



A HISTORY
OF
BRITISH STARFISHES.

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A HISTORY
OF
BRITISH STARFISHES,
AND OTHER ANIMALS OF THE CLASS
ECHINODERMATA.

BY EDWARD FORBES, M.W. S. FOR. SEC. B. S. ETC.



ILLUSTRATED BY WOODCUTS.

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TO
PROFESSOR AGASSIZ,
IN ADMIRATION OF HIS SCIENTIFIC LABOURS,
AND IN GRATITUDE FOR THE SERVICES HE HAS RENDERED TO
THE NATURAL HISTORY OF BRITAIN,
THIS VOLUME IS DEDICATED
BY
A BRITISH NATURALIST.

P R E F A C E.

THIS History of the British species of a much neglected but beautiful and interesting class of animals originated in an attempt to revise the characters of such Starfishes as inhabit the Irish Sea, and to introduce the generic arrangements proposed by Professor* Agassiz, which I laid before the Wernerian Society, with the approbation of its distinguished president, Professor Jameson, and which was published in 1839 in the eighth volume of its Transactions. Without the kind assistance of my brother naturalists, the materials for the following pages could not, however, have been gathered. To my friend Mr. John Goodsir I am especially indebted for assistance and advice. From Mr. Thompson of Belfast a great portion of my information has been derived ; and the materials which he had been collecting for several years, in order to prepare an account of the Irish species, were most liberally, and without reserve, placed in my hands, as were, also, with like kindness, Mr. Robert Ball's collections for an account of the Echinidæ. In Scotland I have derived most valuable aid from Professor Jameson, Dr. Johnston of Berwick,

and Dr. P. Maclagan; in England from Mr. Alder, Mr. Beau of Scarborough, Mr. Bellamy of Plymouth, and Mr. Gray of the British Museum, and from many other gentlemen in both countries, and in the sister island, whose assistance I have recorded in the text. In Dublin Captain Portlock most liberally permitted me to examine the Ordnance collection. To all these gentlemen I return my fervent thanks, also to Professor Agassiz, who most kindly permitted me to make use of the notes he had made on the British collections of these animals during his last visit to our country.

Nor must I forget favours of the pencil. To my friend Mr. G. J. Bell the volume is indebted for some of its most interesting embellishments: Mr. Alder and Mr. Thompson have also contributed to the ornamental part. The wood-cutting speaks for itself,—thanks to Mr. Bastin, who in the most praiseworthy manner made himself acquainted not merely with the drawings, but with the texture and appearance of the animals themselves, in order the better to express them.

With three exceptions the figures of species are from my own drawings, and with a view to secure correctness were mostly drawn on the wood by myself. In the text I have endeavoured faithfully to do justice to preceding writers, and rarely have quoted a synonym which I have not myself verified. I have endeavoured to bring the subject as near as possible to the present state of science, and trust that few memoirs essential to my purpose have escaped me. I should have wished to have made more

use than I have done of the valuable papers on the Echinidæ by M. Desmoulins, but could lay hands on a portion of them only. Since I commenced the publication two papers have appeared which I must notice, as they add several to my enumeration of the synonyms of the Starfishes. The one is a Memoir by one of the greatest living physiologists, Muller of Berlin, on the genera of the Starfishes, read before the Berlin Academy in April 1840. This paper must be praised on account of the excellent way in which the characters of the genera are drawn up. The chief novelty is the employment of the anus of Starfishes (or anal pore) as a source of family distinction, which aperture Muller describes as existing in all Starfishes saving *Asterias* proper, and a new genus, *Hemichemis*, which seems identical with my previously constituted *Luidia*. His genus *Crossaster*, also, is my *Solaster*, published the year before. Several generic names previously adopted by Agassiz and Nardo are wantonly changed; thus, *Urastrer* is turned into *Asterocanthium*, and *Palmipes* into *Asteriseus*, with which he unites *Asterina*. In this paper Muller maintains that one of the five intermediate inferior plates of the Ophiuridæ bears a madreporiform tubercle, or rather corresponds to that body, a view which I am not inclined to adopt.

The other Memoir to which I must allude is one by Mr. Gray on the Starfishes, which he calls the class *Hypostoma*, and defines somewhat ambiguously, published simultaneously with my two first numbers, in the *Annals of Natural History*. I am afraid I must censure Mr. Gray for chang-

ing names still more than Muller, and with less reason. It is a pity zoologists do not take a lesson from their fellow labourers in the field of Nature, the botanists, in this respect. Mr. Gray has increased the confusion by giving fragments of descriptions instead of generic and specific characters, probably from carrying too far a laudable desire for brevity. His essay deserves praise, however, for recording many new foreign habitats of the beautiful animals he catalogues.



INTRODUCTION.

THE ECHINODERMATA constitute one of the three great classes into which the Radiata are divided. The radiate type presents us with animals which either have their parts arranged in a ray-like manner round a common centre, or have their bilaterality so modified as to give them a star-like form. The Zoophytes, the Medusæ, and the creatures to which this volume is devoted, constitute the type. The Echinodermata are most highly organized, much more so than the Polypes; they are almost all free animals, creeping about at the bottom of the sea; and as the greater number of species are covered with a coriaceous skin, which is commonly strengthened by calcareous plates or spines, they have derived their general appellation from that remarkable character, which at once distinguishes them from the Medusæ, free swimming animals of the most delicate and membranous texture.

Throughout animated Nature forms and structures merge into each other. While the central groups of a type present its essential characters, the more distant families approach in appearance and habits to the members of some other great class of forms. This is equally true respecting small as well as large groups. Thus, the class of Radiata before us presents examples, at one extreme, of animals truly symmetrical, and, at the other, of species which approach either in general form or in their early life to the Amorphozoa, the lowest of animal types. For example,

while the first state of a Comatula is analogous to a sponge or a Polypidom, the highest groups of Echinodermata are creatures resembling Mollusca or Annelida. Correspondent with the progression of form is the progression of organization and of sagacity.

Externally, the majority of Echinodermata are radiated, and the lowest groups resemble Polypes. The first species figured in this history is the Feather-star, a creature which in its youth is fixed and pedunculate, like a Zoophyte ; in its adult state free and star-like. When dredging in Dublin Bay in August 1840, with my friends Mr. R. Ball and W. Thompson, we found numbers of the Phytocrinus or Polype state of the Feather-star, more advanced than they had ever been seen before, so advanced that we saw the creature drop from its stem and swim about a true Comatula ; nor could we find any difference between it and the perfect animal, when examining it under the microscope. From the Comatula we proceed onwards through forms gradually changing character, until in the Sea-Urchins we have the true representatives of the Echinodermata. In them we have the perfection of an Echinodermatous integument. We have arrived, as it were, at the summit of a pyramid, and we descend through a series of forms as gradually conducting us to the Mollusca and the Vermes. The Holothuriadæ, which at first have the appearance of soft Sea-Urchins, gradually change their forms, and become more and more Molluscan in character. The Sipunculidæ progress in like manner towards the Annelida ; and in the animals described last in this volume, we see Radiata, which have so put on the garb of worms that by many naturalists they have been classed as such.

Every great class in the animal kingdom, when considered anatomically or physiologically, may be looked on

as the completing of some organ or function, even as zoologically it represents the completing of some important modification of form. In the lowest division of the Radiata, that of Zoophytes, the digestive system has passed through all its essential changes, therefore we do not see a true progression of the organs of that system among the Echinodermata. We find its variations depend rather on the circumstances under which the species are destined to live than on any progression of structure. Thus it appears anomalous at first, that the lowest Echinodermata should have digestive organs of more complicated nature than some higher tribes; that the Feather-star should have an intestinal canal with two orifices, whilst all the Ophiuridæ and many true Starfishes have but one; or that the Splanchno-skeleton (dental apparatus) of the Echinidæ should be more highly developed than that of the Holothuridæ; but looking at the system according to the view I have taken of its completion in a lower tribe, this is what we should expect. Not so, however, with all the functional systems. The respiratory goes through a series of modifications complicating as we advance, so also do the circulatory and the nervous. But it is the muscular which is especially presented in all its essential modifications in the class before us, from the first appearance of a contractile tissue, as seen in the granular tissue of the lowest Echinodermata, to its perfect developement in the complicated muscular mechanism presented by many of the Vermigrade species.

The system most characteristic of the Radiate type is the Aquiferous, or apparatus for a water circulation; indeed, it can scarcely be said to exist in any of the other types. It is chiefly developed in the Arachnodermata and Echinodermata, and in the last is intimately connected

with the movements of the animals; for it is by means of this water circulation that the suckers or cirrhi are enabled to act as organs of progression. In many species of the most typical group, that of Echinidæ, we find a portion of the dermato-skeleton turned in, as it were, to form arches for the protection of the water-canals, thus evidencing their great importance in those creatures. Among the Annelidous Echinodermata, however, the aquiferous system seems altogether to disappear.

On the modifications of this characteristic system, its presence or absence, and its combination with the tegumentary system for purposes of motion, I have founded my arrangement of the Echinodermata. I look upon the Echinodermata and Arachnodermata as two parallel groups, and hold it as a law that *the divisions of parallel groups should be based on a common principle*. The orders of the latter class have always been founded on the modifications of their organs and modes of progression: the orders of the class before us I have founded on the same consideration, and need only call the attention of the philosophical zoologist to the naturalness of the divisions so formed, and to their equidistance from each other, and I feel confident he will acknowledge the truth of my arrangement.

- Order I. PINNIGRADA. CRINOIDÆ—First appearance of cirrhi, springing from brachial membranes, which, with the true arms, form the organs of motion.
- II. SPINIGRADA. OPHIURIDÆ—Disappearance of brachial membranes, cirrhi as before; true arms clothed with spines for motion.
- III. CIRRHIGRADA. ASTERIDÆ — Arms disappear; body more or less lobed, and lobes channeled beneath for cirrhi, which act as suckers, and are the organs of motion.

Order IV. CIRRHII-SPINIGRADA. ECHINIDÆ—Gradual disappearance of lobes; cirriferous canals appearing as avenues where cirrhi act as in Order III. but are assisted by mobile spines clothing the integument.

V. CIRRHII-VERMIGRADA. HOLOTHURIADÆ—Lobes disappear; motions effected by avenues of cirrhi, assisted by contraction and extension of the soft body.

VI. VERMIGRADA. SIPUNCULIDÆ—Cirrhi become obsolete and disappear; motion effected by the contraction and extension of the animal's body.

A glance at this arrangement will at once show that it is most natural. There is nothing novel in it as regards the constitution of the groups, saving the recognition of the Ophiuridæ as an order equivalent to the other orders; but as an explanation of the true nature and relation of the Echinodermatous tribes, I prefer it to any arrangement at present used, and have accordingly followed it throughout this work.

All the Radiata are greatly influenced in the arrangement of their parts by some definite number. In the Echinodermata the reigning number is five. The name of "five-fingers," commonly applied by mariners to the Starfishes, is founded on a popular recognition of the number regnant. It has long been noticed. Among the problems proposed by that true-spirited but eccentric philosopher, Sir Thomas Browne, is one, "Why, among Sea-stars, Nature chiefly delighteth in five points?" and in his Garden of Cyrus he observes, "By the same number (five) doth Nature divide the circle of the Sea-star, and in that order and number disposeth those elegant semicircles or dental sockets and eggs in the Sea Hedge-hog." Among the lower and the typical orders we find this number regulating the number of parts. Every plate of the Sea-Urchin is built up of

pentagonal particles. The skeletons of the digestive, the aquiferous, and the tegumentary systems, equally present the quinary arrangement; and even the cartilaginous framework of the disk of every sucker is regulated by this mystic number. When the parts of Echinoderms deviate from it, it is always either in consequence of the abortion of certain organs, or it is a *variation by representation*, that is to say, by the assumption of the regnant number of another class. Thus do monstrous Starfishes and Urchins often appear quadrate, and have their parts fourfold, assuming the reigning number of the Actinodermata, consistent with a law in which I put firm trust, that *when parallel groups vary numerically by representation they vary by interchange of their respective numbers.*

In this short introduction I have rather given the generalities of the subject than details of structure, for which I would refer the reader to the excellent account of the anatomy of Echinodermata given by Professor Jones in his *Outlines of the Animal Kingdom*. I shall conclude by presenting a tabular view of the distribution of our native species. In the first of the two following tables, the numbers of species of each family known to inhabit the several zones of the sea is given; in the second a view of their distribution in the various provinces of the British seas, with such foreign localities as are recorded. I have divided the marine provinces thus:—I. Thulean, including the Orkney and Shetland Isles. II. Hebridean. III. Scottish eastern coast. IV. English eastern coast. V. English Channel. VI. St. George's Channel. VII. Southern, the district between Land's End and Cape Clear. VIII. South-west Irish. IX. North-west Irish. X. The Clyde province and North Channel. XI. The Irish Sea.

I.

TABLE OF ZONAL DISTRIBUTION.

Zones of the Sea.	Crinoideæ.	Ophiuridæ.	Asteriadeæ.	Echinidæ.	Holothuriadæ.	Sipunculidæ.	Total.
Littoral	0	4	6	3	1	2	16
Laminarian	1	5	6	4	5	6	27
Coralline	1	9	11	7	12	2	42
Deep-sea Coral . .	0	3	3	3	?	?	9

II.

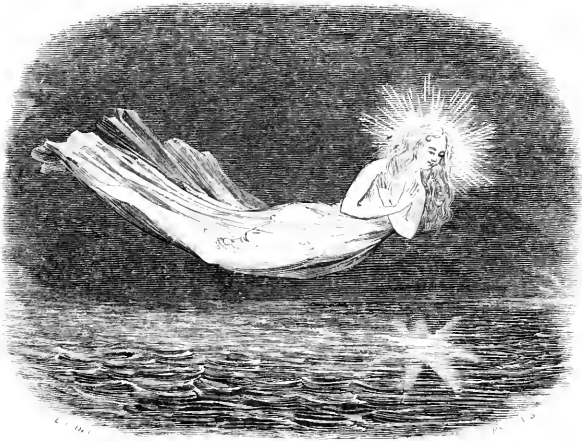
TABLE OF THE GEOGRAPHICAL DISTRIBUTION OF THE BRITISH SPECIES OF ECHINODERMATA.

	Genera and Species.	British Distribution.	General Distribution.
I.	PINNIGRADA.		
1	COMATULA, Lam. rosacea, Link.	I. II. VI. VII. X. XI.	Scandinavia, Mediter- ranean.
II.	SPINIGRADA.		
1	OPHURA, Lam. texturata, Lam.	I.—XI.	Scandinavia, Celtic, Mediterranean.
2	albida, Forbes.	I.—XI.	North Sea.
III.	OPHIOCOMA, Agas.		
1	neglecta, Johnst.	I. III.—VI. VIII.—XI.	
2	Balli, Thomp.	VI.	
3	punctata, Forbes.	III.	
4	filiformis, Mul.	VIII. X.	Norway.
5	brachiata, Mont.	V. X.	
6	granulata, Link.	I. V. VI. X. XI.	Scandinavia.
7	bellis, Link.	I.—VI. X. XI.	Arctic and Scandina- vian Seas.
8	Goodsiri, Forbes.	I. III.	
9	rosula, Link.	I.—XI.	Arctic, Scandinavian, Celtic, and Mediter- ranean Seas.
10	minuta, Forbes.	VII. XI.	
IV.	ASTROPHYTON, Link.		
1	scutatum, Link.	I. VII.	Arctic and Scandina- vian Seas. Indian Ocean? Mediter.?
V.	CIRRHIGRADA.		
1	URASTER, Agas.		
1	glacialis, Lin.	II. VII. VIII. X. XI.	All the European seas.
2	rubens, Lin.	I.—XI.	Throughout the seas of Europe.
3	violacea, Mul.	I.—IV. VI. VII. X. XI.	Norwegian and Baltic Seas.
4	hispida, Pen.	II. III. X. XI.	
VI.	CRIBELLA, Agas.		
1	oculata, Pen.	I.—IV. VI. VII. X. XI.	Norway? West of France.
2	rosca, Mul.	VII. X.	
VII.	SOLASTER, Forbes.		
1	endeca, Lin.	I. III. IV. VI. VII. XI.	Scandinavia.
2	papposa, Lin.	I.—XI.	Scand. and Celt. Seas, Mediterr.? Asia?

	Genera and Species.	British Distribution.	General Distribution
VIII.	PALMIPES. Link.		
1	membranaceus. Retz.	IV. VII. X. XI.	Arctic, Scandinavian, and Mediter. Seas.
IX.	ASTERINA. Nardo.		
1	gibbosa. Pen.	II. V.—XI.	Celt. & Mediter. Seas.
X.	GONIASTER. Agas.		
1	Templetoni. Thomp.	I. V. VII. X. XI.	
2	equestris. Gmel.	III. IV. VII.	North Sea.
XI.	ASTERIAS. Lin.		
1	aurantiaca. Lin.	I. III.—XI.	All the European seas.
XII.	LUDIA. Forbes.		
1	fragilissima. Forbes.	I. III. IV. VII. VIII. X. XI.	
	CIRRHI-SPINIGRADA.		
XIII.	CIDARIS. Leske.		
1	papillata. Flem.	I.	Norway.
XIV.	ECHINUS. Lin.		
1	sphæra. Mul.	I.—XI.	Arctic, Northern, and Celtic Seas.
2	miliaris. Leske.	I.—VII. X. XI.	
3	Flemingii. Ball.	I. VII.	
4	lividus. Lam.	VIII. IX.	Mediter. Portugal?
5	neglectus. Lam.	I.	West of France.
XV.	ECHINOCYAMUS.		
	Leske.		
1	pusillus. Mul.	I.—XI.	Norway. West of France.
XVI.	ECHINARACHNIUS.		
	Leske.		
1	placenta. Gmel.	I.	Canada, Asia?
XVII.	SPATANGUS. Klein.		
1	purpureus. Mul.	I. III. IV. VI. XI.	Scandinavia, Mediterranean.
XVIII.	BRISSUS. Klein.		
1	lyrifer. Forbes.	X.	
XIX.	AMPHIDOTUS. Agas.		
1	cordatus. Pen.	I.—XI.	Northern seas.
2	roseus. Forbes.	I. III. VI. VII. X. XI.	
	CIRRHI-VERMI-GRADA.		
XX.	PSOLUS. Oken.		
1	phantapus. Lin.	I. III.—V. X. XI.	Norway.
XXI.	PSOLINUS. Forbes.		
1	brevis. F. and G.	I. X.	
XXII.	CUCUMARIA. Blainv.		
1	frondosa. Gunner.	I. III.	Norway.
2	pentactes. Mul.	III.—V. X.	Northern and Celtic Seas.
3	communis. F. and G.	III. VII. X.	
4	fusiformis. F. and G.	I.	
5	hyalina. Forbes.	I.	
6	Drummondii. Thomp.	X.	
7	Hindmanni. Thomp.	VIII. X.	
8	fucicola. F. and G.	I.	

	Genera and Species.	British Distribution.	General Distribution
XXIII.	OCNUS. F. and G.		
1	brunneus. Forbes.	III. X. XI.	
2	lactens. F. and G.	I. III. X.	
XXIV.	THYONE. Oken.		
1	papillosa. Mul.	I. III. VIII. X. XI.	Norway.
2	Portlockii. Forbes.	X.	
XXV.	CHIRODOTA. Esch.		
1	digitata. Montagu.	V.	
	VERMIGRADA.		
XXVI.	SYRINX. Bohadsch.		
1	nudus. Lin.	IV. V. VII.	Celtic Seas. Mediter.
2	papillosus. Thomp.	VIII. XI.	West Indies.
3	Harveii. Forbes.	V.	
XXVII.	SIPUNCULUS. Lin.		
1	Bernhardus. Forbes.	I. XI.	Norway, France.
2	Johnstoni. Forbes.	III. V. ?	
XXVIII.	PRIAPULUS. Lam.		
1	caudatus. Lam.	I. III. IV. X.	Arctic and Scandina- vian Seas.
XXIX.	THALASSEMA. Cuv.		
1	Neptuni. Gaertner.	IV.	
XXX.	ECHIURUS. Cuv.		
1	vulgaris. Savig.	III.	Belgic coast.

BRITISH ECHINODERMATA.



CRINOIDEÆ,

OR PINNIGRADE ECHINODERMATA.

ONE of the most remarkable phenomena displayed to us by the researches of the geologist, is the evidence of the existence, in primæval times, of animals and plants, the analogies of which are now rare or wanting on our lands and in our seas. Among those tribes which have become all but extinct, but which once presented numerous generic modifications of form and structure, the order of Crinoid Starfishes is most prominent. Now scarcely a dozen kinds of these beautiful animals live in the seas of our globe, and

individuals of these kinds are comparatively rarely to be met with: formerly they were among the most numerous of the ocean's inhabitants,—so numerous that the remains of their skeletons constitute great tracts of the dry land as it now appears. For miles and miles we may walk over the stony fragments of the Crinoideæ; fragments which were once built up in animated forms, encased in living flesh, and obeying the will of creatures among the loveliest of the inhabitants of the ocean. Even in their present disjointed and petrified state, they excite the admiration not only of the naturalist but of the common gazer; and the name of Stone-lily popularly applied to them, indicates a popular appreciation of their beauty. To the philosopher they have long been subjects of contemplation as well as of admiration. In him they raise up a vision of an early world, a world the potentates of which were not men but animals—of seas on whose tranquil surfaces myriads of convoluted Nautili sported, and in whose depths millions of Lily-stars waved wilfully on their slender stems. Now the Lily-stars and the Nautili are almost gone; a few lovely stragglers of those once-abounding tribes remain to evidence the wondrous forms and structures of their comrades. Other beings, not less wonderful, and scarcely less graceful, have replaced them; while the seas in which they flourished have become lands, whereon man in his columned cathedrals and mazy palaces emulates the beauty and symmetry of their fluted stems and chambered shells.

Throughout the animal kingdom we find groups which, when compared with a neighbouring group of equal value, present higher *affinities* and yet lower *analogies*. The order before us is a good example, and may serve as an explanation of this rather obscure-sounding doctrine. The

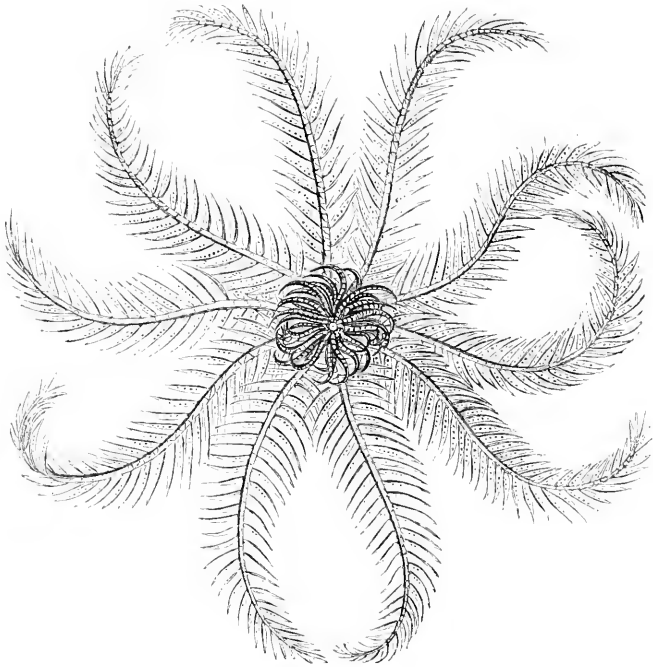
Crinoids as *analogues* of the Polypes are lower than the Asteroids, but as *allies* of the Asteroids are their superiors. An Emericite is a Polype-like Starfish. Suppose, as Professor Jones has well suggested, an Ascidioid Zoophyte strengthened by depositions of calcareous matter in its arms and stems, and you have a Crinoid Starfish. In that point of view the latter is a link between the Echinoderms and the Polypes. But the link is, as it were, lateral—a link of *analogy*—for the Ascidioid Polypes themselves are higher in their organisation than many Echinoderms. Their digestive system is more developed than that of the Starfishes. In them we see for the first time Echinoderms with two openings to their digestive canal. Their generative system is spread over the tegumentary covering of their body and arms, they have tentacular filaments like those of the Ophiuræ; and the pinnæ with which the arms are furnished, have the skin so developed on their sides as to enable them to serve as fins wherewith the animal can swim through the water in the manner of the Medusæ, whence the name of *Pinnigrade Echinoderms* which I have applied to them, indicative of this mode of progression.

It will be seen in the account of the *Comatula*, or Feather-star, that we believe that animal to be fixed and stable, like one of the fossil Emericites, when it is young. At the same time it is very probable that there are Crinoids which are stalked throughout life, and that most of the fossil species were of such a nature. Tribes which form a link between one mode of existence and another, generally present examples of both and combinations of both. Thus among the Polypes do we find in the family Tubulariadae the connecting link between the naked and clothed Hydroid Polypes, animals which are naked

CRINOIDEÆ.

throughout life, others naked through a part of their existence, and others which are enclosed in a tube throughout their lives. In like manner may we expect to find in the order of Crinoideæ animals fixed throughout life, others fixed through a portion of their existence only, and others which are free almost from their births. As yet, however, we know so little of the history of the tropical species that we cannot pronounce with certainty, and at present we can only recognise two families of Crinoids as properly constituted, such as are stalked as the *Eucrinites* and the *Comatulæ*, and such as are sessile, as the genus *Holopus* of M. D'Orbigny. This division can only be regarded as provisional.

CRINOIDEÆ.

Genus *Comatula*. Lamarek.

Generic Character.—Body having five bifurcated pinnated arms: when adult, free, with simple filiform jointed appendages attached to the sides of its dorsal disk. When young, fixed on a long simple jointed (pentangular) stalk. (Phytocrinus.)

ROSY FEATHER-STAR.

Comatula rosacea. Link.

Specific Character.—Rays dorsally rounded, with only two joints below the bifurcation of each.

Stella (decamerus) rosacea, LINK, p. 55, t. xxxvii. f. 66. Encyc. pl. cxxiv. f. 6.

Stella (decamerus) barbata, LINK, t. xxxvii. f. 65.

- Asterias bifida* and *A. decacnemus*, PENNANT, Brit. Zool. IV. pp. 65, 66, No. 70, 71, tab. xxxiii. f. 71.
- Asterias pectinata*, ADAMS, Lib. Trans. V. 10.
- Comatula Mediterranea*, LAM. 1 Edit. II. p. 535. 2 Edit. III. p. 210. SÆRS, Besk. og Jagt. p. 40, pl. viii. fig. 19.
- Comatula rosacea*, FLEMING, Brit. An. p. 490. BLAINV. Man. d'Actin. p. 248. FORBES, Wern. Mem. VIII. p. 128.
- Comatula barbata*, FLEMING, Brit. An. p. 490.
- Comatula finbricata*, MILLER, Crinoideæ, p. 132, pl. i.
- Alecto Europæa*, LEACH, Zool. Misc. II. p. 62.
- Jour. Pentacrinus Europæus*, THOMPSON, Mem. on. Pentac. Eur. t. i. and ii. Edin. Phil. Journ. vol. xx. p. 35, pl. ii. FLEMING, Brit. Anim. p. 490. BUCKLAND'S Bridg. Tr. pl. lii. f. 2.
- Phytoecrinus Europæus*, BLAINV. Man. d'Actin. p. 255, pl. xxvii. f. 1—3.

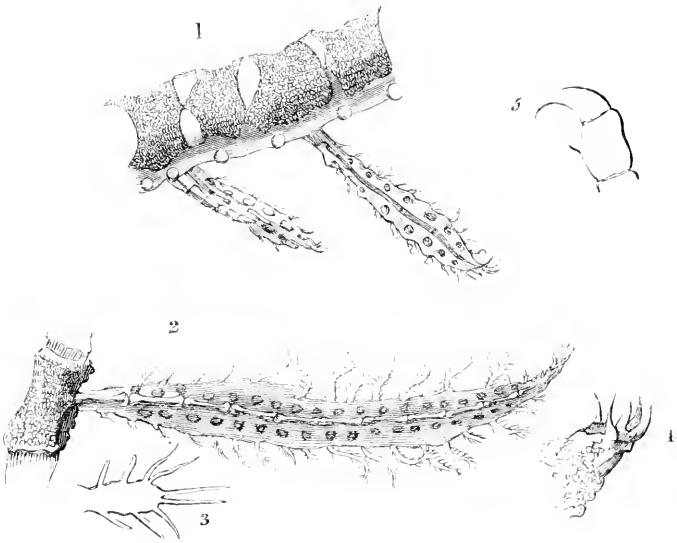
AFTER what I have said of the former importance of the Crinoid Starfishes in the economy of the world, it need scarcely be remarked that the history of the only Crinoid animal at present inhabiting our seas, at one time so full of those beautiful and wonderful creatures, must present many points of great interest not to the zoologist only, but also to the geologist. And in truth the history of the Feather-star,—for so on account of its plumose appearance I would designate the Starfish called by naturalists *Comatula*,—is one of the little romances in which natural history abounds, one of those narrations which, while believing, we almost doubt, and yet, while doubting, must believe. Nevertheless, there is nothing inconsistent with the creature's position in the animal kingdom in the account of the developement of the *Comatula*; but before speaking of that subject, it is best we describe the animal in all its parts.

The adult *Comatula* consists of a cup-shaped calcareous base, in the concavity of which is placed a soft body, and on the convexity a number of slender, jointed, simple arms. The base branches into five arms, which very soon bifur-

cate, so that as the two branches of each arm are very long, and the undivided part extremely short, the animal appears to be ten-armed. These arms are pinnated with single pinnæ, each of which bears a membranous expansion and other organs, all which parts we must now examine in detail.

1. The cup-shaped base is very convex on one side, and deeply concave on the other. The convex part consists of a somewhat pentangular disk or true base, and five sides or surfaces. The disk is smooth, but the sides are punctate, with concave hexagonal impressions, the largest of which are lowest. These are the sockets of the filaments, which vary in number according to the age of the animal, being from twenty to thirty in one full grown. There are also perforations on these punctate sides, which seem to be the openings of canals branching out from five main canals, which proceed from near the bottom of the concavity or cup. The disk is imperforate; but when we make a section of the cup, we find a funnel-shaped cavity, which extends very nearly to the surface of the centre of the disk. The concavity of the cup presents ten canaliculated radiating ribs, five of which are more depressed than the others.

2. The filaments, jointed appendages, or simple arms, with which the convexity of the base is furnished, are calcareous and jointed; the joints a little concave in the middle, and thickest at each end, so that the articulations have a slightly knotted appearance. These filaments are not all alike; there are two kinds of them. The larger have fourteen joints, and a small, thick, blunt, curved claw, which is smaller than the joints and has a horny lustre: the smaller filaments have eighteen rough joints, and an almost straight claw, which is larger than the joints preceding it.



1, Part of an arm with two pinnae. 2, A single pinna. 3, One of the tentacula. 4, Claw at the extremity of a pinna. 5, Claw of a filiform process : all magnified.

3. The arms are five, but bifurcate shortly after their origin, each of the bifurcations being very long and tapering to its extremity. Before bifurcating the arms are simple; but the bifurcations are pinnated with calcareous, jointed, slender pinnae, which, when fully developed, consist each of from twenty-two to twenty-four perforated joints, and a claw of five or six crooked finger-like hooks at the end. The joints are rough as if covered with short spiculae; but the claws are smooth. The arms consist of calcareous joints with sloping diagonal segments, which can be separated from each other even as the joints can. The joints of the pinnae are sometimes similarly constructed. In a full-grown Feather-star there are thirty-four pinnae on each side of each bifurcation.

4. The soft parts consist of the stomach, which is placed in the concavity of the cup, and of a membrane and appendages which cover the surface of the stomach, and ramify over the arms and along the pinnae. The stomach is thin and membranous, and opens externally by a sub-central mouth, the margins of which are crenate. From its side, opening into it by a rather small aperture, proceeds an intestine, which winds round the body, and opens externally by a laterally-placed proboscis-shaped anus, the aperture of which is round, crenate, and wide, though not so wide as at the base. This curious vent has been mistaken by many authors for a mouth, and has greatly puzzled others; and M. de Blainville suggested that it might be connected with the functions of respiration or generation: but any one who examines the *Comatula* alive, or dissects a specimen well preserved, will not doubt it is a true vent. The membrane or skin which covers the stomach is also the covering of the arms, and branches out to the extremity of their pinnae. It is channelled in the following manner:—From the mouth proceed five canals, fringed at their edges, which radiate and bifurcate, though not equally, in order to run up the bifurcations of the arms; for, looking at the body from above, the origins of the arms are hidden. These canals run up the arms to their extremities, and also to the extremities of all their pinnae; and the membranes which depend from the pinnae are very ample, and furnished with numerous long white pinnated tentacula or cirrhi. At certain seasons this membrane bulges out on the pinnae, and is then filled with white milky globules; but at all times the margins of the canals, on the body, on the arms, and on the pinnae, are studded with round brown dots, placed in regular rows and at regular distances. They

are not, however, all of the same size, nor placed on all parts equally distant from each other; for on the body they are small, and the margins of the canals appear lined with them, but on the arms and pinnæ they are larger and more distant. On the extreme pinnæ they are very small, proportionate to the length of the pinna and the development of the membrane, for their number is the same on all the pinnæ. Thus, as there are thirty-four pinnæ on each side of each of the ten bifurcations of the arms, and eighty-four brown spots in each, the whole ten annulets will present the great number of 57,120 of these spots, which appear to be the animal's ovaries. The white milky fluid, on the contrary, would seem to be seminal, as minute rounded, active animalcules are seen in it when a drop is highly magnified.

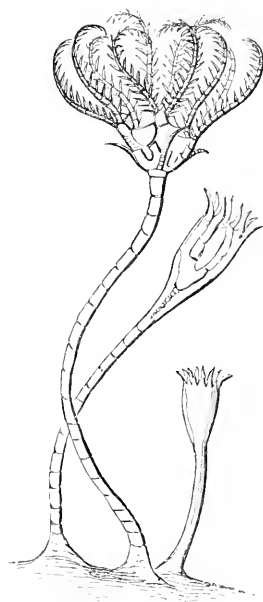
The whole of the animal is of a deep rose colour, dotted by these brown ovaries, and fringed with the transparent cirrhi. The description here given I have carefully drawn up from specimens before me, taken by myself in the Irish Sea, without adding several points observed by other describers, but which I have not seen.

M. Sars says there "are found on the upper part of each arm, above the proper fins, on each side, four or five thinner cylindrical thread-like fins (or pinnæ) of greater or less length, some consisting of seven or eight, others of nearly twenty calcareous joints, which are also furnished with feet" (cirrhi). M. Dujardin states that the inferior or ventral surface of the arms and pinnæ is provided with a double range of fleshy tentacula, protected by a double range of fleshy lamellæ, presenting between them a furrow filled with papillæ furnished with vibratile cilia, by the motions of which animalculæ and microscopic vegetables are conducted along the arms to the mouth, in order to

serve as food for the animal. This observation I cannot confirm, not having ever found any vibratile cilia on this animal, saving on the walls of its stomach. Several authors state that besides the stomach and intestine, the body is provided with a liver.

“In the months of May and June,” says Mr. J. V. Thompson, “the full-grown *Comatula* have the membranous expansion inside each of the pinnæ considerably extended, at least as far as the fifteenth or twentieth pair; these, which are the matrices or conceptacula, at length show themselves distended with ova, which in July, or even earlier, make their exit through a round aperture on the facial side of the conceptaculum, still, however, adhering together in a roundish cluster of about a hundred each by means of the extension and connection of their umbilical cords.”

And now commences the strange chapter in the history of the Feather-star; a history which has excited much discussion in the world of science. In the year 1823, Mr. J. V. Thompson discovered in the Cove of Cork, a singular little pedunculated crinoid animal, which he named *Pentacrinus Europæus*. This creature was taken attached to the stems of Zoophytes of different orders. It measured about three-fourths of an inch in height, and resembled a minute *Comatula* mounted on the stalk of a



Pentacrinus. The discovery excited great interest both at home and abroad; for it was the first animal of the Eocrinite kind which had been seen in the seas of Europe, and the first recent Eocrinite which had ever been examined by a competent observer in a living state. The base of its column, which was flexible and bent, and twisted itself at the will of the animal, was expanded into a convex calcareous plate, by which it attached itself to foreign bodies. From the centre of the plate arose the column, built up of about twenty-four joints, and somewhat thicker towards its upper extremity than at the lower. Round its uppermost joints, springing from the base of its cup-like body, was a row of jointed filaments with hooked extremities. The body bore five bifurcating arms, each bifurcation consisting of about twenty-four joints, in the older specimens pinnated, in the younger simple. Along the sides of each arm were rows of dark spots, and from the membrane of the arms proceeded fleshy flexible tentacula. The body resembled that of *Comatula* in its structure, having a separate mouth and probosciform lateral anus. The youngest specimens found had neither column nor arms, but appeared like little clubs fixed by a spreading base, and sending out from their summits a few pellucid tentacula. Dr. Fleming first proposed the generic separation of this animal from *Pentacrinus*, and suggested the propriety of associating it with *Comatula* by an improved definition of the family *Comatulidæ*. M. de Blainville afterwards constituted for its reception the genus *Phytocrinus*, and associated it with the Eocrinites. But in 1836, Mr. J. V. Thompson published a second memoir on the subject in the Edinburgh New Philosophical Journal, communicating the results of further researches. In

that paper he maintained the proposition that his *Pentacrinus Europæus* was only the young of *Comatula*; that the Feather-star commenced life as an Ecerinite, and thus, as it were, changed its nature from a pseudo-polype to a Starfish. He there compares the youngest *Comatula* he had met with, with the oldest *Pentacrinus*, and shows the gradual progression of form during the development of the latter towards the adult state of the former, the development of the arms, the gradual appearance of the pinnæ and the original absence of dorsal filaments, and the increase in their number as the animals of each kind grow older. He figures an advanced *Pentacrinus* just beginning to form pinnæ, and compares it with the figure of the youngest *Comatula* he had ever obtained by dredging, and remarks, "In the *Pentacrinus* it is to be observed that the arms are just beginning to form pinnæ towards their extremities; that they have the sulphur yellow colour and dark marginal spotting observable in the other, which shews in like manner that the upper pinnæ are first formed." Afterwards the dorsal cirrhi are increased from five to nine. *Comatulæ* "a little older are comparatively common in which the pinnæ are complete, and from this period they appear to form regularly at the apex of the arm as this goes on extending in length. These small *Comatula* still retain the original sulphur yellow colour towards the apices of the arms, the lower part and body assuming the characteristic red of the adult *Comatula*. From observations repeatedly made," says Mr. J. V. Thompson, "I think it most probable that the *Comatula* attain their full growth in one year so as to be in a condition to propagate their kind the summer following that of their birth." Further on he remarks:—"Another circumstance confirmatory of these being the young of *Co-*

matula is derived from these *Pentacrinæ* being first seen about the time of the dispersion of the ova of the *Comatula*, and again entirely disappearing in September, the only season in which young *Comatula* are to be obtained.” “By what means the ova are dispersed, or how they become attached to the stems and branches of corallines, remains to be discovered; but it is strongly to be suspected that the animal is gifted with the power of placing them in appropriate situations, otherwise we should find them indiscriminately on fuci, shells, stones, &c. which does not appear to be the case. However this may be, if we are allowed to assume that the *Pentacrinus Europæus* is the young of *Comatula*, we first perceive the dispersed and attached ova in the form of a flattened oval disk, by which it is permanently fixed to the spot selected, giving exit to an obscurely-pointed head, in which individual the animal is sufficiently advanced to show the incipient formation of the arms and the mouth, with its tentacula, by means of which it obtains the food necessary for its successive growth.”

Although the change of the *Pentacrinus* into the *Feather-star* has never been seen, yet the arguments of the discoverer of the former appear to me sufficiently to warrant the union of these two animals as one species in different states. I feel more confident in expressing this belief since I know that the identity of the *Comatula* and *Pentacrinus* is held by Mr. Thompson of Belfast, and Mr. Ball of Dublin, two gentlemen who have examined the latter animal under the most favourable circumstances, and who exhibited the creature alive to the members of the Natural History Section of the British Association during its session in Dublin. Through the kindness of the former of those naturalists I have been enabled to examine several

specimens of *Pentacrinus Europæus* preserved in spirits, also some very young *Comatula*. In one of Mr. Thompson's specimens of the latter, I found the basal disk concentrically ribbed, and presenting traces of a central perforation. Its pentangular form would lead us to suppose that the column of the young animal is of the same shape. The column of the *Pentacrinus Europæus* examined was very long compared with the body, and composed of eighteen joints. Under the microscope it appeared of a granular texture. When compressed between plates of glass and highly magnified, the substance of the column and body presented a beautiful reticulated appearance, in consequence of the separation of the plates of calcareous matter with which it was studded. These plates were mostly pentagonal. They are themselves composed of little calcareous particles, each of which also appears to be pentangular; but they adhere more firmly together than the plates do to one another. The same peculiar regular granular structure is seen in the calcareous substance of other Echinodermata, especially when the animal is young; and such a structure is very favourable to the spheroidal growth of these creatures.

The adult *Comatula* frequents both deep and shallow water. In deep water we find them full grown; and when dredging in such a situation I have never seen a small one. In the region of Laminariæ they abound in several localities, and there are found of all sizes, in company with the stalked form or *Phytoerinus*. Probably they frequent those forests of sea-weeds for breeding purposes at certain seasons, and retire to the deep sea at other times. We are told by Mr. J. V. Thompson that *Comatula* swims like a Medusa. "In swimming," he says, "the movements of the arms of the *Comatula* exactly resemble the

alternating stroke given by the Medusa to the liquid element, and has the same effect, causing the animal to raise itself from the bottom, and to advance back foremost even more rapidly than the Medusa." I have observed that they effect the movement by advancing the arms alternately, five at a time. The stalked young are not only found on corallines, as Mr. J. V. Thompson supposed. Mr. W. Thompson finds them on the leaves of fuci, and remarks that they are very active animals on their pedicles.

The Rosy Feather-star is found on many parts of the British coast. It was sent to Link by Llwyd from Penzance, was found at Milford Haven by Mr. Miller, in Wales by Mr. Adams, and on the west coast of Scotland by our distinguished zoologist, Pennant. I have never heard of its being found on the eastern shores, though in Shetland Mr. Goodsir and I found several in ten fathoms water on Laminariæ, the roots of which they were grasping with their dorsal filaments or claws, their arms winding among the branches and twining round them. In the Irish Sea I have often dredged large ones in twenty fathoms' water at some distance from land. In Ireland Mr. Ball finds it abundant on the Dublin coast, Mr. J. V. Thompson at Cork, and Mr. W. Thompson on the shores of Antrim and Down. Mr. Ball and Mr. William Thompson dredged it in company with the stalked young off Ireland's Eye, near Dublin, attached to *Delesseria sanguinea*. A plant of *Halidrys siliquosa* brought up by the latter gentleman at the entrance of Strangford Lough in October 1839, had about twenty full-grown *Comatula* attached to it.

Two species of *Comatula* are given as British in most works on British zoology,—the *Comatula rosacea*, having

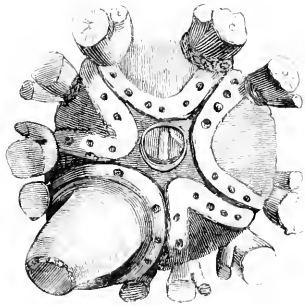
thirty dorsal filaments; and the *Comatula barbata*, having only ten. They are evidently the same animal, of different ages, or in different states of preservation, as may be seen at once by referring to the figures given of each. They are both identical with the *Comatula Mediterranea* of Lamarek. A Feather-star is a very different animal when preserved in spirits with its expanded fins, from what it appears when dried. The range of the Rosy Feather-star extends from Norway to the shores of the Mediterranean.

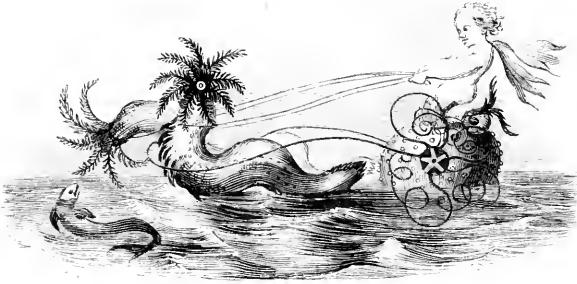
When a freshly-caught Feather-star is plunged into cold fresh water, it dies in a state of contraction; but if not so killed, or else if not killed in spirits, it breaks itself into pieces like an *Ophiura*. When dying, either in fresh water or in spirits it gives out a most beautiful purple colour which tinges the liquid in which it is killed. This colour is retained a long time in spirits. The fact was long ago noted by Bartholinus, who observed it at Naples, and whose observations on it will be found in a note to Fabius Columna.

Mr. J. V. Thompson has the following note on a curious animal, which is parasitic on the Feather-star:—"Connected with the natural history of the *Comatula* is that of a nondescript parasite, which appears to be a complete zoological puzzle, as it is not possible to determine from its figure and structure to what class it ought to be referred, its natural size not exceeding that of the breadth of the ossicula of the arms of the *Comatula*: it resembles a flat scale, and runs about with considerable velocity on the arms of the animal, and occasionally protrudes a flexible tubular proboscis, ending in a papillary margin. The disk or body is surrounded by eighteen or twenty

retractile and moveable tentaculi, and beneath is furnished with five pairs of short members, each ending in a hooked claw.—Query, is it a perfect animal, or a larva? and does it belong to the Crustacea, the Amelides, or what?”

The vignette represents the upper surface of the body of the Feather-star magnified, from a sketch by Mr. Templeton.





OPHIURIDÆ.

OR SPINIGRADE ECHINODERMATA.

THESE STARFISHES are so named from the long serpent, or worm-like, arms which are appended to their round, depressed, urchin-like bodies. Naturalists have associated them with true Starfishes, and made them a family of Asteriadae; but in reality they are as distinct from those animals as they are from the Crinoid Starfishes. In fact, they hold the same relation to the Crinoidea that the true Starfishes hold to the Sea-Urchins. They are *Spinigrade* animals, and have no true suckers by which to walk, their progression being effected (and with great facility) by means of five long flexible-jointed processes, placed at regular distances round their body, and furnished with spines on the sides and membranous tentacula. These processes are very different from the arms of the true Starfishes, which are lobes of the animal's body; whereas the arms of the Ophiuridae are superadded to the body, and there is no excavation in them for any pro-

longation of the digestive organs. The stomach is a sac with one aperture, its walls externally covered with vibratile cilia. The ovaries are not branched; they are placed near the arms, and open by orifices near the mouth, between the origins of the arms. Their investing membrane is also ciliated; but on the rest of the body and arms no cilia exist—hence we may conclude there is no separate respiratory system.

The Ophiuridæ are always regularly radiate, and they seldom vary in the number of their parts. With them the number *five* is absolute. Colour and proportions are the subjects of variation in this order. Generic characters among them are founded on the simplicity or complexity of the arms, the mode of their insertion, and on the forms of the plates which separate their origins beneath. The sources of specific character are derived from the spines and scales of the body and arms, and the proportions of arms and disk. Colour is variable in all the known species.

What I take to be the nervous system will be found described under the account of *Ophiocoma bellis*. There is no appearance of ocular spots in the animals of this order.

The *Ophiuridæ* are very generally distributed through the seas of our earth, both of its northern and southern hemispheres. The species do not present such wide ranges as the true Starfishes. They are more affected by climatal causes, which seem to influence their size, they being largest in the tropical seas. In our own seas they are very abundant, and are among the most curious and beautiful game pursued by the dredger. Among the relics of the Radiata of the primæval seas we find several species of Ophiuridæ. No extreme change has taken place

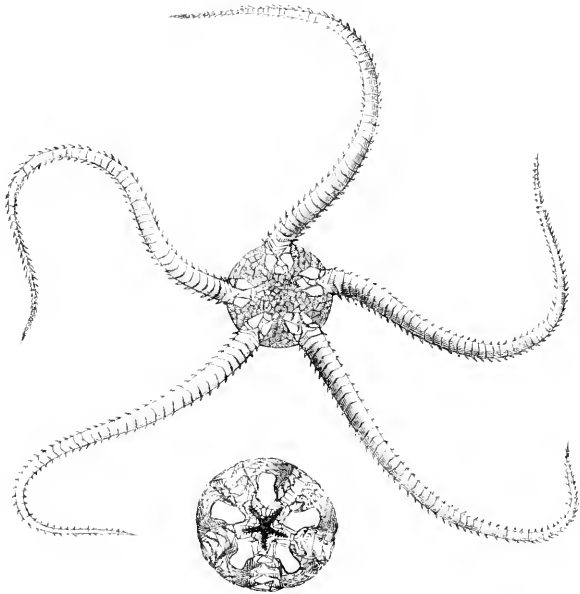
in the forms of the family since the extinction of the species found fossil.

The British Ophiuridæ belong to two families, that of *Ophiuræ* and that of *Euryalæ*. The animals of the former family have simple arms; those of the latter, arms ramifying into many processes.



OPHURIDÆ.

OPHURÆ.

Genus *Ophiura*. Lam. Ag.

Generic Character.—Rays simple, squamose, prolonged into the disk superiorly, and separated at their origins beneath by large shield-shaped plates. (Cirrhi simple.)

COMMON SAND-STAR.

Ophiura texturata. Lam.

Specific Character.—Pectinated scales clasping the bases of the rays with more than twenty teeth. Inferior intermediate plates hollowed out at the sides. Lateral ray-plates each bearing seven spines.

Asterius Ophiura, LINN. MULLER, Zool. Dan. Prod. 2840.

Asterius lucertosa, PENN. Brit. Zool. IV. p. 63.

Ophiura texturata, LAM. Anim. sans Vert. 1 Edit. II. p. 542 ; 2 Edit. III. p. 221. BLAINV. Man. d'Actin. p. 243. FORBES, Wern. Trans. vol. VIII. p. 125. pl. iv. f. 3, 4.

- Ophiura bracteata*, FLEM. Brit. Anim. p. 433. JOHNSTON, in Mag. Nat. Hist. VIII. p. 465, f. 41.
Ophiura Aurora, RISSO, Eur. Merid. V. p. 273, f. 29.
Ophiura arenosa, LEACH, Zool. Misc. II. p. 58.
Stella lucertosa, LINK, p. 47, tab. ii. No. 4.

PROFESSOR AGASSIZ very properly proposed the generic separation of the lacertose from the worm-armed *Ophiuræ*. The habits and characters of each are equally distinct. The true *Ophiuræ* live in sandy places. Their preference of such a locality is amusingly enough accounted for by Reaumur, who tells us that, because they are so fragile they are not able to live among rocks, and therefore inhabit sand:—a true closet reason; had he only walked to the sea-shore, he would have seen the *Ophiocomæ*, which are far more brittle, in abundance among the rocks, moving about in perfect safety. Natural, however, as is the genus, the character, as restricted by Professor Agassiz, is quite inapplicable, and might serve as a warning against the dangerous practice of defining genera of radiated animals without reference to their habits and appearance when alive. “Disk much flattened; rays simple, squamose, bearing very short spines adhering to the rays.” The disk is only flat in the dried specimen. When the animal is alive, it pouts it out so as to make it very convex; in fact, the disk is much more moveable than in the next species. The spines are quite as long as those of many species of *Ophiocomæ*, and are only appressed when the animal is dead: when it is alive, they stand out as in a Brittle-star; but as they are placed in a different manner on the lateral ray-plate,—or rather as the lateral ray-plates are somewhat imbricated,—they naturally close on the ray when the animal has no power over them. The cirrhi, which are placed between the rows of spines, are long, simple, and very flexible. Round the mouth there

are twenty tentacula similar in form and nature to the cirrhi; in fact, the ten exterior (for ten are within the mouth) are so many of the cirrhi of the lowest joints of the rays applied to another purpose. The uses of these tentacula are curious. Not only do they serve to convey food to the mouth, but they also serve to eject the matter digested. They are continually in motion, waving up and down; and every now and then when the stomach pouts up and ejects some digested matter, the lowermost or inner tentacula shovel it up, and the uppermost or outer clear it away. This is done with great regularity; and it is a very curious sight, for not only are the motions and actions of the tentacula admirable, but when the stomach swells, there appear bright orange stripes of a most vivid metallic lustre running along its surface, with an almost phosphorescent gleaming.

The *Ophiura texturata* has a regular round disk, into which the arms are as it were dovetailed above. This disk is covered with small smooth scales, rosulated in the centre, round which many of the scales are exceedingly small. Opposite the insertion of each ray are two triangular plates which diverge and are separated from each other throughout their lengths by two large transverse scales. The rays are long, tapering to a very fine extremity, and obtusely carinate. The scales which cover them are very broad and narrow. Beneath they are clothed with small lenticular plates. The marginal plates are prominent and rounded; those nearest the base bear seven short flattened obtuse spines, those uppermost longest; but the number diminishes with the breadth of the rays. The scales of the disk clasping the bases of the rays, bear from twenty to twenty-five teeth or little spines. The plates between the origins of the rays beneath are large

and fiddle-shaped. The disk of the largest specimen I have taken was nine-tenths of an inch broad ; and the rays vary from three times the length of the disk's breadth, or even less, to five times as large. The disk is generally reddish, marbled with purple-brown ; the sides white ; and the under surface and spines are generally pale yellowish, or white.

Dr. Johnston records a remarkable variety or rather monstrosity, having a square disk and four rays, the other parts also regulated by the number four. I have the disk of a young one presenting a somewhat similar appearance ; but in it there are five arms, two of them originating together, so that the quaternary arrangement of the other parts may be looked upon as the result of the union of two sets of organs.

When very young, this species has much the aspect of an *Ophiocoma* ; the lateral spines are longer in proportion to the rays, and the latter are not so deeply inserted in the disk. On comparing a series of specimens from a very small size to the full grown state, we see that the chief increase has been on the outer edge of the disk (the centre being perfect in the arrangement of its scales in the youngest specimen), and at the sides of the superior arm-plates, which are at first almost ovate.

The common Sand-star is found on most parts of the British coast, and does not confine itself so much to sandy ground as the next species. In England, Dr. Coldstream found it in Devonshire, Mr. Couch in Cornwall, Pennant in Anglesea ; and Mr. Bean says it is dredged in deep water at Scarborough, but is very rare. Dr. Johnston takes it at Berwick, and it is abundant near the mouth of the Frith of Forth ; but is superseded by the next species, higher up that estuary. On the Dogger Bank, and gene-

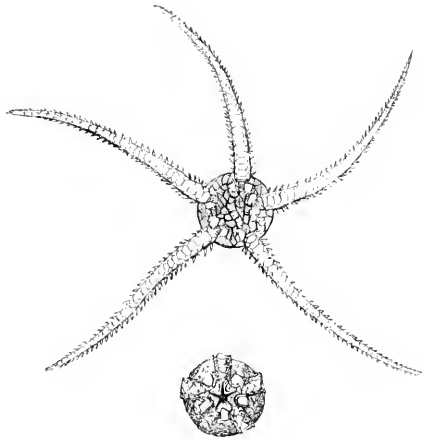
rally off the east coast of Scotland, it is frequent. It is found among the Hebrides, in the estuary of the Clyde, and Mr. P. Maclagan sends me it from Ayrshire. In the Irish Sea it is rather scarce; but is common, according to Mr. Thompson, on a sandy bottom in the north-east and south of Ireland.

In Stewart's Elements of Natural History it is stated that this Sand-star "is supposed to be the cause of the injuries sometimes received from eating muscles, which at certain times of the year feed upon it." There are no grounds for this absurd notion, nor have I ever met with any persons who entertained it.



OPHIURIDÆ.

OPHIURÆ.



LESSER SAND-STAR.

Ophiura albida. Forbes.

Specific Character.—Pectinated scales, clasping the bases of the rays with fewer than sixteen teeth. Inferior intermediate plates with straight sides. Lateral ray-plates with four or five spines on each.

*Ophiura albida,*FORBES, WERN, Trans. vol. VIII. p. 125,
pl. iv. f. 536.

Ophiura texturata, 2 *eadem minor albida*, LAMARCK, Anim. sans Vert. 1 Edit.
vol. II. p. 542 ; 2 Edit. vol. III.
p. 221.

THE LESSER SAND-STAR is more common than the last ; but had long been confounded with it, or passed over as its young, until I separated it from that species under the name of *Ophiura albida*, giving it that name (though it is not altogether appropriate, seeing that the creature is white only when dried), under the belief that

it was the variety, 2 *albida*, of Lamarek. It had long before, however, been placed aside as distinct by my friend, Mr. W. Thompson of Belfast; and I have seen it so separated in several collections, under the belief that the larger species was the *lacertosa* and this the *texturata*.

The disk is round, imbricated above with smooth unequal scales, a large one in the centre, surrounded by five others of equal size. The scales are always larger and fewer than in the last species; and this serves also to distinguish the young of the two Sand-stars from each other, though, besides this distinction, the young *albida* is much thicker and smaller in proportion to its arms, than the young *texturata*. Opposite the base of each ray are two triangular plates, similarly placed to those in the last species. The pectinated scales clasping the rays never bear more than sixteen teeth. The plates separating the origins of the rays beneath are shaped like a shield, with straight sides. The rays are covered superiorly by transversely ovate hexagonal scales, and below by smaller plates of a similar form. The lateral ray-plates bear each four or five short appressed spines. The rays are three or four times as long as the disk is broad. The largest disk I have met with measures half an inch across. When alive the disk is generally pink, with ten white spots, which occupy half of each of the ten plates opposite the ray-origins. The centre of the arms is pink; the under surface and spines white; the cirrhi and tentacula are tipped with yellow: sometimes the disk is marbled with orange spots.

When one of these creatures is put into a vessel of salt water, it will remain quiet for some time, contrary to the habit of the Brittle-stars, and then slowly move its arms up and down. Should it be placed on its back, that position appears to be very disagreeable to it; for it imme-

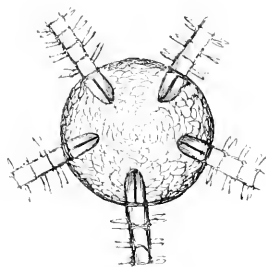
diately proceeds to change it by raising its body to a perpendicular and tumbling over. This it effects by bending two or three of the rays into an arch, leaving the others straight and spread out.

It frequents oyster-beds and sandy places probably on all our coasts. Mr. Bean says it inhabits deep water at Scarborough. I find it on most parts of the Scottish coast, and abundant in the Irish Sea. Mr. Thompson says it is common on a sandy bottom on the coast of Down and Antrim, and adds the following note:—"At Portaferry on one occasion, and in the month of October, we dredged up a considerable number of the *albida* and not one of the *texturata*. The *Ophiura albida* is very valuable in colour, presenting many shades of grey, brown, and red. The only white any of them exhibited on the upper surface, was a narrow stripe on each side of the base of the rays, and this was present in every one of them."

It is common also in Dublin Bay, and on the west coast of Ireland.

OPHIURIDÆ.

OPHIURÆ.

Genus, *Ophiocoma*. Agassiz.

Generic Character.—Rays simple, squamose, not prolonged into the disk superiorly, and separated at their origins beneath by small pentangular plates. (Cirri pinnate.)

GRAY BRITTLE-STAR.

Ophiocoma neglecta. Johnston.

Specific Character.—Disk round, flat, imbricated with small smooth scales. Two oblong, parallel, touching plates opposite the origin of each ray. Upper ray-scales square; lateral ray-plates, bearing four or five spines each, which are equal in length to the breadth of the ray.

Ophiura neglecta, JOHNSTON, Mag. Nat. Hist. VIII. p. 467, fig. 42. LAMARCK, Anim. sans Vert. 2 Edit. p. 226.

Ophiocoma neglecta, FORBES, Wern. Mem. vol. VIII. p. 126, pl. iv. fig. 7.

Ophiura elegans, LEACH, Zool. Misc. II. p. 57.

THE BRITTLE-STARs are at once recognised as distinct from the true Ophiuræ, either alive or dried, by their

peculiar habit, as well as by minute but more easily-definable characters. The rays of the Sand-stars have a whip-like or lizard-tail appearance; those of the Brittle-stars look like so many Centipedes or Annelides, attached at regular distances round a little Sea-urchin. The latter are much more flexible than the former, more irritable, more brittle, nevertheless much more tenacious of life. When dried, the ray-spines of the Brittle-stars stand out from the ray; whereas in the preserved Sand-star they are appressed to its sides. The cirrhi, too, which are seen between each row of spines in the living animal, are pinnate, or as if covered with short tubes in the Ophiocomæ. The Brittle-stars are much more active animals than the Ophiuræ; they seldom remain quiet for a moment, but are continually twisting about their arms, and if laid hold of they break up into little pieces with wonderful facility, each fragment of an arm also breaking itself up into smaller pieces; and, frequently when we seize one of these creatures, in a moment we find nothing but the disk remaining. They can reproduce their arms in the same manner as the *Asteriada*.

This habit of breaking themselves into pieces when captured, renders it very difficult to preserve them for collections. Dr. Johnston has given the following directions for their preservation in the ninth volume of the Magazine of Natural History:—"The Ophiuræ must be brought from the shore in sea-water, where, after being allowed to remain at rest for an hour or so, they will crawl about and expand themselves on the bottom and sides of the vessel. When in this state remove them with the fingers cautiously, and plunge them instantly into a large basin of cold fresh water. They die in a state of the most rigid expansion, and so quickly that even the most brittle species have no

time to make the contraction necessary to break off their rays. Allow them to lie in fresh water for twenty-four hours, when they are to be displayed on white paper, and dried very slowly before the fire." I would recommend another mode which saves time, and is more convenient to the traveller. It is this: drop the Sand or Brittle star as soon as possible into fresh water, let it lie there for an hour or so, and then *dip it* for a moment in boiling water; it is then to be dried in the sun or in a current of air, which will be effected in a very short time, and packed in paper. By such a simple process as many specimens as the collector pleases may be dried and put away in a couple of hours. The fresh water acts as a poison on the Ophiuræ, as well as on most other marine animals, and kills them instantaneously. Mr. F. H. N. Glossop notices its effects on the Starfishes generally, in the ninth volume of the Magazine of Natural History.

The Gray Brittle-star is a little species, having very much the aspect of a Sand-star, and constitutes with some allied forms a connecting link between the two genera. They cannot, however, be confounded, as the origins of the rays, whether extended into the disk above, or inserted entirely beneath, at once show whether the creature before us is an Ophiura or an Ophiocoma, independent of the other characters. Its body which rarely exceeds two-tenths of an inch in breadth, and is seldom so large, is circular and flat, imbricated above with small smooth scales which are rosulated in the centre. Opposite the origin of each ray are two oblong narrow plates, the inner margins of which touch throughout their lengths. The scales between the inferior origins of the rays are small and pentangular. The rays, which are generally a little more than three times as long as the breadth of the

disk, are covered above by almost square scales, beneath by longitudinally oblong plates. Each of the transverse ridges on the sides of the rays bears four or five conical short spines, equal in length to the breadth of the ray. These spines appear smooth to the naked eye; but when highly magnified are seen to be rough with little points. The colour of the body and rays is gray; the spines lighter. The plates opposite the origins of the rays are deep gray with white tips.

This species was first distinguished and named by Dr. Johnston of Berwick in the year 1835. It seems to be the Starfish mentioned in Mr. Templeton's catalogue of the Rayed Animals of Ireland, under the name of "*Ophiura minuta* found in the pools of marine rocks of Antrim and Down." Dr. Leach characterises a species from "among rocks on the coast of Devonshire" under the name of *Ophiura elegans*, which possibly is the *neglecta*. He describes his Starfish thus:—"Body squamous, very slightly emarginate between the rays, with ten geminated scales larger than the others; rays long, with somewhat transverse scales and short spines, gray annulated with white." The distribution of the Gray Brittle-star on the coasts of Britain is extensive. In England Mr. Couch finds it on the shores of Cornwall, and Dr. Johnston at Berwick, "between tide-marks; not rare." Mr. Bean takes it in a similar situation at Scarborough. In the Irish Sea I have dredged it in deep water on the Manx coast. In Ireland it was taken by Mr. Thompson and Mr. Hyndman in Strangford Loch in the year 1834, and set aside as distinct. In that locality it is abundant in rock-pools among *Corallina officinalis*. They have also dredged up a few on the coasts of Down and Antrim, and it is common on the west coast. In Scotland, Mr. Henry Goodsir found it at Newhaven in the

Frith of Forth. On the west coast I found it under stones on the shore at Campbeltown, Argyleshire, plentiful; and Mr. John Goodsir and I took it both in Orkney and Shetland by the dredge. In the Channel Islands I found it in August 1839 at low water in Herm.

I doubt not this species will be found on the coasts of France, and in the north of Europe. Starfishes do not seem to be so local in their distribution as Mollusca and the higher classes of animals. Indeed, the remark may be extended to the radiate animals generally; for among them we find more forms, in proportion to their numbers, common to great tracts of ocean, without reference to climate, than in any other division of the animal kingdom.



OPHIURIDÆ.

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BALL'S BRITTLE-STAR.

Ophiocoma Ballii. Thompson.

Ophiocoma Ballii, THOMPSON, Annals of Natural History, vol. V. (April, 1840), p. 99.

Specific Character.—Disk round or angular, covered with imbricated scales, two diverging broadly wedge-shaped scales at the base of each ray. Upper ray-scales fan-shaped; lateral ray-plates, each bearing four spines, which are as long or sometimes longer than the breadth of the ray.

THIS pretty little species, one of the many contributions to the fauna of our islands, for which we owe thanks to the indefatigable researches of Mr. Ball, was dredged by that gentleman several years ago in Dalkey Sound on the coast of Dublin; and was described and named after its discoverer by Mr. Thompson in the fifth volume of that valuable periodical, the Annals of Natural History. Several specimens of the *Ophiocoma Ballii* were taken; the disk of the largest was two and a half lines broad, and the rays were nearly four times as long as its breadth. The disk is rather flat, round; in some specimens pentangular. The whole of the upper surface is imbricated with smooth scales,

which are rosulated in the centre. On the disk of the largest example were a few minute scattered spines. Opposite the origin of each ray are two diverging wedge-shaped scales. The plates which separate the origins of the rays beneath are transversely ovate, and rather larger than in the neighbouring species of *Ophiocoma*. The rays are covered above with fan-shaped scales, beneath with rudely heart-shaped plates; and their sides are clothed with transverse plates, each bearing four spines, which are rough and as long as, in some cases longer than, the breadth of the rays. These spines are rough, with deep punctations; and when viewed under a lens, all the scales of the body and rays are punctate in a similar manner. The colour of this species is pink. Although it has hitherto only occurred on the Irish coast, it should be sought for elsewhere, as from its resemblance to *Ophiocoma neglecta* it may be passed over as that species. Independent of the other characters, the diverging scales at the bases of the rays easily distinguish it.

OPHIURIDÆ.

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THE DOTTED BRITTLE-STAR.

Ophiocoma punctata. Forbes.

Specific Character.—Disk pentangular, covered with smooth imbricated scales; two diverging narrow wedge-shaped scales opposite the origins of each ray. Upper ray-scales oblong, each with a central ridge and a deep depression anteriorly. Lateral ray-plates, each bearing five spines, which do not equal in length the breadth of the ray.

THE stomachs of fishes are often zoological treasures. The Haddock is a great conchologist. In his travels through the country of the Mermaids, he picks up many curiosities in the shell way. Not a few rare species have been discovered by him; and the ungrateful zoologist too frequently describes novelties without an allusion to the original discoverer. As Haddocks are not in the habit of writing pamphlets or papers, the fraud remains undiscovered, greatly to the detriment of science; for, had the describer stated to whom he was indebted for his specimens, we could form some idea of its habitat and history,

whether littoral or deep sea,—very important points in the economy of Mollusca,—important not only to the malacologist, but also to the geologist. Like the Haddock, the Cod also is a great naturalist; and he, too, carries his devotion to our dear science so far as occasionally to die for its sake with a new species in his stomach, probably with a view to its being described and figured by some competent authority. The Cod is not so much devoted to the Mollusca as to the Echinodermata; and doubtless his knowledge of the Ophiuræ exceeds that of any biped. He has a great taste for that tribe. It was a Cod that communicated the pretty little species I am about to describe, to my friend, Mr. Henry Goodsir, at Anstruther; and, as far as that gentleman could learn, it would appear the industrious animal had observed and entrapped this new Ophiocoma in the North Sea near the Dogger Bank.

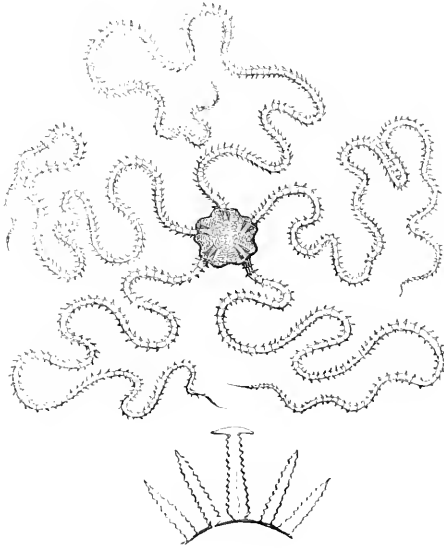
The Dotted Ophiocoma is a very little species. Its body is only one-eighth of an inch in diameter; but its rays are very long, being seven times as long as the disk is broad. The disk is pentangular. The upper surface is imbricated with smooth scales, which are rosulated in the centre, the central scale round and large. Opposite the origin of each ray are two long wedge-shaped scales, the basal angles of which touch, but the apices diverge. Beneath, the scales which separate the origins of the rays are ovate, and rather large in proportion to the disk. The rays are long and narrow, six times as long as the disk is broad. Above they are covered with oblong plates, which present a more or less prominent ridge in the centre, and in front a deep dimple or impression, which is strongest towards the origins of the rays. Their under surfaces are covered with longitudinally

oblong plates; their sides with short, pointed spines, not equalling their breadth, arranged in lines on prominent transverse ridges. The whole surface of the ray and spines is seen to be finely frosted when highly magnified. The colour is pinkish gray.



OPHIURIDÆ.

OPHIURÆ.



THREAD-RAYED BRITTLE-STAR.

Ophiocoma filiformis. Muller.

Specific Character.—Disk subpentangular, notched, flat, imbricated with small smooth scales. Two oblongo-lanceolate, diverging scales, opposite the origin of each ray. Rays very long. Upper ray-scales square; lateral ray-plates, each bearing five spines, which are shorter than the breadth of the ray.

Asterius filiformis, MULLER, Zool. Dan. Prod. 2843; Zool. Dan. t. lix. pl. cxxii. f. 1-3.

Ophiura filiformis, LAM. 1 Edit. II. p. 546; 2 Edit. III. p. 236. BLAINV. Man. d'Actin. p. 244.

AMONG other places visited on a dredging excursion, in company with Mr. Smith of Jordanhill, in his pretty yacht the Amethyst, during the month of July 1839, was

the beautiful bay of Rothsay. The sea bottom in this bay is a soft shining gray mud, abounding in the usual shell-fish inhabiting such a locality, as *Nucula Margaritacea*, *Corbula nucleus*, and *Amphidesma Boysii*, and that very beautiful Zoophyte the *Tubularia indivisa*, which seems to flourish upright on this muddy ground like a flower, fixed by the tapering root-like termination of its horny case. The common open-meshed dredge is of no use on such ground, as the mud is washed out through the meshes and the animals included have escaped before it can be drawn up to the surface. A dredge constructed of a triangle of flat pieces of iron to which a canvass bag, pierced with eyelet holes in order that the water may drain off, is attached, obviates such inconveniences, and secures the wished-for prey. Besides the creatures I have just mentioned, two beautiful radiate animals inhabit Rothsay Bay; both of them are unrecorded as members of the British Fauna. The one is a *Spatangus*, which I shall describe in its proper place; the other is the singular Brittle-star described and figured by Muller under the appropriate name of *Asterias filiformis*. Of this most curious of Ophiuræ I first found one of the thread-like arms winding amongst the mud. Arm after arm occurred, but no body: at length the skeleton of a body was found, and when I had almost begun to despair of finding anything like a disk, an almost perfect specimen appeared. A few days after, dredging on similar ground in the Gair Loch opposite Greenock, I was astonished by the sight of masses of interlacing arms of the same animal, as large as a man's fist, coming up in the dredge. They were all alive, and twisting in every direction; yet, strange to say, there were no more than seven or eight disks secured, although several hundreds of arms were taken. The fact

is, the disk is extremely soft, especially when the animal is in egg, as was the case in the instance mentioned; and not being so well secured to its skeleton, as in the other Brittle-stars, it was almost always rubbed away or destroyed by the rough usage it met with in the dredge on its way to the surface. The arms, however, seem to preserve their integrity much more patiently than those of the neighbouring species. The two localities mentioned are the only places in Britain where this *Ophiura* has as yet been observed; it is probable, however, that it will be found in similar situations in other loughs on the west coast of Scotland. In July 1840 it was taken for the first time in Ireland by Mr. Thompson, Mr. Ball, Mr. Hyndman, and myself, in the Killary and other marine Loughs of Connemara. Muller first observed individuals in Norway, "in sedimento argillaceo 1773, rarissime; postea in fundo argillaceo maritimo Norvegiæ occidentalis frequentam reperi;" so that its habitat appears to be always muddy.

The disk is somewhat pentangular, slightly lobed and notched opposite the rays. Its surface is covered with minute, smooth, rosulated scales; and opposite the origin of each of the rays are two oblongo-lanceolate scales, which converge, but do not touch, at their upper extremities. The arms are extremely long, though variable in their length in various specimens; in some, ten or twelve times as long as the breadth of the disk, and of nearly equal thickness to near their extremities, where they suddenly taper to the termination. They are covered above with square scales, below with lenticular plates. Muller reckoned no less than one hundred and thirty-four joints in each arm of one of his specimens. Their sides are clothed with spines, which are rough and conic, scarcely as long as half

the breadth of the rays, and arranged in rows of about five in each row. The body is dark-reddish brown; the rays red or flesh-colour, with a reddish line down the centre of each scale. The ovaries, which are large, and of a brilliant orange-red, sometimes are seen through the disk, and give it the colouring represented in Muller's figure. The disk of one of my specimens measures three-tenths of an inch across; and from ray to ray the distance is seven inches.

The most remarkable peculiarity in this Starfish's organization remains to be described, and has as yet, as far as I am aware, escaped notice either in this or any other species of its tribe. All the spines on each lateral ray-plate resemble those of other *Ophiuræ*, except the third (counting from above). Instead of tapering to a point, as the others do, both in this and in all other described *Ophiocoma*, this spine is longer than the rest, and is furnished at its extremity with two transverse-curved spiny processes, giving it exactly the form of a pickaxe. Eight or nine notches are seen on the broad apex. To what end is this singular modification of structure devoted? Why should this species present such a curious armature, and not any of its congeners? The reason is not hidden from us. This *Ophiocoma* lives in soft slimy mud, and thus has to make its way through a very different medium from that inhabited by most other Brittle-stars. The position, the increased size, and the pickaxe heads of these strange spines, are just the modifications of structure especially adapted to further locomotion in such a locality. They may be compared to the lateral hooks or bristles of many earth-boring Annelides, and serve for the same purposes. The contrivance is a very beautiful example of the adaptation of organization to the locality in which the creature is destined to live.

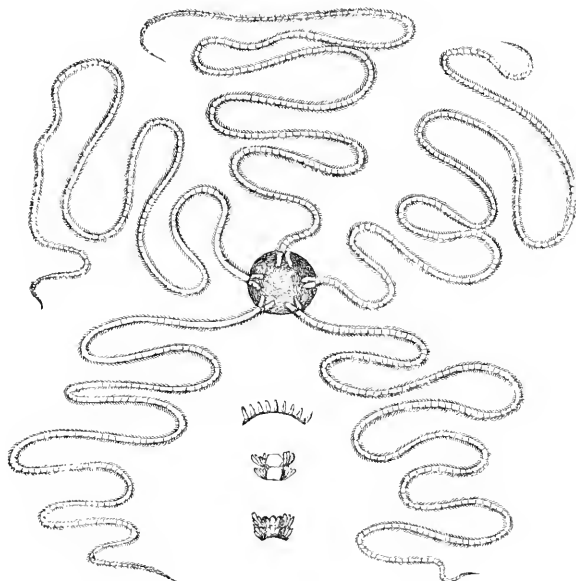
How truly doth old Rondeletius speak out of the studies of the marine zoologist: “Immensa et summe admirabilis Dei potentia atque solertia in rebus coelestibus, iisque in aëre et terra fiunt, maxime vero in mari, in quo tam variae et stupendae rerum formae conspiciuntur, ut quaerendi et contemplandi nullus unquam futurus sit finis.”

The vignette is a view of the ruins of Peel Castle.



OPHIURIDÆ.

OPHIURÆ.



THE LONG-ARMED BRITTLE-STAR.

Ophiocoma brachiata. Montagu.

Specific Character.—Disk round, or subpentangular, notched, imbricated above with small smooth scales; sides rough. Two oblong diverging plates opposite the base of each ray. Rays very long. Upper ray-scales transversely oblong; lateral ray-plates, each bearing eight or nine thick obtuse spines, which are shorter than the breadth of the ray.

Asterias brachiata, MONTAGU, Linn. Trans. VII. p. 84.

Ophiura brachiata, FLEMING, Brit. An. p. 488. BLAINV. Man. d'Actin. p. 243.

AMONG the most ardent investigators of the animals of the British seas, Colonel Montagu stands conspicuous. Whilst the discoveries of other sea-searching naturalists are too often dubious and unsatisfactory, owing to the

imperfect descriptions they have transmitted of the subjects of their observations, there is no question about the identity of any animal Montagu described. It is not merely the copiousness of his descriptions which gives them their peculiar value, though their fulness is a great merit; nor merely their perspicuity, though that is a still greater merit; but it is their logical character, that instinctive perception of the essential attributes and relations of each species, which is the most important faculty a naturalist can possess. Too many of our older naturalists (and can we claim exemption from the fault yet?) described forms as if there could be no creatures existing with which those forms might be confounded; they wrote of the animals they were characterizing, as if the whole book of Nature was already in print. Montagu was a forward-looking philosopher: he spoke of every creature as if one exceeding like it, yet different from it, would be washed up by the waves the next tide. Consequently his descriptions are permanent; and when he had full opportunities of examining any marine animal, subsequent observers have but little to add to his words. Had Montagu been educated a physiologist, and made the study of Nature his aim, and not his amusement, his would have been one of the greatest names in the whole range of British science.

The singular animal before us is one of the discoveries of that great naturalist. Its general appearance is so similar to that of the last species that, having specimens of each before, I had put them aside as one, until corrected by my friend Mr. Thompson, who, luckily, persisted in the assertion that the *Asterias brachiata* of Montagu was not the *Asterias filiformis* of Muller; and, a close examination of the specimens which he had been so fortunate as to preserve of the *brachiata*, showed the minute

correctness of Montagu's description, and the very great differences which distinguish these two spider-legged Brittle-stars. It would be an injustice to the discoverer not to give his account of the species in his own words. "Body roundish, or subpentangular, covered above with small oval scales, disposed in ten alternate broad and narrow rays; the smaller rays rather conic, terminating between two oblong smooth plates, placed at the junction of each arm; the arms are five in number, extremely long and slender, very gradually decreasing to their ends: each of these is composed of between three and four hundred articulations, which appear like so many smooth scales above and beneath. The sides are furnished with very small moveable spines, eight or nine in a row, at every joint; the scales near the body beneath are bisulcated longitudinally; and the arms at that part run quite to the centre or mouth, which is a small cinquefoil, and appears to be formed of four little plates regularly placed at each angle. On the body between the arms the surface is rough with minute papillæ; colour, when alive, purplish brown, and sometimes bluish ash colour.

"Diameter of the body scarce half an inch; length of the arms from seven to eight inches, making in all an extent of about sixteen inches, or four feet in circumference. One in my cabinet, whose body is only three-eighths of an inch diameter, has the arms seven inches in length, which is more than eighteen diameters of the body: a disproportion not before noticed in any species of *Asterias*.

"This extraordinary animal is taken in sand at one particular part of Salcomb Bay, where that article is collected for manure. The only perfect specimens obtained were such as had been dried in a heap of the sand. In

any other way it would be impossible to kill them without breaking into small pieces from the extremely fragile quality of the arms or rays."

The Irish specimens agree in every particular with those described by Montagu. In addition to his description I may mention that the body is thick and firm. The plates opposite the origins of the rays have a deep sulcation running across them near their upper extremities, where the plates of each pair nearly touch, but diverge greatly towards the lower. The spines which border the rays are nearly of equal thickness throughout their length; their ends are obtuse, and when highly magnified, they do not present so many rough points at their sides as the spines of most Brittle-stars, and especially those of the last species do. In each transverse row of spines those of the two extremities are a little larger than the others. The great number of spines in each row, and their shortness, are doubtless conveniences for the aiding of the animal's movements through the wet sand. The curious fluting of the under surfaces of the rays is not to be seen in any other British species of this genus. The plates between the origins of the rays are somewhat triangular in form, and furrowed across.

Mr. Thompson obtained two specimens by dredging on a sandy bottom off Dundrum, county Down, in August 1836. He had previously found one in a very young state during the year 1835 in Belfast Bay, and subsequently at Strangford in rock-pools among *Corallina officinalis*.

Of the two first-mentioned, the body of the more perfect was four lines in diameter; the arm least broken measured three and a half inches, and where broken was nearly as broad as at the base.

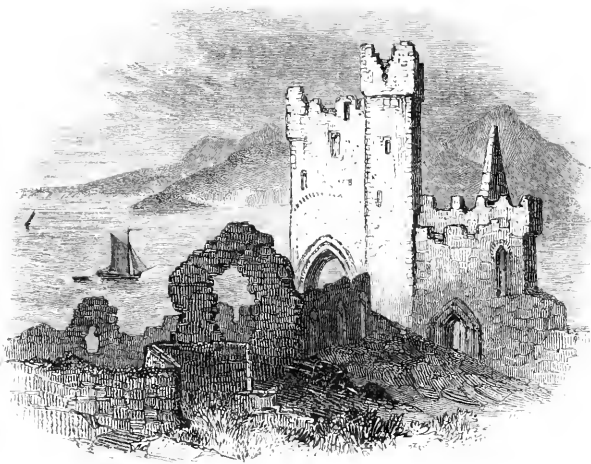
Dr. Fleming refers Pennant's *Asterias minuta*, which

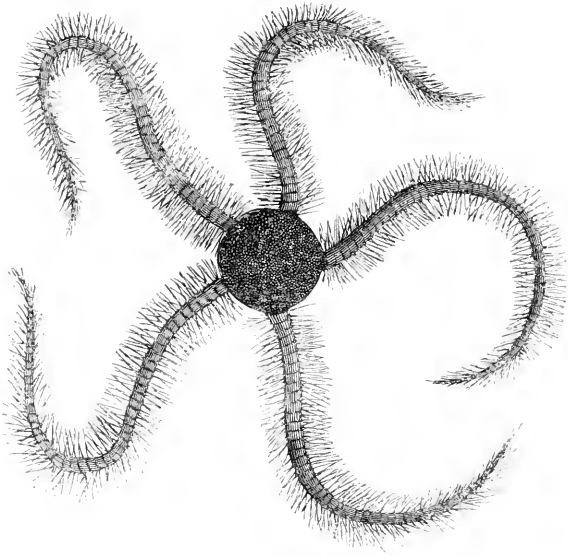
I make a synonym of my *Ophiocoma minuta*, to this species.

Mr. Couch in his "Cornish Fauna," mentions this species as an inhabitant of the shores of Cornwall.

Probably the "*Ophiura filiformis*" mentioned as Irish in Mr. Templeton's catalogue of the Rayed Animals of Ireland was the Long-armed Brittle-star.

The vignette represents a view of the north-west coast of the Isle of Man, and the ruins of St. Germain's Cathedral.





GRANULATED BRITTLE-STAR.

Ophiocoma granulata. Link.

Specific Character.—Disk round, flat, minutely granulated. Upper ray-scales transversely oblong; lateral ray-plates, each bearing from four to seven slender spines, longer than the breadth of the ray.

Stella scolopendroides granulata, LINK. p. 50, tab. xxvi. fig. 43; Encyc. Metr. pl. exxiv. f. 2, 3.

Asterias nigra, MULLER, Zool. Dan. III. p. 20, t. xciii. fig. 1-4.

Ophiura granulata, FLEMING, Brit. An. p. 433. JOHNSTON, Mag. of Nat. Hist. vol. IX. p. 595, f. 67. BLAINV. Man. d'Actin. p. 243.

Ophiura echinata, LAM. 1 Edit. II. p. 543; 2 Edit. III. p. 223.

Ophiocoma granulata, FORBES, Wern. Mem. VIII. p. 127.

Ophiocoma echinata, AGASSIZ, Prod.

THIS BRITTLE-STAR is remarkable for having its disk so closely covered with minute spines that no appearance of the real surface is seen, consequently it has hitherto always been described as having a body without scales; whereas, if we rub away the granulated or spinous surface, we shall

see a squamous skin beneath, exactly similar to that presented in the *Ophiocoma filiformis* and its allies, only the scales are much smaller. Looking at the body in its ordinary state, we also see no trace of scales opposite the origins of the rays as in the other Brittle-stars, which, if it were really the case, would reduce the presence of those scales from generic, or rather family rank, as sources of character to specific importance; but if we examine the denuded disk very attentively, we shall find there are two such scales of a triangular form placed in the usual position, though at a greater distance from each other than is usual in the genus. There are some foreign species nearly allied to the one before us, which form a gradation between it and our other Brittle-stars; since in them we see the granulated surface as in ours, but denuded for a little space above the plates or scales opposite the origins of the rays, so as to allow them to peep out, as it were, from their hiding-places. The granules composing the second surface of the disk, are extremely stunted little spines, themselves rough with sharp points.

The rays are smooth, covered above with transversely ovate scales, and beneath with nearly square plates. Their margins are clothed with spines arranged in transverse rows of from one to three, being most numerous towards the origins of the rays. There are also two little obsolete or undeveloped spines at the edge of each of the under ray-plates. The rays taper gradually, and vary in their proportions as compared with the disk, but are generally from three to three and a half times as long as the disk is broad. The ray-spines are long, slender, and sharp, and when magnified appear very rough. Beneath, the origins of the rays are separated by ovate-triangular transverse plates.

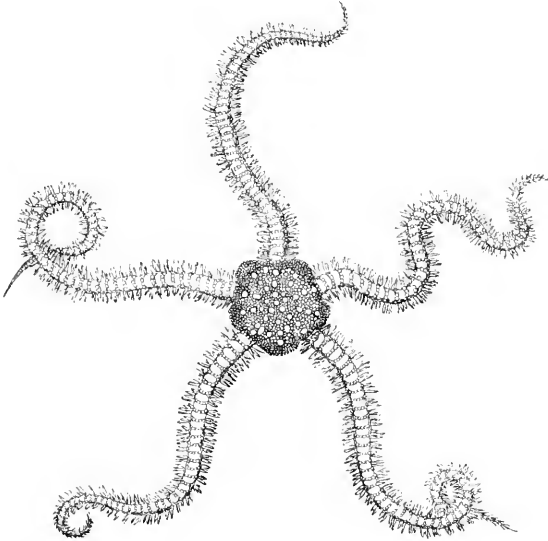
The disk of this species generally measures half or three-

fourths of an inch across. It sometimes grows much larger. Mr. Ball has a specimen six inches in diameter; the disk half an inch broad: and I have one before me at present which measures eight inches across the rays. Like its allies it is extremely frangible when alive, and has the power of reproducing its rays when they are broken off. On its frangibility Mr. W. Thompson communicates the following note:—"The power of this animal to break itself up is exemplified in an interesting manner by a specimen in Mr. Ball's collection. He placed it on a sheet of paper, and glued down each part as it broke it off, thus exhibiting the appearance presented by the fossil species."

Muller's name well applies to the usual colour of this Brittle-star: the disk and rays are commonly black, or brownish black; the ray-spines dusky white or bluish. Sometimes the disk is prettily variegated, and there is a variety of an orange colour not uncommon in the Irish Sea. Mr. Goodsir and I found some specimens in Shetland, of a most beautiful delicate rose colour. It appears to be very generally distributed on our shores, though local. Mr. Couch finds it in Cornwall; Dr. Johnston, at Berwick; Mr. Thompson, in Strangford Lough, and the open sea on the coast of Down; and Mr. Ball, common about Dublin. I believe Dr. Fleming was the first to note it as a British species, having found it in Kirkwall Bay, Orkney, unless the *Asterias sphaerulata* of Pennant be this Brittle-star, which I think is not improbable. It inhabits both the open sea and saltwater lochs in from seven to thirty fathoms water. I have never heard of its occurrence in a littoral locality. It is found throughout the seas of Northern Europe. Templeton at home, and Della Chiagi abroad, have mistaken varieties of *Ophiocoma rosula* for it.

OPHIURIDÆ.

OPHIURÆ.



DAISY BRITTLE-STAR.

Ophiocoma bellis. Link.

Specific character.—Disk subpentangular, convex, covered with small rosulated scales, divided by spinous spaces. A cordiform depression opposite the origin of each ray. Upper ray-scales ovate, separated and bordered by granular plates. Lateral ray-plates, bearing from four to six conical flattened spines, which are shorter than the breadth of the ray.

Bellis scolopendroides. LINK, t. xl. f. 71.

Asterius aculeata, MULLER, Zool. Dan. Prod. 2841 ; Zool. Dan. III. p. 29, t. 99.

Ophiura bellis, FLEMING, Brit. Anim. p. 488. JOHNSTON, Mag. Nat. Hist. VIII. p. 595, f. 66.

Ophiura Flemingii, LEACH, Zool. Misc. II. p. 56.

Ophiocoma bellis, FORBES, Wern. Mem. VIII. p. 126.

THIS species is one of the prettiest of its tribe. The disk is large and subpentangular, and generally bulges out

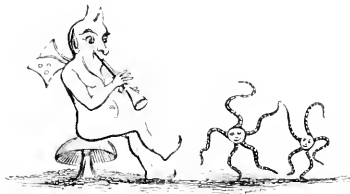
between the insertions of the rays. The upper surface is ornamented with oval, round, or angular plates, variously arranged, and surrounded by numerous, very short, blunt, little spines, which in some places cover considerable portions of the disk. The general arrangement of the plates on the disk is as follows:—A round central plate, surrounded at a little distance by a circle of five semicircular plates, each of which is placed at the apex of a cordiform depression, the base of which is at the origin of a ray. Several large and small plates stud this cordiform depression, sometimes irregularly, sometimes in a regular row. The little spines mingled with these plates are smaller than those on other parts of the surface, and sometimes the depressions are bordered by larger spines. The intermediate spaces have a row of plates proceeding from the centre to the margin. This intermingled surface of spines and plates gives the disk that likeness to a daisy-flower, whence it has been called “bellis” by some; nor is the flower at all degraded by the comparison, for but few daisies can show such beauty either of form or colour as is presented by this little Sea-star. Beneath there are no plates on the much-rounded angles between the rays, the whole being thickly studded by the little spines. Between the origins of each pair of rays there is a little broad angular plate. The rays themselves vary much in length, and are generally very thick and rather flat. They are covered above by transversely ovate plates, each of which is surrounded by a border of little, flat, roundish granules, seeming like a brooch set in a frame of gems. Sometimes these plates are divided into two or three pieces; and when such is the case, the pieces are similarly framed by granules. The rays are bordered by rows of thick, compressed, obtuse spines, generally six in each row, the largest uppermost,

and they scarcely so long as the ray's breadth. The under surfaces of the rays are studded with transverse, oblong, quadrangular plates, which are set at a little distance from each other. The rays taper rather suddenly to their extremities. The disk is generally of a reddish colour, the plates being lighter, giving it a beautifully variegated appearance. There is a variety having a yellow star on the body. The rays are generally reddish, banded with darker bands, or with yellow. Some varieties are entirely of a deep chocolate hue. The proportions of the disk and rays vary much; but generally the rays are not more than three times as long as the disk is broad, yet I have seen specimens in which they were twice that length. In Shetland specimens occur having their bodies one inch across; generally, however, three quarters of an inch is the measurement of the disk. The Shetland specimens are larger in all parts than those of the Irish Sea or English coast, and are much more vividly coloured; and varieties occur in the latter locality, having a very small disk.

This *Ophiocoma* was first figured by Link, who received his specimen from Greenland. It was afterwards observed in the Norwegian seas by Muller, who figured it in the *Zoologia Danica*. In Britain it was first noticed, on the Scottish shores, by Dr. Fleming; and Dr. Leach, apparently unaware of its having been described before, named it after that distinguished Scottish naturalist. It is by no means an uncommon species. On the English coast Mr. Couch takes it in Cornwall, and Mr. Bean finds it at Scarborough "under stones at very low tides, rare." In Scotland it is found on both east and west coasts, and is very abundant in a few fathoms water in Orkney and Shetland. In the Irish Sea it is common in deep water, off

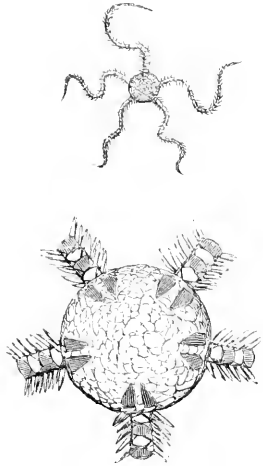
the shores of the Isle of Man. On the Irish shores Mr. Thompson and Mr. Hyndman take it by dredging in the lochs of Strangford and Belfast, and Mr. Ball in Dublin Bay.

In texture this Ophiocoma is much more leathery than its allies. It is a good subject in which to examine the nervous system. Surrounding the mouth, but at some distance from it, is a white nervous cord, which seems double; radiating from it are fifteen pairs of nervous threads, which are arranged in threes, but have not a common origin,—indeed, there appear to be no ganglionic enlargements. Of each set of three pairs the central goes to the body between the rays, and the two lateral run up the sides of two different rays, so that each ray is provided with two pairs from two different sets. This arrangement is very distinct and easily seen, by removing the upper surface of the disk and the enclosed stomach and ovaries.



OPHIURIDÆ.

OPHIURÆ.



GOODSIR'S BRITTLE-STAR.

Ophiocoma Goodsiri. Forbes.

Specific Character.—Disk round, convex, imbricated with small smooth scales. Two triangular, parallel, but not touching scales, opposite the origin of each ray. Upper ray-scales transversely ovate; lateral ray-plates, bearing four spines each, which scarcely equal the breadth of the ray.

THE tracing of the connections between species and species, through minute differences combined with general resemblances, is one of the greatest pleasures which enliven the studies of the naturalist. Every here and there in organized nature we find creatures presenting the forms of one species and the structure of another, filling up a supposed blank, or overturning a supposed barrier. The discovery of such forms frequently annihilates genera which we had long considered fixed, or brings together species which we had long looked upon as but doubtfully

related to each other. There are men who affect to look down on the investigator of "mere species," who, with patronizing self-sufficiency, talk of the "humble observers of minute differences of forms," and who scarcely rank the recorder of new animals or plants above the mere collector or virtuoso. Yet such persons affect perfectly to understand the great laws of nature; and will write on what they are pleased to term the philosophy of natural history, often without the knowledge of a single form or structure save from a picture in a book. The humility which the knowledge of the abundance of undiscovered things teaches the practical naturalist, prevents him retorting on such would-be philosophers; and knowing how little we yet know, he scarcely ventures to pronounce any law general. He knows too well that the conclusion he drew in the morning is often overturned by the discovery he makes in the evening, to pronounce himself the lawgiver of nature; yet also knowing, from the perfection of all he sees around him, that the machinery of nature is perfect, and hoping the laws of that machinery discoverable, he points out the indications of those laws wherever he perceives a glimpse of their influence, and works as trustfully towards the development of the truth.

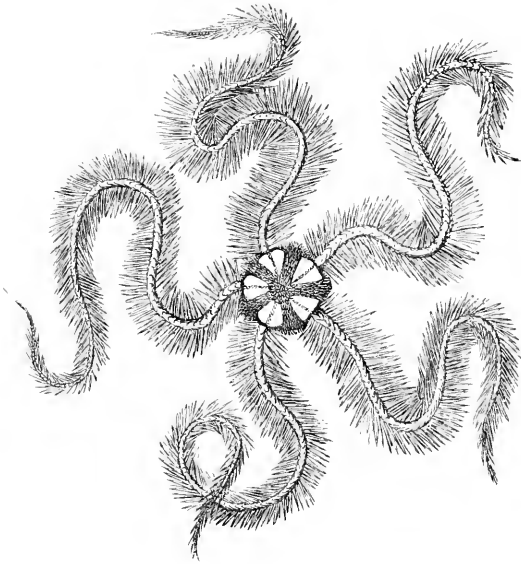
The pretty *Ophiocoma* which I have named after my friend and companion in research, Mr. Goodsir, forms a beautiful link between the scaly and the plated Brittle-stars. Before I saw this species, I had some doubts as to the propriety of retaining those two variations of character in the one genus, and suspected that *Ophiocoma rosula* was the type of a separate group. In the species under consideration, however, we find scaly rays and an imbricated body, with so much of the habit of the Daisy Brittle-

star, that it is not until we look closely at its very distinct characters, we can recognise it as something different from the young of that species. The disk of the *Ophiocoma Goodsiri* is round, smooth, and very convex, covered with small imbricated scales, which are rosulated in the centre, the central scale being as usual in such cases largest. Opposite the origins of each of the rays are two triangular plates, which do not diverge, but are separated from each other by a few scales. There are on one of the specimens a few minute spines towards the margin of the disk near these plates. Beneath, the intermediate plates are triangular. The rays are covered above with transversely oblong plates, which are slightly imbricated. Each of the lateral ray-plates bears four conical spines, which are rather shorter than the breadth of the ray. These spines are not so rough as they usually are in this genus. The plates of the under surface of the rays are somewhat heart-shaped. The rays are about three times as long as the body. The colour of the whole animal is white, variegated with bright-red, the disk being beautifully variegated, and the arms prettily belted. The disk measures a little more than two-tenths of an inch across.

The first specimen of this species was found by Mr. Goodsir in a Cod's stomach taken off Anstruther in Fifeshire. When we were in Shetland, we found a second adhering to a branch of *Cellepora cervicornis*, brought from deep water by the Ling fishermen, so that we may regard it as a deep-sea species.

OPHIURID.E.

OPHIUR.E.



COMMON BRITTLE-STAR.

Ophiocoma rosula. Link.

Specific Character.—Disk convex, rounded, covered with spines of various lengths. Two large triangular parallel plates opposite the origin of each ray. Upper ray-scales triangular, carinated, imbricated. Lateral ray-plates, bearing five spines each, which are much longer than the breadth of the ray.

Rosula scolopendroides,

LINK, pl. xxxvii. fig. 65 ; pl. xxvi. fig. xlii. Encyc. Metr. pl. cxxiii. f. 6-7.

BORLASE, Cornwall, t. xxv. fig. 19-24.

Asterias ciliata,

MULLER, Zool. Dan. Prod. No. 4842.

Asterias fragilis,

ABILGAARD, in Muller's Zool. Dan. III. p. 28, t. xcvi.

Asterias pentaphylla, varia, aculeata, hastata, fissa, et nigra, PENNANT, Brit. Zool. IV. pp. 64, 65. Nos. 64-69.

Ophiura ciliaris, fragilis, et rosularia, LAMARCK, Anim. sans Vert. 1 Edit. II. p. 545-6 ; 2 Edit. III. p. 224-6.

Ophiura vulgaris,

LEACH, Zool. Misc. II. p. 54.

- Ophiura rosula*, FLEMING, Brit. Anim. p. 439. JOHNSTON, Mag. Nat. Hist. IX. p. 231, f. 26.
Ophiura spinulosa, RISSO, Hist. Nat. d'Eur. Merid. p. 272, No. 12, pl. vi. f. 30.
Ophiura fragilis, BLAINVILLE, Man. d'Actin. p. 244.
Ophiocoma rosula, FORBES, Wern. Mem. VIII. p. 127.
Stella echinata, RONDELET, Liber de Insect. p. 123.

OF all our native Brittle-stars this is the most common and the most variable. It is also one of the handsomest, presenting every variety of variegation, and the most splendid displays of vivid hues arranged in beautiful patterns. Not often do we find two specimens coloured alike. It varies also in the length of the ray-spines, the spinousness of the disk, and the relative proportions of rays and disk; and in some places it grows to a much greater size than in others. It is the most brittle of all Brittle-stars, separating itself into pieces with wonderful quickness and ease. Touch it, and it flings away an arm; hold it, and in a moment not an arm remains attached to the body.

The body is round and convex, but when in egg sometimes bulges into a pentangular form. It is usually thickly covered with long spines, the only parts of the surface free from them being the large triangular plates opposite the origins of the rays, which are separated from each other by rows of spines, the spaces between the two, which compose each pair, being very narrow. There is a variety, however, which has the disk very rough, but not covered with long spines. Beneath, the rays are separated at their origins by small, oblong, pentangular plates. The rays are covered above with small, triangular, carinate, obtusely pointed scales, which lap over one another, like tiles on the roof of a house. Beneath, they are clothed with transversely oblong plates. The lateral ridges are broad, and each bears five very long, tapering, rough spines, which are sometimes nearly three times as long as the breadth

of the ray, but in general are not quite so long, being about twice the breadth. These spines, when highly magnified, present a very complicated structure; and their roughness arises from spine-like processes on their surface. When the animal is alive, a membrane appears to web these processes together; but I have never been able to observe anything like ciliary motions excited around the spines. Between each row is a pinnated cirrus, which likewise does not appear to be ciliated. It is very flexible, and can be withdrawn in great part within the ray. Round the mouth are twenty tentacula, ten external, and ten internal, similar in structure to the cirrhi. The rays vary in their proportions to the disk, but are usually from four to five times as long as the disk is broad. The disk generally measures in a fair-sized specimen about four-tenths of an inch across. It is sometimes of a dusky rose-colour, with gray scales; sometimes white, spotted with red, often marked with a star of red or yellow; and occasionally nearly black. The rays are generally white or gray, banded with bright pink; often of a deep blue, with rose-coloured spines, or banded with bright yellow, or speckled with brown and orange. The spines have sometimes brown tips and blue bases. Little red spots are often seen on each of the points of junction of the rays beneath; but as they are not constant, nor always of the same form, I cannot regard them as ocular. When the creature is in egg, the ovarian masses shine through the body, giving it a yellow tinge between the rays; they are reniform and yellow, and transversely striated in consequence of the arrangement of the round yellow eggs. In the month of April, instead of eggs, I have often found those masses filled with a milky fluid which, when magnified, presents the spectacle of a great number of very

minute round bodies, swimming about in all directions with eccentric motions. Are not these spermatic animalcules? and may not Hermaphrodite animals, such as the *Ophiuræ*, be at one time male and another female? or are there two sexes of these creatures? These questions must be investigated. The membrane including the ovaries is covered with vibratile cilia.

The *Ophiocoma rosula* seems to be equally abundant on all parts of the coast of Britain and Ireland. It frequents oyster, and other shell-banks in great numbers; and is in many places, as on the west coast of Scotland, and on some parts of the east of England, found on the shore at low water. It is fond of rocky places, but is rare in sandy localities. In Shetland it grows to a much larger size than elsewhere, and the spines of the Shetland specimens are longer than those from other localities.

The Common Brittle-star often congregates in great numbers on the edges of scallop-banks, and I have seen a large dredge come up completely filled with them; a most curious sight, for when the dredge was emptied, these little creatures, writhing with the strangest contortions, crept about in all directions, often flinging their arms in broken pieces around them, and their snake-like and threatening attitudes were by no means relished by the boatmen, who anxiously asked permission to shovel them overboard, superstitiously remarking that "the things weren't altogether right." Rondeletius, who figured and described this species long ago, well describes their motions:—"Radiorum flexuoso motu serpentum ritu reptat hæc stella, et in sicco posita eos movere nunquam desinit, quousque in partes disiecerit, quæ separatæ etiam moventur per flexus: ut vermiû partes, et lacertorum caudæ abscissæ." He says they prey on little shells and crabs.

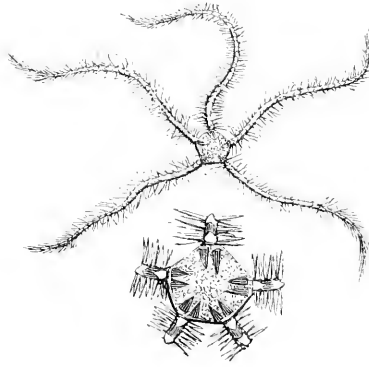
They constitute a favourite article of diet in the Cod fish's bill of fare, and great numbers of them are often found in the stomach of that fish. They seem to inhabit all parts of the European and Mediterranean seas.

The vignette represents part of a spine of this Brittle-star highly magnified, exhibiting a structure, the lightness and beauty of which might serve as a model for the spire of a Cathedral.



OPHIURIDÆ.

OPHIURÆ.



SAND BRITTLE-STAR.

Ophiocoma minuta. Forbes.

Specific Character.—Disk flat, pentangular, covered with short, rough, trifurcated spines. Two triangular, slightly diverging scales opposite the origins of each ray. Upper ray-scales triangular, imbricated. Lateral ray-plates bearing three or four spines each, which are longer than the breadth of the ray.

*Ophiocoma minuta,*FORBES, Wern. Trans. VIII.
p. 127, pl. iv. f. 3.*Hirsuta seu stella grillatoria vel macroscelus Luvlii,* LINK, p. 50.?*Asterias minuta,*PENNANT, Brit. Zool. IV. p.
63, No. 61.?

THIS is a critical species, very nearly allied to the last. Though convinced of its distinctness, and though there is no mistake about its habit, I find it very difficult to distinguish the one from the other in words. That it is not the young of the *rosula* will at once be seen by comparing it with a common Brittle-star of the same size; for then the latter will be found to have the centre of the disk as yet cartilaginous, and its spines will present that peculiar glistening frosted appearance seen on the spines of all

young Ophiuræ, while the flatness and firmness of the disk, and the general aspect of the *Ophiocoma minuta* have all the aspect of maturity.

The disk, which I have never found to exceed two-tenths of an inch in breadth, is pentangular and flat, covered above with very short, rough, trifurcated spines. Opposite the base of each ray are two large triangular scales. The rays are imbricated above with short sub-carinated triangular scales, and clothed below with square plates. Their sides are set with transverse ridges, each bearing three or four long, sharp, pectinated spines, one-fourth of their length longer than the breadth of the ray. The rays are generally more than six times as long as the disk is broad.

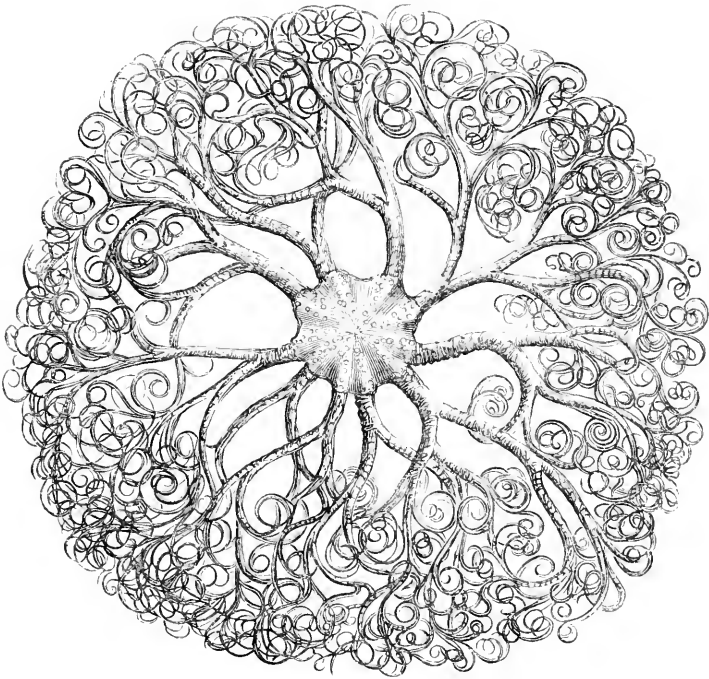
It is a very pretty species, the centre of the disk being generally occupied by a white pentangle, which is bordered by deep red, the plates opposite the rays being bluish-grey. The rays themselves are grey, belted with rose-colour; and the spines are some white, others rose. It lives buried in sand at very low water. I have hitherto found it only on the shore of Ballaugh, Isle of Man.

Mr. W. Thompson records it in the Annals of Natural History for May 1840, as an inhabitant of the north of Ireland, and mentions that it has also been found in Court Muskerry Harbour (county Cork) by Mr. Allman.

I think it not unlikely that this is the "*Hirsuta seu Stella grillatoria vel Macroscelus Luidii*," said by Link to have been found by Llhewyd at Denbigh in Wales, and called by Pennant *Asterias minuta*.

OPHIURIDÆ.

EURYALES.



Genus *Astrophyton*. Link.

Generic Character.—Rays five, branching dichotomously from their roots, with cirrhus extremities.

THE SHETLAND ARGUS.

Astrophyton scutatum. Link.

Specific Character.—Disk radiated above with granulated ribs; rays rounded above, flattened beneath, with spiniferous tubercles at the angles.

Astrophyton scutatum, LINK, t. xxix. No. 43. FLEMING, Brit. An. p. 439.

- Asterias caput-Medusæ*, LINNÆUS, Syst. 1101. MULLER, Zool. Dan. Prod. 2844. TURTON, Brit. Fauna, 149.
Asterias arborescens, PENNANT, Brit. Zool. IV. p. 67, No. 73.
Euryale verrucosum, LAMARCK, 1 Edit. vol. II. p. 539; 2 Edit. vol. III. p. 216.
Euryale scutatum, BLAINVILLE, Man. d'Actin. p. 246.

THE EURYALES connect the Ophiuræ with the Crinoideæ, to which they bear considerable resemblance, both in form and in habits. The genus *Astrophyton* of Link, called *Euryale* by Lamarck, and *Gorgonocephalus* by Leach, is considerably removed from the last genus which we considered, namely, *Ophiocoma*; but there are animals inhabiting distant seas, such as those of the genus *Trichaster*, which link the one form with the other.

The only British *Astrophyton* is a very rare animal. It was first observed on the coast of England by Borlase, the Cornish antiquarian and naturalist, who found it on the coasts of his native county. In Scotland it was first recorded as a native by the celebrated naturalist of Edinburgh, Professor Jameson, who found it on the coast of Zetland, where it has since been observed by Mr. Nicol and Dr. Charlton. In Orkney it was found by Mr. Low; and it would appear also to inhabit the south-east coast of Scotland, as in a manuscript of the late Captain Laskey, he mentions having found "a great Medusa's-head Starfish in a herring-net at Dumbar." It is a native of the Arctic seas and the coasts of Norway; it is also said to inhabit the Indian seas.

The body is somewhat pentangular in form, and radiated above with warty ribs; the mouth is five-rotate, and placed in the centre of the under surface of the disk in the midst of the origins of the arms. The arms branch dichotomously nearly from their origins. They are composed

of narrow calcareous joints, and are rounded above with precipitous sides, but flattened beneath. On the lower angles are placed transverse tubercular ridges with rows of spines, five, six, or seven in number near the body, but fewer as the arms grow smaller. The flattened surface of the arms is covered with small rounded granules, not placed in any regular order, and not all of one size. The upper surface is likewise granulated; but the granules marking the separation of the plates are arranged in two transverse regular rows. On the thicker parts of the arms there are sometimes scattered a few spines, short, thick, flattened, and somewhat conical in form, resembling the spines on the tubercles. The extremities of the rays are very much attenuated and branched, the branches curling and interlacing. The *Astrophyton scutatum* measures a foot or more across.

The singular aspect of this animal has long excited admiration among naturalists. Rondeletius especially expresses his wonder; and Bradley remarks in his *Works of Nature*, p. 50, "So odd a creature as this is well worth the contemplation of such curious persons as live near the sea, where every day they have subjects enow to employ their curiosity and improve their understanding." Grew, in his account of the Museum of the Royal Society, tells us that "As he swims he spreads and stretches out all his branches to their full length; and so soon as he perceives his prey within his reach he hooks them all in, and so takes it as it were in a net." My friend, Mr. Thomas Edmonston, jun. of Unst, Zetland, informs me that "it is very rare, and is not found so far from land as the Piper (*Cidaris papillata*). The fishermen (by whom it is called 'Argus') occasionally catch it; but in clean-

ing their lines before landing, generally throw it and other animals overboard. They report that it always clings fast round the lines, and that it takes some effort to disengage it."

The vignette represents the upper and under surface of one of its arms, an arm-joint, and the oval surface of the disk.



THE TRUE STARFISHES.



ASTERIADÆ,

OR CIRRHIGRADE ECHINODERMATA.

THE beauty and symmetry of the true Starfishes attracted the attention of such observers of nature as dwelt by the sea-side from a very early period, and several kinds are noticed by ancient authors. No separate treatise, however, was devoted to their history until the year 1733, when a splendid folio volume, containing figures of a great many species and varieties, with short descriptions attached, was published by John Henry Link, an apothecary at Leipsic. Link was a fellow of the Royal Society, and studied botany as well as zoology. He wrote an account of the coffee-tree; and Micheli dedicated a genus of plants to him in honour of his botanical acquirements. He died

in 1734, in the sixty-sixth year of his age. His work is a very valuable one, chiefly on account of the figures it contains, which have been often copied, and which have in fact supplied most of the representations of Starfishes extant. Link distributed the Starfishes under many genera, but on false principles. His mistakes arose from want of opportunities of studying the animals in a living state. In most respects he is much in advance of subsequent writers on the subject.

A fanciful analogy between the form of these Radiata and the popular notion of a star, has originated a name applied to them in most maritime countries, — a name which has given rise to a fine thought or two. “As there are stars in the sky, so are there stars in the sea,” is Link’s first sentence. “*Coelorum spectare sidera decet juvatque Astronomos: Physicorum interest stellis marinis visum intendere,*” saith Christian Gabriel Fischer in his preface to Link’s volume. Our own poet, James Montgomery, whose inspiration has revelled gloriously among the wonders of Nature, beautifully expresses the same analogy.

The heavens
Were thronged with constellations, and the seas
Strown with their images.

The true Starfishes are either stellate or angular in form, the angles or arms being dilated processes of the body. They are covered with a tough leathery integument, which is more or less strengthened by a network of calcareous plates, and in most species with strong spines variously arranged. The entire surface is also clothed with a finer and softer membrane, and through pores the lining membrane of the interior pouts out. Among and on the spines in many species are seen curious pincer-like

bodies, which will be described hereafter. The under surface of the body presents the mouth in the centre, and deep grooves radiate from it to the extremities of the arms. These grooves contain the suckers, curious tubular extensible organs, filled with a fluid, and capable of adhering to the surfaces of bodies by means of a terminal disk. They serve as feet, and by means of them the animal can walk about with great facility. They are arranged in longitudinal rows. On the dorsal surface is seen a wart-like striated body placed laterally between two of the rays: this is the *madreporiform tubercle* or *nucleus*. When the animal is cut open, there is seen a curved calcareous column running obliquely from the tubercle to the plates surrounding the mouth; Dr. Sharpey says it opens by a narrow orifice into the circular vessel. It is connected by a membrane with one side of the animal, and is itself invested with a pretty strong skin, which is covered with vibratile cilia. Its form is that of a plate rolled in at the margins till they meet. It feels gritty as if full of sand. When we examine it with the microscope we find it to consist of minute hexagonal calcareous plates, which are united into larger plates or joints, so that when the investing membrane is removed it has the appearance of a jointed column. Professor Ehrenberg remarked the former structure, Dr. Sharpey the latter: they are both right. Both structures may be seen in the column of the common Crossfish. The latter distinguished anatomist, speaking of the probable uses which have been conjectured as the purposes of this singular organ, says, "Tiedemann conceives the function of the sand canal (the term he applies to it) to be that of secreting the earthy matter required for the growth of the calcareous skeleton. Micheli considers this view as very improbable;—and the

description we have given does not tend to corroborate it ;” —and adds, “ We must confess ourselves unable to offer more than mere conjecture as to the use of this singular structure. If the fluid contained in the feet and their vessels be sea-water (either pure or with an admixture of organic particles), which is probable from its chemical composition, may it not be introduced and perhaps again discharged through the pores of the disk and the calcareous tube, the porous disk serving as a sort of filter to exclude impurities ?” I do not agree with either of these explanations. My friend, Dr. Coldstream of Leith, has suggested one much more satisfactory to my mind, and of a more philosophical character, namely, that this singular column is the analogue of the stalk of the Crinoid Starfishes. We see the tubercle indicating it in the Urchins, which are free ; but we find no traces of it in the Crinoideæ or in the Ophiuridæ, the former of which are certainly fixed animals in the young state, the latter probably so.

The centre of the true Starfish’s interior is occupied by the stomach, which is thin and membranous, rounded, and slightly lobed, and which has but one external orifice ; from it branch out into each arm two cæca, which are of a similar texture, and very much pinnate and ramified. They, as well as the stomach and the lining membrane of the body, are covered with very minute vibratile cilia. The appearance of these cæca I regard as a first step towards the separation of the respiratory organs from the digestive. Higher up among the Echinodermata we find those cæca almost separated from the digestive system, and mainly appropriated to the purposes of respiration. Above the stomach in some species are seen pyriform sacs, the special uses of which are unknown. On each

side of each arm is a branched ovary, which opens externally near the union of each pair of arms, though the aperture is seen with difficulty, saving when the animal is in full egg. On the under surface of the interior of the arms are seen rows of round bladder-like vesicles; these are the vesicles of the feet, and they are connected with vessels which communicate with a vascular circle surrounding the mouth. The internal walls of the suckers and their vessels are ciliated, and a continual circulation of the fluid they contain goes on within them. The nervous system has been described by Tiedemann, the great anatomist of Heidelberg. It is a white circular cord surrounding the mouth, and sending off branches to the arms. Professor Ehrenberg says these nerves run to the extremity of the arms, and that there is a nervous ganglion under each of the red spots which are seen near the tips of the rays, and which from analogy may be regarded as eyes of low organisation. The existence of ganglions in the nervous system of these animals is, however, generally regarded as doubtful.

The number *five* is dominant among the *Echinodermata*, and we accordingly find it regulating the forms and organs of the Starfishes, though numerical variation more frequently occurs in this order than among the Ophiuræ or Sea-Urchins. In no British genus of true Starfishes is number positively specific, though generic in several. In *Luidia* and *Solaster* it is of least importance. The numbers of variation are generally four and its multiples, which we might expect when we consider that four is the dominant number of the parallel order of *Actinodermata*.

The genera of Asteriadae are founded on characters derived from the outline of the body, the number of rows of suckers in the avenues, and the structure and arrange-

ment of the spines covering the surface and bordering the avenues. These characters represent respectively the digestive, the motor, and the tegumentary systems. As might be expected, those derived from the last, it being characteristic of the order, furnish the most constant character. Useful characters may be drawn from the form and arrangements of the spinous eyelids; but the madreporiform tubercle, which several Continental authors have suggested as a good source of distinctive character, furnishes none of importance, either generic or specific. The sources of specific character are various in the different genera. The spines of the skin furnish the most important; colour, probably, may be ranked next; and proportions of parts last, though in some genera of great importance.

The causes which seem to affect the distribution of Mollusca on the British coasts do not appear to influence that of the true Starfishes. There are as many kinds found in Cornwall as in Zetland belonging to the same genera, and even identical as species. A very few seem to prefer the western to the eastern shores of Britain, or *vice versa*. The multiplication of individuals is of course affected by the nature of the sea-bottom. When we look abroad, climate appears to affect but slightly the forms of this tribe. The Cushion-stars, perhaps, present some indications of tropical influence, and of a concentration of their genus in the eastern seas; but among other Starfishes neither form nor colour are remarkably modified by geographical position. Of the numbers and distribution of true Starfishes in the primæval seas we cannot well judge, their substance and structure being such as to be ill adapted for preservation in a fossil state.

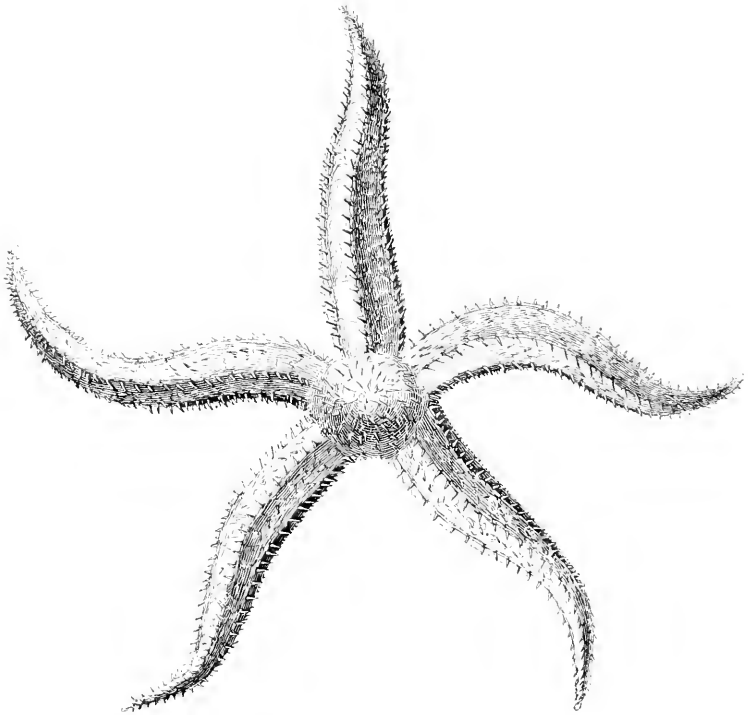
The British species of Asteriadae may be arranged under

four families. First, The URASTERLE, Stellate Starfishes, with rounded arms, and four ranges of suckers in each avenue. Of this family we have but one genus, *Uraster*. Second, The SOLASTERLE, also stellate (sometimes multi-radiate), with rounded arms, but only two ranges of suckers in each avenue, such as *Cribella* and *Solaster*. Third, The GONIASTERLE, which are pentagonal, and have two ranges of suckers. To this family belong the genera *Asterina*, *Palmipes*, and *Goniaster*. And fourth, The ASTERLE, including *Asterias* and *Luidia*, stellate Starfishes, with the upper surface of the body flat.



ASTERIADÆ.

URASTERIÆ.

Genus *Uraster*. Agassiz.

Generic Character.—Body stellate, few-rayed ; rays rounded, spinous ; avenues bordered by three sets of spines ; suckers quadriserial.

SPINY CROSS-FISH.

Uraster glacialis. Lin. Ag.

Specific Character.—Rays long, pentangular, the angles with large strong spines ; avenues regularly tapering.

Asterius glacialis, LINN. LAM. Anim. sans Vert. 1 Edit. II. p. 361, No. 26 ;
2 Edit. III. p. 243. MULLER, Zool. Dan. Prod. 2333.

Asterius echinophora, DELLA CHIAGI, Mem. vol. II. p. 356. pl. xviii. f. 5.

<i>Asterias angulosa</i> ,	MULLER, Zool. Dan. II. p. 1, t. xli.; Encyc. Metr. pl. cxix. f. 1.
<i>Sol echinatus cancellatus</i> ,	LINK, f. 33, tab. xxxviii.-ix. Encyc. Metr. pl. cxvii.-xviii.
<i>Stellonia glacialis</i> ,	AG. Prod. FORBES, Wern. Mem. vol. VIII. p. 123.
" " <i>Junior</i> ,	
<i>Asterias spinosus</i> ,	PENNANT, IV. p. 62. FLEMING, Brit. Anim. p. 437.
<i>Pentadactylosaster spinosus</i> ,	LINK, p. 35, t. iv. No. 7. Encyc. Metr. pl. 119, f. 2, 3.
<i>Stella Hibernica echinata</i> ,	PETIVER, Gaz. t. xvi. fig. 5.

THE STARFISHES of the genus *Uraster* are distinguished from all others by having four rows of suckers in each of the avenues which groove the rays beneath. In consequence of the great number of these singular organs, the under surface of a living Crossfish presents a sight truly curious and wonderful. Hundreds of worm-like suckers, extending and contracting, coiling and feeling about, each apparently acting independently of the others, give the idea rather of an assemblage of polypi than of being essential parts of one animal. Sensitive in the extreme, if we touch one of those singular tubes when outstretched, all those in its neighbourhood are thrown into a state of agitation; and when it shrinks from our touch, changing from a lengthy fibre to a little shrunk tubercle, some of its neighbours, as if partaking in its fears, contract themselves in like manner. If we cut one off, however long it may have been at the moment of injury, all its power of extension is instantly gone, and in an inconceivably short time it changes its form, contracting into a little knob-like mass.

The first species of this genus which we have to describe is one easily distinguished by its very angular arms and large strong spines. The Spiny Crossfish grows to a large size. Mr. Couch describes a specimen, the diameter of which across the disk and rays was no less than thirty-three inches, the largest of the rays being fourteen inches

long; the diameter of the disk in one direction three and a half, and in another three inches: the rays at their origins were two inches wide, the breadth of the disk being to the length of the ray as two and a half to twelve. The specimen from which my figure was taken is of more ordinary dimensions, being fifteen inches across, the longest ray seven inches and a half long and one inch in breadth, which was also the breadth of the disk. This species varies greatly in its proportions; but the rays are always more taper in proportion to the disk than those of any other British Uraster. The rays are acutely pentangular and tapering, the uppermost angle forming a keel. The angles are crowned by strong conic spines placed on tubercles, and surrounded towards the base by a circle of numerous spinules. The intermediate spaces are strongly reticulated. Here and there among the reticulations are scattered a few large spines similar to those on the angles. The surface is also covered by little divided pincer-like spinules, which organs are seen on all the species of the genus. The madreporiform tubercle is small, finely striate, and placed very lateral. Beneath, the avenues taper to the ends of the rays, and the border spines are shorter, finer, and less conic than those crowning the angles. The disk is very prominent and round; it is reticulated, and provided with spines similar to those on the rays, but not so numerous. The rays are not so firmly attached to the disk as in the other species of Uraster. "The weight of the body," says Mr. Couch, "cannot be sustained, or even turned over, by lifting it by the rays without separating them." I have dredged up living rays without bodies, evidently in consequence of this facility of separation. It is doubtful, however, whether the animal has the power of throwing them off voluntarily, as is the case with *Luidia*

and the Ophiuræ. I do not think it can. The colour is reddish or orange. A specimen taken on the Manx coast was bright red. Mr. Couch describes his example as "reddish brown; tufts round the spines yellow; interior of the stomach pale-green."

The Spiny Crossfish is a local species, as far as I know confined to the western shores of Britain. I have taken it in Skye and elsewhere among the Hebrides, half buried in sand and gravel, at low water; also in the Kyles of Bute by the dredge in fifteen fathoms. Mr. R. Ball has taken it in deep water at Youghal on the Irish coast, where he found many specimens of *Natica Alderi*, a favourite article of food with the Starfishes, in its stomach. Dr. J. L. Drummond has found it in a young state at Belfast; and Mr. Allman has frequently procured it on the south-west coast of Cork, where it is abundant, chiefly on a rocky bottom. Mr. Philip Maclagan found it on the coast of Ayrshire. Mr. Wallace has a specimen from deep water on the Manx coast; and Mr. Couch records it as a native of Cornwall, also from deep water.

The "*Pentadactylosaster spinosus regularis*" of Link, found by Luid in Cornwall, and on the west of Ireland, was, I doubt not, the young of this species. Petiver figures the same as "Watty Penson's Sea-star from Ireland." When young, the rays are much shorter in proportion to the body than they afterwards become. When very young, only an inch or two across, *Uraster glacialis* bears a close resemblance to the young of the next species; but is easily distinguished by having the spines conic, thickest at the base, whereas in *Uraster rubens* they are nearly of the same thickness throughout.

The Starfish usually called *Asterius glacialis* by British authors, is not this but the next species. This, however,

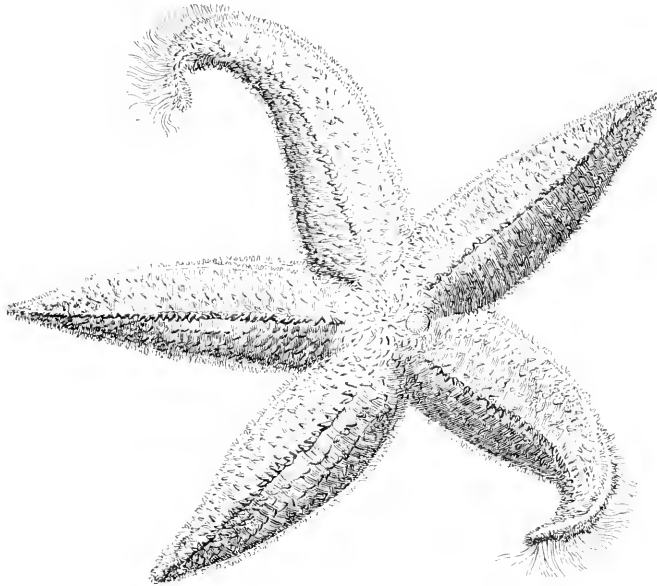
is the species of Linnæus, as may be seen by consulting the characteristic figures of Link to which he refers. *Asterias tenuispina* of Lamarek is, I doubt not, a variety of this, with more rays than usual. The *Asterias Saveresi* of Della Chiagi is also a variety; and that author does wrong to unite *Asterias violacea* of Muller with the *Uraster glacialis*.

Its rarity is probably owing to its habitat, rocky places in deep water. The Hebridean locality is an exception; but it is a remarkable fact, one which I have elsewhere pressed on the attention of geologists when considering the Mollusca, that whenever, as in the Hebrides, the tides fall but a few feet, these animals, usually inhabitants of deep water, may be found living above low water mark. This holds good as well in regard to Radiata as to Mollusca; and the mixture of species generally considered inhabitants of the depths of the sea, with truly littoral species, should a fossil bed be formed, might lead to false conclusions unless such fact be borne in mind. Thus a change in the tides of a line of coast would materially affect its fauna.



ASTERIAD.E.

URASTERI.E.



COMMON CROSSFISH.

Uraster rubens. Lin. Ag.

Specific Character.—Rays about three and a half times as long as the disk is broad, rounded, very spiny. Avenues lanceolate.

Asterias rubens. LINN. 1099, Fabr. Fauna Groen. p. 369. MULLER, Zool. Dan. Prod. p. 2330. LAM. 1 Edit. II. p. 562; 2 Edit. III. p. 160. BLAINV. Man. d'Actin. p. 239, pl. xxii. A. B. BASTER, t. xii. fig. 1-4. LINK, pl. vii. fig. 9; pl. xi. fig. 15; pl. xiv. fig. 23; pl. xv. and xvi. fig. 13; pl. xxx. fig. 50; pl. xxxiv. and xxxv. fig. 53; pl. xxxvi. fig. 67; pl. xl. fig. 70. Enc. pl. cxiii. f. 1, 2; pl. cxii. f. 3, 4.

Asterias glacialis. PENN. Brit. Zool. IV. p. 60, No. 54. FLEMING, Brit. An. p. 437. COUCH, Cornish Fauna. HOGG, Stockton-on-Tees.

Asterias clathrata. PENN. Brit. Zool. IV. p. 61, No. 55. (*Junior.*)

Stellonia rubens. AGAZ. Prod. FORBES, Wern. Mem. VIII. p. 121.

THE COMMON CROSSFISH has generally five rays, occasionally six, and not unfrequently as few as four. The rays are rounded, and taper gradually to a point. They are commonly about three and a half times as long as the disk is broad, and the breadth of each is somewhat less than a third of its length. Both disk and rays are reticulated, and at the angles of the reticulations arise conical blunt spines, the bases of which are surrounded by circles of thickly-studded spinules. The spines generally form a more or less regular keel on the upper surface of each ray, and sometimes an irregular circle round the disk. In the spaces between the reticulations are numerous small, cleft, pincer-shaped, flattened, pedunculated spinules. Beneath, the avenues taper according to the shape of the rays, and are not so contracted at their origins as in the next species. The edges of each avenue are bordered, first, by thickly-set, long, thin, tapering spines, which have frequently several spinules projecting in a radiant manner from their inner side near their tips. Next to these are transverse rows of stout spines, similar to those on the rays above, but larger and stronger. There are generally three in each row, and their bases are surrounded by tufts of spinules. At some distance from these spines bordering the upper surface of the ray is a row of similar spines, not so thick or strong, placed longitudinally in pairs. At the extremity of each ray we find the eyes surrounded by a circle of moveable spines, not different from the ray-spines near them, either as to form or size. The mouth is protected by spines of a similar nature with and but little longer than those forming the immediate edging of the avenues. The suckers are cylindrical, nearly equal in thickness throughout their lengths, and furnished with globose extremities. They are very extensile, especially those near the extremities of the

rays. The madreporiform tubercle is placed near the margin of the disk, between the origin of two of the rays. It is large, convex, and finely striate, with wavy radiating striae which bifurcate towards the margin. The colour of this species is generally yellow or orange; sometimes purple or red. It occasionally measures more than a foot across, and generally from nine inches to a foot. In very young specimens the pincer-shaped spinules are frequently wanting. In that state it is the *Asterias clathrata* of Pennant.

The Common Crossfish varies considerably, sometimes in colour, sometimes in the breadth of the rays, which, when much attenuated, approach nearly in character to those of the next species. There is a variety common in the Frith of Forth, in which the spines of the dorsal ridge are much developed and very prominent. Another variety has the upper surface of a deep purple colour, the under surface yellow, the arms much broader, and the skin more leathery in texture than usual. It is a littoral form, and for distinction may be called *Uraster rubens*, *B. coriacea*.

This species abounds on most parts of our shores. It may be regarded as the most common native *Uraster*. In the Irish Sea it inhabits various depths of water, from thirty fathoms to a few feet. At Liverpool it occurs under stones at low water. In the Frith of Forth it is abundant in from seven to ten fathoms. It ranges from Devonshire to Zetland. Dr. Johnston takes it at Berwick-on-Tweed; Mr. Bean, at Scarborough; Mr. P. MacLagan on the Ayrshire coast; and Mr. W. Thompson at Dublin and Belfast. The coriaceous variety occurs abundantly under stones at low water, and creeping on the sides of jetties on many parts of the Fifeshire coast. Mr. Ball finds the same form common at Youghal in Ireland, where it occurs

nine inches in diameter, and grows much larger. The variations in the number of the rays of the Crossfish furnished Link with many supposititious species. These variations are sometimes congenital, but more frequently the result of injury. It has the power of reproducing rays broken off; and I add a figure of a very remarkable specimen, kindly communicated by Mr. Bean of Scarborough, in which no less than four of the rays have been broken off and are reproduced, giving from this small development a most strange and unradiate appearance to the creature, converting it from a star into a comet. The oyster fishermen fancy that it loses its rays in consequence of its oyster-hunting propensities, that it insinuates an arm into the incautious oyster's gape, with the intent of whipping out its prey, but that sometimes the apathetic mollusc proves more than a match for its radiate enemy, and closing on him holds him fast by the proffered finger; then the Crossfish, preferring amputation and freedom to captivity and dying of an oyster, like some defeated warrior, finding

“The struggle vain, he flings his arms away,
And safety seeks in flight.”

This story has long been believed. Link gives a vignette representing the mode of attack, with the motto, “Sic struit insidias.” Doubtless the Crossfish is a sworn enemy to oysters, a submarine Dando; but there is reason to think he destroys his prey in a very different manner from that just narrated. Starfishes are not unfrequently found feeding on shellfish; in such cases they enfold their prey within their arms, and seem to suck it out of its shell with their mouths pouting out the lobes of the stomach. They can project the central parts of their stomachs in the manner of a proboscis. Mr. Ball once found one embracing a *Mactra stultorum*, which was pierced with a hole, and

the Starfish had inserted a sucker through the hole. Mr. Ball's impression was, that the Starfish had made the perforation. I should rather consider it the action of some siphonostomatous Gasteropod, which, not having extracted its prey, the Uraster was devouring the remains, and perhaps sounding with its sucker the prospects of a meal. M. Eudes Deslonchamps has published some interesting observations on the feeding of this species in the Memoirs of the Linnean Society of Calvados for 1825. He tells us that when the tide was out, and while two or three inches of water remained on the sand, he saw balls of *Asterias rubens*, five or six in a ball, their arms interlacing, rolling about. In the centres of the balls were Mactrae stultorum in various states of destruction, but always unable to close their valves and apparently dead. Does not the Starfish in such cases destroy its food by a poisonous secretion, and thus master the Shellfish? *Uraster rubens* has long been believed to secrete an acrid fluid from its skin, which burns the skin of those who handle it. This story is repeated in works of natural history to the present day; yet I have handled hundreds without having felt any such sensation, and I never met any person who had felt it. Pliny tells us Starfishes can burn all they touch (lib. ix. c. 60); also Aldrovandus and Albertus, who said their nature was so hot that they cooked everything they meddled with. Link thought that their eggs had been mistaken for cooked food; and Luid, who was an out-door naturalist, denied the notion altogether. Possibly it arose from confounding them with the stinging Medusæ, which are also called Sea-stars by many, and confounded by the vulgar with Starfishes. Sir Thomas Browne notes on this notion, "*Stellæ Marinae*, or Sea-stars in great plenty about Yarmouth. Whether they be bred out of the Urticus, Squal-

ders, or Sea-jellies, as many report, we cannot confirm; but the Squallers in the middle seem to have some lines or first draughts not unlike."—(Works, Wilkin's Edit. vol. iv. p. 333.) Although there is no good reason to believe the skin of the *Uraster* secretes an acrid and poisonous fluid, the stomach possibly may, and the inquiry offers a good subject for experiment. The Starfishes of this genus prey on all kinds of Mollusca, and are very commonly found with *Natica Alderi* in their stomachs, the animal of which being large and fleshy must furnish them with excellent nourishment. They do not confine themselves, however, to Mollusca, as will be seen by the following note furnished me by my friend Mr. W. Thompson. "September 19, 1837.—W. D. an intelligent fellow, tells me that he has frequently, when fishing in Belfast Bay, taken Starfish on his hook; they seized upon the lugworm (*Lumbricus marinus*) he was using as bait, and when drawn up, the 'centre' (to use his own words) of the animal was always fastened to the hook. The 'pluck' of the Starfish was such as to induce him to believe he had hooked a fair-sized fish. I showed him specimens of our native Asteriadæ, when he identified the *Uraster rubens*, and it alone, as the intruder."

The *Uraster rubens* is popularly called "Crossfish," and "Five-fingers," on most parts of the English and Scottish coasts. In Cornwall it is called Clam or Cramp. The fishermen of Newhaven, near Edinburgh, tear them across the stomach in order to destroy them before returning them to the sea; and there are local regulations in many places prohibiting the dredgers to throw them overboard alive. In Bishop Sprat's History of the Royal Society, we are told that the Admiralty Court laid penalties on those engaged in the oyster fishery "who do not tread

under their feet, or throw upon the shore, a fish which they call *Five-finger*, resembling a spur-rowel, because that fish gets into the oysters when they gape and sucks them out." Dr. J. L. Drummond of Belfast favours me with the following note on their Irish denomination. "The Starfishes are called at Bangor (county Down) the *Devil's fingers*, and the *Devil's hands*, and the children have a superstitious dread of touching them. When drying some in the little garden behind my lodgings, I heard some of them on the other side of the hedge put the following queries. 'What's the gentleman doing with the bad man's hand? Is he ganging to eat the bad man's hands, do ye think?'"

On the east and south coasts the Crossfishes are used for manure in large quantities; and Lamarck tells us that they serve the same purpose on the coasts of France, where the species under consideration is equally abundant as in Britain. A gardener told me that he would desire no richer manure than Starfishes for his garden.

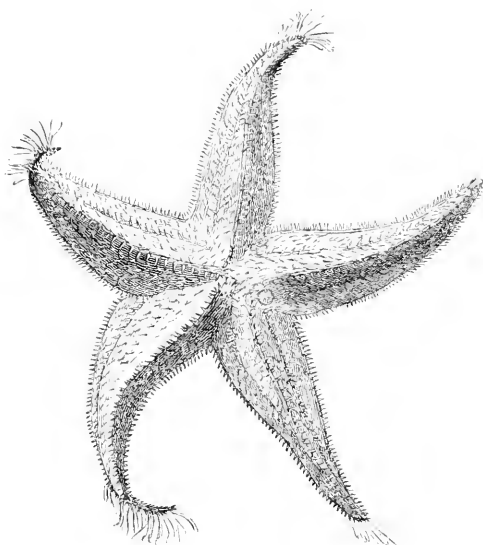
Common as this species is, its history has been involved in sad confusion as regards synonyms. Of the older authors it is certainly the *Asterias rubens*, and Otho Fabricius describes it with his accustomed accuracy under that name. The *Asterias rubens* of Dr. Fleming appears to be strangely compounded of this and *Solaster endeca*. Dr. Johnston described the *Luidia fragillissima* under the same name; and in the new edition of Lamarck, by some oversight, his description is referred to among the synonyms of the true *rubens*. Blainville's references are correct, as also those given by Stewart in his "Elements of Natural History." Link gives many characteristic figures of it, one of which is from a British specimen, called by Luid "Lutea vulgaris." Baster figures it, and tells us that

these stars are not only able to creep, but also to swim; which is probable, since Mr. Couch (who calls it *Asterias glacialis* after Fleming) tells us in his Cornish Fauna, that it is “abundant in the early months of spring, but they retire to deeper water in summer.” The same ardent naturalist has also a note on the species in the twenty-seventh number of the new series of the Magazine of Natural History, where he says, “This species is in great abundance in spring, being found in multitudes in the fishermen’s crab-pots, the baits of which they readily find. As the season becomes warmer they disappear, and in summer comparatively few are seen.” In the same place he describes the following remarkable monstrosity of this “the Clam or Cramp. It is of the ordinary size, and possesses eight rays; but to distinguish it from the simple duplication of parts, it possesses three of those circular dorsal organs, the use of which is uncertain, but of which a common specimen possesses only one. These three occupy triangularly one-half of the disk, and seem connected with four of the rays, the other four lying distinct from them.” Probably the result of the union of three ova.



ASTERIAD.E.

URASTERI.E.



VIOLET CROSSFISH.

Uraster violacea. Muller.

Specific Character.—Rays from two and a half to three and a half times as long as the disk is broad, rounded, spiny, tapering suddenly to their apices. Avenues pyriform-lanceolate.

Asterias rubens violacea, MULLER, Zool. Dan. t. lxi.

Sol coriaceus planus, LINK, p. 33, t. xi. No. 15.

Asterias violacea, LINN. Gmel. p. 3163, No. 24. BLAINV. Man. d'Actin. p. 239. LAM. Anim. sans Vert. 2 Edit. III. p. 256. EHRENBERG, Berlin Trans. vol. XXII. p. 209, t. viii. f. 9.

THE VIOLET CROSSFISH is a critical species. At times it is very difficult to distinguish it from the last species; yet after a thoughtful study of very many specimens, I feel convinced they are distinct. Muller doubted, and apparently could not make up his mind; for he figures it as

“*Asterias rubens violacea.*” In both animal and vegetable kingdoms there are genera in which we find habit of equal or greater importance than minute character, in which every organ and appendage are liable to variation, and yet the sum of them is such as to render the recognition of a species at sight easy, though it be difficult to say wherefore we pronounce on its name. Doubtless this is according to a fixed law as yet undiscovered; and if smaller groups and variations be analogous to the greater divisions of the kingdom to which they belong, it is to be expected, seeing that a fifth part of the animal kingdom, according to the greater modifications of structure as indicated by form, presents *habit* as a distinguishing characteristic.

The *Uraster violacea* has the rays generally from two and a half to three and a half times as long as the disk is broad. They are broad at their origins, and at about half their length they taper suddenly to their extremities. They appear margined, from having the upper row of avenue spines placed very high, much higher than in *rubens*. The upper surface of the rays and disk is strongly reticulated and spinous, and the central ridges are very regular, the spines upon them being closely set and surrounded by spinules. They do not stop short at the disk as in the last species, but meet in its centre. The spaces between the reticulations are covered with pincer-shaped spinules. These spinules are more pointed than the same organs in *Uraster rubens*. Beneath, the spines bordering the avenues are arranged as in the other species of the genus. The avenues partake of the form of the rays, being suddenly attenuate towards the extremities, very wide towards their origins, and very much contracted at the mouth. The form of the avenues is very constant,

and affords the best characters for the distinguishing of species in this genus. The colour of *Uraster violacea* varies much, and is often very beautiful, being of a bright orange, or rich red, with blue spots, and beneath not uncommonly straw colour. Frequently the rays are of a livid purple towards their extremities. The bases of the spines are often surrounded with a ring of blue. The madreporiform tubercle is very lateral, the striae coarse, undulating and radiating from the centre, often bifurcating towards the base.

This species is apparently gregarious, and somewhat confined in its habitats. In the Frith of Forth it is exceedingly abundant. Off Anstruther, at the mouth of the Frith, it is by far the commonest species; and the fishermen bring up great numbers of them on their lines, while *Uraster rubens* seldom occurs. Dr. Johnston informs me that it is the most common species on the coast of Berwickshire, while the *rubens* is rare. High up the estuary of the Forth the *rubens* is common, and *violacea* scarce. In some parts of the Irish Sea it is not to be met with. On the coast of Ireland, however, Mr. Thompson states it is common at Belfast, Dublin, and Youghal, and is found mixed with *rubens*. Mr. Goodsir and I took it in Orkney and Shetland. At Scalloway in the Shetland Isles we found a remarkable variety, which at first sight had much the aspect of a distinct species. The rays tapered from their bases and were very narrow. The central and lateral ridges of spines had the spines placed at considerable distances from each other in an extremely regular manner. The spinules round the bases of the spines, which were as usual in this species long and tapering, were highly developed. Very few spines were scattered over the reticulations of the rays; but a good num-

ber over the surface of the disk. Beneath, the avenue spines of the second row were longer than usual. The avenues presented the usual character. Although so much attenuate, the rays in this variety bore the same proportions to the disk as in the common form of the species.

The dimensions of the Violet Crossfish vary much. In some places they are seldom found measuring more than four or five inches across. In other localities they attain the magnitude of the common Crossfish.

The vignette is a view of Breda Head, Isle of Man.



ASTERIADÆ.

URASTERIÆ.



LITTLE CROSSFISH.

Uraster hispida. Penn.*Specific Character.*—Rays short, rounded, spinous. Avenues ovate.*Asterias hispida,*

PENN. Brit. Zool. IV. p. 62, t. xxx. f. 58.

Stellonia hispida,

FORBES, Wern. Mem. VIII. p. 123.

Stella coriacea acutangula hispida, LINK, p. 31, t. ix. f. 19 ; t. xxxv. f. 39.

THE *Uraster hispida* is the smallest of our native Cross-fishes. It was first distinguished by Pennant, who gives a figure sufficiently characteristic to enable us to identify the species, though very different animals have been referred to his *Asterias hispida*. This species seldom measures more than an inch and a quarter across. The rays are very broad and short, being but little longer than the breadth of the disk, in some specimens even shorter. The body is very convex, and generally of a bright rose colour. Pennant's specimen was brown. The upper surface is reticulated ; stout spines of nearly equal thickness throughout their length, and mostly simple at their bases, crowning the angles of the reticulations. The ridge down the centre of the very gibbous arms is often very indistinctly

marked. Beneath, the spines bordering the avenues are longer and finer than those on the reticulations, and are arranged in the same manner as in other species of *Uraster*. The avenues are elongato-ovate in form,—a good distinguishing character throughout this genus.

The little Crossfish is a scarce species, and where found does not seem to occur in much plenty. Pennant found it in Anglesea. I have taken it at Arisaig, on the coast of Ross-shire, in crevices of the gneiss rocks at low water; and under stones on the shore in the Kyles of Bute. It occurs also on the east coast of Scotland, as I found several specimens cast up by a storm on the sandy shore at St. Andrew's, in December 1839. Dr. Coldstream found it among limestone rocks at Castletown, Isle of Man; and Mr. W. Thompson informs me it occurs, though rarely, on the coast of Down in Ireland. The Irish specimens were only ten lines in diameter. Captain Portlock has taken it in Belfast Bay. I am not aware of any instance of its occurrence out of Britain; but it probably will be found on the Scandinavian shores. It may easily be passed over as the young of one of the more common species, but is very distinct.

The Starfishes of the genus *Uraster* have a very wide geographical distribution. The Common Crossfish has been observed in Greenland, and other places very far north, and is found in the Mediterranean, and on the southwestern shores of Europe. The Spiny Crossfish has a similar distribution. A species very nearly allied to it, having broader and shorter rays, but very similar in the arrangement of its spines, has been found by Mr. Wallace on the coast of Peru at Islay. A Starfish, very nearly allied to *rubens*, but differing in the fineness and greater number of its spines, is preserved in the Hunterian collection from the Arctic Seas. This may possibly occur on

our own shores. The Violet Crossfish is found on the Norwegian coast, and in the Baltic Sea.

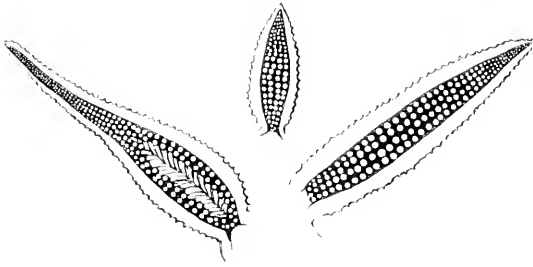
Anciently the *Urasters* were used in medicine. They were given internally as a decoction with wine in hysterical diseases, and against epilepsy. The physicians of old times, members of a profession never very remarkable for logical acumen, applied them externally in hernia, from some fanciful analogy between their pouting stomach and the appearance of the rupture. Any medical man, who would wish to revive the practice, will find the prescriptions carefully gathered together in Link, who, however, does not appear to have put much faith either in the medical or gastronomical virtues of Starfishes; yet, conceiving it necessary to find some use for them, according to the manner of his times, tells us they are of use to man, not because they serve as food to him themselves, but because they feed the fishes, and the fishes feed him, adding, “*Miror hinc et in providentia divina sapientiam.*”

In describing the species of *Uraster*, I have frequently spoken of spinules, by which name I have designated those singular pincer-shaped bodies termed by Muller *Pedicularia*,—bodies seen on the surface of many species of Starfishes and Sea-Urchins, and in the dried specimen appearing like little cleft spines. Dr. Sharpey thus describes them in his account of the anatomy of *Uraster rubens*:—“They cover the surface generally, and form dense groups round the spines. Each consists of a soft stem, bearing on its summit, or (when branched) at the point of each branch a sort of forceps of calcareous matter, not unlike a crab’s claw, except that the two blades are equal and similar. When the point of a fine needle is introduced between the blades, which are for the most part open in a fresh and vigorous specimen, they instantly close and

grasp it with considerable force. The particular use of these prehensile organs is not apparent ; their stem, it may be remarked, is quite impervious." I have examined them very carefully in the same species. Those on the body and upper spines differ in shape from those on the spines immediately bordering the avenues. The former are much shorter and blunter in the blades than the latter. The calcareous forceps, of which their heads consist, are imbedded in an integument of a soft granular tissue, which envelopes the forceps when closed ; and this apparatus is mounted on a bulging body of a similar substance, which crowns the round flexible and contractile peduncle, sometimes simple, sometimes branched, each branch having a similar termination. I could detect no evidence of vibratile cilia on their stalks ; but there appeared to be ciliary motions within the blades. When the Starfish is alive, the *Pedicellariæ* are continually in motion, opening and shutting their blades with great activity ; but when cut off they seem to lose that power. If they be not distinct animals, as Muller fancied, for what purpose can they serve in the economy of the Starfish ? If they be parasites, to what class or order do they belong ?—what is their nature, what their food ? Truly these are puzzling questions. These organs or creatures have now been known for many years—have been examined and admired by many naturalists and anatomists—have been carefully studied and accurately delineated, and yet we know not what they are. This is but one of the many mysteries of natural history—one of those unaccountable things which we know and know not—of those many facts in nature which teach us how little is man's knowledge, and how wondrous and unsearchable is God's wisdom. It is folly and vanity to attempt to account for all facts in nature, or to pretend to

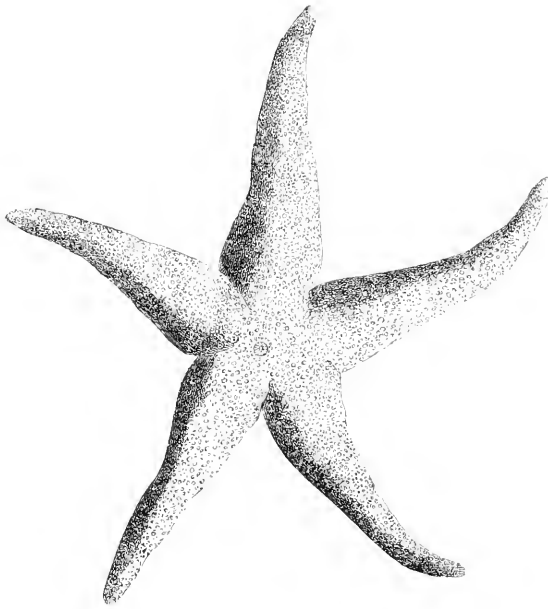
say why the Great Creator made this thing, and why he made that, and to discover in every creature a reason for its peculiar organization. It is but another form of the same vanity, having satisfied itself of the discoveries it has made, to pretend to praise the all-wise Maker's wisdom in so organizing his creatures. That God is all-wise is a revealed truth; and whether the organization before us seem excellent or imperfect it matters not—we *know* it is perfect and good, being the work of an all-wise God.

The vignette represents the form of the avenues in the Common, the Violet, and the Little Crossfishes.



ASTERIAD.Æ.

SOLASTERIÆ.



Genus *Cribella*. Agassiz.

Generic Character.—Body stellate; rays rounded, covered, as well as the disk, with spiniferous tubercles; intermediate spaces porous; avenues bordered by two sets of spines; suckers biserial.

EYED CRIBELLA.

Cribella oculata. Pennant.

Specific Character.—Rays and disk irregularly covered with oblong reticulating spiniferous tubercles.

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| <i>Pentadactylosaster oculatus</i> , | LINK, p. 31, t. xxxvi. f. 62. |
| <i>Asterias oculata</i> , | PENNANT, Brit. Zool. IV. p. 61, t. xxx. f. 56. |
| | FLEMING, Brit. An. p. 487. |
| <i>Linkia oculata</i> , | FORBES, Wern. Mem. vol. VIII. p. 120. |
| <i>Asterias multifora</i> , | LAM. Anim. sans Vert. II. p. 565 ? |
| <i>Asterias perforata</i> , | MULLER, Zool. Dan. Prod. 2334 ? |

THE genus *Cribella* forms a connecting link between the Urasters and the Solasters. It has the form of the former, with the suckers and texture of the latter. The name *Linkia* given it by Nardo must be rejected on account of a genus of plants having been so named previously, therefore I have adopted Professor Agassiz's proposed appellation. At the same time I feel by no means convinced that a name should be changed, if long established, for the reason I have mentioned: there are great generic appellations common to both animal and vegetable kingdoms universally adopted, and yet causing no confusion. It had best, however, be avoided; a repetition of the same name generically in either of the organic kingdoms separately is quite inexcusable.

Two species of this genus inhabit the British seas: there are several exotic forms. The first of our native species, the *Asterias oculata* of Pennant, seems strangely enough to have been confounded, both by many British writers and foreign naturalists, with *Uraster rubens* and *Solaster endeca*. Its colour must have misled in the former case, its texture in the latter. It received its name of *oculata*, either on account of the moniliform pores, or the five dark spots which occasionally mark the origins of the rays. The pores on the surface are not characteristic of this genus only, as Professor Agassiz seems to think. They may be seen in many other Starfishes, and in the young of almost all the species. In the living animal, a brownish peritoneal membrane pouts out at each pore. Are they not subservient to respiration?

The rays are five in number, rounded, and generally nearly four times as long as the disk is broad; they vary in form according to the state of the animal. When it is in egg, they are broad and swelled out at their bases;

when not so they taper very gradually, and terminate obtusely. The spawning season makes a very great difference in the forms of many Starfishes, always adding greatly to their convexity, and their skin at such times is much softer than usual. The disk and rays are covered with oblong reticulating tubercles arranged irregularly. The spines on these tubercles are very numerous, short and rough. The spaces between them are porous. The avenues are bordered by two sets of spines. That nearest each avenue (which is very narrow) consists of regularly transverse rows of from three to six rough spines. The second row is composed of oblong tubercles, bearing fasciculi of from four to six spines. Between these two rows there is a line of pores larger than those on other parts of the rays. The spines protecting the mouth are a very little larger than those on the border. At the end of each ray is an eye, protected by an irregularly ovate ring of spines. Mr. Goodsir has examined this eye carefully, and finds it to consist of a red cushion, with pits on its surface. The madreporiform tubercle is placed laterally, and is rudely striate with coarse undulating striæ. The colour is generally dark red or deep purple above, and straw colour beneath. Small specimens are lighter. Occasionally specimens are taken of a bright vermilion. As in many other Starfishes, the spines are more regularly placed on the yellow portions than on the red. What is the relation between these arrangements and the colour? The *Cribella oculata* seldom measures more than three inches and a half across.

This species varies much. The spiniferous tubercles are much more numerous and finer on most specimens from the east coast than on those from the west. The latter are usually found in deep water, the former at low water.

A very remarkable variety was obtained by my friend, Mr. Henry Goodsir, from the deep sea-fishing off the coast of Fife. One specimen only occurred. The rays in this form are covered with oblong tubercles, bearing numerous short, thick, oblong spines, which are much fewer and larger than in the usual form. The tubercles are more distant from each other, and the oculated spaces not so numerous, giving the whole animal a rough granulated appearance. The spines bordering the avenues are arranged in transverse rows, three or four in each row, thick and clavate: in the common form they are six or seven, more regular and finer, the rows often being double. The suckers are larger and thicker than usual. The eyelids are similarly formed of three spines forming an arch, and two on each side parallel. When first taken it was of a deep-orange colour. It measures four inches and a half across, and each ray is one inch and three quarters long. Though presenting much of a specific appearance, I cannot regard it otherwise than as an extreme form of the species under consideration.

The *Cribella oculata* varies much in its habitat. On the east coast I generally find it among rocks at low water; on the west I take it in deep water by the dredge. These habitats are not however constant in either case. It is very common in the Irish Sea. Pennant found it on the shores of Anglesey. It was noticed as Irish by Mr. Templeton. Mr. W. Thompson obtained it by dredging in the north of Ireland; and Mr. Ball finds it at Dublin and Youghal. Mr. Couch says it is not uncommon in Cornwall. Mr. Hogg records it as a native of Durham; and Mr. Alder informs me it is common on the coast of Northumberland. Mr. Bean has taken the rough variety in deep water off the coast of Scarborough, where he notes

it as rare. A specimen which he kindly sent me for examination, measured no less than seven inches across. He also finds the smooth variety at low water, but not common. In Scotland it is abundant on the east coast. In the Shetland Isles it is very common at low water. One day, when Mr. Goodsir and I were seeking for marine animals when the tide was out in Bressay Sound, we found the rocks covered in many places with minute round red bodies, always in the neighbourhood of one of these Starfishes. On magnifying some we doubted not that they were very young *Cribellæ*. They were quite soft, of an orange-red colour, and presented no traces as yet of tubercles or spines. They were distinctly five rayed, the rays truncate and notched at their extremities. The truncation and notching may be seen in very young specimens of several other species. The parents had probably come up from deeper water to spawn on the shore. It was in June, and at the same time there was much spawn of *Eolida*, and other Mollusca, on rocks and stones. These creatures swim with great facility, and many of them are to be seen on the coast only at spawning season; so that it would be of great consequence to collect data as to the spawning seasons of all the Mollusca and Radiata, since we may be led into many mistakes about the geographical distribution of species, if we do not take into account the fact that the animals apparently absent from a coast, may be habitual visitors at certain periods.

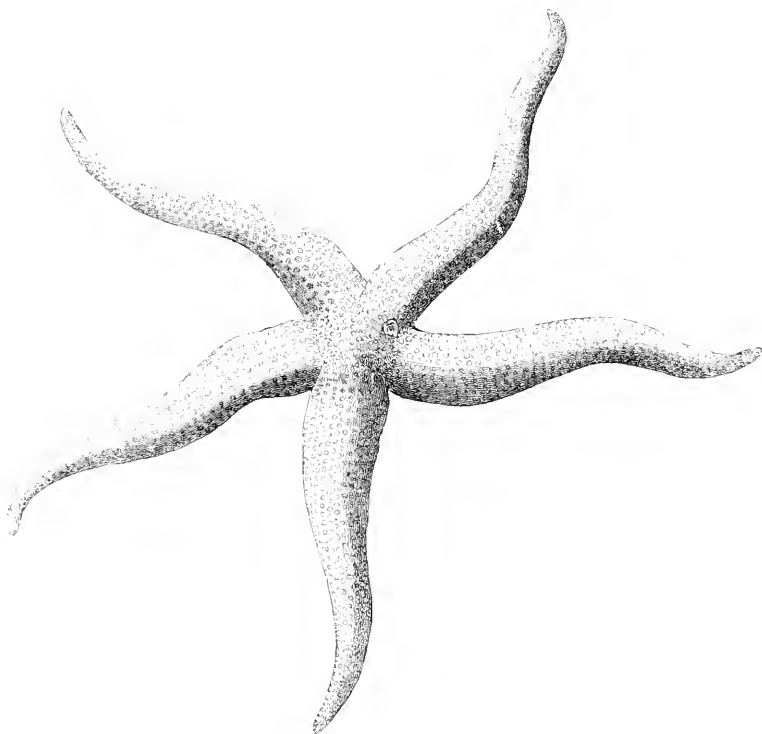
Having mentioned the youngest Starfishes which I ever met with, I think it right here to allude to the interesting observations of a distinguished Norwegian naturalist, M. Sars, clergyman of the parish of Kind, near Bergen, on the development of the young of *Asterias sanguinolenta* of Muller, by which species, I suspect, may be meant the

Cribella oculata. They were published in Wiegmann's Archives for 1837, and an account of them is given in the new edition of Lamarck. According to M. Sars, the little Starfishes immediately after birth have the body depressed and rounded, and furnished with four very short club-shaped appendages, or arms, at their anterior extremity. When they are a little more developed, one can distinguish some papillæ disposed in five radiating series on the upper surface. These young Starfishes move slowly, but uniformly in a straight line, with their four arms in advance. Their movement is probably effected by vibratile cilia. Their arms serve also to fix them to or enable them to creep slowly along the sides of rocks. At the end of twelve days, the five rays of the body, which till then were rounded, begin to grow; and after eight days more, the two ranges of feet, or tentacula, are developed under each ray, and can assist the movements of the animal by elongating and contracting themselves alternately, and by performing the function of suckers. By that time the swimming movements have altogether ceased. At last, in the space of a month, the four original arms have altogether disappeared; and the animal, at first symmetrical or binary, has become radiate.



ASTERIADÆ.

SOLASTERLE.



THE ROSY CRIBELLA.

Cribella rosea. Muller.

Specific Character.—Rays and disk with regular longitudinal rows of sub-triangular reticulating spiniferous tubercles.

Asterias rosea, MULLER, Zool. Dan. Prod. 2837. Zool. Dan. t. lxxvii.

IRELAND has been long looked upon as a sort of terra incognita by British naturalists. Although it might seem to the politician a land of plagues and agitations, to the

zoologist and botanist it seemed a land of promise. Several times the Emerald Isle has been threatened with an invasion of English and Scottish philosophers, who have long been fully convinced in their own minds, that there is a great deal more in the Hibernian bogs than meets the eyes of Irishmen. The botanists actually invaded the sister country one year, determined to find out the undiscovered riches of this El Dorado of Nature, with what success we leave them to say: still, they retain their hopes. But the zoologists are yet more sanguine; and even in the year 1840 one of our most eminent styles the land of St. Patrick "that very interesting, but little investigated country." Yet all this time Ireland abounds in naturalists, true field-philosophers, whose only bad habit is the modesty which prevents them publishing their discoveries, too often, until some less retiring students of nature proclaim new facts and new animals, which should have been recorded long before. England and Scotland conjoined can scarcely show as many zoologists engaged in original and practical observation of their marine invertebrate animals as Ireland; and a great part of the additions during late years to that division of the British Fauna has come from the sister country. Among those, not one of the least beautiful is the pretty Starfish which I am about to describe.

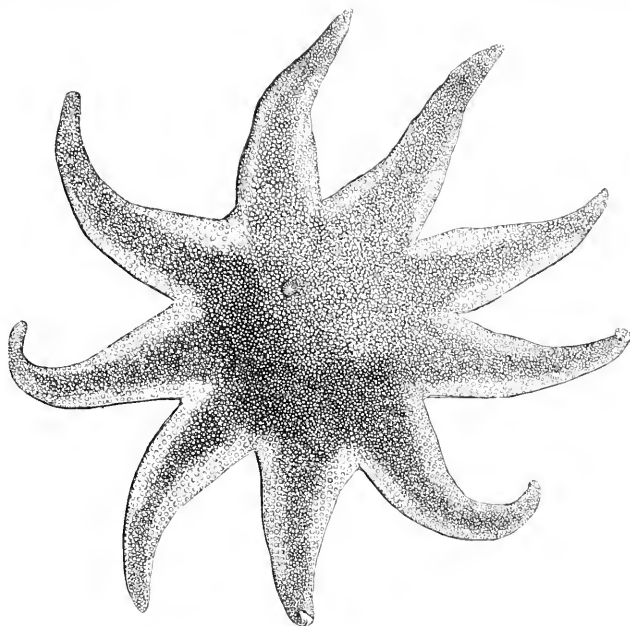
The *Cribella rosea* has five rounded tapering rays, which are each four and a half times as long as the disk is broad. The upper surface and sides of the arms and disk are covered with triangular reticulating spiniferous tubercles, which on the arms are arranged in regular longitudinal rows, and are more distant from each other than in the last species. The spines crowning these tubercles are short, rough, blunt, and very numerous. The spaces between the reticulations are porous. Beneath, the avenues are

wider than in the *Cribella oculata*. They are bordered by two sets of spines. The edge-row consists of transverse ridges of long tapering spines placed two and three together. The spines projecting over the mouth are longer and sharper. The madreporiform tubercle is very lateral, and finely striate. It is surrounded by a border of short spines similar to those on the spiniferous tubercles. The eyelids are like those of the Eyed *Cribella*.

Mr. Ball was the first contributor of this beautiful species to the British Fauna. He obtained it many years ago from the Nymph-bank off Waterford, and has two specimens in his collection. When recent he says it was of a bright orange colour. The specimen I have figured I owe to the kindness of my friend, Mr. Philip MacLagan, who was so fortunate as to add this species to the Fauna of Scotland during the summer of 1839. He found it on the coast of Ayrshire. It measures six inches and three-fourths in diameter. The disk is nearly an inch broad, and the rays above half an inch thick at their origins. Muller was the original discoverer of the *Cribella rosea*. He found it on the Norwegian coast, and figures it of a bright rose colour. The *Cribella oculata* would appear also to be found in the same region, and has been observed on the coast of France. The genus extends its range to the West Indies.

ASTERIADÆ.

SOLASTERIÆ.

Genus *Solaster*. Forbes.

Generic Character.—Body stellate, multi-radiate, covered with fasciculated spines; avenues bordered by three sets of spines; suckers biserial.

PURPLE SUN-STAR.

Solaster endeca. Linnaeus.

Specific Character.—Rays nine to eleven, shorter than the breadth of the disk; fasciculi of spines oblong; spines short, thick.

Asterius endeca, LINN. LAMARCK, Anim. sans Vert. 1 Edit. vol. II. p. 560, No. 23; 2 Edit. vol. III. p. 247. FLEM. Brit. An. p. 487. SOWERBY, Brit. Misc. p. 49, t. xxiv. JOHNSTON, Mag. Nat. Hist. vol. IX. p. 300, f. 44; Encyc. Meth. pls. 114, 115. LINK, tab. 15, 16, No. 26; tab. 17, No. 27.

Solaster endeca, FORBES, Wern. Mem. VIII. p. 121.

Stellonia endeca, NARDO. AGASSIZ, Prod. Echin.

Asterius aspera, MULLER, Zool. Dan. Prod. 2833.

THE *Solasters* are suns in the system of sea-stars. Their many rays and brilliant hues give them a distinguished place among the marine constellations. Two species inhabit the seas of Britain. The genus extends its range far to the south. The *Solaster helianthoides*, a species nearly allied to our common *Solaster papposa*, but having many more arms, is found on the western shores of South America. They differ from the *Urasters*, with which Professor Agassiz proposed to unite them, not only in form and arrangement of spines, but also in having only two ranges of suckers in each avenue, whereas the Cross-fishes have no less than four.

The Purple Sun-star has from nine to eleven rays, which are rounded and shorter than the breadth of the convex disk. The disk and upper surfaces of the rays are purple; the under surface and sides of the arms cream colour. Both arms and disk are thickly covered with oblong tubercles, which are scattered on almost all the purple parts, but arranged in irregular rows on the cream-coloured portions. Each of these tubercles is crowned by a circle of strong rough spines, which generally surround a central one, similar in appearance to the others. Beneath, the avenues are narrow. Three sets of spines border them. That immediately bordering each avenue-margin, consists of transverse comb-like rows of from five to ten spines webbed together towards the base. Next to these we have transverse ridges, narrow and compressed, each bearing a double row of shorter spines. Beyond this is a row of tufted spines similar to those upon the upper surface, but thicker. The madreporiform tubercle is sublateral, circular, and finely striate with radiating striæ. There is a curious aperture with a spinous border seen in the centre of the back of this and several other Starfishes, the nature

of which is not rightly understood, though it appears to bear some analogy to the arms of the Echinidæ. The largest Starfish of this kind which I have seen, measured eight inches and a half across. It grows larger. Mr. Ball has a specimen nine inches in diameter.

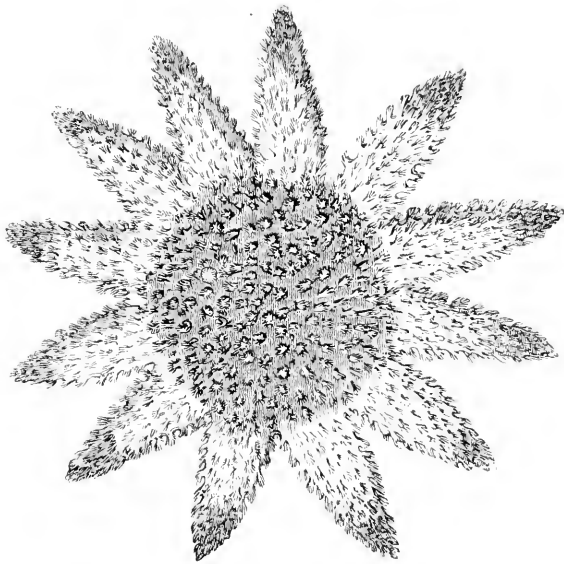
In Sowerby's British Miscellany, this species is first recorded as British "found by James Brodie, Esq. on the Nain coast in the Moray Frith." In the Irish Sea off the Isle of Man it is not rare in deep water. Mr. Alder informs me that it is frequent on the coast of Northumberland. Mr. Bean finds it at Scarborough "in deep water, not rare." Mr. Goodsir takes it at Anstruther. It occurs in Orkney. In Ireland, Mr. Thompson finds it on the coasts of Down and Antrim; and Mr. Ball at Dublin and Youghal. He finds *Natica Alderi* in its stomach.

To the pencil of Mr. Alder I am indebted for a view of Tynemouth, a locality which has yielded many rarities to the naturalist.



ASTERIADÆ.

SOLASTERIÆ.



COMMON SUN-STAR.

Solaster papposa. Linnæus.

Specific character.—Rays twelve to fifteen, one-half as long as the breadth of the disk; fasciculi of spines circular; spines long, slender.

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| <i>Asterias papposa,</i> | LINN. 1089. MULLER, Zool. Dan. Prod. 2832. LAMARCK, Anim. sans Vert. II. p. 559; 2 Edit. III. p. 246. FLEMING, Brit. An. p. 487. JOHNSTON, Mag. Nat. Hist. IX. p. 475, f. 69; Encyc. Meth. pl. cvii. f. 4, 5. |
| <i>Stella dodocactis,</i> | LINK, tab. xvii. No. 23; tab. xxii. No. 52. |
| <i>Asterias helianthoides,</i> | PENNANT, Brit. Zool. IV. p. 66, No. 72. |
| <i>Stellonia papposa,</i> | AGASSIZ, Prod. |
| <i>Solaster papposa,</i> | FORBES, Wern. Mem. VIII. p. 121. |

THIS STARFISH is one of the commonest, and, at the same time, of the handsomest of all the British species. The

rays are generally twelve or thirteen in number, sometimes as many as fifteen. They are about one half as long as the disk is broad. They are somewhat rounded, but the disk is flat. The upper surface is covered by tubercles, which are arranged in regular rows on the arms, but are scattered on the disk. Each of these tubercles bears a bundle of long spiculiform striated spines, eighteen or twenty in each fasciculus. On the arms there are generally five rows of these spiniferous tubercles. The intermediate spaces are reticulated. The madreporiform tubercle is sublateral, and striated in a radiating manner. Beneath, the avenues are lanceolate. Their immediate border consists of longitudinal fasciculi of spines, four or five in each fasciculus. Next to these are regular transverse rows of spines placed on transverse ridges, eight or ten in each row. The third series forms a bordering to the arms, and consists of sets of from eighteen to twenty long fasciculated spines placed on broad compressed articulated bases. The mouth is protected by a beautiful and peculiar mechanism. The angles formed by the joined origins of the rays each bear an ovate sub-triangular plate, grooved down the centre, and carrying two semicircles of long tapering spines, which project in a comb-like manner over the mouth. A similar organization is seen in the purple Sun-star.

In the genus *Solaster* the eyelid is not composed of a circle of spines, as in most of the allied genera; but of a transverse terminal row, which laps like the fingers of a hand over the eye. In *Solaster papposa* these spines are separate, and much longer than those around them; but in *Solaster endeca* they are united together, or webbed, so as to form an almost solid piece, which is bilobed. This eyelid forms a very perfect protection to the eye, and if closed, it is extremely difficult to force it open against the

animal's will. In the very young *Solaster papposa* the eye-spines are very large in proportion to the length of the rays, forming nearly a third of their length; and the eyes are fully formed even then, appearing like large vermilion specks near the ends of the rays on the under side. In a specimen of *Solaster endeca*, in which a ray had been broken and regenerated, the eye was present, also the eyelid, though not so prominent as usual. In cabinet specimens of *Solaster papposa* the eyelids are frequently destroyed by handling, their position rendering them very liable to injury.

The *Solaster papposa* varies much in colour. Sometimes the whole upper surface is deep purple. Frequently the disk is red, and the rays white, tipped with red. I once took a large specimen having the body entirely deep red, and the spiniferous tubercles bright green, presenting a very beautiful appearance. Beneath, it is generally white, or straw colour. Very young specimens are altogether white, with the exception of the red eyes. It grows to a considerable size. I have taken several measuring nine inches across, and Mr. Ball has found one eleven inches broad. It is very ravenous, devouring shellfish. Mr. W. Thompson has found a *Cypræa* and *Turbo Crassior* in its stomach,—shells not often forming the food of Starfishes. It frequents oyster and scallop banks, often in great numbers, and sometimes colonises the sides of harbours frequented by oyster-dredgers, in company with *Uraster rubens*; but while the Crossfish puts up with this forced littoral habitation, the Common Sun-star soon grows tired of his new position, and in a few days generally leaves, probably seeking for deeper water, and a more abundant supply of food.

The *Solaster papposa* seems to be generally distributed

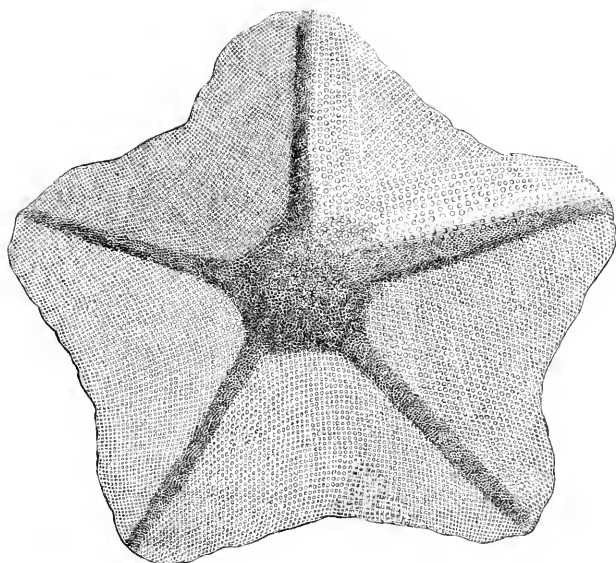
round the British shores, on the east coasts of England and Scotland. It is found at Scarborough, by Mr. Bean, "very common at low tides;" at Stockton, by Mr. Hogg, "not unfrequently;" on the coast of Northumberland, common, by Mr. Alder; at Berwick, by Dr. Johnston; and it is very abundant in the Frith of Forth. Mr. Goodsir and I found it in Orkney in ten fathoms water. On the west coast of Scotland it is frequent, and abundant in the Irish Sea. Mr. Couch finds it in Cornwall. In Ireland, Mr. Thompson informs me it is common. Mr. Ball finds it at Youghal, and states that at Portmarnock it is often thrown ashore in large quantities. This species is found on all the coasts of Scandinavia, and probably on all those of western Europe. M. Collard de Cherres records it along with *Uraster rubens* and *glacialis* as an inhabitant of the seas near Finisterre. I am not aware of its ever having been observed in the Mediterranean. Lamarck says it inhabits the Asiatic seas.

Grew mentions this Starfish in his account of the Museum of the Royal Society; he says it is "by some called Sunfish: 'twas taken in the British seas."



ASTERIADÆ.

GONIASTERIE.



Genus *Palmipes*. Link. Agassiz.

Generic Character.—Body pentagonal, flat, thin, covered above and beneath with fasciculated spines; avenues bordered by longitudinal fasciculi of spines; suckers biserial.

THE BIRD'S-FOOT SEA-STAR.

Palmipes membranaceus. Retz.

Specific Character.—Lobes broad, ample, subacute. Colour, white, with red rays and border.

Asterias membranaceus, RETZ. Gmel. Syst. Nat. 3164. LAMARCK, An. sans Vert. 1 Edit. vol. II. p. 558; 2 Edit. vol. III. p. 244.

Stella quinquefida palmipes, LINK, p. 29, t. i. f. 2.

Asterius placenta, PENNANT, Brit. An. IV. p. 62, tab. xxi. fig. 59, A.

Asterius cartilaginea, FLEM. Brit. An. p. 485.

Palmipes membranaceus, AGASSIZ, Prod. FORBES, Wern. Mem. VIII. p. 119.

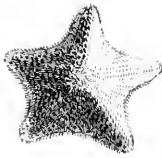
THE BIRD'S-FOOT STARFISH is a very singular species. It is the thinnest and flattest of all its class. When alive, it is flexible, like a piece of leather; and a person who had never seen it before, would be apt to mistake it for the torn away dorsal integument of some gibbous Goniaster. It is white, with a red centre, and five red rays proceeding from it to the angles, and the margin is generally bordered with red. The upper surface is covered with spiniferous tubercles, which are arranged differently on the white and coloured parts. On the red disk and radiations they are smaller and closer together than on the rest of the body, and are arranged irregularly. On the white portions they are arranged in regular rows, the largest tubercles being towards the disk. On the red margins they are very small, and closely placed in regular rows, running from the edge towards the centre. Each of these marginal rows has a tuft of spines at its extremity, projecting beyond the outline of the body. The spines are short, acute, very numerous, and radiate on the summits of the somewhat oblong tubercles. When they are rubbed away in a dried specimen, the surface of the skin appears regularly tessellated. The madreporiform tubercle is small, flat, striated, and placed towards the centre of the disk. Beneath, the spiniferous tubercles cover the triangular spaces, and are arranged in regular rows. They differ greatly in form from those above, being linear, and bearing the spines in a single row of from five to nine in number, the central ones longest. This arrangement gives a pectinated appearance to the tubercles. The avenues are bordered by longitudinal fasciculi of larger spines; those immediately around the mouth are largely developed. At each angle the margin is notched, and forms a little hood for the protection of the eye.

This species grows to the size of five or even six inches in diameter. It is generally accounted very rare, but is by no means uncommon in deep water in the Irish Sea off the coast of the Isle of Man, where I have dredged many specimens. On the English coast it was long ago noticed by Pennant, who describes it from Weymouth. Mr. Couch takes it in Cornwall. Mr. Hogg, in his Natural History of Stockton-on-Tees, records a specimen "caught near Hartlepool, in the summer of 1821." In Ireland, Mr. Templeton found it in Strangford Loch, where it has also occurred to Mr. Thompson. Mr. Ball found a specimen six inches in diameter at Youghal, the only one he obtained, though said by the fishermen not to be uncommon there. The Rev. Mr. Landsborough has found it on the coast of Ayrshire in Scotland.

The *Palmipes membranaceus* ranges from the Arctic seas to the Mediterranean; and there are one or two other species belonging to the genus. The *Asterias calcar* of Lamarck, a native of the seas of New Holland, is referable to it; and the *Asterias rosacea* of the same author is nearly allied to our native species. Comparing the Bird's-foot Sea-star with its exotic allies, it would seem that colour is a true source of specific character in this genus, and that the form, depth, and acumination of the lobes are also characters of great importance.

ASTERIADÆ.

GONIASTERIÆ.

Genus, *Asterina*. Nardo.

Generic Character. — Body pentagonal, gibbonous, thick, covered above and below with short spines; avenues bordered by a single row of spines; suckers biserial.

THE GIBBOUS STARLET.

Asterina gibbosa. Pennant.

Specific Character. — Dorsal spines short, thick, arranged in pairs; spines beneath in regular rows.

- Pentaceros plicatus*, LINK, t. xxxvi. No. 62. BORLASE, Cornwall, p. 260, t. xxv. f. 25, 26.
Stellula hibernica glabra, PETIVER, Gaz. t. xvi. f. 8.
Asterias gibbosa, PENNANT, Brit. Zool. IV. p. 62, No. 59.
Asterias exigua, LAMARCK, 1 Edit. vol. II. p. 554; 2 Edit. vol. III. p. 241.
Asterias minuta, BLAINVILLE, Man. d'Actin. p. 238.
Asterina minuta, NARDO, AGASSIZ, Prod.
Asterina gibbosa, FORBES, Wern. Mem. VIII. p. 120.

THE *Asterina gibbosa* is the least of the British *Asteriadae*. Large specimens measure only an inch across. The body is pentangular, with the angles produced. It is very gibbonous. Above, it is covered with tufts of short thick

spines, ranging from two to six in each tuft, arranged in regular rows, which on the rays proceed from the disk to the angles. The madreporiform tubercle is small, coarsely striate, and sub-central in its position. Beneath, the triangular spaces are covered with spines, arranged similarly with those above, but not grouped in tufts, being mostly single. The avenues are very narrow and deep, and are bordered by longitudinal tufts of spines arranged in threes. The spines of the surface behind these are in some specimens longer than usual, and arranged in pairs, so as to present the appearance of a second set of border spines. A semicircle of seven or eight long stout spines project from the oral angle of each triangular space, and form a sort of cover to the mouth. The avenues widen at the extremities so as to expose the eyes, and thus give a notched appearance to the angles. The colour is generally greenish yellow, sometimes tinged with red, and sometimes brownish. The largest specimen with which I am acquainted is one in Mr. Ball's collection, measuring one inch and five lines across.

The Gibbous Starlet is widely distributed on our coasts, though apparently confined to the western and southern shores of Britain. It was noticed as a British species at a very early period. Petiver figures it as "Luid's small Donegal Sea-star." Link also figures it as British from Luid. In England it is found in Cornwall by Mr. Couch, where it was also observed by Borlase. In the Isle of Man I find it in pools among the limestone rocks at Castletown when the tide goes out; and Dr. Coldstream found many specimens in the same locality. I have taken it in similar situations though not on the same sort of rock, in Herm, one of the Channel Islands. In Scotland I have found it on the gneiss shores of Ross-shire. In Ireland,

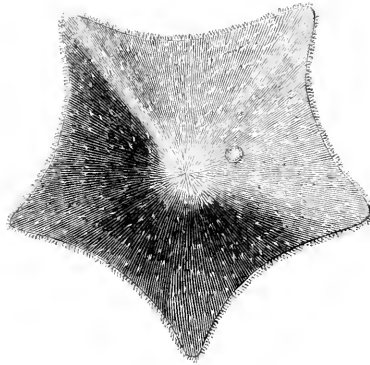
Mr. W. Thompson says it is found all around the coast in pools among the rocks at low water; such would appear to be its locality everywhere. I have never heard of a specimen being taken by the dredge. The differences in the rise and fall of tides, which so materially affect the localities of other species, do not appear to change its habitation. This species extends its range to the Mediterranean, where it is common, and probably occurs on all the shores of Europe. Blainville has separated it into two species, *Asterias minuta* and *Asterias pulchella*, and figures the last in the Fauna Française; but I cannot find good specific distinction between them, and (after having examined specimens of each) regard them as specifically identical. A nearly allied form is found on the west coast of South America.

The vignette is a view of Belfast Bay, from a sketch by my friend Mr. Thompson, whose observations have made it a classical locality to the zoologist.



ASTERIADÆ.

GONIASTERIÆ.

Genus *Goniaster*. Agassiz.

Generic Character.—Body pentagonal, gibbous, thick, bordered by a series of laminae edged with spines; avenues bordered by transverse rows of spines; suckers biserial.

TEMPLETON'S CUSHION-STAR.

Goniaster Templetoni. Thompson.

Specific Character.—Body above and below smooth; tessellæ of the triangular spaces mostly quadrangular.

Goniaster Templetoni, FORBES, Wern. Mem. VIII. p. 118, pl. iv. fig. 1, 2.

THE *Goniasters* bear much analogy to certain Sea-Urchins. They may be regarded as connecting the true *Asteriadae* with the *Echinida*. This connection is seen in the general form of all the species, and in the structure of the spines in such as are spiniferous. The capital of the genus appears to be situated in the eastern seas. In our own seas we have two species belonging to two different sections; such of the Cushion-stars as have naked bodies, and such as are covered with spines. The pentangular

form and gibbous body is characteristic of all the true *Goniasters*; and the border of marginal plates distinguishes them from *Asterina* and connects them with *Asterias*.

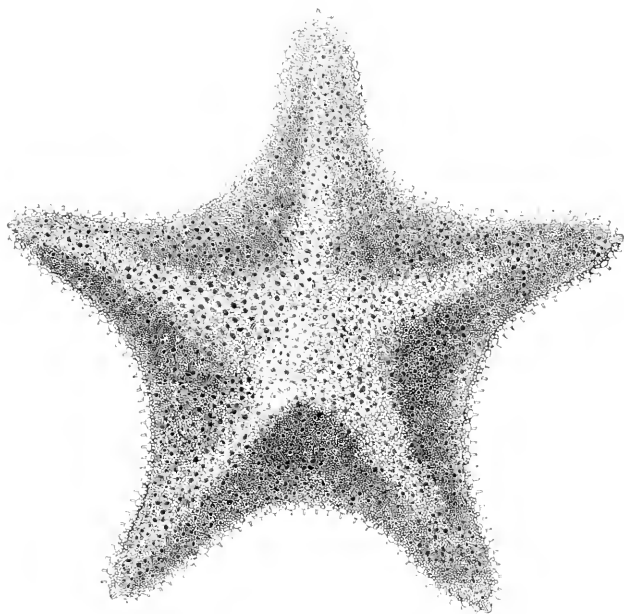
The *Goniaster Templetoni* has the body very convex, smooth, and lubricous when fresh, though when dried it becomes granularly reticulated. Though there are no spines there are here and there little pointed forceps-shaped spinules, the remains of pedicellariæ, which, when the animal is alive, give a villous appearance to the surface. These organs are seen on the skin of most of the Starfishes. In the next species they are larger than in any other British Sea-star. There are sometimes a few true spines seen towards the apices of the rays or angles of this Cushion-star; but these are by no means constant. The margins of the body above are bordered by rows of oblong plates, which bear at their outer edges fasciculi of from two to four conical spines. The madreporiform tubercle is small, finely striate in a radiating manner, and placed about half way between the centre and the margin, with which it appears to communicate by a furrow or canal. Besides the madreporiform tubercle, in one specimen which I possess, there is on the disk, in the very centre, a circle of short, thick, sub-globose spines. Beneath, the triangular spaces are smooth and tessellated by oblong plates, which are mostly quadrangular. The margins of the avenues are bordered by transverse rows of long pointed spines, two or three spines in each row. Two spines shorter than the rest, and placed close together, project over the mouth from the oral angle of each triangular space. The eyes are placed beneath, near the extremities of the tentacular avenues, and do not seem to be protected by spines. The colour of this species is very beautiful; bright scarlet above, sometimes with cloudy

whitish markings, and straw colour beneath. The largest specimen I have taken measured three inches and a half across; generally they are little more than half that size.

This species was named by my friend, Mr. W. Thompson, after the late Mr. Templeton, so well known for his researches in the natural history of Ireland. It is the species recorded as Irish by Mr. Templeton under the name of "*Asterias equestris?*" in his papers on the Radiate Animals of Ireland, in the ninth volume of the Magazine of Natural History. The specimen there mentioned was "found by James Grimshaw, Esq. in Belfast Loch;" it was thrown ashore after a storm. Mr. Gray showed me specimens in the British Museum obtained by Dr. Leach in Plymouth Sound. As long ago as 1819, Mr. Ball obtained several specimens from the Nymph Bank, off Waterford. They were brought up on long lines. Dr. Coldstream found it some years ago in Bute. Mr. Smith, of Jordan Hill, has taken it by dredging near the same island, and also in Lamlash Bay, in the island of Arran. Mr. Philip Maclagan found it on the coast of Ayrshire, and Dr. Pollexfen on the shores of Orkney. I have dredged it frequently on the north-western coast of the Isle of Man, where it lives among scallops in deep water. I do not think it has been observed on the eastern coast as yet. The *Asterias pulvillus* of Muller, *Zoologia Danica*, tab. xci. nearly resembles this Cushion-star. The attitude there drawn is frequently presented by our animal when alive. The form of the tessellæ on the under surface is, however, so different that I dare not venture to consider the species identical with ours, especially as the tessellæ are of specific importance in this genus. Professor Agassiz informs me that Dr. Fleming's specimen of his *Asterias irregularis* is this species.

ASTERIAD.E.

GONIASTERI.E.



KNOTTY CUSHION-STAR.

Goniaster equestris. Gmelin.

Specific Character.—Body above and below covered with mammiform tubercular spines.

Asterias equestris,

GMEL. 3164? SOWERBY'S Brit. Misc. No. 2, p. 8,
pl. lxiii. LAM. vol. II. p. 555; 2 Edit. vol. III. p. 242?
Encyc. Meth. pls. ci. cii. FLEM. Brit. An. p. 485.
JAMESON, Wern. Mem. I. p. 559.

Pentaceros planus,

LINK, p. 21, t. xii. f. 21; t. xxxiii. f. 53.

Goniaster equestris,

AG. Prod.

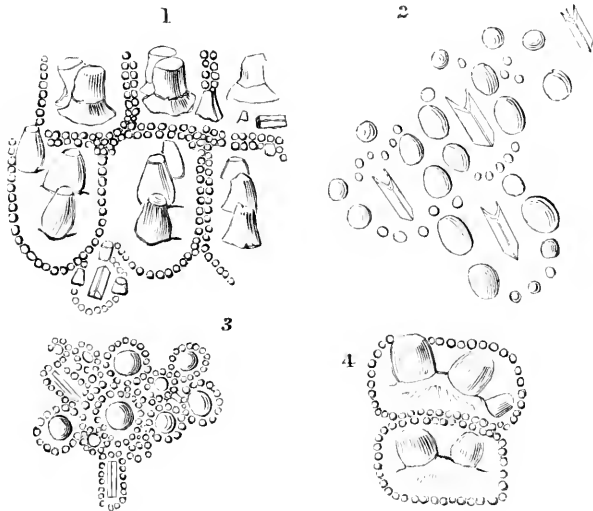
Var. Asterias Johnstoni,

JOHNSTON, Mag. Nat. Hist. v. IV. p. 146, f. 21.
LAM. An. sans Vert. 2 Edit. vol. III. p. 257.

THIS CUSHION-STAR is one of the rarest and most beautiful of our native Starfishes. It was first figured as British by Mr. Sowerby in the *British Miscellany*, from a specimen "found by James Brodie, Esq. in February 1806, on the coast near Brodie House," in the north of Scotland. Professor Jameson had recorded it in the *Wernerian Memoirs*, as having been found "by Mr. (now Dr.) Neill near Newhaven in the Frith of Forth." The figure I have given was drawn by Mr. John Thornhill, from a specimen obtained by a fisherman off Cullercoats, Northumberland, now in the collection of Mr. Richard R. Wingate, the celebrated animal preserver of Newcastle, through whose kindness I am enabled to present the following original description drawn up with the assistance of my distinguished friend, Mr. Alder.

The diameter of the Newcastle specimen, the largest British example with which I am acquainted, is nine inches and three-fourths. The form is sub-pentangular. The upper surface is covered with irregularly placed mammiform tubercular spines, varying from the one-eighth to the one-thirty-second of an inch in diameter, and of about the same height. These spines are smooth, and are placed in the centres of nearly circular plates, each of which is surrounded by a border of minute tubercles. The intermediate spaces are granulated by similar tubercles, among which are scattered furrowed forceps-like spinules, which are long and equal in shape. The madreporiform tubercle is sub-central and small. The margins of the upper surface are bordered by two rows of plates, varying in shape, but mostly oblong, with nearly semicircular ends, their longest sides being in juxta-position. These plates are smooth, raised in the centre, and bear from one to three mammiform tubercular spines. A border of small

tubercles surrounds their margins. The under surface is bordered by similar but flatter rows of spiniferous plates with those above. These plates are pentangular. The triangular spaces between the avenues are covered with mammiform tubercular spines, similar to those on the upper side, but smaller, and not placed as on the upper surface in the centre of plates. The intermediate spaces are interspersed with minute tubercles, which, however, do not surround the bases of the spines in a regular manner as they do on the upper side. Forceps-like spinules, similar to but larger than those on the upper side, are arranged in regular transverse and longitudinal rows in each of the triangular spaces. The margins of the avenues are bordered by longitudinal rows of spines arranged in pairs, and an outer series of plates, each bearing from three to five long obtuse blunt spines, placed in transverse rows. Each arm is terminated by a blunt and regular tubercle. When fresh, Mr. Wingate states his specimen was of a



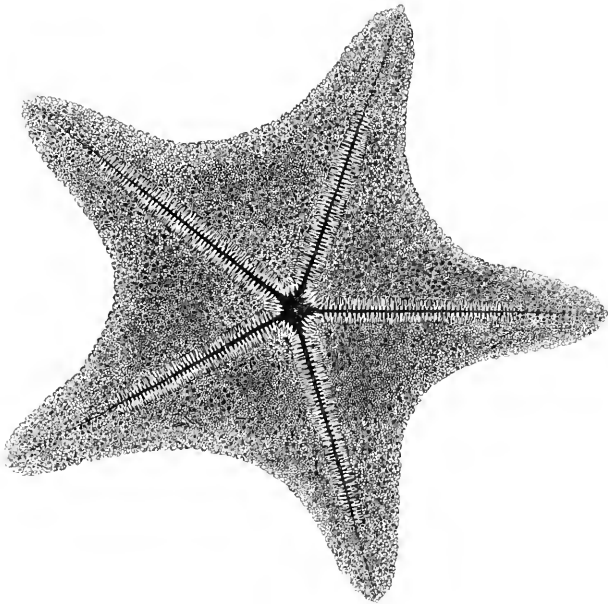
pale orange colour. It is in fine preservation, although it is now twelve years ago since it was taken. Mr. Brodie's specimen was bright red above; beneath, yellowish with red margins.

In the vignette on the preceding page, the two first figures represent the tubercles and spinules of the surface and border of the lower surface; the third and fourth those of the upper.

In the Magazine of Natural History for March 1836, Dr. Johnston describes and figures a Starfish from the coast of Caithness, under the name of *Asterias Jonstoni*, which I regard as a variety of this species. Dr. Johnston says, "Mr. J. E. Gray, who has examined the specimen figured, tells me that it is quite distinct from the true *Asterias equestris*; and he has in consequence assigned to it the specific name which is here adopted. I am, nevertheless, convinced the species is identical with the *Asterias equestris* of British authors." The specimen is now in the British Museum, and seems to be a four-angled form of this Cushion-star. Such a variation of form is not uncommon in the genus *Goniaster*. Dr. Johnston describes his animal thus: "Body square; sinuated between the angles, of which two are somewhat more produced than the others, flat, rough, with papillary warts and miliary granules, the latter encircling the dilated smooth base of the obtuse papillæ; these granules and warts cover the surface, but in the centre of a ring of granules there are frequently small apertures protected by a pair of roundish scales, which open and shut at the will of the animal; operculum lateral, slightly convex, deeply grooved, the grooves branched; margin obtuse, thick, protected by a double series of large square plates, studded with from two to four papillæ, and each of them surrounded with a series of granules; the

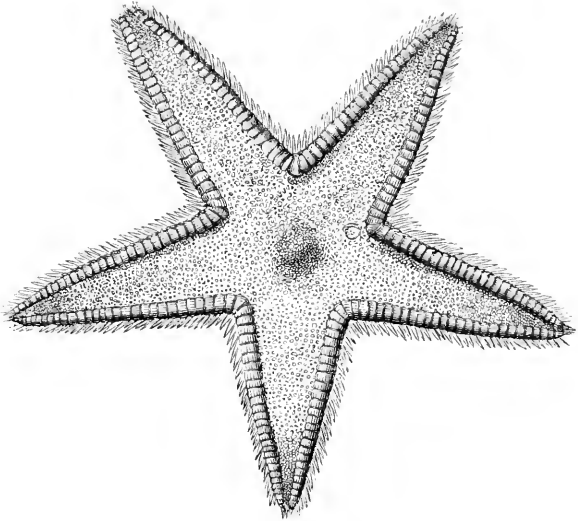
ventral surface is divided into four triangular spaces by the tentacular avenues, which are fringed on each side with a double series of smooth, blunt, short, and slightly compressed processes or spines; the triangular spaces are very rough with enlarged granules and valvular openings; but there are no dilated bases for papillæ, and the valvular apertures are arranged in rows; in the centre of each of the compartments there is a large irregular opening. When fresh, the colour is a bright red or scarlet, but on keeping, the colour fades to a faint and dirty brownish yellow."

Mr. Couch records the occurrence of one specimen of this variety on the coast of Cornwall, in his *Cornish Fauna*.



ASTERIADÆ.

ASTERIÆ.



Genus *Asterias*. Linnæus. Agassiz.

Generic Character.—Body stellate; rays flat, with a border of marginal plates; avenues bordered by three sets of spines; suckers biserial.

THE BUTTHORN.

Asterias aurantiaca. Linnæus.

Specific Character.—Disk broad; rays lanceolate; margin spinose.

- Asterias aurantiaca* (or *aranciaca*), LINN. Syst. Nat. 1100. MULLER, Zool. Dan. Prod. 2831; Zool. Dan. III. tab. lxxxiii. LAMARCK, Anim. sans Vert. vol. II. p. 563; 2 Edit. vol. III. p. 251. FLEMING, Brit. An. p. 486. JOHNSTON, Mag. Nat. Hist. vol. IX. p. 299, f. 44. FORBES, Wern. Mem. VIII. p. 118. PENNANT, Brit. Zool. IV. p. 61, No. 57.
- Asterias irregularis*,

<i>Astropecten,</i>	LINK, t. v. vi. f. 5, 13; t. viii. f. 11, 12; tab. iv. f. 14; t. xxvii. f. 44.
“	Encyc. Meth. pl. ex. f. 1-5; pl. cxi. f. 1-6.
“	BRADLEY, Works of Nature.
<i>Var. ? Asterias Jonstoni,</i>	DELLA CHIAGI, Mem. tom. II. p. 356.
<i>Stella Marina minor,</i>	JONSTON, Historia Naturalis, t. viii. f. 11.

THE genus for which the name of *Asterias* has been specially reserved is one of the most elegant of its tribe, the shape of the species it includes being more regular than that of any other Starfishes. There is but one species belonging to it a native of Britain, the *Asterias aranciaca* or *aurantiaca*, for the name has been written indifferently either way. It has five equal lanceolate arms, with straight sides, which are bordered by transversely oblong plates. The whole of the disk, and the surface of the arms within the borders, are thickly set with tubercles, crowned by circles or groups of minute spines. These are placed sufficiently close together to give the surface a compact appearance. In the centre of the arms and disk they are arranged irregularly, but on the sides there is a tendency to a transverse linear arrangement. The centre of the disk is prominent, and the madreporiform tubercle is small, striate, and very lateral, being placed close to the junction of two of the arms. The marginal plates are prominent and rounded. Their surface is thickly studded with minute tubercles, and their summits are often furnished with two or three short acute conical spines. The sides of the rays at the junction of the upper and lower surfaces are fringed by a border of numerous long, lanceolate, flattened spines. On the under surface, between these and the immediate borders of the avenues, is a broad space covered by thick-set transverse plates, each of which bears upon its summit seven or eight diverging oblique rows of short, flattened, clavate spines. The spines immediately bordering the

avenues are much longer, similar in form, and arranged in transverse fasciculi. The mouth is guarded by a mechanism similar to that seen in the *Solasters*; oval plates at the oral junctions of the rays, bearing four series of upright spines on their surface, and a comb of about seven long spines projecting over the mouth. In this species the points of the five combs nearly meet, so as to form a very efficient protection. Such a protection is more needed in the Butthorn than in other Starfishes, as its body and arms are not nearly so flexible. The extremity of each ray is turned up, and presents a circle of blunt spines forming the eyelid.

This species sometimes measures six inches across; generally from three to five. Mr. Ball says it grows to nine at Youghal. It is extremely variable, varying in the form of the rays, in the number of border-plates, and the presence or absence of spines upon them, and in colour. These variations have given rise to the creation of several spurious species, such as the *Asterias Jonstoni*, and *pentacantha* of Della Chiagi, and the *Asterias spinulosa*, *platycantha* and *subinermis* of Phillippi; perhaps, also, the *Asterias bispinosa* of Otto. There has been a fancy among naturalists to split up the Linnæan *Asterias aurantiaca*, which has been carried much too far. Species have been founded on the breadth of the rays,—a point in which every specimen differs more or less from another; and on the number of the marginal plates, which varies according to age and size. The spines seen sometimes on the marginal plates furnish no true characters, as specimens not unfrequently occur in which the plates of one ray bear spines, and those of the other are naked. The form of the border spines also varies exceedingly, even in the same specimen. The colour, sometimes altogether brick-red

above, sometimes a light pink or yellow, with purple tips to the rays, furnishes no better characters. I have now before me nine specimens taken at random from various localities. They differ much in form, size and colour. Four of them are from the east coast of Scotland; their marginal plates present all variations of spinosity, and are severally on each side of the rays, thirty-two, twenty-five, thirty-three, and thirty-four. The largest measures five inches across, that having twenty-five plates only three. One is from the east coast of Scotland; it measures above five inches, and the rays have thirty-eight spineless plates on each of their sides. One is from Shetland; it measures nearly three inches across, the number of plates on each ray-margin is twenty-seven. Each plate bears one spine. Two fresh specimens, a very little larger, present respectively the numbers twenty-nine and twenty-three, and the plates are spineless. A specimen from the Mediterranean differs in no essential points from these. It measures three and a half inches across; the sides of each ray are bordered by thirty plates, which bear two or three spines each. Considering, therefore, these variations to arise merely from age or situation, I see no ground for making more than one species out of the Limæan *aurantiaca*.

Sometimes the whole of the upper surface is covered by an adhesive glutinous matter, but this is by no means constant. This variety is common in some parts of the Frith of Forth. The species is very generally distributed. On some of the southern shores of England it is common. Mr. Harvey took it abundantly at Teignmouth. Dr. Johnston takes it at Berwick-on-Tweed; Mr. Bean at Scarborough. It is generally distributed on the coasts of Scotland, and occurs in both Orkney and Shetland. In Ayrshire it is found by Mr. P. Maclagan. On the Manx coast it has

been taken by Mr. Wallace. In Ireland, Mr. W. Thompson finds it on the coast of Down and Antrim, and Mr. Ball at Youghal, from whence he has a specimen in his collection seven and a half inches in diameter. In several specimens he found *Natica Alderi* in its stomach, and one contained nine of that shell with a *Turritella Terebra*. He takes them in deep water. In Donegal Bay it is common on a sandy bottom. It has been taken abundantly in Ross Bay (county Cork) by trawling, by Mr. George J. Allman of Bandon, who finds it on all the south-west coast of Cork. I do not think it is ever a littoral species; and those I have dredged were always taken on sandy ground. I have one with a small *Venus cassina* in its stomach.

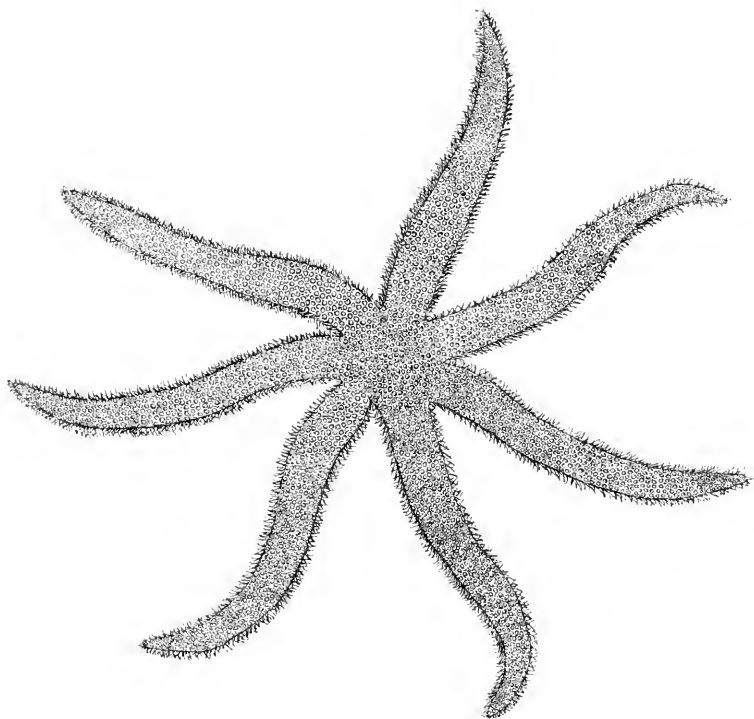
Mr. Bean has communicated the following account of a singular superstition in regard to this species observed by the fishermen of his neighbourhood. "Our fishermen call this species a Butthorn. The first taken is carefully made a prisoner, and placed on a seat at the stern of the boat. When they hook a But (Holibut) they immediately give the poor Starfish its liberty, and commit it to its native element; but if their fishery is unsuccessful it is left to perish, and may eventually enrich the cabinet of some industrious collector."

The vignette represents the "dreg," an instrument used by the Shetlanders for procuring shells, &c. from deep water.



ASTERIADÆ.

ASTERIÆ.

Genus *Luidia*. Forbes.

Generic Character.—Body stellate; rays flat, covered above with spiniferous tubercles; avenues bordered by two sets of spines; suckers biserial.

THE LINGTHORN.

Luidia fragillissima. Forbes.

Luidia fragillissima, FORBES, Wern. Mem. VIII. p. 123.

Asterias rubens, JOHNSTON, Mag. Nat. Hist. vol. IX. p. 144, fig. 20.

Asterias pectinata, COUCH, Mag. Nat. Hist. New Series, Jan. 1840.

IN my Memoir on the Asteriadae of the Irish Sea, published in the Wernerian Memoirs for 1839, I constituted

the genus *Luidia* for the reception of the most remarkable and largest of all our British Starfishes. Generally distributed as this beautiful species appears to be on the shores of Britain, it altogether escaped observation, or rather description, until the year 1836, when Dr. Johnston figured and described it in the Magazine of Natural History under the name of *Asterias rubens*, with which species, however, it has no relation, being next door neighbour to *Asterias aranciaca* on the one hand, and the *Ophiura* on the other. With no native or foreign Starfish can it be confounded.

I have dedicated the genus to the name of Edward Llhuyd, one of the earliest observers of our native Starfishes, and from whom Link derived many materials for his work. Llhuyd was born in Carmarthenshire, in the year 1670; was a student of Jesus College, Oxford; succeeded Dr. Plot as head keeper of the Ashmolean Museum; travelled for scientific purposes throughout England, Scotland, Ireland, and Brittany, and died in the year 1709. He was a man of great knowledge and great talent. His studies were extended over large tracts of science and literature, and he enlightened both with his researches and his writings. He united a comprehensive and philosophical mind with an observing eye, and the energy to execute. Amid the multiplicity of his studies there was no confusion. He wrote on insects, plants, fossils, antiquities, and languages; on all much and well. His principal works were “*Lythophylacii Britannici Ichnographia*,” and “*Archæologia Britannica*.” Ray praised him. Strange to say his name is omitted in many of our cyclopedias, which devote whole pages to men of less repute.

The *Luidia fragillissima* when full grown measures two feet across, and would appear to exceed that size occa-

sionally, judging from fragments. The rays are from five to seven in number, quite flat, and generally five times as long as the disk is broad. Commonly they taper very gradually; but in some of the specimens from the east coast they are broadest towards the middle, as represented in Dr. Johnston's figure. The upper surface of both rays and disk is covered with tubercles, each bearing a radiating circle of from six to eight sub-clavate papillose spines, generally with from one to three short clavate spines in the centre. These tubercles are very closely set, so as to give the surface when not looked at near a very compact appearance. Dr. Johnston says the circle of spines crowning the tubercles can be expanded or closed at the will of the animal. Towards the sides of the rays the tubercles are arranged in regular transverse rows. The margins of the rays are bordered by long rounded spines, which are arranged in rows of four or five placed on regular transverse ridges; the uppermost spines are thickest. The spines forming the immediate borders of the avenues are long, slender, and angular, and are also placed on transverse ridges. The madreporiform tubercle is extremely lateral, almost marginal, and reticularly striate. The suckers are placed in two rows in each avenue, and are very long and cylindrical, not inflated as in the last genus. The eyes are placed in the centre of a circle of spines at the extremities of the rays. The colour is brick-red above, varying in intensity; the under surface and lateral spines are straw coloured.

This species varies in the number and proportion of its arms. They are always either five or seven: I know of no specimen as yet found having six arms. Those found on the east coast have generally smaller tubercles on the less tapering rays than the specimens from the west or

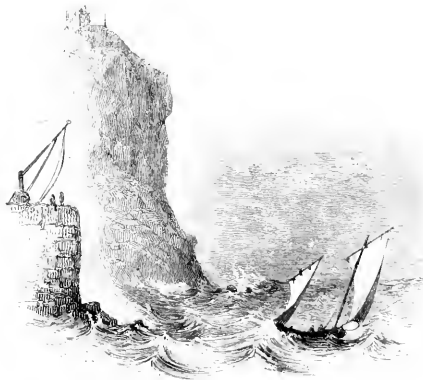
north. This equally applies to five and seven rayed examples. At one time I fancied the five-rayed *Luidia* was a distinct species, conceiving that in a genus approaching the *Ophiuræ* we should probably find a greater specific constancy in the number of rays than in the other *Asteriada*, such constancy being a family character among the *Ophiuræ*, and a generic character in the preceding genus *Asterias*. But as accompanying definitive characters are absent, I prefer regarding the five-rayed specimens as variations of the ordinary or seven-rayed form. It is the wonderful power which the *Luidia* possesses, not merely of casting away its arms entire, but of breaking them voluntarily into little pieces with great rapidity, which approximates it to the *Ophiuræ*. This faculty renders the preservation of a perfect specimen a very difficult matter. The first time I ever took one of these creatures I succeeded in getting it into the boat entire. Never having seen one before, and quite unconscious of its suicidal powers, I spread it out on a rowing bench, the better to admire its form and colours. On attempting to remove it for preservation, to my horror and disappointment I found only an assemblage of rejected members. My conservative endeavours were all neutralised by its destructive exertions, and it is now badly represented in my cabinet by an armless disk and a diskless arm. Next time I went to dredge on the same spot, determined not to be cheated out of a specimen in such a way a second time, I brought with me a bucket of cold fresh water, to which article Starfishes have a great antipathy. As I expected, a *Luidia* came up in the dredge, a most gorgeous specimen. As it does not generally break up before it is raised above the surface of the sea, cautiously and anxiously I sunk my bucket to a level with the dredge's mouth, and proceeded

in the most gentle manner to introduce *Luidia* to the purer element. Whether the cold air was too much for him, or the sight of the bucket too terrific, I know not, but in a moment he proceeded to dissolve his corporation, and at every mesh of the dredge his fragments were seen escaping. In despair I grasped at the largest, and brought up the extremity of an arm with its terminating eye, the spinous eyelid of which opened and closed with something exceedingly like a wink of derision. Young specimens are by no means so fragile as those full grown; and the five-armed variety seems less brittle than that with seven arms. Like other Starfishes, it has the power of reproducing its arms.

The first recorded specimens of this Starfish are those mentioned by Dr. Johnston as having been taken in Berwick Bay. In a large specimen from that locality the dimensions were "diameter of the disk two inches; length of each ray nine inches, and its greatest breadth one and a half inches." He found both the varieties. Mr. Goodsir and I dredged a small five-rayed specimen in about fifteen fathoms water off Stromness, Orkney. Mr. W. C. Trevelyan finds it in Arran; and Dr. Fleming has found it on the Northern shores. Dr. Coldstream has also taken it on the Scottish coast. On the English coast Mr. Bean has taken both varieties at Scarborough. The five-armed form is there called Lingthorn by the fishermen, and is taken in deep water, but is very rare. Mr. Bean has taken only one specimen of the seven-armed form, which occurred to him in very deep water. This specimen measures eighteen inches across. Under the name of *Asterias Pectinata*, Mr. Couch notices this species from the Cornish coast in the Magazine of Natural History for January 1840. His specimen also measured eighteen

inches; the disk two and three quarters, and the breadth of the ray, where widest, one and three-tenths of an inch. He found a purple *Spatangus* crushed together in its stomach. In Ireland it has hitherto been taken only on the south-western coasts, where it was observed many years ago by Mr. Ball. He states it is common about Youghal. All his specimens have seven arms, and he has found *Natica Alderi* in their stomachs. On the coast of the Isle of Man I have taken it several times, always with seven arms. I found it in twenty fathoms water on the Scallop Bank, about four miles from the north-western shore. Mr. Wallace has a young five-armed specimen in his collection, probably from the Irish Sea. The species, as far as known, seems peculiar to Britain. The genus extends its range to the Red Sea.

My friend, Mr. G. J. Bell, has favoured me with the sketch I here give of Scarborough, the scene of the researches of Mr. Bean.



THE SEA-URCHINS.



ECHINIDÆ,

OR CIRRHIO-SPINIGRADE ECHINODERMATA.

OF equal importance to zoologist and geologist is the study of the Sea-Urchins: to the former they present the perfection of radiism, as well as the first steps towards a symmetrical or bilateral form; to the latter the knowledge of their habits and organization is necessary in order to understand the relations and associations of the numerous species which abound in many of the earth's strata. Of all the Radiata they are most perfectly preserved in a fossil state. Their hard calcareous integument, or *shell*, as it is popularly but inaccurately termed, the parts of which are

jointed together with wondrous completeness, is especially durable; consequently we find the hard parts of the extinct species frequently as perfect as those of the recent examples preserved in our cabinets.

The Sea-Urchins are distinguished from all the other Echinoderms by their form, which is more or less rounded, without arms of any kind, and by their integument, in which calcareous matter is deposited so as to form series of regular plates, which plates are studded with tubercles, bearing jointed on them spines of various forms and sizes according to the genus or family. Ambulacra, variously arranged, perforated with pores for the exertion of suckers or feet similar to those of the true Starfishes, are seen on the surface of this hard integument. On the apex the ovarian holes are seen, and there are two openings to the digestive canal, a mouth always below, and sometimes armed with an internal dental apparatus, and a vent which is very variable in its position. The intestine is winding, and is attached to the inner surface of the shell by a mesentery, the surface of which, as well as of the membrane lining the shell, is covered with vibratile cilia, and serves doubtless for respiratory purposes. There are ovaries, in number four or five, forming large masses placed in the spaces between the ambulacra. There is a more or less complicated vascular system, having a portion with muscular parietes, and exhibiting pulsations, therefore regarded as a heart, and other branches considered to perform the offices of arteries and veins. M. Van Beneden has asserted that a nervous system exists in the Urchins similar to that described by Tiedemann as existing in *Holothuria*, but no one has as yet confirmed the observation. It is probable, however, that if what is regarded as a nervous system in the Starfishes and *Holothuria* be really

of such an important nature, a similar organization should exist in the *Echinidæ*.

The *Echinidæ* progress by means of the joint action of their suckers and spines, using the former in the manner of the *Asteriadae*, and the latter as the *Ophiuridæ* do. Many Sea-Urchins, such as live on hard surfaces, moor themselves also by means of the suckers, and thus adhere very firmly to the rocks. That such is the mode of progression and rest among this family I assert, not only from the general belief of naturalists, but also from personal observation. It is necessary to do so in consequence of the following statement of Professor Agassiz, which I quote from the translation of his *Prodromus*, in the *Annals of Natural History*. “As to the membranous tubes issuing from the holes of the ambulacra, it is proper to remark that they do not in any way contribute to *locomotion*. It is rather amusing to trace the history of their advancement to the honours of this function. As they are placed in the Echini in bands more or less narrow between the large mamellated plates which bear the spines, the old naturalists, fancying that they bore some resemblance to the alleys or walks in a park, gave them the name of *ambulacra*, without describing with greater precision their nature and destined use. More recently the idea attached to the word ambulacra was extended to the organ which is placed amongst them, and has been since then most erroneously considered as a locomotive organ. How in fact could these small tentacula, situated as they generally are in that part of the body which is never brought into contact with the ground when the animal moves, and overhung by calcareous solid spines,—how, I ask, could these flexible tubes be used as organs of motion? It is an undeniable fact, and I have often observed it myself,

that it is with their spines the Echini move themselves, seize their prey, and bring it to their mouths, by turning the rays of their lower edge in different directions. But the correction of an error respecting the functions of the ambulacral tubes does not solve the problem relating to their nature and use. This problem we are yet unable to solve, as we know nothing more respecting them than that they are connected with the aquiferous system."

There can be little doubt that in all the Echinoderms provided with these suckers, they serve not merely for progression; the lower we descend in the scale of animal nature (and equally in the vegetable kingdom), the more functions do we find performed by one organ. But observe a living Starfish, or a living *Holothuria*, and see what effective organs of progression these soft, flexible, weak-looking tubes are. I have seen an *Echinus miliaris*, a *Spatangus purpureus*, and an *Amphidotus roseus* all walk along the bottom and up the sides of a dish of salt water by means of their inferior tentacula; and the first mentioned anchored itself by extending and bending its superior suckers, so as to reach the bottom of the dish. In the Sea-Urchins they are of a similar structure, and the argument against their being organs of motion, founded on their position above as well as below, would equally apply to the spines, to which organs the distinguished naturalist of Switzerland has attributed all progressive powers in these animals.

The Sea-Urchins, as far as we know, are free throughout their existence. In some of the genera we find a madreporiform tubercle or nucleus resembling that of the Asteriadæ, but there is no internal column attached. This nucleus is very large in the embryo Urchin, and is placed on one of the ovarian plates, all of which form a large

portion of the animal's body when it is very young, the number of the other plates of the integument increasing with age, and enlarging by means of a deposition of polygonal calcareous particles at their edges.

The Echinidæ have been investigated by several very distinguished naturalists, with a view to their classification, especially M. de Blainville, Mr. Gray, M. Desmoulins, and Professor Agassiz. While in most of the tribes of the *Echinodermata*, the constituted genera, till lately, partook rather of the character of families, in this order there has been a tendency to an extreme multiplication of genera.

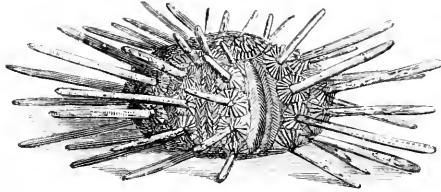
The British species of Sea-Urchins belong to three families, — 1. The CĪDARITES, including *Echinus* and *Cidaris*. The animals of this family have the mouth central and inferior, the anus central and superior. The five ambulacra form continuous rows from the apex to the mouth; the ovaries are five, and the mouth is furnished with a complicated dental apparatus. The spines of these Sea-Urchins vary in almost every species, and furnish good specific characters; but in the other families their form and sculpture is generic, or rather characteristic of the whole group.

2. The CLYPEASTERIÆ, which have both mouth and anus below, the former central, and usually armed with teeth. Their ambulacra are not continuous, and there are five ovaries. To this family belong *Echinocyamus* and *Echinorachnius*.

3. The SPATANGACEÆ. These have the mouth eccentric and inferior, and the anus terminal. There are no teeth; the ambulacra are not continuous, and the ovaries are four in number. To this family belong the genera *Spatangus*, *Brissus*, and *Amphidotus*.

ECHINIDÆ.

CIDARITES.

Genus *Cidaris*. Leske.

Generic Character.—Body globose; anus and mouth nearly equal. Ambulacra continuous from mouth to anus, which are both central, the former below, the latter above; spiniferous tubercles perforate; spines of several forms.

THE PIPER.

Cidaris papillata. Leske. Fleming.

Specific Character.—One tubercle on each inter-ambulacral plate, none on the ambulacral; spines long, cylindrical, regularly ridged with distant crenated ridges.

Cidaris papillata, FLEMING, Brit. An. p. 477. Encyc. Meth. t. cxxxvi. f. 6, 7.

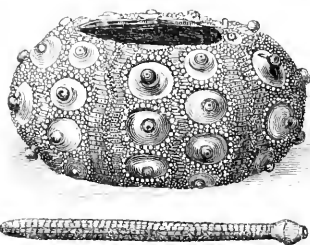
Echinus Cidaris? var. *a*. SOWERBY, Brit. Misc. tab. xlv.

Thus, the most elegant of all our native Sea-Urchins, is by far the rarest, being confined to the Zetland seas. It measures about one inch and three quarters across, and is of a depressed globose form. The anal opening of the shell is as wide as the oral, and the latter is furnished internally with five erect plates, which are divided in the centre nearly to their bases, so as to give the appearance of ten plates. These serve for the attachment of the muscles of

the dental apparatus, which resembles that of the Echinus. The surface is covered with spines, which are of two sorts; the one kind few in number, and very long, measuring an inch and a half in length, sometimes more. These are slightly of a clavate form, and furrowed with about ten deep striæ, which are as broad as the intervening crenated ridges. The prominences round their bases are finely striated, and not furrowed by the striæ of the rest of the spine. The spines of the second sort are very short, flattened, and finely striate. When the spines are rubbed away, we then see the wide inter-ambulacral spaces, each bearing about ten large tubercles, placed in the centre of wide, smooth, circular depressions, which are bordered by a frame of small tubercles, and separated from each other by transversely striated spaces. The large tubercles somewhat resemble the Urchin itself in form, and are smooth and polished, with a depression or perforation in their centres, which, however, does not run through the substance. This character is common to the genera *Cidaris* and *Diadema*. The inter-ambulacral spaces are extremely narrow, and equal in breadth throughout; they bear four longitudinal rows of minute tubercles or granules, and are waved in consequence of the undulations of the avenues, each of which is composed of a longitudinal row of pores arranged in pairs. A furrow connects the pores of each pair. All the long spines are placed on the large inter-ambulacral tubercles, one of which is seen on each inter-ambulacral plate. The depression on the summit of the tubercle is for the reception of the ligament of the spine. All the smaller spines are placed on the granules forming radiated borders round the tubercles, the avenues, the anus, and the mouth.

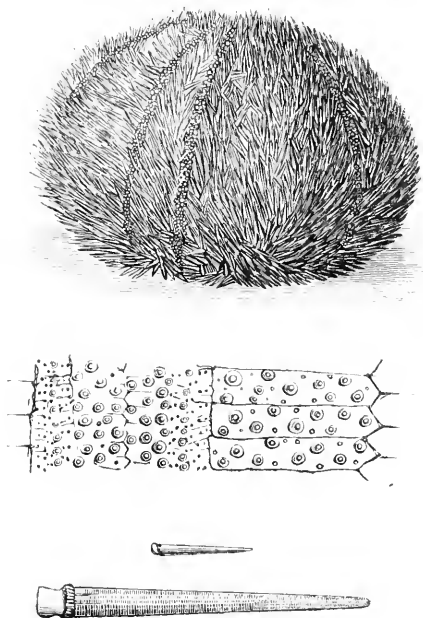
This beautiful Urchin was first recorded as British, and

figured in Sowerby's Naturalist's Miscellany, to which work it was communicated by Alexander M^rLeay, Esq. who discovered it in Zetland. It is there stated that the fishermen fancy it is sometimes seen with spines a foot long. The Zetlanders call it Piper, comparing the spines to the drones of a bagpipe. My friend, Mr. Thomas Edmonstone, tells me it is also called King of the Sea-Eggs, and that it is found in the "furthest haaf," the term applied to the deep sea fishing in deep water. It probably inhabits rocky ground, as it is never found but in company with Tusk (*Gadus brosmus*), which is caught on very rocky ground. "Two or three intelligent seamen whom I have spoken to on the subject," says Mr. Edmonstone, "say they generally draw up several entangled among their hooks every season."



ECHINIDÆ.

CIDARITES.

Genus *Echinus*. Linnaeus.

Generic Character.—Body globose; ambulacra continuous from mouth to anus, which are both central, the former below, the latter above; spiniferous tubercles imperforate; spines of one form.

THE COMMON EGG-URCHIN.

SEA-EGG. SCA' AD MAN'S HEAD.

Echinus sphaera. Muller.

Specific Character.—Rows of pores obliquely parallel, three pairs of pores in each row; spines thick, conic, longitudinally striate; striæ broader than the ridges, and transversely striated; primaries scarcely longer than secondaries.

Echinus marinus, LISTER, *Ab. Ang.* p. 169, t. iii. f. 18. BORLASE, *Com.* p. 278, t. xxviii. fig. 27.

Echinus sphaera, MULLER, *Zool. Dan. Prod.* 2845. GMELIN, 3169.

- Echinus esculentus*, PENNANT, Brit. Zool. IV. p. 67, No. 74, t. xxxiv. f. 74.
 FLEMING, Brit. An. p. 478.
Echinus globiformis, LAM. 1 Edit. II. p. 44; 2 Edit. III. p. 360.

THAT the common Sea-Urchin of our shores is the *Echinus sphaera* of Muller I have no doubt; and that it is not the *Echinus esculentus* of the Mediterranean I am equally certain, having compared a specimen of the latter, kindly sent me by Mr. Ball, with our own species. Blainville's figure of the true *esculentus* is good, and will enable the naturalist to distinguish that animal should it occur on our shores. It differs from all our native species in having four pairs of pores in each row, and the ridges on the spines crenated. It is probable the *Echinus melo* of Continental authors is identical with the *Sphaera*, but Muller's name has the priority and must be retained.

The common Egg-Urchin varies much in form. It is sometimes almost globose, sometimes much depressed; and the extreme variations which it presents have led many zoologists to suppose that several species were included under one name. The essential characters of the species are, however, constant in all. The variation is merely of proportion. It seems to be arbitrary, and not depending on locality, as the following comparison of the sizes of specimens selected at random from various localities will show.

Specimen from the	Circumference	Height
Isle of Man,	12 inches.	$3\frac{5}{10}$ inches.
„ „ Frith of Forth,	15	3
„ „ Frith of Forth,	11	$2\frac{3}{4}$
„ „ Frith of Tay,	9	2
„ „ Belfast,	$9\frac{1}{2}$	$2\frac{4}{10}$
„ „ Youghal,	10	$2\frac{1}{2}$
„ „ Youghal,	$14\frac{1}{2}$	$3\frac{3}{4}$
„ „ Youghal,	12	$2\frac{1}{2}$

The essential specific characters depend on the arrangement of the tubercles which bear the spines, on the spines

themselves, and on the number and arrangement of the pairs of pores in the avenues of suckers. These present good marks of distinction throughout the genus *Echinus*. The spines are especially important, as from the examination of a single spine it is possible to pronounce on the species to which it belongs. To the geologist this is evidently of great consequence, as frequently he meets only with a few scattered spines. But when we leave the family Echinidæ, we leave this important character behind us. Among the Heart-Urchins the spines present one common family structure. A single plate, either ambulacral or inter-ambulacral, will also, from the arrangement of the spiniferous tubercles which cover its surface, enable us to pronounce pretty certainly on the animal of which it formed a part. Thus, in this family of Echinodermata, from an apparently insignificant fragment we can construct, as it were, a species, even as the student of the Vertebrata, from a broken bone can pronounce on the form and habits of the animal to which it belonged.

The apex of the Egg-Urchin presents the anal opening surrounded by five triangular, or somewhat cordate plates, called the ovarian plates. They are so termed since we find in each of them a perforation, which is the opening of the ovaries, and through which the eggs are excluded. One of these plates is somewhat larger than the rest, and much rougher on the surface, being occupied, as it were, by a large porous wart. This body is of the same nature with the madreporiform tubercle of the Starfish. It is the *nucleus* of the Sea-Urchin,—we might almost say the *navel*. The ovarian plates are strengthened internally by a strong transverse rib. Their apices are directed *from* the anus, and they are separated from each other by five smaller cordate plates with apices directed *towards* the

anus ; each of these has a little triangular depression, and a perforation at its lower part. When the animal is alive these perforations are seen to be filled up by a red membrane, or substance ; and I regard them as analogous to the so-called eye of the Starfish. They are placed exactly in the corresponding position,—namely, at the extremities of the avenues of suckers, each pair of avenues meeting in fact at these little plates. There are five pairs of avenues ; they run from mouth to anus. The plates which separate the two avenues of each pair are called ambulacral ; and those which separate the pairs, forming a space of double the width or more, are called inter-ambulacral. Both ambulacral and inter-ambulacral plates are studded with mamillary spiniferous tubercles. On each ambulacral plate there is usually one large tubercle and three or four small ones ; on each inter-ambulacral plate there are from five to seven large tubercles and several small ones. The spines which crown these tubercles are all of one form, though of various dimensions as regards thickness. They are all finely striated longitudinally, and have the ridges narrower than the furrows, which latter are finely striated across. There is generally one small tubercle separating the transverse rows of pairs, which are oblique, three pairs in each row, the rows running parallel to each other. Small ridges and furrows also separate the pairs of pores from each other. The avenues are broadest towards the middle of the animal, smallest towards the mouth and the apex. Through the pores protrude the suckers, which are long, cylindric, and provided with a circular disk at their extremities. The number of these suckers is very great. In a moderate-sized Urchin I reckoned sixty-two rows of pores in each of the ten avenues. Now, as there are three pairs of pores in each row, their number multiplied by six, and again by

ten, would give the great number of 3720 pores ; but as each sucker occupies a pair of pores, the number of suckers would be half that amount, or 1860. The structure in the Egg-Urchin is not less complicated in other parts. There are above 300 plates of one kind, and nearly as many of another, all dove-tailing together with the greatest nicety and regularity, bearing on their surfaces above 4000 spines, each spine perfect in itself, and of a complicated structure, and having a free movement on its socket. Truly the skill of the Great Architect of Nature is not less displayed in the construction of a Sea-Urchin than in the building up of a world !

The whole of the external surface when the animal is alive is invested with a fine membrane, as also the spines, the joints of which have their flexibility greatly increased by a thick fleshy envelope. It has been stated by Professor Ehrenberg that the membrane of these spines is clothed with vibratile cilia ; but such cilia I have never been able to see, nor are any currents produced in the water around the spines which would lead us to suspect their presence. Arguing from analogy there should be no such cilia. The mouth of the Urchin is placed in the middle of a wide circular web of muscular skin which occupies the concave and central part of the base. This skin is studded with scattered calcareous tubercles. It is very muscular. In the centre is seen the oral opening, and the points of the five teeth projecting from it. There are ten small fleshy tubercles placed on the margin, and at some distance from it are seen ten tubular tentacula also placed in pairs. On the oral margin of the shell, and between the origins of the suctorial avenues, are seen ten brown plumose appendages, somewhat resembling the tentacula of *Holothuria*, of which I regard them as the analogues,

though by some they are considered as respiratory tubes. Neither they nor the tubular tentacula are ciliated. There is usually an irregular circle of slender spines developed on the oral membrane near the mouth; they do not differ in structure from those on the surface of the body-plates.

The five polished pointed teeth which project from the mouth form part of a remarkable dental apparatus, known by the fanciful appellation of Aristotle's lantern. The lantern consists of five long three-sided triangular sockets or jaws united together, with their apices pointing downwards, so as to form a sort of pyramid. Each of these jaws is broadly keeled on its outer side, and bordered by raised margins; towards the upper and broader part, which forms part of the base of the pyramid, the keel bifurcates and the space between the bifurcations is triangular and perforate, being filled up with membrane instead of bony matter. The shape of the keel and of the perforation varies in different species. In the *Echinus lividus* the keel is grooved, and the apex of the perforate space broad, obtuse, and bidentate. In *Echinus miliaris* the base of the triangular perforation is much more acutely angular than in *Echinus sphaera*, and the keel broader in proportion. The other two or inner sides of each jaw are quite flat and finely striated across, their edges being pectinated like a comb. Each of these jaws is separated from the others above and in a manner united with them, as well by five oblong horizontal plates, with their outer ends bent downwards and widened, so as greatly to strengthen the apparatus. The margins of these plates are not straight but somewhat fiddle-shaped. From the inner ends of these oblong plates, and springing seemingly from the centre of the lantern immediately around the gullet, rise five long slender processes bent outwards, and having mace-shaped

flattened heads, giving them the appearance of so many golf-clubs. To all these plates a complicated machinery of muscles and ligaments is attached. The teeth themselves are very long and slender, soft, and bent inwards at their upper parts, hard and enamelled towards their points. Their outer surface is prismatic, and grooved in the centre; their inner fluted, but having a strong, very prominent, compressed rib or keel running down to near the triangular point. Dr. Sharpey remarks on them that they "are very hard at the point, but softer towards the roots, where they are easily separated into transverse scales or plates, with a fine silky or asbestine lustre; they seem to grow continually at the root, and wear at the point as in the *Rodentia*." Round the inner margin of the mouth of the shell are five large oblique plates of a quadrangular form with a wide oval aperture in the centre. These serve for the attachment of the muscles which connect the lantern with the shell, and through their perforations pass the aquiferous vessels of the avenues.

Scattered over the surface of the body and around the mouth are great numbers of *Pedicellariae*, bodies of the same form and similar structure with those described under the account of the Starfishes of the genus *Uraster*. These were first observed on the species before us by Muller, who described and figured three kinds in the *Zoologia Danica*. They have since been investigated carefully by Sars; and, as his account, being published in the Norwegian language, is inaccessible to most English readers, I shall make no apology for giving a full abstract of his observations, and then offer my own comments. Muller conceived them to be parasitic animals, Lamarck followed him, and Cuvier also, with a doubt, as also Schweigger. Munro, Oken, and Sharpey regard them as organs of the animal.

M. Sars states, "In examining *Echinus sphaera*, I found upon it all the three sorts of *Pedicellaria* described by Muller, viz. *P. tridens*, *P. triphylla*, and *P. globifera*. Besides what Muller states in regard to *P. tridens*, I will make the following remarks:—Internally there is a hard stem, which is enclosed by a strong transparent skin, like a sheath. It is thickest at the upper and lower ends, and reaches from the neck, as it is called, to the base, where it remarkably enough is fixed and jointed to an exceedingly small barb projecting from the Sea-Urchin's shell. This circumstance, which is invariable in the *Pedicellaria*, seems not to have been sufficiently attended to. The three teeth are concave on the side turned inwards, angular and furnished with small teeth on their edges. They are hard and calcareous; when viewed through a microscope they are seen connected with very small globules arranged in rows. The stem is also calcareous, yet it can be slightly bent without breaking. The neck is nearly as thick again as the stem, it is fleshy, transparent, and very flexible. The motions observed in the *Pedicellaria* when irritated, are, that the teeth close and squeeze pretty firmly; in this way by inserting the point of a pin between them, after the *Pedicellaria* was torn off, I could draw it out of the water; further, that the neck bends and inclines to all sides, and can even contract a little, in doing which transverse wrinkles are formed on it; and lastly that the stem itself inflexible may bend along with the whole *Pedicellaria* to the side. The form called *Pedicellaria globifera* by Muller, has a head consisting of three outspread flaps, standing nearly horizontally. Each of these flaps is oval, very convex externally, and concave internally, and at the upper end slightly indented and provided with a sharp point somewhat bent. From the

indentation runs a raised stripe or rib longitudinally downwards through the flap. On the inner side of these flaps at their base is seen an oval and apparently calcareous leaf. The stem, which is similarly constituted with that of the *P. tridens*, proceeds directly from the head (there is no neck in this species), is small above, and thicker below, until at the bottom it completely fills the hollow of the sheath which encompasses it. With regard to the motions of these *Pedicellariæ*, they not only quickly open and shut the three flaps, but can also turn the head to the different sides, and up and down, and that very quickly.

“Muller says, regarding *P. tridens*, ‘Variat absque aristis, an perditis?’ Of such I have also found a large number of specimens; but I scarcely believe that they belong to the *P. tridens*, since the teeth of these last are fixed so firmly that they could scarcely fall off. Either they are a separate species, or a variety of the *P. triphylla*, which they resemble in every point except that the three flaps are broad at the bottom and small at the ends. These flaps seemed there also to be calcareous, and consisted of many small globules, which were arranged in transverse rows, clearly separated from each other by a light transparent line. Such a line also ran longitudinally down the flap. In *P. triphylla* the flaps are not obtuse, but a little rounded, and have, like the foregoing, globules extending in rows.

“If we now consider the construction of the *Pedicellariæ*, and their manner of life as a whole, we can scarcely believe them to be anything but organs of the Sea-Urchin. The following reasons seem to prove the accuracy of this opinion.

“1st. In all Sea-Urchins without exception are found *Pedicellariæ*, and under the same circumstances, which

would certainly not always be the case if they were parasitical animals. Just as Lernææ are not always found in all fishes, &c.

“2nd. The hard calcareous teeth or plates, and the internal stem also calcareous, and often filling up along the sheath, which are found in all Pedicellariæ, bear a greater resemblance to an Echinus spine than to any animal of the Polype kind. There is neither opening, nor mouth, filaments, &c.

“3rd. The *Pedicellariæ* are firmly fixed in the skin which envelopes the whole Sea-Urchin, upon a very small projecting knob of the shell, to which knob they are very strongly attached, but yet movable, like the prickles of the Sea-Urchin; the under surface of the stem of a *Pedicellaria* being somewhat hollowed and articulated with the knob. When a *Pedicellaria* is torn out, it is observed that the sheath or skin connecting the stem is torn at the lower end, which, doubtless, is a consequence of its connection with the skin, with which the shell of the Sea-Urchin is covered, and which, when the *Pedicellaria* is torn out, must be rent.

“4th. When the skin of the Sea-Urchin, or a single *Pedicellaria* is irritated—for example, with a pin—the surrounding *Pedicellariæ*, which stand in a wide circle, invariably bend themselves quickly towards the irritated part. This phenomenon, which I have often observed, shows clearly an organic connection between the *Pedicellaria* and the skin of the shell of the Sea-Urchin. The same thing precisely is observed with the spines.”

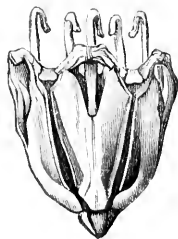
On the purpose of these organs M. Sars remarks, “Perhaps Nature, who has so abundantly provided the Sea-Urchin with such an astonishing number of feet and prickles, has also given the *Pedicellariæ* as a sort of an-

tennæ, partly to seize the small animals which serve for its sustenance, partly to lay hold of whatever might approach their sensitive skin which covers the surface of the shell, and thus in conjunction with the prickles protect it from injury." He says that some which he had cut off moved six hours afterwards with considerable liveliness.

The description of the structure of these bodies as given by M. Sars is so accurate that I need not add to it; suffice to say, I have also observed the rows of globules, the arrangement of the calcareous parts, &c. in all the kinds of *Pedicellaria* he describes. Of one point I cannot satisfy myself, that there is a knob on the shell for every *Pedicellaria*; moreover, they are not all on the shell, there are great numbers on the oral membrane. I have over and over again repeated M. Sars's experiment of irritating the skin, without obtaining the result he mentions. In no case did the *Pedicellariæ* bend of themselves towards the irritated point, and the same I may say of the spines. No irritation of one *Pedicellaria* affected those in its neighbourhood unless they were accidentally touched. The fleshy substance of these bodies is exactly that of many animals of acritous structure, and they are so scattered over the body of the Urchin, without reference to form or figure, that it is almost impossible to assign them, or the various kinds of them, special offices in the animal's economy. Each seems independent of the others, and of the Sea-Urchin, which is not the case with the spines. As to their resemblance to an Echinus spine I can see but little. I agree with M. Sars in believing Schweigger to have been mistaken when he stated *Pedicellariæ* to exist on certain testaceous Mollusca; but can by no means consider the question of their nature to be settled, and find myself quite undecided as to whether they

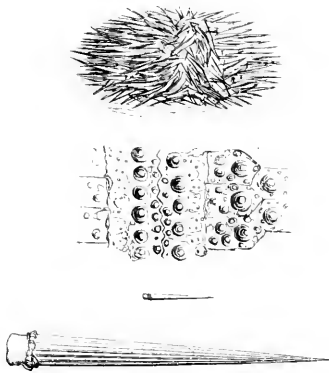
are organs of the Echinodermata, or parasitic creatures, though inclined to the former opinion.

The common Sea-Urchin is usually of a reddish or purplish colour with white spines. The spines are in some specimens tipped with purple. It lives in various depths of water, extending its range from the littoral zone to that of Corallines. It usually congregates in greatest numbers on a clean sea bottom. It is found on all the shores of Britain and Ireland, almost equally common everywhere, and is much used as a chimney ornament by cottagers. Abroad, like its congener, the true *Echinus esculentus*, it is much eaten, and Pennant says it is eaten by the poor in many parts of England. Among the ancients it was a favourite dish, and eaten both raw and cooked in various ways. The ovaries were the parts selected; and when these are full of egg, the animal is in season, which is usually about autumn. In the month of May I found the ovaries full of a white milky fluid, which contained little revolving bodies with eccentric motions. Are these to be regarded as spermatic animalcules? Is the animal male at one season and female at another? Both Dr. Wagner and M. Milne Edwards look upon the Urchin as bisexual.



ECHINIDÆ.

CIDARITES.



PURPLE-TIPPED EGG-URCHIN.

Echinus miliaris. Leske.

Specific Character.—Depressed ; rows of pores not parallel, three pairs of pores in each row ; spines longitudinally striated, shining, smooth ; striae narrower than ridges ; primaries long.

- Cidaris miliaris savatilis*, LESKE, p. 82, tab. ii. f. A, B, C, D, t. xxxviii. f. 2, 3.
Cop. in Encyc. Meth. t. cxxxiii. f. 1, 2, a, b.
- Echinus miliaris*, GMELIN, p. 3169. LAMARCK, Anim. sans Vert. 1
Edit. II. p. 49 ; 2 Edit. III. p. 367. BLAIN-
VILLE, Man. d'Actin. p. 227.
- Echinus savatilis*, MULLER, Zool. Dan. Prod. p. 2847.

MINGLED with the common Egg-Urchin on oyster-beds and scallop-banks is the little species before us, and probably it is often passed over as the young of *Echinus sphaera*. Its long purple spines, however, at once distinguish it from the latter in its young state ; and when we examine it more carefully we find that it presents many excellent characters peculiar to itself.

The *Echinus miliaris* is the least of our native Egg-Urchins, commonly not measuring more than three-fourths of an inch across, by three-tenths high; but it sometimes attains the diameter of an inch and three-fourths, and a proportionate height, its form always being much depressed, nor does it vary in that respect like other Urchins. Its body is rose colour, with white tubercles; all the primary spines, which are often nearly thrice as long as the secondaries, are purple, with yellow bases, and the secondaries yellow. On large examples the primary spines are not so long in proportion to the others as on small; and there is a variety which has all the spines very nearly equal in size, and very thick. Usually they are long, tapering and slender, and always shining, which lustre is derived from the broad smooth ridges on them, and the striæ not crossed by transverse striations. When the spines are rubbed away, the shell presents a very pretty radiated appearance in consequence of the tubercles of the primary spines being much larger and more prominent than the other tubercles, and closely placed together, forming twenty white rays on the pink body, there being one large primary tubercle, and a number of small secondary ones on each ambulacral and inter-ambulacral plate. The tubercles are depressed polished spheroids, mounted on broad prominent bases. On each of the ovarian plates are four tubercles, three being placed on the upper edge, so that there is a ring of tubercles round the anus. On each inter-ovarian plate there is one small tubercle. The ovarian holes are large, somewhat oval, and surrounded by a distinct prominence or ring. The madreporiform tubercle is triangular, prominent, and very porous. The ambulacra are undulated in consequence of the rows of pores being arranged almost vertically. Each pair of pores is placed

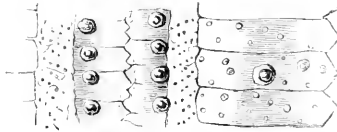
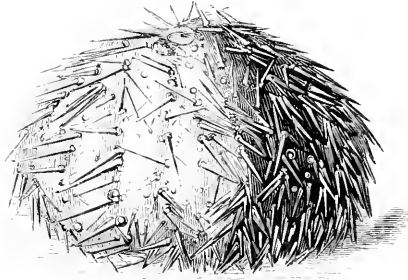
on a smooth space, and separated from the next by a finely granulated space.

The Purple-tipped Egg-Urchin is abundant in the Irish Sea, as also on the west coast of Scotland. The Rev. Gilbert Laing has sent me a specimen from Orkney. Mr. Thompson takes it in the north of Ireland, and Mr. Ball at Dublin and Youghal, where he informs me it is "usually dredged up adhering to the dead valves of oysters and other bivalves. In England it has been observed on the southern shores, and I have found it in Guernsey. In the month of August 1839, when seeking for marine animals at low water on the coast of the last-mentioned island, I had the pleasure of seeing one of these Urchins exclude its eggs spontaneously through the ovarian holes.

The Pedicellariæ which abound on the spines and near the mouth of this Egg-Urchin form very interesting microscopic objects. They consist of a head of a rounded form, apparently bearing three bill-like blades, mounted on a long flexible pedicle, which is itself placed at one end of a long stalk with a bell-shaped extremity at each end made of the same substance with the head. When highly magnified, the stalk and head appear to consist of a fleshy substance, having regular transverse rows of granules imbedded; an appearance represented by Sars in his drawings of the Pedicellariæ of *Echinus sphaera*. A toothed line borders the granular space of the bladed part, and a similar toothed line, marking the junction of the blades, runs down the centre. All these appearances are well seen in specimens preserved in spirits, and are represented in the vignette at page 174.

ECHINIDÆ.

CIDARITES.



FLEMING'S EGG-URCHIN.

Echinus Flemingii. Ball.

Specific Character.—Rows of pores subparallel, three pairs in each row; primary spines thick, much fewer than the secondary, and nearly thrice as long; spines longitudinally striate; striae somewhat narrower than the very narrow ridges.

Echinus miliaris, FLEMING, Brit. An. p. 478. Wern. Mem. II. p. 246.

PROFESSOR AGASSIZ, when examining the collection of Dr. Fleming at Aberdeen in October 1840, recognised in the *Echinus miliaris* of the "British Animals," the splen-

did new species before us, first found in deep water in Zetland, and since taken by Mr. Ball, who has long considered it distinct from any described species, off Youghal, on the south-west coast of Ireland, in very deep water, and by him has been named after its discoverer. It is by far the finest British species.

In its form it is somewhat conico-globose. The pores of the avenues are arranged in oblique rows of three pairs each. These rows are sub-parallel, the last pair of the one row being parallel with the first of the next. Transverse ridges divide the pairs of pores. On each ambulacral plate there is one primary tubercle, bearing a primary spine, with two or three irregularly-placed secondary spiniferous tubercles near it. On the lower half of the body the number of secondary spines is greatly increased. The inter-ambulacral plates of the lower half have two or three primary spines each, and several secondaries, while on those of the upper part the primaries are sometimes wanting, though when present generally longer and thicker, and the number of secondaries is considerably diminished. The tubercles of the primaries over the whole surface are elevated on very prominent bases. The ovarian plates have a few secondaries scattered irregularly over them. The madreporiform tubercle is prominent, very large, broadly heart-shaped and compact. The ground colour of the surface is yellow; two broad longitudinal stripes of orange-red blending into the yellow at their edges run down each division of ambulacral and inter-ambulacral plates. The spines are yellowish-white, with purplish bases. The striae which groove their surfaces are more numerous than in the other British Urchins, and the intermediate ridges very narrow, though slightly broader than the striae. There are no transverse striae on the

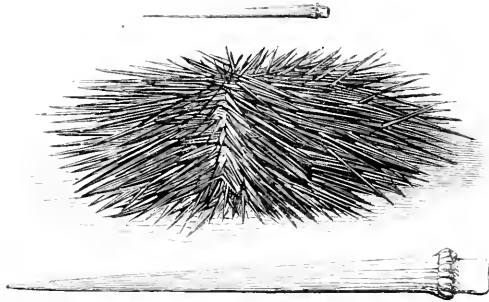
spines. The Pedicellariæ seem to be very numerous and very long.

The specimen of this species which Mr. Ball kindly submitted to my examination, measured thirteen inches and a half in circumference, and was three inches and a half in height.



ECHINIDÆ.

CIDARITES



PURPLE EGG-URCHIN.

Echinus lividus. Lamarck.

Specific Character.—Rows of pores bent, five pair in each row above and centrally, but diminishing in number near the mouth; spines striated; ridges broad, smooth; primary spines longer than secondaries.

Echinus lividus, LAMARCK, 1 Edit. II. p. 50; 2 Edit. III. p. 367. BLAINVILLE, Man. d'Actin. p. 223. BENNETT, Lin. Trans. vol. XV.

Echinus saxatilis, LINNÆUS? MULLER, Zool. Dan. Prod. 2347?

Echinus lithophagus, LEACH, Tilloch's Phil. Mag. vol. XXXIX. p. 100.

THE PURPLE EGG-URCHIN measures about two inches in diameter when deprived of its spines, sometimes a little more. The spines are usually about an inch in length, very slender and tapering, and of a deep but shining purple hue. There is a variety which has the spines much shorter and thicker, and of an olivaceous green. The spines always present the same character whatever be their form, when magnified being finely striate longitudinally, the ridges between the striæ rather broad, and both quite smooth. The primary spines are generally somewhat longer than the secondaries, but in the green variety the difference of length is very slight. When the

spines are rubbed away, the body is of a brownish hue, and has a highly ornamental appearance in consequence of the very prominent tubercles. On each ambulacral plate there is one large tubercle with two smaller, one placed on each side of it, one of them being among the pores. On each inter-ambulacral plate there are, except towards the apex, three large tubercles, the central one largest, and sometimes one or two smaller ones, besides some very small ones which form irregular borders round the larger. On each ovarian plate there are three very little tubercles, forming a border round the anus on their upper margins. The avenues of pores from the apex to very near the mouth have five pairs of pores in each oblique row. The rows are bent, and four of the pairs of pores are above the bend. Near the month the number of pairs of pores in the rows diminishes, first to four pairs and lastly to three. The month is somewhat pentangular. The entire body of this Urchin is usually round; but in one specimen in Mr. W. Thompson's collection it is pentangular.

This species was first observed as British by Dr. Leach, who, supposing it to be altogether undescribed, exhibited it to the Wernerian Society under the name of *Echinus lithophagus*. That distinguished and much-lamented naturalist, Mr. E. T. Bennett, afterwards communicated an account of it to the Linnaean Society, rightly referring it to the *Echinus ligidus* of Lamarek, but was unaware of its prior discovery by Dr. Leach. The latter gentleman named it lithophagus, on account of its singular boring habit. In many places where it is found it is seen inhabiting cavities or depressions in rocks, corresponding to it in size, and evidently formed by itself. Mr. Bennett describes each cavity as circular, agreeing in form with the contained Urchin, and so deep as to embrace more than two-thirds

of the bulk of the animal inhabitant. They are large enough to admit of the animal rising in them a little but not of its coming out easily, and their depth is in several considerably increased by the deposition around their upper circumference of a species of coralline several lines in thickness, and by a thin layer of which they are lined throughout. The Urchins adhere by their numerous suckers so firmly to the lodgement they have formed as to be forced with extreme difficulty from them when alive.

In the British isles this species is peculiar to Ireland, where it is chiefly found in the south, but ranges as far north as Bundoran, where it was noticed by Mr. Hyndman. Mr. Ball, who has paid particular attention to this species, communicates five varieties. The first is a burrower in limestone from Arran, on the coast of Clare. It has long purple spines. The second is from the same place, and is associated with the first, also burrowing in limestone. It is not found in such great numbers, and differs in having shorter and thicker spines of a dark olive-green colour. The third has also short thick spines, very blunt and purple. It is found on granite rocks in the county Mayo, but does not excavate. The fourth is associated with the third, and has whitish spines with purple tips, the primaries being longest. The fifth is from the county Cork, and has very long slender purple spines. It is found on a very soft clay slate, and does not burrow.

“The coast of the county of Clare, Mr. Humphreys informs me,” says Mr. Bennett, “at Milltown Mallbay, and indeed from the mouth of the Shannon northward to the Isles of Arran, is without a harbour; and except a few bays of fine sand, presents to the eye the most majestic cliffs. Wherever the rocks project into the sea, so as to form ledges accessible at low water, protected in front by higher

rocks, and which are never left entirely dry, these ledges are perforated by the Echini; and I have seen thousands of them lying in these cavities side by side. The largest which I saw thus embedded were about three inches in diameter, and the few that I perceived out of their *nidi*. All that I thus observed were of the same species. The fishermen sometimes take the common Echinus in their lobster-pots; but these are never lodged in the rock. I have been lately informed that they lodge in a similar manner in the rocks about Berelhaven and Bantry in the west of our county (Cork)."

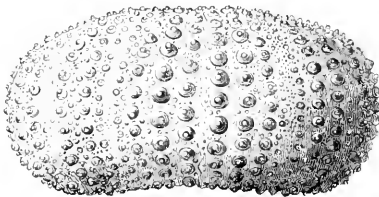
Mr. W. Thompson informs me it is gregarious, and was seen abundantly in rock pools at low water by himself and Mr. Ball when visiting the south Isles of Arran in 1834. It is always stationary, the hole in which it is found being cup-like yet fitting so as not to impede the spines. Every one lived in a hole fitted to its own size, the little ones in little holes and the large ones in large holes; and their purple spines and regular forms presented a most beautiful appearance studding the bottoms of the grey limestone rocks' pools. The same gentleman states that the coral lining the cavities, alluded to by Mr. Bennett, is the common *Millepora*. I saw it under similar circumstances in Donegal Bay, in August 1840.

Mr. Ball has paid much attention to this animal at the request of the British Association, with a view to discover its mode of boring, though as yet without conclusive results. He brought from Galway some masses of limestone with the animals alive in situ. "These," Mr. Ball says, "I deposited in various positions at Kingston, some in baskets, others amongst the rocks, and the remainder I threw out into the harbour; all that I could again visit had died, but as some may have survived it may be well

if you recorded the fact should they increase, the date of their introduction to this side of the island, 1836, may thus be known."

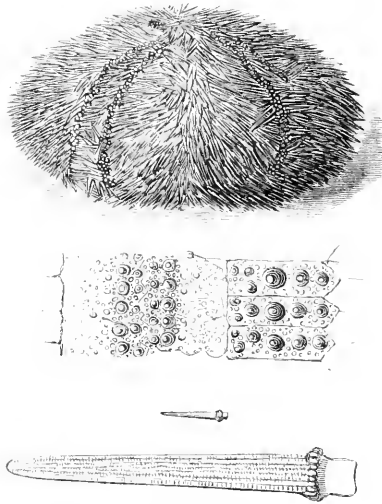
That these Urchins live in cavities of rocks was observed long ago by Rondeletius, who figures some in that situation. That these cavities are formed by the animals, and are not mere depressions from some other cause, is the opinion of those who have attended most to their history, of Dr. Leach, Mr. Bennett, Mr. Ball, and Mr. Thompson. How the boring is effected is another question, and one not as yet settled. The probability is that the animal forms the first perforation by means of the teeth, and softens the rock by some secreted solvent. The circumstance of its burrowing in limestone only, favours this view, especially as when found on soft clay slate they do not bore, though such animals as the pholas, which bores by mechanical means, perforate slate—a rock mineralogically similar.

The subject of boring animals is still open to the zoologist and chemist. Much has been written on it but little satisfactory. Dr. Drummond has suggested that some of these creatures may have the power of decomposing the sea-salt as their wants may require, and applying the liberated muriatic acid to the solution of the calcareous rock. Mr. Thompson has some interesting observations on the subject in a paper on the *Teredo navalis* and *Limnoria tercbrens* published in the Edinburgh New Philosophical Journal for January 1835.



ECHINID.E.

CIDARITES.



SILKY-SPINED EGG-URCHIN.

Echinus neglectus. Lamarck.

Specific character.—Rows of pores bent, five pair in each row throughout; spines thick, conic, glistening, longitudinally striate; striae and ridges equal, transversely striated; primary spines scarcely longer than secondaries.

Echinus neglectus. LAMARCK, *AN. sans Vert.* 1 Edit. II. p. 49; 2 Edit. III. p. 366. *Encyc. Meth.* pl. cxxxiii. fig. 3, a, b.

Echinus lividus, var. BLAINV. *Man. d'Actin.* p. 226.

Echinus subangularis. FLEMING, *Brit. An.* p. 479.

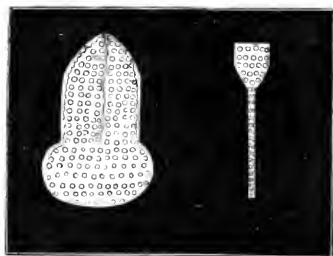
THE form of this Urchin is depressed and angular; the ground colour dark brownish-purple with pinkish-white tubercles and greenish spines. From the *Echinus lividus* it is easily distinguished by its short spines, greater size, and the pairs of pores being always five in each row from

apex to mouth. When fresh taken, one is much more apt to confound it with a depressed variety of the common Sea-Urchin, from which, however, the five pairs of pores in each row at once distinguish it, independent of the excellent characters presented by the spines. The spaces between the rows of pores are rather broad and very tubercular, bearing secondary spines. The ambulacral plates are rather narrow, each bears two primary tubercles, which are very prominent, and polished and elevated on prominent bases, round which a number of secondaries are seen. Each inter-ambulacral plate bears a transverse row of four or five primaries, with a number of secondaries interspersed. The primaries diminish in number towards the apex. The ovarian plates are thickly studded with secondary tubercles, and the madreporiform tubercle is large, prominent, heart-shaped, and compact. The spines thickly stud the body, and are nearly equal in size. They have a fine silky lustre, and when magnified are seen to be striated longitudinally, the striae and the intermediate spaces nearly equal in breadth and crossed by very fine transverse striae. The largest specimen measured a little more than nine inches in circumference, and was one inch and eight-tenths in height.

This Sea-Urchin was first added to the British list by Dr. Fleming, and afterwards found by Mr. Goodsir and myself, during our visit to the Orkney and Shetland Islands in the summer of 1839. We obtained three specimens of it, each of which was taken in a locality distant from the other two. The first we dredged in ten fathoms water, opposite the town of Lerwick; the second, off Scalloway on the west coast of the Mainland of Shetland; and the third, in rather deeper water in the

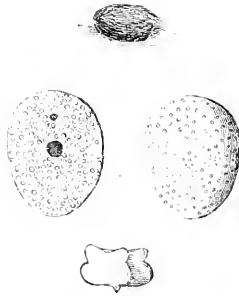
neighbourhood of Stromness, Orkney. I have little doubt as to its being the *Echinus neglectus* of Lamarck. Klein's "*Cidaris miliaris*, sp. m. *angulosa*," t. n. F, and m. A, B, resembles it greatly, but has been referred to an Indian species, the *Echinus subangulosus* of Lamarck.

The vignette represents the microscopic structure of the head and stalk of a Pedicellaria.



ECHINIDÆ.

CLYPEASTERIÆ.

Genus *Echinocyamus*. Leske.

Generic Character.—Body oval, with rounded sides; ambulacra dorsal, five, short; mouth central, inferior; anus between the mouth and posterior margin.

GREEN PEA-URCHIN.

Echinocyamus pusillus. Muller.

Specific Character.—Body ovate, depressed, beneath concave; apex central.

<i>Spatangus pusillus</i> ,	MULLER, Zool. Dan. p. 13, tab. xci. figs. 5, 6.
<i>Echinus ovalis depressus</i> ,	WALKER, Test. Min. p. 25, t. iii. f. 33.
<i>Oradum marinum</i> ,	BORLASE, Corn. t. xxviii. f. 26.
<i>Echinus perovipuus</i> ,	PETIVER, Gaz. t. xxxi. p. 10.
<i>Echinus minutus</i> ,	GMELIN, p. 3194.
<i>Echinocyamus minutus</i> ,	BLAINVILLE, Man. d'Actin. p. 214.
<i>Echinocyamus pusillus</i> ,	FLEMING, Brit. Anim. p. 481.
<i>Fibularia</i> ,	LAMARCK.

THE genus *Echinocyamus* is one of the connecting links between the true *Echini* and the *Spatangacea*. It has the teeth of the former, and the spines of the latter. The little species before us is the least of all the British Urchins,

and at the same time one of the commonest and prettiest. When alive it is of a bright green colour, such a powdery green as is seen on the elytra of many beetles; but when cast on the shore, as we usually find it, dead, it becomes of a dirty white. It is very common among shell sand.

The upper surface is depressed; the general form ovate, rather broader posteriorly than anteriorly. In the centre of the back are seen the four ovarian holes, and from these radiate the five ambulacra, at nearly equal distances from each other, each composed of two double parallel rows of seven or eight pairs of pores. These ambulacra run about half way towards the circumference. They are level with the surface, which is studded with little flattish moniliform spiniferous tubercles, which are surrounded by smaller ones. Beneath, we find the mouth in the centre, which is somewhat concave, and between it and the broadest margin is the anus. Both are round, the latter much smaller than the former. The spines are very short, closely placed, and resembling those of *Spatangus* in their structure. The coats of its intestine are covered with vibratile cilia.

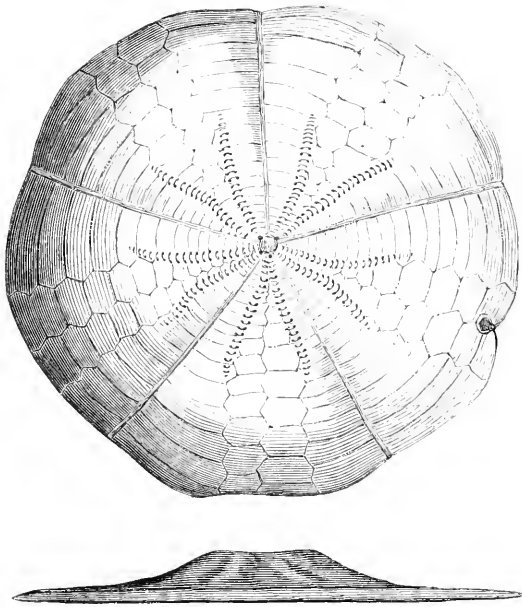
Internally the shell is strengthened by ten strong ribs, which run in pairs at equal distances from mouth to apex.* The mouth bears a dental apparatus of the same nature with that seen in *Echinus*, but different in form, being much shorter and broader, as befits the shape of the internal cavity. It consists of five complicated teeth, the keels of which are greatly produced into compressed beaks, which are rounded at the margins and grooved. The whole apparatus has the appearance of five rostra placed round an ancient naval column.

The Green Pea-Urchin has been observed on most parts of the coast of Britain from Devon to Shetland, both east

and west. In Ireland, Mr. W. Thompson informs me it is found at Bantry Bay and Portmarnock, and Captain Portlock finds it in the north. In the Irish Sea it is abundant, and I have dredged it frequently alive in deep water among bivalve shells. In Guernsey I have found it alive at low water. It probably is found throughout the seas of Europe.

I believe the *Fibularia ovulum* and *F. tarentina* of Lamarek, and the *Fibularia angulosa* of Deslonchamps, will all prove to be identical with this species.



*ECHINIDÆ.**CLYPEASTERIÆ.*

Genus *Echinarachnius*. Leske.

Generic Character.—Body circular, very much depressed, with the margin subacute and entire; ambulacra dorsal, five, short; the ambulacral spaces broader than the inter-ambulacral; anus marginal, superior; mouth central.

THE CAKE-URCHIN.

Echinarachnius placenta. Gmelin.

Specific Character.—Body orbicular, very flat; ambulacral spaces between the avenues prominent; base slightly concave.

Echinarachnius,

LESKE, ap. KLEIN, t. xx. f. A, B. Encyc. Meth. pl. cxliii. figs. 11, 12.

- Echinus placenta*, GMELIN, 3195.
Echinarachnius placenta, FLEMING, Brit. An. p. 479. GRAY. AGASSIZ, Prod.
Scutella placenta, LAMARCK, Anim. sans Vert. 1 Edit. vol. III. p. 11 ;
 2 Edit. vol. III. p. 283. DESMOULINS, Echin. p. 223.
Echinodiscus placenta, BLAINVILLE, Man. d'Actin. p. 218.

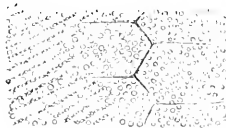
THROUGH the kindness of Professor Jameson I am enabled to figure and describe the only British example of this remarkable Sea-Urchin, one of the many additions he made to the British Fauna when examining the zoology of the North many years ago. He obtained it from very deep water off the island of Foulah, one of the Zetland group. It is usually recorded in zoological manuals as an inhabitant of the southern seas ; whether it has so wide a range is questionable, but it is undoubtedly an inhabitant of the North, as the specimen I describe testifies, and in Mr. Lyell's collection there are several exactly similar from the coast of Canada. The Foulah specimen measures two inches and three-fourths across.

The Cake-Urchin is allied to several genera, presenting very singular and eccentric forms,—forms which may be regarded as linking the Sea-Urchins with the true Starfishes, and the study of which, therefore, presents many points of great interest. Even the arrangement of the parts in the species before us is very Starfish-like, especially on the under surface. In form it is nearly circular, and very much depressed, the centre only being somewhat prominent. The apex is occupied by a pentangular tubercle or button, similar to those seen on the apices of Spatangii, and which prominences may be regarded as of the same nature with the madreporiform tubercles of the Echinus and the Starfishes. From this button radiate five pairs of short ambulacra. In the arrangement of these ambulacra there is a remarkable generic peculiarity, which was kindly pointed out to me by Professor Agassiz. It

is this: the ambulacral plates are much broader than the inter-ambulacral, consequently the two ambulacra nearest to each other appear to belong to the same pair, whereas each belongs to a different pair. That such is the case is proved by the position of the oviducal pores, which are seen at the heads of the narrow or inter-ambulacral spaces. There are four of these pores instead of five, the one wanting being the anal pore. At the heads of the ambulacral spaces there are also minute pores, which are probably in the living animals filled up with ocular points, as in the Echinus. The ambulacra are curved, and diverge greatly towards their extremities; each is furnished with about forty pairs of pores for the exertion of suckers. These pores are somewhat distant from each other, and connected by a deep furrow. Down each ambulacral space runs a smooth groove, which is continued round the under surface to the mouth. The inter-ambulacral plates are minutely but irregularly rugose, with spiniferous granules. The ambulacra are also granulated, but in a more complicated manner. That portion of their surface nearest the inter-ambulacral spaces is granulated irregularly, but the rest is occupied by granules of two sizes arranged in alternate rows, which slope towards the ambulacral grooves. A similar arrangement is seen on the under side, with the addition that the grooves have a border of minute tubercles or granules, analogous to the border avenue-spines of the Starfish. The vent is lenticular, and is placed quite on the upper margin in a notch; there is a short groove beneath it, which is connected with a smooth shallow furrow leading to the mouth. The base is almost flat; if anything, slightly concave. The mouth is placed in the centre; a pentangular space resembling an Asterina, on which the tubercles are irregularly placed, surrounds it, and

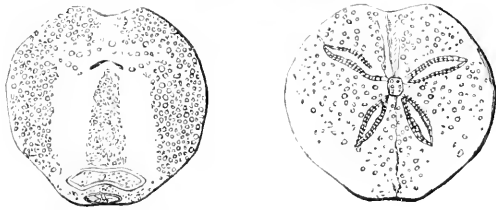
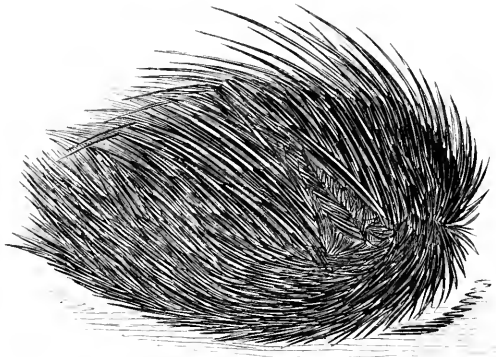
it is protected by five groups of spines projecting over it, as in a Starfish. Within these are teeth. The inside of the Cake-Urchin is curiously strengthened by irregular calcareous processes or plates; and the spines, which are very minute, are nearly similar in structure to those of the Spatangii.

The vignette represents a magnified view of a spine, and of a portion of the surface, showing the arrangement of the granules.



ECHINIDÆ.

SPATANGACEÆ.



Genus *Spatangus*. Klein.

Generic Character.—Body cordate, depressed, having two sets of ambulacra, dorsal and oral, four of the dorsal ambulacra petaloid; no dorsal impression; sub-anal impression transverse sub-inferior.

PURPLE HEART-URCHIN.

Spatangus purpureus. Muller.

Specific Character.—Broadly heart-shaped, depressed, sloping towards the anus; anal impression ovate; sub-anal broadly reniform; lateral ambulacra linear lanceolate, pointed at both ends.

Spatangus purpureus, MULLER, Zool. Dan. Prod. 2350; Zool. Dan. tab. vi. LESKE, p. 235, t. xliii. fig. 3-5. LAMARCK, Anim. sans Vert. 1 Edit. III. p. 29; 2 Edit. III. p. 324. Encyc. Meth. pl. clvii. f. 1-4. FLEMING, Brit. Anim. p. 480. BLAINVILLE, Man. d'Actin. p. 202. pl. xiv. f. 1, 2, 3. AGASSIZ, Prod.

Echinus purpureus, GMELIN, p. 3197.

Echinus lacunosus, PENNANT, Brit. Zool. IV. p. 69, t. xxxv. f. 76.

Spatangus meridionalis, RISSO, t. v. p. 280.

THE HEART-URCHINS form a very natural division of the Echinidæ. Their name expresses their form; their colours are various shades of red, purple, and yellow; most of them bury themselves in sand or mud, and the greater number of their spines are directed backwards, doubtless for the facilitating of this custom of living interment. The two apertures of their digestive canal are placed very differently from their positions in the true Egg-Urchins, the anal being terminal, and the oral eccentric and beneath. The mouth is protected by a projecting plate. In separating the species referred to the old genus *Spatangus*, I have taken a similar view of their generic distinctions with that maintained by M. Desmoulins, and have not adopted those proposed by Professor Agassiz, which seem to me insufficient, and founded on the imperfect evidences afforded by fossil species. The characters proposed by the distinguished Swiss zoologist for the separation of his genera, I must regard as appertaining rather to family and species. Those afforded by the marks or impressions seen on the back, round the anus, and below the anus (in the dried specimen generally naked, in living examples thickly covered with short slender spines), are constant, certain arrangements of them agreeing with certain arrangements of the ambulacra in each generic assemblage of forms. The five British *Spatangi* which I find on our shores may thus be well arranged under three genera, for which I have severally retained the names of *Spatangus*, *Brissus*, and *Amphidotus*, in order that synonyms be multiplied no more than is absolutely necessary. The English terms of Bank-Urchin, Mud-Urchin, and Sand-Urchin might be respect-

ively applied to each of these genera as descriptive of locality. The organic importance of the impressions on which I have mainly founded my characters is as yet undiscovered; though from the circumstance of the genus *Spatangus* (proper) having no such marks on the back, while they are very regular and evident in the two other genera, and largest in that inhabiting thick mud, may we not conjecture that the little spines clothing those impressions serve the animal for progression through the medium in which it buries itself? When we look through a magnifier at the surface of one of these impressions when the spines are rubbed away, we see the minute tubercles which cover it are very different from those bearing the true spines; and doubtless the purpose of each set of spines is different also. Strange to say, these impressions, though affording excellent and most obvious specific as well as generic characters, have escaped mention in the descriptions of most of the species. The attention of describers of *Spatangi* has been chiefly directed to the number of ambulacra, whether four or five, and to the depth of the dorsal grooves; most fallacious characters, especially the former, as in all the species there are four perfect and lateral dorsal ambulacra, and one imperfect and central; which latter, however, has frequently through carelessness escaped notice, the holes being sometimes obsolete without though evident within.

The Purple Heart-Urchin is one of the handsomest of the British Echinidæ, and by much the largest and most elegant of our native *Spatangi*. It is the only native species of the restricted genus *Spatangus*. It grows to the length of four inches by three and a half broad, and is occasionally larger. It is of a deep purple colour with pale spines. Some of these spines are very long and

curved, especially those of the back, towards the anus ; but the spines which thickly clothe the greater part of the body are short and close-pressed, bending over each other, the greater number being directed towards the posterior extremity. The spines covering the post-oral space beneath, are divided into two sets by a median depression, and each set bends forward from that median line. Their apices are truncated and compressed, but not much widened. On each side of the post-oral spinous space below, there is an avenue which seems naked ; but when we look closely to the surface, we find there are little slender hairs scattered here and there on the surface. These little hairs when magnified prove to be spines, not differing in their structure from the larger spines. The spines around the anus bend over it for protection, and the spines within the bounds of the sub-anal impression form two projecting tufts or tails.

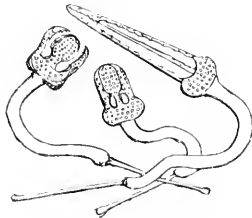
When we rub away all the spines, we then see the structure and markings of the shell well displayed. Above there is a star formed by the four lanceolate leaf-shaped ambulacra. The number of pores in each of these ambulacra, which are nearly equal in size, is about forty-eight, and they are placed close together. Transverse grooves run between the pairs of pores. The two anterior ambulacra are somewhat sinous. The central is placed in a shallow groove, and almost obsolete ; but when we look within the shell, we see that its pores are placed pretty closely together in a single row on each side of the median suture, the pores of the rows alternating. In the centre of all the ambulacra is a little oblong-quadrangular depression, at the anterior end of which are seen the four ovarian holes, the two hindermost of which are placed further apart than the two foremost. The whole of the

upper surface is rough, with little eminences for the smaller spines: but between the ambulacra there are many larger eminences, surrounded by a depressed ring; these are for the larger spines, and similar eminences abound on the under surface. The anus is transversely oblong, and surrounded by an oval ring. Below the anus, and placed in a great measure below the body, is the post-anal impression, large, and broadly reniform. The mouth, which is transverse and narrow, is surrounded by a star of five lanceolate ambulacra.

In England this species is said to be rare. Pennant records it from Weymouth. On the Scottish coast Dr. Fleming states it is common in the Frith of Forth. In Ireland Mr. W. Thompson informs me it is rare, and is found on the coast of Wicklow. On the Scallop-banks off the Isle of Man it is abundant, and is generally found on the cleanest part of the bank, among the Scallops. On its spines we sometimes find in considerable numbers, a little parasitic bivalve Mollusc, the *Montacuta substriata*.

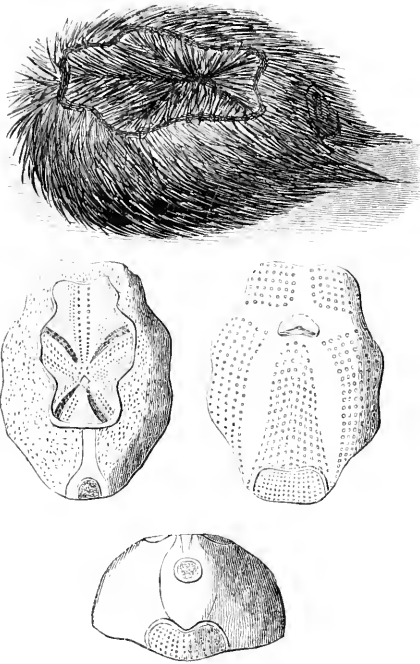
In foreign countries it is found on the Norwegian coast, on the shores of France, and in the Mediterranean Sea.

In the vignette I have represented the Pedicellariæ of *Spatangus purpureus*.



ECHINIDÆ.

SPATANGACEÆ.

Genus *Brissus*. Klein.

Generic Character.—Body cordate, convex, having two sets of ambulacra, dorsal and oral; four of the dorsal ambulacra petaloid; a dorsal impression inclosing the ambulacra; sub-anal impression transverse, sub-inferior.

FIDDLE HEART-URCHIN.

Brissus lyrifer. Forbes.

Specific Character.—Body ovate; a deep and narrow dorsal depression; ambulacra deep; dorsal impression fiddle-shaped; post-oral spinous space narrow, lanceolate.

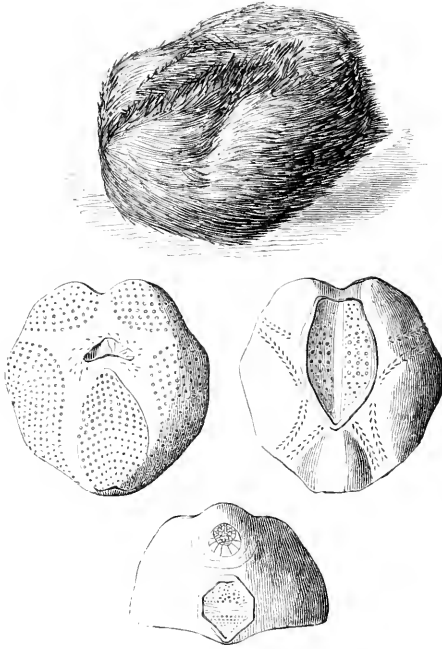
THE genus *Brissus* connects the genus *Spatangus* with *Amphidotus*. It has the form of the latter with the

post-anal impression of the former, and a dorsal impression peculiar to itself. One British species, which I have called the Fiddle Heart-Urchin, on account of the peculiar shape of the dorsal impression, belongs to it. The *Brissus lyrifer* I cannot find described or figured in any author on this subject. It is a very handsome and remarkable species, having a red body, with pale yellowish white spines, and the dorsal and post-anal impressions of a rich brownish purple. It inhabits mud at the depth of from ten to fifteen fathoms in various localities in the estuary of the Clyde, as off the island of Cumbray, in Rothsay Bay, and the Kyles of Bute, in which places I met with it for the first time in July 1840. I have a specimen one inch and three-fourths in length by one and three-tenths in breadth, and one inch in height. I found fragments which indicated that it attained larger dimensions.

In form it somewhat resembles a slightly depressed egg; the back is convex and highest posteriorly. It is thickly clothed by long curved spines, those within the post-anal impression forming two caudiform tufts, and on the post-oral space they are long, slender, and spatulate at their extremities. On the back the four lateral ambulacra are placed in depressions, and form a St. Andrew's cross. Each of them is included within the dorsal impression. The ovarian holes are placed in the centre at the origin of the four ambulacra; two of them are placed close together, and the two anterior diverge. The ambulacra are ovate, petaloid in form, and have the holes so placed that the four rows composing the two sets of pairs, are almost equally distant from each other, The two anterior ambulacra are longer than the two posterior, and the numbers of pairs of suckers in each of the two anterior are eighteen and twelve, and in each of the two posterior

twelve and fourteen. The pores of the central ambulacra are evident, closely placed in two single rows, distant, and nearly opposite. The anal impression is circular; the sub-anal, ample and reniform. On the under surface the post-oral space is long and narrow, the smooth imperforate avenues wide, and the oral ambulacra somewhat triangular.



*ECHINIDÆ.**SPATANGACEÆ.*Genus *Amphidotus*. Agassiz.

Generic Character.—Body ovate or cordate, convex, having two sets of ambulacra, dorsal and oral; four of the dorsal ambulacra truncate, oblong; dorsal impression within the ambulacra; sub-anal impression ovato-cordiform, terminal.

COMMON HEART-URCHIN.

MERMAID'S HEAD.

Amphidotus cordatus. Pennant.

Specific Character.—Body cordiform; a deep dorsal depression; dorsal depression ovate; post-oral spinous space broadly ovate.

Echinus spatagus, MERRET, p. 192. LINNÆUS, 1104? BORLASE, p. 278, t. xxviii. f. 28. ENCYC. METH. pl. clvi. f. 28. LISTER, App. t. i. f. 13.

- Echinus pusillus*, GMELIN, 3198.
Echinus cordatus, PENNANT, Brit. Zool. IV. p. 69. t. xxxiv. f. 75.
Spatangus pusillus, LESKE, p. 230, t. xxiv. f. c, d, e, xxxviii. fig. 5.
Spatangus cordatus, FLEMING, Brit. An. p. 480.
Spatangus flavescens, MULLER, Zool. Dan. III. t. xci. f. 1-4.
Spatangus arcuarius, LAM. 1 Edit. III. p. 31; 2 Edit. III. p. 323. BLAINV.
 Man. d'Actin. p. 201.
Amphidotus pusillus, AGASSIZ, Prod.

THE commonest of all the Heart-Urchins is the species before us, found throughout the seas of Europe. It abounds in all our sandy bays, and after storms great numbers are cast on shore. Popularly it is known by the names of Mermaid's-head, Child's-head Urchin, and Hairy Sea-egg. In form it is broadly heart-shaped; dorsally, the centre is much depressed, and a deep groove with precipitous sides runs from the ovarian holes to near the mouth. This depression and part of the groove are bounded by the ovate dorsal impression from which and beyond radiate the four ambulacra, which are placed also in grooves, though not so deep as the centre. These ambulacra are very wide at their origins, and taper towards their centres, when each row of pores runs on parallel, and is truncate at the extremity. The numbers of pores in the anterior pair are generally six and eleven in each, in the posterior nine and nine. The two anterior ovarian holes approximate, the two posterior diverge. Above the anus the back is exceedingly prominent, much higher than any other part of the body. The anus itself is almost round. It is formed of a number of small triangular hair-like plates radiating to a centre. These are surrounded by an ovate ring of eleven small polygonal plates, and these again are bounded below by five quadrangular plates, the lowermost of which are very large. The post-anal impression is somewhat lenticular in form. Beneath, the

body presents a naked but capacious mouth, from which run five almost smooth avenues, two lateral and short, two backwards and extended, inclosing the broadly ovate post-oral spinous space, and one in front running to the anterior groove. The five oral ambulacra are very short, and resemble the dorsal one in shape. With the exception of the avenues the whole of the under surface is studded with mammillary spiniferous tubercles, which are very much larger than those on the back, as indeed are the spines. The spines are hair-like and pointed on the back and sides, but spathulate on the post-oral spaces. Mr. Couch states in his "Cornish Fauna," that the animal burrows by means of the lesser spines, and then covers itself by means of the long ones on the back. From the ambulacral pores on the back very long ringed worm-like suckers are protruded, while from those round the mouth short tentacula, with disks, surrounded by numerous clavate tentacular filaments, proceed. This difference of form was noticed by Muller, and is common to the tribe.

When alive, this species is of a yellowish white colour, and usually measures about an inch and three quarters in length by very nearly the same breadth, and nearly one inch and a quarter in height posteriorly. Young shells are generally longer than broad, but old ones have a tendency to become broader than long. In a gigantic specimen found by the Rev. Gilbert Laing in Ireland, which I owe to the kindness of my friend, Dr. Balfour, the breadth exceeds the length by more than a quarter of an inch. This remarkable specimen measures three inches in length and two in height, and has the sub-anal impression transversely oval, and broader than long. Saving the last character, however, it presents no grounds for separation as a species, though the attention of observers

is requested to the young state, as, if the peculiar shape of the sub-anal impression be constant throughout its life, and not an effect of abnormal growth, the form must be considered specifically distinct.

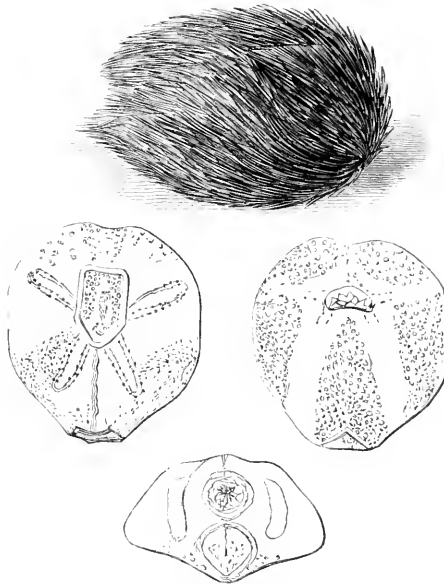
M. Sars has observed *Pedicellaria* on this species. He says they are but few, from thirty to forty in number. In size they are rather large. They have a short thin stem, and a very large head, consisting of three, dark brown, thick, blunt teeth, which often open and shut as in the other kinds. They stand in five incomplete rows, rather irregularly, and only on the back of the shell. The dark brown head makes them apparent.

When any of the Spatangi tribe are opened, we find their intestines filled with sand or mud. They seem to swallow those substances for the sake of the animal matter mixed up with them.



ECHINIDÆ.

SPATANGACEÆ.



ROSY HEART-URCHIN.

Amphidotus roseus. Forbes.

Specific Character. — Body ovate, no dorsal depression; dorsal impression oblongo-pentangular; post-oral spinous space lanceolate.

Spatangus ovatus, FLEMING, Wern. Mem. V. p. 287, t. vi. British Animals, p. 480.

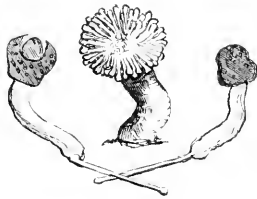
THIS pretty Heart-Urchin was discovered by Dr. Fleming, who referred it to a figure of Leske's representing a different species; and it is not the *ovatus* of Continental authors, to whom it appears to be unknown. I have accordingly given it the name of *roseus*, as expressive of its usual colour when alive. Its form is oval, and its back is

convex. It is thickly clothed with long curved spines, directed as is usual in the tribe. The spines of the post-oral space have wide bent spoon-shaped tips. On the back are seen the four lateral ambulacra, approximating much more nearly at their origins than they do in the common Heart-Urchin. Within them is the dorsal impression, shaped like an escutcheon, bearing many prominent spiniferous tubercles. Near its posterior extremity are seen the ovarian holes, two of them placed close together, two diverging. The ambulacra are not so wide at their origins as in the last species, and the pairs of pores are not placed in such deep grooves. In the two anterior ambulacra there are five pairs in the foremost row and ten in the hindermost. In the posterior the numbers are equal, nine in each series. The pores of the central ambulacra are nearly obsolete, and are placed in a single row on each side of the suture, distant and alternate. The tubercles on the anterior portion of the body are largest. The anal impression is circular. The sub-anal is somewhat cordiform, and there are two pores on each side of the space it incloses. That portion of the back between the dorsal impression and the posterior extremity is much wider and not nearly so prominent as the same part in the last species. On the under surface the post-oral spinous space is lanceolate, and slightly carinated throughout its length. The projecting lip over the mouth is nearly straight. The largest specimen which I have seen measures one inch and a half in length and one and a quarter in breadth, and is eight-tenths high.

The *Amphidotus roseus* was first found by Dr. Fleming in Zetland in 1809. Dr. Coldstream afterwards found it twice on Leith sands. During the winter of 1840, I met with a dead specimen on the sandy shore at St. Andrew's;

and in Ireland, Mr. Ball, who observes that it is rose-coloured when alive, has taken it at Dublin and at Youghal. It occurs also near Belfast. In England, Mr. Couch says it is found in Cornwall, less common than the last; and I have taken it in deep water on the Manx coast.

The vignette represents its Pedicellariæ, and one of its oral tentacula. The former have deep purple heads and white stalks, and are very irregularly scattered in the spaces between the two dorsal avenues. The latter are yellow, and resemble those of *Spatangus purpureus*, saving that the Purple Heart-Urchin has brown oral tentacula.





HOLOTHURIADÆ,

OR CIRRHIO-VERMIGRADE ECHINODERMATA.

A *HOLOTHURIA* may be regarded in one light as a soft Sea-Urchin, in another as a radiated animal, approximating the Annelides. The radiation of the surface is more or less complete in all the genera of *Holothuriadæ*: the internal organisation is mostly bilateral. The skin is usually soft and leathery; in a few genera strengthened by calcareous or horny spines. Five avenues of suckers separate the body into as many longitudinal segments, which in the majority are of equal, or nearly equal dimensions. In some the suckers are developed only on one side, so that the animal, when creeping, presents in a manner a back and a belly. The suckers are similar to those of the true Star-fishes and Sea-Urchins. Besides progression by means of

these suckers, the *Holothuriadæ* move as Annelides, by the extension and contraction of their bodies. They have a mouth and an anus, each terminal, and placed at opposite extremities of their bodies. The mouth is surrounded by plumose tentacula, the number of which, when they are complete, is always a multiple of five; but as these animals are singularly subject to the loss or absence of parts, in *individuals* of the various species much confusion has arisen from the establishment of supposititious species from characters founded on abnormal numbers of the parts. The tentacula are ramose cirrhi; they can be retracted within the mouth, and sometimes when in captivity the animal will not exert them for days together, though otherwise active.

They are drawn in with the skin, and when we cut open a *Holothuria* having its tentacula retracted, we find them in the centre of the dental circle. The circle of teeth is analogous to that of the



Echini. The œsophagus passes through it, and opens into a more or less muscular stomach, from which an intestine, often very complicated, proceeds to the posterior extremity of the body, where it opens into a funnel-shaped cloacum, into which also open the two tree-like respiratory organs. There is a vascular circle (and some say a nervous cord,) surrounding the mouth, and vessels are distributed from it to various parts of the body and organs. One or more sacs of a pyriform shape depend from a vessel surrounding the pharynx, and are by many believed to be salivary organs. Mr. Goodsir has found a sac containing calcareous conerctions on one side of the mouth in certain species. This he regards as a madreporiform tubercle or nucleus. The ovaries are in many species very numerous.

in others very few, and unite to form a tube which opens at one side towards the upper extremity of the animal. The inner surface of the animal's skin is lined with powerful longitudinal and transverse muscles, by means of which the creature contracts its body and lengthens it out in many directions, changing its form in a wonderful manner. Sometimes the creature ejects all its viscera, or bursts the body with its convulsive contractions. It is usually stated that the *Holothuriæ* do so whenever they are taken, but such is not the case. I have never seen the animal disgorge its intestines, but specimens of many species have I seen in which there was not a trace left of the creature's bowels and other internal organs, though it seemed when taken alive and healthy. It is astonishing how long they can live deprived of the most essential parts of their organism. Sometimes they are found wanting the respiratory organs, and sometimes the generative tubes are deficient, and these deficiencies so frequently occur that we should be extremely shy of proclaiming differences in the internal structure of species; and when we see genera and species (as has been the case) *anatomically* defined from the want of respiratory trees or genital tubes, we should be extremely cautious about admitting such, and rather regard such wants as accidental deficiencies in a few specimens than as organic peculiarities.

Sir John Graham Dalyell, whose knowledge of the habits of the lower invertebrate animals exceeds that of any living naturalist, communicated some most interesting observations on reproduction of organs in the *Holothuriæ*, to the meeting of the British Association at Glasgow in 1840. He there stated that he had observed them lose "the tentacula, with the cylinder (dental apparatus), mouth, œsophagus, lower intestinal parts, and the ovarium, separating from

within, and leaving the body an empty sac behind. Yet it does not perish. In three or four months all the lost parts are regenerated, and a new funnel, composed of new branches as long as the long body of the animal, begins to exhibit the same peculiarities as the old one, though longer time be required to attain perfection. Other species of the *Holothuria* divide spontaneously through the middle into two or more parts, all becoming ultimately perfect by the developement of new organs. Yet the anatomical structure of the whole genus is so complex as to defy the skill of anatomists in discovering the proper functions of some of the parts. A single *Holothuria* has produced 5000 ova in the course of a night. The young resembles a white maggot when the size of a barleycorn. The animal may lose and regenerate its organs more than once, and is very rarely to be procured entire."

The *Holothuriadæ* are generally distributed through the seas of the globe, but are congregated in greatest numbers in the Eastern seas. On our shores they are rare and unattractive animals, not often seen even by the zoologist; but abroad they are very abundant, and are in some places used as food. Of one genus, the Trepang, many species are eaten. In Mr. F. D. Bennett's interesting "Account of a Whaling Voyage round the Globe," we are told that there are two kinds of Trepang abundant on the rocks at Raiatia, and that they are very indolent animals. "When handled," says Mr. Bennett, "the Trepang contracts its body in a longitudinal direction, and should its tentacles be expanded they are instantly concealed; but no noise or agitation of the surrounding water will excite these symptoms of alarm, or cause any attempt to escape. They usually lie exposed in the shallow waters, though we have very often seen them buried in beds of coral sand, their plummy tentacles

being alone exposed, and floating in the water above, apparently as a lure for prey. Some may also be observed lying on the rocks, their bodies completely encrusted with coral sand, which may either have been accumulated by a previous burrowing, or thus used as a disguise. It would appear to be partly the instinct of the animal to take its prey in ambush; but what that prey is, as well as the entire economy of these Molluses, remains a perplexing mystery. Their intestines invariably contain many hard and solid masses of madreporic rock or tree-coral, some of them more than an inch in length, and all moulded as pellets to the calibre of the intestinal canal. It is difficult to say how these stony bodies have been obtained by the Trepang, though it is easy to conceive that they may be rendered serviceable as nutriment by the assimilation of the animal matter they contain. It is this animal which the Malays of the Oriental Isles seek so diligently for the supply of the China market, where it obtains a good price when well preserved. It is employed by the Chinese in the preparation of nutritious soups, in common with an esculent sea-weed, shark's fins, edible bird's-nests, and other materials, affording much jelly." Jaeger says the intestines are extracted, the animal then boiled in seawater, and dried in smoke.

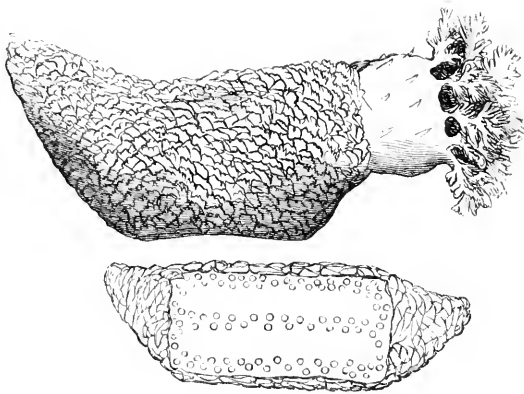
The chief writers on the subject of the Holothuriadæ are Della Chiagi, a distinguished anatomist of Naples; Jaeger, a German physician; and Brandt, a Russian naturalist. The two latter gentlemen have instituted many genera, and added greatly to the number of species; but it seems to me that they have multiplied the genera overmuch, and not always based them on the soundest and most permanent characters.

The British Holothuriadæ belong to four families, viz.

the *PSOLIDÆ*, or Ascidian *Holothuriadæ*, animals approaching the *Mollusca* in their form, and having a soft circumscribed disk like the foot of a *Gasteropodous Mollusc* on which the suckers are placed for progression. 2, The *PENTACTÆ*, which have the suckers arranged in five regular rows, and are more or less angular in form. 3, The *THYONES*, which have the suckers scattered all over the surface of the body ; and, 4, The *SYNAPTÆ*, in which there are no suckers on the body, the oral tentacula being the only representatives of those organs.

HOLOTHIURIDÆ.

PSOLIDÆ.

Genus *Psolus*. Oken.

Generic Character.—Body irregular, ascidiform; suckers in five rows, three only of which are developed, and placed on a soft disk or foot; tentacula ten.

SNAIL SEA-CUCUMBER.

Psolus phantapus. Linnæus.

Specific Character.—Brown; head reddish white, with orange spots and orange tentacula; body covered with pectinated scales, or rugæ.

Holothuria phantapus, LINNÆUS, Syst. p. 1039. MULLER, Zool. Dan. Prod. 2303; Zool. Dan. t. cxii. f. 1, 2, 3. Encyc. Meth. pl. lxxxvi. f. 1-3. LAMARCK, 1 Edit. III. p. 73; 2 Edit. III. p. 440.

Ascidia rustica, PENNANT, Brit. Zool. vol. IV. p. 48, t. xxxiii. f. 35.

Cuvieria phantapus, FLEMING, Brit. An. p. 483. JOHNSTON, Mag. Nat. Hist. IX. p. 472, f. 86.

Psolus phantapus, JAEGER, de Hol. p. 2. BRANDT, Prod. AGASSIZ, Prod.

THROUGHOUT Nature we find creatures belonging to one class emulating the forms of another. Here we have an animal of the radiate type emulating the symmetrical forms

of the Ascidian Mollusca. When the tentacula of the *Psolus phantapus* are withdrawn, the animal has all the aspect of an *Ascidia*; so striking, indeed, is the resemblance, that twice have naturalists of repute been deceived, and twice has it been figured as an *Ascidia*.

The body of this animal measures from six to eight inches in length, and from two to three in height. It is of an oblong form, and turned up at both extremities. Beneath, there is a soft oblong square disk, the surface of which is studded with three longitudinal rows of suckers, which are large and strong. There are from two to three placed across the breadth of each row, but at each extremity of the disk the suckers increase in number, so that the ends of the rows are sometimes connected by transverse rows of suckers. The spaces between them are smooth. All the rest of the body is covered with a tough coriaceous skin of a deep brown colour; beneath it is lighter, and there are sometimes orange dots. This skin is strengthened by a scale-like arrangement of short spines placed on tubercles, so that the integument of the *Psolus* approaches in its character to that of the true Starfishes. Along the back are two deep longitudinal furrows, which indicate the two rows of suckers wanting, or rather obsolete. The hinder part is somewhat conical, and more turned up at the vent than the anterior, which is rather obtuse and bears the large head. This head or neck is about an inch in length, and covered with a soft skin, of a more or less reddish colour, with orange or scarlet spots, and a few conical white papillæ, which Dr. Johnston states are arranged in five imperfect rows. At its extremity are five large triangular, shelly, pedunculated tentacula of a bright orange colour, with darker spots. These tentacula are

ten in number. The vent is surrounded by a circle of suckers.

Dr. Johnston remarks on the skin, "The coat is divisible into two parts, viz. an exterior scaly true skin of a sub-calcareous texture, and an inner muscular layer formed of ligamentous fibres arranged in close parallelism, and transverse or circular in their direction, so that when in action their effect must be a compression of the body, by which it will be elongated and rendered slenderer. The protrusile part of the mouth is entirely formed by a continuation of this ligamentous coat, which likewise, in a more delicate modification, forms the arborescent tentacula."

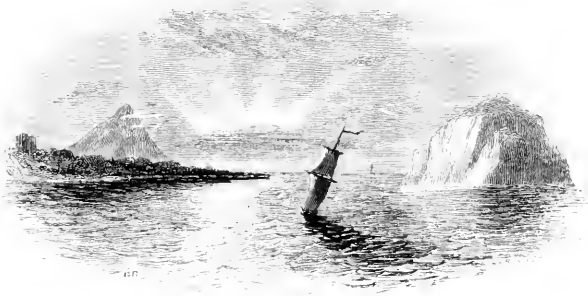
When dissected, we find the generative tubes very long and numerous, a very large œsophageal sac, and a respiratory tree moderately branched. The muscles of this animal are remarkably powerful.

The *Psolus* adheres to substances with great firmness by means of its ventral disk, much stronger than any of the other *Holothuriada*, as might be expected from the concentration of its locomotive organism. So powerfully does it adhere, that I have known the head of the animal carried away by the dredge when it brought up entire every other fixed animal which it came in contact with.

Pennant first recorded the species as British. He says it was taken off Scarborough. Dr. Fleming states it is occasionally found, from Devon to Zetland. Dr. Johnston found it on the coast of Berwickshire. Mr. Goodsir has twice procured it on the coast of Fife in deep water. I have taken it in ten fathoms water in the Gair Loch, opposite Helensburgh, on the Clyde. Mr. W. Thompson has recorded it as obtained by him in 1835 at Bangor, county of Down.

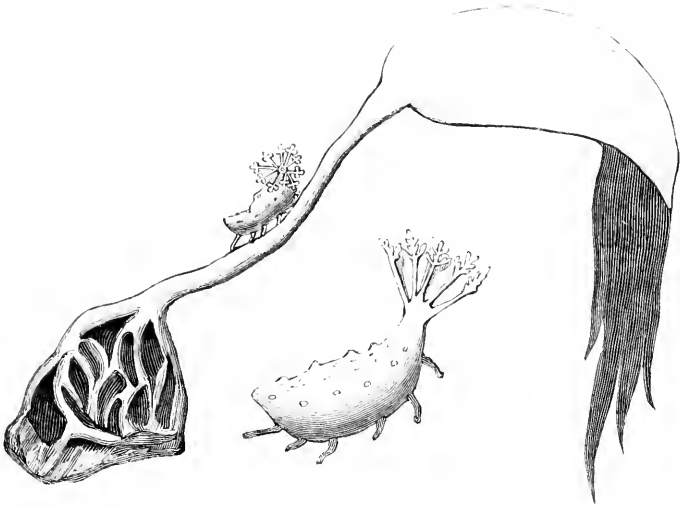
It was first discovered on the coast of Norway by Muller. The genus ranges to the Indian seas. The *Psolus tenama* of Jaeger and Lesson should form the type of another genus, distinguished by its twenty tentacula. The genus *Cucieria* of Peron should be united with *Psolus*. The family of *Psolidæ* is a very natural group.

The vignette represents the entrance to the Frith of Forth, with the Bass Rock and North Berwick Law.



HOLOTHURIADÆ.

PENTACTEÆ.

Genus *Psolinus*. Forbes.

Generic Character.—Body irregular, ovate, arcuated, with five rows of distant suckers, those below always bent; tentacula ten; dental apparatus short, truncate; no gizzard.

THE SHORT PSOLINUS.

Psolinus brevis. Forbes and Goodsir.

Specific Character.—Body obtuse posteriorly, pinkish white, with minute papillæ; tentacula long, pedicled, digitate at the extremity.

Holothuria brevis, FORBES and GOODSIR, Athenæum, No. 618.

THE genus *Psolinus*, which I have thought it right to constitute for the reception of the singular little Holothuria which was discovered by Mr. Goodsir and myself in the Shetland seas, adhering to the stems of Laminae, and which I afterwards found in a similar situation in the Kyles of

Bute, links the family of Psolidæ with that of Pentactæ; but, wanting a ventral disk, appertains rather to the latter group than to the former. The *Psolinus brevis* is about half an inch in length, of an ovate form, with both its extremities bent upwards. The body is of a pinkish white colour, and covered with delicate skin, minutely papillated. There are five rows of suckers, which range single, six or seven in a row, distant from each other; those of the convex or undermost side are very long and always bent, the bending seeming to depend on some peculiarity of organisation, and not on the will of the animal. The posterior part of the body is very obtuse, but the anterior tapers to a narrow neck. The tentacula are very long, white, and digitated at their extremities.

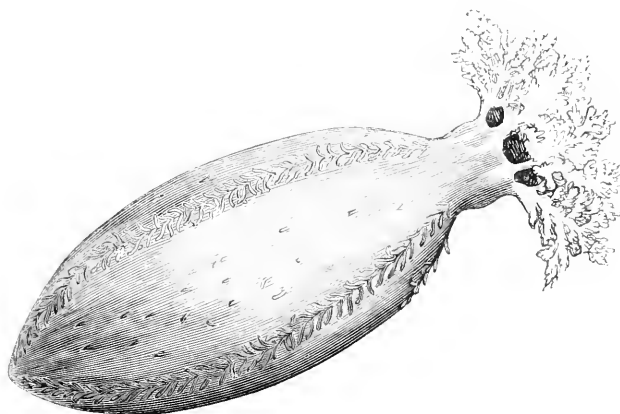
Internally we find a well developed intestinal tube, but no gizzard; moderately developed respiratory trees, few genital tubes, and one œsophageal sac. The teeth are short and truncate.

In its habits it appears sluggish as regards progressive motion, but moves about its tentacula freely.



HOLOTHURIDÆ.

PENTACTÆ.

Genus *Cucumaria*. Blainville.

Generic Character.—Body regular, more or less pentangular, with five longitudinal rows of approximate suckers; tentacula ten; dental apparatus composed of nearly square plates (no gizzard).

GREAT SEA-CUCUMBER.

Cucumaria frondosa. Gunner.

Specific character.—Body ovate, nearly smooth, dark purple brown on one side, purplish white on the other; suckers alternate, two-ranged, in five rows; tentacula pedunculate, frondose.

Holothuria frondosa, GUNNER, Act. Stock. 1767, pl. iv. f. 1, 2. FABRIC, Fauna Groenl. p. 353. MULLER, Zool. Dan. Prod. No. 2602. Encyc. Méth. pl. lxxxv. figs. 7, 8. LAMARCK, 1 Edit. III. p. 73; 2 Edit. III. p. 439.

Holothuria pentacta, ABILGAARD, Zool. Dan. 108, 1, 2, and 124.

Holothuria grandis, FORBES and GOODSIR, Athenæum, No. 613.

Pentacta frondosa, JAEGER, de Hol. p. 12.

THE SEA-CUCUMBERS are the most typical of the Holothuriadæ, and their popular name is very expressive of their

usual form. They have all the power of changing their shapes in the strangest manner, sometimes elongating themselves like worms, sometimes contracting the middle of their bodies, so as to give themselves an hour-glass shape, sometimes blowing themselves up with water so as to be perfectly globular. Many of the species are apathetic in character, but others are exceedingly active, drawing in and sending out their tentacula with great vivacity. They are by no means elegant animals, being rather disagreeable in aspect; though when their tentacula are expanded they cannot fail but excite some degree of admiration even in the most careless observer. Their habits are not well known, in consequence of their rarity and the difficulties attending the observation of them. They usually live among sea-weeds, or in mud, and are supposed to seize their prey by means of their large tentacula. The genus ranges over the greater part of the seas of the globe, and there are many species which have, however, from want of appreciation of essential characters by their describers, been very dubiously characterised.

The Great Sea-Cucumber is the largest of all the known European species, and probably one of the largest *Cucumariæ* in the world, measuring when at rest fully one foot, and capable of extending itself to the length of three. He is the king of the Sea-Cucumbers, and seems to have gathered the greater number of his subjects around him in the Shetland seas, where his majesty was first recognised as a native of Britain by Mr. Goodsir and myself in June 1839. When he first came up in the hooks of the dreg, an instrument used by the Shetlanders as a means of procuring horse-mussels, *Modiola vulgaris*, called by them Yoags, for bait, he astonished us with his monstrous appearance. The Shetlanders designate him by the some-

what undignified name of Sea-Pudding, a sobriquet not altogether inappropriate. He is arranged by them in an extensive though most unphilosophically constituted class of marine animals, to which they apply the term "Pushen," which being translated signifies poison. In this Thulean arrangement numbers of the rarest of British animals are unfortunately included,—I say, unfortunately, for all members of the class *Pushen* are unceremoniously and speedily thrust overboard almost as soon as seen in the fishing-boats, being considered unlucky and dangerous in their nature. The class is not an ultimate division. The Shetland fishermen arrange all marine animals not used as food under the general head of "Combustibles,"—certainly a most extraordinary application of that excellent English word. "Combustibles" they divide into Harmless Combustibles and Pushen, under which last division I fear all the animals which it has been my fortune to describe in this volume must take their places.

The body of this *Cucumaria* when at rest is of an ovate form, and somewhat pentagonal. It is nearly smooth, and is very dark purple on one side, and inclined to whitish on the other. Between the angles on the darker side there are a few scattered suckers. On the angles are five double and alternate ranges of suckers. The tentacula are large, ten in number, frondose and pyramidal. Their branches are beautifully pinnate, and of a dark brown colour with occasional whitish dots.

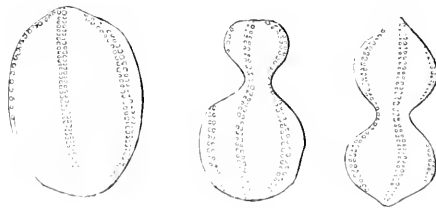
Internally we see a complicated intestine, and a stomach strengthened by granulated striæ, but no gizzard. The generative tubes are very long, and exceedingly numerous, more so than in any other British species. There are two œsophageal sacs. The so-called respiratory trees are highly developed, but there is no appearance of cilia on their sur-

face, either internal or external. Vibratile cilia are only seen on the mesentery, and there they are very minute. The inside of the skin presents the vesicles of the suckers, pyriform, and of a pink colour. The teeth are broadly triangular.

Unwieldy as this animal is, it seems active; one we kept alive in a vessel of sea-water was always in motion. It inhabits the Sound of Bressay opposite the town of Lerwick, in from seven to ten fathoms water, living among the mud close to the town in places where all the refuse of the sewers must collect. The fishermen assured us that they are found in great numbers off Fitful Head. Mr. Goodsir obtained one off the coast of Fife, which does not appear to differ from the Shetland specimens, and is equally large.

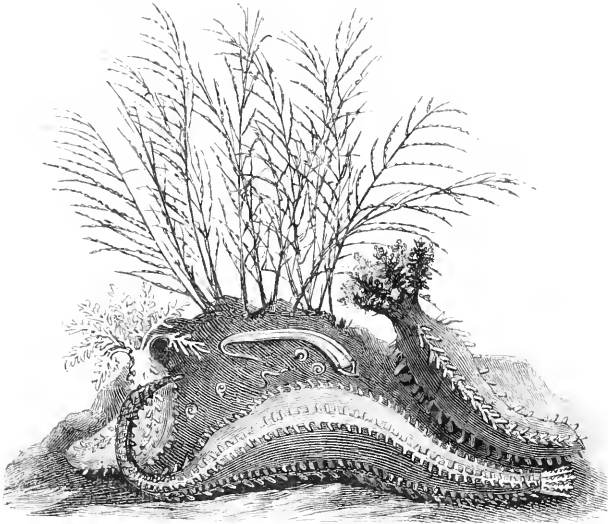
When we described this species at the meeting of the British Association at Birmingham, we called it *grandis*. There can be little doubt, however, that it is the animal called *Holothuria frondosa* by Gunner, and referred to by Fabricius and Muller, as attaining the length of a foot. The *pentacta* of Abilgaard is evidently identical. The name *grandis* has been applied by Braudt to another species from the Caroline Isles.

Some of the changes of form assumed by this species are represented below.



HOLOTHURIADÆ.

PENTACTÆ.



ANGULAR SEA-CUCUMBER.

Cucumaria pentactes. Muller.

Specific Character.—Body elongate, pentangular, rough with strong suckers at the angles; intermediate spaces smooth; suckers numerous, alternate; tentacula peduncled, plumose.

- Holothuria pentactes*, MULLER, Zool. Dan. Prod. 2306; Zool. Dan. t. xxxi. f. 3. PENNANT, Brit. Zool. IV. p. 51, No. 41, t. xxvi. f. 41. FLEMING, Brit. Anim. p. 482. LAMARCK, 1 Edit. III. p. 73; 2 Edit. III. p. 441.
- Hydra corallifera*, &c. GAERTNER, Phil. Trans. 1761, p. 75, t. i. b, fig. 3, A, B.
- Holothuria Gaertneri*, BLAINVILLE, Dict. Sc. Nat. t. xxi. p. 318; Man. d'Actin. p. 195.
- Pentacta pentactes*, JAEGER, de Holuth. p. 12.
- Var. Holothuria Montaguï*, FLEMING, Brit. Anim. p. 483. MONTAGU, Lin. Trans. IX. p. 112, t. vii. f. 4.

IN every difficult and partially investigated tribe or genus, there is some scapegoat species which serves as a general re-

pository for all animals which cannot easily be referred to any other more definitely characterised, no matter how unlike they may be to each other. By this means the local faunist and florist ease their consciences when puzzled, and the compilers of systems of nature, when synonyms crowd too thickly upon them. Among the *Holothuriadæ* the *Holothuria pentactes* has hitherto had the dubious notoriety of being scapegoat general and refuge for the destitute.

Unfortunately, in Muller's *Zoologia Danica*, three distinct species have been figured under the name of *pentactes*; one of these, however, is so evidently the *pentactes* of the *Prodromus Zoologiæ Danicæ*, the *Hydra corallifera* figured by Gaertner, and usually referred to as *pentactes*, though by Blainville made distinct under the name of *H. Gaertneri*, and the *pentactes* figured by Pennant; and, moreover, is the only one which agrees with the original character, "H. tentaculis denis; corpore quinquefariam verrucosa," (alluding to the strong wart-like suckers.) that I have no hesitation in confining the name to the species which I have here figured. The *Holothuria pentactes* of the *Faune Française* is also evidently the same animal, at least the body is, for the tentacula seem to have been drawn from the imagination of the painter, following out his view of the term "pinnate," which has been carelessly applied to them.

The *Cucumaria pentactes* is of a long cylindrical form, very angular, having double rows of strong warty suckers placed alternately on the five angles. The skin is very coriaceous and quite smooth. The tentacula ten, large, more or less plumose or dendriform and pedunculate. It measures from two to four inches in length. Internally we find largely developed respiratory trees, moderately numerous genital tubes, two œsophageal sacs, the one large

and globose, the other small, and small broadly triangular plates composing the dental apparatus.

It is extremely variable in colour; generally of a deep purple, sometimes altogether white, sometimes purplish white. The tentacula and head of both varieties vary equally, either purple or white. It varies also in the pinnation of the tentacula, and in their relative size and number. The *Holothuria Montagu* of Dr. Fleming, founded on a white variety described by Montagu, has eight full sized tentacula and two small ones, which are alternately in motion, covering the mouth. The tentacula of this form are not so pinnate as in the common or purple state. The *Holothuria Dicquemarii* of Cuvier seems to be a quadrangular variety with similar tentacula. It varies also with six angles. It can change its form at pleasure, and sometimes contracts itself so as to become exceedingly hard. Gaertner well remarks that "in its contracted state it has more of the appearance of a caterpillar than of a polype."

That author, who first observed it on the coast of Britain, gives the following characteristic description of its suckers and tentacula:—"The surface of its cylindrical body is marked with six double rows of perforated knots, which the animal can transform into as many legs if occasion requires, by extending each tuberculum into a small transparent cylinder, whose extremity, like that of the suckers of the Starfish, sticks fast to everything which the animal gets hold of, and consequently serves as an instrument, not only to fix its body with, but also to push it forward by the help of many of these suckers that are formed of the several knots of different rows. The feelers are eight or ten in number, and of the same substance and colour with the head; they are divided into several branches, to which as well as to the principal stems many

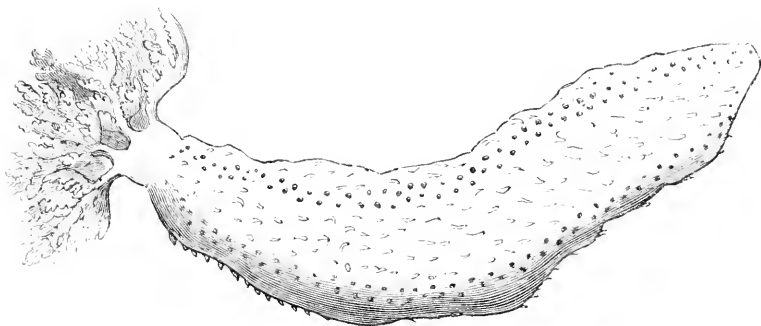
clusters of very minute papillæ adhere, which make them exactly resemble small branches of trees covered with their leaves. These leaves or papillæ not only contribute to the beauty of the feelers, being of a pale yellow, mixed with a shining white, like silver, but they also render the feelers more useful to the animal in filling up the interstices between them, through which smaller insects else must pass without being perceived by the animal whose natural food they are." "This polype seems to live at the bottom of the sea, distant from the land. I met with it but once upon the shore between Penzance and Newland, where it was thrown up by the sea inclosed in a large hollow root of the *Fucus palmatus*."

Gaertner's inference about its habitat is not correct. The circumstances under which he found it would indicate its locality to be the region of Laminariæ. Pennant dredged it at Weymouth, and Montagu on the coast of Devonshire. I have dredged many of all varieties in the Frith of Clyde. In the Gair Loch it is abundant in about ten fathoms water.

Abroad it inhabits the coasts of France and of Norway.

HOLOTHURIADÆ.

PENTACTÆ.



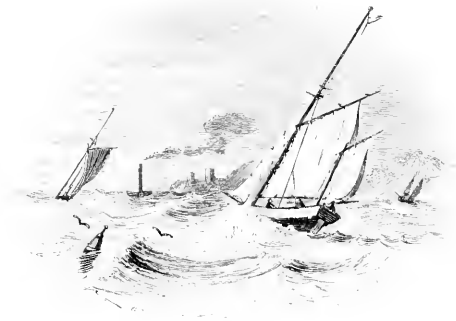
COMMON SEA-CUCUMBER.

Cucumaria communis. Forbes and Goodsir.

Specific Character.—Body elongate, pentangular, with numerous alternate suckers at the angles; skin papillose; tentacula pedunculate, plumose.

It is very probable that this animal, which appears to be common on some parts of our coast, is the species usually referred to as *Holothuria pentactes*. It has, however, no immediate relation with that species. It attains the size of from four to eight inches, and is of a cucumber shape. Its tentacula are ten in number, pinnate, and plumose, stalked, and rather large. They are of a deep red colour. The body is five-sided, with numerous suckers on the angles, but none on the sides, which are papillose. The Scottish specimens I have seen are of a yellow colour, the Irish purplish, but otherwise they do not differ. On dissection, we find a moderately branched respiratory tree, and very numerous genital tubes. The muscular system is highly developed. The inside of the gullet is of a deep brown colour.

Great numbers of this species have been thrown ashore after storms on the east coast of Fifeshire, where they were observed by Mr. Goodsir. They probably inhabit the region of *Laminariæ* not far from land. On the Irish coast it has been dredged in the north by Mr. W. Thompson, and at Youghal by Mr. Ball. From the remarks of the fishermen on the coast of Scotland, it would seem to be by much the most common of its genus. It is frequently found in the stomach of the Cod.



HOLOTHURIADÆ.

PENTACTÆ.



LONG SEA-CUCUMBER.

Cucumaria fusiformis. Forbes and Goodsir.

Specific Character.—Body much elongated, cylindrical, white, rough with papillæ; suckers numerous, alternate, in five regular rows; tentacula ten, short, triangularly pinnate.

Holothuria fusiformis, FORBES and GOODSIR, Athenæum, No. 618.

THIS is the longest, in proportion to its thickness, of all the British Sea-Cucumbers. It is a small species, measuring about an inch in length. It is rounded, and tapers slightly towards each extremity. The pinkish-white skin is covered with plumose papillæ, and the five rows of suckers are not prominent. The suckers are doubly ranged, and alternate in each row, generally above thirty. The tentacula are ten, short, somewhat triangular, white, and pinnated to their bases. It is a sluggish animal, and not fond of changing form. We dredged several specimens in the Shetland seas during the summer of 1839.

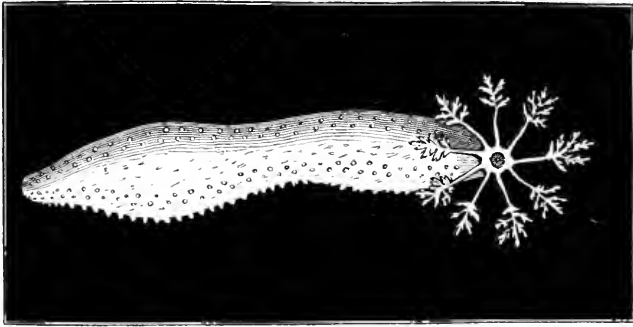
The specimens examined, when dissected, presented the respiratory trees rather simpler than in its allies, the intestinal canal well developed, and the teeth rather small; but we found no traces of genital tubes or of an œsophageal sac. The examples were probably young specimens; but there can be no question of the distinctness of the

species from any other British kind of Cucumaria. It is allied to the *Holothuria fusus* of Muller, and is one of those forms which connect the true *Cucumaria* with the singular worm-like *Synapta*, many of which at first sight rather resemble *Annelides* than *Holothuria*. None of these curious creatures have as yet been discovered in the British seas; indeed they seem mostly to be congregated in the Indian Sea, and among the islands of the Pacific. They are often beautifully coloured, and attain a great size, even three feet and more in length. The *Holothuria digitata* of Montagu, a species of Chirodota probably, appears to be allied to them.

Mr. F. D. Bennett describes one of these worm-like *Holothuria* as having its cylindrical body usually distended with muddy water; its skin rough with minute spines, and of a clouded olive colour, and its mouth surrounded by tentacula, and furnished with bony plates. He says it lies passive upon the coral shoals close to the land, its body placed in a waved form and often attached by its posterior extremity to a rock. The disappearance of the feet, small hooked prickles supplying their places, indicates the progression through *Synapta* of the Holothuriadæ to the *Sipunculidæ*.

HOLOTHIURIDÆ.

PENTACTÆ.



GLASSY SEA-CUCUMBER.

Cucumaria hyalina. Forbes.

Specific Character.— Body elongate, translucent, bluish-white; suckers numerous, alternate, in five rows; intermediate spaces papillose; tentacula pedunculate, plumose, white.

Holothuria pellucida, FLEMING, Brit. Anim. p. 483. FORBES and GOODSIR, Athenæum, No. 618.

THE GLASSY SEA-CUCUMBER is a most beautiful and delicate animal, being almost transparent and of an opaline hue. It was discovered by Dr. Fleming in the Shetland seas, and was re-found by Mr. Goodsir and myself when dredging near Lerwick in 1839. In both cases it was referred to the *Holothuria pellucida* of Muller, which is doubtless a nearly allied species, but differs from our animal in being quite smooth. The smoothness and fleeciness of the surface of the Sea-Cucumbers is of great importance as a source of specific character in the genus, being very constant. When at rest, the *Glassy* Sea-Cucumber is of a fusiform shape, and attenuated at each extremity. The tentacula

are large, pedunculate, and pinnate at their extremities. The suckers are placed in two close rows in each avenue. The specimen taken by us was two inches and a half in length. Dr. Fleming says it attains the length of six inches.

On opening our specimen we found one œsophageal sac, a complicated intestine, a moderately developed respiratory tree, and rather small teeth. The generative tubes were wanting. It is probable these tubes are not developed in the *Holothuriadæ* until the animal has attained a certain age, as we almost always found them wanting in such specimens as appeared to be young. The one before us being only half grown (supposing the size noted by Dr. Fleming to be the animal's full dimensions) bears out the observation.



HOLOTHURIADÆ.

PENTACTE.



DRUMMOND'S SEA-CUCUMBER.

Cucumaria Drummondii. Thompson.

Specific Character.—Olivaceous and white, with light brown suckers; tentacula long, pedicled, trifid, plumose, purple.

Holothuria Drummondii, THOMPSON, An. Nat. Hist. vol. V. p. 100. (April 1840.)

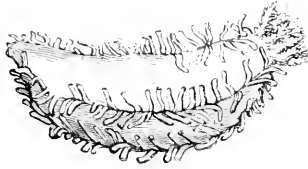
DR. DRUMMOND, one of the excellent naturalists whose domicile in Belfast, and author of several interesting works and important papers on various departments of natural history, drew up the following description of this species, which Mr. Thompson has dedicated to its discoverer, from the living animal found by him in Belfast Bay :—“ Bangor, June 27, 1839. Holothuria dredged yesterday, of an

olivaceous and white colour ; at first the shape of a lemon, and nearly as large as a middle-sized one ; to-day two inches long, contracting itself slowly in many places, but has not yet shown its tentacula. It has five broad longitudinal bands of tubercle-like suckers running from end to end ; these have four in each transverse row ; suckers light brown ; down the middle of each of the five series a whitish band extends to the spaces between the belts of suckers of a bluish-white, with numerous narrow transverse whitish lines of various breadth." When preserved in spirits, in which state I examined and delineated it, the body appeared white, with a tinge of pink, angular and corrugated ; the corrugations were smooth, and the suckers very numerous on the angles. There were from six to twelve suckers in each transverse irregular row, and a few scattered in the furrows between the corrugations. The tentacula were long and pedicled, trifid towards their extremities, and pinnate, their colour being deep purple.

Mr. Goodsir dissected the species, and found the dental apparatus to be very large, strong, and of a deep purple. The teeth consisted of twenty triangular pieces, attached back to back in pairs, with processes running forward to the mouth. The retractile muscles of this machinery were ovate, and attached to the anterior part of the body. To the circular canal surrounding the œsophagus there were attached, by narrow necks, three elongated, ventricose, pointed, transparent vesicles, perfectly free in all directions. The intestinal canal exactly resembled that figured in Hunter's drawing. The respiratory apparatus was very highly developed, more so than in the drawing alluded to, extending, when stretched out, four inches. This tree had no vesicles or cœca attached to its trunk.

HOLOTHURIADÆ.

PENTACTÆ.



HYNDMAN'S SEA-CUCUMBER.

Cucumaria Hyndmanni. Thompson.

Specific Character.—White, five-angled; skin smooth; a double close row of large (non-retractile?) suckers on each angle; tentacula ten, sessile, white, plumose.

Holothuria Hyndmanni, THOMPSON, An. Nat. Hist. vol. V. p. 100. (April 1840.)

This very pretty species, two inches in length, was dredged in Belfast Bay, by Mr. Hyndman of Belfast, whose natural history researches well entitle him to the compliment paid by Mr. Thompson in associating this *Holothuria* with his name. Besides the characters mentioned in the specific diagnosis, Mr. Goodsir found it to present, when dissected, the following anatomical appearances.

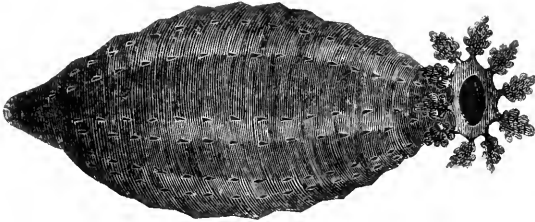
The dental apparatus consists of ten plates, which are composed of twenty white chalky triangular pieces arranged in pairs. The retractile muscles of this apparatus are short, ovate, and attached posteriorly a little behind the mouth. The canal surrounding the attachment of the œsophagus bulges out between each of the ten plates. To this circle or canal there is attached a sac of a cylin-

drical shape, slightly bulging at the extremity. The intestinal canal is of moderate length, and its coats are very tender. The branchial tree is not very complex, and has no sacs attached to its trunk. The generative tubes are comparatively few, not exceeding fifty, and are short and white. The skin is coriaceous, and the muscular tunic thin.

When dredging on the west coast of Ireland with Mr. W. Thompson, Mr. Ball, and Mr. Hyndman, in the summer of 1840, we took a great number of this handsome species, many as large as four inches, and all presenting the external characters described above. It appears to be rather an apathetic species, and to have scarcely any power of retracting its suckers; but this may have been owing to a circumstance which is of no small interest to both zoologist and geologist. The Lough of Killery, in which we found it, is a narrow and long inlet of the sea. Towards the upper part of it, whilst the under-water is salt and full of truly marine animals, the surface-water is so fresh that our boatmen were used to drink it. The consequence was that in drawing the dredge through the layer of fresh water the contained animals were paralysed, and many observations which we had planned to make upon them were thus unexpectedly defeated.

HOLOTHURIADÆ.

PENTACTÆ.



TANGLE SEA-CUCUMBER.

Cucumaria fucicola. Forbes and Goodsir.

Specific Character.—Body ovate, rounded, purple, smooth; tentacula deep brown, ovate, pinnate, shortly pedunculate; suckers numerous in each avenue, alternate.

Holothuria fucicola, FORBES and GOODSIR, Athenæum, No. 618.

This species is not uncommon in Bressay Sound, Shetland, where it is found in seven fathoms water, adhering to the stems of *Laminariæ*. It is about three inches in length when full grown, and is very smooth. When at rest with its tentacula, which are short, and somewhat clavate or sub-globose in form, exerted, it generally assumes an ovate form. It is a sluggish species, and adheres strongly by means of its suckers, which are closely arranged in five equidistant rows. Its internal structure presents no peculiarities. There is but one œsophageal sac; the respiratory trees are moderately developed, and the generative tubes rather numerous. The teeth are somewhat triangular at their apices.

To this genus also belongs the following species of Dr. Fleming (if, indeed, it be more than a variety of *Cucumaria pentactes*).

“*H. dissimilis*. (Fleming, Brit. An. p. 483.)

“Body pentangular, tapering to both extremities; suckers hard, conical; tentacula of two kinds; those which are plumose are shorter than the five simple ones which are opposed to them.

“A single specimen of this probably new species, about two inches in length, was found by Dr. Coldstream on Leith shore.”

In the same valuable work is the following notice of a species which seems to be distinct, but is very ambiguously characterised.

“*H. Neillii*. Tentacula ten, with ten subsidiary ones surrounding the margin of the mouth.—Frith of Forth, Mr. (now Dr.) Neill.

“This species, in form and colouring, bears a near resemblance to the preceding (*Holo. Montagni*), but it differs in the exterior tentacula being more subdivided, and in the number of the anterior ones. These last are similar in form to the outer ones, though only one-fourth of their size. This species was brought to Mr. Neill by a Newhaven fisherman, 3d September 1818. Being in company with this intelligent observer of nature at the time, he kindly presented it to me, and remarked that it was different from the two species which Professor Jameson, on his authority, had recorded (*Wern. Mem. I. p. 558*) as natives of the Frith of Forth, circumstances which indicated the propriety of its specific appellation. I have since received a specimen from Cape Wrath through the kindness of my friend Dr. Coldstream.”

HOLOTHURIDÆ.

PENTACTE.

Genus *Ocnus*. Forbes and Goodsir.

Generic Character.—Body regular, cylindrical, pentagonal, with five rows of distant suckers on the angles; tentacula ten; dental apparatus very short (a gizzard).

BROWN SEA-GIRKIN.

Ocnus brunneus. Forbes.

Specific Character.—Colour brown; tentacula long, pedicled, pinnate.

Holothuria brunnea, FORBES, MS. THOMPSON, Annals of Natural History, No. 29. April 1840.

THE animals to which we have applied the name of Sea-Girkins, differ from the *Cucumariæ*, externally, in the very few suckers which crown their angles, and, internally, in having a strong muscular gizzard. In their motions they differ also very considerably, not constricting themselves, and blowing themselves up as the Sea-Cucumbers do, but elongating themselves like worms, to which animals they approximate in their movements. Their suckers are exceedingly strong, and always exerted, few in number, and appearing as if ranged in a single line. Two species, both of which seem to have escaped the observations of British naturalists till lately, are found in our

seas. The first, that before us, appears to be among the most abundant and extensively distributed of all the British *Holothuriadae*. The *Oeni* are sluggish creatures.

The Brown Sea-Girkin is about three-fourths of an inch in length, and sometimes longer. It is regularly pentangular, obtuse posteriorly, and truncate anteriorly. There are about nine large suckers on each of the angles. The tentacula are very long, and digitate or simply pinnate towards their extremities. They are white, as also the suckers; but the body is pinkish-brown, with darker specks, and quite smooth. It lives on shell-banks at various depths, both on the east and west coasts. At the mouth of the Frith it frequently comes up on the haddock-fishers' lines. In the Frith of Clyde it is common. It also occurs on the shores of the Isle of Man. Mr. W. Thompson states that it is the most common species taken by dredging in the loughs of Strangford and Belfast.

The vignette represents a Runic or Buddhist cross near Ramsey Bay, Isle of Man.



HOLOTHURIADÆ.

PENTACTE.



MILK-WHITE SEA-GIRKIN.

Ocnus lacteus. Forbes and Goodsir.*Specific Character.*—Colour milk-white; tentacula short, triangular, pinnate.*Holothuria lactea*, FORBES and GOODSIR, Athenæum, No. 613.

A SECOND species of Sea-Girkin was found by Mr. Goodsir and myself in the Sound of Bressay, Shetland, at the same time with the various Sea-Cucumbers which we have described from that quarter. The one before us is a very pretty species. It is small, the largest examples being not more than three-fourths of an inch in length. The body is of nearly the same thickness throughout, cylindrical, and five-angled. On each angle there is a row of prominent non-retractile suckers. The rows appear single in consequence of the distances between the alternating suckers, which are from seven to nine in each. The posterior and anterior extremities seem as if truncated; the latter bears the tentacula, ten in number, short, pyramidal, and pinnate. The entire animal is of a white colour.

Mr. Goodsir and I opened all our specimens of this animal, save two, without finding any traces of respiratory organs, and but few of genital. In two specimens, how-

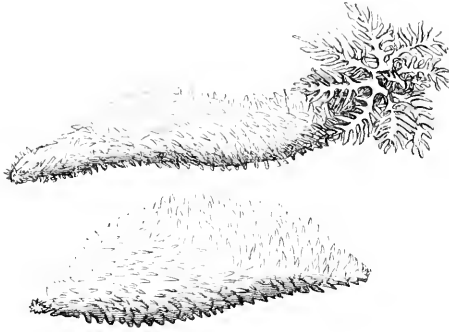
ever, the former were seen in the usual position and of the usual form, but not so much branched as the respiratory trees in other Sea-Cucumbers. There was but one sac attached to the œsophagus. The teeth or dental plates were short, and formed as in the last described. The intestine enlarged into a gizzard-like globose stomach just below the mouth, and was not so complicated in its rolled-up length and numerous twists, as in the *Cucumaria*. The interior of the muscular coat was much smoother, and the muscles apparently weaker.

The specimens alluded to above were dredged adhering to muscles. Mr. Goodsir has since found many of them, brought up on fishermen's lines off the Fife coast and in the German Ocean. It has been added to the Fauna of Ireland, by my friend Mr. W. Thompson of Belfast, who obtained it on the north-east coast.

Sir John G. Dalyell, who has also found this species, observes regarding it and other Holothuriadæ that when in confinement the tentacula are usually expanded towards night. "When evening comes," he says, "a tuft protruding from the larger extremity unfolds into a capacious funnel, composed of eight, or ten, or twenty beautiful branches implanted on a shelly cylinder, in the centre of which is the mouth. Each branch now begins to sweep the water in succession, and descends almost to the root within the mouth in a contracted state, whence it arises to enlarge anew. These evolutions are protracted until the latest hour; but as morning dawns the whole apparatus is withdrawn, the skin becomes close and compact as before, and a fountain begins to play from the opposite extremity." (See Athenæum, No. 675.)

HOLOTHURIDÆ.

THYONES.

Genus *Thyone*. Oken.

Generic Character.—Body nearly regular, covered with scattered papillose suckers; tentacula ten; teeth of the dental apparatus long and filiform.

COMMON THYONE.

Thyone papillosa. Muller.

Specific Character.—Body elongate-ovate, brownish white; tentacula much pinnate.

Holothuria papillosa, MULLER, Zool. Dan. tab. cviii. fig. 3. JAEGER, de Holuth. Encyc. Méth. pl. lxxxvi. figs. 5, 6. BLAINVILLE, Man. d'Actin. p. 193, pl. xiii. fig. 2.

Mulleria papillosa, JOHNSTON, Mag. Nat. Hist. vol. VII. p. 584, fig. 66.

Thyone papillosa, OKEN. AGASSIZ, Prod.

THE genus *Thyone* was constituted by the distinguished German naturalist and philosopher, Oken, for the reception of such *Holothuria* as have the suckers dispersed over the whole surface of the body, as in the species before us. But though the suckers are so scattered, the pentagonal form and radiated appearance of the animal is not so much lost as in *Psolus*; indeed, in many specimens certain of

the suckers may be seen arranged regularly as in *Cucumaria*, while in the latter genus we occasionally find examples of a similar variation in the way of suckers, scattered here and there between the avenues, thus indicating an approach to *Thyone*. Some time after Oken had so named these animals, Dr. Fleming, unaware of the circumstance, and equally perceiving the necessity of their generic separation (which was indeed suggested by Cuvier), constituted the genus under the name of *Mulleria*, which name has been since applied by Jaeger to another section of the tribe.

The species before us was first observed by Muller, who obtained it from the Faröe Islands. As a native of Britain it was first noted by Dr. Johnston, who published an excellent description and figure of this species in the seventh volume of the Magazine of Natural History. He found it in Berwick Bay; it is, however, by no means an uncommon species on our shores. A few winters past great numbers were thrown ashore after a violent storm at Anstruther in Fifeshire, where they were observed by my friend Mr. Goodsir. I dredged up a small one on the Scallop-banks off the Isle of Man in 1838; and it has been taken on the Irish coast by Mr. W. Thompson, in Belfast Bay and Strangford Loch. In Ireland it also occurs on the west coast in Killery, and Mr. W. McCalla pointed it out at Roundstone, Cunnemara, living in great numbers buried in gravelly sand at low water, which circumstance accounts for the quantity of gravel usually adhering to it.

The Common Thyone measures from one to nearly three inches, and is of a brownish-white colour, more or less dusky, and of an ovate or pear-shape when at rest, though it can lengthen itself considerably. When the tentacula

are withdrawn it usually appears more bulging on one side than on the other. The skin is rather tough, and covered all over with non-retractile suckers, which give it a papillose appearance. The tentacula are ten in number, large, and not always equal; sometimes two of them are much smaller than the rest, and when such is the case it is in the habit of moving these two alternately towards the mouth, while the others are at rest. Many *Holothuriadae* exhibit this custom. The tentacula are large, generally whitish, and broadly pinnate. In Dr. Johnston's specimens they were brown, with darker dots. The hinder part of the body tapers, and the vent is stellate.

On opening a number of specimens, many of them were empty, the animal having ejected its intestines. A perfect one presented a well-developed intestine, moderately branched respiratory trees, one œsophageal sac, and numerous generative tubes full of eggs, being then yellow and



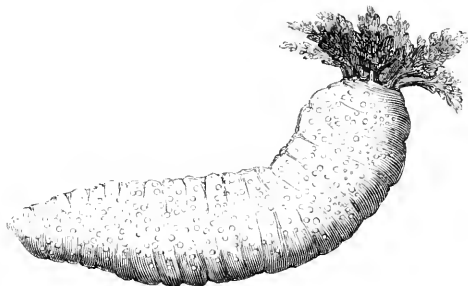
much dilated, the eggs of a yellow colour, and not arranged in any peculiar manner. This specimen was taken in January; but as several others taken at the same time presented no appearance of eggs, no inference can be drawn as to the animal's breeding season. The teeth were singular and very peculiar, being much elongated and filiform, and separated from each other by rows of pentagonal plates. There was but one œsophageal sac. Dr. Johnston's had five. One specimen dissected had ejected all its internal organs, saving the generative tubes; and in another there were no traces even of them.

Dr. Johnston gives the following interesting account of its habits in confinement in the paper alluded to:—"The surfaces of the body," he says, "were at first partially

covered with fragments of shells and corallines, which were evidently retained by the suctorial property of the papillæ, and the animal, on being kept a day in sea-water, threw them off. It had a slow progressive motion; slower than the shadow of the dial, which was effected by elongating the papillæ of one part, fixing them to the plate, and then drawing itself forward by again contracting those elongated parts; but the papillæ were oftener used for the purpose of anchors than of feet, the creature being of an indolent and immoveable character. When stationary, it was ever slowly changing its outward form; it was now shortened and swollen in the centre; then it would relax itself and become cylindrical; again one part would be blown out, and another drawn in with a deep stricture, as if a thread had been tied round; or again the contraction would begin near the head, which is then made very narrow, and would spread backward, the anterior portion recovering its original diameter as the wave of constriction passed away; and sometimes the constriction will spread in the opposite direction. It often raised the posterior extremity a little from the surface of the plate, and to one side; but I never saw any current flow from the aperture. To effect these varied motions, we must suppose the existence of muscular bands or fibres on the coriaceous skin, both in a longitudinal and circular direction; and on opening the body we find such to be the case: five strong, white, raised bands run from one end to the other, radiating from the circular apertures, and numerous fibres pass between them transversely, among which minute pores open everywhere, which are the inner orifices of the cuticular papillæ." Dr. Johnston adds the following account of the voluntary ejection of its viscera:—"The worm having been kept in sea-water, unchanged for two or three days, sickened, and,

by the more frequent involutions and evolutions of its oral end, evinced its uneasiness. Being left unobserved in this state for an hour or so, I found on my return that it had vomited up its tentacula, its oral apparatus, its intestinal tube entire, and a large cluster of ovaries which lay about the plate. The muscular convulsion must have been very great that thus so completely embowelled the creature; and yet life was not extinct, for the tentacula contracted themselves on being touched, and the empty skin appeared by its motions to have lost little of its irritability."

Dr. Johnston conjectures the water is conducted into the body through the tubes, and then floating round the respiratory filaments is ultimately forced through the canal that leads to the anus. In all of the species I have examined, I do not think this possible, the feet resembling in their structure internally and externally those of the Starfish and Sea-Urchin. In some works it is stated that the Echinodermata fill their bodies with water by swallowing it, but the statement is based on no foundation. On cutting open a distended *Cucumaria frondosa*, Mr. Goodsir and I found the water entirely lodged between the sides and the external coats of the intestinal canal. How it enters is a problem yet to be solved.



PORTLOCK'S THYONE.

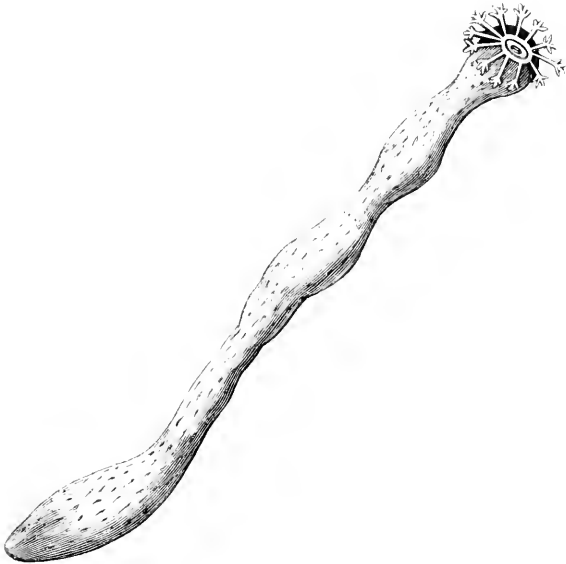
Thyone Portlockii. Forbes.

Specific Character.—Body cylindrical, corrugated, white; suckers numerous, large; tentacula frondose, purple.

THE *Thyone Portlockii* is a large species, measuring five inches in length, and connects by its form and general aspect the genus *Thyone* with *Cucumaria*. The body is white, and is covered with a strong smooth coriaceous integument, over which the strong white suckers are somewhat irregularly scattered. On the five angles they are most numerous and rudely arranged in rows. The tentacula are ten in number, large, frondose, and purple. The internal structure of the animal presents a large and strong dental apparatus, numerous genital and respiratory tubes, and one pyriform sac. This handsome species was kindly communicated to me by Captain Portlock, to whom I have dedicated it, and by whom it was discovered in Belfast Bay, in the course of the Ordnance investigations in the North of Ireland.

HOLOTHURIADÆ.

SYNAPTÆ.

Genus *Chirodota*. Eschscholtz.

Generic Character.—Body cylindrical, vermiform, without suckers; tentacula elongate, digitate at their extremities.

MONTAGU'S CHIRODOTA.

Chirodota digitata. Montagu.

Specific Character.—Body vermiform, white, with orange spots; tentacula long, peduncled, digitate.

Holothuria digitata, MONTAGU, Lin. Tr. vol. xi. p. 22, t. iv. fig. 6. BLAINVILLE, Man. d'Actin. p. 194.

Fistularia digitata, LAMARCK, 1 Edit. III. p. 76; 2 Edit. III. p. 448.

Malleria digitata, FLEM. Brit. Anim. p. 484.

This remarkable animal was discovered by Montagu on the southern shores of Devonshire. Its discoverer

refers it to the *Holothuria inharens* of Muller, with a query ; but it is assuredly distinct from that animal, which is a *Cucumaria*, nearly allied to our *Cucumaria fusiformis*. As I have never seen living examples of the *Chirodota digitata*, I think it best to quote in full the description of it given by the eminent and accurate observer who first found it.

“ Body long, cylindric, covered with minute papillæ of a yellowish white colour, marked with small spots of red orange, closely disposed, and in many parts confluent ; posterior end tinged with green ; tentacula twelve, short, dividing at their tips into four obtuse branches of a pale colour ; length, when extended, between three and four inches.

“ This rare species is capable of great contraction, and probably multiplies by natural division, as it separates without violence into an indefinite number of pieces : this is effected by muscular stricture, which forms ligatures and separates portions into globular pieces ; sometimes two or three of these ligatures are formed together, and as many separations ensue, provided the exterior one first falls off ; otherwise the part separated appears to continue in that moniliform state. This, however, may be a forced action from confinement in a glass of sea-water, and one division at the extremity is the order Nature most likely pursues. It must, however, be admitted that our knowledge with respect to these inhabitants of the deep is extremely limited, since they can only be examined when taken from their natural abode ; the form of these creatures is nearly all we may expect to become acquainted with, for their œconomy is concealed from us by that insurmountable barrier which no philosopher can pass.

“The faculty which this animal possesses of separating into so many parts renders it almost impossible to preserve a perfect specimen entire.”

It is evident from the above description that this animal cannot be associated generically with any of the other British Holothuriadæ; it may be questioned whether it is not a member of the next order of Echinodermata, where indeed all the Synaptæ might be placed. So accurate an observer as Montagu would scarcely have passed over the suckers without mention had they been present. Its characters, as at present known, associate best with the genus *Chirodota*; and until more specimens be procured, and an anatomical examination instituted, it must be placed in that genus, seeing that as yet there are not grounds enough known for adopting it as a type of a separate genus.

Doubtless there yet remain many undiscovered species of Holothuriadæ in the British seas. Of Starfishes we must not expect to find many more kinds, though *Goniaster miliaris*, and some few others which have been seen on the Norwegian shores, may be looked for. Of Sea-Urchins there are probably still fewer unnoticed; but of the Sea-Cucumbers many. Their comparatively unattractive aspect, the difficulty of preserving them (they must always be kept in spirits), their habitat in the sea, and the little attention that has hitherto been paid to them by native zoologists, all lead me to believe that many species have been passed over. We have as yet no representative of the typical Holothuriæ which have twenty tentacula in the British Fauna. Several of these, such as the *Holothuria elegans*, and *Holothuria mollis*, inhabitants of the Scandinavian shores, will probably ere long prove to be natives of our own.

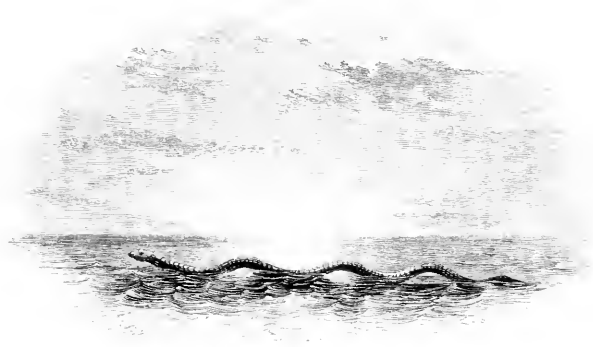
Much yet remains to be done towards a full investiga-

tion of the anatomy of the Sea-Cucumbers, more especially with a view to a comparison of the structure of the Molluscan with the Annelidous forms of Holothuriadæ. The elaborate dissections of Chiagi require to be repeated before we can put implicit confidence in their accuracy.

There is a point in the economy of these animals, and also of the Sea-Urchins, to which I would direct attention. In some specimens, not in all, nor in all the examples of any one species, we find red globules, variable as to number and large as to size, floating in the fluid of the aquiferous system.

The vignette is a view of St. Andrew's Castle and Bay, a rich gleaning ground to the naturalist.





SIPUNCULIDÆ.

OR VERMIGRADE ECHINODERMATA.

IN the animals of which we have now to treat, RADIISM sets and ANNULISM appears. In their external appearance they are worms, for the likeness they bear to the Holothuriæ depends on a correspondence with the vermiform, and not the radiated characters of those animals; but internally they afford evidence of belonging to the same great class. They are, in fact, Annelidous Radiata, the transition between the Radiated and Symmetrical types of form. They have no rows of suckers; their bodies are not divided into a quinary arrangement of lobes or segments; their mouths are either not surrounded by tentacula, or their tentacula are no longer regulated by a definite number. Their motions and habits are those of worms. Instead of having their skins strengthened by calcareous spines, such as have prickly appendages have corneous bristles, nearly resembling those seen in many

Annélides. These characters have induced many great naturalists to remove them altogether from the Radiata, and place them among the Annélides. Regarding, however, structural characters as the main tests of affinity, and form, adapted to locality, as characteristic of analogical relations, I cannot agree with their views, and accordingly include them in this work. At the same time, our knowledge of their structure and habits is confessedly small; and future discovery will probably throw new and at present unanticipated light on their position in the animal kingdom. The tide of research may wash up new forms, the want of which to guide us in our comparisons prevents our proposing the arrangements here given as more than provisional.

The British species may be grouped under three very distinct families:

The SIPUNCULACEÆ, having a retractile proboscis, at the base of which the vent is placed, and round the extremity of which is seen a circle of tentacula.

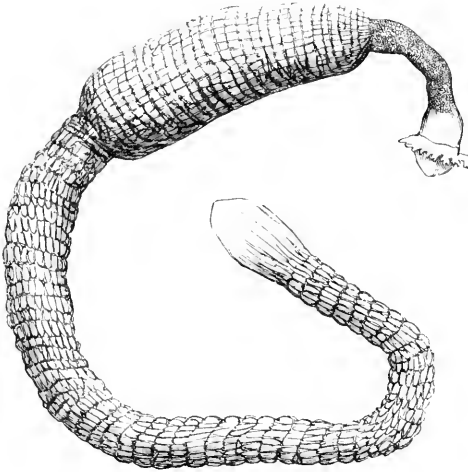
The PRIAPULACEÆ, which have also a retractile proboscis, but no tentacula, and which have the vent at the extremity of a long filiform caudal appendage.

The THALASSEMACEÆ, which have a proboscis, having a long fleshy appendage attached. They have no tentacula, and their vent is placed at the posterior extremity.

Generic characters in the first of these families depend on the form of the tentacula; in the last on the presence, absence, and arrangement of corneous bristles on certain parts of the body. Of the Priapulaceæ there is but one genus known. Specific characters throughout the tribes appear to depend on variations of the integument and on proportions of parts. Colour would appear to be of little or no value, except perhaps in the last family.

SIPUNCULIDÆ.

SIPUNCULA CEE

Genus *Syrinx*. Bohadsch.

Generic Character.—Trunk cylindrical, shorter than the body, having a circle of short digitate tentacula near its extremity.

ROUGH SYRINX.

Syrinx nudus. Linnæus.

Specific Character.—Body rugose, with deep reticulating striæ; posterior extremity ventricose, smooth, furrowed longitudinally; trunk granulated, except near the extremity.

Syrinx,

BOHADSCH, Anim. Mar. p. 93, t. vii. f. 6, 7.

Sipunculus nudus,

LINNÆUS, 12th Edit. p. 1078. GMELIN, p. 3094.

PENNANT, Brit. Zool. vol. IV. p. 36, t. xx. fig. 10.

FLEMING, Brit. An. p. 491. LAMARCK, 2 Edit.

vol. III. p. 469. GRAY, Spicel. Zool. p. 3.

Sipunculus balanophorus,

DELLA CHIAGI, Mem. t. i. pt. II. p. 22, pl. 1.

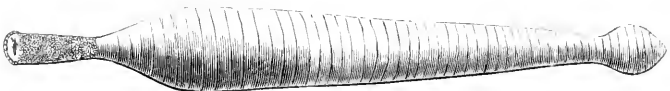
Syrinx tessellatus,

RAFINESQUE, Précis. p. 32.

THE ROUGH SYRINX, or Tube-worm, as Pennant styles it, attains the length of from six to eight inches. The

body is cylindrical, and covered with a strong coriaceous integument, which, being longitudinally furrowed, and deeply striated transversely, is very rugose, except at the posterior extremity, which is inflated, smooth, and longitudinally grooved to near its termination. The vent is situated at some distance from the origin of the proboscis, which is short, not more than one-tenth the length of the body. It is minutely granulated, saving near its extremity, which is surrounded by a rim of digitated tentacular filaments, webbed together at their bases. On opening the specimen I have figured (which was taken by Mr. Harvey at Teignmouth), I found a somewhat simple intestine filled with coarse sand. There were two genital tubes, each lobed into a second smaller one at its base, the largest lobe being filled with yellowish eggs. What appeared to be respiratory tubes were very large, and attached to the sides by a mesentery.

Pennant notices and figures this animal, but does not mention a locality; and I am not sure that his figure represents the same species: it appears to be derived from the representation of Rondeletius. The original animal of Bohadsch is evidently identical, as may be seen from the copy of Bohadsch's figure, which I have introduced for comparison. He says that it is of a whitish yellow colour, that it never contracts itself into a ball, and that it lives in the deep sea, whence it is never cast on shore, save when it enters the nets along with fishes.



SIPUNCULIDÆ.

SIPUNCULACEÆ.



PAPILLATED SYRINX.

Syrinx papillosus. Thompson.

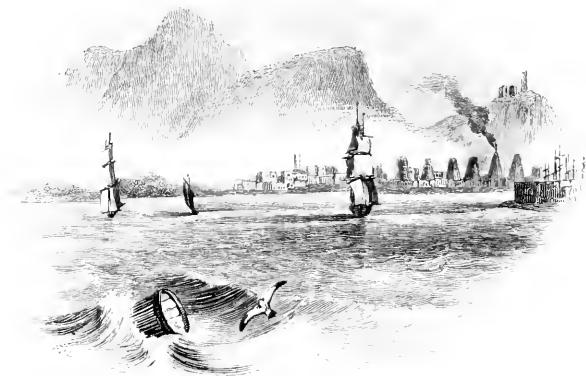
Specific Character.—Brownish or mottled; skin striated concentrically, and covered with brown papillæ.

Sipunculus papillosus, THOMPSON, Ann. Nat. Hist. vol. V. No. 29, p. 101. (April 1840.)

THIS handsome species, measuring four inches in length, and portly in proportion, appears to have escaped description until very lately, when Mr. Thompson had the pleasure of introducing it to the public, characterizing it from specimens obtained at Miltown Malbay, on the coast of Clare, by Mr. Harvey, and at the south islands of Arran, Ireland, by Mr. Ball. Captain Portlock has taken many specimens on the north coast of Ireland; and its geographical range would appear to be extensive, as Mr. Gray showed me a bottle full of specimens in the British Museum, which came from the West Indies. According to Mr. Harvey, it lives under stones among sand-covered rocks. It is of a brownish white colour, often with dark markings of brown, and has its tough skin finely striated longitudinally and concentrically, and covered with brown papillæ, which are more numerous on the sides than on the

dorsal and ventral surfaces, and are most numerous at the posterior extremity, which tapers to a point. The proboscis (which is retracted in the figure, drawn from a specimen in spirits) is about one-third the length of the body, and is provided towards its extremity with a circle of tentacular filaments, flattened, lanceolate, and jagged, or digitate at the edges. The vent opens near its back. On opening the creature we find no dental processes, but a digestive apparatus, consisting of a narrow œsophagus, which opens into an intestine twisting spirally on itself to the posterior extremity of the body, and then returning in a similar manner along the same spiral to the vent, on each side of which is a short brown muscular tube, probably respiratory. The vascular system is complicated, and the nervous consists of a strong nervous cord, which runs along the abdominal surface of the animal terminating posteriorly in numerous filaments, and anteriorly by two delicate threads which surround the œsophagus where it joins the base of the proboscis.

The vignette is a view from Leith Roads.



SIPUNCULIDÆ.

SIPUNCULACEÆ.



HARVEY'S SYRINX.

Syrinx Harveii. Forbes.

Specific Character.—Body smooth, except at the posterior extremity and at the origin of the trunk, where it is finely reticulated; trunk short, the upper two-thirds smooth, with the exception of a band of minute bristles near the extremity.

THROUGH the kindness of Mr. Waterhouse I am enabled to give a description and figure of this very distinct species, discovered by his friend, Mr. Harvey of Teignmouth, who for some years so successfully investigated the marine fauna of that interesting locality, and who has since dipped his dredge in the seas of the Antipodes with equal success. I have dedicated the species to its discoverer. It measures two inches and a half in length. The body is quite smooth, except at the two extremities, where it is finely reticulated. The skin is tender and very lax, which makes me suspect that some of the animals described under the name of *Sipunculus saccatus* (as that mentioned in “Martin’s Marine Worms,”) and supposed to have been the cast skins of the *nudus*, may have belonged to this species. The proboscis is short, in the preserved specimen being only one-seventh the length of the body, and has a circle of bristly papillæ surrounding it near its extremity. Beyond

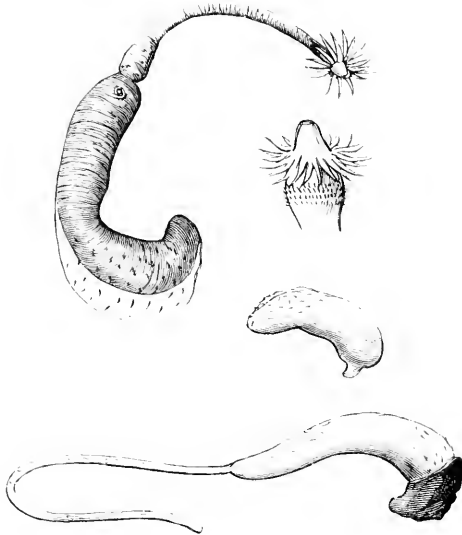
these is a circle of tentacula, very numerous, and jagged at the edges. The internal structure resembles generally that of the last species, saying that in the specimen examined I could find no respiratory tubes. The muscles of the skin are very tender, and are strongest near the anterior extremity; those of the trunk, however, are very strong, and bifurcated at their bases. There is a genital tube opening opposite the vent. The animal is of a pinkish colour.

The pencil of my friend, Mr. G. J. Bell, has furnished the accompanying sketch of one of the dredger's worst enemies, a squall. The scene is the Holy Loch in the Clyde district; a province which, thanks to Mr. Smith, has contributed many rarities to the British Fauna.



SIPUNCULIDÆ.

SIPUNCULACEÆ.

Genus *Sipunculus*. Linnæus.

Generic Character.—Trunk cylindrical, long, having a circle of simple linear tentacula near its extremity.

SHELL-BEARING SIPUNCULUS.

Sipunculus Bernhardus. Forbes.

Specific Character.—Body smooth anteriorly, studded with small bristles towards its obtuse posterior extremity; trunk long, smooth, saving near the extremity, where it is surrounded by four rows of minute bristles.

Sipunculus Strombi, MONTAGU, Lin. Trans. VII. p. 74. FLEMING, Brit. An. p. 491. GRAY, Spicel. Zool. 3.

B. Sipunculus Dentalii, GRAY, Spicel. Zool. 3.

THE form of the tentacula and the general habit of the animals, distinguish the genus *Sipunculus* from *Syrinx*.

The species bury in sand, or in the crevices of rocks, or, as is the custom of the curious animal before us, adopt the shells of dead univalve testacea for a house and home, after the manner of the Hermit Crab. The Sipunculus would appear, however, to be of a less changeable disposition of mind and body than its crustacean analogue, and when once securely housed in a shell to make that its permanent habitation. Whether the egg is originally deposited in the future habitation of the animal by some wonderful instinct, or is only developed when lodged by the waters in such a locality, or whether the parent Sipunculus bequeaths the chosen lodging of its caudal termination to its eldest born, and so on from generation to generation, a veritable *entailed* property, we know not at present; but the inquiry is a most interesting one, and well worth the attention of the experimental zoologist. The Sipunculus is not, however, content with the habitation built for it by its Molluscan predecessor; it exercises its own architectural ingenuity, and secures the entrance of its shell by a plaster-work of sand, leaving a round hole in the centre sufficiently large to admit of the protrusion of its trunk, which it sends out to a great length, and moves about in all directions with great facility. This trunk is long and cylindrical, and slightly enlarged at its extremity, where it is surrounded by about twenty or more linear-lanceolate tentacula, which are very seldom protruded. Behind these tentacula are four circles of minute bristles. The trunk can be entirely retracted within the body. In the lowermost figure I have represented the Sipunculus alive in a Periwinkle shell, of which I have broken away the upper part in order to show the animal's body; the figure immediately above represents the creature freed from the shell, but with the trunk retracted; and the two uppermost represent the animal

with all its parts expanded, as seen after preservation in spirits, and the head magnified under the same circumstances. Near the junction of the trunk with the body is seen the vent; the body itself is smooth, with the exception of the posterior portion, where there are minute bristles arranged at regular distances. The colour of the creature is white, and it can extend itself to more than three inches in length. The internal structure of the animal is not so complicated as that of a *Syrinx*, and the digestive system is much more simple.

The shells selected by this *Sipunculus* for its habitation are usually specimens of the *Strombus Pes-Pelicanus*, and *Turritella Terebra*; but I have also seen it in *Littorina littorea*, when that shell happened to fall into sufficiently deep water, and *Dentalium Entalis* is frequently adopted by it. The parasite of the last named shell Mr. Gray considers a distinct species, and has published it as such; but after examining many both living and dead, I am reluctantly obliged to differ from that distinguished zoologist's opinion, and to regard the characters he has given as dependent on accidental causes; namely, the contraction of specimens preserved in spirits, and the form of the shell in which they were parasitical.

The *Sipunculus Bernhardus* (I have thought proper so to style it, in order to prevent the confusion arising from naming it after the shell which it inhabits) is found on most parts of the British coast. On the east, west, and north of Scotland it is frequent; on the coast of Ireland not uncommon, and on the west and south coast of England by no means rare. It lives in from ten to thirty fathoms water.

SIPUNCULIDÆ.

SIPUNCULACEÆ.



JOHNSTON'S SIPUNCULUS.

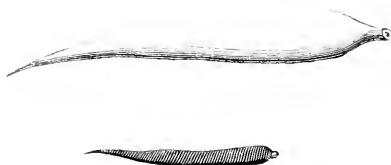
Sipunculus Johnstoni. Forbes.

Specific Character.—Body rough, with minute papillæ; posterior extremity tapering to a point; trunk smooth, nearly half the length of the body.

This little species is one of the many discoveries of my valued friend, Dr. Johnston, who found it at Berwick, and to the pencil of his accomplished lady I am indebted for the figure of it. He writes me regarding it,—“It is not uncommon sometimes at the roots of corallines, lurking in the sand, the colour of which it resembles. It is rarely, I should think, half an inch long, contracts and lengthens itself, as is usual with the tribe, draws in the anterior end, and extends it as a snail doth its horns, and when it is fully extended there is an appearance of two minute papillæ at the orifice.”

Pallas, in his *Miscellanea Zoologica*, tab. x. figs. 7, 8, 9, has figured two English Sipuncular worms, which nearly approach the *Sipunculus Johnstoni*. The one he says he found among sand on the coast of Sussex in the year 1762; the other he states is black, smooth, and capable

of changing its body into many shapes. The notices are too imperfect to enable us to judge with certainty of the species; but I subjoin copies of the figures in the hopes of their leading to the rediscovery of the animals noticed by that most accurate observer. It is very probable that several other minute Sipunculi inhabit the British seas. Those of other regions have been still less attended to.



SIPUNCULIDÆ.

PRIAPULACEÆ.



Genus *Priapulus*. Lamarek.

Generic Character.—Body cylindrical, having a trunk without tentacula, and a branched filamental caudal appendage, proceeding from the truncate posterior extremity.

THE TAILED PRIAPULUS.

Priapulus caudatus. Lam.

Specific Character.—Body finely striated longitudinally and transversely by distant striae; trunk striated longitudinally.

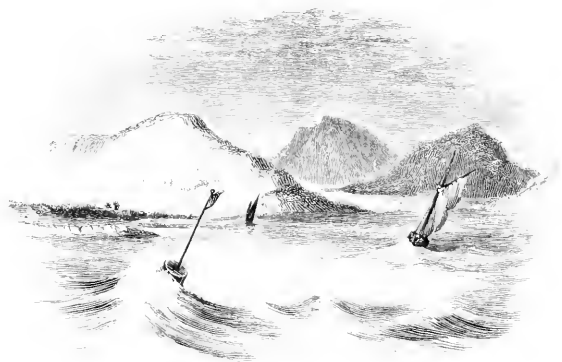
Holothuria priapus, LIN. Syst. 1091. FABRICIUS, Fauna Groen. 355. MULLER, Zool. Dan. Prod. 2807; Zool. Dan. t. xevi, 1, and t. cxxxv, 2.

Priapulus caudatus, LAM. 2 Edit. III. p. 467. FLEMING, Brit. An. p. 491.

THE PRIAPULUS is one of the most curious animals inhabiting the British seas. It is shaped like a dice-box, with a curious pyramidal filamentous tail at one end, and an equally curious sub-conical trunk at the other. When dredged up it presents little appearance of its tail, and still less of its trunk; but if left undisturbed for a few moments the shapeless lump of white flesh, for such it seems to be, becomes suddenly animated, and with a fierce energy assumes its true form, and jerks out its cartilaginous proboscis to its full proportions, changing in a moment its size from half an inch to as many as four or five inches. Then it will as suddenly withdraw its trunk within its body, the puzzle to the spectator being as to where it contrives to pack it, especially as on anatomical examination we find a fair supply of digestive, circulating, and other apparatus already stowed inside. It is of a bluish-white or pinkish colour, the body being finely striated longitudinally with distant striæ, which are crossed by others, but the reticulations are not so evident about the centre. The proboscis, which swells out towards its extremity, is striated only in one direction, namely, longitudinally. The body is truncate posteriorly, and shaped like the mouth of a trumpet, out of which comes the long white pyramidal tail, composed of a number of hollow filiform processes, whirled round a common axis, each circle diminishing in size towards the extremity. We find the anus opening at the extremity of this remarkable appendage, which Sars regards as an organ of respiration. A microscopic examination of this singular appendage in the living animal is most desirable, as it possibly may be furnished with some singular ciliary apparatus. The intestinal canal is simple, and on the abdominal surface a white line is seen running along the centre, which is composed of vessels and nerves.

The Priapulus was first observed on the British shores by Dr. Fleming, who found it in the Zetland seas in 1810, and his specimen was no less than six inches long. Mr. Goodsir and I found it in the same locality in 1839; we dredged it in seven fathoms water, among Laminariæ, in the Sound of Bressay, opposite Lerwick. Our specimen was three inches and a half in length. Dr. Coldstream has taken it in two localities very distant from each other, namely, Leith, and the coast of Devon. Captain Portlock has added it to the Irish fauna: he dredged it in Belfast Bay. Abroad it inhabits the seas of Norway and of Greenland.

The vignette represents the entrance to the Kyles of Bute.



SIPUNCULIDÆ.

THALASSEMACÆÆ.

Genus *Thalassema*. Cuvier.

Generic Character.—Body cylindrical, posterior extremity smooth; proboscis retractile, short, without tentacula, and furnished at one side with a long fleshy furrowed simple sheath or appendage, which is not retractile.

GAERTNER'S SPOON-WORM.

Thalassema Neptuni. Gaertner.

Specific Character.—Body purplish anteriorly, gray posteriorly; appendage saffron.

Lumbricus Thalassema, PALLAS, Spicel. Zool. fasc. x. p. 3, t. i. f. 6. GMELIN, Syst. p. 3034.

Thalassema rupium, LAMARCK, Syst. (1801) p. 329.

Thalassima mutatoria, MONTAGU, Lin. Trans. vol. XI. p. 24, t. v. f. 2.

AMONG the many contributions sent from England by Gaertner to Pallas was the singular worm-like Echinoderm before us. Its sagacious discoverer evidently saw the necessity of constituting a genus for its reception; and though he does not appear to have defined it, he gave the name

by which the creature is here designated. Cuvier and Montagu followed up the views indicated by Gaertner, and to the great zoologist of Devon is due the credit of first perceiving the true relations of the *Thalassema*; for, speaking of this worm, he says, "I think it might with propriety immediately precede *Holothuria*." Cuvier afterwards held the same view of its position, and Brandt has followed him. Lamarek, Blainville, and others, associated the Spoon-worms with the true Annelida. After having studied both the British species, in conjunction with Mr. Goodsir, both zoologically and anatomically, and observed one of them under most favourable circumstances alive, I hold them to be structurally *Radiata*, and their relation with the worms to be a relation of analogy.

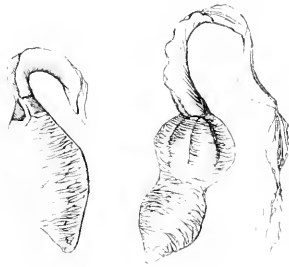
Montagu considered Gaertner's animal, as figured by Pallas, to be identical with his own, but badly represented. The figure given by Pallas, however, is not a bad one, but very characteristic of the creature when preserved in spirits, as may be seen on comparing it with my drawing, which I made from a preserved specimen taken by Mr. Harvey at Teignmouth, kindly communicated by Mr. Waterhouse. As Montagu observed the creature alive, I prefer giving his account of it, and then adding what information I have gathered additional from an examination of the dead animal. He tells us it is "ovate-oblong in a quiescent state, and rather more than half an inch in length, but sometimes extends to more than an inch, and then changes its form by alternately inflating each end. It is furnished with annulations, which become ridged at the posterior end, where it terminates in a point or nipple; it has also longitudinal striæ that decussate the annulations, giving it a squamous appearance. At the anterior end the margin of

the aperture extends into a very long amorphous appendage, frequently three or four times the length of the body, at other times contracted very short, but never receding within the mouth: in the former state it is usually flat, in the latter the sides fold together and almost form a tube, becoming much scalloped or wrinkled at the margin, and at the base the sides unite forming a sort of funnel to the mouth; by this implement not only nourishment is collected but its only progressive motion is performed. It is in continual action, thrown about in all directions in search of food, and occasionally by fastening it to a distant body the animal is drawn forward or turned to either side. At the anterior end immediately behind the long appendage are two very minute feelers, which are not always protruded. The posterior half of the body is of a bluish gray, the other purplish pink; the appendage saffron, paler at the extremity. This curious animal was kept alive in sea-water several days for examination, and was never observed to take in or eject that element like the *Holothuria* tribe, but at the posterior end is an evident opening for the discharge of the fæces."

In this characteristic description of Montagu no mention is made of a trunk; but in both this animal and the next there is a retractile proboscis resembling that of a *Sipunculus*, but unprovided with tentacula at the extremity. The singular spoon-shaped appendage of the mouth would seem to be a sheath for the proboscis, and a means of bringing the food of the creature within its reach. The internal anatomy nearly resembles that of the *Echiurus*, but the intestinal canal is not so long.

Hitherto this animal has been found only on the coasts of Devon and Cornwall. Gaertner and Montagu describe it as living among submarine rocks.

The vignette is a copy of Montagu's figure. Any one who has seen the extraordinary changes of form presented by animals of this tribe when alive, will not be surprised at the difference between it and my drawing.



SIPUNCULIDÆ.

THALASSEMACÆÆ.

Genus *Echiurus*. Cuvier.

Generic Character.—Body cylindrical, posterior extremity with circles of corneous bristles; proboscis retractile, short, and furnished at one side with a long fleshy furrowed simple non-retractile appendage.

COMMON SPOON-WORM.

Echiurus vulgaris. Savigny.

Specific Character.—Body pink, ringed with minute pale granular spots; appendage scarlet.

Lumbricus echiurus, PALLAS, Spicel. Zool. f. 10, t. i. fig. 1-5.

Lumbricus ovyrus, PALLAS, Miscel. Zool. p. 146, t. xi. fig. 1-6.

Thalassema echiurus, LAMARCK, Anim. sans Vert. I Edit. vol. V. p. 300;
2 Edit. vol. V. p. 533. BLAINVILLE, Dict. des Sc.
Nat. t. lvii. p. 499.

Thalassema aquatica, LEACH, Enc. Brit. Sup. t. i. p. 451.

Thalassema vulgaris, SAVIGNY, Syst. des Anim. sans Vert. p. 102.

ONE day during the winter of 1840, when walking on the sandy shore at St. Andrew's, seeking for such living treasures as the sea might have thrown up after a terrific storm, I found among a profusion of Heart-Urchins, Razor-

fish, Zoophytes, and other dwellers in the deep, a number of the curious worms I am about to describe. They were twisting about on the wet sand with many symptoms of discomfort, and near them lay as many curious fleshy red bodies, which seemed alive, and to be independent animals. They were not so, however, but were the broken-off appendages or sheaths to the creature's proboscis, by means of which probably the Spoon-worm makes its way through the sand in which it lives, or perhaps folding it into a funnel, thereby secures a supply of water when buried deep beneath the surface. From the marrow-spoon shape of the sheaths I have given the worms an English appellation.

The *Echiurus* was first described by Pallas, and his account has furnished the materials for all the descriptions published since his time. He obtained it from the coast of Belgium, where he says it lives buried in the sand, and is used as a bait by the fishermen.

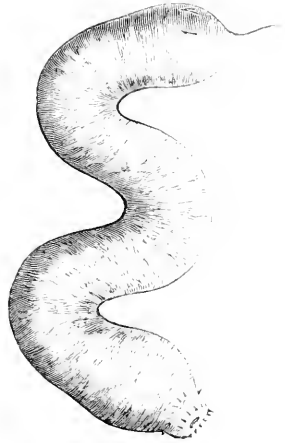
The largest specimens I examined measured six inches in length, and half an inch in diameter. Their bodies were cylindrical, of a bright rose colour, and annulated with little tubercles, which were paler than the ground colour. The oral end is furnished with a proboscis about half an inch in length, having a red margin at its extremity, but no tentacula. This proboscis is retractile, but not so the singular long extensile homogeneous sheath or spoon of a scarlet colour fixed on one side its base. This appendage is so slightly fixed that it breaks away on the slightest touch. A little way from its junction with the body are two shining lustrous cartilaginous horns or antennæ, short, lanceolate, acuminate, curved, and retractile, their colour being golden yellow. These are the genital hooks. From between these proceeded a red line, indicating the course

of an internal blood-vessel to the anus, which is placed at the posterior extremity, and surrounded by two circles of ten similar but shorter bristles. The skin near the vent is longitudinally striated.

On dissection we find a long and winding intestine of a brownish hue. There is a dorsal vessel running the length of the animal, containing red blood, the globules of which are large and irregular in form. The bristles near the head are retracted by powerful muscles. Near them open four genital sacs, two on each side. In these were detected spermatic animalcules. These sacs are transparent, and tipped with orange. On each side of the anus are two tubular sacs, each about three-fourths of an inch in length. These are the organs of respiration. When a portion of one of them is placed under the microscope alive in seawater, a most beautiful organization is presented. They are seen to be studded with cup-shaped bodies, like polypes in form, round the margin of each of which is a circle of vibratory cilia, so large that they may be easily seen with a common lens of three-fourths of an inch focus. On the internal surface of the respiratory sacs instead of cups there are little tubercles corresponding to the cups, and covered like them with vibratile cilia, the whole forming one of the most beautiful arrangements of those singular organs seen in the animal kingdom. This arrangement has, as far as I am aware, not been noticed hitherto. It is represented in the vignette.

The Spoon-worms were continually changing form, filling themselves with water, perhaps through the medium of the respiratory tubes. When supplied with fresh water they would swim in a revolving manner like a worm with great vivacity, and afterwards rest at the bottom of the vessel and swell themselves out.

With this notice of an animal in which the characteristic features of the Radiate type are almost obliterated, I conclude my account of the British Echinodermata. Among them we have seen some of the most extraordinary forms in the animal kingdom, some of the most wonderful structures and of the strangest habits. Much yet remains



to be done towards their elucidation, and the investigation of them both structurally and formally presents a wide field of inquiry to the student of Nature, as yet but imperfectly explored. The great naturalist of Denmark, Müller, long ago said that we need not resort to distant regions and foreign climes for rare or wonderful creatures; that the fields, the woods, the streams, and the seas of our native lands abounded in wondrous evidences of God's power and wisdom. The investigation of our native animals must ever be a chief source of sound zoological knowledge, for it is there only we can watch, under favourable circumstances, for the observation of their development, their habits, and their characters. The naturalist whose acquaintance is confined to preserved specimens in a cabinet, can form but a vague idea of the glorious variety of Nature, of the wisdom displayed in the building up of the atoms of matter to be the houses of life and intellect. And unless we study the creatures living around us, how can we gain that delightful knowledge? The passing note of an animal observed during travel is an addition to

science not to be scorned; the briefly characterizing of a new species from a preserved specimen, if done with judgment, is of importance; but the real progress of natural history must ever depend on the detailed examination of the beings gathered around us by the laws of geographical distribution, living and multiplying in their destined homes and habitats.



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ERRATA.

- Page 29, line 14, *for* "valuable" *read* "variable."
" 46, " 15, *for* "was" *read* "were."
" 50, 60, and 79, among synonyms, *for* "Metr." *read* "Meth."
" 70, line 6, *for* "oval" *read* "oral."
" 73, last line, *for* "Micheli" *read* "Meckel."
" 106, add to synonyms of "*Cribella rosca*" "*Linkia rosca*, THOMPSON,
An. Nat. Hist. No. xxxi. June, 1840.
" 224, line 2, *for* "two" *read* "ten."

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