bianco Luno.
- 1951b. Report on the Echinoidea Collected by the "Atlantide" Expedition. *Atlantide Report* 2:293-303, plates I-II.
- Panning, A.
- 1934a. Die Gattung *Holothuria*, 2. *Mitteilungen aus dem Zoologischen Staatsinstitut und Zoologischen Museum in Hamburg*, 45:24-50, figures 22-44.
- 1934b. Die Gattung *Holothuria*, 3. *Mitteilungen aus dem Zoologischen Staatsinstitut und Zoologischen Museum in Hamburg*, 45:65-84, figures 45-71.
1935. Die Gattung *Holothuria*, 4. *Mitteilungen aus dem Zoologischen Staatsinstitut und Zoologischen Museum in Hamburg*, 45:85-107, figures 72-102.
- Robinson, A. R.
1976. Eddies and Ocean Circulation. *Oceanus*, 19(3):2-17.
- Rosewater, J.
1975. An Annotated List of the Marine Mollusks of Ascension Island, South Atlantic Ocean. *Smithsonian Contributions to Zoology*, 189:1-41, 24 figures.
- Rowe, F.W.E.
1969. A Review of the Family Holothuriidae (Holothuroidea: Aspidochirotrida). *Bulletin of the British Museum (Natural History)*, Zoology, 18(4):119-170, 21 figures.
- Scheltema, R. S.
1968. Dispersal of Larvae by Equatorial Ocean Currents and Its Importance to the Zoogeography of Shallow-water Tropical Species. *Nature*, 217:1159-1162.
1971. Larval Dispersal as a Means of Genetic Exchange between Geographically Separated Populations of Shallow-water Benthic Marine Gastropods. *The Biological Bulletin*, 140(2):284-322.
- Selenka, E.
1867. Beiträge zur Anatomie und Systematik der Holothurien. *Zeitschrift für Wissenschaftliche Zoologie*, 17:291-374, plates 17-20.
- Sturm, M., and K. Voigt
1966. Observations on the Structure of the Equatorial Undercurrent in the Gulf of Guinea in 1964. *Journal of Geophysical Research*, 71(12):3105-3108.
- Sullivan, W.
1974. *Continents in Motion*. 399 pages. New York: McGraw-Hill Book Company.
- Theel, H.
1886. Report on the Holothuroidea Dredged by H.M.S. *Challenger* during the Years 1873-1876, Part 2. *Report on the Scientific Results of the Voyage of H.M.S. Challenger, Zoology*, 14(39):290 pages, 16 plates.
- Thorson, G.
1946. Reproduction and Larval Development of Danish Marine Bottom Invertebrates with Special Reference to the Planktonic Larvae in the Sound (Oresund). *Meddelelser Kommissionen Havundersøgelser Kjobbenhavn, Plankton*, 4(1):343-367.
1950. Reproductive and Larval Ecology of Marine Bottom Invertebrates. *Biological Reviews of the Cambridge Philosophical Society*, 25(1):1-45, 6 figures.
- Tommasi, L. R.
1966. Lista dos Equinoides recentes do Brasil. *Contribuições avulsas do Instituto Oceanográfico Sao Paulo*, 11:1-50, 9 plates, 72 figures.
- Tortonese, E.
1965. *Echinodermata. Fauna d'Italia*. Volume 6, xv + 422 pages, 186 figures. Bologna: Edizioni Calderini.
- Utinomi, H.
1954. A Checklist of Echinoids Found in the Kii Region. *Publications of the Seto Marine Biological Laboratory*, 3(3):339-358.
- Voight, K.
1975. The Atlantic Equatorial Undercurrent. *Technical Series Intergovernmental Oceanographic Commission*, 11:12-19.
- Wilson, J. T.
1963. Evidence from Islands on the Spreading of Ocean Floors. *Nature*, 197:536-538.
- Yamaguchi, M.
1973. Early Life Histories of Coral Reef Asteroids, with Special Reference to *Acanthaster planci* (L.). In Jones and Endean, editors, *Biology and Geology of Coral Reefs*, II(Biology, 1):369-387. New York: Academic Press.



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