Obs. 2. *R. Günteri* is referred by Arrhenius to *R. glandulosus*, to which it is doubtless very nearly allied. Its armature seems to differ and so does its panicle. Probably *R. thyrsiflorus* (Weihe) is only a form of this species; and that, together, they will take a place close adjoining to, but not absorbed in, *R. glandulosus*.

N.B. This plant is named, on my recommendation, *R. glandulosus* var. *subracemosus* in the 'Fasciculus of Rubi,' issued lately by the Rev. A. Bloxam.

III.—*On a peculiar Organ found in the Rays* (Raia, *Cuv.*).

By M. le Dr. Ch. Robin.

There exists upon each side of the tail of the Rays an organ which is not mentioned in any of the works which I have hitherto been able to consult. This apparatus however deserves, on more than one account, to attract the attention of physiologists, and probably of physicists also.

The two organs united form nearly the third of the entire bulk of the tail of the Rays. The bulk of each, at its largest part, is in one of these fishes of an average size, nearly that of the index-finger. Their origin is towards the union of the first and second quarter of the caudal appendage of the Rays, and they terminate in a point at the extremity of the latter. Their anterior extremity is soft and more or less slender, according to different individuals: it swells gradually as far as the middle of the tail of these fishes; the volume remains the same as far as the origin of the posterior quarter, whence it diminishes finally to the end. This organ is at first almost cylindrical, though a little flattened on the sides (to about the extent of the anterior quarter); in the whole of that part it is enveloped by several thin and concentric muscular layers. These muscles soon terminate in as many aponeurotic layers; the organ then becomes subcutaneous, and at the same time its form changes, becoming round externally and flattened within. In a word, this organ, separated from the tissues to which it adheres, presents the form of an elongated fusiform body, swollen in the centre, more or less blunt at the extremity, and always flattened upon its internal surface.

In a Ray one metre* long, the tail was 49, and the organ 36 centimetres in length; 11 millimetres in the transversal direction, and 13 from above downwards.

The tissue of this organ has the semitransparency of gelatine, but more consistence, and its colour is a clear translucid gray. It is furnished with a general fibrous envelope, which adheres to the adjoining tissues by aponeurotic membranous layers ranged at regular distances.

* The metre is equivalent to 39·37 English inches.

I have already said that its anterior portion was completely surrounded by some concentric muscular layers, and then that it became subcutaneous in its three posterior quarters, for the greatest part of its surface. I add, by way of more detail, that its internal surface alone is not subcutaneous, and is separated from the vertebral column by the two long muscular and tendinous bundles intended to move the caudal vertebræ. Its upper margin is traversed by a large subcutaneous vein, a branch of the lateral vessel; its external surface is traversed by the lateral vessel itself, which is accompanied by the lateral nerve. This nerve is situated betweeen the organ and the skin, throughout the whole length of the subcutaneous portion.

After these details on the relations of this apparatus with the adjacent organs,—relations, moreover, common to all the species of Rays,—I proceed to make known the *texture* of the tissue peculiar to this organ and the distribution of its vessels and its nerves. For this purpose I shall adopt a comparative course, that is to say, at each step I shall refer to the relations of this organ with those which most resemble it in other fishes.

On examining attentively the apparatus in question, we observe that its substance does not constitute an uniform gelatinous mass, but that it is divided into a large number of polygonal flattened discs by the partitions of cellular tissue. These discs have consequently two surfaces larger than the rest, one turned forwards, the other backwards. With respect to the faces of the circumference, they are in number three, four or five, which gives the discs a triangular, tetragonal or pentagonal form; their smallest diameter measures the thickness of the disc, which is 1 millimetre in nearly all the species. The diameter of the large surfaces, which measures the height of the disc, is 2 mill., one more in the *Raia rubus* and *R. batis*, and 3 to 4 mill. in the *Raia clavata*.

From this difference it follows, in the greatest diameter of the discs according to the species, that in a transverse section of the organ, from eleven to fifteen discs are counted in a *R. clavata*, and twenty to twenty-five in the *R. rubus* and the *R. batis*. The volume of the discs increases with age and the size of the individuals, but their number does not appear to increase.

These gelatinous discs are piled up one upon another, in the direction of the length of the apparatus, by the adherence of their broad faces, with the interposition nevertheless of a thin cellular partition. These longitudinal rows of discs are arranged side by side, reunited by a cellular partition thicker than that which separates each disc from that which follows or precedes it. The kinds of longitudinal columns represented by the piled-up discs are not rectilinear and do not all follow the length of one

of the faces of the apparatus; but they are more or less contorted, and are interrupted at intervals. The interruptions proceed from the discs becoming at intervals irregular, more narrow, and the series of discs terminates ordinarily in a very small, triangular one. It follows from these anatomical arrangements, that on the surface of the organ we may perceive one of the small faces of each of the superficial discs, and study very regularly the elongated, quadrilateral or lozenge-shaped polygonal, sometimes hexagonal form which it assumes in consequence of the reciprocal pressure which it undergoes from the adjoining discs. We may moreover very easily perceive that when the discs of a series begin to lose their form and are interrupted, there exist at the side other irregular discs which commence a new series. It is to be remarked also that the discs are ranged more regularly on the internal surface of the apparatus in the *Raia rubus* and *R. batis* than in the *Raia clavata*; in the first two species we also observe on the internal surface of the organ, that one of the partitions which separates the series of discs on the internal surface, follows its whole length and is of greater thickness than the rest: it is formed by glistening aponeurotic fibres, and it forms a sort of longitudinal pile into which the vessels and the nerves penetrate.

With respect to the gelatinous substance of the discs, magnified 400 diameters, it is seen to be hollowed out by cavities, and the walls of the latter are hollowed by cavities gradually lessening in size. The substance too which circumscribes these areolæ (to which we shall recur hereafter) is hyaline, homogeneous and transparent; it is studded with extremely fine molecular granules. From one spot to another are very regular granular spheres of $0^{mill}{\cdot}0050$, surrounded by a very pale circular mass of granules similar to the preceding. It is impossible to recognise veritable cellules with walls and nuclei, and it is easy to see that the preceding areolæ are not cellules; we shall soon speak of their uses. On the margins of the discs, the homogeneous gelatinous substance presents regularly undulated striæ which it would be impossible to take for fibres.

At the point at which we are arrived, it is impossible not to recognise a great analogy between the semitransparent gelatinous substance which essentially constitutes the discs of the peculiar organ of the Rays, and that of the prisms of the apparatus of the Torpedo, the rhomboidal meshes of the *Silurus electricus*, and those interrupted ones between the transversal and vertical fibrous laminæ of the *Gymnotus*.

Although there may be differences in form between the discs of the organ of the tail of the Rays and those which constitute the prisms of the electrical apparatus of the Torpedo, these differences are certainly less considerable than those of the portions

of gelatinous substance circumscribed by the partitions and areolæ of the apparatus in the *Silurus* and *Gymnotus*, which however produce similar effects to those of the Torpedo.

The mode of arrangement of these discs is as regular in the Ray as in the Torpedo, and approximate much nearer to the latter than to that of the same parts in the apparatus of the *Silurus* and *Gymnotus*.

The nerves of this apparatus originate in the portion of the spinal marrow which is prolonged into the caudal vertebræ. I have an object in view in remarking that this portion of the spinal marrow must be composed of sensitive and motive nervous fibres, for it corresponds to the portion called *cauda equina* in the higher animals.

The nervous roots which originate from this organ do not take their rise together at the same level, but there springs alternately an anterior and a posterior root. It is always from the anterior one (before its anastomosis with the posterior) that the greatest number of nerves which exist in the apparatus proceed; lastly, some issue from the ganglion and the lowest branch of the two which proceed from it. These nerves are of the number of four to seven for each nervous pair. They are, as is seen, very numerous, and their diameter is from $\frac{1}{5}$ to $\frac{1}{2}$ millimetre. These nerves are finally distributed in the thickness of the partitions which separate the lateral muscles from the tail, when they penetrate into the organ, after being more or less subdivided. In the *Raia rubus* and *R. batis* the greatest number penetrate into the longitudinal pile of the internal surface; in the *Raia clavata* they penetrate into some one of the partitions of that surface. In these three species several branches wind round the superior and inferior margins of the apparatus to penetrate into one of the partitions of its subcutaneous portion. In the first two species these superficial branches freely anastomose before penetrating.

It results from these facts that a considerable number of nerves extend into the partitions of each series of discs infinitely subdividing. From these subdivisions part the filaments which penetrate between the partition which separates each disc from that with which it is in contact. This filament expands opposite to the anterior face of each disc, but never does a single one penetrate into the substance of the disc. The nerves spread out on the internal surface of the partition between it and the disc. No single thread ever ramifies against the posterior face of the disc; we shall soon see that this surface receives only vessels.

The elementary fibres of the nervous filaments have a double character; that is, they are true elementary nervous tubes traversed by a semifluid substance which escapes in drops of variable forms from their extremities when torn across. [These observa-

tions however would require to be verified upon animals fresh captured.]

The elementary tubes which spread out against the prism are from $0^{m}{\cdot}01$ to $0{\cdot}013$, that is to say, half the diameter of the elementary tubes measured on the nerves at the point of their penetration into the apparatus. The elementary nervous tubes do not terminate in a net-work, but actually in very large meshes, to effect which they fork out several times into two or three branches and anastomose by inosculation.

These facts rest on the clearest evidence, being easily proved even with a magnifying power of 100 diameters. The semifluid nervous substance contained in these elementary tubes may be made to flow out, and be seen to penetrate into each of their subdivisions and anastomoses. These anastomotic terminations of the elementary nervous tubes have already been proved to exist by Savi, in his "Anatomical Investigation of the Torpedo (1844)." He has also proved this fact in the partitions which separate the discs of gelatinous substance of the electric apparatus of this fish.

The last facts which I have just established exhibit a still greater analogy between the organ in question and the apparatus of the electric fishes. It is true that these nerves proceed from the termination of the spinal marrow, that is to say, from the *cauda equina*, but the same fact takes place in the *Gymnotus*, the most potent in its discharges of the electrical fishes, whose electrical organs however, according to Hunter, do not receive a mass of nerves proportionably so considerable as those of the Torpedo. In the Ray, as in the *Gymnotus*, the mass of the nerves sent to the electric apparatus by each nervous pair, is at least as considerable as those which they transmit to the skin and the muscles. The lateral nerve does not in the Ray, any more than in the *Gymnotus*, send any filament to the organ in question.

The nerves of the electrical apparatus of the *Silurus*, examined by Geoffroy St. Hilaire, M. Valenciennes, Rudolphi and Peters, proceed from the lateral nerve, a branch of the eighth pair.

Thus there is nothing constant in the origin of the nerves of the electrical apparatus, as they proceed sometimes from the eighth and ninth pair (*Torpedo*), sometimes from the eighth pair alone (*Silurus*), sometimes from the pairs which arise from the spinal marrow (*Gymnotus* and *Raia*). Their situation has also no constancy, as they are sometimes situated towards the head (*Torpedo*), around the body (*Silurus*), and on each side of the tail (*Gymnotus* and *Raia*).

The vessels of this organ are numerous and curiously arranged. Between the articulation of each vertebra there passes a vessel, alternately an artery and a vein, proceeding from the principal

artery and vein of the tail. These two vessels never pass together to reach their foramina, and they never traverse the inferior spinal apophyses, like the nerves, to issue from the spinal canal. Beyond the vertebræ, the vessels follow the course of the nerves, and penetrate with them into the apparatus. Several branches ramify on its surface, surround it with their anastomoses, and from the plexus which they form, some branches are detached, destined either for the skin or the adjoining muscles.

Those vessels which penetrate the thickness of the organ are there subdivided infinitely in the partitions of connective tissue which separate the discs from one another.

From the plexus formed by the arterial and venous ramifications capillaries are given off, which are directed towards the posterior face of the disc which is in front of them, and penetrate into its substance. A capillary vessel never penetrates into the anterior surface of a prism; but we have stated that the nerves ramify opposite to or against that surface. The capillaries which penetrate the discs are very elegantly arranged in flexuous loops, and are sometimes agglomerated in the form of tufts. These loops and tufts are lodged and buried in the cavities by which the disc is hollowed out; these excavations exist only on the posterior face of the discs, whilst the anterior face against which the nerves are arranged is smooth. The capillaries which are buried in the discs are from $\frac{1}{10}$ to $\frac{1}{25}$ of a millimetre in diameter.

To sum up the matter, there exists in the Rays a pretty voluminous organ, situated in the tail of that fish, as in that of the *Gymnotus*. [From a letter which I have received from Prof. J. Müller, Rüppell would appear to have described an organ analogous to the former in the tail of the fishes of the genus *Mormyrus*.] This organ of the Rays receives fine but very numerous nerves. It is formed of a gelatinous semitransparent and firm matter, as in all the electrical organs known. This substance is, as in all these fishes, divided into polygonal discs, regularly piled together, against which nerves ramify that terminate by successive bifurcations and anastomoses supplied from their elementary fibres. How can we help seeing in this an electrical apparatus? It is true that its position is not the same as in the Torpedo, but in the *Gymnotus* and the *Silurus* the organ is also situated in the tail or around the body. These conclusions are further confirmed by the following facts: I have proved that this apparatus is wanting in the tail of the Torpedo and the genera *Mustelus*, *Scyllium*, *Squatina*, *Zygæna*, *Acanthias* and *Carcharias*.

The presence of this apparatus in the tail of the Rays explains the immoderate proportional length of this organ, its flattened form beneath, and the absence of the inferior lobe on the caudal

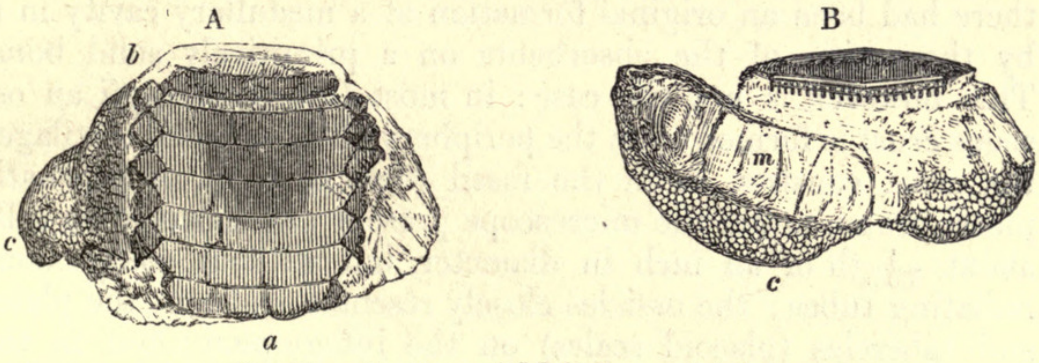
fin, which scarcely exists in the Rays. The anal fin is also wanting in the Rays, it is also wanting in the Torpedos; but all these fishes have a complete caudal fin, whereas it is wanting in the Rays, as I have just observed.

I am indebted to the kindness of M. Bibron for being enabled to ascertain that the other fishes allied to the Rays (*Cephaloptera, Myliobates* and *Pastinacus*) whose tail is terminated by a thin and extended whip or prolongation, do not possess this apparatus. The whip is formed of a portion of the tail, which the electrical apparatus would occupy if it existed.

As we have just seen, this organ cannot be regarded as a gland, for it has not the structure of one; it does not possess an excretory duct, it does not communicate in any part with the inside, and no gland receives so many nerves of animal life*.

IV.—*Notice of an Ichthyolite from Sheppey, in the collection of Mr. Tennant, F.G.S.* By Prof. Owen, F.R.S.

The unfrequency of the discovery of any part of the internal skeleton of the cartilaginous fishes associated in a fossil state with the teeth, which are the most common evidences of the extinct *Chondropterygii,* induces me to send the following description of the Ichthyolite figured in cuts A and B, which has been kindly transmitted to me for that purpose by Mr. Tennant, F.G.S. It was found in the well-known and rich fossiliferous deposit of London-clay at the Isle of Sheppey, and consists of a portion of the premandibular bone (*c*) with six of the large median (*a*) and a few of the small lateral (*b*) dental plates of the extinct species of Eagle-ray, called by M. Agassiz '*Myliobates striatus.*'



Fossil under jaw of *Myliobates striatus.*

The first appearance likely to attract attention in the portion of lower jaw here preserved is that of a large medullary cavity at

* Nevertheless the proof of its being an electrical organ must depend upon its power of giving electric shocks. Such a property, in our common Rays, if it existed, could hardly have escaped the notice of fishermen, in the constant habit of handling large Rays, Skates and Thornbacks immediately after their capture.—Ed.

Robin, Ch. 1847. "III.—On a peculiar organ found in the Rays (Raia, Cuv.)." *The Annals and magazine of natural history; zoology, botany, and geology* 19, 19–25. https://doi.org/10.1080/037454809494486.

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