Pelvic and Perineal Anatomy of the Male Gorilla: Selected Observations

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ABSTRACT The anatomy of parts of the pelvic outlet and perineum is described in an adult male gorilla. Two previously undescribed muscles are presented: (1) The puborectalis muscle, completely separated from the levator ani, arises from the region of the symphysis and forms a sling for the rectum while it also substitutes for the perineal membrane. (2) The puboampullaris muscle, a paired smooth muscle, arises from the pubis and inserts into the rectum to elevate the rectum while additionally providing support for the urogenital viscera. The levator ani muscle is recounted to point out its lack of attachment to the pelvic viscera while allowing a hiatus in which the rectum is exposed within the perineum. The sphincter urethrae muscle is presented emphasizing its true sphincteric characteristics, its absence of lateral attachments and its similarity to man. Other muscles of the pelvis and perineum as well as urogenital viscera are described or modified where necessary. The manner in which these structures enter into the support of the pelvic viscera is considered.

Death of an adult male gorilla in the Detroit Zoological Garden has provided anatomists and physical anthropologists with an opportunity to add to the meager literature on the anatomy of this great ape.

Because of a long standing personal interest in the development and adult structure of the pelvic diaphragm and perineum in man, this specimen was looked upon as an opportunity to correlate these structures in the gorilla. Not only did this specimen provide illumination for problems of the human pelvis and perineum but presented some anatomy of the pelvic diaphragm and perineum not previously recorded for the gorilla. The dissection was made from the pelvic outlet in order to preserve the skeletal elements. The present observations deal primarily with musculature and are new or in part clarifications of structures previously described. This is not meant to be a comparative or an exhaustive study of the pelvis and perineum since the descriptions are derived from a single specimen.

The specimen examined was MAXIMO, a male lowland gorilla *(Gorilla gorilla gorilla)* that died in the Detroit Zoological Garden in 1975. MAXIMO was received by the Zoo on May 6, 1955 and was estimated to be 1+ years old. Upon arrival at the zoo he was considered to be overweight and seemed to maintain that condition throughout life. At death he weighed 538 pounds.

The literature on primate anatomy is voluminous. Studies on the anatomy of the gorilla are limited, especially so in the region of the pelvis and the perineum. The literature cited is limited to those studies in which the anatomy of the gorilla is specifically considered.

Eggeling (1896), Elftman ('32), Raven ('50) and Hill ('50) described much of the pelvic structure, musculature and organ systems of the gorilla. Eggeling described his specimen as *Troglodytes gorilla,* Elftman did not indicate his species, while Raven and Hill indicated their specimen was *Gorilla gorilla.*

The pelvic floor

M. levator ani. The levator ani muscle (Hill, '50) consists of two muscle masses, pubococcygeus and iliococcygeus (Elftman, '32; Raven, '50).

In the gorilla the term levator ani seems appropriate since only the origin of these muscles can be used to differentiate them. No separation between the muscles nor overlapping of component parts exists as in man. The

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descriptive character of the term levator ani might also be questioned as it applies functionally in the gorilla. Regardless of these facts, and to maintain a logical phylogenetic relationship, the terms pubococcygeus and iliococcygeus are used in the following descriptions, although pubocaudalis and iliocaudalis respectively have been used interchangeably with the pubococcygeus and iliococcygeus in primates (Eggeling, 1896).

M. pubococcygeus. The pubococcygeus muscle (figs. 1A,B, 2A) arises from the pubic bone, near the symphysis, and the fascia of the obturator internus muscle. The origin is fleshy, providing a muscle approximately 5 mm thick. The parallel muscle fascicles pass dorsally behind the rectum and are continuous with the corresponding muscle of the opposite side. Fibers of the pubococcygeus do not reach to the coccyx. There is no interdigitation of muscle fibers or an anococcygeal raphe; however, on the perineal surface of this portion of the levator ani the thickened inferior fascia between the external anal sphincter and the coccyx appears to form an anococcygeal raphe. It may function as a ligament (anococcygeal ligament) from the coccyx to the external anal sphincter but in no way interrupts the fibers of the pubococcygeus (or the iliococcygeus muscle) or becomes an insertion for the muscles of the two sides.

Along the lower edge of the pubococcygeus muscle, immediately behind the rectum, an intermingling of fibers from the deep part of the external anal sphincter (figs. 1B, 2A) may be mistaken for an interdigitation of fibers of the two sides of the pubococcygeus.

M. iliococcygeus. The iliococcygeus muscle (figs. 1A,B, 2A) arises from the fascia of the obturator internus by an aponeurosis and distinctive tendons, each giving rise to from three to five muscle fascicles. Although fused to the fascia of the obturator internus muscle, these tendons may extend as far as the ilium with no separation between this muscle and the pubococcygeus. The muscle fascicles parallel those of the pubococcygeus and continue from one side to the other behind the rectum. Near the coccyx a small aponeurotic area in the iliococcygeus part of the levator ani (fig. 1a) is an insertion of its upper fibers into the coccyx.

As the muscles of the levator ani sweep dorsally they pass lateral to the bladder-prostate-urethra-sphincter urethrae complex and, further dorsally, the rectum. These fibers do not attach to any of the pelvic viscera despite Elftman, ('32) and Ravens ('50) remark indicating these fibers do insert into the rectum. The confusion is due to the presence of a distinctive smooth muscle mass, the puboampullaris, which they apparently did not separate. The absence of an attachment of the pelvic diaphragm to the rectal wall makes it impossible to use this as a guide to the end of the rectum and the beginning of the anal canal as is sometimes used in man. Indirectly, through the continuity of the rectal wall with the superficial and the deep external anal sphincters, there is a point of fixation behind the rectum.

The inferior margin of the pubococcygeus lies adjacent to the sphincter urethrae and further dorsally lies lateral to that portion of the rectum corresponding to the ampulla. The muscles of the levator ani, passing dorsally and around the rectum, provide a large opening, the recto-urogenital hiatus (fig. 1B), through which the urogenital and alimentary structures pass from the pelvic cavity to the perineum. This opening leaves a great disparity between that portion of the rectum covered by the levator ani dorsally and ventrally. Dorsally the pubococcygeus and the iliococcygeus completely cover the rectum. Anteriorly the ampullary part of the rectum and the anal canal lie caudal to the levator ani, exposed in the perineum. Approximately 8 cm of the anterior wall of the rectum is exposed below the pubococcygeus.

The striated parts of the levator ani just described appear to have no direct function in support of the alimentary canal and the bladder-prostate-urethra complex. As the two sides of the muscle contract and advance the rectum toward the pubis they may act as a sphincter to close off the recto-urogenital hiatus by approximating the mid-line. With the appearance of the following muscle a more logical arrangment for support of the pelvic viscera becomes apparent.

M. puborectalis. The puborectalis muscle (figs. 1A, 2D) is described until the present as characteristic of man. Eggeling, ('29) used the term to describe some of the caudal fibers of the pubococcygeus muscle encircling the dorsal side of the rectum in the orangutan. In man it has been considered both as a part of the pubococcygeus and as a separate muscle.

In the gorilla it is a completely separate muscle not entirely comparable to the puborectalis of man.

The puborectalis in the gorilla arises by means of an aponeurosis (fig. 2D) from the connective tissue in the region of the sub-symphysial angle (arcuate pubic ligament), the fibrous tissue associated with the attachment of the tunica albuginea of the corpus cavernosum penis and the symphysis. It is slightly expanded at its immediate attachment and perforated by branches of the internal pudental artery and vein and pudendal nerve as these pass to the dorsum of the penis and to the cavernous bodies. Being bilateral, the two aponeurotic origins surround the urethra immediately deep to the corpus spongiosum. These aponeurotic origins seem to function as a perineal membrane (inferior fascia of the so-called urogenital diaphragm) in as much as they seem to support the urethra, the sphincter urethrae and the corpus spongiosum; however, they lie parallel to the mid-line and do not fill in the entire sub-symphysial angle as the perineal membrane does in man. On a plane cephalic to this aponeurotic origin lie the nerves, arteries and veins of the pudendal canal, the sphincter urethrae muscle and the deep transverse perineus muscle, the latter extending lateral to the puborectalis muscles (fig. 2D). The origins of the puborectalis muscles become fleshy near the posterior border of the corpus spongiosum where they parallel one another and lie inferior to the anterior rectal wall, exposed within the recto-urogenital hiatus. Continuing dorsally they parallel the lower border of the pubococcygeus muscle (fig. 1A) and lie lateral to the rectum as a cylindrical mass 2 cm × 1 cm. The muscle continues overlying the inferior border of the pubococcygeus and part of the deep external anal sphincter. Behind the rectum it becomes continuous with the corresponding muscle of the opposite side (fig. 1A) to form a characteristic "sling muscle." Here a few fascicles of muscle intermingle with the deep external anal sphincter but do not attach to the levator ani.

This muscle undoubtedly functions to bring the rectum toward the pubis. The presence of these puborectalis masses near the mid-line just behind the corpus spongiosum tends to close off the large recto-urogenital hiatus and prevent rectal prolapse.

Though the puborectalis of the gorilla and of man are not entirely comparable, the pubococcygeus part of the levator ani also has characteristics similar to the puborectalis in man since it actually has no attachment to the coccyx and sweeps behind the rectum in continuity with the external anal sphincter.

Previous investigators may have seen the muscle but did not thoroughly appreciate its unique structural characteristics. Elftman ('32) indicates in his discussion of the external anal sphincter that: "—an especially strong band crosses to either side of the urethra, in addition sending some bundles to insert in the ischium near the symphysis." Raven ('50, plate 93) shows a similar, unlabeled mass of muscle lying between the ischiocavernosus and the bulbospongiosus muscles.

M. puboampullaris. Within the pelvic cavity, lying on the superior surface of each half of the pubococcygeus muscle, a large (30 mm high × 5 mm thick), well defined paired smooth muscle (fig. 2A) arises from the pubic bone (right and left) just medial to the origin of the pubococcygeus muscle and passes dorsally paralleling the inner surface and the lower border of the pubococcygeus. Though lying adjacent to the pubococcygeus it by no means arises from or attaches to that muscle. It is separated from the pubococcygeus by a thin fascial plane, the superior fascia of the pelvic diaphragm. Each muscle passes dorsally, lateral to the prostate and the sphincter urethrae muscle and attaches to the wall of the rectum, becoming distinctly fasciculated. The fascicles pass between the longitudinally arranged fascicles of smooth muscle of the rectal wall (fig. 2B), turn inferiorly and blend to form a more homogeneous sheet becoming indistinguishable from the longitudinal smooth muscle of the rectum (fig. 2A). The most caudal fibers sweep toward the mid-line where they unite in front of the rectum with the fibers of the opposite side to blend into that region of the rectum and anal canal exposed between the portions of the pelvic diaphragm or the area exposed in the recto-urogenital hiatus (fig. 1B). As these two muscles sweep dorsally and join together on the rectum they in effect provide a smooth muscle urogenital hiatus (fig. 2A) similar to the recto-urogenital hiatus of the pubococcygeus part of the levator ani. Within this hiatus and passing from the pelvis to the perineum lie the urethra and its investing sphincter urethrae muscle.

Just above the anal columns the anal canal is angulated dorsally (presumably the effect of the puborectalis) so that the rectum and anal canal lie at approximately a 45° angle. The point of angulation is the point of attachment of the smooth muscles just described. Although the rectum is not dilated in this region, the term ampulla seems appropriate.

The term pubovesical (M. pubovesicales) has been used to describe what appears to correspond with this muscle by Raven ('50). He also included it in illustrations (plates 59, 96) as having a common origin with the pubococcygeus and that it had an insertion into the: "—lateral aspect of the bladder near the margin of the prostate area." Elftman ('32) does not mention this muscle specifically but indicates that the pubococcygeus inserts into the rectal wall. The difficulties here center, as in man, with the confusion created by the densities of the endopelvic fascia. Elftman saw this muscle inserting into the rectum but could not separate it, as smooth muscle, from the pubococcygeus and thus indicated that the pubococcygeus inserts into the rectal wall. There is no pubovesical muscle in the gorilla. I therefore suggest the term puboampullaris for this muscle so that confusion does not exist between this smooth muscle and the striated muscle, puborectalis.

Functionally these smooth muscle bundles elevate and pull the rectum forward. Additionally the two muscle masses provide a sling for the urogenital structures as well as support since in effect contraction would narrow the urogenital hiatus.

M. sphincter ani externi. The external anal sphincter consists of two parts, superficial and deep. Both surround the anal canal and are thick, heavily fasciculated muscles. The anal canal is characterized by a distinctive mucosa, anal valves, anal sinuses and anal columns. Since the pelvic diaphragm does not attach or adhere to the rectal wall this attachment cannot be used to distinguish the rectum from the anal canal. The anal canal therefore extends to the upper border of the anal columns.

The *superficial external anal sphincter* (figs. 1B, 2A) can be distinguished by two characteristics. It is fusiform in its anterior (ventral) portion and the longitudinal smooth muscle of the rectum passes between adjacent fascicles to attach to the skin surrounding the anal verge, as in man. The superficial external anal sphincter surrounds the anal verge at the same plane as the internal anal sphincter, just inferior and adjacent to the deep external anal sphincter. Through a cylindrical muscle, it is somewhat flattened and horizontal in disposition. On the dorsal side of the anus, the fascicles encircle the anal canal. A few peripheral fascicles may radiate toward the coccyx but by no means reach it as they disperse within the superficial fascia. The anterior (ventral) part is fusiform. Though a few deep fascicles encircle the anterior portion of the anal canal the major fibers extend forward, superficial to the bulbospongiosus muscle, paralleling the midline. These fibers radiate upward toward the scrotal septum and the raphe of the bulbospongiosus muscle where they attach. This arrangement is necessitated since the plane of the fusiform part of the external anal sphincter is approximately 25 mm superficial to the more anterior perineal structures. A few fibers radiating toward the ischial tuberosities resemble a superficial transverse perineus muscle, but they are thin and sparse and do not reach the ischial tuberosities. At the periphery of the external anal sphincter a few muscle fascicles radiate into the superficial fascia of the ischiorectal fossa. These fibers are the exception and by no means form the massive radiating superficial external anal sphincter seen in the chimpanzee (personal observation).

The *deep external anal sphincter* (figs. 1B, 2A) is a dense circular mass, somewhat flattened vertically, surrounding the anal canal deep to the superficial external anal sphincter. No longitudinal fibers of the rectum pass between its fascicles as it lies completely external to the longitudinal smooth muscle of the anal canal. Ventrally its vertical face lies against the posterior portion of the bulbospongiosus muscle. Along its dorsal side it is continuous with and blends inseparably from the caudal fibers of the pubococcygeus part of the levator ani muscle (figs. 1B, 2A). There is no attachment to the wall of the anal canal. As the puborectalis muscle passes dorsally, it lies along the upper (cephalic) border of the deep external anal sphincter; however, as it continues to the mid-line behind the anal canal it comes to overlie the deep external anal sphincter (fig. 1A).

Perineal and urogenital muscles

M. sphincter urethrae. The sphincter urethrae muscle (figs. 2B,C) embraces the urethra from the base of the bladder to the cephalic border of the corpus spongiosum. It is separated from the corpus spongiosum by the aponeurotic origin of the puborectalis muscle on which the sphincter rests. The muscle fibers are individual, not well fasciculated, and frequently separated from one another by fat. In addition the muscle contains a vascular plexus continuous with and part of the vesical plexus, typical of mature adult and old human sphincter urethrae muscles.

The sphincter urethrae muscle does not extend throughout the entire length of the urethra on the dorsal side due to the presence of the paired prostate, the ductuli deferentes and the seminal vesicles extending as far caudally as the seminal colliculus. The extent of the sphincter along the anterior (ventral) wall of the urethra is 45 mm while it is only 25 mm posteriorly (dorsally). The upper border of the muscle therefore slopes caudally (fig. 2B). Though the prostates, seminal vesicles and ductuli deferentes cause the muscle to lie more caudally on the dorsal side, the muscle somewhat ensheathes the lateral border of these structures and forms a cone like cavity or compartment for them.

The major portion of the sphincter urethrae lies within the pelvic cavity. At the inferior border of the puboampullaris muscles the sphincter urethrae passes through its urogenital hiatus. Below this narrowed hiatus the sphincter expands to fill the area between the ischial rami or the region of the sub-symphysial angle. The muscle rests on the aponeurotic origins of the puborectalis muscles which parallel the mid-line (fig. 2D). The fibers lying immediately adjacent to the urethra are sphincteric while those fibers situated more peripherally radiate outward extending toward the obturator fascia and the fascia lunata, investing the pudendal vessels, but do not attach. The posterior part of the sphincter urethrae is enlarged or bulging as it contains the bulbourethral glands. Dorsally it is in contact and inseparable from the deep transverse perineus muscle. The sphincter urethrae muscle therefore lies within the pelvic cavity, in the urogenital hiatus and within the urogenital triangle of the perineum. Being muscular it is surrounded by a muscular fascia. In the pelvis, this fascia is inseparable from the endopelvic condensations which also invest the paired prostate, seminal vesicles, ductuli deferentes and the base of the bladder. The fascia fuses with the superior fascia of the pelvic diaphragm to close off the urogenital hiatus.

The sphincter urethrae of the gorilla, because of its size, simplicity and absence of an invasive prostate presents us with a true sphincter mechanism. A similar arrangement can be seen in man at term and in early developmental stages prior to puberty. The sphincter urethrae in the gorilla is a cylindrical sphincter surrounding the urethra without lateral attachments, and not a horizontal plane of muscle as often incorrectly depicted in man. In man the continued growth of the prostate (encircling the urethra) has invaded the sphincter urethrae muscle and resulted in a major loss of fibers. Though striated muscle sphincter fibers still exist external to the capsule of the prostate and overlain by the investing prostate anteriorly, the appearance of the grossly visible sphincter muscle, surrounding the membranous urethra, has resulted in a false concept of a horizontal muscular diaphragm (urogenital diaphragm) with a fascia above and below and surmounted by the prostate. It is not the purpose of this paper to delve into the validity of the urogenital diaphragm in man, however, it is important to point out that with only a minor modification (the increase in growth of the prostate) we see in the gorilla the same sphincter urethrae muscle in all aspects and relationships that we see in man. In addition in man the sphincter urethrae (bladder and prostate) rest on a perineal membrane. In the gorilla the anterior parts of the puborectalis seem to support these structures and form a support and attachment for the corpus spongiosum. Elftman ('32) denied the existence of the urogenital diaphragm in primates (excluding man) with the exception of the chimpanzee. Having dissected both male and female chimpanzees I find no urogenital diaphragm there either.

M. transversus perinei profundus. The deep transverse perineus muscle (figs. 2B,D) consists of well fasciculated, transversely oriented fibers lying adjacent to the posterior border of the sphincter urethrae (that portion which lies in the perineum); and arising from the fascia of the obturator internus muscle about 2 mm cephalic to the ischial ramus. The origin is crossed inferiorly (superficially) by the pudendal canal and its contained vasculature. Some thin anterior fibers, possibly aponeurotic, lie inferior to the sphincter urethrae muscle and radiate forward to attach to the obturator fascia. At the mid-line dorsal to the corpus spongiosum continuity with the sphincter urethrae prevents a clear line of separation. At the mid-line some of the fibers interdigitate with the superficial external anal sphincter, the bulbospongiosus and some of the smooth muscle on the anterior wall of the rectum, certainly a point of muscular fixation similar to a perineal body.

The deep transverse perineus lies just cephalic to and rests upon the tendon of origin of the puborectalis muscle (fig. 2D).

M. rectourethralis. Additional smooth muscles can be found passing from the rectal wall to the sphincter urethrae. This mass arises from that part of the rectal wall angulated forward and in contact with the prostates, seminal vesicles, sphincter urethrae, 8-10 cm above the anal verge. The rectourethralis muscle (figs. 2B,C) consists of thin sheets (approximately 8 near the mid-line) which arise between the longitudinal fascicles of smooth muscle of the rectum and pass forward to the sphincter urethrae muscle. These fibers extend as high as the upper border of the sphincter urethrae and as far caudally as the bulb of the corpus spongiosum. The fibers for the most part, interdigitate, intermingle and diffuse into the sphincter urethrae; however, those near the mid-line pass through the sphincter and attach to the dorsal side of the urethra and to the bulb of the corpus spongiosum (fig. 2C). Though the fibers attach to the urethral wall, they do not encircle it or provide any form of a smooth muscle sphincter in addition to the smooth muscle wall of the urethrae itself. These smooth muscle fibers attach to the urethrae below the level of colliculus seminalis and appear to be only anchoring points between the rectum and the urethrae with its sphincter.

M. bulbospongiosus. The bulbospongiosus muscle arises from the ischial rami and the septum of the penis. The posterior fibers arise by an aponeurosis from the ischial ramus just above and adjacent to the attachment of the crus of the corpus cavernosum penis. The paired origins, along the ischial rami, continue forward converging on one another at the mid-line beneath the symphysis to unite just anterior to the urethra as it enters the corpus spongiosum. The two united origins continue forward attaching to the septum of the body of the penis (corpus cavernosum). As the septum disappears within the shaft of the penis, the muscle origins again become paired and arise from the tunica albuginea of the inferior surface of the shaft of the penis. This origin continues forward to a point 25 mm from the tip of the penis. The entire length of the origin of each side is approximately 110 mm long. The muscle fibers extend from their origins to pass around the corpus spongiosum and its contained urethra and ultimately insert by interdigitating with the corresponding muscle of the opposite side in a mid-line raphe along the inferior surface of the corpus spongiosum. Fusiform fibers of the superficial external anal sphincter extend through the superficial fascia to attach to the mid-line raphe of the bulbospongiosus muscle as in man. The muscle is obviously a compressor of the bulb, the corpus spongiosum and the contained urethra.

In man the bulbospongiosus muscle arises from the inferior surface of the perineal membrane and encircles the bulb. With the absence of a perineal membrane, in the gorilla, the posterior origin arises from the ischial ramus. This origin is at first aponeurotic and then becomes muscular passing posteriorly and inferiorly around the hemispheric bulb of the corpus spongiosum. As this aponeurotic sheet extends dorsally toward the bulb it provides a distinct plane of connective tissue which appears as a "perineal membrane". Moreover, by this attachment and disposition it does provide fixation for the corpus spongiosum and the contained urethra, thereby supporting the urogenital viscera cephalic to it.

M. ischiocavernosus. The ischiocavernosus muscle is relatively simple and comparable to the ischiocavernosus found in most other primates. It arises from the ischium, just anterior to the ischial tuberosity, and passes forward along the ischial ramus for 25 mm where it reaches the tip of the crus of the corpus cavernosum penis. Fibers of the muscle then fan medially, laterally and inferiorly, to the crus of the corpus cavernosum penis and insert into its tunica albuginea. The major muscle mass continues forward on the inferior and lateral wall of the crus to the shaft of the penis where fibers insert, in a vertical line, into the tunica albuginea of the proximal end of the shaft of the penis just prior to its perineal flexure. A few of the fibers near the dorsum of the penis become aponeurotic and cross the mid-dorsal-line (covering the deep dorsal vein, the dorsal arteries and the dorsal nerves) to interdigitate with the corresponding fibers of the opposite side.

Urogenital viscera

The bladder (figs. 2B,C) is distinctly tapered (funnel shaped) toward the urethra. It is concave on its dorsal side forming a cavity for the ductuli deferentes and seminal vesicles. In the lower 25 mm the ventral wall becomes thickened and gives the appearance of a smooth muscle sphincter. This disappears suddenly and only the urethral wall surrounded by the straited sphincter urethrae continues.

The *urethra* (fig. 2C) from the base of the bladder to the corpus spongiosum is 45 mm long and 7.5 mm in diameter. Its course is slightly concave (ventrally). Since the prostate does not surround the urethra it cannot be divided into prostatic and membranous parts, however, it would be appropriate to call it the membranous urethra due to its investment by the sphincter urethrae muscle. The mucosa in the collapsed state is longitudinally folded throughout. On the dorsal side 15 mm from the base of the bladder the seminal colliculus surmounts a typical urethral crest. The paired ejaculatory ducts open onto the apex of the colliculus seminalis separated by the shallow prostatic utricle. At the sides of the colliculus and the urethral crest the prostatic sinuses receive the ducts of the prostate glands. Just as the urethra enters the corpus spongiosum it receives the ducts of the bulbourethral glands (fig. 2C) on its dorsal side. The urethra enters the corpus spongiosum and lies in its cephalic part surrounded by erectile tissue on three sides. Only as the urethra reaches the glans penis does it become centrally located within the corpus spongiosum.

The *ductuli deferentes* (figs. 2B,C) pass to the dorsal side of the bladder to converge toward the mid-line. Approximately 60 mm from their termination they become tortuous, somewhat visible externally. They continue caudally lying between the bladder and the corresponding seminal vesicle. The wall throughout is very thick exceeding in thickness the diameter of the lumen. Just before perforating the urethral wall each unites with the duct of a seminal vesicle. The thinwalled *ejaculatory duct* thus formed, approximately 10 mm long, continues within the connective tissue surrounding the base of the seminal vesicle and the ductus deferens. Each enters the posterior wall of the urethra but does not pass through the prostate.

The *seminal vesicles* (figs. 2B,C) are 50-60 mm long, 5-7 mm broad; their distinct tortuosity becomes less pronounced as the seminal vesicles lie between the prostate glands. The duct of the seminal vesicle joins the ductus deferens 10 mm from the urethral wall. For the distal 20 mm of their course the ductuli deferentes and the seminal vesicles are embraced by the pair of prostate glands and the posterior wall of the bladder. The fascia of the pelvis provides an additional investment of great density.

Each of the paired *prostate glands* (figs. 2B,C) is 25 mm long, 15 mm wide and 7 mm thick. The cephalic end is pointed and lies against the base of the bladder; the caudal end is blunt and rounded with a medial concave surface. In its caudal one-third each gland lies against the posterolateral wall of the urethra in the region of the corresponding prostatic sinus (fig. 2C), where the multiple ducts open into the urethral lumen. The glands contact only the posterior one-third of the urethra. They do not lie lateral to or encircle the urethra. The prostate gland does not resemble what Raven ('50) described (also his plate 94). Steiner ('54) indicates only measurements for the prostate but assumes the gland to be unpaired.

The *bulbourethral glands* (fig. 2C) are paired cylindrical glands without distinct capsules 10 mm in dimension situated within the most caudal part of the sphincter urethrae muscle posterolateral to the urethra. The duct seems to arise in a hilar region of the gland, is 0.5 mm in diameter and courses 10 mm forward through the sphincter urethrae muscle to reach the proximal portion of the penile urethra. The bulbourethral glands were readily identified in our specimen.

DISCUSSION

Support of pelvic viscera is an important consideration in the structure of the pelvic outlet. Although fascias do provide support, muscles are the most useful on a comparative basis. Muscular closure of the pelvic floor of the gorilla is incomplete when compared with man but all of the muscle elements are well developed, either smooth or striated, providing active dynamic support.

The gorilla lacks smooth muscle support of the alimentary canal from the vertebral column, though atrophic remnants of the caudoanalis and caudorectalis do persist. The smooth muscle support for the rectum has apparently shifted to the pubis in the form of a well developed muscle, the puboampullaris.

The striated muscle levator ani, represented by the pubococcygeus and iliococcygeus, though in part closing off the pelvic outlet, provide no direct support for the alimentary or urogenital viscera since these structures lie in the large rectourogenital hiatus between the two halves of the levator ani. The rectum is supported indirectly by the attachment of the deep part of the external anal sphincter to the caudal fibers of pubococcygeus. Since the pubococcygeus has no direct attachment to the coccyx and merely "slings" the rectum its probable action would be to move the rectum toward the symphysis stabilizing it against the more anterior urogenital viscera as well as slightly elevating it. It may assist the external anal sphincter in its function of closing the alimentary canal. The puborectalis muscle, by its position, supports the exposed anterior rectal wall and assist in closing off the rectourogenital hiatus. Since it parallels the lower border of the pubococcygeus its probable function in contraction would be similar to that of the pubococcygeus.

Elftman ('32) emphasized the function of the external anal sphincter in supporting the pelvic floor as well as its strength and distribution. The extent and strength seen here is only comparable to the size of the anal canal and the animal and certainly not as proportionately large and elaborately distributed as the external anal sphincter of the chimpanzee. The sphincters in many respects resemble man but cannot be considered to support the pelvic floor since they lack true supportive attachments. Elftman described some heavy bands of muscle, of the external anal sphincter, crossing to either side of the urethra and inserting into the ischium near the symphysis. He may have seen the puborectalis incompletely and considered it a part of the external anal sphincter, thereby giving the external anal sphincter undue credit for support of the pelvic outlet.

The absence of a distinct perineal membrane in the urogenital region seems to necessitate the specialization of other structures to provide support. Three distinct elements appear to support the urogenital viscera as well as close off the urogenital portion of the pelvic outlet. First: the puboampullaris muscle with its attachment to the rectal wall forms a narrow sling surrounding the urethra and its sphincter. Upon contraction, not only would it narrow the urogenital hiatus, but move the rectum forward, reducing the anterior-posterior dimension of the hiatus. Secondly: that portion of the sphincter urethrae below the puboampullaris and the pelvic diaphragm rests directly on the anterior aponeurotic origin of the puborectalis. This shelf not only provides direct support for the sphincter and the viscera above but provides a point of fixation for the urethra and the corpus spongiosum below. Lastly: the bulbospongiosus muscle, by arising from the ischial ramus in part, and extending dorsally to invest the bulb of the corpus spongiosum, stabilizes, fixes and supports the corpus spongiosum in the subsymphysial angle.

A perineal body does not appear to be a distinctive feature of the perineum; however, some fibers of the deep transverse perineus, the superficial and deep external anal sphincter, the bulbospongiosus muscles and the rectal wall do intermingle. Additionally the rectourethralis (smooth) muscle provides anchorage between the rectal wall and the sphincter urethrae muscle.

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PLATES

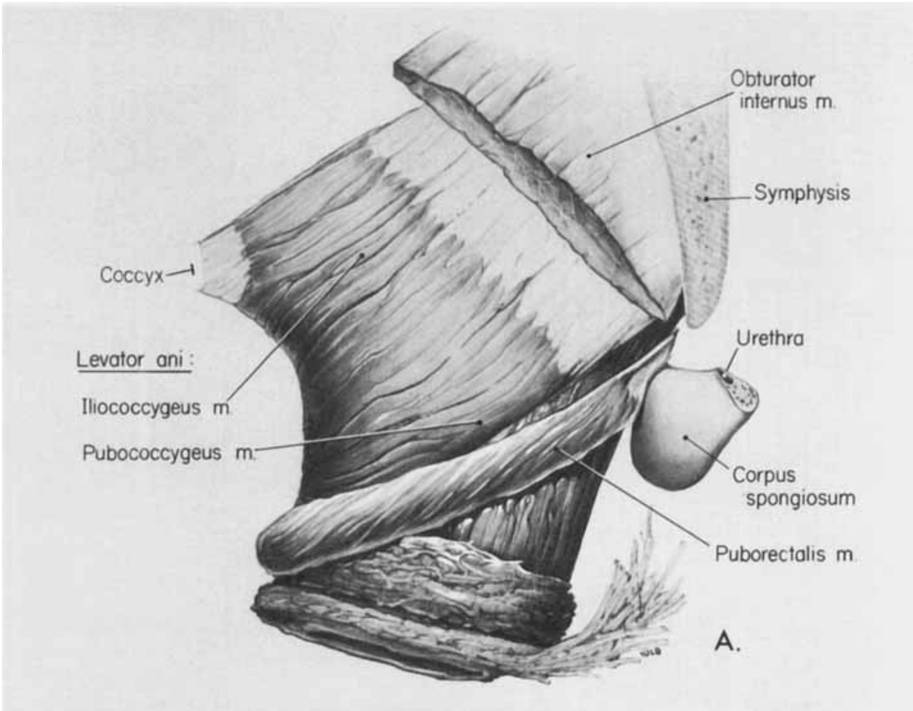
PLATE 1

EXPLANATION OF FIGURES

1 Lateral views of the pelvic musculature of the male gorilla; skeletal elements removed.

A Muscles of the anal region intact (1/2 natural size).

B Puborectalis muscle removed demonstrating the recto-urogenital hiatus (1/2 natural size).


Obturator internus m.
Symphysis
Coccyx
Levator ani:
Iliococcygeus m.
Pubococcygeus m.
Urethra
Corpus spongiosum
Puborectalis m.
A.

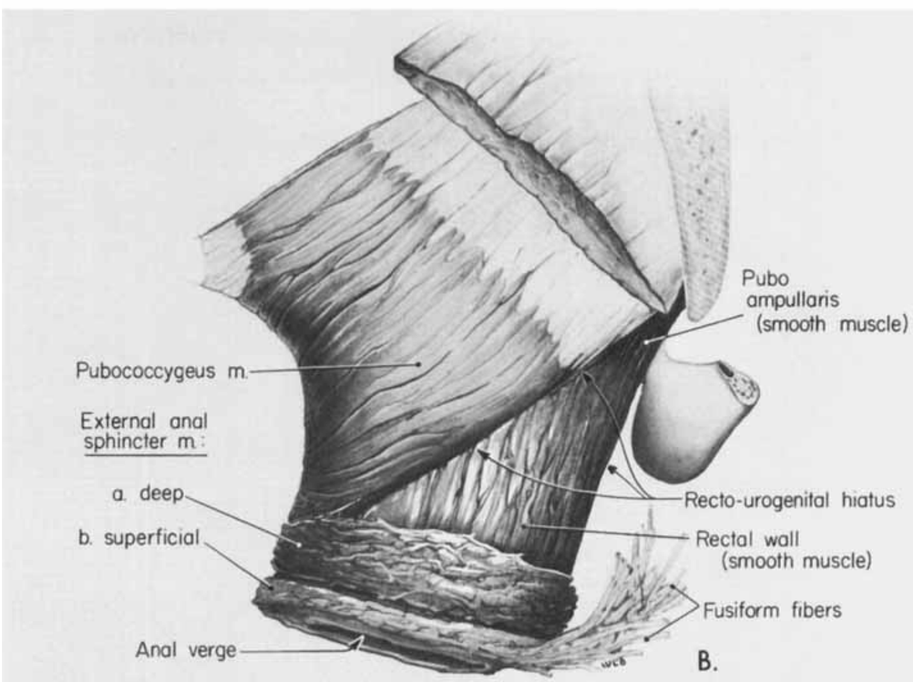

Pubo ampullaris (smooth muscle)
Pubococcygeus m.
External anal sphincter m.:
a. deep
b. superficial
Anal verge
Recto-urogenital hiatus
Rectal wall (smooth muscle)
Fusiform fibers
B.

PLATE 2

EXPLANATION OF FIGURES

2 Rectal and urogenital anatomy of the male gorilla.

A Levator ani reflected to show puboampullaris muscle attached to the rectum (1/2 natural size).

B Lateral view of urogenital structures, puboampullaris reflected (1/2 natural size).

C Lateral view of urogenital structures with sphincter uretrae muscle removed (1/2 natural size).

D Perineal view of the origin of the puborectalis muscle (1/3 natural size).

Thomas M. Oelrich