of the nerve are always found in the perifascicular connective tissue. The connection of the intrafascicular connective tissue with the lymphatics has not yet been demonstrated.

Some physiological considerations conclude the paper.

---

The Luminous Organs and Light of Pyrosoma. By Paul Panceri, Professor of Comparative Anatomy in the University of Naples.

The memoir presented by me to the Academy is intended to make known the results of the researches which I undertook during last winter, and which I continued in December and January of this year on Pyrosoma giganteum, in continuation of those which I have already made on animal light. In the historical sketch which forms the introduction to my memoir I have quoted, first, the observations made by Peron in the Atlantic between 19° and 20° W. long. (from Paris) and 3° and 4° N. lat., when, in December of the year 1800, on his way to Australia, he met a bank of Pyrosoma, which, during a dark night, strongly illuminated the waves tossed by the storm.

Bennet, in 1833, in the Atlantic, close to the equator, saw the sea all on fire owing to the Pyrosoma, and he gave some valuable information on this phenomenon. I afterwards analysed the memoir of Meyen, in which he describes a luminous organ, which was in consequence of his assertion so generally believed. My observations demonstrate the error into which Meyen and Bennet fell in attributing a luminous power to the red pigmentary cells, which are spread over the surface of the oesophagus and stomach.

The work of Huxley, although the author's principal object was to make known the parts of the Pyrosoma and some natural analogies with the other Tunicates, contains some data on the light which emanates from that animal, and makes mention of the luminous points which are spread and propagated on a Pyrosoma; that is the light which traverses the colony from one end to the other. These authors, as well as others who have written on the Pyrosoma,

1 We must refer the reader to the fifth volume of the 'Atti della R. Accademia della Scienze Fisiche e Matematiche di Napoli' (1872), for longer memoirs by Prof. Panceri on the Phosphorescence of Pholas, Pyrosoma, Pennatula, and Phyllirhoe, illustrated by numerous beautifully executed plates.
have not succeeded in indicating where the luminous move-
ment of the animal has its seat, and this is why, as preliminary
to my memoir, I have said by what means I succeeded in deter-
mining with certainty what were the luminous organs of the
animal. Every time that I have had at my disposal any Pyro-
soma I have been able to prove that its light takes its origin
really from thousands of brilliant points or spots placed at
nearly equal distances one from another in the inner surface
of the tube: but I perceived also that these spots were
disposed in couples.

At first sight it is difficult to determine exactly the seat of
these brilliant points, yet in the direction of the largest conical
tubercles there are sometimes seen a couple of luminous
points more raised than the others (which make the surface
of the tube rough). For determining, in the first place, the
precise spot where these luminous points are found, I thought
of making use of fresh water, which has the power of fixing
the light in the phosphorescent animals of the sea; and
whilst a whole colony was all alight by this means, I cut the
tube through (Fig.1). By this proceeding I was able to observe
that the couples of luminous points are found very near
to the exterior wall of the tube, and nearly in the same
position where the ganglia of the ascidia are found. In ob-
serving the conical tubercles with which there always corre-
sponds an ascidium larger than the others, with a very long
neck, so as to reach two thirds of the height of the tubercle,
I perceived that the two luminous points belonged to that
ascidium, and owing to the lengthened form of the neck they
were far more raised than the others. By this observation
I was convinced that in the Pyrosoma the light has its source
in determinate parts, which are in the proportion of two to
each ascidium.

In subsequently examining the little ascidia in the place
in which the luminous points ought to correspond, I found
nothing but two bodies, which Le Sueur and Savigny had
declared to be the ovaries. Yet, before studying these organs,
it was necessary to be assured whether it were really from
them or from some other source that the light sprung. Having
made some transverse sections with the razor through the walls
of the tube, so thin that they could contain but one layer of
ascidia, I again employed fresh water, and I placed these sec-
tions under the microscope. The observations were made in the
evening, and when there appeared under a magnifying power
of eighty diameters and even less, in the field the two
aforesaid bodies, I extinguished the lamp, and at the same
place and in the same forms, the two luminous spots appeared
(Fig. 2). I say under the same form, for if it happened that one of the organs was on its side, and, consequently, with a very different outline to the other, the luminous image, nevertheless, seen in the darkness repeated the same outline. By this proof I assured myself that the luminous organs of the ascidia of the Pyrosoma are really those bodies which the two above-named naturalists considered to be ovaries.

As one Pyrosoma, which is, for example, eight centimeters long, contains about 3200 ascidia, there will be then in the whole colony about 6400 brilliant points. The phosphorescent organs, which I recognised as such in the Pyrosoma, have not then been ignored by anatomists, and they were thought to be ovaries until Huxley, in 1851, proved that the ovary is placed near the testicle, and is composed of an ovisac and of a single egg, as is the case with the Salpa. In consequence of these observations the functions of these organs having become problematical, Huxley confined himself to calling them "cell masses," and he figured them under the same name, both in the adult and in the young born by budding, expressing, however, a suspicion that they might be urinary organs.

Vogt also, in his drawings, annexed to the information which he gives on the Pyrosoma, represents these organs without making mention of them, and Keferstein and Ehlers, under the title of "brissenförmiger Körnerschaufen,"


Professor Panceri.

describes them exactly without speaking of their signification. These organs, then, are found in each ascidian at the base of the back, in correspondence with the upper edge of the two branchiae at the bottom of each of the lateral arches of the vibratile bands, and immediately below the two nerves, which form the first or upper part of the lateral nerves of the ganglion. The form of these organs is oval and sometimes triangular; and if they are observed from one side, one can perceive how they are placed in the blood-lacunary space placed between the two tunics of the teguments, and are exclusively attached to the external tunic. As to their structure, they are made up entirely of spherical cells of 0.2 mm. diameter on an average which are not found shut in a common membrane, but are bathed directly by the blood of the lacuna. These cells have no nucleus, and contain a substance soluble in ether and an albuminous substance. Notwithstanding the proximity of these organs to the nerve already spoken of, no filament is seen which on leaving that nerve proceeds to end in the organ; the organ in question receives very probably nerves from cutaneous filaments.

The luminous organs once recognised in their structure, I occupied myself with their origin in the embryos. From the researches of Savigny and from those of Huxley it is known that the Pyrosoma has two sorts of embryos; the composite embryos, which proceed from the egg, or rather from a nurse or generative larva, that Huxley called "cyathozooid," which produces the four twins which become the founders of a new colony, and then it appears that there are other embryos produced by budding on a special tubercle which is found at the base of the endostyle. These last are destined to remain in the colony, which thus grows and enlarges. I have followed the development of the two sorts of embryos at the same time, and I have observed that the luminous organs are formed from the external layer of the blastoderma of which they are a part. The cells which compose this organ are distinctly seen when the first traces of the branchial apertures are perceived.

I was able to prove by using fresh water that the luminous organs of the embryos of the young colonies, which are on the point of being laid, have already the power of shining, so that these organs are of such a nature that from the embryo of the two sorts to the adult condition they change neither their form nor their functions. Having ascertained that the phosphorescence may be manifest from the earliest age of the young colonies, I then occupied myself in studying it in the adult, first making known the varying states in which the animal
may be found, especially on account of the weakness to which it is subject on being submitted to experiment; after that I described the luminous currents. In the Pyrosoma these currents may be compared to those of the Pennatula, because the light starts from the point excited, and spreads through the whole mass; they are not, however, so rapid nor so flaming as those of Pennatula, and are not repeated spontaneously after a single stimulation, and the two convergent currents have never been observed to pass one another.

It is also very important to remark the fact of the different colours which the light can exhibit in the Pyrosoma. Whilst in the species studied by me (P. giganteum), as well as in that studied by Huxley in the Pacific, the light was clear azure,—in the P. atlanticeum, studied by Péron and then by Bennet, the light appeared red at first, and then gold colour, orange, and then greenish, and finally ultramarine blue. This phenomenon of the changing of the colours of the light in the same individual can only be compared to the tricolour phosphorescence of the Appendiculariae observed by Giglioli in crossing from Montevideo to Batavia.

The special studies made for the purpose of explaining the transmission of the excitement, which produces progressively the light in the different ascidia of the Pyrosoma-colony, have led me to the discovery of a particular social muscular system, by which all the ascidia are united with each other. Having, then, described the muscles of the diaphragm which are found at the entrance to the common cloaca, mention must also be made of the special muscular ribands which, by interlacing, join together the ascidia, and are attached to them where there corresponds in each the constrictor muscle of the cloaca. These muscular ribands are not always very regular in their course, nor always of an equal number with the ascidia. They can, nevertheless, be classified in two categories, according to their direction.

There belong to a first category those which are observed in a section of the tube of the Pyrosoma, which is made perpendicular to the axis, and these pass usually from one ascidium to another, crossing so that the fasciculus which is found at the back of one goes and encircles the ventral aspect of the other, to return to the back of the third, and so on.

There belong to a second category those which go from one ascidium to another, parallel to the axis of the tube, thus reuniting the ascidia of one horizon with those of another by uniting their homonymous sides. After having spoken of the special conformation of those organs which are used to
dilate the orifice of the diaphragm, the muscles of the social system are examined, which are formed of long fibres and nuclei, resembling the smooth fibres of vertebrate animals. Since there exists between the ascidia a special muscular social system, it can well be believed that the nerves of this system are those which, passing from one to another, are used for the transmission of the excitement, which is capable of producing the general illumination of the colony.

The researches that I have made up to the present have not yet given any certain results as regards these nerves. My supposition, however, does not cease to be reasonable.

In the last place, I shall explain the results serving to determine the various agents which may cause the appearance of the light:

A sudden shock, rubbing, or touch are enough to excite the light and the currents in fresh specimens, and if, as did Pliny with the Pholades, one masticates a fragment of Pyrosoma, the mouth becomes shining, and when it is opened, the light which comes out of it is sufficient to render easily recognisable the features of a person at hand. Fresh water, as has already been proved, has an energetic action, and if a Pyrosoma is steeped in it, after some minutes it will be seen to be alight, and the light will last several hours, until the death of the animal. The diminution of the temperature of the fresh water in no way diminishes its intensity, inasmuch as having placed two individuals, one in melting ice, the other in fresh water of 35° C., the same effects were obtained on exciting the animal by touch as if the water were of the usual temperature.

In fresh water heated up by degrees, the luminosity of the Pyrosoma is extinguished at 45°.

Alcohol and ether excite the light immediately in the whole Pyrosoma, and it is extinguished together with the life of the animal, about a quarter of an hour after its immersion, but if these two agents succeed in coming in contact with the luminous material of the organ, the light disappears immediately. This fact has been demonstrated equally in the Meduse and in the Pennatulæ, as in the Pyrosoma; it is also demonstrated by using the liquid which results from pressing the body of the animal through a cloth. This liquid, which pours out in a luminous state contains without doubt the material of the crushed luminous organs, which, a little while after it is extracted, becomes non-luminous; and if, after it has lost its light, it is mixed with fresh water, the light will return very brilliantly, but if, on the contrary, alcohol is used, the light
will not again appear, or if it has been obtained by means of fresh water, it will be immediately extinguished.

Electric currents have no special action on the Pyrosoma in the way of rendering it luminous, and there is every reason to believe that this happens from the want of conductivity in the mucous tissue of the common mantle. Neither daylight nor the action of solar rays on Pyrosoma lessen the luminous power, as in the case of the Beroes.

On diminishing the temperature of sea water to 1° the luminous power of the Pyrosoma will not on that account be visibly weakened, and if, on the contrary, it is heated, the light will appear at about 28°, and will not leave off shining till about 60°.

My investigations on the light of the Pyrosoma have led me to conclude that the photogenic substance of the Pyrosoma is, in all probability, fatty matter. In every case it presents the same phenomena as the matter found by me in the luminous organs of the Pennatulae, in the cells of the exterior epithelium of the phosphorescent Medusae, as also in the special organs in the Pholades, in the Chætopterus, as well as in the Beroes, and it reacts with stimulants just as that contained in the Noctiluæ and Thalassicollæ.

When once the Pyrosoma is dead the light can no longer be made to shine from its body, which is then on the way to putrefaction; nevertheless, the matter extracted from the animal, whilst still alive, by means of pressure (of which we have already spoken above), retains for a certain time the power of again becoming luminous by means of mechanical stimulus and of fresh water, even after it has been dried.

Notes on Hanstein's Researches on the Development of the Embryo in Monocotyledons and Dicotyledons (Die Entwicklung des Keimes der Monokotylen und Dikotylen, von Dr. Johannes Hanstein, 'Botanische Abhandlungen, Heft 1). By W. R. McNab, M.D., Professor of Botany, Royal College of Science for Ireland.

In Cryptogams the tissues at the growing-point of a stem or root always form by division from a single apical cell. Hanstein, in his researches on the development of the tissues at the growing-point of the stem of Phanerogams, found that the tissues were developed, not from a single apical cell, as in