Echinodermata of the Gold Coast

AILSA M. CLARK

British Museum (Natural History)

SUMMARY

A number of Asteroidea, Ophiuroidea, and Echinoidea collected in the Gold Coast are enumerated. Keys for the identification of the West African species of these groups are presented together with much information on the diagnostic features, affinities, and the known ranges of the different species. In addition, several new Ophiuroids are described.

THIS paper deals with a collection of Echinoderms made by the Department of Zoology, University College of the Gold Coast, Achimota, Gold Coast, from 1949 to 1951* at many shore stations along the Gold Coast as well as from dredging and trawling in the vicinity of Accra in depths down to 64 metres. Some additional specimens, mainly Ophiuroids, collected more recently,† using a Petersen grab in depths down to about 45 m., are also included.

No Crinoids were taken, and indeed only one crinoid species—*Antedon hupferi* Hartlaub—has been reported from the shallow water of the Gulf of Guinea. The Holothurians are being studied by Dr. G. Cherbonnier of Paris, so the present report deals only with the Asteroids, Ophiuroids, and Echinoids.

Of particular interest is a fine range of material of *Astropecten michaelseni* Koehler and some large specimens of *Luidia atlantidea* Madsen, as well as several species of Amphiurids which appear to be new. Two of these fragile forms are unfortunately represented only by specimens lacking the disc. The collection also extends the known ranges of several species, particularly Ophiuroids, such as *Ophiura* (formerly *Ophiocten*) *africana* (Koehler) and *Amphipholis clypeata* Koehler, which were previously known only from Angola.

Only a few of the species already reported from the Gold Coast are absent from this collection, notably *Astropecten mamillatus* Koehler, *A. jarli* Madsen, *Luidia alternata numidica* Koehler,‡ *Echinaster sepositus* (Gray), *Genocidaris maculata* A. Agassiz, *Spatangus purpureus* O. F. Müller (doubtfully recorded by Mortensen, 1951—from fragmentary specimens), *Brissopsis jarli* Mortensen, and *Acrocnida semisquamata* (Koehler). This does not include species known only from depths of 100 m. or more, which are also excluded from the following tables of Echinoderm species known from tropical West Africa between the latitudes of 15°N and 15°S (Cap Blanc to Angola).

Also omitted from the tables are species of which the Cape Verde area appears to be the southern limit and others with Angola as their northern limit. The

* Collector, Mr. R. Bassindale.

† Collector, Mr. J. B. Buchanan.

‡ Since this paper was completed Mr. Buchanan has collected some additional material including *Luidia alternata numidica* from Takoradi in 20 m., *Brissopsis jarli* Mortensen from Accra in 50 m., *Ophidiaster ophidianus* (Lamarck) from rock shore at Axim and *Tripneustes ventricosus* (Lamarck) from the Christiansborg shore, Accra. The last two are new records for the Gold Coast.

two marginal columns are only intended to show the extension north or south of species known more particularly from tropical West Africa or the occurrence of those known from the Cape as well as from Mauritania but not yet recorded in between, such as *Ophiothrix fragilis*.

Some of the references given in the tables are to names now accepted as synonyms of those listed. The maximum number of references for any one species is given as far as possible though only one record from each locality can be included. The species marked with an asterisk are represented in this collection. The authors' names are given in full in the keys to the species. The letters in the table refer to the following references :—

A. Koehler, 1907a.
B. Koehler, 1911.
C. Koehler, 1914.
D. Koehler, 1923.
E. Mortensen, 1925a.
F. Mortensen, 1927a.
G. Mortensen, 1936.
H. Mortensen, Monograph.
I. Mortensen, 1951a.
J. Greeff, 1881.
K. Studer, 1882.
L. Cadenat, 1938.
M. Cadenat, 1941.
N. Döderlein, 1917.
O. Darteville, 1950.
P. Cotteau, 1889.
Q. de Loriol, 1900.
R. H. L. Clark, 1925.
S. Rochebrune, 1881.
T. Fisher, 1940.
U. Marktanner-Turneretscher, 1887.
V. Verrill, 1871.
W. Perrier, 1875.
X. Madsen, 1950.
Y. Troschel, 1873.
Z. This paper.

In the keys that follow, though many characters are illustrated by the accompanying diagrams, some terms may need clarification for those unfamiliar with Echinoderms. Firstly, the words 'aboral' and 'adoral' (meaning away from and towards the mouth) apply dorso-ventrally for a more or less spherical sea-urchin but horizontally for the more flattened sea-stars, where they may be used in place of 'proximal' and 'distal'. The aboral spines of the echinoid *Arbacia* are therefore dorsal, but the aboral infero-marginal spines of *Astropecten* are those along the distal edge of the infero-marginal plate, not those most dorsal. Secondly, the 'fascioles' of heart-urchins (Spatangoida) are narrow continuous bands of small ciliated spines whose position is also clear on the denuded test and is very characteristic. Two kinds of fascioles are mentioned in the key, namely sub-anal, occurring on the posterior side of the test below the anus, and peripetalous, on the upper half of the test passing outside the tips of the petals as the name suggests.

	Cape Verde - Tangier, Canary Is.	Cape Verde Islands	Senegambia	Portuguese & French Guinea	Sierra Leone & Liberia	Ivory Coast	Gold Coast	Dahomey & Togo	Nigeria, Cameroons & Spanish Guinea	St. Thomas, Annobon, Rolas, etc.	Gaboon, French Congo & Cabinda	Angola	South-West Africa	Other localities (*Abbreviations*: A. Ascension; Az. Azores; B.B. Bay of Biscay; Br. Brazil; E. Europe; Mad. Madeira; Med. Mediterranean; IWP. Indo West-Pacific; St.H. St. Helena; S.Afr. South Africa; W.Atl. West Atlantic; W.I. West Indies)
ECHINOIDEA														
**Eucidaris tribuloides africana* Mn. ..		I	L	I	C		I			C	C			
Cidaris cidaris meridionalis Mn. ..	H		I											B.B., Mad.
**Arbacia lixula* (L.) and *f. africana* (Tr.)	L	L	L				Y		F	C		I		Med., Br.
Arbaciella elegans Mn.	E?										C	C		
Diadema antillarum Ph.	C	C			C					C				W.I.
**Centrostephanus longispinus* (Ph.) ..	L		L	I	I	I	I		I	G	I			Med., Az.
Genocidaris maculata (A.A.)			I	I	I		I				I			W.I.
Tripneustes ventricosus (Lk.)										J			C	W.I., St.H.
Paracentrotus gaimardi (Bl.)									C			B		Br.
**Echinometra lucunter* (L.)		I	L		C		I		C	C		G		W.I., St.H.
Echinocyamus pusillus (O.F.M.) ..	E	I		B	I									E.
Clypeaster rangianus D.		S			L					J		R		
**Rotula deciesdigitata* (Leske)					I	B	C	C	F					
Rotula orbiculus (L.)		I	C	L				C	F	C	B	C		
Spatangus purpureus O.F.M. ..	E		I	I			I?					I?		E., S.Afr.
Plagiobrissus africanus (V.)			H	I	V						O			
Plagiobrissus jullieni (C.)				I	P				I	J?				
Brissopsis atlantica Mn.		I			I	I			I					
Brissopsis jarli Mn.			I				I							
**Schizaster edwardsi* C.					P		I		I			I		
ASTEROIDEA														
Astropecten irregularis pentacanthus D.Ch.	E				K		X							E., Med.
Astropecten irregularis africanus K. ..	B	T	C	X	X						X			
Astropecten liberiensis K.					C									
**Astropecten michaelseni* K.					C		C	X	C		X	C		
A. michaelseni f. ambiguus Md.			X		X			X						
Astropecten spiniphorus Md.									X		X			
Astropecten aranciacus (L.)	E		C	B	X							X		Med.
Astropecten hupferi K.		'W	est	Afr	ica'									
Astropecten mamillatus K.					C		C	C						
Astropecten jarli Md.			X	X	X		X							
Astropecten guineensis K.				B										
Astropecten weberi Död.			N											
Tethyaster subinermis (Ph.)	E		X		K									Med.
Luidia africana Sl.	E		L	B	X	X								S.Afr.
**Luidia atlantidea* Md.	X	X	X	X	X		Z							
**Luidia sagamina aciculata* Mn. ..			X	X	X		X				T			St.H., Natal.
**Luidia heterozona* F.	M		X	X	X	X	X		X		T	T		
Luidia alternata numidica K.		X	X	B	X		X				C			
Goniaster cuspidatus Gray		W	X	X						C				W.Atl., IWP.
**Oreaster clavatus* M & Tr.		W	L	L	E		Z		C	C				
**Asterina stellifer* (Mob.)			B				X	C	C			C	C	
Linckia bouvieri P.		W								C				W.I., St.H., A.
Linckia guildingi Gray		W								C				All tropics.
**Narcissia canariensis* (d'O.)	L	X	L	X	X		X							
Ophidiaster ophidianus (Lk.)	X	W	X							C				Med., St.H., Az.
Chaetaster longipes (R.)	X	L			K									Med., St.H., A.
Echinaster sepositus (Gray)	L		X		X		X							Med., B.B.

	Cape Verde - Tangier, Canary Is.	Cape Verde Islands	Senegambia	Portuguese & French Guinea	Sierra Leone & Liberia	Ivory Coast	Gold Coast	Dahomey & Togo	Nigeria, Cameroons & Spanish Guinea	St. Thomas, Annobon, Rolas, etc.	Gaboon, French Congo & Cabinda	Angola	South-West Africa	Other localities
OPHIUROIDEA														
Ophiacantha angolensis K.												D		
O. angolensis f. inermis Mn.											G			
**Ophiactis lütkeni* M-T.	B	L	C		C		C			U	B	C		
**Ophiactis lymani* Lj.			C				Z	C		C				St.H., W.I.
**Ophiactis savignyi* (M. & Tr.)		U					Z			J				Cosmopolitan.
Amphiura chiajei Fo.	E										G	G		E.
Amphiura incana Lym.										G			G	S.Afr.
***Amphiura sculpta** sp. n.							Z							
Amphiura ascia (Mn.)												G		
Amphiura capensis Lj.			C									C	C	S.Afr.
A. grandisquama guineensis Mn. ..										G				
**Ophiostigma abnorme* (Lym.)							Z			C				W.I., A.
Acrocnida semisquamata (K.)				L			C							
**Amphipholis clypeata* K.							Z					C		
Amphipholis bananensis K.											B			
**Amphipholis nudipora* K.					C		C				G			
**Amphipholis squamata* (D.Ch.)	E		C				Z					C	C	Cosmopolitan.
**Amphiodia acutispina* K.						C	Z				G			
**Amphiodia* sp.							Z							
**Ophionephthys* sp.							Z							
***Amphioplus archeri** sp. n.							Z							
**Amphioplus cincta* (K.)					C		Z	C						
**Amphioplus congensis* K.				L	B	C	C	C	C		C			
Amphioplus occidentalis K.						C		C	F		C			
Amphioplus aciculatus Mn.											G			
***Amphioplus aurensis** sp. n.							Z							
**Ophiocoma pumila* Ltk.							Z			J	A			W.I.
**Ophiopsila guineensis* K.			C				Z			C				
Ophiopsila platyspina K.	?	ty	pe	loc	alit	y				G				
Ophionereis sexradia Mn.										G				
Ophiothrix fragilis (Ab.)	E			L									C	E., Med., S.Afr.
Ophiothrix nociva K.											A			
**Ophiothrix cotteaui* (de L.)					Q		Z				B	C		
**Ophiothrix congensis* K.							Z			C	B	C		
**Ophiothrix tomentosa* K.						C	Z							
**Ophiopteron atlanticum* K.			C	L			C				C	C		
**Ophioderma longicauda guineense* G. ..			B				Z			J	A			
Ophioderma appressa (Say)			C									C		W.I., Br.
Ophiarachnella africana K.		L							C					
Dictenophiura skoogi (K.)											G	D		
Ophiolepis affinis St.					K			C			C	D		
**Ophiolepis paucispina* (Say)							Z			G				W.I.
**Ophiura africana* (K.)							Z					D		

(Abbreviations : A. Ascension ; Az. Azores ; B.B. Bay of Biscay ; Br. Brazil ; E. Europe ; Mad. Madeira ; Med. Mediterranean ; IWP. Indo West Pacific ; St.H. St. Helena ; S.Afr. South Africa ; W.Atl. West Atlantic ; W.I. West Indies)

ASTEROIDEA

1.	One or both series of marginal plates very large and conspicuous, making a distinct border to the flattened disc and arms	2. Phanerozonia
1¹.	The marginal plates may form distinct and regular series but are not enlarged to form a conspicuous border to the body; dorsal surface convex	19. Spinulosa
2.	Dorsal plates paxilliform (that is, elevated and crowned with spinelets); tube feet pointed or tapering to a small disc	3
2¹.	Dorsal plates not paxilliform but flat or tabulate; tube feet with a large terminal disc	18
3.	Supero-marginal plates large, both series contributing to the border of the body	4. Astropectinidae
3¹.	Supero-marginals hardly, if at all, distinct from the neighbouring dorsal paxillae; the edge of the body is formed by the massive infero-marginals	14. *Luidia*
4.	Ventro-lateral areas large, with more than two series of plates. Reported from the Mediterranean to Liberia ..	*Tethyaster subinermis* (Philippi), 1837
4¹.	Ventro-lateral areas small, with only one or two short series of plates	5. *Astropecten*
5.	Only one large spine at the upper end of each infero-marginal plate visible in dorsal view, or if a second but smaller one is also visible, then it is aboral to the main spine (Fig. 1*a*)	6
5¹.	Two or more large spines on about the same level at the upper end of each infero-marginal, sometimes slightly oblique when seen in side view, the adoral-most, if any, being the smallest (Figs. 1*c* and *d*)	8
6.	Single central spinelets of the proximal paxillae often enlarged into conspicuous tubercles. Reported from Liberia to Dahomey	*A. mamillatus* Koehler, 1914

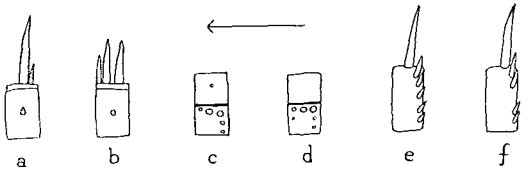


Fig. 1.

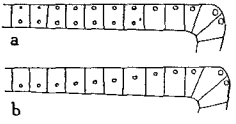


Fig. 2.

Fig. 1. (*a*) and (*b*) dorsal, (*c*) and (*d*) side, and (*e*) and (*f*) ventral views of marginal plates of some *Astropecten* species. The arrow points adorally.

Fig. 2. Proximal supero-marginal plates of (*a*) *Astropecten aranciacus* and (*b*) *A. hupferi*.

6¹.	No central paxillar spinelets noticeably enlarged ..	7
7.	The aboral spines of the infero-marginal plates form a continuous series along the edge of each plate (Fig. 1*e*); the two series of supero-marginal spines or large tubercules (i.e. those along the inner or ad-radial edge of the proximal plates and those placed centrally on the plates usually from about the fifth plate to the tip of the arm) are quite distinct from each other and may overlap (Fig. 2*a*). Reported from the Mediterranean to Angola	*A. aranciacus* (Linnaeus), 1758

7¹.	Aboral infero-marginal spines not in a continuous series but the inner one or two spines are separated by a space from the outer ones (Fig. 1*f*); the two series of supero-marginal spines merge into one another between about the fifth and the twelfth plates where the spines or tubercles are intermediate in position between the inner edge and the middle of each plate (Fig. 2*b*). The former of unknown locality beyond 'West Africa', the latter reported from French Guinea	*A. hupferi* Koehler, 1914, and *A. guineensis* Koehler, *1911
8.	In side view the spines of the dorsal-most infero-marginal row are seen to lie on the same level (Fig. 1*d*)	9
8¹.	The dorsal-most infero-marginal spines form an oblique row, the adoral one being the highest (Fig. 1*c*) ..	10
9.	Ventral surface of the infero-marginal plates bare except for the peripheral spinelets; one (rarely two) furrow spines on each adambulacral plate followed by only one or two spinelets and one or two spines. Reported from Nigeria to the Congo	*A. spiniphorus* Madsen, 1950
9¹.	Ventral surface of the infero-marginals covered with slender spinelets; three furrow spines on each adambulacral plate followed by a row of three or four spines with some smaller ones on the outer part of the plate. Reported from Gambia to the Gold Coast	*A. jarli* Madsen, 1950
10.	Madreporite very large, exceeding in diameter the length of three proximal supero-marginal plates. Reported from Senegal	*A. weberi* Döderlein, 1917
10¹.	Madreporite with diameter less than three times the length of a proximal supero-marginal plate. Reported from Senegal to Angola	11
11.	When R is 20 to 30 mm. only two unequal infero-marginal spines are visible in dorsal view; a well-developed complete series of single supero-marginal spines present (in all the specimens known) the first few being placed on the inner edges of the plates, the position gradually becoming central on the following plates. Reported from Liberia ..	*A. liberiensis* Koehler, 1914
11¹.	When R exceeds 20 mm. usually three infero-marginal spines are visible in dorsal view, the adoral one being much smaller than the other two which are more nearly equal (Fig. 1*b*); supero-marginal spines may be lacking or present on the plates after about the fourth, or there may also be spines on the inner edges of the first two or three plates	12
12.	Arms wide basally, triangular and usually evenly-tapering in shape; supero-marginal spines, if present, only from about the fifth marginals onwards; infero-marginal spinelets appressed except for the few enlarged aboral and external spines; usually appearing very flattened. Reported from Liberia to Angola, and the forma (? subspecies) *ambiguus* Madsen from Gambia	*A. michaelseni* Koehler, 1914

* I am unable to find a positive character to distinguish between these two.

12¹.	Arms narrow, even at the base ; supero-marginal spines may be present on the proximal plates or only on those from about the fifth plate onwards or absent altogether. Reported from Europe south to Gaboon	13. *A. irregularis* Pennant, 1777
13.	No supero-marginal spines. Reported from Europe to Spanish Guinea (?) (Madsen)	*A. irregularis* forma *pentacanthus* (Delle Chiaje), 1825
13¹.	Supero-marginal spines present. Reported from Mauritania to Liberia	*A. irregularis africanus* Koehler, 1911
14.	Eight to 11 arms. Reported from Mauritania to Angola ..	*L. heterozona* Fisher, 1940
14¹.	Five arms	15
15.	A few conspicuous large, isolated dorsal spines, usually on the lateral paxillae only. Reported from the Cape Verde Islands to the French Congo	*L. alternata numidica* Koehler, 1911
15¹.	No conspicuous spaced dorsal spines, though *all* the paxillae may have the central spinelet noticeably larger than the peripheral ones sometimes assuming the proportions of a small spine	16
16.	One central spinelet of each paxilla much thicker and longer than the peripheral ones ; ventro-lateral pedicellariae three-valved. Reported from Gambia to the Congo as well as St. Helena and Natal	*L. sagamina aciculata* Mortensen, 1933a
16¹.	Central spinelets of the paxillae may be a little thicker but no longer than the peripheral ones ; ventro-lateral pedicellariae two-valved	17
17.	Supero-marginal paxillae almost square and conspicuously pale in colour, forming a light stripe along each side of the arms. Reported from Mauritania to the Gold Coast ..	*L. atlantidea* Madsen, 1950
17¹.	Supero-marginal paxillae usually longer than wide, not forming a light stripe along the arms. Reported from Mauritania to the Ivory Coast as well as from South Africa, the type locality	*L. africana* Sladen, 1889
18.	Dorsal plates flat and covered with a layer of very fine granules ; dorsally the pore areas between the plates are very conspicuous ; ventral plates with large single tubercles projecting from the surface. Reported from the Cape Verde Islands to the Cameroons	*Oreaster clavatus* Müller and Troschel, 1842
18¹.	Dorsal plates tabulate, with peripheral granules only, the pores not grouped into areas but occurring inconspicuously in the interstices between the plates ; ventral plates covered with a flat layer of granules. Reported from the Cape Verde Islands to Rolas Island	*Goniaster cuspidatus* Gray 1840
19.	Edge of disc and arms sharp, arms very short, disc large. Reported from Senegal to South-West Africa	*Asterina stellifer* (Möbius) 1859
19¹.	Arms and disc rounded between dorsal and ventral surfaces ; disc small and arms rather long	20

20. Dorsal plates forming a network and bearing single small cylindrical spines. Reported from Mauritania to the Gold Coast as well as from the Mediterranean and Bay of Biscay — *Echinaster sepositus* (Gray), 1840

20¹. Dorsal plates not forming a network but sometimes in regular rows and covered with a continuous layer of granules or spinelets 21

21. Dorsal plates irregular in size and position 22

21¹. Dorsal plates in very regular longitudinal and transverse series 24

22. Adambulacral armature spiniform, projecting beyond the level of the ventral granulation ; arms triangular in cross section with a dorsal crest. Reported from the Canary Islands and from Mauritania to the Gold Coast .. .. — *Narcissia canariensis* (d'Orbigny), 1839

22¹. Furrow spines very short, almost granuliform, not projecting; arms nearly cylindrical .. .. 23. *Linckia*

23. Dorsal plates varying considerably in size, the larger ones may be several millimetres in diameter. Reported from Annobon, St. Thomas, and the Cape Verde Islands (type locality), as well as from the West Indies, St. Helena, and Ascension .. .. — *L. bouvieri* Perrier, 1875

23¹. Dorsal plates not very variable in size. Reported from the Cape Verde Islands and St. Thomas as well as elsewhere in the tropics of all the oceans .. .. — *L. guildingi* Gray, 1840

24. Plates granule-covered. Reported from the Mediterranean to Senegal and from St. Thomas and Rolas Island .. — *Ophidiaster ophidianus* (Lamarck), 1816

24¹. Plates thickly covered with fine spinelets. Reported from the Mediterranean to the Cape Verde Islands, Ascension, and St. Helena, and from Liberia .. .. — *Chaetaster longipes* (Retzius), 1805

OPHIUROIDEA

1. Apex of each jaw bearing a cluster of small tooth papillae (Figs. 3*a* and *b*) 2

1¹. Apex of each jaw with a single oral papilla, a pair of equal papillae, or sometimes one to three irregularly placed papillae (Figs. 3*c* and *d*, 4*a* and *b*) 10

2. Oral papillae present on the sides of the oral plates as well as the apical tooth papillae which are little, if at all, smaller (Fig. 3*a*) .. .. 3. Ophiocomidae

2¹. No oral papillae present ; the apical cluster of small, blunt tooth papillae very compact (Fig. 3*b*) .. .. .. 5. Ophiotrichidae

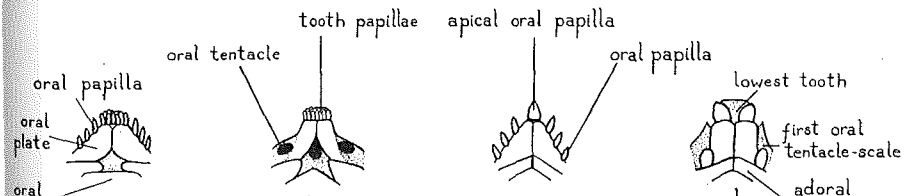


Fig. 3. Diagrams of jaw-angles of Ophiuroids : (*a*) *Ophiocoma*, (*b*) *Ophiothrix*, (*c*) *Ophiacantha*, and (*d*) *Amphiura*.

3. The inner of the two tentacle-scales extraordinarily enlarged so that it crosses over its fellow from the other side giving the appearance of crossed swords on each ventral arm-plate (Fig. 4*c*) .. .. 4. *Ophiopsila*

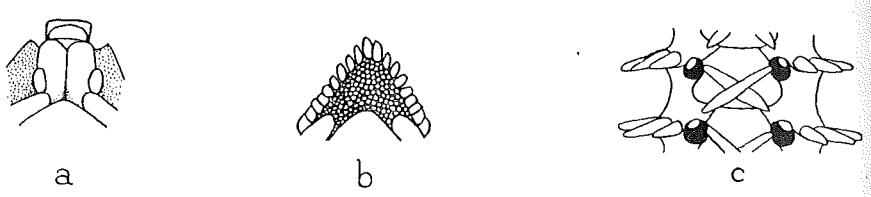


Fig. 4. Jaw-angles of (*a*) *Ophiactis* and (*b*) *Ophiarachnella*. (*c*) An arm joint of *Ophiopsila* in ventral view.

3¹. Tentacle-scales not enlarged or peculiar. Reported from the Gold Coast to the Congo .. .. *Ophiocoma pumila* Lütken, 1859

4. Arm-spines markedly flattened and spatulate, also the inner tentacle-scales. Reported from Annobon .. .. *O. platispina* Koehler, 1914

4¹. Arm-spines cylindrical or slightly tapering. Reported from Senegal to Rolas Island and Annobon .. .. *O. guineensis* Koehler, 1914

5. Arm-spines joined by a web of skin. Reported from Senegal to Angola .. .. *Ophiopteron atlanticum* Koehler, 1914

5¹. Arm-spines not webbed, or only in very young specimens with the disc diameter less than 2 mm. .. .. .. 6. *Ophiothrix*

6. Disc covered with very short stumps, hardly, if at all, longer than thick, having the appearance of granules .. 7

6¹. Disc covered by stumps with thorny spines intermingled, or with short similar spines 8

7. Disc stumps placed sparsely on the disc scales and also on the radial shields; similar stumps on the dorsal arm-plates. Reported from the Ivory and Gold Coasts .. *O. tomentosa* Koehler, 1914

7¹. Disc stumps placed densely on the dorsal disc scales only, leaving the large radial shields conspicuously bare; dorsal arm-plates without granules. Reported from Liberia to Angola .. .. *O. cotteaui* (de Loriol), 1900

8. Radial shields bare and conspicuous; dorsal arm-plates rhombic (Fig. 5*a*). Reported from Europe to French Guinea and from South-West Africa .. .. .. *O. fragilis* (Abildgaard), 1789

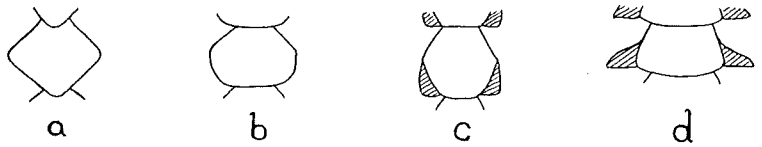


Fig. 5. Dorsal arm plates of (*a*) *Ophiothrix fragilis*, (*b*) *Ophiothrix congensis*, (*c*) *Ophionereis sexradia* and (*d*) *Ophiolepis affinis*. The supplementary plates are shaded.

8¹.	Stumps or short spines also occurring on the radial shields ; dorsal arm-plates with the distal edge rounded or straight, lacking a distinct apex (Fig. 5*b*)	9
9.	Disc covered with short stumps and a few scattered spines. Reported from the Congo	*O. nociva* Koehler, 1907
9¹.	Disc covered with short, similar, thorny spines. Reported from the Gold Coast to Angola	*O. congensis* Koehler, 1911
10.	A pair of almost triangular supplementary dorsal arm-plates bordering the lateral edges of the distal half of each dorsal arm-plate (Fig. 5*c*) and a single large, oval tentacle-scale ; no apical oral papilla usually ; radial shields small and not very conspicuous, disc scaling very fine. Reported from off Annobon	*Ophionereis sexradia* Mortensen, 1936
10¹.	Supplementary dorsal arm-plates very rarely present, if they do occur (*Ophiolepis*, Fig. 5*d*) then there are two large tentacle-scales and the disc scales are large and small intermingled, the small ones encircling the large	11
11.	Apex of each jaw bearing a symmetrical pair of oral papillae placed close together (Figs. 3*d* and 6) below the lowest tooth ; other oral papillae also usually very symmetrical in size and position	12. Amphiuridae
11¹.	Apex of each jaw with a single papilla or one to three irregularly-placed papillae, not a symmetrical pair (Figs. 3*c*, 4*a* and *b*)	31
12.	No oral papillae on the sides of the oral plates so that the first oral tentacle-scales can be seen higher up in the mouth slit (Fig. 3*d*) ; one (rarely two) distal papillae placed on the adoral shields or at their point of junction with the oral plates	13
12¹.	Two or three (rarely four) oral papillae on the sides of the oral plates in series with the infra-dental ones, the outermost may be partly or completely based on the adoral shield (Fig. 6)	19
13.	Ventral and marginal disc scales very small, thickened and conical as if each bears a tubercle. Reported from French Guinea and the Gold Coast	*Acrocnida semisquamata* (Koehler), 1914
13¹.	Ventral disc scales not tubercular	14. *Amphiura*
14.	Two distal oral papillae on each adoral shield, the inner one spiniform ; no tentacle scales. Reported from Angola	*A. ascia* (Mortensen), 1936
14¹.	One distal oral papilla ; one or two tentacle-scales ..	15
15.	One tentacle-scale ; distal oral papilla not widened basally	16
15¹.	Two tentacle-scales ; distal oral papilla wider than long	17
16.	Six to eight flattened arm-spines proximally ; ventral arm-plates with straight or slightly concave distal edges. Reported from Senegal and Angola as well as South Africa	*A. capensis* Ljungman, 1867
16¹.	Five or six tapering arm-spines proximally ; ventral arm-plates with convex, continuously curved distal edges. Reported from Annobon	*A. grandisquama guineensis*, Mortensen, 1936

17. Disc scales conspicuously thickened, variable in size, the five primary radials with radially-directed grooves ; dorsal arm-plates wide elliptical. Reported from the Gold Coast — *A. sculpta* sp.n.

17¹. Disc scales not thickened, disc smooth in outline, plates not sculptured .. .. — 18

18. Four to six tapering arm-spines ; dorsal arm-plates wide with sharp distal angles. Reported from the north-east Atlantic, the French Congo, and Angola .. .. .. — *A. chiajei* Forbes, 1843

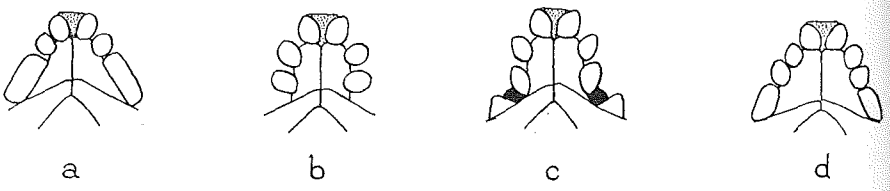


Fig. 6. Jaw-angles of (*a*) *Amphipholis*, (*b*) *Amphiodia*, (*c*) *Amphioplus cincta* (showing the oral tentacles in black) and (*d*) *Amphioplus aurensis*.

18¹. Up to eight short, flattened arm-spines ; dorsal arm-plates squarish with rounded corners, narrow. Reported from South Africa and Annobon .. .. — *A. incana* Lyman, 1879

19. Three oral papillae on each side (including the infra-dental one), the outermost about twice as wide as the other two (Fig. 6*a*) .. .. — 20

19¹. Three or four oral papillae, when three the outermost is not twice as wide as the next one to it (Fig. 6*b* to *d*) .. .. — 23

20. Scattered conical spines present on the disc. Reported from the West Indies and Ascension as well as from the Cape Verde Islands to the Gold Coast and St. Thomas .. — *Ophiostigma abnorme* (Lyman), 1878

20¹. Disc without spines .. .. — 21. *Amphipholis*

21. No tentacle-scales. Reported from Liberia to the French Congo .. .. — *A. nudipora* Koehler, 1914

21¹. Two tentacle-scales .. .. — 22

22. Oral shields longer than wide. Reported from the Gold Coast to Angola .. .. — *A. bananensis* Koehler, 1911, and *A. clypeata* Koehler, 1914

22¹. Oral shields as wide as, or wider than, long. Cosmopolitan — *A. squamata* (Delle Chiaje), 1828

23. Three oral papillae only (Fig. 6*b*) .. .. — 24. *Amphiodia*

23¹. Four oral papillae each side .. .. — 25

24. Third (distal-most) oral papilla peg-like, not wide-based and tapering ; ventral arm-plates narrowing distally. Reported from the Gold Coast .. .. — *Amphiodia* sp. (see text)

24¹. Third oral papilla very widely basally and tapering to an acute tip ; ventral arm-plates not tapering distally. Reported from the Ivory Coast to the French Congo .. — *A. acutispina* Koehler, 1914

25. Arm spines with large, distally-directed hooks ; oral shields with almost semicircular proximal half ; disc unknown. Reported from the Gold Coast .. .. — *Ophionephthys* sp. (see text)

25¹. Arm spines lacking big hooks although sometimes truncated ; oral shields with a distal proximal angle .. 26. *Amphioplus*

26. Oral papillae mostly conical and spaced, the third one much elongated and spiniform ; one tentacle-scale. Reported from the French Congo .. .. *A. aciculatus* Mortensen, 1936

26¹. Oral papillae short and blunt ; two tentacle-scales .. 27

27. The third or fourth oral papilla larger than the others, the papillae themselves being in a straight row capable of closing the mouth slit (Fig. 6*d*) 28

27¹. Oral papillae similar in size, arranged in a concave row often with a space between the third and fourth (Fig. 6*c*) 29

28. The third oral papilla almost twice as wide as the fourth ; tentacle-scales very large. Reported from Senegambia to Cabinda .. .. *A. congensis* (Studer), 1884

28¹. The fourth oral papilla much larger than the other three ; tentacle-scales small. Reported from the Gold Coast .. *A. aurensis* sp.n.

29. Arm-spines eight proximally (when the disc diameter exceeds 5 mm.), five on most arm joints. Reported from the Gold Coast .. .. *A. archeri* sp.n.

29¹. Arm-spines four or five proximally, only three on most joints 30

30. Disc naked below. Reported from Liberia to the French Congo .. .. *A. occidentalis* Koehler, 1914

30¹. Disc completely scaled below. Reported from Liberia to Dahomey .. .. *A. cincta* (Koehler), 1914

31. A single wide, blunt apical papilla on each jaw (Fig. 4*a*), widely separated from the one or two distal oral papillae which arise from the adoral shields ; one tentacle-scale ; disc usually with scattered spines, especially around the margin .. .. 32. *Ophiactis*

31¹. One or several, usually conical apical papillae in series with others along the sides of the oral plates and the radial ends of the adoral shields (Figs. 3*c* and 4*b*) .. 34

32. Radial shields very conspicuous, usually more than half the disc radius in length ; normally two distal oral papillae each side ; typically six arms. 'Tropicopolitan'.. *O. savignyi* (Müller and Troschel), 1842

32¹. Radial shields not more than one-third of the disc radius in length ; normally one distal oral papilla on each side ; five or six arms 33

33. Usually six arms, sometimes five, often reproducing by regeneration of divided specimens ; disc scales rather variable in size. Reported from the West Indies and St. Helena and from Senegal to Dahomey and Rolas Island .. .. *O. lymani* Ljungman, 1871

33¹. Usually five arms, rarely reproducing asexually ; disc scales rather uniform in size (except for the larger centrodorsal plate). Reported from Mauritania to Angola .. *O. lütkeni* Marktanner-Turneretscher, 1887

34. Disc covered with spines, often very short and thorny-tipped ; arm-spines long and projecting. Reported from the French Congo and Angola .. .. *Ophiacantha angolensis* Koehler, 1923

34¹. Disc either covered with granules or bare ; arm-spines short and appressed 35

35. Disc covered with granules ; arms long, not tapering for some distance beyond the disc 36

35¹. Disc plates naked, often arranged symmetrically ; arms short and tapering immediately from the base 38

36. Radial plates and three other shields at the base of each arm left bare, also an interradial plate ; two genital slits in each interbrachial area ; oral shields with a distal supplementary piece. Reported from the Cape Verde Islands as well as from the Cameroons (type locality) .. *Ophiarachnella africana* Koehler, 1914

36¹. Only the radial shields if any plates left bare ; four genital slits in each interbrachial area, two on each side ; no supplementary oral shields .. .. .. 37. *Ophioderma*

37. Radial shields either bare or granule-covered ; oral shields also covered, as well as the oral and adoral plates ; Some dorsal arm-plates may be divided into two or more pieces ; 10–14 arm-spines in the adult (the disc diameter may exceed 20 mm.). Reported from Senegal to the French Congo .. .. *Ophioderma longicauda guineense* Greeff, 1881

37¹. Radial shields always granule-covered ; oral shields bare ; dorsal arm-plates undivided ; eight to nine arm-spines. Reported from Senegal and Angola as well as from the West Indies and Brazil .. .. *Ophioderma appressa* (Say), 1825

38. Disc scales of two very different sizes, the small ones being arranged in regular rings around the larger ones ; supplementary latero-dorsal arm-plates present (Fig. 5*d*) ; ventral arm-plates large, contiguous, at least proximally ; two large tentacle-scales on all the pores together making an oval which can completely close the pore .. .. 39. *Ophiolepis*

38¹. The smaller disc scales are not arranged in rings around the larger ones ; no supplementary arm-plates ; ventral arm-plates very small, not contiguous ; tentacle-scales reduced to one small one after the first few joints .. 40

39. The larger disc scales conspicuously thickened at the edges ; radial shields similar in size to the larger disc plates. Reported from the Gold Coast, Annobon, and Rolas Island as well as from the West Indies .. .. *O. paucispina* (Say), 1825

39¹. Disc scales not thickened at their edges, forming a fairly smooth surface ; radial shields distinctly larger than the other disc plates. Reported from Liberia to Angola .. *O. affinis* Studer, 1882

40. The two arm-combs at the base of each arm are separated widely by an intermediate pair of plates bearing a series of small papillae on each side facing the main arm-combs (Fig. 7). Reported from the Congo and Angola .. *Dictenophiura skoogi* Koehler, 1923

40¹. No secondary arm-comb or intermediate plates separating the ordinary arm-combs from each other and from the first dorsal arm-plate (Fig. 23). Reported from the Gold Coast as well as Angola .. .. *Ophiura africana* (Koehler), 1923

ECHINOIDEA

1.	Anus dorsal, within the apical system, mouth in the centre of the ventral surface; test usually circular in outline (oval in *Echinometra*)	2. 'Regularia'
1¹.	Anus posterior or ventral, not within the apical system; test distinctly bi-laterally symmetrical	12. 'Irregularia'
2.	Plates of test extending over the peristome in a continuous series to the mouth; primary spines very large, stout and spaced, conspicuously different from the small secondary ones, some of which encircle them (Pl. II) ..	3. Cidaroida
2¹.	Peristome skin-covered, with only a few plates embedded; primary spines not regularly ringed by much smaller secondary ones	5
3.	Primary spines with *c.* 12–16 longitudinal ridges; smaller secondary spines usually erect; peristome distinctly smaller than the apical system; denuded test white. From depths of 50 m. or more. (Senegal is possibly the southern limit of its distribution)	*Cidaris cidaris meridionalis* Mortensen, 1928
3¹.	Primary spines with *c.* 18 longitudinal ridges; secondary spines usually appressed; peristome about the same size as the apical system; denuded test greenish. Littoral as well as from deeper water. Reported from the Cape Verde Islands to the Congo	4. *Eucidaris tribuloides africana* Mortensen, 1909
4.	Primary spines cylindrical or only slightly tapering, mostly ending abruptly in a crown which may be thicker than the shaft. Littoral	*africana* typical form
4¹.	Primary spines markedly tapering to quite acute tips (Pl. II). From depths of about 40 m. or more	*africana* forma *attenuata* f.n.

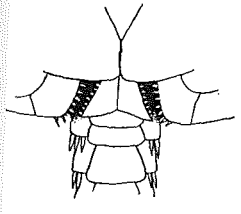


Fig. 7.

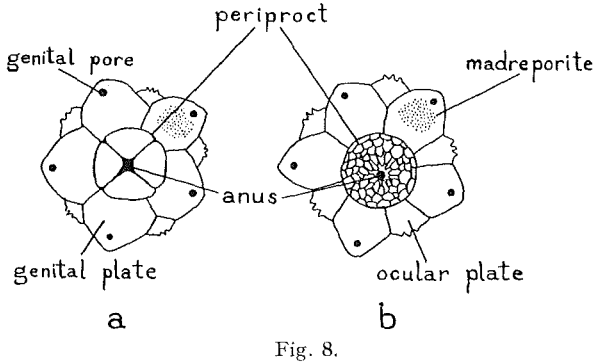


Fig. 8.

Fig. 7. *Dictenophiura*. Dorsal view of the base of an arm.

Fig. 8. Apical systems of (*a*) *Arbacia lixula* with all the ocular plates exsert and (*b*) *Tripneustes ventricosus* with three oculars insert.

5.	Periproct covered by four (rarely five or six) large triangular valves (Fig. 8*a*)	6
5¹.	Periproct covered by numerous small, usually irregular plates (Fig. 8*b*)	7

6. Primary spines wide, tapering abruptly just below the tip, completely absent from the aboral surface; small, the horizontal diameter usually less than 10 mm. Reported from the French Congo and Angola and (?) Mauritania .. .. *Arbaciella elegans* Mortensen, 1910

6¹. Spines slender, usually elongate, though the aboral ones may be abruptly shorter than those at the ambitus and below it; test diameter up to about 50 mm. Reported from Mauritania to Angola, as well as the Mediterranean and Brazil .. .. *Arbacia lixula* (Linnaeus) 1758

7. Spines very long, usually at least one and a half times the horizontal diameter of the test in length. From depths of about 50 m. or more 8

7¹. Spines short, forming a dense coat over the whole surface, though equalling the test diameter in some specimens of *Echinometra lucunter*, which is distinguished by having the test oval. Littoral or from deeper water 9

8. Spines present on the buccal plates; globiferous pedicellariae present; primary spines banded purple and yellow or greenish. Reported from Mauritania to the Congo .. *Centrostephanus longispinus* (Philippi), 1845

8¹. No spines on the buccal plates; no globiferous pedicellariae; spines banded black and white in young specimens, uniformly dark coloured in larger ones. Reported from Mauritania to Liberia, Annobon, and Rolas Island *Diadema antillarum* (Philippi), 1845

9. Either very small forms (not known larger than 13 mm. test diameter) with the test sculptured, having rings of depressions round the primary spines (Fig. 9*a*) or larger forms (with test sometimes exceeding 100 mm. in diameter) having deeply incised gill slits (Fig. 9*b*) .. 10

9¹. Size variable; test not sculptured; gill slits not deeply incised (Fig. 9*c*) 11

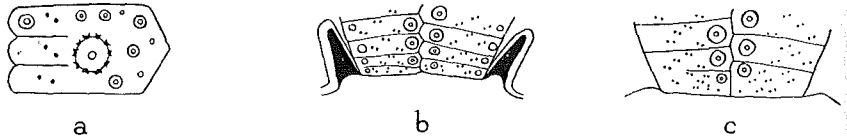


Fig. 9. (*a*) Ambulacral plate of *Genocidaris maculata*, (*b*) lower end of ambulacrum of *Tripneustes ventricosus* and (*c*) of *Echinometra lucunter*.

10. Small forms, test diameter not known to exceed 12·7 mm.; pore pairs in a single vertical series; gill slits inconspicuous; all the ocular plates exsert (as in Fig. 8*a*); globiferous pedicellariae with an unpaired lateral tooth (as in Fig. 10*b*); test sculptured mainly with rings of pits round each primary tubercle (Fig. 9*a*). Reported from Senegal to the Congo .. .. *Genocidaris maculata* A. Agassiz, 1869

10¹. Test diameter up to about 120 mm.; pore pairs usually in three vertical series (Fig. 9*b*); gill slits sharp and deep; two (or three) of the oculars insert (Fig. 8*b*); globiferous pedicellariae without lateral teeth; test not sculptured. Reported from St. Thomas as well as from the West Indies and St. Helena .. .. *Tripneustes ventricosus* (Lamarck), 1816

11.	Test ambitus circular ; valves of the globiferous pedicellariae almost triangular with the base tapering in to the neck and a pair of lateral teeth near the tip (Fig. 10*a*). Reported from Spanish Guinea and Angola as well as Brazil	*Paracentrotus gaimardi* (de Blainville), 1825
11¹.	Ambitus usually oval ; valves of the globiferous pedicellariae with the base rectangular and the narrow neck projecting abruptly from it ; a lateral tooth on one side only (Fig. 10*b*). Reported from the Cape Verde Islands to Angola as well as the West Indies and St. Helena ..	*Echinometra lucunter* (Linnaeus), 1758

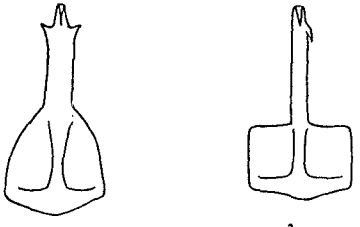


Fig. 10. Valves of globiferous pedicellariae of (*a*) *Paracentrotus* and (*b*) *Echinometra*.

12.	Mouth central ; dental apparatus present ; test flat and discoidal if not very small forms with ovoid test	13. Clypeastroida
12¹.	Mouth towards the anterior end ; no dental apparatus ; test ovoid, not very flattened	16. Spatangoida
13.	Test not discoidal ; size small (length normally much less than 20 mm.). Reported from Europe and as far south as Sierra Leone	*Echinocyamus pusillus* (O.F. Müller), 1776
13¹.	Test almost discoidal, sometimes slightly elevated centrally ; the adult exceeds 20 mm. in length	14
14.	Test rounded pentagonal in outline. Reported sporadically from the Cape Verde Islands to Angola	*Clypeaster rangianus* Desmoulins, 1835
14¹.	Test with finger-like processes posteriorly, or in young specimens with the posterior half of the edge scalloped ..	15. *Rotula*
15.	Two anterior lunules or slits within the test. Reported from Liberia to the Cameroons	*R. deciesdigitata* (Leske), 1778
15¹.	No lunules. Reported from the Cape Verde Islands to Angola	*R. orbiculus* (Linnaeus), 1758
16.	No closed sub-anal fasciole present ; only two genital pores ; test very high posteriorly ; apical area towards the posterior end and the frontal ambulacrum very long, wide, and deep. Reported from Liberia to Angola ..	*Schizaster edwardsi* Cotteau, 1889
16¹.	A closed sub-anal fasciole present ; four genital pores ; apical area about the middle of the length or anterior ..	17
17.	No peripetalous fasciole. Reported from Europe to South Africa, sporadically in West Africa	*Spatangus purpureus* O.F. Müller, 1776

17¹.	Peripetalous fasciole present	18
18.	No enlarged tubercles within the peripetalous fasciole which is markedly concave between the antero-lateral and the posterior petals	19. *Brissopsis*
18¹.	Enlarged tubercles very conspicuous within the peripetalous fasciole which is similar in shape to, though a little smaller than the ambitus	20. *Plagiobrissus*
19.	Globiferous pedicellariae without thorns on the outsides of the valves ; the first ambulacral plate making part of the sub-anal fasciole is the sixth. Reported from the West Indies and the Mediteranean to Spanish Guinea ..	*B. atlantica* Mortensen, 1907
19¹.	Globiferous pedicellariae with conspicuous thorns on the outsides of the valves ; the seventh posterior ambulacral plate is the first to come into the sub-anal fasciole. Reported from the Gold Coast and Senegal	*B. jarli* Mortensen, 1951
20.	A frontal depression or groove present ; some primary tubercles occur dorsally in the posterior inter-ambulacrum. Reported from Senegal to Gaboon ..	*P. africanus* (Verrill), 1871
20¹.	Frontal ambulacrum not at all depressed ; no primary tubercles in the posterior interambulacrum dorsally. Reported from the Gulf of Guinea	*P. jullieni* (Cotteau), 1889

(*Note.*—Reference lists given are not necessarily complete)

I. ASTEROIDEA

ASTROPECTEN MICHAELSENI Koehler

Astropecten michaelseni Koehler, 1914 : 144, Pl. 4, Figs. 3–6, 8–11, Pl. 5, Figs. 1, 2, 13, 16, 17; Dilwyn John, 1948 : 502 ; Madsen, 1950 : 173, Text-fig. 1, Pl. 14, Fig. 3.
Astropecten dahomensis Döderlein, 1917 : 77, Pl. 16, Figs. 3*a–d*.

MATERIAL. Many stations off Accra, 7–51 m.—105 specimens, those from deeper water mainly juveniles.

REMARKS. A comparison of the moderate- to large-sized specimens of *michaelseni* with the available material of *A. irregularis africanus* indicates that the latter has the arms basally narrower, particularly in middle-sized specimens with R = 40–70 mm. Six such specimens of *africanus* had R/br averaging 4·6/1 (br being the breadth of the arm at the level of the sutures between supero-marginals 1 and 2 on each side). In 10 specimens of *michaelseni* of comparable size the average ratio was 3·6/1. Thus when R is about 60 mm. in *africanus* br is 12–13 mm., but in *michaelseni* 14–16 mm. When R is about 100 mm., br is only 16–18 mm. in three specimens of *africanus* but 18·5–21 mm. in fourteen specimens of *michaelseni*. I cannot be certain of the identification of some of the very young specimens tentatively assigned to this species. Madsen has named some juvenile Astropectens from off the Gold Coast, *A. irregularis* forma *pentacanthus*, a form closely related to *A. michaelseni*.

RANGE. Gambia to Angola in 6–51 m.

LUIDIA ATLANTIDEA Madsen

Luidia atlantidea Madsen, 1950 : 192, Text-fig. 5, Pl. 16, Figs. 1 and 2.

MATERIAL. Five stations off Accra, about 10–13 m.—five specimens.

REMARKS. The colour of the dorsal side of the spirit specimens varies from grey to light brown, usually with a narrow dark mid-radial stripe and a conspicuous white stripe on each side of the arms made by the supero-marginal plates, as described by Madsen. Three of the specimens are very large with R about 200 mm.

RANGE. This record extends the range of the species to the south-east. The 'Atlantide' material came from Morocco, the Cape Verde Islands, and south only to Sierre Leone. It is known from depths of 10–80 m.

LUIDIA SAGAMINA ACICULATA Mortensen

Luidia aciculata Mortensen, 1933a : 425, Text-fig. 7, Pl. 20, Figs. 7–12 ; Fisher, 1940 : 268, Fig. M5.
Luidia sagamina var. *aciculata*, Madsen, 1950 : 199, Text-figs. 6 and 7.

MATERIAL. St. 117, off Accra, 64 m.—two specimens.

REMARKS. This species is distinguishable from the other West African Luidias by the enlarged central spines of the dorsal paxillae, well figured by Madsen, although it superficially resembles *Luidia africana* in the dark colour of the bases of the marginal spines. *L. alternata numidica* Koehler has a very large conspicuous spine, much larger than those of *aciculata*, on a few of the paxillae, particularly laterally. It is not represented in this collection although the 'Atlantide' took a specimen from off the eastern end of the Gold Coast.

RANGE. Cape Verde to Cape Lopez (French Congo), in 32–95 m. (Madsen).

LUIDIA HETEROZONA Fisher

Luidia heterozona Fisher, 1940 : 265, Fig. M4, Pl. 23 ; Madsen, 1950 : 203.
Luidia mortenseni Cadenat, 1941 : 53, Figs. 1–3.

MATERIAL. Sts. 117 and 133, off Accra, 51–64 m.—nine specimens ; Buchanan st. D 1, 45+m.—two juvenile specimens.

REMARKS. This many-rayed species was taken in the same haul as the five-armed *L. sagamina aciculata*. The 'Atlantide' has shown that it is very widespread off West Africa.

RANGE. Cap Blanc to Angola in 50–100 m. (Madsen).

OREASTER CLAVATUS Müller and Troschel

Oreaster clavatus Müller and Troschel, 1842 : 49 ; Döderlein, 1936 : 321, Pl. 21, Figs. 7–9 ; Madsen, 1950 : 212.
Asterias dorsata Linnaeus, 1753 : 114, Pl. 9, Fig. 2. (Not included in the Systema Naturae Ed. 10, 1758.)
Pentaceros dorsatus, Koehler, 1914 : 168.

MATERIAL. Two miles beyond Densu, two miles offshore, 15 m.—one specimen.

REMARKS. The single specimen collected by Mr. Bassindale is immature. The 'Challenger' took some very large ones in the Cape Verde Islands with R nearly 150 mm. The species has not previously been recorded from the Gold Coast, although it was known from north-west and south-east of it.

RANGE. The Cape Verde Islands to the Cameroons, from the shore down to about 15 m.

NARCISSIA CANARIENSIS (d'Orbigny)

Asterias canariensis d'Orbigny, 1839 : 148, Pl. 1, Figs. 8–15.
Narcissia canariensis, Koehler, 1909 : 91, Pl. 7, Figs. 1 and 2, Pl. 20, Fig. 6 ; Madsen, 1950 : 216, Text-fig. 11.

MATERIAL. Sts. 111, 117, 131, and 132, off Accra, 37–64 m.—26 specimens ; Buchanan st. D 1, 45+m.—two juvenile specimens.

RANGE. The 'Atlantide' has already shown that this species extends to the western end of the Gold Coast. It is otherwise known from the Canary Islands and various points between the Cape Verde Islands and the Gold Coast, in 0–*c.* 100 m.

ASTERINA STELLIFER (Möbius)

Asteriscus stellifer Möbius, 1859 : 4.
Asterina stellifer, Bell, 1893 : 25 ; Madsen, 1950 : 213.
Asterina marginata Valenciennes, manuscript ; Hupé (nom. nud.), 1857 ; Koehler, 1914 : 171, Pl. 6, Figs. 9–13.

MATERIAL. Many shore stations, Tenpobo, Winneba, Axim, Apam, Christiansborg, Princes Town—*c.* 110 specimens.

REMARKS. Out of all these specimens four are six-rayed. This is obviously the common littoral sea-star of the Gold Coast. It was not taken at any of the offshore stations.

RANGE. Brazil and the Canary Islands to Luderitz Bay in South-West Africa from the shore down to about 18 m.

II. OPHIUROIDEA

OPHIACTIS LÜTKENI Marktanner-Turneretscher

Text-fig. 11

Ophiactis lütkeni Marktanner-Turneretscher, 1887 : 298, Pl. 12, Figs. 7 and 8.
Ophiactis africana Koehler, 1911 : 17, Pl. 3, Figs. 4 and 5 ; 1914 : 182.

MATERIAL. Off Chorkor, 14 m.—48 specimens ; two miles off Densu, 15 m.—49 specimens ; Accra, shore—one specimen ; Densu—one specimen ; 15 miles from Accra, beyond Densu, on rocks and gorgonians—one specimen ; one mile offshore, two miles west of Densu, 7 m.—eight specimens ; Princes Town, shore—one specimen ; Apam, shore—one specimen ; Axim, Hospital reef—three specimens ; Winneba, neap tide—one specimen ; Christiansborg, Accra—four specimens ; Buchanan st. 55—one specimen.

REMARKS. The abundance of disc spines is extremely variable in these specimens, some of them having a very few spines only around the edge of the disc or even none at all, while others have more numerous and larger spines particularly on the ventral side (Figs. 11*a* and *b*). Thus one extreme form, with the disc completely bare, resembles Marktanner-Turneretscher's type of *Ophiactis lütkeni* while the very spiny form is like Koehler's type of *O. africana*. The majority of specimens have a few small scattered spines around the edge of the disc. However, specimens from any one station may show a tendency in one direction or the other with regard to this character. For instance, the two first stations in the list above are only about six miles distant from one another, but specimens from one station (Chorkor) all have some disc spines, which may be as prominent ventrally as in the type of *O. africana*, while in those from off Densu, 12 specimens out of 22 examined have no disc

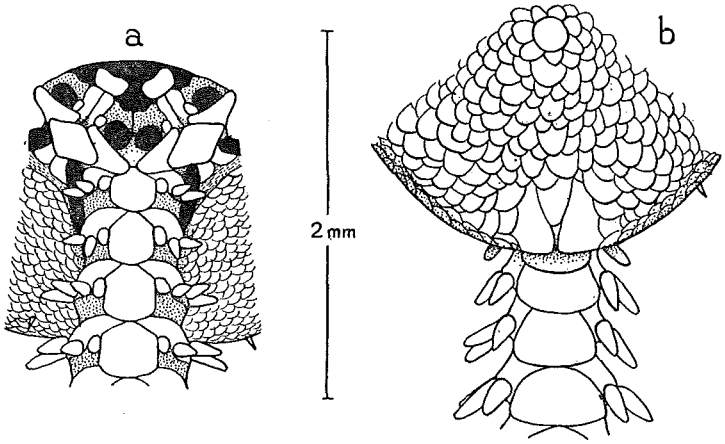


Fig. 11. *Ophiactis lütkeni* Marktanner-Turneretscher. (*a*) Ventral and (*b*) dorsal views of part of the disc and the base of an arm.

spines at all and none of the others has many. The intermediate specimens from the two stations are indistinguishable. Koehler (1914) remarked on the close resemblance of *africana* and *lütkeni*, but his more limited material apparently included no specimens completely lacking in disc spines. There is also some variation in the proportions and thickness of the ventral disc scales, which seems to be connected with the sexual maturity, for it is particularly in the 'ripe' specimens with distended discs that the ventral scales appear to be most delicate and even partly lacking towards the oral shields. Possibly there is a seasonal development of skin in this area which allows for expansion of the disc when the genital products are mature.

This is a five-armed species of *Ophiactis*. I have seen only one specimen in process of regeneration, and this had only two large arms with three diminutive ones. A few specimens were taken together with *Ophiactis savignyi*, which is easily distinguished by its much larger radial shields, two distal oral papillae and usually six-armed form.

COLOUR. Some of these preserved specimens have dark brownish markings on the disc and bands at intervals on the dorsal sides of the arms while others are pale. However a darker spot on the inner end of each radial shield is usually distinct even in the otherwise pale specimens.

RANGE. Reported sporadically from Senegal to Angola, from shore level down to 15 m. depth.

OPHIACTIS LYMANI Ljungman

Text-fig. 12

Ophiactis lymani Ljungman, 1871 : 629 ; Koehler (? *lymani*), 1909 : 172, Pl. 28, Figs. 9 and 10 ; 1926 : 24, Pl. 5, Figs. 1 and 2 ; Mortensen, 1933a : 442, Text-fig. 15 (non *O. lymani* H. L. Clark, 1918).

Ophiactis mülleri Koehler, 1914 : 184, Pl. 7, Figs. 9 and 10 (non *O. mülleri* Lütken).

MATERIAL. Sts. 111, 112, and 132, off Accra in 43–44 m.—14 specimens.

DIAGNOSIS. A species of *Ophiactis* with usually six arms (rarely five) ; radial shields equal in length to about one-third of the disc radius ; dorsal disc scales usually rather unequal in size ; disc spines mainly peripheral and ventral, with a hyaline tip, at least in specimens from West Africa and St. Helena ; oral shields very variable in shape, oval, quadrangular, or pentagonal with rounded corners, they may be longer or shorter than wide ; adoral shields mainly lateral to the orals sometimes just meeting interradially ; one distal oral papilla on each side ; dorsal arm-plates fan-shaped ; ventral arm-plates pentagonal with the proximal angle truncated and distal side slightly concave (in West Indian and West African specimens), or slightly convex (in specimens from St. Helena) ; four arm-spines, the middle ones especially being blunt-tipped, distally the lowest spine becomes hook-shaped at the tip ; one oval tentacle scale.

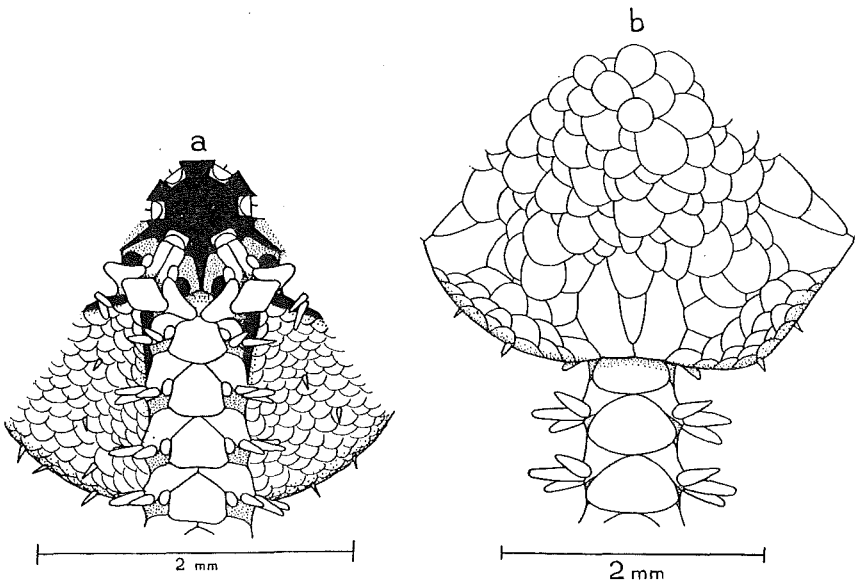


Fig. 12. *Ophiactis lymani* Ljungman. (*a*) Ventral and (*b*) dorsal views of part of the disc and the base of an arm.

REMARKS. These specimens are similar to the one mistakenly named *O. mülleri* and figured by Koehler (1914) as well as to his photograph of the type of *O. lymani* (1926). Neither of these photographs shows very well the radial shields which appear to be rather short and not much larger than the disc scales around them. They have this form in a few of these Gold Coast specimens also, including one from off Dixcove from an earlier collection, which

is peculiar in having only a single, short, squarish shield instead of a pair in five out of six radii. However, the majority of specimens have the radial shields distinctly longer than the surrounding scales as in Mortensen's figure (1933a, Fig. 15) of a specimen from St. Helena.

The shape of the oral shields is very variable, even within a single specimen, the shields sometimes having the wide diamond shape found in *Ophiactis lütkeni* while adjacent ones may be pentagonal or oval and as long as wide or a little longer as in the type and in Mortensen's figure.

The arrangement of the disc scales is usually rather irregular, the placing of the primary plates being probably disturbed by regeneration. The disc spines have attenuate hyaline tips as noticed by Mortensen. The radial shields have no dark spot proximally unlike *O. lütkeni*. The colour is usually greenish (in spirit) with no distinct bands on the arms or spots on the arm-spines unlike Mortensen's St. Helena specimens. The distal edges of the ventral arm-plates usually have a slight concavity in their central part. In larger specimens with d.d. *c.* 3·5 mm. the consecutive plates may be quite separate.

AFFINITIES. This species is closely related to *O. mülleri* Lütken from which Mortensen distinguished it by the shape of the oral shields, dorsal and ventral arm-plates, and colouration, *mülleri* having characteristic dark blue spots. I also note that the type of *mülleri* as figured by Mortensen (1933a, Fig. 16*b*) has each pair of radial shields contiguous for more than half their length, which I have not seen in *lymani* where they only touch at their distal ends. *Lymani* differs from the Mediterranean species *O. virens* (Sars) in having the ventral side completely scaled (*virens* has bare skin towards the oral shields), the dorsal arm-plates fan-shaped rather than oval and the radial shields usually larger than the plates around them, unlike *virens*. On the other hand, *virens* resembles *lymani* in having the ventral arm-spines hooked in the distal part of the arms.

RANGE. Reported from the Virgin Islands (West Indies) in 73 m., Cape Verde Islands (? *lymani*) in 91 m., West Africa (Senegal to the Gulf of Guinea) in 13–44 m., and St. Helena in 9–110 m.

OPHIACTIS SAVIGNYI (Müller and Troschel)

Ophiolepis savignyi Müller and Troschel, 1842 : 95.
Ophiactis savignyi, Ljungman, 1867 : 323 ; H. L. Clark, 1918 : 305.
Ophiactis ljungmani Marktanner-Turneretscher, 1887 : 297, Pl. 12, Figs. 9–11.

MATERIAL. Axim, Hospital reef—four specimens ; Princes Town, shore—one specimen.

REMARKS. Four of these specimens have six arms (one is in process of regenerating three arms and half of the disc), while the fifth has five arms. The species is easily recognized from other West African species of *Ophiactis* by the very large radial shields and the two distal oral papillae.

RANGE. Littoral throughout the tropics.

AMPHIODIA ACUTISPINA Koehler

Amphiodia acutispina Koehler, 1914 : 195, Pl. 7, Figs. 11–14 ; Mortensen, 1936 : 290.

MATERIAL. Dredged off Accra (station uncertain)—one specimen ; Buchanan sts. 13, 132, and 154, 25–45 m.—four specimens ; all lack the disc.

RANGE. Known from Wapoe, Ivory Coast (no depth given), off Accra (25–45 m.), and off Cape Lopez, French Congo, in 58–67 m.

? *AMPHIODIA* sp.

Text-fig. 13

MATERIAL. Buchanan st. 68, 13 m.—one specimen, lacking the disc. (Since there is only a single specimen and this is incomplete, it might belong to one of the genera *Ophiocnida*, *Ophiophragmus*, or *Ophionephthys*, only the characters of the disc distinguishing these from *Amphiodia*.)

DESCRIPTION. The arms are all broken within 30 mm. from the mouth, but a detached piece measures nearly 100 mm. in length. The disc was probably about 8 or 9 mm. in diameter, judging from the development of the proximal dorsal arm-plates. The oral

shields are slightly longer than wide, the widest part being about one-third of the distance from the distal end. The proximal part tapers evenly to a widely truncated inner end, whereas the distal part is evenly rounded. The triangular adoral shields are widely separated by the width of the straight proximal side of the oral shield.

The oral plates appear sunken and bear on each side two spaced oral papillae which are narrow at the base with blunt tips, and are in series with the infra-dental pair of papillae. The first ventral arm-plate is half as long as the second one which it overlaps slightly. The second plate and those following taper in their distal part after an initial short widening up to the proximal ends of the tentacle-pores. The distal edge is convex at first but becomes almost straight by the fourth plate ; it is sometimes distinctly thickened, at least at the proximal joints. The plates are longer than wide, as are the dorsal arm-plates, which are very similar in shape to the ventral ones, with the widest part just proximal to the spines, tapering off distally to a slightly convex distal edge. The lateral arm-plates bear six spines on the proximal joints. However, most of the arm joints have only four spines on each side. The middle spines taper to a truncate, slightly bihamulate tip. The lowest one is larger than the rest. The first two tentacle-pores and the distal ones appear to lack scales, but from the third to about the twenty-fifth a distally tapering scale is visible along the side edge of each ventral arm-plate. This scale is not very opaque and after about the eighth plate becomes progressively less well calcified until it is quite undiscernible.

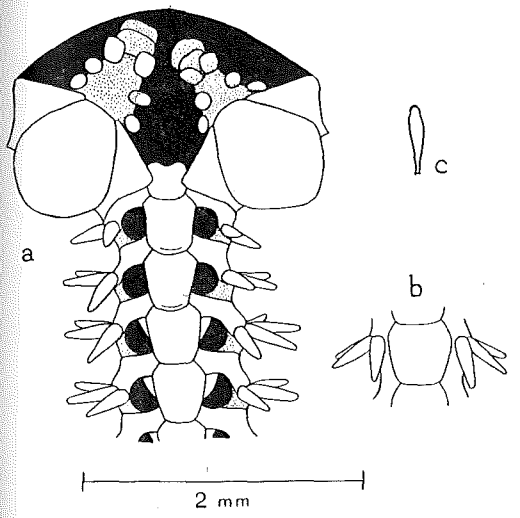


Fig. 13.

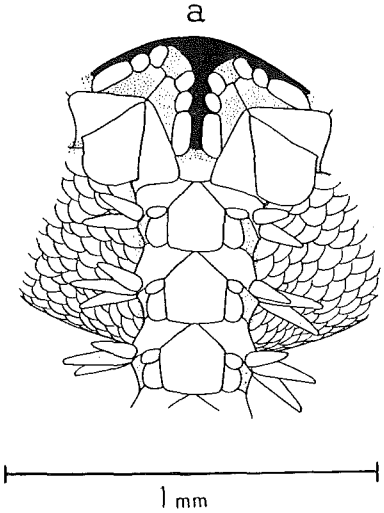


Fig. 14 (*a*)

Fig. 13. *Amphiodia* sp. (*a*) Ventral view of part of the mouth frame and the base of an arm, (*b*) dorsal view of a proximal arm joint, and (*c*) a middle arm spine in ventral view.

Remarks. This specimen has quite a lot in common with *Ophionephthys limicola* Lütken from the West Indies, although its two distal oral papillae are relatively larger and the adoral shields are widely separate inwardly instead of meeting broadly. Should the disc prove to be naked or have scales only around the radial shields then it would be better placed in *Ophionephthys*, but for the present I refer it tentatively to the more widespread genus *Amphiodia*. It differs from *Amphiodia acutispina* Koehler in the spaced and cylindrical oral papillae, the outermost papilla in Koehler's species being conspicuously wide based and tapering. The shape of the arm-plates is also very different.

OPHIOSTIGMA ABNORME (Lyman)

Ophiocnida abnormis Lyman, 1878 : 227, Pl. 2, Figs. 37–9 ; 1882 : 153, 155 ; Koehler, 1914 : 186.
Ophiostigma africanum Lyman, 1879 : 41, Pl. 13, Figs. 368–70 ; 1882 : 165, Pl. 18, Figs. 17–19 ; Koehler, 1909 : 168 ; H. L. Clark, 1915 : 243.
Amphipholis abnormis, Verrill, 1899 : 312, 316 ; H. L. Clark, 1915 : 240.
Ophiostigma abnorme, Mortensen, 1936 : 293.

MATERIAL. Sts. 131, 132, and 133, off Accra, 37–51 m.—10 specimens.

REMARKS. A single specimen from st. 73 (41 m.) lacking the disc, might belong either to *Amphipholis squamata* or to this species, so similar are the mouth parts and arms of the two, the difference in the tentacle scales being inconspicuous. I follow Mortensen in placing *africanum* in the synonymy of the West Indian *abnorme*, although I have no West Indian material for comparison. There are some small differences in Lyman's figures of the two species, particularly in the adoral and the radial shields. If these differences are real and constant then at least a sub-specific distinction should be made between the forms from the two sides of the tropical Atlantic. There is some variation in these African specimens, as well as the 'Discovery' ones from Ascension, in the extent of the disc spines. These may be mostly peripheral or may cover the whole disc, the scaling being obscured. Two specimens have three small oral papillae besides the wide distal one, on some jaw angles.

AFFINITIES. The other Atlantic species of *Ophiostigma*, *O. isacanthum* (Say), from the West Indies, differs from *O. abnorme* chiefly in having short tubercles rather than spines on the disc.

RANGE. Reported from the Gulf of Mexico (25°33'N : 84°21'W) in 185 m. and from the Cape Verde Islands (no depths given), Gold Coast in 37–51 m., St. Thomas in the Gulf of Guinea (no depth given), and Ascension in 16–27 m.

AMPHIPHOLIS SQAMATA (Delle Chiaje)

Amphiura squamata Delle Chiaje, 1828 : 74.
Amphipholis squamata, Mortensen, 1927 : 221, Fig. 125.

MATERIAL. Tenpobo, section 6B—one specimen ; Tenpobo, reef number one—one specimen ; Axim, lighthouse reef—half a disc (probably of this species).

REMARKS. This is the first record of this species from the Gold Coast though Koehler has reported it from Senegal and from Angola.

RANGE. Cosmopolitan in temperate and tropical seas, from the shore down to about 270 m.

AMPHIPHOLIS CLYPEATA Koehler

Text-fig. 14

Amphipholis clypeata Koehler, 1914 : 191, Pl. 7, Figs. 16 and 17.

MATERIAL. Tenpobo, sections 6A and 11B—two specimens ; Apam, shore—one specimen ; Christiansborg, shore—two specimens.

REMARKS. It is possible that *clypeata* is a synonym of *Amphiura bananensis* Koehler (1911 : 14) from the Congo Estuary, known from a single specimen with the centre of the disc damaged. Koehler's figure of the dorsal side of *bananensis* (probably partly reconstructed) shows even-sized disc scales and no distinct rosette of primary plates such as is found in the type of *A. clypeata*, though not in some of my specimens. The oral shields and other mouth plates and papillae of the two seem to be almost identical. However, the ventral arm-plates in *clypeata* tend to be separated farther out on the arms, whereas in *bananensis* they are said to be all contiguous. Koehler made no mention of the latter species when describing *clypeata*.

RANGE. Known from Angola (type locality) and the Gold Coast, littoral.

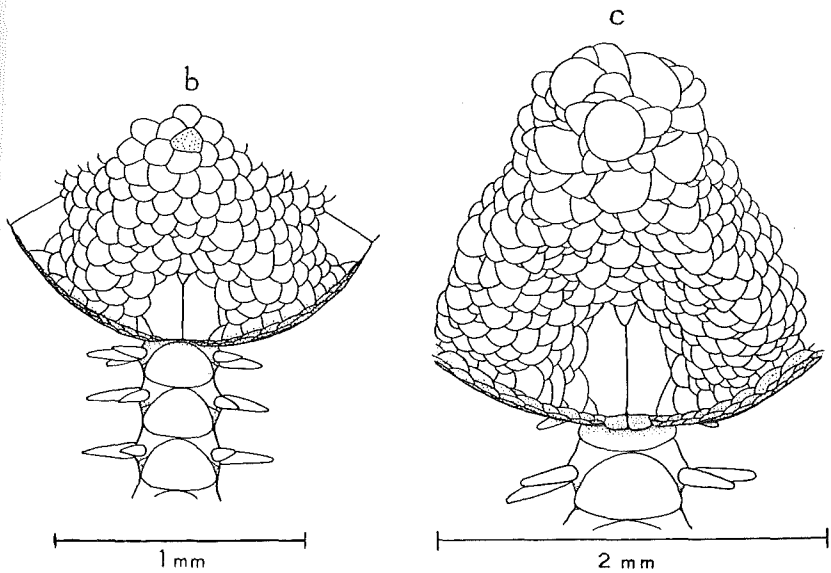


Fig. 14 (*b*) and (*c*).

Fig. 14. *Amphipholis clypeata* Koehler. (*a*) Ventral and (*b*) dorsal views of part of the disc and the base of an arm of a specimen with disc diameter 1·5 mm. (*c*) Dorsal view of part of the disc of one with disc diameter 2·5 mm. (The stippled plate in (*b*) is approximately central.)

AMPHIPHOLIS NUDIPORA Koehler

Text-fig. 15

Amphipholis nudipora Koehler, 1914 : 193, Pl. 8, Figs. 15 and 16 ; Mortensen, 1936 : 293.

MATERIAL. St. 52, off Accra, 45 m.—one specimen lacking the disc ; Buchanan sts. 3, 4, 11, 23, 24, 25, 26, 28, 29, 31, 45, 50, 52, 61, 62, 63, 64, 65, 66, 67, 79, 112, 115, 117, 118, 120, 135, 136, 137, 138, 146, 147, 149, 150, 5–20 m.—75 specimens, mostly incomplete.

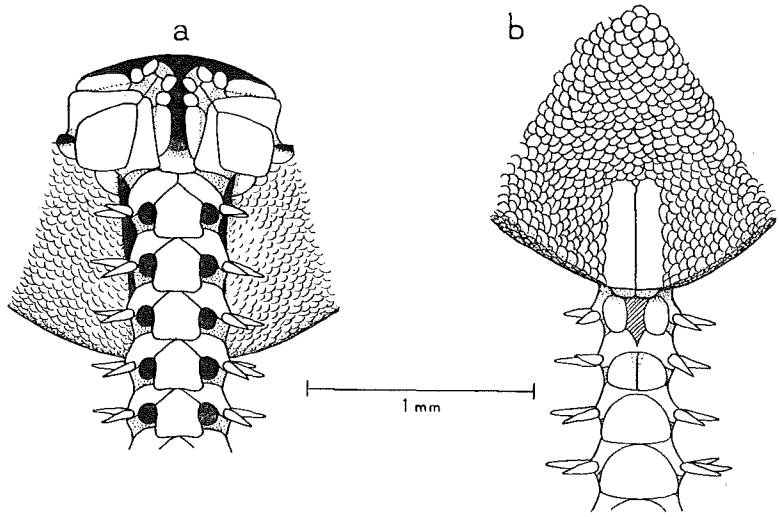


Fig. 15. *Amphipholis nudipora* Koehler. (*a*) Ventral and (*b*) dorsal views of part of the disc and the base of an arm of a specimen with the disc in process of regeneration.

REMARKS. Fortunately a few of these specimens have retained the disc, unlike Koehler's types. Even in these, however, the disc seems to be in process of regeneration as they have incomplete dorsal arm-plates on the joints just beyond the disc. The diameter of the largest barely exceeds 2 mm. The disc scaling in all of them is very fine, and the primary plates are indistinguishable. The radial shields are long and narrow, just under half the disc radius in length and those of each pair are contiguous for their whole length. Their interradial edges are also straight so that each is a narrow rectangle three to four times as long as wide. Ventrally, the scales are also very fine and delicate, becoming indistinct towards the genital slits.

RANGE. Known from Sinoe, Liberia, in 13 m., off Accra in 9–45 m., and off Cape Lopez, French Congo, in 58–67 m.

AMPHIOPLUS CONGENSIS (Studer)

Text-fig. 16

Amphiura congensis Studer, 1882 : 19.
Amphiura resecta Koehler, 1911 : 16, Pl. 2, Figs. 10–12.
Amphioplus congensis, Koehler, 1914 : 199 ; H. L. Clark, 1915 : 252, Pl. 8, Figs. 10–12.

MATERIAL. St. 47, off Accra, 44 m.—five specimens ; Buchanan st. 2, 7 m.—one specimen.

REMARKS. *A. congensis* is easily distinguished from the other West African members of the genus by the massive tentacle-scales, the inner one extending to the level of, or beyond, the distal edge of the corresponding ventral arm-plate. Another difference between *congensis* and *cincta* (Koehler) is the shape of the oral shields which have a pear-shaped form with short distal lobe in the former but a very long distal lobe in the latter, usually exceeding the proximal part in length. In one specimen the fourth oral papilla is very small and may be over-lapped by the large third one, producing an *Amphipholis*-like appearance.

I think that Koehler may have confused smaller specimens of *Amphioplus cincta* with *A. congensis*. He says that specimens of *congensis* with disc diameter about 5 mm. have the ventral arm-plates relatively wider than in large ones measuring 8–9 mm. across the disc. This is the converse of the usual change in proportions of the arm-plates with increased

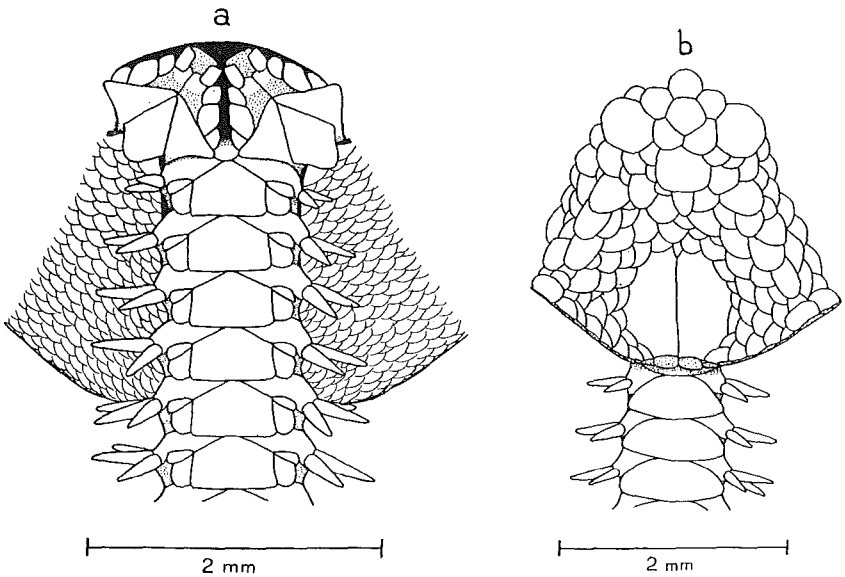


Fig. 16. *Amphioplus congensis* (Studer). (*a*) Ventral and (*b*) dorsal views of part of the disc and the base of an arm.

total size. Also he says that these smaller specimens lack the enlarged third oral papilla typical of the species and, in addition, have the fourth papilla separate from the third one, just as in *A. cincta*.

AFFINITIES. This is one of the *Amphioplus* species which has the oral papillae in a continuous row capable of closing the mouth slit. Another such form is *A. integer* (Ljungman) from South Africa, which differs from *congensis* in having the third oral papilla not enlarged.

RANGE. Known from French Guinea to Cabinda, 7–44 m.

AMPHIOPLUS AURENSIS sp. n.

Text-fig. 17

MATERIAL. St. 47, off Accra, 44 m.—one specimen ; st. 117, 64 m.—one specimen lacking the disc ; st. 112, 43 m.—two specimens, one of which lacks the disc ; Buchanan sts. 131 and 155, 40–45 m.—four specimens, one lacking the disc.

DIAGNOSIS. A species of *Amphioplus* with very long delicate arms ; thin, almost transparent, small, even-sized disc scales on dorsal and ventral sides ; the radial shields of each pair contiguous for their whole length, very narrow and rectangular in form ; oral shields pear-shaped, half again as long as wide ; adoral shields barely meeting interradially ; four oral papillae in a straight row, all borne on the oral plates, although the outermost (which is much larger than the others) arises partly from the adoral shield ; dorsal arm-plates fan-shaped ; ventral arm-plates pentagonal ; two tentacle-scales.

DESCRIPTION. The larger of Mr. Bassindale's two complete specimens has the disc diameter 4 mm. The arms are all broken but were probably over 50 mm. long. The smaller specimen has the disc diameter 3 mm. and its arms are also broken, but since it is less contorted than the other it is taken as the holotype and described here.

The disc is rather transparent, being covered completely with small, even-sized, very thin scales, a few central ones, but no rosette, being slightly larger. There are about nine scales in a length of 1 mm. On the ventral side the scales are continuous up to the genital slits and distal ends of the oral shields. The radial shields are small, 0·6–0·7 mm. long and 0·2–0·25 mm. wide, those of each pair being contiguous for almost their whole length. The oral shields are pear-shaped, the widest part being about one-third or less of the distance from the distal end. The adoral shields are triangular and meet interradially. Radially

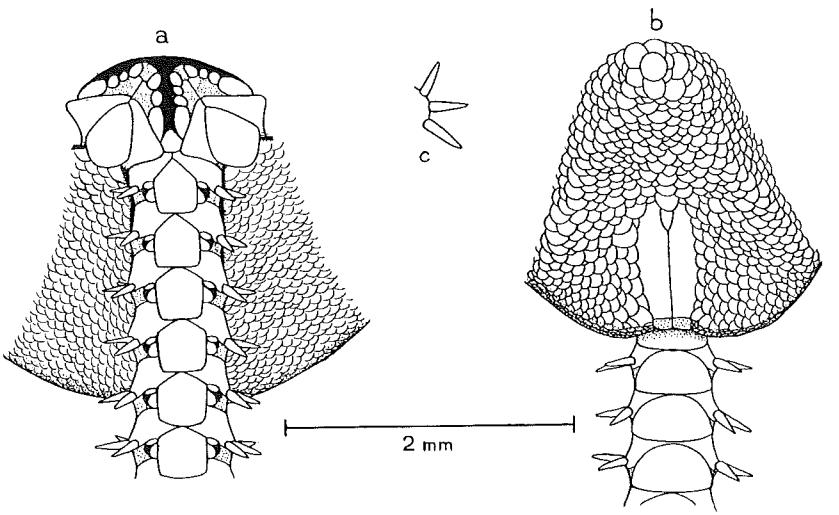


Fig. 17. *Amphioplus aurensis* sp.n. Holotype. (*a*) Ventral and (*b*) dorsal views of part of the disc and the base of an arm ; (*c*) the spines of a proximal arm-joint.

they are separated by the very small first ventral arm-plates. The oral plates are slightly sunken (except near the apex of each mouth angle, where they are somewhat thickened) and each bears four rounded oral papillae in a straight line so that the mouth slit can be closed. Of these four papillae, the innermost is infra-dental and blunt-tipped, the second one is usually the smallest, the third is about the same size as the infra-dental one, but the fourth and outermost is about twice the size and opercular in shape, like the third papilla of an *Amphipholis*.

The dorsal arm-plates are fan-shaped, consecutive plates just touching on the inner part of the arm (for about a quarter of its probable length). The ventral arm-plates are pentagonal, one to one-and-a-quarter times as long as wide, a little wider at the distal end than at the inner end of the tentacle-pores. The distal edge is slightly concave on most plates beyond the disc. The consecutive plates just touch on the inner part of the arm but do not overlap. The lateral plates bear three almost equal, tapering spines, about two-thirds of the joint in length. There are two tentacle-scales to each pore, one on the lateral arm-plate and the other on the side of the ventral arm-plate.

Affinities. This species, like *A. congensis*, belongs to the group of *Amphioplus* species with contiguous radial shields and the oral papillae in a straight line rather than a concave one. It differs from *congensis* in having relatively smaller disc scales when young, the ventral arm-plates if anything narrower than long, smaller tentacle-scales, and particularly in having the outermost, rather than the penultimate, oral papilla much larger than the others.

Amphioplus integer (Ljungman) known from South Africa, has several characters in common with this West African form, such as the contiguous radial shields and pear-shaped oral shields. It differs in having the fourth oral papilla not enlarged or rectangular, larger tentacle-scales, and relatively wider ventral arm-plates. *A. hastatus* (Ljungman) also known from South Africa, differs in the same way from *A. aurensis* but *A. pectinatus* Mortensen, from off Durban, has the radial shields largely divergent and five oral papillae rather than four, though it has arm-plates like this new species. The species most like *A. aurensis*, even to the oral papillae, is *A. intermedia* (Koehler) (1905), which comes, however, from the East Indies.

AMPHIOPLUS CINCTA (Koehler)

Text-fig. 18

Amphiodia cincta Koehler, 1914 : 197, Pl. 8, Figs. 13, 14, and 20.

Material. St. 65, off Accra, 7 m.—one specimen, lacking the disc ; Buchanan sts. 3, 4, 20, 21, 22, 24, 33, 50, 51, 52, 59, 60, 76, 78, 80, 94, 115, 117, 118, 136, 137, 146, 147, 148, 149, and 150, 7–11 m.—55 specimens, of which 19 lack the disc.

Remarks. This species should clearly have been referred to *Amphioplus* since Koehler himself noted four oral papillae. Because it has some resemblance to *Amphioplus archeri* described here, detailed drawings are given for comparison. Both species are similar ventrally in the concave, spaced row of oral papillae, elongate oral shields, ventral arm-plates with a distal concavity in the edge and possession of two tentacle-scales. However, when the disc diameter is more than 5 mm., *archeri* has eight (or even nine) arm-spines on the proximal joints, the number falling to five on the middle arm joints, while *cincta* has only five proximally, the number soon falling to three. Also in *cincta* some of the spines have truncated tips, whereas they are all acute in *archeri*.

A second difference is in the scaling of the disc ventrally. In *cincta* the scaling is continuous and all the scales overlap, whereas in the new species they are often spaced out in the skin. Contingent on this is the fact that only two of the 14 specimens of *archeri* have the original disc. Thirdly, the dorsal arm-plates of *cincta* are widest near their distal edges and narrow *inwardly*. In *archeri* the widest part is just proximal to the middle of the length of the plate, and the sides of the plate taper slightly towards the *outer* end or are nearly parallel. In no specimen of *archeri* that I have seen do they diverge.

Range. Known from Liberia, Dahomey, and from Accra in 7–11 m.

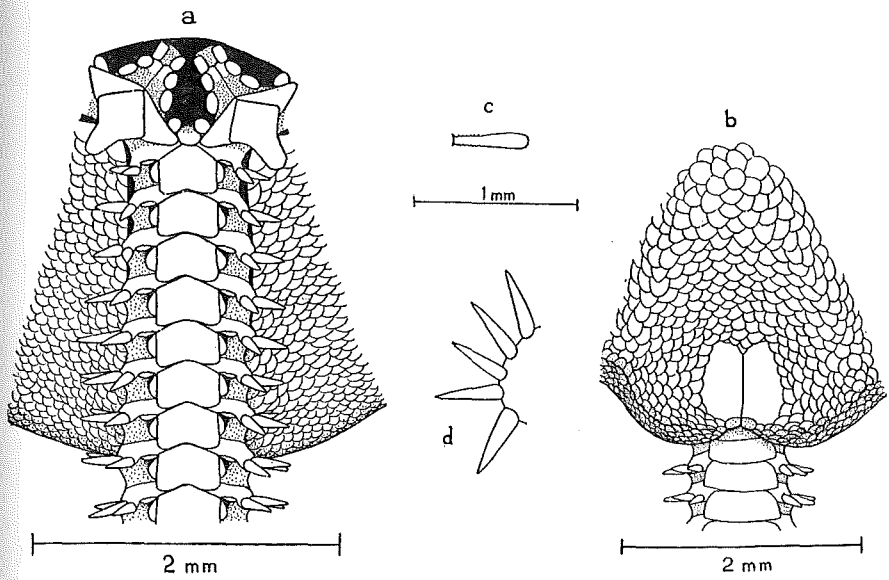


Fig. 18. *Amphioplus cincta* (Koehler). (*a*) Ventral and (*b*) dorsal views of part of the disc and the base of an arm ; (*c*) a middle arm-spine in ventral view ; (*d*) the spines of a proximal arm-joint.

AMPHIOPLUS ARCHERI sp. n.

Text-figs. 19 and 20

MATERIAL. Buchanan sts. 0, 17, 20, 35, 72, 86, 110, 111, 124, and 125, 1·5–7·5 m.—14 specimens, two being incomplete.

DIAGNOSIS. A species of *Amphioplus* with the primary plates distinct on the original (i.e. not regenerated) disc, and circular or oval in shape, being spaced out from one another when the disc diameter exceeds 5 mm. ; the radial shields of each pair in contact for almost their entire length, each shield being not more than twice as long as wide (usually one-and-a-half times) when fully developed, with a convex interradial edge ; ventral disc scales abruptly smaller than the dorsal ones, rather delicate, and when the disc is swollen in maturity they may be spaced from one another in the skin ; papillae or projecting scales may occur along the edge of the disc, especially in young specimens with the disc not distended ; oral shields elongate with a long narrow distal lobe, and the two proximal sides usually concave on either side of a rather acute proximal angle ; the oral papillae forming a concave row, the fourth and outermost being spaced from the third one ; the two infra-dental papillae on each jaw separated from each other by about their own width ; dorsal arm-plates very wide with straight proximal and distal sides, about three times as wide as long when the disc diameter is about 6 mm. or more ; ventral arm-plates about twice as wide as long, with straight proximal edges but the distal sides very concave in the middle ; five arm-spines on the middle arm-joints but up to eight on the proximal ones ; two tentacle-scales, the inner one tapering distally and about half the length of the arm-plate ventral which it borders.

DESCRIPTION. The dried holotype has the disc diameter 6·5 mm. All its arms are broken off close to the disc, but judging from the degree of taper of the broken pieces their length was about 60 mm. The general appearance is robust and the arms were probably not very flexible, the joints being wide and short. The circular primary disc plates (except for one of the radials) are conspicuous. They are separated by about their own diameter from each other. The rest of the disc is covered by smaller scales coming to an abrupt edge around the periphery. Below this, the scales are much smaller and except near the oral shields

and genital slits the scales do not overlap each other but are slightly spaced in the stretched skin, the whole disc being rather distended. Actually, all the interradii are ruptured ventrally in this specimen, but the scaling seems to have been continuous, though delicate.

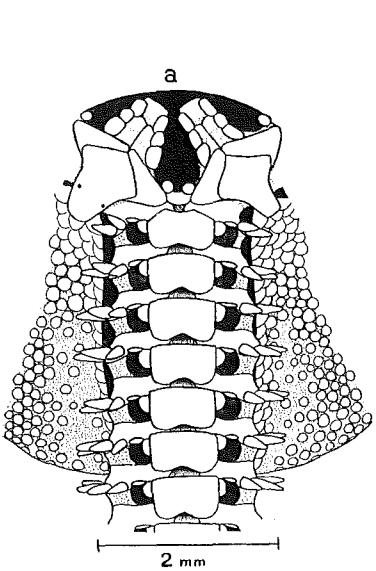


Fig. 19 (*a*)

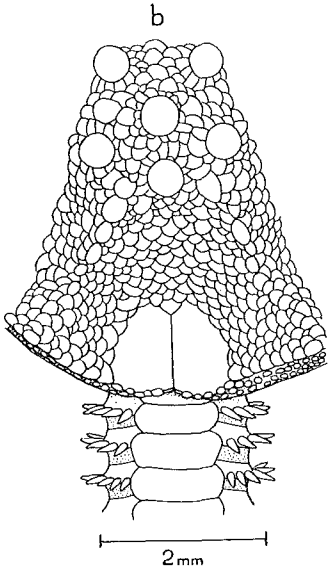


Fig. 19 (*b*).

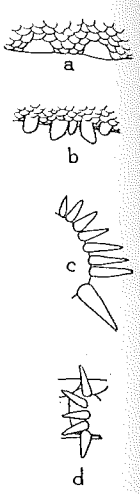


Fig. 20.

Fig. 19. *Amphioplus archeri* sp.n. Holotype. (*a*) Ventral and (*b*) dorsal views of part of the disc and the base of an arm (in (*a*) the oral shield on the left is the madreporite).

Fig. 20. *Amphioplus archeri* sp.n. (*a*) Part of the edge of a regenerating disc in dorsal view showing the rudimentary radial shields ; (*b*) ventral view of an interradial part of the disc edge of a specimen with disc diameter 3·5 mm. ; (*c*) the spines of a proximal arm-joint of the holotype ; and (*d*) side view of a middle arm-joint.

The oral shields are always longer than wide, and their widest part is normally in the proximal half of the length though it may be midway when the usual long narrow distal lobe is under-developed. In this type specimen, the sides of the shields narrow in abruptly distal to the lateral angles and are then almost parallel for the rest of the length. The proximal sides are also slightly concave and come to an acute angle. The adoral shields do not taper much interradially, and their rounded inner ends meet quite widely inside each oral shield.

The infra-dental oral papillae of each pair are spaced from each other usually by more than the width of each, so that the lowest tooth is clearly visible. The second papilla on each side is about the same size as the first or a little smaller, but the third is larger. All these are borne on the oral plates. In the type specimen, the tentacles are expanded and the oral papillae are erected almost vertically so that the row is quite concave. The fourth papilla is separated from the third by more than its own width. It is rounded and appears to arise as much from the first ventral arm-plate as from the outer end of the adoral shield.

The ventral arm-plates (except the first) are nearly twice as wide as long with almost straight proximal and lateral edges at right-angles to one another. The distal edge of each has a marked concavity in the middle. The consecutive plates are narrowly separated, and the inner ends of the lateral plates can be seen leaving between them a dark space revealed by the concavity of the previous ventral plate. The dorsal arm-plates are up to three times as wide as long, with straight proximal and distal edges ; their widest part is towards the proximal end so that the sides taper inwards slightly towards the distal edge.

The lateral arm-plates carry eight spines on the joints just beyond the disc, of which the uppermost is the smallest and the lowest the largest, being abruptly larger and flatter than the seventh spine and directed downwards rather than sideways (Text-fig. 20*c*). After a few joints the number of spines is reduced, and on the middle part of the arm there are five on each side, the lowest being barely longer than the rest but a little thicker basally. All the spines taper to a fairly acute tip without hooks or any notable asperities.

Of the two tentacle-scales, the one on the lateral arm-plate is small with a rounded free edge while the other, bordering the ventral arm-plate, is also relatively small, its length rarely exceeding half the length of the ventral plate. Each of these scales tapers in towards the ventral plate distally, being widest near the proximal end of the tentacle-pore.

The specimen from st. 72 seems to be the only one besides the holotype to have retained the original disc, all the others having the disc relatively small. This specimen is young with the disc diameter only 3·5 mm. It has relatively larger primary radial and interradial plates than the holotype, the former separated from the radial shields by only about their own width. All these plates are circular or oval in shape and are not overlapped on their proximal sides by other scales. They are largely in contact with each other, and there are only a few single small scales in the interstices between them. The disc is contracted ventrally, and although the ventral disc scales are loosely placed around the margin, as in the type, some of them distinctly project in each interradius, like the papillae of *Ophiophragmus marginatus*. Koehler described a similar condition in a small specimen of *A. cincta*.

Remarks. None of the specimens with regenerating discs has distinct primary plates. Their ventral sides have the scaling discontinuous. Where the new disc is only large enough to cover the mouth frame, the radial shields are still undeveloped. They make their appearance as the disc grows, those of each pair being at first separated by more than their own width, though they gradually grow together as they increase in breadth as well as length. Mortensen (1933) has figured a specimen of *Amphioplus integer* (Ljungman) in process of regeneration, the short radial shields being similarly separated. He remarked that the disc had probably regenerated abnormally, but it seems to me that the abnormality is due to regeneration being incomplete, the first few dorsal arm-plates being irregular and obviously secondary in his specimen. The absence of distinct primary plates in regenerated discs suggests that their non-occurrence in Amphiurid species, of which only a few complete specimens are known, should not be used as diagnostic.

Affinities. The similarity between this form and *A. cincta* in the shape of the radial and oral shields, the ventral arm-plates, tentacle-scales, and oral papillae is very striking. But the deficient ventral scaling of the disc, the more numerous arm-spines, and the more rectangular shape of the dorsal arm-plates are so constant in all specimens that I must distinguish this form specifically. *A. archeri* differs from *A. occidentalis* Koehler in having at least partial ventral scaling to the disc, relatively wider and shorter radial shields, and again more numerous arm-spines. This last character, as well as the shape of the oral shields, also distinguishes it from *A. congensis* and *aurensis*.

? *OPHIONEPHTHYS* sp.

Text-fig. 21

Material. St. 117, off Accra, 64 m.—one specimen; st. 133, 51 m.—one specimen; Buchanan sts. 8, 11, and 132, 16–38 m.—three specimens. All these lack discs.

Remarks. This species might well belong to the genus *Amphioplus* since it has four oral papillae. However, its affinities seem to be with the species *Ophionephthys stewartensis* Mortensen, 1925, *O. magellanica* Mortensen, 1936, and *Amphioplus seminudus* Mortensen, 1940a, the last-named being misplaced in my opinion. I do not think that any of these species are congeneric with *Ophionephthys limicola*, the type species of *Ophionephthys*, since their oral papillae are of the *Amphioplus*-type, not like *Amphiodia*. Also, they have two well-developed tentacle-scales on each pore, whereas these scales are reduced in *limicola* both in size and number. At the same time the species with *Amphiura*-type mouth parts and no tentacle-scales at all, such as *O. octacantha* H. L. Clark, should also be split off from *Ophionephthys* sensu stricto. This is no place to embark on such drastic revision, so I tentatively place these incomplete specimens under the above name.

DESCRIPTION. Judging from the development of the proximal dorsal arm-plates the disc was about 7 or 8 mm. in diameter. The arms are all broken within 30 mm. of the centre, but even in that length have not tapered at all from the initial widening just beyond the disc. Their length in life was probably at least 70 mm. The oral shields are about one-third as long again as wide. The shape varies slightly, but the widest part is in about the middle of the length, the proximal part is almost semicircular though the distal angle is more acute, the two distal sides being straight or even a little concave. The adoral shields do not meet interradially inside the oral shields, although each is quite wide inwardly; they have a lateral lobe separating the oral shield from the first lateral arm-plate. The oral plates are rather sunken except for a pair of prominences just below the infra-dental papillae. These papillae are particularly large and taper in their outer half to a fairly acute tip. On each side of them are three further oral papillae, the second being small, its tip not even reaching the level of the base of the infra-dental papilla so that the first oral tentacle-scale is visible above and between them. The third oral papilla is also borne on the oral plate but may appear to arise partly from the adoral shield. The fourth is based on the adoral and is nearly semicircular in shape, while the second and third papillae may be somewhat oval. The oral tentacle is visible above and between the third and fourth papillae.

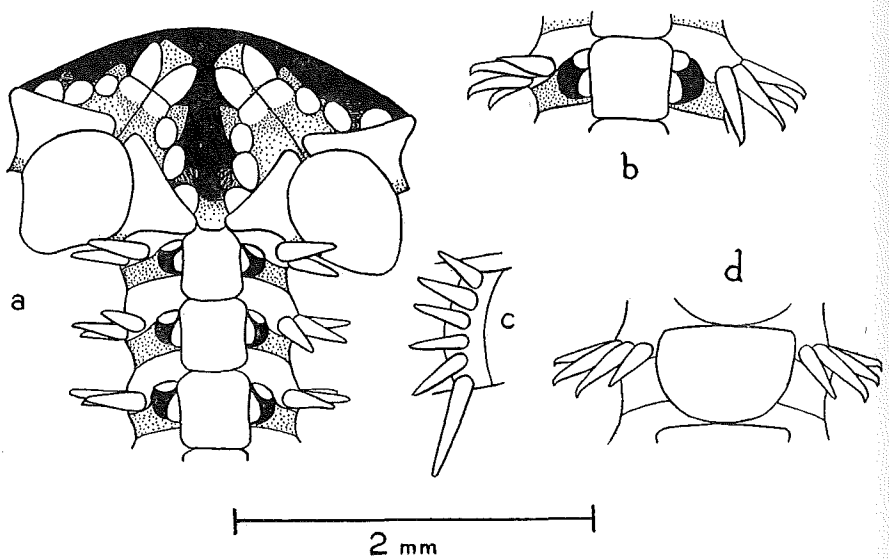


Fig. 21. *Ophionephthys* sp. (*a*) Ventral view of part of the mouth frame and the base of an arm; (*b*) ventral; (*c*) oblique side-view; and (*d*) dorsal views of the twelfth arm-joint.

The dorsal arm-plates are semicircular with the proximal side only slightly convex. They are about 0·5 mm. long and at first about 0·65 mm. wide, but as the arm widens out beyond the edge of the disc they also expand to nearly 1 mm. in width. The ventral arm-plates are rectangular with rounded corners. The first one is less than half the size of the second and is apparently hexagonal owing to the overlap of the adoral shields on its outer half. The next three or four plates are longer than wide, and their distal edges from being slightly convex become straight or slightly concave. The following plates become gradually more nearly square. The lateral arm-plates bear six spines just beyond where the disc ended, the number being reduced to five after a few joints. The lowest spine is the longest, just exceeding a joint in length. All the spines are tapering, and after the first five or six joints, each develops a small, transparent, distally-directed terminal hook. There are two unremarkable tentacle-scales to each pore.

In another specimen, which seems to be a little larger than the one described, the arm-spines are more noticeably hooked, the infra-dental papillae are not so conspicuously

larger than the other papillae, the ventral arm-plates lose their overlap on the arms after about 20 mm., and their blunt proximal angle is revealed so that they appear pentagonal rather than quadrangular. Also the adoral shields meet interradially. The tentacles being extended, the homology of the two outermost oral papillae with the tentacle-scales is very distinct. Distally, the dorsal arm-plates develop an almost straight distal edge and become more elliptical in form, but proximally they are widest at their inner ends as in the specimen described.

AFFINITIES. This form is clearly distinguished from the West African *Amphioplus* species by the shape of the arm-plates and oral shields, the prominence of the infra-dental papillae, and the hooked arm-spines. It most nearly resembles *'Amphioplus' seminudus* Mortensen (1940a) from the Persian Gulf, from which it differs particularly in the hooked arm-spines.

AMPHIURA SCULPTA sp.n.

Text-fig. 22

MATERIAL. St. 47, off Accra, 44 m.—two specimens.

DIAGNOSIS. A species of *Amphiura* with the disc scales coarse and considerably thickened, giving a sculptured appearance and an irregular outline to the disc ; radial shields quite separate ; oral shields rhombic, about as long as wide ; adorals meeting interradially ; the distal oral papilla extremely wide, its base occupying almost the whole length of the adoral shield and its free edge, if anything, even longer ; dorsal arm-plates elliptical or widest slightly towards the distal edge ; ventral arm-plates pentagonal, wider than long, with the distal edge concave ; six arm-spines proximally ; two tentacle-scales.

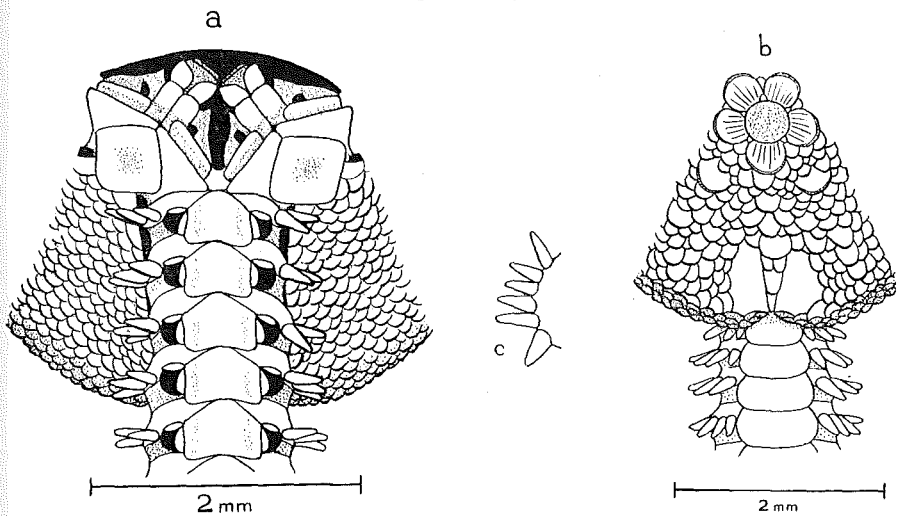


Fig. 22. *Amphiura sculpta* sp.n. Holotype. (*a*) Ventral and (*b*) dorsal views of part of the disc and the base of an arm ; (*c*) the spines of a proximal arm-joint.

DESCRIPTION. Disc diameter of the larger specimen = 4·5 mm. ; arm length *c.* 36 mm. Colourless in spirit. The primary rosette is very distinct, the six plates being all sculptured, the five radials have grooves across them in a radial direction. The centro-dorsal measures 0·4 mm. in diameter and the other five plates are very little smaller. They are separated by a few small scales with indistinct edges. Farther distally, about halfway between the centre of the disc and the edge, is an enlarged interradial plate, about the same width as the primary radials but shorter owing to overlapping of the more proximal scales. There are about 12 scales between the centro-dorsal and the edge of the disc interradially. The radial shields of each pair are completely separated by a wedge of about four scales, two of which are parallel proximally, the other two being placed in series ; each shield measures 0·75 mm. in length, that is just about one-third of the disc radius. As usual, the junction between ventral and dorsal scales comes just above the ambitus. The thickened scales give an irregular outline to the disc.

The oral shields are rhombic with two straight proximal sides and an obtuse angle. The distal sides are slightly concave where they face the ends of the genital slits and the distal angle is blunt. The shields are as wide as, or a little wider, than long. The adoral shields are triangular and each pair meets interradially. Each bears a very wide oral papilla along nearly the whole length of its proximal side, with an even longer free edge. The oral plates are narrow and slightly swollen proximally behind the infradental papillae, the distal part being rather sunken. The first oral tentacle-scale on each side is quite distinct, but at a slightly higher level in the mouth slit.

The dorsal arm-plates are elliptical, or their widest part may be slightly towards the distal edge. They are about twice as wide as long and broadly contiguous. The ventral arm-plates are pentagonal with an obtuse proximal angle and a distinctly concave distal edge. They are wider than long in at least the proximal half of the arm. The first few joints beyond the disc bear six short, blunt arm-spines on each side, but the number soon drops to five. Of these the lowest one or two are the longest, but even these are only a little more than half as long as a joint.

There are two tentacle-scales to each pore, the proximal one borne on the lateral arm-plate and the other, which is particularly long, on the side edge of the ventral plate.

Besides the disc scales, some of the other plates are thickened and the ventral arm-plates appear to be slightly keeled, also the oral shields are a little sunken centrally.

AFFINITIES. This species is most nearly related to *Amphiura incana* Lyman (1879) from South Africa and the Gulf of Guinea, and to *A. chiajei* Forbes from European Seas south to the Azores. Both of these have two tentacle-scales and a wide distal oral papilla, though not as wide as in this species. *A. chiajei* also has up to six short arm-spines and the ventral arm-plates slightly keeled and pentagonal in shape, the oral shields are again rhombic. On the other hand, the disc scales are much finer (though the primaries are distinct) and are not noticeably thickened. Also the dorsal arm-plates usually have acute distal angles. *A. incana*, too, has much finer and thinner disc scales than this new species as well as more numerous arm-spines, up to eight.

OPHIOTHRIX TOMENTOSA Koehler

Ophiothrix tomentosa Koehler, 1914 : 210, Pl. 10, Figs. 9 and 10.

MATERIAL. St. 70, 71, 72, 73, or 74, off Accra, 25–41 m.—one specimen.

REMARKS. The present specimen has the disc only 2·5 mm. across. It is very similar to Koehler's photographs of the type of *O. tomentosa* with short uniform stumps all over the disc scales and radial shields and also a few on the dorsal arm-plates. It is possible that this species, described from a single small specimen of disc diameter less than 4 mm., from the Ivory Coast, is a synonym of *Ophiothrix nociva* Koehler (1907a) also known from only a single specimen taken off the river Congo mouth and having a disc diameter of 5·5 mm. The fact that the latter has a few spines on the disc among the thorny stumps can have little significance in the light of the well-known variability of most species of *Ophiothrix* in respect to this character. The larger number of arm-spines (seven or eight proximally rather than six) in *nociva* may be due to the larger size of that specimen though the difference in shape of the dorsal arm-plates may have some significance. Koehler's very diagrammatic figures of *nociva* may give an exaggerated idea of the density and length of the stumps on the disc which are rather sparse and very short in *tomentosa*.

RANGE. Known from Wapoe, Ivory Coast, in 39 m., and from off Accra in 25–41 m.

OPHIOTHRIX CONGENSIS Koehler

Ophiothrix congensis Koehler, 1911 : 21, Pl. 1, Figs. 5–7, Pl. 2, Fig. 15 ; 1914 : 208.

MATERIAL. Two miles off Densu, 15 m.—six specimens ; Princes Town, shore—one specimen ; Tenpobo, intertidal—one specimen ; Tenpobo, section 11B—one specimen ; Axim, Hospital reef—three specimens ; st. 131, 132, or 133, off Accra, 37–51 m.—one specimen.

RANGE. Known from the Gold Coast to Angola, littoral to about 50 m.

OPHIOTHRIX COTTEAUI (de Loriol)

Ophiocnemis cotteaui de Loriol, 1900 : 84, Pl. 7, Fig. 11.
Ophiothrix gracilis Koehler, 1911 : 19, Pl. 1, Figs. 1–4 ; 1914 : 209, Pl. 10, Fig. 8.

MATERIAL. St. 62, off Accra, 30 m.—one specimen ; on Alcyonarian, Chorkar, Accra—one specimen ; Osu Fisheries, on Gorgonian—eight specimens.

REMARKS. There are two differences between de Loriol's description and figures of the type of *cotteaui* from off Liberia and Koehler's of *gracilis* from off the Congo. Firstly, de Loriol gives the number of arm-spines in specimens of disc diameter 3–5 mm. as four or five, whereas Koehler counted seven in one with the d.d. 5 mm. The specimen from st. 62, off Accra, has the d.d. 5·5 mm., and there are six arm-spines on two or three basal arm-joints, thereafter five. The lowest of these spines is very small and little bigger than the adjacent tentacle-scale. Secondly, Koehler says that the surface of the ventral arm-plates is covered with 'granules bien apparents', whereas de Loriol remarks that all the arm-plates are smooth. In these specimens from the Gold Coast the arm-plates appear smooth when wet, but on drying the ventral arm-plates have a visibly rough surface with an almost granular appearance. Koehler (1914) has reported specimens of *O. gracilis* from off Liberia which, together with the observations made above on the present material and the similarities between the two (for instance, in the shape of the ventral arm-plates which is rather unusual), leaves little room for doubt that the two are synonymous.

The generic position of *cotteaui* is, however, open to doubt since the generic limits within the family Ophiotrichidae are rather poorly defined. De Loriol placed this species in *Ophiocnemis* which formerly included only *O. marmorata* (Lamarck), adding simultaneously another Indo-Pacific species—*O. venusta*, which seems to be more closely related to some species of *Ophiothrix*, such as *O. striolata* Grube than to *Ophiocnemis marmorata*. *O. cotteaui* also seems to have greater affinity for some *Ophiothrix* species such as *O. infirma* Koehler (1905) from the Indo-Pacific, as well as *O. inducta* Koehler (1906) and *O. indigna* Koehler (1906), both from the North Atlantic in the vicinity of the Canary Islands and Madeira, the latter in over 100 m. It is doubtful whether the differences in the disc covering, short thorny stumps or rounded granules, are very significant in all these species.

I think that *Ophiocnemis* is better kept as a monotypic genus. *Ophiocnemis marmorata* grows to a very large size, over 20 mm. in disc diameter, which magnitude few, if any, Ophiothrixes attain. The West African species *cotteaui* is, in my opinion, not so closely related to *marmorata* as to the species of *Ophiothrix* named above, and is therefore transferred to that genus in this paper. H. L. Clark (1939) has referred *Ophiothrix infirma* Koehler to his genus *Placophiothrix*, distinguished from *Ophiothrix* by the possession of conspicuous radial shields. That genus is, however, very ill-defined owing to the great variability of many species in the relative size of the radial shields and the extension of the disc granules or stumps on to them, and accordingly I hesitate to refer *cotteaui* to it at this time.

RANGE. Known from Liberia to Angola in 1–30 m. depth.

OPHIOTHRIX sp.

MATERIAL. St. 47, off Accra, 44 m.—one juvenile specimen ; st. 72, 38 m.—one juvenile specimen.

These two specimens are very small with disc diameters less than 2 mm. Both have relatively large centro-dorsal plates (a juvenile characteristic of *Ophiothrix*), and one has very large radial shields so it may be a young *Ophiothrix tomentosa*. The other has a suggestion of webbing on some of the arm-spines like the genus *Ophiopteron*, but young *Ophiothrix* also go through an *Ophiopteron* stage with the spines webbed. It is in poor condition.

OPHIOPTERON ATLANTICUM Koehler

Ophiopteron atlanticum Koehler, 1914 : 212, Pl. 10, Figs. 6, 7, 11, and 12.

MATERIAL. St. 117, off Accra, 64 m.—one specimen.

RANGE. Known from Senegal, the Gold Coast, French Congo, and Angola in 11–64 m.

OPHIOPSILA GUINEENSIS Koehler

Ophiopsila guineensis Koehler, 1914 : 203, Pl. 8, Figs. 1–4, 7, and 8.

MATERIAL. St. 132, off Accra, 44 m.—one specimen ; Buchanan st. D.1, 45 m.—one specimen.

REMARKS. The hypertrophied inner tentacle-scales make this genus an easy one to recognise.

RANGE. Rolas Island (Gulf of Guinea) and Senegal (no depths given) as well as the Gold Coast in 44 m.

OPHIOCOMA PUMILA Lütken

Ophiocoma pumila Lütken, 1859 : 248, Pl. 4, Figs. 5*a–d* ; Koehler, 1914 : 208.

MATERIAL. Tenpobo, intertidal—four specimens ; Axim, Hospital reef—three specimens.

REMARKS. These specimens (and others in the British Museum (Nat. Hist.) from the Gulf of Guinea), besides growing to a larger size, seem to have shorter and more flattened arm-spines than the typical West Indian form. Possibly West African specimens can be distinguished subspecifically at least from those inhabiting the West Indies.

RANGE. Known from the West Indies, Brazil, and West Africa from the Cape Verde Islands, Gold Coast, and the Gulf of Guinea ; littoral.

OPHIODERMA LONGICAUDA forma *GUINEENSE* Greeff

Ophioderma guineense Greeff, 1881 : 156 (p. 11 of separate).
Ophioderma longicauda, Koehler, 1911 : 13.
Ophioderma longicauda var. *guineense*, Koehler, 1914 : 173, Pl. 9, Figs. 1–3.

MATERIAL. Tenpobo, intertidal—two specimens ; Tenpobo, section 7B—one specimen ; Axim, Hospital reef—three specimens.

RANGE. This forma (or perhaps subspecies, as it seems to be distinguished geographically) occurs in the Gulf of Guinea. Koehler (1914) referred specimens from Senegal to typical *longicauda* as found in the Mediterranean. It is a littoral species.

OPHIOLEPIS PAUCISPINA (Say)

Ophiura paucispina Say, 1825 : 149.
Ophiolepis paucispina, Müller and Troschel, 1842 : 90 ; Lütken, 1859 : 204, Pl. 2, Fig. 2 ; Koehler, 1914 : 177, Pl. 9, Fig. 14.

MATERIAL. Dixcove, shore—10 specimens ; two miles off Densu, 15 m.—two specimens ; Axim, Hospital reef—one specimen ; Tenpobo or Accra—one specimen ; Tenpobo, section 9A—nine specimens ; Tenpobo, number one reef—one specimen.

RANGE. Known from the West Indies and West Africa from the Gold Coast and Gulf of Guinea ; littoral.

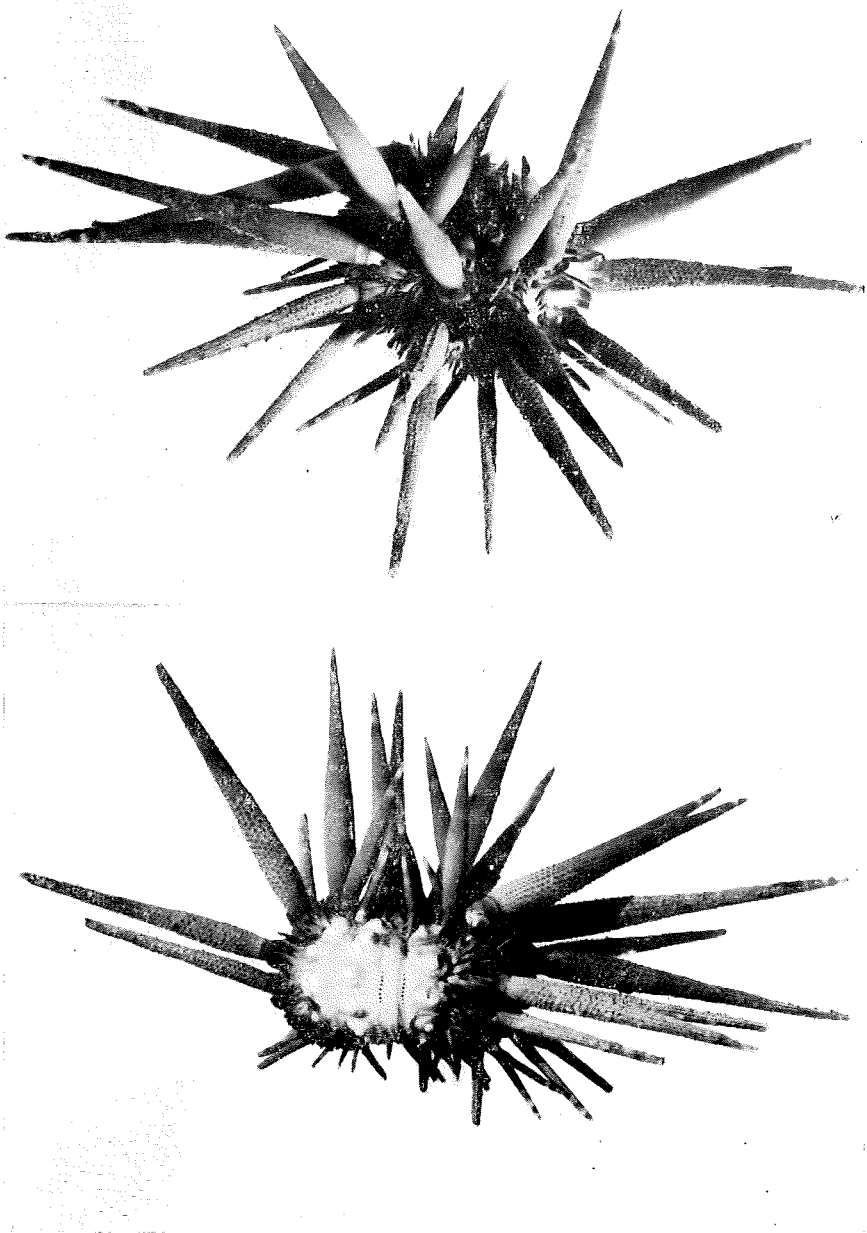
OPHIURA AFRICANA (Koehler)

Text-fig. 23

Ophiocten africanum Koehler, 1923 : 15, Figs. 6 and 7.

MATERIAL. St. 111, off Accra, 43 m.—one specimen : st. 47, 44 m.—one specimen ; st. 73, 41 m.—one specimen ; st. 112, 43 m.—two specimens ; st. 117, 64 m.—one specimen ; st. 132, 44 m.—two specimens.

REMARKS. Mortensen (1933 : 391) has already recommended that this species be referred to *Ophiura* rather than to *Ophiocten*, a move with which I fully concur. The two arm-combs at the base of each arm are not continuous as in typical *Ophiocten* and are inclined towards each other. Each has about six or seven thin, pointed spinelets. The disc edge is also rounded not sharp, and the scales are very variable in size though the larger ones are regularly arranged. The small scales do not form rings around the larger ones, but are merely interstitial. All the scales are thin and make a very smooth covering to the disc.



Pl. II. *Eucidaris tribuloides africana* forma *attenuata* forma nov.

I here give figures of the dorsal and ventral sides to supplement Koehler's photographs. The only difference between these specimens and the types from Angola is that the former may have four oral papillae on each side of the central one, or there may be two or three papillae close together at the apex of a jaw.

RANGE. Known from Angola and the Gold Coast in 41–64 m.

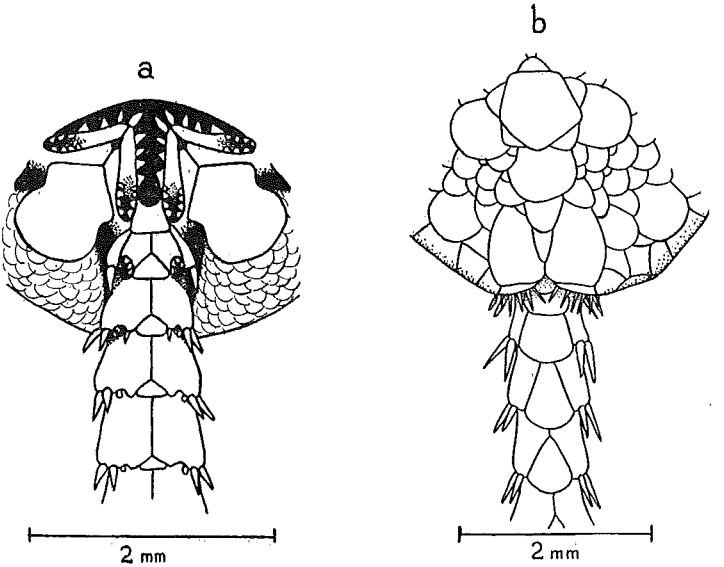


Fig. 23. *Ophiura africana* (Koehler). (*a*) Ventral and (*b*) dorsal views of part of the disc and the base of an arm.

ECHINOIDEA

EUCIDARIS TRIBULOIDES AFRICANA Mortensen

Pl. II

Eucidaris tribuloides var. *africana* Mortensen, 1909 : 40, Pl. 6, Figs. 1, 3, 10, and 13, Pl. 10, Figs. 1 and 4, Pl. 13, Fig. 17, Pl. 14, Figs. 11–13 and 19, Pl. 15, Figs. 1, 15, 18, and 19, Pl. 16, Fig. 19 ; Koehler, 1914 : 216, Pl. 11, Figs. 11 and 23 ; Mortensen, 1928 : 406 ; 1951 : 295.

Cidaris minor Koehler, 1914 : 217, Pl. 11, Figs. 16 and 17, Pl. 12, Fig. 10.

MATERIAL. Christiansborg, Accra—five specimens ; Apam, shore—three specimens ; Axim, Hospital reef—six specimens ; two miles off Densu, 15 m.—two juvenile specimens ; st. 111, off Accra, 43 m.—one juvenile specimen ; st. 112, 43 m.—two specimens ; st. 133, 51 m.—one juvenile specimen.

REMARKS. There is a considerable difference in external appearance between the littoral specimens in this collection and the two adult ones from 43 m. The latter have long and tapering primary spines in comparison to the blunt cylindrical or fusiform ones of the littoral examples. Mortensen (1928) has also remarked on the more tapering form of the spines in specimens of *Eucidaris tribuloides* from deeper water, the species having been recorded from depths as great as 450 m. This deeper forma is so strikingly different in appearance that I think it merits a distinct name, for which I propose *attenuata* **forma n.**

RANGE. The subspecies *africana* is known from the Cape Verde Islands, Liberia, the Gold Coast, Gulf of Guinea, and the French Congo ; littoral to at least 50 m.

ARBACIA LIXULA AFRICANA (Troschel)

Arbacia africana Troschel, 1873 : 327 ; Koehler, 1914 : 222, Pl. 13, Figs. 7–15, Pl. 14, Figs. 1–18, 20, and 21, Pl. 15, Figs. 1–6, 11, and 12.

Arbacia lixula var. *africana*, Mortensen, 1935 : 570 ; 1951 : 296.

MATERIAL. Christiansborg, Accra—12 specimens ; Apam—six specimens ; Tenpobo, number one reef—three specimens ; number two reef—two specimens ; intertidal—one specimen ; Axim, Hospital reef—19 specimens ; Winneba, shore—10 specimens.

REMARKS. This species is often taken in the same areas as *Echinometra lucunter* (Linnaeus) from which it is distinguished by having the test circular, rather than oval, in dorsal or ventral view. The most noticeable variation is in the length of the spines, particularly the aboral ones, which may either be abruptly shorter than the ambital spines or quite long and tapering. The different forms resulting from this seem to be localized since most specimens from Christiansborg and Winneba have short dorsal spines, whereas those from Axim, Apam, and Tenpobo have longish, more slender ones. The ambital interambulacral plates may have up to six tubercles across their width as in typical *lixula*, whereas Mortensen and Koehler note that *africana* rarely has more than four on each plate. The spines are often tipped with white, unlike those of *Echinometra lucunter*. Mortensen gives the colour of the cleaned test as reddish, but this is not true of the few of these specimens cleaned which have only a narrow orange-red band down the pore areas and sometimes red tubercles ; the interambulacral plates may be a dark slate-colour or light brownish-grey.

RANGE. The subspecies *africana* is known from the Cape Verde Islands to Angola in depths of less than 5 m.

CENTROSTEPHANUS LONGISPINUS (Philippi)

Diadema longispinus Philippi, 1845 : 354.

Centrostephanus longispinus, Koehler, 1909 : 220, Pl. 31, Fig. 20 ; Mortensen, 1940 : 300, Pl. 34, Figs. 1–11, Pl. 35, Figs. 11 and 12, Pl. 75, Figs. 5–24 ; 1951 : 296.

MATERIAL. Sts. 47, 48, 52, 73, 111, and 117, 41–64 m.—23 specimens.

RANGE. Known from the western Mediterranean, Azores, Cape Verde region, and south to the Gulf of Guinea from 40–208 m.

ECHINOMETRA LUCUNTER (Linnaeus)

Echinus lucunter Linnaeus, 1758 : 665.

Echinometra lucunter, Koehler, 1914 : 249, Pl. 15, Figs. 83 and 84 ; Mortensen, 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 and 20–24 ; 1951 : 298.

MATERIAL. Christiansborg, Accra—eight specimens ; Axim, Hospital reef—15 specimens ; Lighthouse reef—one specimen ; Tenpobo, number one reef—two specimens ; Winneba—two specimens ; Sekondi, high level plateau—one specimen.

REMARKS. This widespread species seems to be quite common on the Gold Coast in the same areas as *Arbacia lixula africana* from which it is distinguished by the longer spines, often very oval shape of the test, absence of bare patches on the test aborally, and possession of a normal periproct with many small irregular plates.

RANGE. Known from the West Indies, St. Helena, Ascension, Brazil, and off West Africa from Dakar to Angola ; mainly littoral, but sometimes down to *c.* 45 m.

ROTULA DECIESDIGITATA (Leske)

Echinodiscus decies digitatus Leske, 1778 : 209, Pl. 22, Figs. A and B ; 1778a : 145.

Rotula augusti Klein, 1734 : 32, Pl. 22, Figs. A and B ; Greeff, 1881 : 9 ; Studer, 1889 : 27 ; Koehler, 1911 : 24, Pl. 2, Fig. 16 ; Koehler, 1914 : 259, Pl. 12, Figs. 17 and 18, Pl. 14, Fig. 19, Pl. 15, Figs. 31–43 ; Darteville, 1935 : 108 ; 1940 : 184, Pl. 2, Figs. 3 and 4, Pl. 3 ; Mortensen, 1951 : 457, Pl. 57, Fig. 2.

Rotula decies digitata, H. L. Clark, 1914 : 78.

Rotula deciesdigitata, H. L. Clark, 1925 : 175 ; Mortensen, 1927 : 482.

MATERIAL. St. 122, off Accra, 8 m.—three specimens.

Note on the use of this specific name. Mortensen, in his Monograph, reverted to Klein's name *augusti* for this species, though previously (1927) he had followed H. L. Clark (1914) in using the first post-Linnean name, *deciesdigitata* Leske. The reason he gave for this change was that Leske's name, *Echinodiscus decies digitata*, was not bi-nomial like Klein's pre-1758 one. Admittedly this is true, but since Mortensen has elsewhere used Leske's names in preference to Klein's (for instance *Mellita quinquiesperforata* (Leske) rather than *Mellita testudinata* Klein) it is inconsistent to reverse the ruling here, and certainly Klein's specific names should not be used without special dispensation. It is very unfortunate that Leske should have abandoned Klein's names and used double ones as the resultant confusion has been considerable, Klein's names having been in general use until 1911 when H. L. Clark abandoned them for Leske's according to the rules of nomenclature. It might have been better at that time to apply to the International Commission on Nomenclature for the recognition of Klein's widely-used names, but now Leske's names have been adopted by most other authors.

RANGE. Reported from Gambia to Angola from the shore down to about 18 m. depth.

SCHIZASTER EDWARDSI Cotteau

Schizaster edwardsi Cotteau, 1889 : 286, Pl. 3, Figs. 7–12, Pl. 4, Figs. 1–12 ; Mortensen, 1951 : 304, Pl. 21, Figs. 1–4 and 11–13, Pl. 54, Figs. 4, 6, 10, 11, 13, and 18 ; 1951a : 301.

MATERIAL. Sts. 117 and 112, off Accra, 64 and 43 m.—four specimens ; Buchanan sts. 12 and 13, 28 m.—two specimens.

RANGE. Known from Cape Palmas (Liberia) to Angola in 17–66 m.

REFERENCES

BELL, F. J. (1893). On the names or existence of three exotic starfishes. *Ann. Mag. nat. Hist.* (6),**12,** 25–9.

CADENAT, J. (1938). Liste des échinodermes recueillis pendant la cinqieme croisière du navire de recherches 'President-Théodore-Tissier'. *Rev. Trav. Pêches marit. Paris,* **11,** 349–75, Figs. 1–8.

—— (1941). Les Echinodermes de la côte occidentale d'Afrique. Description d'une astérie nouvelle de la région du Cap Blanc. *Ann. Soc. Sci. nat. Charente-Inf.* n.s. **3,** 53–67, three Figs.

CLARK, H. L. (1914). Hawaiian and other Pacific Echini. I. *Mem. Mus. comp. Zool. Harv.,* **46,** 1–78, Pls. 122–43.

—— (1915). Catalogue of recent Ophiurans. *Mem. Mus. comp. Zool. Harv.,* **30** (4), 165–376, Pls. 1–20.

—— (1918). Brittle-stars, new and old. *Bull. Mus. comp. Zool. Harv.,* **62,** 265–338, Pls. 1–8.

—— (1925). *A catalogue of the recent sea-urchins (Echinoidea) in the collection of the British Museum (Natural History),* London. xxviii+250 pp., 12 Pls.

—— (1939). Ophiuroidea. *Sci. Rep. John Murray Exped.,* **6,** 29–136, Text-figs. 1–62.

COTTEAU, G. (1889). Description de trois Echinides vivants recueillis par le Dr. J. Jullien sur les Côtes de Guinée (Liberia). *Int. Congr. Zool.,* **1889,** 281–92, Pls. 2–5 (see also *Bull. Soc. zool. Fr.,* **8,** 340–2 ; **14,** 15.

DARTEVILLE, E. (1935). Les Rotulinae des collections du Musée du Congo. *Bull. Cerc. zool. congol.,* **11,** 105–9, two Figs.

—— (1940). Les 'Rotules' de la côte occidentale d'Afrique. *Bull. Inst. Colon. Belge,* **11,** 175–95, Pls. 1–3.

—— (1950). Sur un Oursin remarquable de la côte occidentale d'Afrique, *Plagiobrissus africanus* (Verrill). *Bull. Inst. Colon. Belge,* **21** (4), 913–7, one Pl.

DELLE CHIAJE, S. (1823–29). *Memorie sulla storia e notomia degli animali senza vertebre del Regno di Napoli.* Napoli. Four vols.

DILWYN JOHN, D. (1948). Notes on Asteroids in the British Museum (Natural History)—I. The species of *Astropecten*. *Novit. Zool.*, **42** (3), 485–508, Pls. 1–4.

DÖDERLEIN, L. (1917). Die Asteriden der Siboga-Expedition. I. Die Gattung *Astropecten* und ihre Stammesgeschichte. *Siboga-Exped.*, **46a,** 1–192, 17 Pls.
—— (1920). Die Asteriden der Siboga-Expedition. II. Die Gattung *Luidia* und ihre Stammesgeschichte. *Siboga-Exped.*, **46b,** 193–294, Text-figs. 1–5, Pls. 18–20.
—— (1936). Die Asteriden der Siboga-Expedition. III. Die unterfamilie Oreasterinae. *Siboga-Exped.*, **46c,** 295–369, Pls. 21–32.

FISHER, W. K. (1940). Asteroidea. *'Discovery' Rep.*, **20,** 69–306, Figs. A–M, 23 Pls.

GREEFF, R. (1881). Echinodermen beobachtet auf einer Reise nach der Guinea-Insel Sao-Thomé. *Zool. Anz.*, **1881** (105–7), 114–20, 135–9, 156–9 (pp. 1–15 of separate).

HUPÉ, L. H. (1857). Zoophytes. *In* CASTELNAU, F. L. de L. de. *Expedition dans les parties centrales de l'Amerique du Sud.* Paris. VII. Zoologie, **3,** 103 pp., 22 Pls.

KLEIN, J. T. (1734). *Naturalis dispositio Echinodermatum accessit lucubratiuncula de aculeis Echinorum marinum.* Gedani. 1–78 pp., 36 Pls.

KOEHLER, R. (1905). Ophiures littorales. *Siboga-Exped.*, **45b,** 1–142, 18 Pls.
—— (1906). Descriptiones des ophiures nouvelles recueillis par le 'Travailleur' et le 'Talisman' pendent les campagnes de 1880–1883. *Mem. Soc. zool. Fr.*, **19,** 5–35, Pls. 1–3.
—— (1907). Ophiures. *Exped. Sci. Travailler, Talisman,* **8,** 245–311, Pls. 18–21.
—— (1907a). Revision de la collection des Ophiures du Museum d'Histoire naturelle de Paris. *Bull. Sci. France Belgique,* **41,** 279–351, five Pls.
—— (1909). Echinodermes provenant de campagnes du yacht 'Princesse-Alice'. *Result. Camp. sci. Monaco,* **34,** 1–317, 32 Pls.
—— (1911). Mission Gruvel sur la côte occidentale d'Afrique (1909–10). Echinodermes. *Ann. Inst. océan,* **2** (5), 1–25, three Pls.
—— (1911a). Mission en Mauritanie occidentale. Echinodermes. *Actes Soc. Linn. Bordeaux,* **65,** 19.
—— (1914). Asteroidea, Ophiuroidea et Echinoidea. *Beitr. Meeresfauna Westafr.*, **1** (2), 87–303, Pls. 4–15.
—— (1923). Sur quelques Ophiures des côtes de l'Angola et du Cap. *Göteborgs VetenskSamh. Handl.*, (4), **25** (5), 1–11, Pl. 1.
—— (1926). Révision de quelques ophiures de Ljungman appartenant au Musée d'Histoire naturelle de Stockholm. *Ark. Zool.*, **19a** (2), 1–29, Pls. 1–4.

LESKE, N. G. (1778). Klein. *Naturalis dispositio Echinodermatum accesserunt lucubratiuncula de aculeis Echinorum Marinorum.* Lipsiae. xx+278 pp., Pls. 1–54.
—— (1778a). *Additamenta ad Jacobi Theodori Klein Naturalem Dispositionem Echinodermatum et Lucubratiunculam de Aculeis Echinorum Marinorum.* Lipsiae. xx + 214 pp., Pls. 37–54.

LINNAEUS, C. (1753). *Museum Tessinianum.* Holmiae. fol.
—— (1758). *Systema Naturae,* Ed. X, **1.** Holmiae. 824 pp.

LJUNGMAN, A. V. (1867). Ophiuroidea viventia huc usque cognita enumerat. *Ofvers. VetenskAkad. Forh. Stockh.*, **23,** 303–36.
—— (1871). Förteckning öfver uti Vestindien af Dr. A. Goes samt under Korvetten 'Josefinas' Exped. i Atlantiska Oceanen samlade Ophiurider. *Ofvers VetenskAkad. Forh. Stockh.*, **28,** 615–58.

LORIOL, P. DE (1900). Notes pour servir à l'étude des Echinodermes, 8. *Rev. suisse Zool.*, **8,** 55–96, Pls. 6–9.

LÜTKEN, C. F. (1859). Additamenta ad historiam Ophiuridarum. II. *K. danske vidensk. Selsk. Skr.*, Naturv. mathem. (5), **5,** 179–271, five Pls.

LYMAN, T. (1878). Reports on the dredging operations of the U.S. Coast Survey steamer 'Blake'. Ophiurans. *Bull. Mus. comp. Zool. Harv.*, **5** (9), 217–38, three Pls.

—— (1879). Ophiuridae and Astrophytidae of the 'Challenger'. II. *Bull. Mus. comp. Zool. Harv.*, **6** (2), 17–83, Pls. 11–19.

—— (1882). Ophiuroidea. *Rep. Sci. Res. 'Challenger'* Zool., **5**, 1–386, 46 Pls.

MADSEN, F. J. (1950). The Echinoderms collected by the Atlantide-Expedition 1945–46. I. Asteroidea. *Sci. Res. Danish Exped. W. Afr.*, **1**, 167–222, Text-figs. 1–11, Pls. 14–16.

MARKTANNER-TURNERETSCHER, G. (1887). Beschreibung neuer Ophiuriden und Bemerkungen zu bekannten. *Ann. naturh. (Mus.) Hofmus. Wien*, **2**, 291–316, Pls. 12 and 13.

MÖBIUS, K. (1859). Neue seesterne des Hamburger und Kieler Museums. *Abh. Naturw. Hamburg*, **4** (2), 1–14, Pls. 1–4.

MORTENSEN, T. (1909). Die Echinoiden der deutschen Südpolar-Expedition, 1901–1903. *Dtsch. SüdpolExped.*, **11**, 1–114, Pls. 1–19.

—— (1925). Echinoderms of New Zealand and the Auckland-Campbell Islands. 2. Ophiuroidea. *Vidensk. Medd. naturh. Foren.. Kbh.*, **77**, 91–177, Text-figs. 1–36, Pls. 3 and 4.

—— (1925a). Echinodermes du Maroc et de Mauritanie. *Bull. Soc. Sci. nat. Maroc.*, **5**, 178–87, Pl. 32.

—— (1927). *Handbook of the Echinoderms of the British Isles*. Oxford. 471 pp., 269 Text-figs.

—— (1927a). *In* MONOD. Contribution à l'étude de la faune du Cameroun. **1**. *Faune Colon. franç.*, **1**, 481–2.

—— (1928-51). *Monograph of the Echinoidea*. Copenhagen. I. Cidaroidea, 1928 ; II. Bothriocidaroida, Melonechinoidea, Lepidocentroida, and Stirodonta, 1935 ; III (1). Aulodonta, 1940 ; III (2) and (3). Camarodonta, 1943 ; IV (1). Holectypoida, Cassiduloida, (2) Clypeastroida, 1948 ; V (1). Spatangoida 1, 1950 ; V (2). Spatangoida 2, 1951.

—— (1933). Echinoderms of South Africa (Asteroidea and Ophiuroidea). *Vidensk. Medd. naturh. Foren. Kbh.*, **93**, 215–400, Text-figs. 1–91, Pls. 1–12.

—— (1933a). Echinoderms of St. Helena. *Vidensk. Medd. naturh. Foren. Kbh.*, **93**, 401–72, Text-figs. 1–29, Pls. 20–22.

—— (1936). Echinoidea and Ophiuroidea. *'Discovery' Rep.*, **12**, 199–348, 53 Text-figs., nine Pls.

—— (1940a). Echinoderms from the Iranian Gulf. *Danish Sci. Invest. Iran*, **2**, 55–112, 24 Figs., two Pls.

—— (1951a). Report on the Echinoidea collected by the 'Atlantide' Expedition. *Sci. Res. Danish Exped. W. Afr.*, **2**, 293–303, one Text-fig., two Pls.

MÜLLER, J. and TROSCHEL, F. H. (1842). *System der Asteriden*. Braunschweig. xx + 134 pp., 12 Pls.

D'ORBIGNY, A. (1839). Mollusques, Echinodermes, Foraminifères et Polypiers, recueillis aux Iles Canaries. *In* WEBB, P. B. and BERTHELOT, S., *Histoire Naturelle des Iles Canaries*, **2** (2), 152 pp., 14 Pls.

PERRIER, E. (1875). *Revision de la collection de Stellérides du Museum d'Histoire Naturelle de Paris*. Paris, 384 pp. (also published in *Arch. Zool. exp. gén.*, **4** (1875), 263–449 ; **5** (1876), 1–104, 209–304).

PHILIPPI, R. A. (1845). Beschreibung einiger neuen Echinodermen. *Arch. f. Naturgesch.*, **1845** (1), 344–359.

ROCHEBRUNE, A. T. DE (1881). Materiaux pour la faune de l'Archipel du Cap Vert. *Nouv. Arch. Mus. Hist. nat. Paris*, (2), **4**, 215–338, Pls. 17–19.

SAY, T. (1825). On the species of the Linnaean genus *Asterias* inhabiting the Coast of the United States. *J. Acad. nat. Sci. Philad.* (1), **5**, 141–54.

STUDER, T. (1882). Übersicht über die Ophiuriden, welche während der Reise S.M.S. 'Gazelle' um die Erde 1874–76 gesammelt wurden. *Phys. Abh. K. Akad. Wiss.*, **1882**, 1–37, three Pls.

—— (1884). Verzeichniss der während der Reise S.M.S. 'Gazelle' um die Erde 1874–76 gessamelten Asteriden und Euryaliden. *Phys. Abh. K. Akad. Wiss.*, **1884** (2), 1–64, five Pls.

—— (1889). *Die Forschungsreise S.M.S. 'Gazelle'* 1874–1876. III. Zoologie und Geologie. Berlin. vi+322 pp., 33 Pls.

TROSCHEL, F. H. (1872–3). Die Familie der Echinocidariden. *Arch. f. Naturgesch.* (1872), **38**, 293–356 ; (1873) **39**, 308–356.

VERRILL, A. E. (1871). Descriptions of starfishes and Ophiurans from the Atlantic coasts of America and Africa. *Amer. J. Sci.* (3), **2**, 130–3.

—— (1899). North American Ophiuroidea. I. Revision of certain families and genera of West Indian Ophiurans. *Trans. Conn. Acad. Arts Sci.*, **10**, 301–71, two Pls.