

On the anatomy of the elk (*Alces malchis*) / by Morrison Watson and A.H. Young.

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On the Anatomy of the Elk (*Alces malchis*). By Prof. MORRISON
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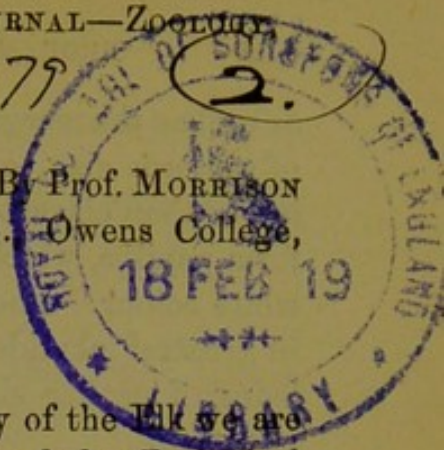
(PLATES VI. & VII.)

FOR the opportunity of examining the anatomy of the Elk we are indebted to the kindness of Messrs. Jennison, of the Zoological Gardens, Manchester. The structure of this animal, so far as we have been able to ascertain from a reference to such books as are at our disposal, appears to have been very imperfectly worked out. Indeed, with the single exception of a paper by Perrault*, in which only the most obvious points in the anatomy of the organs of digestion and circulation are referred to, we have been unable to discover any anatomical description whatever of this aberrant species. The dissection was commenced with the intention of drawing up a complete account of the anatomy of the animal; and had the period of the year been favourable, this would certainly have been done. Coming, however, as the subject did, into our hands in the month of August, we soon found that decomposition advanced so rapidly that we were compelled to abandon this intention, and, after placing the viscera in spirit, to confine ourselves to the muscular anatomy of the limbs, trusting at some future time to be able to supplement the fragmentary notes which form the subject of the present communication. These notes, however, appear, so far as they go, to contain observations which have not hitherto been published, and we therefore venture to place them on record without further apology.

ORGANS OF DIGESTION.

Tongue (Pl. VI. fig. 1).—The tongue is broader and more flattened toward the tip than is usual among the Cervidæ. Its base for a distance of 3 inches in front of the hyoid bone is smooth and devoid of papillæ, which begin to make their appearance on the dorsum radialis (*Zaglas*). The papillæ vallatæ are small, and are confined to the borders of the tongue in the neighbourhood of the root; they do not extend further forward than the dorsum radialis. The rest of the upper surface of the tongue,

* Mémoires de l'Académie royale des Sciences, Paris, 1733.



as well as the margins, are covered with conical papillæ which are of uniform size, except on the dorsum radiceis, where they are larger than elsewhere. Interspersed among these are the fungi-form papillæ, which are readily distinguished by means of their white colour. They are placed about $\frac{1}{4}$ inch apart, and are found in greatest abundance on the margins and tip of the tongue, being of smaller size and more closely aggregated in the latter situation.

Cheek.—The buccal mucous membrane is provided with numerous large papillæ (Pl. VI. fig. 2) which, for the most part, are compound, although some are simple in character. The number of secondary papillæ in connexion with a primary papilla is commonly three, although it is not unusual to meet with only two secondary papillæ attached to a common base. Tertiary papillæ may or may not be present; when present, they are small in size, and their number is extremely variable.

Stomach.—The rumen consists of a number of pouches, and does not differ much in respect of form from the ordinary Ruminant type. The mucous lining is covered throughout with papillæ (Pl. VI. fig. 3), which are largest in the hollows of the pouches, but are not wanting on the ridges which separate these, although here they are much reduced in size. The papillæ are, for the most part, spatulate; but interspersed amongst these are many of a cylindrical form. The largest measure between a fourth and an eighth of an inch in length.

The reticulum is large. Its mucous membrane is thrown into ridges which bound hexagonal spaces. These are largest in the centre, and diminish in size towards the extremities of the compartment. The ridges do not exceed $\frac{1}{8}$ of an inch in depth. Numerous papillæ are placed on their free margins, and are found also on the floor of the spaces which they bound.

The psalterium is small. Its mucous coat is thrown into longitudinal laminæ which are arranged in three series: the primary laminæ of this stomach measure $1\frac{1}{2}$ inch in breadth; the secondary laminæ, situated one on either side of the primary, measure 1 inch in breadth; and the tertiary laminæ not more than $\frac{1}{8}$ of an inch. On either side of each tertiary lamina is a row of partially coalescent papillæ, which gives rise to a fourth series of laminæ. The different laminæ decrease in depth towards the extremities of the psalterium; and the surfaces of all of them are covered with sparsely distributed rudimentary papillæ. Adopting

Prof. Garrod's* method, the accompanying diagram will indicate the arrangement of the laminae.

The abomasum presents the usual form. Its mucous lining is, for the most part, smooth, but close to its commencement is thrown into irregular rugae. At the pylorus the walls of this compartment are much thickened.

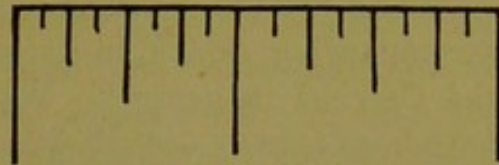


Diagram showing laminar arrangement of mucous membrane of psalterium.

Small Intestine.—The duodenum measured 2 feet in length, and was dilated into a kind of pouch immediately beyond the pylorus. The whole length of the small intestine, including the duodenum, was 43 feet 11 inches. In Perrault's† specimen it measured 48 feet.

Large Intestine.—The cæcum measured $22\frac{1}{2}$ inches in length; according to Perrault‡ 13 inches. Its mucous lining just below the opening of the ileum is thrown into a number of small glandular pouches closely resembling the ileo-cæcal gland of the Giraffe as described by Cobbold§. The pouches, however, are smaller in size in the Elk than in the Giraffe. The rest of the large intestine is arranged in numerous coils, and measures, exclusive of the cæcum, 42 feet 6 inches in length. It diminishes slightly in diameter as far as the rectum, where it is again slightly dilated.

Liver (Pl. VI. fig. 4).—This measures 17 inches from side to side, and $9\frac{1}{2}$ from above downwards; according to Perrault, 1 foot by 7 inches. It is divided into two lobes, right and left, although, as remarked by Perrault, the longitudinal fissure is but feebly pronounced. On the posterior surface of the right lobe is a well-developed caudate lobule of a triangular shape, which lies to the right of the portal fissure, whilst the upper border of the right lobe is prolonged into a triangular Spigelian lobule measuring $\frac{3}{4}$ of an inch in length. The gall-bladder, as remarked by Perrault, is absent.

The *spleen* is elongated oval in form, and measures 8 inches in length and $5\frac{1}{2}$ inches in breadth—measurements which agree with those of Perrault.

* Proc. Zool. Soc. Lond. 1877.

† Mém. de l'Acad. des Sciences, Paris, 1733.

‡ *Loc. cit.*

§ Todd's Cycl. of Anatomy, vol. v.

LARYNX AND CIRCULATORY ORGANS.

The Larynx (Pl. VI. fig. 5), as will be seen by a reference to the accompanying sketch, in its outward features resembles that of the Cervidæ in general. With regard to its cartilages, these have been already described and figured by Professor Owen*.

The Heart is small, and does not differ in respect of form from that of most Ruminants. Its cavities and valves are arranged in the usual manner. The trunk of the aorta divides, as in other Ruminants, into two, anterior and posterior. The "anterior aorta" passes forwards to be distributed to the head, neck, and fore limbs; whilst the "posterior aorta" supplies the trunk and posterior extremities.

URINARY AND GENERATIVE ORGANS.

Kidney.—This is smooth and non-lobulated, a fact previously observed by Perrault (*loc. cit.*). The uriniferous tubules open, not on separate papillæ, but upon a single elongated ridge. In this respect the Elk agrees with the larger Cervidæ.

Testicle and Accessory Parts (Pl. VII. fig. 6).—The testicle (*a, a*) is of the usual form, and is provided with a well-marked epididymis. The scrotum is non-pendulous. The vas deferens (*b, b*) measures 18 inches in length, and is slightly dilated at its entrance into the urethra. Before passing through the wall of this canal, the two vasa are closely applied to one another; they terminate on the floor of the urethra in a manner to be presently described. Connected with the posterior extremity of each vas deferens, previous to its passage through the urethral wall, is a small vesicula seminalis (*c, c*), which measures $1\frac{1}{4}$ inch in length. It is placed along the outer side of the corresponding vas, and is uncovered by muscular fibres. Each unites with the vas of the same side to form the ejaculatory duct.

Lying between the bladder and rectum is a well-marked fold of peritoneum, which consists of two layers, one of which is reflected from the lower aspect of the rectum, and the other from the upper surface of the bladder to become continuous at the free margin of the fold, which is directed forwards. Lying between the laminæ of this fold are the two vasa deferentia and a well-marked vesicula prostatica. The former extend from without inwards, lying in the free margin of the fold, and, having reached the middle line,

* 'Comparative Anatomy of Vertebrates,' vol. iii. p. 594.

pass backward to open into the urethra, whilst the latter lies between the lower extremities of the vasa, and consists of a body and two cornua. The body is represented by a stout fibrous cord, which extends forwards to the free margin of the recto-vesical fold of peritoneum, a distance of 5 inches, where it divides into the cornua. Each of the latter passes outwards in the free margin of the fold for a distance of $3\frac{1}{2}$ inches, and then dwindles into a fibrous cord of such tenuity that it becomes lost in the peritoneum. The body of the male uterus close to its junction with the urethra is united with the vasa deferentia, and diminishes in thickness to the junction of the cornua, where it expands into a mass of tissue of a triangular form. The male uterus is solid, and presents no trace of a cavity except just at its entrance into the urethra, where there is a slight depression of the mucous surface of that canal. There is no trace of a prostate gland.

The intrapelvic portion of the urethra (Pl. VII. fig. 7) measures 3 inches in length. Its walls (*a*, *b*) are thick, and consist of an external coat of circularly arranged muscular fibres, internal to which is a thick layer of erectile tissue. On slitting open this canal an elongated eminence (the veru montanum) is seen to extend from the neck of the bladder to within half an inch of the bulb of the urethra, where it gradually disappears. On the summit of this eminence is the elongated slit-like aperture of a cavity measuring $\frac{1}{4}$ of an inch in depth, on the floor of which are seen the openings of the ejaculatory ducts. There is no trace of any aperture communicating with the fibrous cord, which represents at least a portion of the uterus; and the question whether we ought to regard the walls of the cavity itself as the representative of, and homologous with the uterus or with the vagina of the opposite sex must in the mean time be left undecided. Leuckart* directs attention to the structure of the male uterus in the Hare and Rabbit, and says, "But the most extraordinary circumstance about the utriculus in these animals is this, that it receives the ejaculatory ducts. In all other instances, these open independently, by its sides, into the urogenital canal; but here, departing from this rule, they open into the undermost part of the Weberian organ," &c. It will thus be observed, from what we have above stated, that not only the Hare and Rabbit, but also the Elk, form exceptions to the general rule respecting the relation between the seminal ducts and the male uterus; and this is

* 'Cyclopædia of Anatomy,' art. Vesicula prostatica.

the more remarkable, inasmuch as in other species of Cervidæ the arrangement conforms to the general rule above stated. On either side of the veru montanum are two depressions which appear to be the openings of ducts. The absence of any glandular bodies appertaining to these, however, proved them to be merely superficial depressions of the mucous lining of the urethra.

Cowper's Glands (Pl. VII. fig. 6).—These are two in number, and are situated just behind the bulb of the urethra, being covered in part by the muscular fibres of that canal. Each is about the size of a garden-bean, and gives off a duct which opens into the bulbous portion of the urethra.

Penis measures 11 inches in length, and is laterally compressed. It consists of two corpora cavernosa and a corpus spongiosum. The latter presents a well-marked bulb posteriorly, whilst anteriorly it forms the glans (Pl. VII. fig. 8). This body is conical in form, flattened from side to side, and on its under surface is a shallow groove in which is placed the urethral orifice. There is no vermiform terminal portion of the urethra, such as occurs in many Ruminants. The muscles of the penis comprise an erector, which is arranged in the usual manner, and two retractores penis, the origins of which had been unfortunately divided, so that they could not be identified. The muscles themselves form two rounded and slightly flattened bands which pass forward, one on either side of the penis, to be inserted by means of an aponeurosis into the dorsal aspect of that organ at the junction of its anterior and middle thirds. In the flaccid condition the glans is entirely retracted within the prepuce. The latter is provided with four muscles—two protractors and two retractors. The protractors arise one on either side of the middle line from the abdominal aponeurosis midway between the xyphoid cartilage and the penis, and are inserted into the prepuce. The retractors arise, one on each side, from the abdominal aponeurosis in the inguinal region; their fibres pass transversely inwards, and are inserted along with the protractors into the prepuce. The scrotum is non-pendulous, and between it and the prepuce on either side of the middle line are two rudimentary teats. The anterior of these is situated at a distance of $3\frac{1}{2}$ and the posterior $2\frac{1}{2}$ inches from the middle line of the abdomen.

MYOLOGY.

For reasons afterwards mentioned, in treating of the muscular system, a comparison with that of other Ruminants has not been entered into in detail, but a simple description of the muscles of the body and limbs has been given. We have, for the sake of convenience, adopted the nomenclature of Chauveau*, but we do not consider ourselves bound by it in respect of general homological significance.

Muscles of the Fore Limb: Dorso-scapular Region.

Levator humeri (Mastoido-humeralis).—This muscle is attached posteriorly to the middle half of the anterior border of the shaft of the humerus. It is a strong muscular band which passes forwards and upwards along the side of the neck to be attached by means of a strong aponeurosis to the skull behind the ear. The lowest fibres of the muscle, moreover, pass over the angle of the jaw and parotid gland, and are prolonged forward as a cutaneous muscle of the cheek.

Great Dorsal Muscle (Dorso-humeralis).—The fibres of this muscle take origin from the spinous processes of all the dorsal vertebræ posterior to the highest point of the shoulder-blade, from a strong aponeurosis covering the external oblique muscle of the abdomen, and by a single digitation from the outer surface of the fourth last rib. The fibres pass obliquely downwards and forwards to be inserted as follows:—The anterior fibres terminate by blending with those of the posterior part of the teres major, whilst the posterior and lower fibres end on a cord-like tendon which passes in front of the teres major, and runs up to be inserted into the lesser tuberosity of the humerus, receiving the fibres of the lower half of the deep pectoral muscle, and giving off a tendinous slip which joins the brachial aponeurosis upon the inner side of the arm.

Trapezius.—This muscle arises by two distinct rounded tendons from the transverse process of the atlas, from the ligamentum nuchæ, and from the spines of all the dorsal vertebræ, with the exception of the last four, blending posteriorly with the origin of the great dorsal muscle. The fibres constituting the anterior and posterior thirds of the muscle are inserted into a strong aponeurosis covering the spinati muscles, and continuous with that covering the outer side of the arm. The central fibres of the muscle are inserted directly into the middle third of the spine of the scapula.

Rhomboideus arises from the third, fourth, fifth, sixth, and seventh dorsal spines, and from the ligamentum nuchæ between these; the fibres pass backwards and outwards, and are inserted into the whole length of the superior margin of the scapula.

* 'Traité d'Anatomie comparée des Animaux Domestiques.' The Second Edition, revised by S. Arloing and translated into English by George Fleming.

Angularis scapulæ arises in the middle of the cervical region from about 4 inches of the ligamentum nuchæ, passes downwards and backwards, and is inserted into the cervical angle of the scapula, where it coalesces with the anterior fibres of the serratus magnus.

Pectoral Region.

The superficial Pectoral Muscle arises from the anterior extremity of the sternum, and from the anterior two thirds of the inferior surface of that bone. The fibres are continuous with those of the opposite muscle, and pass outwards and backwards to terminate upon an aponeurosis which covers the anterior surface of the elbow-joint, and is continuous with the fascia of the forearm. This corresponds to that part of the muscle which is described by veterinarians as the sterno-aponeuroticus, whilst that portion of the muscle described by them as the sterno-humeralis has no representative in the Elk.

Deep Pectoral Muscle.—This is a large muscular mass, trapezoid in shape, and exceeding in size the superficial pectoral. It arises from the posterior three fourths of the inferior surface of the sternum, as well as from the aponeurosis which covers the rectus abdominis. The fibres pass forwards and outwards, and are inserted as follows:—The anterior half is attached to the lower border of the greater tuberosity of the humerus, to the lesser tuberosity of that bone, and between these to a strong fibrous band which arches over the biceps muscle; the posterior half of the muscular fibres is inserted along with the tendon of the great dorsal muscle.

Costal Region.

Great Serratus consists of a costal and a cervical portion. The costal portion arises by fleshy digitations from the eight upper ribs close to their junction with the cartilages, whilst the cervical part arises from the lower surfaces of the last three cervical vertebræ. The whole of the fibres converging form a fan-shaped muscle, which is inserted into the ventral surface of the scapula by two processes, one of which is attached to the anterior and the other to the posterior angle of that bone, these two insertions being united by a tendinous arch which bridges over the origin of the subscapularis.

Muscles of Shoulder.

Long Abductor of Arm (Scapular Portion of the Deltoid) is relatively a small muscle. It arises from the inferior extremity of the spine of the scapula, as well as from the fascia covering the subspinatus. The fibres so derived form a single muscle of a quadrilateral form, which is inserted into the outer bicipital ridge of the humerus and into the bicipital groove. It is to be observed that this muscle is not divided into two parts as in the horse.

Teres major (Adductor of the Arm) arises from the upper fourth of the

posterior costa of the scapula, and also from its posterior angle. It passes downwards and forwards, and is inserted by a ribbon-like tendon into the inner surface of the shaft of the humerus, about 2 inches below the head. Posteriorly this muscle receives the anterior fibres of the great dorsal muscle.

Teres minor (*Short Abductor of the Arm*) arises from the middle half of the posterior border of the scapula. The fibres run downwards and forwards, parallel to the subspinatus, and terminate by being inserted into the fascial origin of the external head of the triceps.

Superspinatus (*Antea spinatus*) arises from the supra-spinous fossa of the scapula and from the fascia covering it, and is inserted into the upper border of the great tuberosity of the humerus, as well as into its lesser tuberosity. Between these bony attachments the fibres are inserted in a similar manner to those of the deep pectoral muscle, by means of a strong fibrous band which arches over the long head of the biceps.

Subspinatus arises from the surface of the subspinous fossa and from the fascia which covers the muscle. The fibres end in a stout tendon which is attached to the outer surface of the great tuberosity of the humerus.

Subscapularis arises from the ventral surface of the scapula, with the exception of that portion which receives the insertion of the great serratus; its fibres pass downwards to be inserted by means of a strong tendon into the inner surface of the lesser tuberosity of the humerus. At its origin this muscle is partially divided into three portions, the central one being bridged over by the tendinous arch of the great serratus.

Anterior Humeral Region.

Coraco-humeralis arises along with the biceps from the coracoid process of the scapula, and is attached by means of a linear insertion into the whole length of the inner surface of the shaft of the humerus.

Long Flexor of Forearm (*Biceps*) is a single-headed muscle which arises by means of a thick flattened tendon from the coracoid process of the scapula. This tendon, passing over a trochlear surface on the superior extremity of the humerus, gives place to a fleshy belly which terminates in a strong flattened tendon. This tendon divides into two parts, of which the outer is inserted into the inner border of the radius close to its head, whilst the inner, passing off at right angles, is inserted into the inner border of the olecranon process of the ulna.

Short Flexor of Forearm arises from the posterior surface of the shaft of the humerus immediately below the head, as well as from the outer surface of the root of the great tuberosity. The muscle winds spirally round the external surface of the humerus, and is inserted by a flattened tendon into the inner border of the shaft of the ulna just below the olecranon process.

Posterior Humeral Region.

Triceps Extensor Brachii.—This muscle possesses four distinct heads, which arise as follows:—The outer head has an almost horizontal origin extending from the lower border of the articular surface of the head of the humerus, as far forwards as the outer surface of the base of the great tuberosity. This head receives the fibres of insertion of the teres minor. The middle head is the largest, and arises from the posterior margin of the scapula for about two thirds of its length. A third head is attached to the posterior surface of the shaft of the humerus immediately above the olecranon fossa, whilst the fourth head has an oblique linear origin from the inner side of the upper half of the shaft of the humerus. The fibres derived from these different sources terminate on a single stout tendon which is inserted into the olecranon process of the ulna, after giving an offshoot to the fascia on the back of the forearm. The third head described above corresponds to the anconeus (*Epicondylo-olecranius*).

Muscles of the Forearm: Anterior Radio-ulnar Region: Extensors.

Anterior Extensor of Metacarpus is a broad fleshy muscle which arises from the whole length of the external condyloid ridge of the humerus, and also from the anterior part of the capsular ligament of the elbow-joint. It is inserted by a stout tendon into the anterior border of the head of the great metacarpal bone.

Oblique Extensor of Metacarpus arises from the middle third of the external surface of the radius. The muscle crosses from without inwards, and ends on a tendon which, passing underneath the extensor of the phalanges and superficial to the anterior extensor of the metacarpus, is inserted into the inner small metacarpal bone.

Anterior Extensor of Phalanges consists of two distinct portions. The inner arises along with that portion of the anterior extensor of the metacarpus which is attached to the capsular ligament of the elbow-joint, and forms a fusiform belly which terminates on a tendon opposite the lower end of the radius. This tendon forms an expansion in front of the metacarpophalangeal articulation, from which three bands pass to be inserted into the inner, outer, and dorsal surfaces of the second phalanx of the inner of the two anterior toes. The outer portion of the muscle arises from the outer side of the external condyle of the humerus, by fleshy fibres from the posterior aspect of the upper extremity of the radius, and from an aponeurosis attached to the lower half of the posterior border of the ulna. From this head a tendon is given off, which is distributed to the outer of the two anterior digits, its insertion resembling that of the tendon of the same muscle to the inner toe; but in addition it also gives off, about the middle of the metacarpus, a lateral slip which passes to the terminal phalanx of the outer of the two posterior toes.

Long Extensor of the Phalanges.—This arises by two heads, one of

which is attached to the outer side of the external condyle of the humerus, and the other to the outer surface of the radius 3 inches below the olecranon. The first head ends on two tendons, of which the stronger passes downwards in front of the metacarpo-phalangeal articulation, lying between the two tendons of the preceding muscle, below the expansion of which it divides into two slips, each of which is inserted into the terminal phalanx of an anterior toe. The other and smaller tendon passes down to be inserted into the last phalanx of the inner of the two posterior toes. The second head terminates in a tendon which unites with that of the long extensor opposite the wrist-joint.

Note.—The anterior and long extensors have been thus described for the sake of clearness. With reference to their action, they may be regarded as different parts of the *extensor pedis* of veterinarians.

Posterior Radio-ulnar Region: Flexors.

External Flexor of Metacarpus arises by means of a stout tendon from the posterior border of the external condyle of the humerus. It passes along the outer and posterior aspect of the forearm, and is inserted by means of a tendon common to it and to the following muscle into the pisiform bone, as well as into the proximal extremity of the great metacarpal bone.

Oblique Flexor of Metacarpus.—This muscle originates by two heads, one from the inner side of the olecranon, and the second from a depression on the inner side of the internal condyle of the humerus. These two heads unite upon a tendon which blends with that of the preceding muscle and is inserted along with it.

Internal Flexor of Metacarpus (Palmaris magnus) arises from the inner condyle of the humerus, below the origin of the oblique flexor, and terminates on a rounded tendon, which is inserted into the inner and posterior border of the proximal end of the great metacarpal bone.

Flexor sublimis Digitorum arises together with one of the heads of origin of the flexor profundus from the posterior border of the inner condyle of the humerus. The muscular fibres terminate at the lower end of the forearm in two tendons which pass along the whole length of the metacarpal bone, and are perforated opposite the metacarpo-phalangeal articulations for the transmission of the corresponding deep flexor tendons. Each is inserted by means of two slips into the base and sides of the second phalanx of each of the two anterior toes. Behind the wrist-joint this muscle is connected by means of two tendinous slips to the tendon of the deep flexor on its inner side and to the pisiform bone on its outer side.

Flexor profundus Digitorum arises by two heads, an inner and an outer. The inner head is the stronger, and arises in common with the flexor sublimis, whilst the outer head is attached to the inner side of the olecranon process. The inner head of the muscle, moreover, is more or less divisible into two parts. These end behind the wrist on a single

tendon, which is joined by the long slender tendon of the outer head. The single tendon thus formed passes down as far as the metacarpo-phalangeal articulation, where it divides into two parts, each of which, after perforating the corresponding tendon of the flexor sublimis, is prolonged to the terminal phalanx of an anterior toe.

Muscles of the Hind Limb : Gluteal Region.

Long Vastus is a large muscular mass which arises from the middle line of the sacrum posteriorly, from the upper border of the ischium, and by a strong tendon from the tuberosity immediately below that border. The fibres pass outwards and downwards, the anterior ending on a special tendon which is inserted into the outer border of the patella, blending with the insertion of the extensor mass, whilst the remaining fibres end on a strong aponeurosis which covers the upper half of the external muscles of the leg.

Superficial Gluteus arises from the outer surface of the iliac bone, reaching as far back as the sciatic foramen, from a strong aponeurosis covering the muscle, and from the fascia lumborum; the fibres pass almost directly backwards and converge to be inserted into the upper and posterior borders, as well as into the outer surface of the great trochanter of the femur.

Deep Gluteus.—This muscle lies under cover of the preceding, and is bilaminar, the two laminæ being united along their inferior borders, but separated posteriorly where the sciatic nerve passes between them. The superficial part arises from the external surface of the iliac bone, the deeper portion from the outer surface of the ilium in front of the sciatic notch, from a fibrous membrane which covers the notch, and also from the great sciatic ligament. The fibres from both laminæ converge, and are inserted into the anterior surface of the great trochanter, as well as into the adjacent part of the shaft of the femur.

It will be observed that we have only described two glutei muscles. The bilaminar character of the deeper of these indicates its probable homology with the two deeper glutei muscles usually described in the horse; or it may be that they correspond only to the deepest gluteus, which in the Ruminants is described by Chauveau as being divided into two portions, each of which is referred to by Rigot as a distinct and separate muscle.

Obturator Internus arises from the whole of the ischio-pubic portion of the pelvic wall and from the inner surface of the obturator membrane. The fibres pass obliquely forwards and upwards, and the tendon of the muscle escaping from the pelvis through the small sciatic notch, is joined by the fibres of the gemellus, and is ultimately inserted into a deep pit on the inner side of the great trochanter of the femur.

Gemelli.—These muscles are conjoined, and form a single concave muscular mass, in the concavity of which the extra-pelvic portion of the obturator internus muscle lies. The muscle takes its origin from the border of

the small sciatic notch, and joining the obturator internus tendon is inserted along with it.

Square Crural Muscle (Quadratus Femoris) is attached internally to the inferior border of the ischium, under cover of the posterior fibres of the long vastus; the fibres form a flattened band which passes transversely outwards to be attached externally to a bony ridge on the shaft of the femur, which is continuous with the posterior border of the great trochanter.

Obturator Externus arises from the pubic bone external to the origins of the adductor longus and pectineus, from the ischium behind the obturator foramen, and from the outer surface of the obturator membrane; the tendon of this muscle coalesces with that of the obturator internus, and is inserted along with it.

Pelvi-femoral Region.

Psoas Magnus arises from the transverse processes and bodies of all the lumbar as well as of the last two or three dorsal vertebræ, and before passing out of the cavity of the pelvis unites with the iliacus, with which its insertion is described.

Iliacus arises from the external border of the ilium, as far back as the acetabulum, and from nearly the whole of the iliac fossa. Its tendon unites with that of the foregoing muscle, and the two are inserted together into the small trochanter, and about an inch of the shaft of the femur below that process.

Psoas Parvus.—About half the size of the psoas magnus, lies internal to that muscle, and arises from the bodies of the same vertebræ which afford attachment to the latter. Its tendon is inserted into the ilio-pectineal eminence, as well as to the adjoining portion of the ilio-pectineal line.

Anterior Femoral Region.

The Muscle of the Fascia Lata (Tensor Vaginæ) arises as a fleshy bundle from the anterior extremity of the crest of the ilium, from about two inches of the surface of the bone immediately behind the crest, and also from the fascia covering the superficial gluteus; the posterior fibres of the muscle end in the fascia covering the outer side of the thigh, whilst the anterior (which form the larger part of the muscle) run downwards to join the extensor tendon of the knee.

Long Adductor of the Leg (Sartorius) arises fleshy from the anterior inferior spine of the ilium, by a tendon from the ilio-pectineal line, and from the iliac fascia. The fibres form a ribbon-like muscle which lies in the interval between the other adductors and the extensors. It is inserted into the inner border of the ligamentum patellæ and into the inner side of the upper end of the tibia. Its insertion is united with the upper border of the tendon of insertion of the gracilis.

Vastus Externus.—This muscle arises from the anterior margin of the great trochanter, from the upper half of the linea aspera, and from the

upper three fourths of the external surface of the shaft of the femur. The muscle is inserted along with the rectus femoris.

Vastus Internus takes its origin from the anterior intertrochanteric line, from the upper half of the internal surface of the shaft of the femur, and from the upper three fourths of the anterior surface of that bone. The fibres blend with those of the preceding muscle, and are inserted along with those of the next muscle.

Rectus Femoris arises from the inferior border of the iliac bone immediately in front of the acetabulum. Its fleshy fibres pass downwards, and terminate in a tendon common to it and the two preceding muscles. This tendon is inserted into the anterior tubercle of the tibia, it receives on its outer side some of the fibres of the long vastus, and on its inner those of the long adductor of the leg.

Internal Femoral Region.

Short Adductor of the Leg (Gracilis).—Has an extensive origin from the lower surface of the pubic bone close to the symphysis, and from a median tendinous band which separates it from the opposite muscle. This band extends back as far as the anus. The muscle is inserted by means of a broad aponeurotic tendon, the upper half of which is attached to the inner border of the tibia, whilst the lower half unites with the fascia covering the inner head of the gastrocnemius.

Pectineus arises from the inferior border of the pubis close to the gracilis. It passes downwards, and winds round the middle of the femur to be inserted into the posterior border of the shaft of that bone.

Adductor Femoris arises from the outer surface of the body of the pubis, between the origins of the pectineus and semi-membranosus, and is inserted into the posterior border of the femur, its insertion corresponding to that of the pectineus, but extending a little further down.

Posterior Femoral Region.

Semi-membranosus arises from the external surface of the pubic arch, its origin extending from the posterior extremity of the symphysis to the tuberosity of the ischium. Its insertion is into the lower third of the internal condyloid line of the femur, into the internal lateral ligament of the knee-joint, and into the internal tuberosity of the tibia.

Semitendinosus.—This muscle arises, together with the vastus longus, from a special tubercle of the ischium below the tuberosity of that bone, as well as from the tuberosity itself, and from the upper border of the ischium. The fibres form a thick fleshy mass, which lies parallel to the posterior border of the vastus longus, and is inserted beneath the gracilis into the inner border of the upper part of the shaft of the tibia, and also into the fascia covering the gastrocnemius.

Muscles of the Leg : Posterior Tibial Region.

Gastrocnemius arises by two heads, one from the outer, and the other from the inner condyloid ridge of the femur. The heads unite together about the lower third of the tibia, and are inserted by means of a stout tendon which splits into two parts, a superficial and a deep. The superficial extends as far as the lower end of the metatarsal bone, where it divides into two slips which are inserted into the bases of the second phalanges of the anterior toes. Between these slips the tendon of the flexor perforans passes forward to the toes. The deeper portion of the tendon is inserted into the tuberosity of the os calcis.

This description includes under one head both the flexor perforatus and gastrocnemius, these two muscles being inseparably united. With reference to the muscles of this region we have departed slightly from the nomenclature of Chauveau, our plantaris forming a portion of his flexor perforatus.

Soleus is fusiform and arises along with the outer head of the gastrocnemius. It terminates by joining the tendon of this latter muscle.

Plantaris is a delicate muscle which arises from the external condyloid ridge of the femur, and from the posterior part of the capsule of the knee-joint. It terminates by blending with the outer head of the gastrocnemius.

Popliteus arises by a strong tendon from a pit on the outer side of the external condyle of the femur. Its fleshy belly is inserted into the upper third of the posterior surface of the tibia.

Flexor perforans digitorum.—Arises by three heads. The superficial head is attached to the posterior border of the external tuberosity of the tibia. The two deeper heads arise, one from the posterior surface of the upper two thirds of the tibia with the exception of so much of the bone as affords insertion to the popliteus, and from an intermuscular septum attached to the external border of that bone; whilst the other springs from the internal and lower half of the oblique line of the tibia, and separates the second head of origin of this muscle from the popliteus. The tendons derived from the first and second heads unite opposite the lower end of the tibia and are joined below the ankle-joint by that of the third head. The common tendon thus formed passes as far as the lower end of the metatarsal bone, where it divides into two slips; one of which is inserted into the base of the last phalanx of each of the anterior toes, after passing between the tendinous slips supplied to the same toes by that part of the gastrocnemius which corresponds to the flexor perforatus. The third head of origin of the flexor perforans corresponds to the oblique flexor of the phalanges of Chauveau.

Interossei.—These are represented almost entirely by ligament corresponding to the suspensory ligament of the fetlock in the horse. It consists of a stout musculo-tendinous band, which extends along the whole length of the metatarsus. The muscular portion does not appear to be arranged in any definite manner. Above the metatarso-phalangeal articu-

lation the band divides into three portions, a central and two lateral; the central portion after being connected to the sesamoid bones in this region is inserted into the bases of the first phalanges of the two anterior toes; the lateral portions pass one along the outer, and the other along the inner side of the metatarso-phalangeal joints to terminate on the dorsal aspect of the second phalanges of the anterior toes, by uniting with the extensor tendons.

Anterior Tibial Region.

Flexor of the Metatarsus arises by two heads. One is attached by means of a strong tendon to a pit on the front of the external condyle of the femur, as well as by muscular fibres to the outer surface of the anterior tibial spine. The fibres give place to a stout tendon which passes beneath an annular ligament situated just above the ankle-joint, and is inserted into the inner side of the upper end of the great metatarsal bone, after being perforated by the tendon of insertion of the second head of the muscle. This second head is attached superiorly to the outer side of the anterior tibial spine, to the outer side of the shaft of the tibia, and to a stout fascia which conceals the tendon of the first head. The tendon of the second head passes beneath the annular ligament, perforates that of the first head, and is inserted immediately below it.

Peroneus (lateral flexor of phalanges) arises from the external tuberosity of the tibia behind the extensor of the toes, and from a strong intermuscular septum which separates it from the neighbouring muscles opposite the upper two thirds of the tibia. Its tendon of insertion passes along the outer side of the ankle and beneath the inferior annular ligament to the lower end of the metatarsal bone, where it forms a flattened expansion, which is inserted into the dorsal aspects of the second phalanges of the anterior toes.

Extensor of the Phalanges arises by means of two muscular bellies from the outer condyle of the femur; these end on separate tendons which pass together beneath both anterior annular ligaments as far as the lower end of the metatarsal bone. The inner tendon unites with the fibrous expansion formed by that of the peroneus, whilst the outer divides opposite the metatarso-phalangeal articulation into two slips, which pass to be inserted into the terminal phalanges of the anterior toes. This latter tendon is moreover joined about the middle of the metatarsal bone by a small fleshy slip which arises from the proximal end of that bone.

A muscle, which appears to have no representative in the horse, and which forms as it were a second flexor of the metatarsus, arises from the outer surface of the external tuberosity of the tibia and from the fascial septum between it and the peroneus. It ends on a delicate tendon which is inserted into a deep pit on the posterior and external aspect of the metatarsal bone about one inch below its upper end.

Body and Abdominal Muscles.

Panniculus Carnosus is strong and arises from an aponeurosis covering the buttock, from the region of the knee-joint, and from an aponeurosis which covers the dorsal region; the fibres pass obliquely forward and downward, the posterior ending in the abdominal aponeurosis, whilst the anterior fibres converge and end on the fascia covering the axilla.

External Oblique arises by seven digitations from the outer surfaces of as many of the lower ribs; it is inserted in the usual manner upon the abdominal aponeurosis.

Internal Oblique arises from the outer half of Poupart's ligament, and from the anterior half of the crest of the ilium. Those fibres of the muscle which arise from the ilium are inserted into the last rib, whilst the remainder of the muscle terminates upon the abdominal aponeurosis.

Transversalis.—This muscle arises through the medium of the lumbar aponeurosis from the transverse processes of the lumbar vertebræ, as well as from the posterior margin of the thorax as far forward as the tip of the cartilage of the fourth last rib. It is inserted into the abdominal aponeurosis.

Rectus Abdominis has a tendinous origin from the median raphé which separates the adductor muscles of the thighs. The muscle is inserted into the cartilages of the posterior ribs.

CONCLUDING REMARKS.

Having now completed the account of our observations, it may be as well that we should add a few words by way of comparison of the anatomy of the Elk with that of other Ruminants. In respect of the large size and compound nature of the buccal papillæ, this animal differs from most of the Cervidæ in which they are simple and conical in form, and agrees rather with the Camel and Giraffe. The tongue, viewed either with reference to its form or the arrangement of its papillæ, does not deviate essentially from the Cervine type. Professor Garrod* says with regard to the stomach of Ruminants:—"The rumen varies as to the shape and distribution of the villi on its mucous membrane. In most of the smaller species the folds which constrict the viscus, as well as the pouches between them, are covered internally with villi, though these are larger in the latter situations. In most of the larger species the villi are absent on the folds, and are largest in the middle of the pouches." *Alces* therefore agrees with the smaller species of Ruminants, and not with the larger, as regards the distribution of the villi, whilst their spatulate form recalls to mind the exceptional appearance of these structures in the Rein-

* Proceed. Zool. Soc. 1877, p. 3.

deer* rather than the cylindrical form which they present in the majority of the Cervidæ. Shallowness of its cells characterizes for the most part the Cervine reticulum; and in respect of this division of the stomach, the Elk agrees with the majority of Deer, including the Reindeer, in which, according to Professor Owen †, the cells are extremely shallow. The laminae of the psalterium in the majority of Deer are, according to Prof. Garrod, quadruplicate, and to this general observation the Elk forms no exception; at the same time it is to be observed that in this animal the smallest laminae are represented by rows of papillæ, an arrangement which, according to the tables of the author just named, is also met with in certain species of the genus *Cervus*, but which is by no means so common as that in which the papillæ have completely coalesced to form continuous laminae. The greatest divergence from the Cervine type, so far as the alimentary canal of the Elk is concerned, is to be found in the comparative lengths of the small and large intestines. According to Meckel ‡ the small intestine in the Cervidæ as a rule measures more than twice the length of the large, an observation which is substantiated by a reference to the tables of Prof. Garrod §, whereas in the Elk the large and small intestines are of nearly equal lengths. In this respect the Elk agrees more closely with the Camelidæ, in which, according to Meckel, the small and large intestines are of equal length, than with other members of the genus *Cervus*, only one species of which (*Cervus elaphus*) at all approaches these measurements, and in it the length of the small intestine exceeds that of the large by one third.

With regard to the comparative lengths of the cæcum and large intestine, as well as the absence of a gall-bladder, *Alces* agrees with the Cervidæ in general.

Passing now to the generative organs, we find that Leuckart || figures in the Stag vesiculæ seminales which are almost the counterpart of those we found in the Elk; and the resemblance between the genitals of the two animals is further borne out by the absence of a prostate gland in both. According to Pittard ¶ and Murie **, it is possible that these vesiculæ may represent the pros-

* Owen's 'Anat. of Vertebrates,' p. 471.

† *Ibid.* p. 472.

‡ Cyclopædia of Anatomy, Cobbold, art. Ruminantia.

§ *Loc. cit.* p. 5.

|| Cyclopædia of Anatomy, art. Vesicula prostatica.

¶ Cyclopædia of Anatomy, art. Vesicula seminales.

** Proceed. Zool. Soc. 1870, p. 352.

tate as well; but this view appears to us to be untenable, inasmuch as the vesiculæ of these deer are true diverticula of the vasa deferentia, and that each opens into the urethra along with the vas deferens of the same side. Cowper's glands are present in several species of *Cervus*, whilst in others they are absent. Their presence would appear to be of no great importance in determining the classification of this group. They are absent in *Cervus elaphus*, which in some respects approaches closely to the Elk, in which they are present. The large size and peculiar form of the vesicula prostatica above described differs much from the rudimentary organ figured by Leuckart* in the Stag, but closely resembles the corresponding organ in the Goat. Unfortunately the very limited number of observations on its configuration in different species of Deer prevents any general conclusion being drawn regarding its arrangement in this group. The glans penis, to the form of which as an element of classification of the Ruminants Prof. Garrod† attributes some weight, in the Elk resembles more closely that of *Cervus cashmerianus* than that of any other species figured by the author just named.

Comparative deductions respecting the myology of the Elk do not seem advisable until it be completely worked out. So far as the muscles of the limbs are concerned, they are seen to closely resemble those of the Ox and Sheep amongst Ruminants. Owing to the want of definite information on the myology of Cervidæ, it is impossible to arrive at any conclusions regarding the comparison of the Elk in this respect with the animals to which it is most closely allied.

Taking into consideration, however, those anatomical features of the Elk which are brought out in the foregoing description, there can be no doubt but that they lead to the conclusion that in all essentials the animal is a true though somewhat aberrant species of Deer; at the same time it appears doubtful if the deviation from what may be called the normal Cervine type is sufficient to justify the creation of a separate genus for the reception of *Cervus alces*.

DESCRIPTION OF THE PLATES.

PLATE VI.

- Fig. 1. Dorsum of tongue showing papillæ (half natural size).
2. Mucous membrane of the cheek with papillæ (natural size).

* Cyclopædia of Anatomy, art. Vesicula prostatica.

† Proceed. Zool. Soc. 1877.

- Fig. 3. Papillæ of the mucous membrane of rumen (natural size).
4. Outline of liver (reduced).
5. Larynx from behind.

PLATE VII.

- Fig. 6. Male generative organs. The outline of the bladder is seen through the peritoneum. The lettering applies as follows:—*a a*, testicles; *b b*, vasa deferentia; *c c*, vesiculæ seminales; *d d*, Cowper's glands; *e*, intrapelvic portion of urethra; *f*, bulb of urethra; *g g*, erectores penis; *h h*, retractores penis; *i*, penis; *k*, vesicula prostatica; *l l*, ureters.
7. Intrapelvic portion of the urethra laid open, showing the single opening common to the two seminal ducts: *a*, muscular fibres; *b*, erectile tissue.
8. Glans penis.
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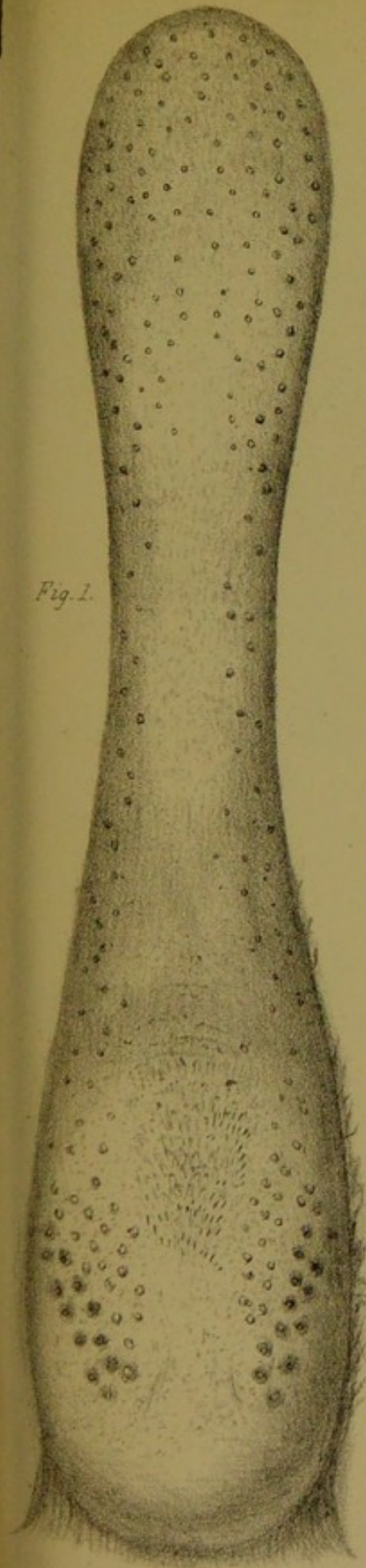


Fig. 1.

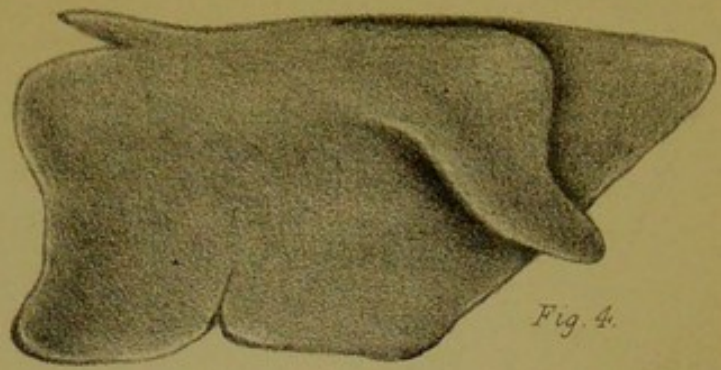


Fig. 4.

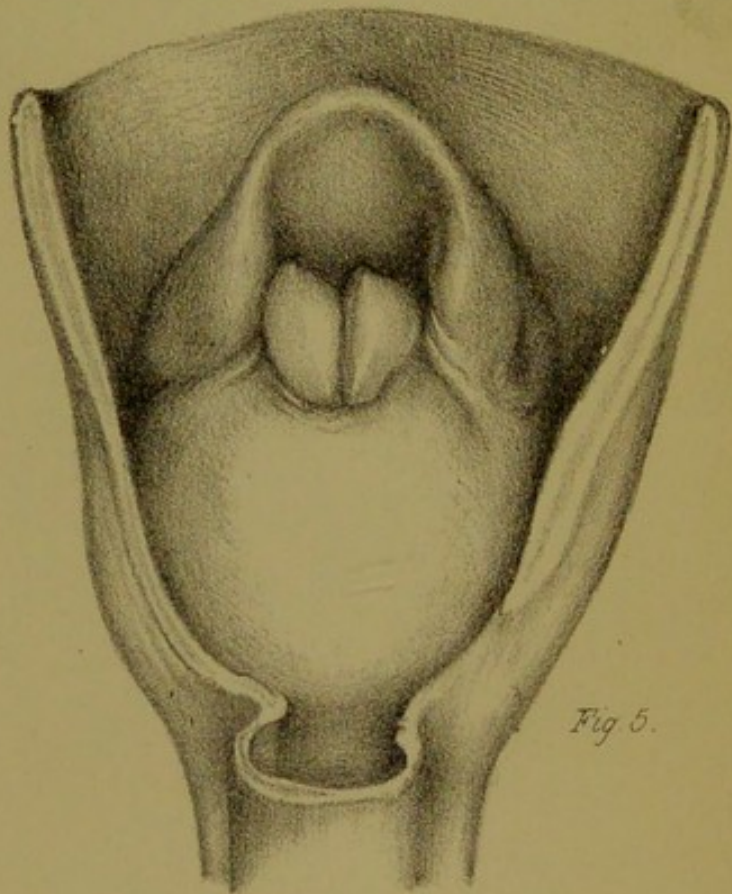


Fig. 5.

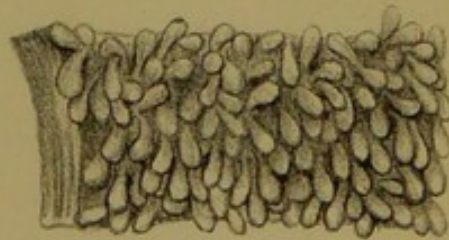


Fig. 3.

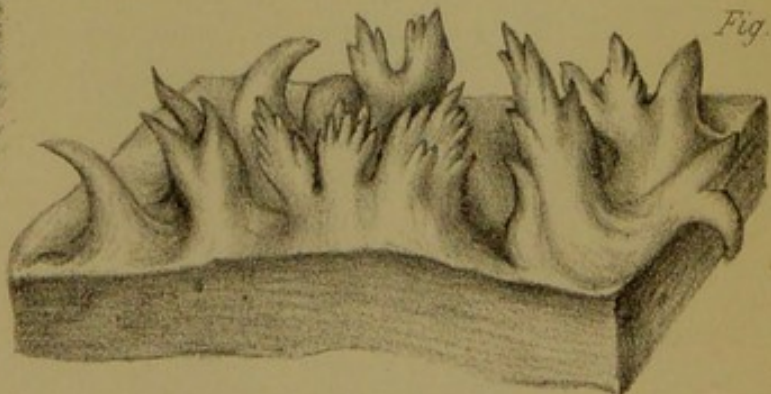


Fig. 2.



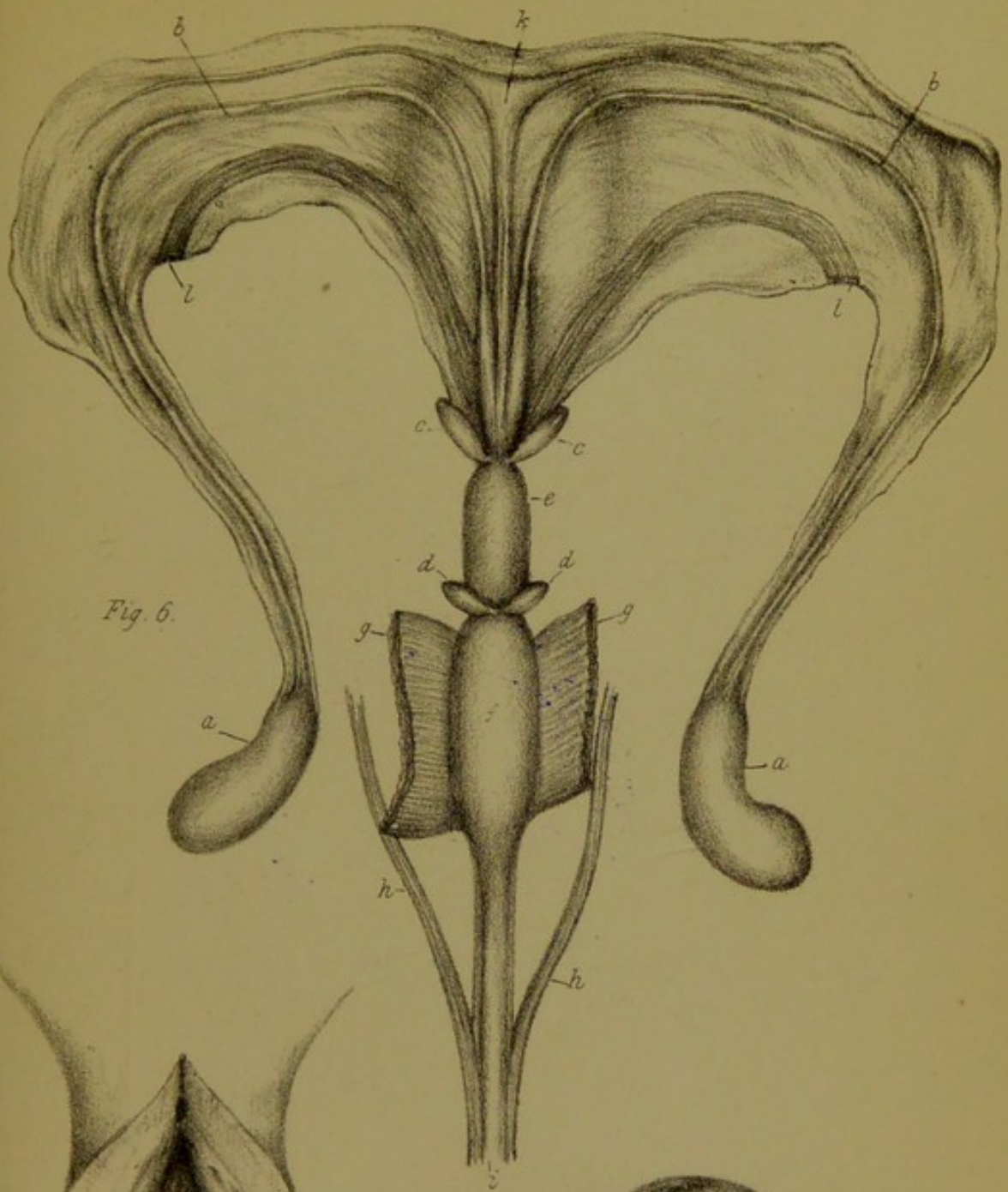


Fig. 6.

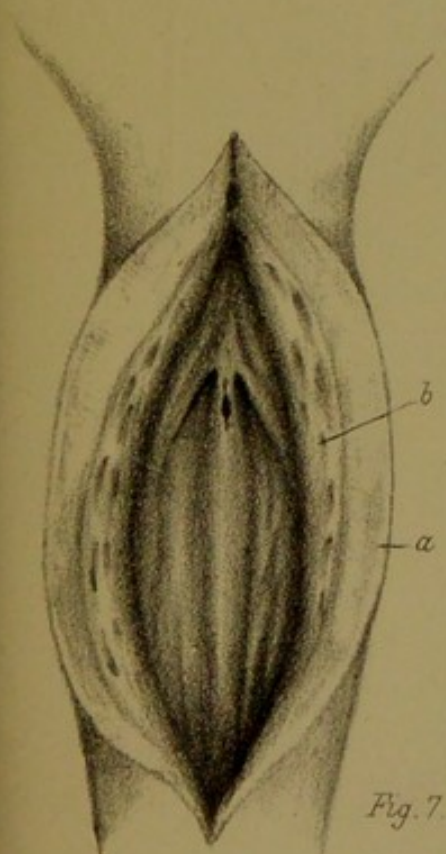


Fig. 7.



Fig. 8.

