

ZOOLOGICAL RESEARCHES.

MEMOIR III.

*On the Luminosity of the Ocean, with descriptions of some remarkable species of Luminous Animals (*Pyrosoma pigmæa* and *Sapphirina indicator*) and particularly of the four new genera, *Nocticula*, *Cynthia*, *Lucifer* and *Podopsis*, of the *Shizopodaæ*.*

THE animals of which we are about to treat, contributing largely to the phosphorescence or sparkling of the sea, the following general observations relating to that subject, may not be deemed unacceptable or out of place.

Of the various Luminous Phenomena which nature offers to our notice, that afforded by the luminosity of the ocean, is one of the most remarkable, and has consequently attracted a good deal of attention from Philosophers and Naturalists: having ever been alive to this interesting appearance, in various seas and regions, I feel myself authorized to offer the following general observations upon the subject.

(A.) The most common and familiar kind of luminosity is that, which, when the water is slightly agitated by the winds or currents, shews itself, in scattered sparkles in the spray of the sea, and in the foam created by the way of the ship; these sparkles or luminous points, vary in magnitude, and often continue to shine for some moments,

as they pass the sides of the vessel, or follow in the track ; the kind of light exhibited by this variety, is perhaps more brilliant and condensed than that of any of the others, and very much resembles every way, that of the red, gold, and silver rain of the Pyrotechnist.

(B.) The former kind of luminosity, is not unfrequently accompanied by flashes of a paler light of momentary duration, and independent of the light with which these strike the visual organs, often illuminate the water to the extent of several feet ; these are more or less vivid, according to the distance of the observer, and the depth at which they make their appearance. This kind of luminosity, resembles extremely the lightning so often seen in tropical regions, and which presents itself in diffused flashes of light, now issuing from one mass of clouds, now from another, in constant succession over the whole face of the heavens.

These modifications of the luminosity of the ocean, are common to every part of it in the more temperate and tropical regions. A variety of the last kind, (B) in which these larger masses of phosphoric light possess a greater degree of permanence, has been noticed by Spallanzani in the Mediterranean, and may occur in other situations, but has never been seen by the author. " If" says he " in the beginning of the night we enter the strait of Messina (October was the month in which these observations were made) in a low bark or boat coasting near the land, where the water is perfectly calm, the Medusæ, which are usually very numerous there, begin to shine with a light, which as the darkness increases, acquires intensity and extent, every medusa resembling a bright torch, that may be seen for some hundred paces around ; and on approaching it, the brilliant phosphorus shews the form of the body. This light, when the evening twilight is extinct, is of a lively white, which strikes the eye even when the animal is five-and-thirty feet below the surface. As the medusa, by its oscillation, transfers itself from place to place, so the light

is variable and is stronger in the systole than in the diastole. Sometimes it continues for a quarter of an hour, half an hour, or more; but at other times it suddenly becomes extinguished, and does not re-appear till after a considerable interval. These luminous medusa are called *Broini* at Messina—at the Lipari islands *candellieri di mare.*" (*Travels*, vol. IV. p. 229.)

(C.) A third kind of luminosity, is peculiar to gulfs, bays, shores and probably to parts of the ocean where the bottom is at no great distance, in all the warmer regions of the globe; here the luminosity is so predominant that the slightest agitation of the waves, the passage of fish, the movement of the oars, or the way of a ship, produces a diffused pale phosphorescence, and under some of its modifications, resembles a sea of milk, or rather of some metal in a state of igneous liquefaction.

Passing for the moment some less common and peculiar kinds of luminosity, it may be observed, that all the various foregoing appearances, so interesting and often alarming to those who travel by sea, have been ascribed at different periods and by different individuals to a variety of causes, viz. *a*, the absorbed light of the sun, disengaged by the friction of the waves; *b*, electricity, excited by the same means; *c*, phosphoric matter diffused through its mass; *d*, lastly, to luminous marine animals. The investigations of the practical Naturalist have tended to set aside all these, with the exception of the last, which would appear to be the sole cause of this curious phenomenon, in all the modifications above stated, as well as in every other instance: the first and third kinds (A & C.) being attributable to minute crustaceous animals, the smaller medusæ and molluscæ, and perhaps some annelides, modified in degree, by the animalcules being more or less scattered, and the prevalence of particular species: the second kind (B.) as already explained, appears to be the production of medusæ of a larger size, of which as yet, but two species have been observed to be

possessed of this curious property, viz. medusa pellucens of Sir Joseph Banks, (*Philos. Trans.* 1810, pl. XIV, fig. 3), and the medusa Spallanzanii not hitherto figured; both of these belong to the genus *Aurelia* of Lamarck, of which we have many species not luminous.

The third kind of luminosity, (C) is comparatively of rare occurrence, and that which is the most alarming in appearance; I had but once an occasion to witness and to investigate it as it occurs in the Mediterranean. Returning from a fishing party late in a still evening across the bay of Gibraltar, in a direction from the Pomones river to the old Mole, in company with Dr. Drummond, (now Professor of Anatomy to the Belfast Institution) and a party of naval officers, the several boats, although separated a considerable distance, could be distinctly traced through the gloom by the snowy whiteness of their course, while that in which we were, seemed to be passing through a sea of melted silver; such at least was the appearance of the water, displaced by the movement of the boat and the motion of the oars; the hand, a stick, or the end of a rope, immersed in the water, instantly became luminous and all their parts visible, and when withdrawn, brought up numerous luminous points less than the smallest pin's-head, and of the softest and most destructible tenderness, appearing on a closer inspection out of the water, like hemispheric masses of a colourless jelly, evidently however, organized and included within an enveloping tunic; these were probably some species of minute medusa. This appearance however, is probably caused by several different animals; thus the animal discovered by Mr. Langstaff on a voyage from New Holland to China, appears to have been the linked young of some *Salpa*, while that observed by Riville is undoubtedly a crustaceous animal of the ostracoda. The former, as cited by Professor Macartney in his valuable paper on luminous animals, (*Philos. Trans.* 1810,) states "In going

from New Holland to China, about half an hour after sunset, the sea presented a milky appearance, the ship seemed to be surrounded by ice covered with snow, no bottom was discovered on this occasion with 70 fathoms of line—a bucket of water being hauled up, and examined in the dark, discovered a great number of globular bodies, about the size of a pin's head, linked together. The chains thus formed did not exceed three inches in length and emitted a pale phosphoric light. By introducing the hand into the water, several chains of the luminous globules were raised—the globules, were so transparent that they could not be perceived when the hand was taken into the light—this extraordinary appearance of the sea was visible for two nights. As soon as the moon exerted her influence, the sea changed to its natural dark colour, and exhibited distinct glittering points as at other times." (*Philos. Trans.* 1810, p. 269, 270.)

Riville's description of this phenomenon is as follows. "The surface of the sea gently agitated, was covered with little stars, each wave which broke around the vessel gave out a very lively light, and like in colour to that of a cloth of silver electrified in the dark. The waves, which seemed from time to time to be confounded one with another, formed at the horizon a plain covered in appearance with snow, and the track of the vessel was of a lively and luminous white, strewed with brilliant and azure coloured points." This was in a voyage to India when off the Malabar coast, in N. Lat $8^{\circ} 47'$, and Long. E. of Paris, 73° at 9 o'clock, P. M. on the 14th July, 1754. (See Godcheu de Riville in *Mem. de l'Acad. des Sciences—Savans Etrangers, tom. iii*, p. 267. Observations on two Entomostraca of which he gives the figures.) Latreille thinks the first of these must be a species of *Lynceus*, but as no species of that Genus has been discovered out of fresh water, this is to be doubted; it may be satis-

factory to know that some new animals of this tribe (Ostracoda) have been detected in our own seas and will be made known in some future Memoir. Riville describes the phosphorescence as residing in what he calls a bluish liquor, which exuded from the animal, giving the same luminous appearance to the water, and which lasted several days; but on due examination, this blue matter was found to be a moveable congeries of globules, lodged within the posterior part of the shell of the animal, of a blue colour, but which became yellowish and dark as the animal approached its end; these globules Latreille imagines to have been its eggs.

To the above may be added the testimony of Captain Horsburgh, (as it relates in all probability to the same animal,) as extracted from the notes he gave to Sir Joseph Banks. "There is (says he) a peculiar phenomenon sometimes seen within a few degrees distance of the coast of Malabar, during the rainy Monsoon, which I had an opportunity of observing at midnight: the weather was cloudy and the sea was particularly dark, when suddenly it changed to a white flaming colour all around. This bore no resemblance to the sparkling or glowing appearance I had observed on other occasions in seas near the equator, but was a regular white colour, like milk, and did not continue more than ten minutes. A similar phenomenon, (he adds) is frequently seen in the Banda sea," &c. (Professor Macartney *Philos. Trans.* 1810.) More lately this appearance has been noticed by Captain Tuckey. "After passing Cape Palmas and entering the gulf of Guinea, the sea appeared of a whitish colour, which increased together with its luminosity until making Prince's Island, so that at night the ship seemed to be sailing in a sea of milk. To discover its cause a bag of bunting, its mouth extended by a hoop, was kept overboard and collected *vast numbers* of animals of various kinds particularly pellucid Salpæ with *innumerable* little crustaceous animals of the *Scyllarus* Genus (*Squillæ*) attached

to them, to which I think the whitish colour of the water may be principally ascribed. Of Cancers we reckoned 13 different species, eight having the shape of crabs, and five that of shrimps." *Tuckey's Voyage to the Congo.*

These are all the recorded instances of this very remarkable kind of phosphorescence having been seen; it is therefore almost unnecessary to say, that the attention of voyagers should be given to it whenever it is met with, and to the animal or animals which appear to cause it, none of which have been satisfactorily described; this may be done by preserving some of the water until next morning for due investigation, or by straining a portion of it and preserving the filter in a well-closed vessel of common spirits, until subjected to the scrutiny of some qualified naturalist.

Independent of the animals which operate in a more general way in the production of the luminosity of the ocean, there are some others which present a peculiar character, and are moreover of a local nature, at least they have never been observed beyond certain circumscribed limits; two very remarkable kinds of luminosity of this sort have as yet been noticed.

The first of these (D.) presents itself to the astonished voyager, under the appearance of thick bars of metal of about half a foot in length ignited to whiteness, scattered over the surface of the ocean; of these, we perceive some to assume the luminous state and continue it as long as they remain in view, while in others, we witness the luminosity to decline and disappear; the greater number of these apparently incandescent masses pass close to the sides of the vessel, or follow in her wake, their phosphorescence being called into activity by coming in contact with her prow or bottom, as that of such as are more distant appears to be, by the conflict of the waves. This appearance results from the *Pyrosoma atlantica*, a compound animal resembling a hollow cylinder of a transparent gelatinous substance, open at one end, and papillary on its

surface, belonging to the class of Tunicata, and first discovered and figured by Messrs. Peron and Le Sueur, (*Voyage aux Terres Australes*, tom. I, p. 448, pl. 30, fig. 1. and *Annales de Museum*, tom. 4, p. 440.) A figure of it may be seen in Shaw's Zoological Lectures, plate 127. The light which this animal yields, appears to pervade its whole substance, and when examined near at hand, varies in intensity and in shade, often exhibiting a very beautiful phosphorescence of a blueish or greenish tinge, like a pale sapphire or aquamarine as it gradually fades away; agitation or friction renews it as in other luminous animals as long as it continues to exhibit signs of life, but it is most vivid, when the animal is first drawn up, and at length can scarcely be called forth by the rudest treatment. As we observed this interesting animal, with Milbert's florid description at hand (*Voyage Pittoresque a l' Isle de France*, tom. I. p. 110.) I can aver, that the red, aurora, and orange colours, did not present themselves to the eyes of any of our numerous party, who were nevertheless, highly gratified at the sight of so brilliant and singular a creature.

This phenomenon may often be witnessed by vessels bound to India or the eastward of the Cape of Good Hope, occurring in the calm latitudes near to the Line. Peron's observations led them to restrict the limits of its habitation between the 19° and 20° of Long. W. of Paris, and the 3° and 4° of N. Lat. We first fell in with the Pyrosoma however, in N. Lat. 12° and carried it with us all the way to the Line, between the Longitudes of 16° and 20° W. Ships generally cross the Equator to the Westward of W. Long. 20° to avoid the calms which prevail nearer to the African coast, those therefore, which from necessity or choice pass to the eastward of this longitude, may expect to meet with the Pyrosoma, within the limits indicated above. As we approached the Equator, a smaller species made its appearance, intermingled with the former; in this, the luminosity is more condensed about the mouths

of the little animals which compose it, and as these are not placed irregularly, as in the larger species, but are arranged in rings or whorls, it puts on a very beautiful appearance, resembling a gem studded with the diamond or opal, Plate 8, fig. 3. This species did not exceed an inch in length, had about seven or eight rows of animals, and a somewhat contracted aperture; this species I would designate by the specific appellation *pygmæa*. Subsequent to the discovery of the *Pyrosoma atlantica*, two other species of this very remarkable Genus have been detected in the Mediterranean, viz. *Pyrosoma elegans** resembling my *P. pygmæa*, and *Pyrosoma gigantea* † having a greater degree of affinity with *P. atlantica*, but having the mouths of many of the animals furnished with a foliaceous appendage probably conduceing to the locomotion of the aggregate; this species exceeds a foot in length. We have yet to learn whether these species are luminous, but they have furnished Naturalists with the means of becoming acquainted with the very peculiar structure of *Pyrosoma*, which will be found amply developed by the authors above cited. I cannot dismiss this subject without adverting to a point connected with the economy of these animals which seems to declare that the Atlantic species have been created for the locality where we find them; possessing no power of locomotion in themselves, they are driven to and fro by the light and variable winds which are known to prevail to the north of the equator, and represso'd from emigration into either Temperate zone by the constant action of the Trade winds on the North and South: the Mediterranean species on the other hand, inhabiting a sea influenced by tides, and by winds and currents altogether variable and often rude, are furnished with exterior appendages which

* Le Sueur, Nouv. Bull. des Sciences, Juin 1813, p. 283. pl. 5 fig. 2; and Mai 1815, pl. 1, fig. 4.

† Idem, Mai 1815, p. 80, pl. 1, fig. 1-3, 5-13. and Journ. de Phys. Juin 1815, fig. 1-3, 5-13. Savigny, Mem. sur les anim. sans Vertebres, Memoir 3d pl. 4. fig. 7. and pl. 22. 23.

seem to have no other use, unless we suppose them to be given for the purpose of locomotion. For a confirmation of this circumstance we naturally look to those Naturalists who may find themselves favorably placed, to make observations upon living Pyrosomæ.

The other kind of luminosity of a more local nature, (E.) is that which presented itself to the observation of Captain Horsburgh, a gentleman richly entitled to National Honours and to the gratitude of posterity, for his valuable contributions towards the safe navigation of a large portion of the trackless Ocean. His example in the present instance deserves to be imitated. At sunrise on April 12, 1798 in the Arabian Sea, he perceived several luminous spots in the water, which conceiving to be animals, he *went in the boat*, and caught one: it proved to be an insect somewhat resembling in appearance the wood-louse, (*Oniscus*) and was about one third of an inch in length. When viewed with a microscope it seemed to be formed by sections of a thin cutaneous substance.—“During the time that any fluid remained in the animal it shone brilliantly like the fire-fly.” Taken from his notes given to Sir Jos. Banks, as quoted by Prof. Macartney, *Phil. Trans.* 1810. who has appended to his paper, Pl. XV. f. 4, an engraving of the animal copied after a pen-sketch by Captain Horsburgh. Having had the good fortune to meet with this same animal (Pl. 8. f. 2. a. b. c.) by day light while in soundings near to the Belliqueux Shoal, which lies off the South extreme of the island of Madagascar, and again on the Agullas Bank near to the Cape of Good Hope, August 9th, 1816, I am entitled to say that it is no *Limulus* as suggested by the learned Professor, and although not sufficiently scrutinized by me to determine its actual structure, is an animal which it is impossible to associate with any other genus of the Crustacea. Individually I feel under great obligations to this beautiful little animal, which by its splendid appearance in the water induced me to commence the use of a muslin

hoop-net, which when it failed to procure me a specimen, brought up such a profusion of other marine animals altogether invisible while in the sea, as to induce a continued use of it on every favorable opportunity. The *Sapphirina indicator*, which is the name I propose for this animal which is so beautifully luminous by night, by day resembles the finest Blue Sapphire in colour, with the opalescence of the Moonstone or precious Opal, and although but one third of an inch in length, this colour (which is thence probably a modified phosphorescence) pervades the surrounding element so as to give the animal the appearance of being round and of the size of a livre or rupee when seen from the deck of a vessel, appearing larger in proportion to its distance below the surface. When turned upon its back, Pl. 8. f. 2. e. it presented an opaline hue, and the appearance of numerous radii or members from each side of the segments which compose its body, together with a trifid colourless process f. 2. b. c. x occasionally projected by the animal at the sides of the corselet; these various members assumed at times a rapid movement backwards and forwards, but as the weather was dark, coarse and unfavorable to minute investigation, I could not succeed in developing the structure of these parts at the moment; but by placing several of the animals in the slides attached to my Microscope hoped to be able to do so at some more favorable juncture, in this however I was disappointed by the slides having been subsequently lost while the Instrument was undergoing some alterations at an Opticians in London. If this animal is elegant when viewed by reflected light, it puts on a still more extraordinary appearance when the light is transmitted through its body to the eye of the observer; by a direct light of this kind it resembled the Fire-stone, with tints of yellow, and by a less vivid and indirect illumination it assumed varied intermingled tints of orange, rose, blue, and green of a metallic splendor, and impossible to imitate. The body of the *Sapphirina*, which

is much depressed, is composed of nine segments; of these, the anterior is largest, constitutes the clypeus, and presents towards its middle part the appearance of a pair of proximate eyes; the posterior segments diminish in width as they approach the opposite end or tail, and the last of them is terminated by two elliptic fins or scales, setaceous on their outer edge and having a central longitudinal nerve or rib. The Sapphirina swims in all directions with apparent ease by the motion of its tail, and often darts away by some sudden effort of its concealed members. There can be no doubt of this animal belonging to the Monoculi of Linnæus, and most probably to the same family with Cyclops, a relationship which will be more apparent, when we become acquainted with the structure of a nondescript member of it lately detected in our own seas, and which it is intended to develope in a succeeding Memoir. The geographical distribution of the Sapphirina appears to be limited to the seas situated to the north and west of a line drawn from the Cape of Good Hope to the southern extremity of the Island of Ceylon.

There is yet another of these luminous Phenomena which merits a moments consideration, viz. that which in violent storms at sea, makes its appearance in a luminous patch or ring upon the masts and on the windward yard-arms, gradually mounting up the former as the storm increases in violence; this appearance most probably results from the minute luminous animals being carried up and lodged there by the spray of the sea, which, while it continually furnishes a fresh supply and excitement, gains gradually a higher range, until the storm is at its height. Having only sailed in *large* Vessels, I have frequently observed an appearance of this kind on the lower masts and windward rigging; this has in all likelihood been often confounded with the Fire of St. Elmo, which would seem to be a purely electrical phenomenon, and is described as resembling a radiant star or flame playing about the very summits of the masts.

Philosophers have naturally been anxious to discover the *object* of this curious property in animals, which is so little obvious, that they have not hitherto been able to bring forward any explanation which applies to more than a limited number of cases ; thus in luminous *Insects*, which are all of them crepuscular or nocturnal, it has been supposed to serve the purpose of bringing the sexes together, which is extremely probable ; but when we investigate this property as it occurs in *marine animals*, this is evidently not the true solution, as the major part of them have the sexes united, are destitute of visual organs, and shine equally in their young or larva state. From the vast number and variety of these last, and from observing all such to be more or less translucent, added to the circumstance that the luminosity seems to be in every case intimately connected with their irritability, and is apparently under the controul of the individual, we should be tempted to consider it as an evidence of volition, or the transmission of the nervous influence in a condensed form, to some of the organs of the animal requiring an encreased energy to counteract the unusual external force which operates upon them for the moment, for it may be remarked, that it is in general the contact of other bodies, or the concussion of the waves which calls the luminous property forth ; we must give up this explanation however, when aware, that numerous translucent marine animals do not shew any luminosity, and that it is not found but in *particular species* of the same Genus. Meditating upon this subject, I think it not improbable, that the Deity, who has done nothing in vain and whose Omnipotence extends to every epoch, foreseeing that man would invent the means of tempting the trackless ocean, and explore the most distant regions of our Planet, has given it as one means of rendering his nights less gloomy, and of diminishing the number of his dangers ; especially if we consider, that this luminosity is seen only in the night season, is vivid in proportion to the darkness, disappearing

even before the feeble light of the moon, and also, that it increases with the agitation of the sea, so that during the prevalence of storms it greatly diminishes the dense gloom which at such times is often impenetrable to the moon or stars, throws such a light upon the Ship and rigging as to enable the sailors to execute their allotted tasks with certainty, and at all times points out to the cautious mariner the lurking danger of sunken rocks, shoals, and unknown coasts, by the phosphorescent or snowy appearance which it gives to the Breakers, so as to render them visible at a considerable distance ; where again the diffused luminous appearance (described under C.) of the Sapphirina indicator is seen, he may be certain that he is in soundings, and probably at no great distance from some fatal spot.

In the terrestrial animals which are luminous, we perceive organs especially provided to secrete and treasure up the luminous matter, and transparent spots to permit the transmission of the light ; in marine animals nothing of this kind has ever been discovered, and their bodies appear so homogeneous and transparent, that wherever the focus of light may be, when excited, it seems to pervade, and as it were light up the whole body of the animal. Dr. Smith indeed, during the interesting voyage of Captain Tuckey to the Congo, observed that the luminosity of a kind of shrimp appeared to emanate from the brain, which "when the animal was at rest resembled a most brilliant amethyst about the size of a large pin's head, and from which, when it moved, darted flashes of a brilliant silvery light" *Tuckey's Voyage*. Spallanzani with his usual ingenuity and perseverance, resorted to a variety of expedients to ascertain where the luminous property resided in the phosphorescent medusæ of the Mediterranean, and came to the conclusion, that it is confined to the viscid excretion which is found towards the margin of the umbel, on the larger tentacula and "on the surface of the purse communicating with that aperture of the umbella which is perhaps the mouth of the animal."

All these parts, he observes, become luminous on being touched—rendering the fingers luminous, “ and if this humour be scraped off with a knife and put into a glass filled with (fresh) water or milk and stirred with the finger or a spatula, both those fluids will become phosphoric, which they will not when the moisture expressed from any other part of the medusa is mixed with them” *Travels*, vol. IV. p. 242-248. Query—Is the luminosity in the viscid excretion, or in the animaleuli which adhere to it, and which probably constitute the food of the animal?

Of Some New Genera of Luminous Crustacea.

IF we sometimes and at particular seasons witness the sparkling appearance of the sea in the Temperate Zones, within the limits of the Tropics it may be said to prevail all the year round, and that in a remarkable degree, soon after the sun dips beneath the horizon and that the light of the moon is withdrawn. The individuals of the first of the following Genera constitute a principal cause of this luminosity, to which the others also contribute,—not that this phenomenon, in the situation indicated, results solely from luminous Crustacea, for a vast number and variety of Mollusca, &c. have been ascertained to lend their aid towards it. Although the muslin towing net cannot be used with effect in detecting these minute animals when the progress of a vessel is considerable, yet we can often succeed in capturing a luminous point now and then, by suspending it by means of a very short line over the stern in such manner as that it may just trip along the surface or dip a little into the water on the heave of the sea, taking care to hawl it quickly up when any of them appear to be intercepted by it, and removing them with a camel-hair pencil, into a glass vessel filled with sea water for examination the following morning: if the observer is either

unprovided with a microscope, or incompetent to the task of developing the structure of such small objects as are thus procured, they can be preserved in a closely corked phial of spirits unchanged for any length of time, with the exception of such as *feel* soft, gelatinous and yielding, which being species of *Medusæ*, cannot be kept from dissolution by any of the means hitherto tried, and if mixed with the others might tend to cause the corruption of the whole; these therefore, should be carefully separated and rejected, or what would be still better, every kind might have a phial to itself. When the luminous animals are observed to be remarkably numerous, they may also be conveniently obtained by drawing up a bucket-full of the water, from which they may be separated by means of a small wire hoop or open spoon covered with muslin.

Genus 1.

Nocticula, or Luminous Shrimp.

THE animal which forms the type of this Genus, was first discovered by Sir Joseph Banks, in the passage between Madeira and Brazil. Observing that the sea was particularly luminous, he had some of the water drawn up in a bucket, and found that the sparkling appearance was owing to the present animal, which he therefore named *Cancer fulgens*. (*Macartney Phil. Trans.* 1810.) The drawing which Sir Joseph caused to be made of it, and published in the paper above referred to (Pl. XIV. f. 1 and 2) and copied Pl. 5 f. 2 although perhaps not remarkably exact, shews that it approximates the Opossum Shrimp (*Mysis*) in figure, and in the number and structure of its members. Having had an opportunity of taking numerous individuals of the Luminous Shrimp, in my homeward passage from the Mauritius, I have been enabled to figure it with more care, Pl. 5 f. 1: Making due allowance for drawings made at sea of such minute

objects, I am inclined to consider these as identical, it may be observed, that neither show the natatory division of the members, which from the great transparency of the animal, their position, and not being suspected, wholly escaped observation; what strengthens the probability of their identity, is, that those obtained by the author were found in the track necessarily pursued by Sir Joseph Banks towards Rio Janiero, viz. between the Latitudes of $5^{\circ} 25' S.$ and $29^{\circ} 30' N.$ and West Long. $17^{\circ} 18'$ and $32^{\circ} 55'$, on the 6th 12th and 25th September, where they were in considerable abundance, widely distributed, and uniform in character.

The *Nocticula Banksii* or Luminous Shrimp, resembles in figure the animals of the Genus *Mysis* described in the former Memoir, as they do also in structure, and particularly in the number and formation of the members, which consist of eight pair, and which, on due investigation will no doubt be found cleft or divided into two branches as in *Mysis*, so that was it not for the very different construction of the sub-abdominal fins, it would merge in that Genus; this peculiarity however, is undoubtedly generic, and argues a somewhat different mode of life and means of rearing their young, which last, is probably effected after the same manner as we witness in the true Shrimps, where the ova are appended to the sub-abdominal fins, which by their great length and more complete developement they are not only fitted to accomplish, but to add considerably to its power as a swimmer. As amongst the individuals taken, none presented the remarkable character of the *pouch* of *Mysis*, this would appear to authorize the opinion of *Nocticula* breeding after a different manner, however as it would be highly desirable to ascertain this point by an examination of the female in the breeding season, I commissioned several gentlemen going to the West Indies, to procure some of these animals, furnishing each of them with a small hoop-net, a line, and phials. One of these alone communicated the result of his exertions (Major Gilland on his outward

voyage in 1825,) which amongst a variety of Gammari, Cyclops and other marine animals, produced a solitary specimen, which on investigation, proved to be the type of an approximating Genus, (*Cynthia*) so that it still remains a desideratum to know in what manner the ova are disposed of and hatched after exclusion from the Ovarium, and whether the animals undergo any change or metamorphosis during their progress to maturity.

This luminous animal, which is the only species of *Nocticula* as yet known, I have named *Banksii* from its first discoverer, and as a small tribute to a Naturalist possessed of affluent circumstances, yet whose zeal for the cultivation of knowledge led him to expose himself to the greatest personal risk and inconvenience — to devote his fortune and his whole life to this object, and finally to bequeath his valuable and accumulated stores of knowledge to posterity. It may be truly averred that no one individual was ever so instrumental in promoting and encouraging every species of knowledge and every useful art : the recollection of these circumstances, of the admirable arrangements which he made for this purpose, and of his obliging condescension and affability to all, must cherish a grateful remembrance in the breast of every Philosopher and Naturalist of the same era, while his bequest to the Nation which he adorned, will secure to him the admiration of posterity, more than any other Monument that could be erected to his memory.

The following description of the Luminous Shrimp, has been copied from my journal.

Corselet like that of the shrimps.

Abdominal portion of seven joints.

Tail composed of five lamina, the outer ones the broadest, oblong, serrate on their inner edge and ciliate, intermediate ones nearly linear, serrate and ciliated, middle lamina taper, acute, having a subulate appendage on each side towards its apex.

Eyes large and conspicuous from their dark blue centre.

Antennæ two pair, the inner and superior pair with three robust basil joints, and terminated by two long multi-articulate hairy setæ, the outer and inferior pair on a basis of but two joints, ending in a single seta, similar and nearly as long as those of the former; at their base, an elongated taper scale (particular form not determined) tufted at the extremity.

Thoracic members eight pair, long, filiform and ciliate within.

Sub-abdominal members five pair, each, of three articulations, the first clavate, and the terminal one ciliate—there are to be seen between the thoracic and abdominal members, some obscure processes in constant and rapid motion, these are no doubt the indications of the natatory division of the posterior thoracic members.

The motions of this animal were observed to be lively, and it gave out brilliant scintillations in the dark when disturbed. It was perfectly transparent, tinged here and there with orange-red, particularly its anterior feet, and showed the circulation most distinctly.

Genus 2.

Cynthia.

It may be objected, that this appellation has been already appropriated by Mons. Savigny to the most common and familiar type of the Ascidiæ, a name, which most Zoologists are more likely to retain, with every respect for that very eminent Naturalist; I therefore beg to apply it where it is more likely to remain undisturbed, and where it indicates the affinity which exists with the other luminous Genera of the Shizopodæ.

As I have just stated, the efforts made to procure females of the former Genus, led to the discovery of the present type, which bears a considerable resemblance both to *Mysis*

and to Nocticula, and in structure coincides to such a degree with the former, that many, of what are very improperly termed rigid Linnæans, would be disposed to consider them merely in the light of different species; no Naturalist however who understands any thing of the Crustacea, will refuse his assent to their being generically distinct, (not notwithstanding that we have only a *male* individual to contemplate) when the very peculiar structure of its sub-abdominal fins is considered; these in Mysis consist of a *single* joint, in Nocticula of *three* joints, while in Cynthia they are intermediate, and composed of but *two*; it is not in the *number* of joints alone, however, that they differ, their form and structure is also essentially different. In Cynthia, the four last of these members are each composed of a very large bilobate scale, supporting at its apex, two taper articulate fins, strongly ciliated with plumose setæ; from between these originates an opaque organ, which bifurcates, its two extremes of unequal length, being rolled inwards the one over the other; the first pair differ in having but one perfect terminal fin, with the rudiment of the second and of the intermediate organ.

In what part of the Atlantic the specimen of this animal was procured has not been ascertained, but may be stated in a general way, as somewhere in the usual track pursued by West-Indiamen between Madcira and Barbadoes; neither is it known whether luminous or not, although presumed to be of the former description, this circumstance therefore remains to be determined, as well as the difference of structure in the female, and the mode of carrying her eggs.

The only other difference which declares it to be generically distinct from Mysis, we find in the inner division of the six posterior feet, which in place of the pluri-articulate termination, have this part obscurely divided into two or three joints only.

Description of Cynthia.

Corselet as in the Shrimps, slightly pointed in front.

Abdominal portion of seven joints.

Tail of five scales; outer ones oblong, obliquely truncated, truncation and inner edge serrate and ciliate, with a strong spine at the outer angle; intermediate scales taper, serrated, ciliated on their outer edge, inner edge with alternate long and short spines; middle scale slightly taper, truncated at the end or very slightly indented, serrate and spinous on its outer edges, the spines lengthened towards its end where they appear almost clustered.

Eyes remarkably large.

Antennæ two pair; the inner antennæ of three remarkably robust basil joints, surmounted each by a pair of pluri-articulate setæ of which the outermost are the longest, at the inside of the last basil joint is a taper sessile appendage very strongly ciliated and analogous to the brush of the male Mysis; inner antennæ of two basil joints ending in a shorter pluri-articulate seta, slightly hairy, the scale at its base, oblong, obliquely truncated, with a short spine at the outer angle of the truncation, and serrated and ciliated along its inner edge.

Thoracic members eight pairs, divided to the Coxæ into two parts; the outer divisions being pluri-articulate, and feathered towards their extreme, and bearing the Branchia at their base; the inner divisions, independent of a basis resembling the branchia of the outer ones, are composed of about five joints, which in the six posterior, bear a strong terminal curved claw, the two anterior resembling considerably the same members in the genus Mysis.

Mouth, not dissected; the Palpi in their two last joints appear to approximate to the same organs in Mysis.

Sub-abdominal fins, already sufficiently described.

The appendage to the Male organs in situation and structure shews also an approximation to the same part in Mysis, and ends in three curved hooks.

*Genus 3.**Lucifer, Long-headed Shrimp.*

THIS singular and extraordinary type of the Shizopodæ, like Nocticula, conduced to the sparkling appearance of the sea in the Tropical regions, the individual figured in the plate having been taken in the Atlantic September 15th N. Lat. $11^{\circ} 56'$ W. Long. $32^{\circ} 55'$

We perceive in this animal a form hitherto unknown amongst the Crustacea, viz. linear or vermiform, the corslet not being broader than the abdominal segments, with its anterior portion lengthened out into a kind of neck widening in a slight degree upwards, and bearing at its extremity, the Eyes and Antennæ with their appendages, while the mouth is situated at a great distance under the breast.

It shews no further relationship to the former Genera, than in possessing, long, simple, ciliated thoracic members, these seem however to be fewer in number, and although the natatory divisions characteristic of the Shizopodæ were not observed, for the same reason as mentioned under Nocticula, I have no doubt of their existence: the thorough developement of the abdominal portion of the animal, of the sub-abdominal fins and tail, discountenance the idea of its being the larva of some known Crustaceous Genus.

The whole of the animal is colourless and transparent, with the exception of its intestinal canal, which from the opacity of its contents could be traced from the thorax to the tail.

Description of Lucifer.

Corslet, linear, posteriorly compressed, anterior portion lengthened out and truncated, with a short spine at the outer angles.

Abdominal portion, of six linear segments, the last largest with two short aculei on each side.

Tail of five scales; the outer ones oblong, obtuse, and ciliated; the intermediate scales taper, rather acute and ciliate; middle scale subulate and somewhat shorter than the rest.

Eyes extremely large, placed at the end of long spreading footstalks.

Antennæ, two pair ; inner pair, linear, longer than the eyes, each composed of a long basil joint and three shorter joints, surmounted by a few short hairs ; outer pair (probably broken in the specimen) composed of two long and one short intermediate joint, rather longer than the inner antennæ. Scales narrow, taper, and ciliate, as long as the first joint of the outer antennæ.

Thoracic members five or six ? pair, long, setaceous and hairy ; the anterior pair, short and bent downwards, were continually in motion, and may probably prove to be its Palpi, as the mouth appears to be situated between them.

Sub-abdominal fins, of which there is a pair to each of the five anterior segments of the abdomen, are composed of a basil joint, supporting two taper ciliated fins, with the exception of the first, which as in *Cynthia*, supports but a single fin.

Genus 4.

Podopsis, Hammer-headed Shrimp.

This Genus remarkable for the great length of the Footstalks on which its large and spreading Eyes are placed, like the former, was discovered in that region of the Atlantic frequented by the Nocticula, being captured in N. Lat. 29° 30', W. Long. 32° 55', on the 25th September, where it contributes its share to the luminosity of the sea. Like the former Genera also it is perfectly diaphanous and colourless, and although its members were not particularly scrutinized, is undoubtedly a natatory Shizopoda.

Description of Podopsis.

Body in general configuration similar to that of the Shrimp, but of a more slender and taper form, with the Eyes spread out horizontally.

Corselet, somewhat taper, truncate or slightly emarginate anteriorly.

Abdominal portion taper, of six segments, the last long and very slender.

Tail of five scales; the outer ones broad at the base, acuminate and ciliated; intermediate scales taper and ciliate; middle scale very short and pointed.

Eyes very large, on extremely long, slender, divaricate footstalks.

Antennæ; near to the insertion of the footstalks of the Eyes, are two short appendages which are probably the rudiments of the upper antennæ; the lower pair of antennæ are as long as the corselet, filiform, composed of four joints tipped with hair, Scales equal in length to the antennæ, taper and ciliated on their inner edge.

Thoracic members; one pair *unique*, nearly twice the length of the corselet, of five joints, the last hairy within; the rest of the members appear to be composed of three or four ? joints, and hirsute.

Sub-abdominal fins, five pair, each, of two or three joints, the terminal joints ciliated, and doubled in the two last pair.

General Remarks on the Shizopodæ.

Having completed the description of all the cleft-footed Crustacea decidedly belonging to this Order, as well as of such as from their structure are presumed to be referable to it, and which if they do not find place here, cannot be associated with any other known group, it may be advantageous to review the characters which are peculiar to these animals, and which appear to distinguish them from the Decapodous Macroura, (Shrimps, &c.) which they most resemble. In all the well defined genera of the Shizopodæ viz. Mysis, Nocticula, and Cynthia, we have found a greater number of locomotive members or feet viz. eight pair, divided to the Coxæ (hip) into two branches, of which

the outer are exclusively adapted to swimming and carry the branchia or gills around their basil joint, so that they present us with *perfect* animals possessed of *four rows of feet!* the inner rows, which are appropriated to the same purposes as the usual members in the true shrimps, are besides wholly unfurnished with chelæ or claspers. Our present ignorance of the habitudes of these animals, will not permit our deriving any benefit from characters taken from their mode of breeding, but as in *Mysis*, it is probable that they do not undergo any metamorphosis.

The animals with which they are most likely to be confounded, however, are the larvæ of the Decapoda, which are *temporarily* Shizopodæ, but may generally be distinguished by the division of the limb originating from the extremity of the femur or thigh, and shewing no appearance of external branchia ; besides, they are comparatively small and *imperfect* animals, in which the sub-abdominal fins and tail are never completely developed. From a consideration of these characters, the author is induced to exclude *Nebalia* from the true Shizopodæ, which as before hinted, is probably the larva of some crustaceous animal ; at all events, its characters have not hitherto been sufficiently developed by the few Naturalists who have become acquainted with it, to enable us to pronounce as to its true situation or affinity.

No doubt the Shizopodæ will receive considerable accessions both of genera and species, when more attention is given to the less conspicuous of the marine Crustacea, for as we have seen, the largest of them scarcely exceed an inch in length, and they appear to be widely distributed, existing from the Equator to the confines of the North Pole, as well in the briny ocean, as in the brackish water of rivers and estuaries.

NOCTICULA.

PLATE V. Fig. 1. *a*, Nocticula Banksii of its natural size. Fig. 1. *b*, magnified; *1 f*, feet; *2 f*, supposed male organs; *3 f*, sub-abdominal fins; *e*, eye; *a 1*, inner pair of antennæ; *a 2*, outer pair of antennæ; *s*, anterior scales. Fig. 1. *c*, Tail more magnified.

Fig. 2. Luminous Shrimp, after the figure in the Philos. Transactions.

CYNTHIA.

PLATE VI. Fig. 1 *a*, Cynthia magnified Fig. 1 *b*, its natural size.

Fig. 2. Anterior parts of the same more magnified; *c*, corselet; *e*, eye; *1 a*, superior antennæ; *b*, analogue of the brush in the nodule Mysis; *2 a*, lower antennæ; *s*, anterior scales.

Fig. 3. Tail of the same still more highly magnified.

Fig. 4. *a*, *b*, the two extreme joints of one of the Palpi.

Fig. 5. One of the inferior antennæ; *a*, its pluri-articulate seta; *s*, its ciliated scale.

Fig. 6. Inner branch of the anterior thoracic member.

Fig. 7. Second Member; *a*, inner division; *b*, outer natatory division; *g*, branchia; *x*, point of attachment to the animal.

Fig. 8. One of the six posterior members; *a*, inner division; *b*, natatory division; *g*, branchia; *x*, point of attachment.

Fig. 9. *a*, One of the second pair of the sub-abdominal fins; *x*, point of attachment; the third, fourth, and fifth are similar.

Fig. 9. *b*, One of the first pair of the sub-abdominal fins.

Fig. 10. One of the scales situated between the hindermost pair of thoracic members.

LUCIFER AND PODOPSIS.

PLATE VII. Fig. 1. Podopsis, magnified, and of its natural size; *3 f*, sub-abdominal fins; *a 2*, anterior members; *p*, probably palpi; *a*, supposed rudiments of the superior antennæ; *a 1*, inferior antennæ; *s*, ciliated scale; *e*, eye.

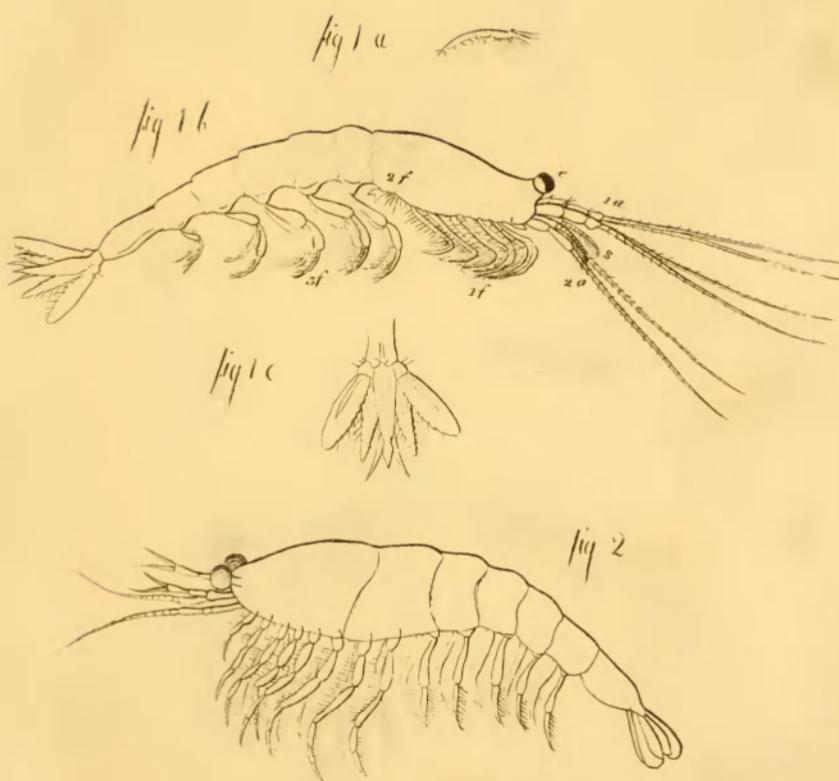
Fig. 2. Lucifer magnified, and of its natural size; *1 c*, anterior part of the corselet; *2 c*, posterior part of the corselet; *f 1*, ciliated members; *f 3*, sub-abdominal fins; *a 1*, superior antennæ; *a 2*, inferior antennæ; *s*, ciliated scales; *e* eye; *t*, tail.

PLATE VIII. Fig. 1. The Zœa of the common crab, (*Cancer pagurus*), magnified. Near the letter *f* it is represented of its natural size; *a*, antennæ; *f*, feet; *s*, one of the lateral spines.

Fig. 2. Sapphirina; *a*, natural size; *b*, magnified, from above; *c*, magnified, from beneath; *x*, trifid anterior members.

Fig. 3. Pyrosoma pygmæa.

PL. V.



NOCTICULA.

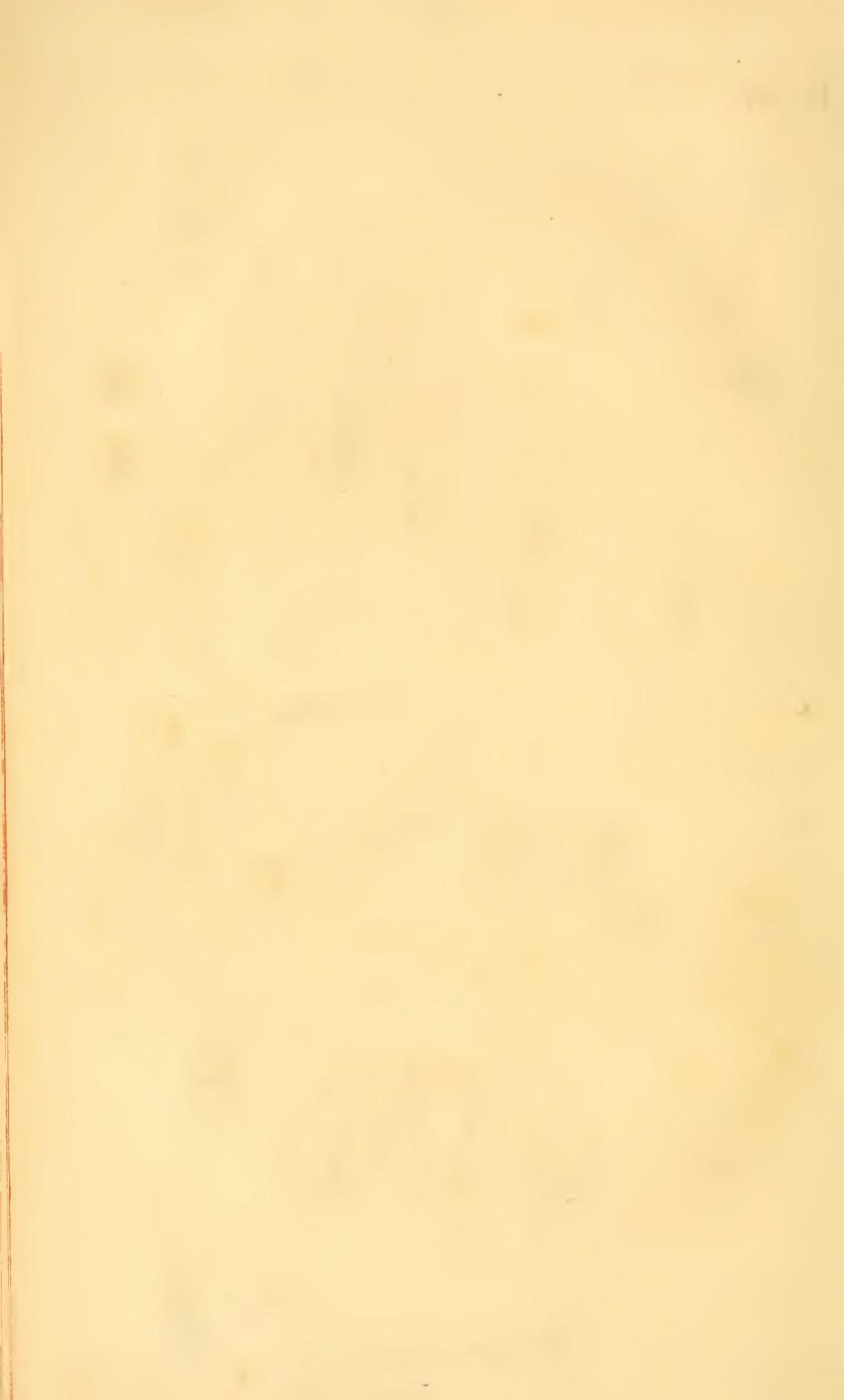
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PL. VI.

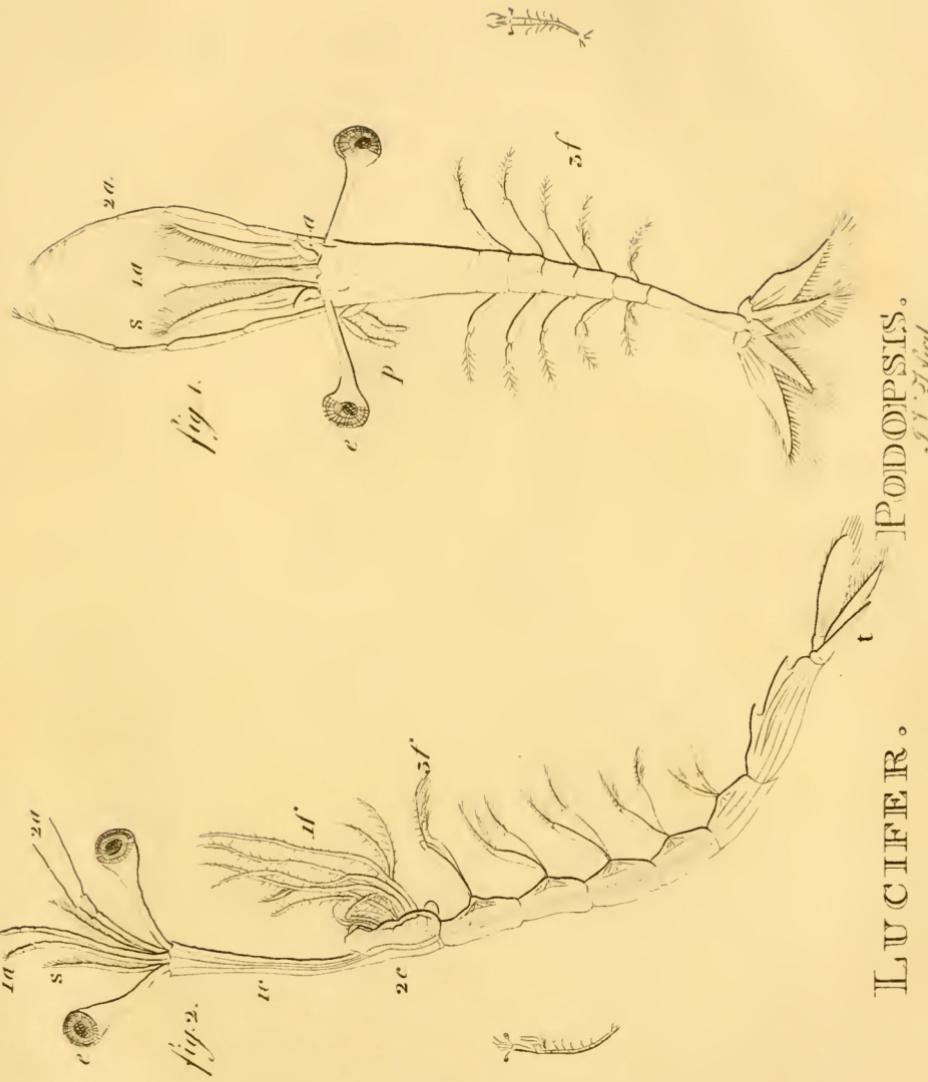
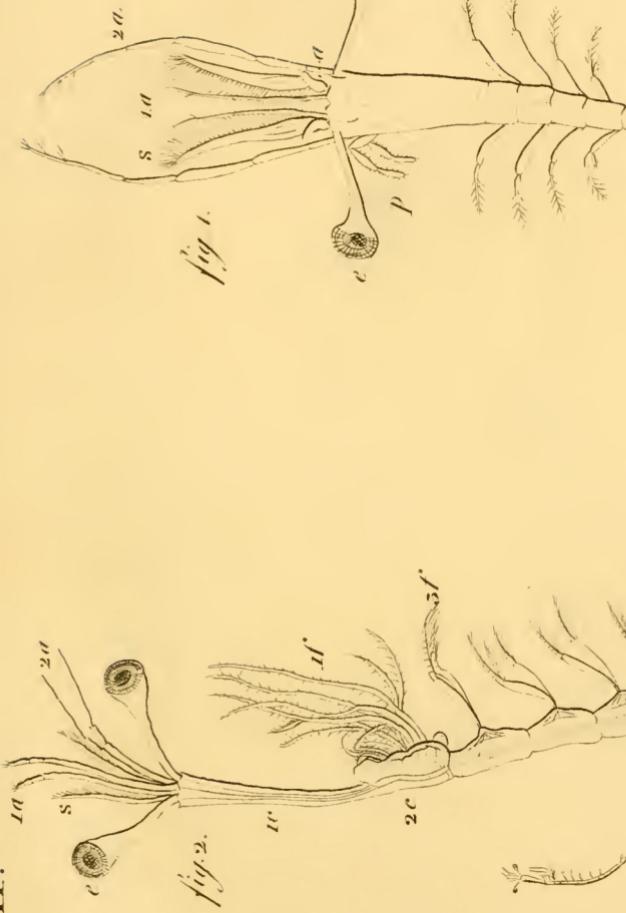


CYNTHIA.

LIT. del d. scaph.



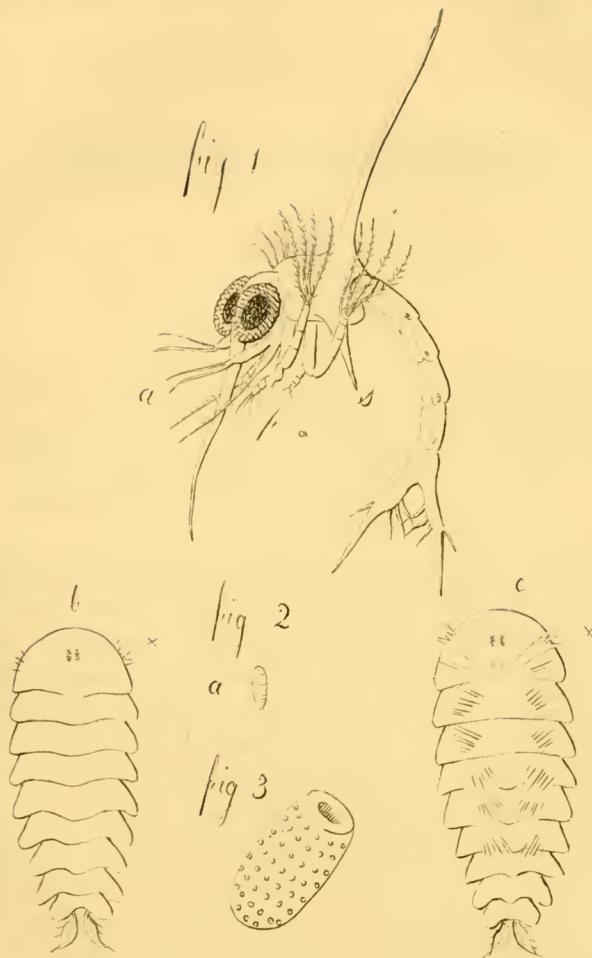
PL.VII.



LUCIFER.

PODOPPSIS.
S. J. H. 1901

PL. VIII.



J.V.T. del et sculpt.

