

ON THE BONES OF "*LOPHIUS PISCATORIUS*,"—ANGLER FISH,
DEVIL FISH, GOOSE FISH, &c., &c.

(Read 13th Feb'y. and 8th May, 1882.)

1. BEGINNING with the frontal bone. You will notice that in this fish it is divided by a serrated suture into two parts, each having on its outer edge a peculiar dentated margin; looking at the two parts as one bone, its central upper surface is depressed, and at about two-thirds of the length from the anterior ends it has two so-called spines on each outer edge.

2. The prefrontals of this fish, when compared with those of the Cod, have the appearance of being reversed, the side which is down in the *Lophius* appears to be uppermost in the Cod, this is in consequence of the attachment of the palatine bone to the anterior edge of the prefrontal, so that the palatine bone, with its teeth, follows nearly the line of curvature of the premaxillary. The long arms of the prefrontals are attached to the frontals underneath their outer anterior margins, and are largely supplemented with fibro-cartilage, extending between the anterior forks of the frontals.

3. The ethmoid is absent.

4. Post-frontals—each has upon it two short spines, and on its outer edge, between the spines, two depressions, the anterior the largest, and on its under side, at about the middle of the anterior depression, the bone forms an angular ridge, above the anterior edge, and in advance of which lies the orbitosphenoid.

5. The basioccipital, at its under posterior extremity, is wide, owing to the presence of thin bony plates for its attachment to the exoccipitals, and is somewhat contracted at its anterior extremity.

6. The basisphenoid is a much broader bone than that of the Cod, and has upon its lower side two arms projecting upwards and posteriorly, the wings being attached to these arms, and reaching nearly to the anterior extremity of the presphenoid. The vomer is inserted in a cavity within the presphenoidal portion of this bone.

A. Between the parietals and the posterior extremities of the frontals, lies a bone somewhat oval in shape and depressed in its

centre, it is attached to the parietals by suture, its anterior end by fibro-cartilage to the posterior extremities of the frontals, and it carries upon it the isolated ray of the first dorsal fin, together with its equivalent interspinous ray. It is a "*wormian*" bone.

7. The parietals—this fish, having **no median crest**, unite; near their posterior **extremities** they have each a small, so-called, spine, and are joined to the supraoccipital.

C. Immediately beneath the parietals, and extending from their anterior extremities, posteriorly, a little more than half their length, also supported by the exoccipitals, and extending transversely, united by a serrated suture directly under the suture of the parietals, are a pair of bones which would seem to serve in the *Lophius* the same purpose as the otoliths in the Cod fish; they are separated from the parietals in the dried skull by a delicate membrane, and on their superior surfaces are smooth and somewhat conical, having in each, on their outer margin, a deep angular depression; on their inferior surfaces they are rough and cancellated, and from the centre of their posterior margins a bar runs across each obliquely outwards to the lower margin of the depression which appears on their superior surfaces; this bar is perforated by a foramen of considerable size. I have not been able to obtain a fresh specimen of this fish in time to make a further examination of these bones.

8. The supra-occipital appears to be anomalous; it takes its rise from, and is ankylosed with, the neurapophyses of the Atlas, which together with it forms the very large foramen magnum, at the same time it forms, almost perpendicularly, a semi-circular cover to the upper posterior part of the skull, as you may see by reference to the skeleton.

9. The paroccipitals project nearly at right angles to the skull, for the peculiar attachment of the supraclavicles; looked at upon their under surfaces they are arrow-shaped, the longer blade of the arrow being on the outside, the shorter on the top of the skull.

10. The exoccipitals are very similar in shape to those in the Cod, but are each perforated by two comparatively large foramina of equal size.

11. The alisphenoids of the *Lophius* are largely supplemented with fibro-cartilage, in their attachment to the adjacent bones, and they are comparatively flat on their upper surfaces.

12. The mastoids, which are deep, short bones, together with the prefrontals, form the seat of the hyomandibulars; upon each there is a spine, and the points projecting from the outline of the skull are quite short.

13. In the *Lophius* I cannot find the squamosal.

14. The orbitosphenoids are extremely small and delicate membrane bones which lie beneath the posterior extremities of the frontals, immediately in front of the post-frontals; in their structure they are very beautiful.

16. The vomer has, in the one exhibited, at present only two teeth, one in each extremity or arm, but it may have had at one time three on each arm, most probably only two at the same time; the large skeleton before you has, as you will observe, two teeth on each arm. On its upper side, curved backward from the teeth, the vomer has a projecting bony plate forming a groove for the reception of the prefrontals, and its posterior extremity, as already stated, is inserted in the cavity of the pre-sphenoid.

17. The inter or premaxillaries are armed on their anterior edges, to their extremities with a row of teeth; those near the median line being five or six long teeth of a character similar to those on the dentary, the remainder are small but gradually increase in size toward the extremity of the bone. On their posterior edges there is a row or rows of teeth extending about half the length of the bones, and speaking generally, decreasing in size from their superior extremities. These bones are from the enormous size of the gape, long and somewhat thin plates; from their superior extremities gradually narrowing for about half their length, their breadth then increases and they terminate inferiorly in a somewhat (posteriorly) scymeter shaped edge. The processes for their attachment to the maxillaries and nasal bones are flat, and in a line following the general line of the top of the skull, but their extremities are oblique, receding from the central line.

18. The maxillaries have upon their superior extremities somewhat lengthly depressed processes for their attachment to the intermaxillaries, so that their superior surfaces lie beneath the inferior surfaces of the processes of the intermaxillaries, and they also articulate with the vomer. That they may form their connection with the articularies they are twisted at one-third of their length from the extremities of the processes already mentioned, so that their inferior are nearly at right-angles to their superior terminations. These bones gradually increase in breadth from their superior until a short distance from their inferior extremities, when they taper to a point.

19. The *Lophius* has no suborbital ring.

20. The turbinal bones (nasal—Owen) are strong and firm, having the same structure as the premaxillaries; their anterior extremities articulating with the posterior superior extremities of the premaxillaries; at this point in the living fish they are capable of considerable lateral motion, and they are attached to the premaxillaries by flat terminations in a line perpendicular to the axis of the fish; at about one-third of their length from their anterior extremities they each assume an irregular triangular form, and gradually taper to a point; at their centres they are sustained by the prefrontals, and between them lies the peculiar spine which supports the first and second rays of the first dorsal fin.

22. The palatine bones articulate between the maxillaries and the prefrontals, close to the toothed arms of the vomer, and on these bones the teeth, of which there are four to six long, and about six short (these latter generally increasing in size as they tend towards their inferior extremities), lie nearly in a line with those on the vomer. On the superior extremity of these bones are two of the so-called spines, which, as they rise above the maxillaries, are generally enumerated in descriptions of the outside of the fish. The inferior extremities of these bones are attached to the inferior edges of the pterygoids.

23. The hyomandibulars have very broad double surfaces for their articulation with their bases, and are very much enlarged at their upper posterior edges. An examination of these bones

will show you that this is essential to the support of part of the opercular apparatus. On their interior inferior terminations there are no prominent surfaces for the articulation of the stylohyals but they rest in a groove and have thin ligamentous attachment.

24. & 25. The pterygoids and entopterygoids are represented in the *Lophius* by single bones, one on each side, which are of an irregular oval form at their posterior, assuming a subtriangular shape at their anterior extremities, and have small processes which connect them with the quadrate bones. They are very thin membrane bones, and the portion below their processes may be taken to represent the pterygoids, for to them are attached primarily the palatines. The upper portion of these bones will represent the entopterygoids.

26. The quadrates, as well as the other bones connected with them, are, for such large fishes, very delicate. The condyles, for their union with the articularies, are exceedingly small, and appear on the inner sides of the bones; rising from them are ridges, folded posteriorly, against which abut the preopercular bones: below the condyles, extending posteriorly and downwards, at a small angle, these bones present somewhat broad surfaces, having at their posterior edges sharp points or spines, which, when the fish closes its mouth, are easily seen.

27. The metapterygoids are very delicate fan-like plates, having narrow thickened edges, which, at their upper arms connect with the hyomandibulars nearly in their centres. These edges are a little wider, and have projecting processes for the attachment of the ligaments which tie them to the prefrontals.

28. The opercula are long and narrow, nearly straight, bones, which articulate with the hyomandibulars just below their junction with the mastoids and prefrontals, they are almost flat on their inner, and have ridges on their outer surfaces; beginning at the centre of their superior and terminating at their anterior edges on their inferior extremities, these ridges support the subopercula; at their superior extremities, they throw out posteriorly each a long slender fin-like ray.

30. The preopercula are small and narrow curved bones, angular at their posterior edges, having ridges upon them which show

on their outer surfaces, and which support the posterior arms of the hyomandibulars; on their inner surfaces they are irregularly flattened, and terminate in an acute angle, abutting for more than half their length against the ridges which rise from the condyles of the quadrates.

32. The subopercula: these are of very peculiar form, and are attached to the anterior faces of the ridges on the opercula bones for rather more than one-half the length of the latter; they decrease in size as they rise, terminating in flattened points which lie close to the opercula; from them extend anteriorly long processes to which fibrous tissue is attached, forming the connection between these bones, the subopercula and epihyals; posteriorly, they are produced into long, fin-like rays, sixteen to eighteen in number, connected by membrane, which gives them a strong resemblance to a fin. At the bases of their anterior processes there are two of the so-called spines. The inferior extremities of the opercula bones extend a little beyond the solid part of these bones, and to about one-third of the breadth, when extended, of the fin-like rays.

33. The interopercula are somewhat triangular in shape, having upon their superior outer extremities peculiarly-shaped processes, to which, at their inner edges is attached the thin tissue connecting them with the preopercula and with the long arms of the opercula bones (not plates). From the superior outer edges of these bones descend their attachment to the epihyals from which thickened branches are sent out to support the anterior angular extremities of the singularly-shaped subopercula bones, and from their anterior extremities strong ligaments attach them to the posterior extremities of the articularies on their inner sides, enveloping at the same time the posterior extremities of the angulars. These bones lie immediately beneath the preopercula, the ossa sympletica (mesotympanic—Owen) and the posterior part of the quadrates.

31. Ossa sympletica (mesotympanic—Owen). These bones lie between the metapterygoids, the preopercula and the forks of the quadrates. They have double anterior margins for the reception of the metapterygoids and the anterior margins of the forks

of the quadrates. They are very thin narrow plates, single at their posterior edges and nearly smooth on their outer surfaces, with an irregular outline. On their under surfaces, at their superior extremities, they have short ridges nearly in their centres, extending downwards about one-third of their length. Against these ridges rest the stylohyals, which are at their upper extremities attached to grooves in the hyomandibulars.

34. The dentaries are long and narrow; at their anterior extremities they are united by symphysis, and support two rows of teeth upon their inner surfaces, one of full size, and the other in various stages of growth; on their lower anterior extremities there are processes for muscular attachment, and on their posterior inner surfaces is the space for *Meckel's* cartilage.

35. The articularies fit into the spaces or grooves of the dentaries. On their upper surfaces the superior anterior faces join the dentaries in sharp points and widen posteriorly to a considerable breadth; at nearly their superior posterior outer edges each has a projecting spine, and on the inner inferior edge processes for connection by ligament with the quadrates; immediately posterior to the spines is the articulation for the condyle of the quadrates. The heads or posterior extremities of these bones extend about one and a quarter inches beyond the anterior edge of the articulation, and upon them rest the spine and the superior part of the broad inferior extremity of the quadrates. From the superior posterior extremities of the dentaries the posterior extremities of the articularies reaching to the anterior edge of the articulation for the condyles of the quadrates rapidly fall, and form a triangular surface, which appears to be for the attachment and play of the maxillaries.

36. The angulars are exceedingly small and thin flat bones, situated on the inner sides of the posterior extremities of the articularies. They have small heads, which are turned outwardly and overlap the articularies.

29. Stylohyals. These bones, as already mentioned, lie in grooves in the hyomandibulars, and are small and somewhat tapering towards their superior extremities and have a ligamentous attachment.

37. Epihyals: these bones are long. At their posterior extremities they are narrow and curved inwards and upwards towards their junction with the stylohyals. They widen out at their anterior extremities, where they present themselves as thin bony plates. On their upper inner anterior edges there is on each a splint, which unites it with its

38. Ceratohyal: these, which are comparatively very long bones, have at their superior anterior extremities processes which connect them with the epihyals, giving to them *in situ* the appearance of having thickened superior edges. The Ceratohyals on their lower posterior extremities present the same thin edges and of equal width with the epihyals. In the anterior third of their length, midway in these bones, on the outer side, is a groove for the reception of part of the branchiostegal rays, of which two on the inner side of the bones are the anterior, and four on the groove mentioned the posterior. At about half their length on the superior surfaces there is on each of these bones a process for their attachment by ligament to the angulars and dentaries, and at this point the bones are twisted so that their inferior are nearly at right angles to their superior extremities.

39, 40. Basihyals: these bones, two on each side form the base of the hyoidean arch; in the *Lophius* they are of irregular shape, and the upper pair present long posterior processes which unite them by squamous suture to the inner side of the ceratohyals at their upper anterior extremities; the lower pair are small, thin and somewhat triangular plates, which are attached to the lower anterior extremities of the ceratohyals. In the *Cod* the lower pair are much the larger bones.

41. The glossohyal, which lies between the basihyals and the

42. Urohyal, which is directly beneath it, are both extremely small bones.

43. The branchiostegals are very long and thin bones. There are six on each side, and in the absence of ribs they serve to form the large abdominal cavity of the *Lophius*.

53. There are in the *Lophius* no representatives of the basi-branchials.*

* I have not yet found any; but will make further examination as soon as a new specimen is obtained.

56. The lower pharyngeals are flat, and have at their posterior extremities a somewhat spatulate shape, gradually tapering to their anterior extremities, from which points to about one-half of their length they are strengthened by lateral ridges; on their outer and inner edges it may be said there are two rows of teeth occupying the anterior two-thirds of their length, the posterior third is for the attachment of the muscles, and between the rows of teeth the bones are somewhat rough.

57. The hypobranchials are not represented in the Lophius as in the Cod by three bones, but the inferior (anterior) extremities of the ceratobranchials of the three first branchial arches are prolonged curving inwards and posteriorly, and tapering to points they rest in, and are supported by the fibrous tissue of the floor of the mouth.

58. Ceratobranchials—the first three pairs of these bones are thin and delicate and there is a comparatively wide space between their inferior extremities; the fourth pair are longer than the others, but their inferior (anterior) extremities are slight and a short distance apart, but tied together by tough fibrous tissue which also serves to support the inferior extremities of the lower pharyngeals.

61. The epibranchials—the first pair in the Lophius are only short representatives of these bones and they do not rise to the support of the upper pharyngeals, but are attached to the ceratobranchials of the first arch in the usual manner, and to the epibranchials of the second arch, of which they are about one-third the length, their superior extremities fitting into a groove in the epibranchial to which they are also attached by ligament. At about their centres they throw out anteriorly, processes, which are slightly curved inferiorly, for their attachment to the muscles which govern the branchial arches. The second pair epibranchials are long and slender bones having expansions for the junction of the first pair, and at each extremity for their attachments inferiorly to their ceratobranchials, and superiorly to the anterior division of the upper pharyngeals, immediately beneath the process for the muscular attachment of this division. The third pair of epibranchials taper slightly from their junc-

tions with their ceratobranchials to about midway of their length, they then gradually enlarge until they reach the upper pharyngeals, to the median division of which they give partial support; at their upper third these bones are closely connected with the fourth pair, and are for a short space enveloped by them, in fact forming on each side a nearly rigid pair. At the superior extremities of these bones on the anterior faces of the median upper pharyngeals are processes for their muscular attachment. The fourth pair are longer and very much stronger bones than the others, being at their inferior extremities in proportion to the others as ten to three; on their posterior edges they are somewhat thin with double anterior ridges; they decrease in size until they reach the third pair, where they expand with shell shaped processes, which as already stated, partially envelop the bones of the third pair; at the junction with their upper pharyngeals they are less in size than at the enveloping process, and also tend to support the median division of the upper pharyngeals, while the posterior division may be said to be entirely sustained by them.

62. The upper pharyngeals contain each three plates or divisions (anterior, median and posterior), armed with teeth strongly curved posteriorly. The anterior divisions contain each ten to twelve teeth, and are narrow, having processes on their superior extremities for attachment of their muscles. The median divisions are somewhat triangular in shape, and their superior edges (the bases of the triangles), are more than four times the breadth of either of the other divisions; they have each on their superior edges a process for their muscular attachment, and each contains from eleven to fifteen teeth. The posterior divisions are also narrow plates; at their anterior inferior edges they are curved under and connected with the under posterior surfaces of the second divisions; on their superior edges there are processes for muscular attachment. These divisions contain each from ten to fourteen teeth.

46. In the *Lophius* the supra clavicle (sometimes called the post temporal) is on each side a broad spatulate plate, thin upon its edges, gradually rising to form a ridge along its anterior

centre: at about one-third of its length from its proximal extremity, the ridge mentioned becomes reduced, and this extremity droops so as to form its articulation immediately beneath the paroccipital and against the exoccipital, thus lying nearly at right angles with the vertebral column.

47. In this fish the interclavicle is not represented.

48. The clavicle is very difficult to describe; from the proximal extremity of its upper limb to midway of the lower limb, lines drawn through the centres of these portions of the bone would in general terms form a right angle; they are not unlike the wooden knee of a ship in the curve formed by the upper and lower limbs, the lower half of the lower limb curving towards the centre of the fish. Upon its proximal superior extremity the bone curves upward, and projecting above the supraclavicle, forms one of the spines of the head. A very long and strong spine rises just above the point of junction with the distal end of the supraclavicle. Upon the outer edge of the clavicle there is also a process for the attachment of the muscles, and at about one-third of the length (from its inferior extremity) of the lower limb of the clavicle, rises the ligament which serves for the attachment of the pelvic limbs.

49. Accessory bone: at the base of the long spine at the upper outer posterior edge of the clavicle, and attached to it, is the accessory bone (post clavicle, of some); it is thin and delicate.

52. Scapula: close to the accessory, and upon the clavicle, and close to its outer edge, is the very small fenestrate scapula, and immediately beneath the scapula, attached to its inferior edge, but lying, its central limb in the centre of what may be called the junction of the upper and lower limbs of the clavicle, is the (51) coracoid, which is an irregularly oval cup-shaped bone, the edges of which are attached to the clavicle, and from its apex a thin process projects angularly towards the outer edge of the clavicle, to which it is attached by cartilage.

53. The carpals, or brachials, in the *Lophius*, are (on each side) two in number, they are very long and are attached to the scapula, the coracoid, and to the clavicle. The upper carpal being about half the length of the lower, does not bear fin rays,

but serves for the support of the lower carpal, (which is also much stronger than the upper), as well as to the fin rays of the superior edge of the pectoral fin. The lower carpal at its lower posterior half, at the point of junction with the inferior extremity of the upper carpal, has a thin posterior edge which continues to its distal extremity, and round which, beginning at the junction with the upper carpal and continuing to its anterior inferior edge, the twenty-seven rays of the (65) pectoral fin are attached.

80. The pubic bones which support the ventral fins are each attached by a strong ligament to the clavicle (see 48) of its side at its upper edge, about the point where the posterior cartilage enters and is covered by the bone. The iliac portion, if it may so be called, being a shaft (containing cartilage), somewhat flattened at its anterior extremity, decreasing in size towards its centre, from whence it widens out to form the ischio-pubic elements, on the outer edge of which the six fin rays are attached, the posterior (82) five being soft rays, and the anterior ray (81) a comparatively short and strong spine, which has in most cases a slight upward and outward curve.

67, 68, 69. The vertebral column contains twenty-nine vertebræ. The Atlas as already mentioned (under No. 8), supports the supra-occipital; the atlas, axis and the third and fourth centra are wider on their superior and inferior surfaces, particularly the two first named, than the remaining centra which gradually taper to the caudal extremity. The vertebræ interlock on their inferior edges by angular processes, while their superior anterior edges are interlocked or supported by the neurapophyses of each succeeding centrum overlapping the posterior edge of its preceding neurapophyses, and they gradually decrease in size until about the nineteenth centrum, from this point being nearly of the same size to the twenty-seventh. The twenty-eighth and twenty-ninth centra have their superior processes very small, but the inferior interlocking processes are of the normal size. The axis is the shortest centrum in the column, being about half the length of the atlas, and not more than half its height at its outer edges. The twenty-eighth cen-

trum is about the same length as the twelfth, and the twenty-ninth is double the length of any other centrum.

The neurapophyses and neural spines. The processes rising from the atlas and supporting the supraoccipital may probably be looked upon as modified neurapophyses; those of the axis and third centrum at their inferior extremities having a greater space between them as these centra are wider than the others, the remaining neurapophyses conforming to the centra to which they are attached. The neural spines rise in height gradually from the axis to the ninth centrum, slightly fall at the tenth, maintain their height to the fourteenth, and diminish gradually to the twenty-first; the twenty-second and twenty-third meet with somewhat rounded points; the twenty-fourth, fifth, sixth and seventh are again slightly prolonged, but the structure of their posterior extremities is much like that of their centra. The posterior edge of the twenty-seventh centrum shows slight increase in median diameter, but the form of the twenty-eighth centrum is different from that of the others, it is marked by a prominence on its median line at each side, and at its posterior extremity the neural spine overlaps the twenty-ninth centrum for about one-half of its length. The twenty-ninth centrum has, extending for nearly two-thirds of its length from its anterior edge, on each side, a broad wing-like process beginning below the prominences on the twenty-eighth centrum, slightly rounded at its outer edge and drooping a little towards its posterior extremity; near its superior posterior extremity this centrum is rounded somewhat and flattened, and at its extremity, it is transverse to the vertical line: the termination of this centrum which supports the caudal fin is vertically narrow and perpendicular to the column. The neural spine appears in this centrum to be represented by an intercalated curved bone, the centre of which lies just posterior to a line drawn through the posterior edge of the anterior third of the centrum, and there are two foramina at the base of the neural canal, below the anterior extremity of the intercalated bone.

The two centra twenty-eight and twenty-nine, appear to be the analogues of the sacrum.

The Ventral aspect of the vertebral column: The Axis has no parapophyses, but at its anterior inferior edge a rounded ridge for its articulation with the basi-occipital, and from the posterior edge of this ridge there is an upward curve, which causes the posterior to be in vertical height to its anterior edge as three to five; the curve mentioned is continued in the axis and third centrum, making the vertical height of the three named less than that of the remaining centra, and not affecting the dorsal line.

The centra, from the axis to the fourteenth, gradually increase, and from the fourteenth to the eighteenth, decrease in vertical height; the remainder are nearly of the same height. It may be observed that while in most of the centra the conical cavities are of greater transverse breadth than vertical height, the reverse is the case in some of the posterior centra, with the exception of that between the twenty-eighth and twenty-ninth centra.

Between the basi-occipital and the anterior face of the atlas, the usual conical cavities exist, but the atlas taken by itself is neither amphicœlous nor procœlous, the conical cavity is found in its anterior face, extending deeply into the centrum, and the posterior *facet* has transversely a small anterior curve, but vertically at its central line it has a straight surface, inclining anteriorly, which causes a slight difference in the length of this centrum, between its upper and lower surfaces, the latter or inferior aspect being the shortest. The axis, which is very short, and the remaining centra, are amphicœlous.

The parapophyses of the axis and third centrum are very minute, if even they can be said to exist; they begin to appear on the fourth, and continue to and upon the *ninth centrum.

The hæmal arches are completed upon the tenth and eleventh centra by the coalescence of the hæmapophyses. The hæmal spines appear on the twelfth, thirteenth and fourteenth centra, and following the general line of the vertebral column, each lies in the anterior space between its posterior hæmapophyses. The spine of the *fifteenth centrum at its posterior extremity has a

* This is variable, as smaller and likely younger specimens show. In one the hæmapophyses do not coalesce until the fifteenth centrum; in another upon the eleventh, and in both of the above the parapophyses continue to and upon the tenth centrum, and also these two specimens show the curved hæmal spine upon the fourteenth centrum, these fish had only ten rays in the anal fin.

slight downward curve, and on the sixteenth it has attained its normal length and angle, and from this, to and including the twenty-seventh centrum, the spines gradually decrease in length and angle. The hæmal spine* of the twenty-eighth centrum is much elongated, and is almost parallel with its neural spine, it extends posteriorly beneath the twenty-ninth centrum for two-thirds of the length of the latter.

On the twenty-ninth centrum there is no hæmal spine, unless a somewhat thick and flattened edge on its posterior extremity may be said to represent it. In the wing-shaped processes at each side there is a foramen for the vessels, slightly posterior to the termination of the hæmal canal proper.

74 & 75. Dorsal fins. This fish has two dorsal fins, the first containing six spines, two of which are close together and near the nostrils, and are supported by a very peculiar dermal longitudinal spine situated between the turbinal or nasal bones; looking upon the superior surface of this spine, at its anterior extremity there is a narrow perforated projection which joins the apex of a flat kite-shaped process, the posterior extremity of which terminates in a sharp point curved slightly above the general line of the spine, and beneath which the spine has a flattened superior edge widening to its posterior extremity where it is quite thin and flat. On its anterior half the spine has at its anterior extremity, vertically, a very thin and deep plate, which is strengthened by the flattened edge and process above mentioned; this thin plate at its anterior inferior extremity is rounded, and curves posteriorly towards the middle of the spine and there disappears. As already mentioned the anterior portion of the longitudinal spine lies between the turbinal bones, and its anterior extremity is slightly in advance of the superior processes of the maxillaries; its posterior extremity extends to nearly the centre of the forks of the frontals. The length of the spine varies in different specimens, a small fish having sometimes a proportionately longer spine than a large one. The spine is enveloped by muscles which control its movements, as well as

* In one specimen before me, the length of the spine is nearly one and a quarter inches, while that of the twenty-ninth centrum is one and five eighths inches.

those of the first and second spinous rays of the first dorsal fin.

The first spinous fin ray articulates with the perforation in the longitudinal spine by what at first appears to be a bony link-joint, but the bifurcated inferior extremities of the fin ray are tied together by a firm cartilage, which, passing through the perforation or ring of the longitudinal spine completes the link-joint. Usually the first fin ray has upon it a fleshy looking lappet, which is supposed to be the bait this fish displays to attract its prey, but another use of it appears to be to warn the fish when it is in shallow water. This lappet is often lost by the fish and is said to be reproduced in a short time; when the large specimen was caught, it was without this bait, and it is possible that old age may put a stop to the process of recuperation.

The second spinous fin ray articulates with the longitudinal spine at the posterior extremity of the kite-shaped process, and is partially supported by it; the bifurcated extremities of this ray are much closer together than those of the first ray.

The third or isolated spinous fin ray, rises from the centre of the depression in the bone already referred to as "A," which has upon it a small longitudinal spine for its articulation; it is much shorter than the first two spinous rays, and in a large specimen, six inches behind the second spinous fin ray. The three remaining, or the fourth, fifth and sixth spinous fin rays cover a space of about three inches, the fourth being about three and a half inches in height, the two others successively shorter; the fourth ray (in the specimen above mentioned) is distant from the third, four and one-half inches, and all three lie above the vertebral column; the fourth ray above the neural spine of the fourth centrum, the fifth above that of the sixth, and the sixth ray above that of the seventh centrum, each having also above the column a small and nearly longitudinal spine which carries almost in its centre a small crest, behind which the fin ray articulates.

The second dorsal contains twelve soft rays, supported by twelve (74) interneural spines; the first spine is inserted between the eleventh and twelfth, and the twelfth between the twenty-second and twenty-third neural spines, and they are strongly bent

posteriorly, their anterior faces lying against the posterior edge of their anterior neural spine, while their superior extremities rise above their posterior neural spine. The first ray of the second dorsal is supported by the superior posterior extremity of the first interneural spine, and the anterior face or angle of the second, and so on until the twelfth, which is sustained by the posterior extremity of the twelfth interneural spine, slightly in advance of the posterior extremity of the twenty-fourth centrum; this last interneural spine is attached by its posterior extremity to the neural spine of the twenty-fourth centrum. The fin rays of the second dorsal, increase in length from the first to the sixth, and then decrease to the twelfth ray.

71. The caudal fin contains eight soft rays, the centre two of which are the longest, and about of equal length; the upper and lower rays, also of about equal length, are the shortest, and the fin when spread, presents at its posterior extremity a rounded outline. The two divisions of the upper ray on their superior edges, as well as those of the lower ray on their inferior edges, unite, and form each an angular edge, but that of the upper ray is much the stronger.

83. The anal fin and interhæmal spines.

79. The interhæmal spines of the anal fin, are ten in number; the first lies between the fifteenth and sixteenth, and the last two or ninth and tenth, between the twenty-third and twenty-fourth hæmal spines, that is both on the twenty-fourth centrum. The fish described has *eleven* anal rays, the first of which articulates with the anterior edge or angle of the first interhæmal spine; the second with the anterior angle of the second interhæmal, and is also supported by the posterior extremity of the first, and thus they continue to the tenth; the eleventh fin ray is attached to the posterior extremity of the tenth interhæmal spine, immediately beneath the centre of the twenty-fifth centrum. The rays of the anal fin increase in length to, and including the seventh, and decrease slightly to the eleventh. In most specimens, the Lophius presents in the anal fin only ten rays; in these the first interhæmal spine may be inserted between the fourteenth and fifteenth, or between the fifteenth and six-

teenth, and the last two between the twenty-second and twenty-third, or between the twenty-third and twenty-fourth hæmal spines, in other words upon the twenty-third or twenty-fourth centrum, (I have specimens of both before me), in this case the last interhæmal spine is very short and does not reach the extremity of its posterior hæmal spine.

72. The Lophius has no ribs.

In conclusion, I would mention that the foregoing paper when read, was illustrated, by the disarticulated bones of the skull, &c., as well as a skeleton of a Lophius, together with the disarticulated bones of the skull, and a skeletal head and shoulder-girdle of a codfish (*Gadus morrhua*).

ART. VII.—ON THE RAVAGES OF THE TEREDO NAVALIS, AND LIMNORIA LIGNORUM, ON PILES AND SUBMERGED TIMBER IN NOVA SCOTIA, AND THE MEANS BEING ADOPTED IN OTHER COUNTRIES TO PREVENT THEIR ATTACKS. BY MARTIN MURPHY, ESQ., *Provincial Engineer*.

(Read Monday evening, 13th March, 1882.)

AMONG the questions which interest the engineer in the Maritime Provinces of the Dominion of Canada, there are none of greater importance than the means whereby the ravages of the *Teredo Navalis* can be checked or prevented. I think I may say that here, as in many other instances, where the operations of nature interfere with the designs of man, we can only remedy these difficulties by a precise knowledge of their causes, a knowledge which may enable us, if not to check, at least to avoid, some of the evil consequences. We know that innumerable boring animals establish themselves in the lifeless trunk of the piles and other submerged timbers of our wharves, piercing holes in all directions into their interior, like so many augers, penetrating the timber in every direction, until they actually destroy its solidity, and dissolve its connec-