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ON THE BONES, ARTICULATIONS, AND MUSCLES OF THE RUDIMENTARY HIND-LIMB OF THE GREENLAND RIGHT-WHALE (*Balæna mysticetus*).

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(C.) THE MUSCLES.

THE muscles connected with these bones may be arranged in four groups, three of which connect them with other parts,—(1) internally with the genital organs; (2) a posterior or caudal mass; (3) an anterior or trunk mass; (4) the fourth group those by which these bones are connected to each other.

19. *Relation to the Genital Organs.*—(*a*) *In the male.* Reference in the first place to the drawings and their explanation (figs. 11 and 12, showing both aspects of these parts), will greatly facilitate the understanding of this relation. The following account is from the dissection of the half-grown male, No. I.:—The crus penis has no direct connection with the pelvic bone, but is set upon a great ligament (interpelvic ligament) which connects together the hinder ends of the pelvic bones. The crus begins by a free conical end which projects an inch behind the interpelvic ligament. Seen from above, the crura are of nearly uniform diameter (about 2 inches), and rounded in form, but larger transversely than vertically, and, after an oblique course of about 6 inches, unite in a broad common body, from which the single corpus cavernosum, scarcely larger than one of the crura, and more or less compressed laterally, is sent forwards. The space between the converging crura is occupied by

a strong ligament (triangular ligament) which is pierced near its fore part by the urethra, and is partly concealed on the under aspect by the bulb of the corpus spongiosum, which projects backwards behind the point where the urethra enters it. On its under aspect the crus forms an ovoid enlargement or bulb, caused partly by a development of erectile medulla, partly by a great thickening of the fibrous cortex on this aspect.[1]

[1] The differences of the internal structure of the penis before and behind the horse-shoe septum may be shortly noted here, as they are not without relation to the surrounding muscles. *Behind the horse-shoe septum*, the *bulb of the corpus spongiosum*, 5 to 6 inches in length by about 2 in breadth, is seen on section to be composed of erectile tissue enclosed in a white fibrous covering. The latter is $\frac{1}{4}$ inch thick behind, gradually becoming thinner forwards to $\frac{1}{8}$ or $\frac{1}{10}$ inch; but at the horse-shoe septum it is $\frac{3}{8}$ thick. All along the middle line it attaches the mesial septum between the posterior compressor muscles. The erectile tissue is loosely reticular, and presents many large and small vascular mouths. In the part behind the entrance of the urethra, about 2 inches in length, the erectile mass is semicircular in form, $1\frac{3}{4}$ by 1 inch, but only half that behind, where the cortex is thick. After the urethra has entered, the mass becomes smaller and more depressed ($1\frac{1}{2}$ by $\frac{3}{4}$ inch), the urethra adhering to the slightly concave upper wall. The *triangular ligament* forms the enclosing wall above. This ligament is continuous on each side with the fibrous tissue of the crus, and behind with the interpelvic ligament. It is a thick and firm structure, at first $\frac{3}{8}$ thick, thinner towards the perforation for the urethra, and here the fibres, instead of being transverse, curve forwards and outwards on each side of the urethral aperture. A number of arteries, 8 or 9 large and several smaller, here enter the crus, and several of large size enter the crus earlier and farther out opposite where the erectile tissue of the crus begins. The *crus penis* for the first two inches, including the conical end, is solid, composed of fibrous tissue densely interwoven. The rest of the crus contains an elongated *medulla* of erectile tissue, in the collapsed state about the size of the forefinger, largest transversely; but the fibrous cortex is easily stretched by the forceps to twice that diameter. It is finely reticular erectile tissue, showing some large and many small vascular mouths, the reticulum less open than that of the erectile tissue of the bulb. Its brown colour and open texture mark it off everywhere abruptly from the dense white fibrous tissue of the cortex, but the trabeculæ are continuous with the cortex. This erectile medulla commences abruptly by a rounded end nearly on a level with where the fore part of the interpelvic ligament joins the crus; is largest 2 inches in front of this, diminishes a little along the anterior third of the crus, and finally at the horse-shoe septum unites with its fellow in the single and very differently-constructed medulla of the corpus cavernosum. The *fibrous cortex* is much thicker on the under than on the upper aspect of the crus; $\frac{3}{8}$ inch above, below nearly 1 inch. The fibres are arranged circularly round the medulla, except those which give the increased thickness below. Here there is, as it were, a superimposed stratum forming more than half the thickness of the wall, composed of coarsely interlacing bundles, partly radiating to where they run out as the horse-shoe septum, and behind it running out in rough ridges on the surface in the direction of the fibres of the posterior compressor muscle. Over this area the

The Interpelvic Ligament above noticed is attached to the blunt posterior end of the pelvic bone (the cartilage intervening) like a fibrous continuation of the bone. Here it is 1½ inch thick antero-posteriorly by 1 inch vertically, composed of soft flexible white fibrous tissue. After a length of nearly an inch it supports and mainly ends on the enlarging crus, but sends strong bundles

surface of the crus is thus rendered hard and roughly streaked in contrast with the smoothness of other parts of the crus. Where the crura first unite, the white fibrous tissue, besides encircling the erectile medullæ (here 3 inches apart), forms a great transverse commissure ¾ inch thick vertically, but along the next 3 inches, till the erectile medullæ meet, the transverse commissural arrangement of the intervening fibrous tissue is replaced gradually by an interlacement, and then by a breaking up into vertical bundles.

In front of the horse-shoe septum, sections of the part surrounded by the anterior compressor muscle show a different internal structure from that of the crura, or of the part in front of the muscle. The whole organ is flattened laterally, the medulla of the corpus cavernosum, also compressed laterally, has little of the erectile character, and the corpus spongiosum becomes smaller and more rounded. The proportions are seen in fig. 15, showing a transverse section made 3 inches in front of the horse-shoe septum, about midway between that septum and the back of the broad dorsal interval. Here the sizes are,—the whole organ, without the mesial septa of the muscles, vertically 4 inches, transversely, at the broadest part, 1⅞; medulla of c.c., 1 inch by ⅝ inch; c.s. vertically, 1¼ by 1 inch. The organ is less flattened at first, and also forwards as it emerges from the muscle, presenting more a vertically oval form. The medulla of the c.c. is distinctly enough marked off by its brown colour and softness. At first it is blunt-pointed above, flattened at the sides (¾ by ½ inch), and presents an obscure white fibrous septum rising from below, between which and the fibrous cortex passes the fine fibrous tissue which appears to form the bulk of the medulla. The fibrous cortex is thicker than the medulla, except below, where it is only ¼ inch thick. Towards the fore part of the muscle the medulla becomes gradually broader, and trabeculæ radiate from the thick solid septum below. Just in front of the muscle the medulla is semicircular, 1 inch both ways, and the radiating trabeculæ are more marked. At first the medulla contains at its upper part two large vascular mouths, represented farther forwards by one large mouth nearly ¼ inch in diameter and nearly as large as the urethra. No other channels are seen until the medulla begins to broaden and become marked by radiating trabeculæ, when, instead of one large vessel, there may be twenty of good size arranged mostly at the sides and top, the largest not at the top. The *corpus spongiosum* continues to present the same open erectile tissue, at first 1¼ inch transversely by ¾ vertically in the collapsed condition. It diminishes forwards until, on emerging from the muscle, the entire mass is only half an inch in diameter, and now of a rounded form, having farther back been of a vertically oval form. The enclosing fibrous cortex is about ¼ inch thick. The *urethra* is now surrounded by the erectile tissue, but lies towards the top. Though not over ¼ inch in diameter in the sections, the urethra admits of being greatly distended, so as easily to admit the forefinger where the corpus spongiosum is large enough.

over the deep aspect of the crus to join its fellow of the opposite side, thus forming a strong transverse ligament uniting the two pelvic bones. Its free posterior edge forms a prominence internal to the apex of the crus and is then concave. The length of the ligament between the cartilages is 8 inches, between the crura penis fully 4 inches, and here it is fully half an inch thick.

In the full-grown male, No. VII., only the parts near the bone remained. The *interpelvic ligament* was much larger than in No. I., about $2\frac{1}{2}$ inches thick at the end of the bone. It sent two strong prolongations on the bone,—one on the superficial aspect for about 5 inches as a fibrous ridge, prismatic in section, its sides increasing the surface for the muscles attached here, and some of the fibres of the great posterior ligament of the femur arose from it; the other along the inner side of the bone, at first sharply prismatic and then gradually less, until it subsided 4 or 5 inches forwards, presenting an approach to the greater expansion here in the female. The remarkable difference in size and form of the hinder end of the pelvic bone in Nos. VII. and VIII. is noted under section 4. These prolongations in No. VII. may have been partly related to the tapering form of the end of the bone, while the great blunt end in No. VIII. would seem to imply the abrupt attachment of an enormous interpelvic ligament.

The Genital Muscles.—A glance at the drawings (figs. 13 and 14) will show that the crura penis and first 12 inches of the corpus cavernosum are enclosed by a great tubular muscular mass. On the upper aspect it appears as one muscle (the great compressor), mostly meeting its fellow in a median raphé, which is the free edge of a fibrous septum, but separated at the fore part by a broad elongated interval in which the corpus cavernosum appears. On the under aspect another median raphé, also the free edge of a deep fibrous septum, runs the whole length, but the muscular mass is divided by a semicircular raphé, the free edge of a deep fibrous septum (horse-shoe septum) into an anterior and posterior portion. The anterior (the great compressor) is continuous with, or part of, the great muscle seen on the upper aspect; the posterior (posterior compressor) is completely cut off from it by the septum, and is concealed at the sides and behind by another muscle (levator ani), also attached

to the horse-shoe septum, from which it passes backwards to a superficial median raphé and behind that to the rectum, separated from the posterior compressor by the rope-like retractor muscle.

(1.) *The great Compressor Muscle* arises continuously from four different parts. First, as seen on the *upper aspect* (fig. 14, *l*), it arises from the whole length of the inner slope of the body of the pelvic bone, and from the inner border as far forwards as the middle of the angular region, a length of 8¼ inches in this half-grown specimen. The fibres, in large bundles, pass obliquely forwards and inwards, and are inserted into the mesial raphé and septum. The inner part of this aspect of the crus penis is only covered by the muscle, separated by loose areolar tissue, but the muscle is attached to the outer part of this aspect of the crus, arising from it behind the pelvic bone, the deeper fibres soon inserted into it farther on, while the more superficial pass to the mesial septum. In the triangular space between the two muscles, before they meet (5 inches forwards) in the raphé, are seen the triangular ligament and the neck of the bladder, with its thick red muscular walls, seen under the microscope to be composed of striped fibre. Towards the back part the muscle is 2½ inches thick; near the fore part of the narrow mesial raphé, 1 inch thick. The whole length of the insertion is 14½ inches, 9 of which belong to the narrow median raphé. The muscular bundles in front of this, opposite the broad white interval (which is 6½ inches long by 1¼ to 1½ broad), are derived from the origins of the muscle on the *under aspect*. These (fig. 13, *l*) are, from the inner slope of the under aspect of the pelvic bone, by fully as much in breadth and in forward extent as on the upper aspect; from the whole anterior wall of the horse-shoe septum, and from the crus and corpus cavernosum in front of that septum; and lastly, from the mesial raphé and septum, for a length of 11 inches. From these origins the fibres, in thick bundles, pass upwards and outwards round the sides of the crus and corpus cavernosum, forming semi-spirals as they pass to the upper aspect, now with a forward and inward direction, to be inserted into the corpus cavernosum; the more anterior and more superficial fibres reaching to the sides of the white interval above noticed, the more posterior and deeper

fibres terminating farther back and farther out on the sides of the flattened corpus cavernosum. Thus the whole surface of the corpus cavernosum has muscular fibres closely attached to it, the deepest passing from one part of the penis to another. This vast muscle in Mysticetus corresponds to two muscles in human anatomy; the part from the inner slope on both aspects of the bone to the erector penis (ischio-cavernosus), enormously developed; the part from the mesial raphé, on the under surface, to the anterior part of the accelerator urinæ (bulbo-cavernosus); the part from the front wall of the horse-shoe septum here renders the two muscles continuous.

The great thickness of the muscular mass surrounding the penis here is shown in fig. 15, the section being made 3 inches in front of the horse-shoe septum. The semilunar mass on each side, 7 inches vertically, is $2\frac{1}{2}$ to 3 inches in thickness. The inferior mesial septum here is $2\frac{1}{2}$ inches in depth, $1\frac{1}{2}$ at midway, and diminishes forwards. The supporting and compressing power of such a mass of muscle must be enormous.

The *horse-shoe septum* shows itself as a raphé on the surface (fig. 13), and, when dissected, is seen to be a great septum completely separating the muscles and attached to the penis. It begins just within the hinder ends of the pelvic bones and crosses the mesial line 6 inches in front of this. The place of attachment to the penis is shown in fig. 11, part on one side being left entire to show the depth. At the middle of each side it is 2 to $2\frac{1}{2}$ inches deep, diminishing outwards, and also less where it crosses the corpus spongiosum. At halfway to the surface it is about $\frac{1}{6}$ inch thick, at its attachment to the crus about $\frac{1}{2}$ inch, where it crosses the corpus spongiosum 1 inch in thickness. Its attachment along the side of the crus is much nearer the under than the upper aspect, and the direction of the septum as it lies between the muscles is oblique forwards and outwards. The whole anterior surface attaching the great compressor muscle is comparatively smooth, the posterior surface is coarsely ridged in the direction of the fibres of the posterior compressor, and in continuation of like ridges on the hard surface of the crus behind it. In sections the septum appears as if a prolongation of the special fibrous stratum which thickens the under surface of the crus, and may be regarded as a con-

tinuation of that stratum, shelving to the surface in relation to the attachment and action of the posterior compressor-muscle.

(2.) *The Posterior Compressor Muscle* (fig. 13, *m*) arises from the median raphé and septum, extending from the horse-shoe septum to a little behind the bulb, where the mesial septum is attached to the triangular ligament. The median septum at midway is over 1 inch in depth. The fibres in thick bundles pass obliquely forwards and outwards, the anterior bundles more forwards, the posterior bundles more outwards, to be inserted into the whole fibrous surface covered by the muscle, the deeper into the fibrous coat of the bulb, the most superficial into the hinder surface of the horse-shoe septum, the intervening and greater part into the hard fibrous surface of the crus. Internal to the middle the muscle is fully 2 inches thick, halfway out 1½, becoming thinner outwards, but a thick muscle throughout. The most posterior fibres of the muscle are nearly transverse in direction, and are attached internally to the triangular ligament where the median septum joins it. Just behind this is a separate transverse bundle of the bulk of the little finger, but more flattened, attached to the free conical end of the crus, and passing across to the opposite side without interruption or intersection.

Action of these Muscles.—The general effect of these muscles must be support and powerful compression of the parts of the penis on which they lie. The posterior muscle will compress strongly the bulb of the corpus spongiosum and the urethra, and by its outer part the bulb of the crus, assisted in this by the counter pressure of the back part of the great muscle on the dorsal aspect. The presence of the horse-shoe septum will enable the posterior muscle to act specially on these parts. The anterior muscle will, by its tubular form, powerfully support and compress the penis in front of the crura, and at the same time draw the pelvic bones inwards. The crura penis having no direct bony attachment, it is not very evident how the penis can be firmly supported unless the interpelvic ligament can be tightened, but it is not evident by what muscular action the pelvic bones can be pulled outwards behind. The enlargement of the crura, surrounded and grasped by the great muscles coming from the pelvic bones, may serve to give sufficient fixity to the organ, converting the pelvic bones and penis

into one firm mass, while the muscles at the same time will expel the contents of the urethra.

(3.) *Levator Ani Muscle.*—As the back part of this muscle was mutilated and only a short part of the rectum present, I am not quite certain of the correctness of the name. As seen in fig. 13, *i*, it arises from the outer half of the horse-shoe septum, superficial to the attachment of the posterior compressor, and, backwards, from the fibrous tissue at the hinder end of the pelvic bone. The bundles curve inwards and backwards, the internal, nearly half the muscle, meeting their fellows, after a course of about 5 inches, in a median raphe in front of the rectum, for 2½ inches. The outer and thicker half of the muscle was divided where the bundles appeared to have been passing back by the side of the rectum, only one large bundle, the size of the little finger, having been left in the mutilated parts, passing to and spreading on the side of the rectum, where the divided ends of other red bundles were also seen. It is a strong muscle, 1½ inch thick behind, 1 inch at the middle, diminishing forwards to a thin free edge, where it conceals the outer and back parts of the posterior compressor, from which it is soon separated by areolar tissue and fat and internally by the rope-like retractor muscle. Apparently assisting the muscle in supporting the rectum, is a considerable fibrous bundle (fig. 14, *t*), attached above to the prominence on the free edge of the triangular ligament, and passing downwards and inwards to the side of the rectum, on which it spreads, in continuity with pale muscular bundles.[1]

[1] *The rope-like Retractor Muscle.*—Only the posterior attachments and perineal stage of this rope-like body remained. As seen in fig. 13, *k*, lying between the levator ani and the deep compressor muscle, it is of a rounded form, about the thickness of the fore finger or thumb, and near its fellow of the opposite side. It is enclosed in a strong but soft fibrous sheath, of a white colour, and internally is composed, among plentiful areolar tissue, of pale yellow bundles disposed longitudinally, which, under the microscope, are seen to be made of unstriped muscular fibre. Traced backwards, it becomes flattened between the levator ani and the posterior compressor, turns round the free edge of the triangular ligament, and breaking up into several longitudinal fasciculi, is attached to the neck of the bladder by tendinous bands, the chief band close to the middle line. Four inches after its origin from the bladder and 1 inch after it has appeared below the triangular ligament, it receives a fasciculus from the side of the rectum, but the origin from the bladder is much larger than that from the rectum. In the figs., 13 and 14, the rectal connection is seen on the right side only, the left side having been cleared. The bundles are continued on the rectum in pale circular

(*b.*) *In the female*, the *interpelvic ligament* is a great structure. As seen in fig. 16, *rr*, besides being attached to the end of the pelvic bone, it sweeps forward along the inner edge as a projecting ligament, gradually subsiding at about the middle of the posterior division of the bone, into the thick fibrous edging of this border of the bone. From this extensive attachment it passes nearly transversely inwards, the anterior edge thin and deeply concave, so that the transverse portion increases in breadth towards the middle line. I have not had an opportunity of examining its relations at the middle line in the female, 4½ inches being the greatest extent of the transverse part present in any of these specimens. This part measured 6 inches antero-posteriorly at its middle, 7 towards the middle line, but in all the specimens a portion of the back part had been shaved off. At its attachment to the pelvic bone it extends on both surfaces of the bone, and both surfaces of the entire ligament are marked by a curved ridge indicating the extent to which this fibrous mass gives origin to the great genital muscular mass. On the under aspect the surface is concave in front of this ridge, and the ligament thins rapidly to the anterior concave edge; on the deep aspect the surface is abruptly scooped out backwards, so that the muscle sinks into a groove, an inch deep, overlapped by the ridge.

The *genital muscular mass*, in the female, arising from the pelvic bone and interpelvic ligament, is very large, as seen in fig. 17, *ll*, which shows the whole extent of the mass present in any of the specimens. The section of the mass two inches from the bone, measured, in the adult, 12 inches in length and 6 inches in thickness. It arises posteriorly, from the greater part of the transverse portion of the interpelvic ligament, as far back as the curved ridges above noticed; externally, from both surfaces of the antero-posterior part of the same ligament, and beyond it from the inner slope of both surfaces of the pelvic bone as far forwards as in front of the middle of the angular region, this attachment to the pelvic bone corresponding to that of the great compressor in the male; and anteriorly, from the outer half of the beak, at the inner border and a little way on the under surface. The mass forms coarse bundles. A little behind these come the pale circular bundles from the suspensory ligament of the rectum, and soon behind these the more pronounced muscular stratum from the levator ani muscle.

bundles directed obliquely inwards and forwards, but more transversely toward the fore part. The part from the beak, consisting of several large fasciculi, is separated from the rest by loose areolar tissue, and may have been a separate muscle.

20. *The Posterior* or *Caudal Muscular Mass* (figs. 13, 14, 17, and 18, *a*).—This great mass is attached to rather more than the posterior half of the body of the pelvic bone, along the outer border and over both surfaces as far in as the intersecting ridge, approaching there the outermost origins of the great genital mass; and, behind the bone, to the outer and posterior part of the interpelvic ligament. It soon gathers into an ovoid mass, the transverse section of which, two inches behind the pelvic bone, was 7 to 8 inches transversely by 5 inches vertically; in the half-grown male, 4 to 5 inches by 3 inches. As far as present in these specimens, it showed no subdivision. Its direction is apparently inwards as well as backwards, and it may be regarded as a large ischio-caudalis muscle, probably continued backwards to the chevron bones. Acting from behind, it will powerfully retract the pelvic bone and interpelvic ligament, with all the apparatus attached to these parts, the direction of the movement being probably inwards as well as backwards. In the half-grown male, its origin from the interpelvic ligament (for about 1 inch) was bounded internally by a fibrous band or tendon (shown in fig. 14), about the size of the little finger, which after giving orgin outwardly to part of the caudal mass, looped inwards to join the suspensory ligament of the rectum, leaving between them and the outer concave edge of the triangular ligament a well defined oval passage (fig. 14, *u*), admitting three fingers, the contents of which had been removed.

21. *The Anterior* or *Trunk Muscular Mass* (figs. 13, 14, 17, and 18).—This mass of muscle, coming back from some part of the trunk, is attached to the femur and tibia as well as to the pelvic bone. It is larger than the caudal mass. In No. II., on transverse section at four inches from its insertion, it was 10 inches transversely, with an average thickness of 3 inches. There was enough present in this specimen (5 inches) to show a distinction into two muscles,—an external, the great mass, directed backwards and inwards, attached to both femur and pelvic bone; and an internal, in the form of a pyramid, or bunch of pyramids, coming

back from a rounded tendon, directed backwards and outwards, and attached to the femur, tibia, and inner part of the pelvic bone.

(1.) The *internal* or *pyramidal muscle*, or part (fig. 17, b^2, fig. 18 b^1), arises abruptly from a thick transversely oval tendon (about 1 inch of which is present) about the thickness of the thumb. The tendon, however, is continued on the deep aspect of the muscle to the end of the pelvic bone, and expands on the bone for 3 inches outwards. The inner part of this tendinous insertion is as large as a somewhat flattened little finger, but, at least in this specimen, does not appear to correspond to the fibrous tuft noticed in some of the specimens as continued from the cartilaginous end of the bone. The *deep* portion of the muscle arises mostly in an abrupt manner from the rounded tendon, but also from the continuation of the tendon to the pelvic bone; forms a flattened pyramid, $2\frac{1}{2}$ inches by 1 inch in thickness at the middle, and is inserted mainly into the pelvic bone for 3 inches along the anterior border and under surface, and by its outer portion, about a fourth of the whole, to the femur, along its distal $1\frac{1}{2}$ to 2 inches. The *superficial* part of the muscle arises abruptly from the tendon, 4 inches from the femur, as two bundles, each 1 inch thick, passing back in pyramidal form, the outer and larger to be inserted to the distal 3 inches of the anterior border of the femur; the inner, not so broad as the outer, to be inserted into the angle of the femur, the caspule of the knee, and a little upon the tuberosity of the tibia.

(2.) The *external* or *great muscle* (figs. 13, 14, and 18,*b*), five to six times larger than the internal, shows no subdivision into strata till close to its insertion, which is to the anterior border of the body and neck of the femur, for about four inches, and to the anterior border of the corresponding part of the pelvic bone, also reaching a little on its under surface and outwards to the promontory. This great muscle approaches the outer and middle parts of the femur with an obliquity inwards, while the pyramid-like muscle is directed obliquely outwards to the inner part of the femur, and more directly backwards to the knee joint. Taking the two masses together, the pelvic bone has most of it at the outer part, rather the least at the inner part, but on the whole rather more of it is attached to the pelvic bone than to the femur.

In none of the other specimens was there much of the length of this mass present, and perhaps it was for this reason that no trace was seen of the separation into the two muscles above described. In the half-grown male, the section of the mass, at two inches in front of the pelvis, is 7 inches across, with an average thickness of 2 inches—thicker internally, less externally. In this specimen, No. I., the mass here, and when cut longitudinally, shows no appearance of separation even into femoral and pelvic strata till close to the bones. The deeper stratum is attached to the whole breadth of the beak of the *pelvic bone*, including the cartilage internally, and as far out as the middle of the promontory; the attachment is to the border and a little way on both surfaces of the bone, the fibres fleshy to near the attachment, except the part on the under aspect of the bone near the promontory, where it is tendinous. To the *femur* it is attached to the whole length of the body and outer half of the neck, the most internal part by oblique tendinous fibres, the rest of the insertion fleshy very close to the femur, and attached by short tendinous bundles to the anterior border and over the anterior third of the superficial surface of the body of the bone. To the *tibia* it is attached at the anterior angle and a little way along the inner border, and in front of this it is attached to the capsule of the knee. Taken as a whole, at the outer part of the mass, most of it goes to the pelvic bone; across the middle, most of it is attached to the femur; and the very inner part goes entirely to the femur and tibia; so that, in this subject, the greater part of the mass, probably about $\frac{2}{3}$ of it, goes to the femur and tibia. The part to the tibia is, on section, 1 inch by $\frac{3}{4}$ inch.

(3.) In contact with the deep aspect of this trunk mass, is a *flat expanded muscular layer*, the broad sheet-like tendon of which is attached to the pelvic bone. This tendon, with muscular fibres attached, is seen in figs. 17 and 14, *c*, and the narrow strap-like continuations of it, over the femur, are seen in figs. 13 and 18, *c*. In No. II., in which it was more fully seen, this tendon, 8 inches in length and 2 in breadth, is opposite the outer $\frac{2}{3}$ of the trunk mass. The insertion to the pelvic bone is obliquely across the outer $\frac{2}{3}$ of the upper surface of the transverse part of the pelvic bone; and, beyond the pelvic bone, turning round the outer edge of the great mass and playing over the promontory,

it sends a strap-like continuation which divides into two bands. One of these curves inwards across the neck of the femur to be inserted at or near the trochanter; the other passes backwards over the head of the femur, which it compresses on the outer side, and then skirting along the outer edge of the pelvic bone, and adhering to the longitudinal capsular muscles, finally joins the outer bundles of the caudal muscular mass. The direction of the sheet-like tendon is backwards and inwards, like that of the muscular fibres which end in it. Of these there was present a portion 6 inches broad, 2 inches long, and over $\frac{1}{2}$ inch thick. On its under surface was another muscular portion, 4 inches long, 2 inches broad, and $\frac{1}{8}$ to $\frac{1}{6}$ inch thick, directed backwards and outwards, and continued into the strap-like tendon.

Without a knowledge of the other connections of these anterior muscles, their *homology* must remain uncertain. The sheet-like tendon and muscle suggest the external oblique of the abdominal wall; but the layer, or portion, crossing it diagonally, is rather incompatible with that view (being on the wrong side to represent an internal oblique), unless it be merely a part the direction of which is modified for the strap-like continuation. If the pyramid-like bunch is a pyramidalis abdominis, and the great mass external to it the rectus abdominis, their continuation to the femur is remarkable. If these are adductor and other muscles of the quadrupedal femur continued upwards, that would imply a very remarkable change of the anterior attachments. The observations of authors on the muscles in toothed cetaceans, so far as known to me, throw no light on the nature of these muscles. The conditions are greatly altered in Mysticetus by the presence of a thigh bone and the accompanying transverse part of the pelvic bone. But whatever the nature of these muscles, they will act powerfully, their general *action* being to advance the pelvis either directly or by pulling on the femur. The pyramid-like muscle will pull obliquely forwards and inwards, the flat muscle obliquely outwards, the great intervening mass with, as far as can be judged from the portion present, a little obliquity outwards. The pelvis will be moved forwards and backwards by the alternate action of these and the caudal mass, or be fixed by their joint action. The very slight extent to which movement of the femur on the pelvis is allowed to

take place accords with the very little subdivision of the trunk mass as it passes to these two bones. The action of this great mass on the femur must therefore take effect on the pelvis, doing so through especially the great posterior ligament of the femur. When the mass is pulled, causing advance of the femur, there is a tendency of the hinder edge of the femur to rise (rotation inwards), which is checked chiefly by the same ligament; and there is a backward projection of the head of the femur, which is opposed by the tightening of the strap-like tendon. The action of the considerable bundle which pulls by the tibia is soon resisted by the fibrous structures which attach the tibia posteriorly.

22. *Muscles passing from the Pelvic Bone to the Femur.*—These muscles may be divided into those which encapsule the head of the femur and those which pass to the body of the bone.

(*a.*) The *capsular muscles* are three in number—two longitudinal, one below and one above; and one transverse, situated above.

(1.) The *inferior longitudinal capsular muscle* (figs. 13 and 17, *d*) arises behind from the pelvic bone, as far back as the anterior fibres of the great caudal mass, and internally from the outer side of the great posterior ligament of the femur. In the half-grown male the flesh is about 3 inches in length and ¾ inch in breadth. Passing upon the head of the femur it becomes tendinous at the middle of the head, appearing at first to be attached to the head, and it may be partially so, but on being divided the tendon proper may be dissected off the head, and is seen to be continued forwards and outwards to be inserted into the pelvic bone on the dorsal aspect, in front of the head of the femur. The muscle encapsules the head on the under and outer aspects, and partly on the dorsal aspect. Internally, a thin expansion is continued from the muscle to the neck of the femur, filling up the triangular space between the muscle and the great ligament of the femur. In No. III. this expansion was continued inwards over the fore part of the great ligament, to be attached to the whole length of the posterior border of the shaft of the femur.

(2.) The *superior longitudinal capsular muscle* (fig. 14, *n*), beginning fleshy on the upper aspect of the pelvic bone, passes backwards along the outer side of the bone. Like the last muscle, it loops longitudinally from one part of the pelvic bone

to another, and binds the head of the femur on its upper aspect. Along the outer edge of the bone it is, in the half-grown male, about the same breadth as the inferior muscle ($\frac{3}{4}$ inch); in the full-grown subjects (Nos. II. and III.), about $1\frac{1}{2}$ inch broad, and at the fore part, where, after arising by five or six large bundles, it spreads on the bone, the flesh is $3\frac{1}{2}$ inches broad and $\frac{1}{2}$ to $\frac{3}{4}$ inch thick. Its origin occupies more than the outer half of the angular region of the bone, between the promontory externally and the insertion of the sheet-like tendon, the oblique line of attachment of which may be recognised on the macerated bone. Posteriorly, becoming tendinous, it is inserted partly into the bone, but largely runs against the outer part of the caudal mass, in common with the continuation of the strap-like tendon which covers it. Part of the caudal mass, as large as a couple of fingers, arises from the tendon of this capsular muscle, and is pulled outwards by it. This gives the caudal mass a pull upon the fore part of the pelvic bone, and might be regarded as an accessory origin to that mass, but the piece of tendon intervenes, and the adaptation seems rather to be that of giving tension to the connecting bundles, and thus more effectually binding down the head of the femur.

(3.) The *transverse capsular muscle* is on the upper aspect. As seen in No. III., it is triangular in form, the flesh 3 inches in length, $\frac{1}{4}$ inch thick; in breadth 3 inches at its origin from the pelvic bone, contracted to 1 inch where it becomes tendinous half-way across the head of the femur. The tendon adheres, and is partly attached, to the head of the femur externally, but when divided can be dissected onwards round the head, as a broad strap expanding over the whole of the under aspect of the head, and terminating on the periosteum where the head joins the neck. This muscle was found only in No. III. Although Nos. I., II., and IV. were carefuly dissected at this part, no trace of this muscle was seen. The great projection and great size of the head in No. III. may possibly account for the presence or great size of this muscle in it.

The head of the femur is thus very effectually enclosed and bound in by the muscles now described. Besides the possibly only occasional transverse muscle found in No. III., these dissections show the presence of three normal encapsuling struc-

tures,—the inferior and superior longitudinal muscles, muscular in the greater part of their length (also mixed with a good deal of fibrous tissue), binding in the head on the under and upper aspects, and, by the union of their contiguous margins, on the outer aspect also; and along the outer side, superficial to these, the continuation backwards of the strap-like tendon, attached behind to the outer side of the caudal mass. This strap, not itself muscular, is made tense by the action of the caudal and anterior trunk masses which it connects, and will not only bind the head of the femur, but enable these masses to press inwards the whole pelvic bone, while they pull on its fore and back parts. The capsular muscles may be regarded as to some extent representing the group of external rotator muscles of the quadrupedal hip.

The *tendinous capsule* thus formed for the head of the femur is the functional capsule, but is not lined by a synovial bursa. The fibrous surface of the head is smooth, but the inner surface of the capsule is lined by flocculent areolar tissue, giving the head sufficient freedom for its limited movements. This quasi-cavity round the head extended, in No. III. (fig. 17), forwards about 1 inch beyond the head, so that the anterior ligament of the head is seen within it; and inwards to the neck, being limited by the insertions of the capsular muscles. It was purely tendinous on the inner surface, externally muscular as above described. It was $\frac{1}{8}$ to $\frac{1}{6}$ inch in thickness, the strap-like tendon forming an additional stratum on the outer side.

(*b*). The *muscles from the pelvic bone to the body of the femur* are four in number; one behind, expanded and thin, reaching also to the tibia (seen in fig. 13, *g'*), and three from the fore part of the pelvic bone (seen in fig. 17, *h*, h^1, h^2). One of these is on the under surface of the femur, and two occupy an interosseous position, one directed inwards, the other directed outwards to the femur. While each of these muscles is more or less of a flexor, the muscle below the femur abducts, and may be termed the abductor; the two between the bones adduct, and may be termed the internal and external adductors.

(1). The *abductor* (fig. 17, *h*) arises from the promontory close in front of the acetabulum, and from the anterior ligament of the head, passes obliquely inwards and backwards and is in-

serted on the under surface of the femur near the trochanter. It is triangular in form; length along the middle $3\frac{1}{2}$ inches, breadth at origin $1\frac{1}{2}$ inch, at insertion 2 inches; thickness at middle $\frac{1}{3}$ to $\frac{1}{2}$ inch. In No. I. it formed a 1-inch equilateral triangle. The outer edge of the muscle adheres to the tendinous capsule, and will assist so far in binding in the head of the femur.

(2). The *external adductor* arises a little in front of the last muscle, and is inserted on the upper surface of the body of the femur not far from the anterior border. In the figure (fig. 17, h^1) it looks like the fellow of the last muscle, passing to the other side of the femur; but its origin may extend inwards on the beak, making the muscle broader and the fibres shorter and less transverse than in the figure. In the half-grown male it was $3\frac{1}{2}$ inches in breadth, the fibres $1\frac{1}{2}$ in length. In No. V. the breadth was $1\frac{1}{2}$, the length 2 inches. The muscle may be partially divided into an outer and an inner part, and the insertion, instead of being on the deep surface, may be on the anterior border and some way on the under surface, as it was in No. VII. The length and breadth in this case were both $2\frac{1}{2}$ inches, the thickness $\frac{1}{2}$ inch. The insertion of the great trunk mass to the femur is between this muscle and the abductor.

(3). The *internal adductor* (fig. 17, h^2), is arranged like an intercostal muscle, the fibres sloping backwards and outwards. Its attachment along the surfaces of the pelvic bone and femur may be for 5 to 6 inches; the length of the bundles about 2 inches, as seen from below, but seen on the deep aspect the external fibres are longer and more oblique. The origin extends along nearly the whole of the beak, and it may be on part of the angular region of the bone, and may occupy all but the most anterior part of the surface. The insertion on the femur is along the deep surface of the shaft and part of the neck, towards the posterior border, but obliquely, so that the outer part is nearer the border than the inner. The thickness varies a good deal; in No. VII. it had the unusual thickness of 1 inch, and was composed of two strata enclosing the deep interosseous ligament. In No. II., a prolongation of this muscle, as thick as a thumb, went back for 4 inches along the deep surface of the

great posterior ligament; the same in Nos. III. and V., but not nearly so large.

Actions and Homology of these Muscles.—The two adductors, besides adducting, flex, rotate out, and cause some gliding, the internal inwards, the external outwards; the abductor, besides abducting, flexes, rotates in, causes some outward gliding, and assists in tightening the capsule of the head. But these movements are so limited, that the use must rather be that of steadying the bone in these directions. Their adducting power is the greatest and will press the femur against the cushion of muscle between the two bones, formed by the adductor muscles and by the part of the trunk mass which fills up the space between them and the femur. Homologically viewed, the internal adductor may be regarded as one of the adductors of the quadrupedal limb; the external adductor as an iliacus internus; the abductor as a portion of one of the deeper glutei.

It was interesting to see the condition of these muscles in No. V., in which the femur on one side was anchylosed. On the left side they were well developed, the internal adductor $\frac{3}{4}$ inch in thickness. On the anchylosed side, the abductor was present but reduced to a fibrous condition, and adhering by the whole of its deep surface; the external adductor had been mutilated, but part of its insertion remained in a muscular condition; the internal adductor was about as large as the same muscle on the movable side, but, on section, was seen to be more mixed with fibrous tissue, which formed about half the bulk of the inner part of the muscle. The muscular prolongation on the great posterior ligament was present, 3 inches in length.

(4). The *posterior muscle of the body of the femur* (fig. 13, *g*), is expanded and thin, and is aponeurotic as well as muscular. In the half-grown male, it occurred as a stratum of muscular fibre supported on its deep surface by an aponeurotic stratum. It arose externally from the inner side of the great posterior ligament of the femur, posteriorly by a narrow part from the hinder end of the pelvic bone, and internal to this from the horse-shoe raphé for several inches, opposite the levator ani and nearly as far in as it. The fibres pass forwards and inwards to be inserted at the posterior edge of the femur from the point of

attachment of the great posterior ligament inwards to the capsule of the knee, the most internal fibres to the posterior or outer border of the tibia. It is from 2 to 3 inches in breadth, about $\frac{1}{8}$ inch thick, the aponeurotic stratum somewhat thinner. The longest fibres, those to the femur, are 6 inches in length; the shortest, those to the tibia, 2 inches. Fully half of the muscle goes to the tibia. It extends the femur and flexes the knee joint, and the aponeurotic stratum gives it great strength in resisting the forward movement of the femur and the inward movement of the tibia. Homologically viewed, it may be regarded as an adductor magnus and a hamstring, proceeding from their quadrupedal origin at the tuber ischii.

In two of the adult female subjects, Nos. II. and III., in which this structure had not been mutilated, it was entirely aponeurotic and more extensive; reaching outwards, over the fore part of the great posterior ligament, so as to receive origin from the pelvic bone, and the fibrous structures over it; and reaching backwards to join the interpelvic ligament. There it conceals the great genital mass, and serves as an aponeurosis to the earlier part of that mass, some of the posterior fibres of the mass arising from its deep surface; but it is quite separate from the mass before it reaches the femur and tibia. This aponeurosis is represented in fig. 18; while fig. 17 shows the parts brought into view by its removal. It was about $\frac{1}{8}$ inch thick, composed of coarse fibrous bundles, having the same direction as those of the muscle in No. I., and serves as a strong resisting structure to forward movement of the femur and tibia. In No. III., on removing this aponeurosis, a distinct red muscular expansion was seen proceeding from the inner edge of the inferior longitudinal capsular muscle, concealing the fore part of the great ligament, and inserted into the whole length of the femur (seen in fig. 17). It adhered to the aponeurosis for 2 inches before it reached its insertion at the posterior border of the shaft of the femur, but at the neck of the bone the insertion was some way forwards on the surface, and separate from the aponeurosis, which was here continuous with the superficial part of the tendinous capsule of the head of the bone.

23. *The Muscular and Tendinous Connections of the Tibia.*—The last described expanded muscle and aponeurosis, or aponeu-

rosis only, is attached along the *outer or posterior edge* of the tibia. In Nos. II. and III. a special band of aponeurosis (shown in fig. 18), passing to the tibia, was placed more transversely and superficially, its fibres at first decussating with the fibres of the general aponeurosis, but at last fused with the fibres of the tibial part of the aponeurosis. Along the *inner edge* of the tibia is attached an aponeurosis, cut short to half an inch in these specimens, the fibres apparently directed inwards and backwards. To the *anterior end*, as noted above, is attached the insertion of the innermost part of the pyramid-like muscle. To the *posterior end* or tip of the tibia is attached what may be termed the longitudinal *tibial band*. This band had been cut short in all the specimens, only from 1 to 4 inches of it remaining, except in No. III., in which it was present in its whole length (as seen in fig. 18, *k*, *k*), extending backwards to the great interpelvic ligament. It is a flat strap-like band of white fibrous tissue disposed longitudinally; length 10 inches; breadth, at its attachment to the tibia, $\frac{1}{2}$ inch; at the middle, $\frac{3}{4}$ inch; at its posterior attachment, about 2 inches; thickness, $\frac{1}{8}$ to $\frac{1}{6}$ inch; in transverse section, flat on the deep surface, convex superficially.

On the deep aspect of this tibial band, and attached to it, between it and the great aponeurosis above described, is a stratum of muscular bundles, forming a *superficial perineal muscle*. As represented in fig. 18, *n*, *n*, these bundles commence on the transverse part of the great interpelvic ligament and the aponeurosis in front of it, and pass forwards and inwards under cover of the hinder half of the tibial band, showing themselves again along the whole length of the inner side of the band where they had been divided. The part here present forms a triangular stratum, 4 inches in breadth at the base, 5 in length, and $\frac{1}{6}$ inch in thickness. The flattened bundles are partly continued past the tibial band, partly attached to it, in a proportion which it was not easy to determine, but a good many, especially those nearest the tibia, arise from the band on its deep surface and inner side, and as far forwards as within an inch of the tibia (seen at *o*, fig. 18); in No. II. still nearer the tibia, and in No. V., they arose quite close to it. On dividing the tibial band, it is seen that it is as it were split by this muscular stratum, the

deeper layer lining the deep surface of the superficial muscular stratum. The tibial band is composed mainly of longitudinal fibres, but connected with the great aponeurosis external to it, to which it forms a kind of longitudinal edging. The aponeurosis and the deep layer of the tibial band adhere behind to the great genital mass as its covering aponeurosis, but as they approach the tibia they are quite free from it, a wide space filled with loose tissue intervening. The outer edge of the superficial layer, or tibial band proper, is not free, but, like the tibia, receives the aponeurosis, being distinguished from it by the direction of its fibres, and there may have been a similar expansion joining its inner edge. This superficial muscle will have some effect in tightening the tibial band, but the connection seems rather to furnish an additional origin to the muscle, which will become a fixed point for muscular action when the tibial band and aponeurosis are tightened by the action of the anterior muscular mass. In the male subjects, Nos. I. and VII., only a short part of the band was left attached to the tibia, and no muscular bundles were noticed.

The longitudinal tibial band being in continuity with the cartilaginous tibia, might be looked on as a fibrous representative of that bone; or, together with the tibial part of the aponeurosis external to it, as representing the hamstring muscles, attached proximally to near the hinder end of the pelvis, distally to below the knee joint.