MALE GENITAL ORGANS AND ACCESSORY GLANDS OF THE LESSER MOUSE DEER, *TRAGULUS JAVANICUS*

M. K. VIDYADARAN, R. S. K. SHARMA, S. SUMITA, I. ZULKIFLI, AND A. RAZEEM-MAZLAN

Faculty of Biomedical and Health Science, Universiti Putra Malaysia, 43400 UPM Serdang, Selangor, Malaysia (MKV),
Faculty of Veterinary Medicine and Animal Sciences, Universiti Putra Malaysia, 43400 UPM Serdang, Selangor, Malaysia (RSKS, SS, IZ),
Department of Wildlife and National Parks, Zoo Melaka, 75450 Melaka, Malaysia (ARM)

Gross anatomical features of the male genital organs and accessory genital glands of the lesser mouse deer (*Tragulus javanicus*) are described. The long fibroelastic penis lacks a prominent glans and is coiled at its free end to form two and one-half turns. Near the tight coils of the penis, on the right ventrolateral aspect, lies a U-shaped ventral process. The scrotum is prominent, unpigmented, and devoid of hair and is attached close to the body, high in the perineal region. The ovoid, obliquely oriented testes carry a large cauda and caput epididymis. Accessory genital glands consist of paired, lobulated, club-shaped vesicular glands, and a pair of ovoid bulbourethral glands. A well-defined prostate gland was not observed on the surface of the pelvic urethra. Many features of the male genital organs of *T. javanicus* are pleisomorphic, being retained from suiod ancestors of the Artiodactyla.

Key words: *Tragulus javanicus,* male genital organs, accessory genital glands, reproduction, anatomy, Malaysia

The lesser mouse deer (*Tragulus javanicus*), although a ruminant, possesses certain features atypical of the suborder Ruminantia (Duwe, 1969; Janis, 1984; Todd, 1975; Webb and Taylor, 1980; Yong, 1973). Phylogenetic studies suggest that ancestors of this unique ruminant diverged from the artiodactylan lineage during the middle Eocene, with the family Tragulidae being a branch of the suborder Ruminantia (Janis, 1984; Webb and Taylor, 1980). Studies on morphology, dietary habits, sexual behavior (Janis, 1984), and social behavior (Dubost, 1975) of *T. javanicus* revealed that this tragulid was more similar to suids than to higher ruminants. A study on skeletal-muscle antigens (Duwe, 1969) demonstrated that this chevrotain has a close immunological relationship with the Tayassuidae. Mochi and Carter (1971) suggested that tragulids also shared pleisomorphic features with the camel. This may be expected because the Suidae are believed to be the common ancestors of the Camelidae, Tragulidae, and Bovidae (Webb and Taylor, 1980). Our objectives are to describe morphology of male genital organs and accessory genital glands of *T. javanicus,* and compare our findings with those reported for the dromedary camel, *Camelus dromedarius* (Camelidae), domestic pig (Suidae), and domestic cattle (Bovidae), to provide evidence of pleisomorphic genital features of *T. javanicus* with those artiodactyls.

MATERIALS AND METHODS

Six adult male *T. javanicus* that had died of natural causes were obtained from Zoo Melaka, Ayer Keroh, Malaysia. The animals were native to Peninsular Malaysia. Carcasses were sealed in plastic bags to prevent dehydration and stored in a freezer at −10°C. Prior to dissection, specimens were allowed to thaw. A craniocaudal incision was made on the midventral wall of the abdomen, and the urogenital organs were dissected out by careful separation from the surrounding tissues, using blunt forceps and scissors. The os pubis was cut cranial and caudal to the obturator foramen with bone shears to facil-

TABLE 1.—*Measurements (mm) of various sections of the penis (six specimens) and accessory glands (three specimens) of* T. javanicus.

Parameter	Section	$\bar{X} \pm SD$
Penis		
Length	Pars libera	48.7 ± 6.1
	Corpus and radix	96.7 ± 5.9
	Total	145.3 ± 7.4
Diameter	Cranial extent	1.2 ± 0.3
	Pars libera	2.5 ± 0.2
	Corpus (sigmoid flexure)	3.4 ± 0.3
	Radix	4.7 ± 0.5
Accessory glands		
Length	Vesicular gland	18.0 ± 1.7
	Bulbourethral gland	10.3 ± 1.2
	Ampulla	20.3 ± 0.6
Width	Vesicular gland	4.7 ± 1.2
	Bulbourethral gland	6.3 ± 0.6
	Ampulla	1.0 ± 0.1

itate removal of the entire urogenital tract. Excessive fat and fascia were removed prior to measuring various sections of the genital organs, namely the penis (from six specimens), testis and epididymis (5 specimens), and accessory genital glands (3 specimens). Measurements (lengths and diameters) were taken using vernier calipers to the nearest 0.1 mm. Weights were determined with a digital scale to the nearest 0.01 g. The whole tract was kept moist throughout the dissection. Description of the pars libera penis, ureter, ampulla, and accessory glands was aided by a dissecting microscope at a magnification of 10×. Data were subjected to a one-way analysis of variance using the General Linear Models Procedure of the Statistical Analysis System (SAS Institute Inc., 1982).

RESULTS

Penis.—The penis of *T. javanicus* was of the fibroelastic type. It originated cranially from the ischiatic arch, passed between the thighs, ventral to the pelvis, and extended close to the umbilicus. The penis consisted of a radix, corpus, and pars libera. Diameter of the penis decreased from radix to pars libera and ended cranially with a diameter of 1.2 ± 0.3 (*SD*) mm.

The pars libera penis was long and accounted for 33% of the length of the penis

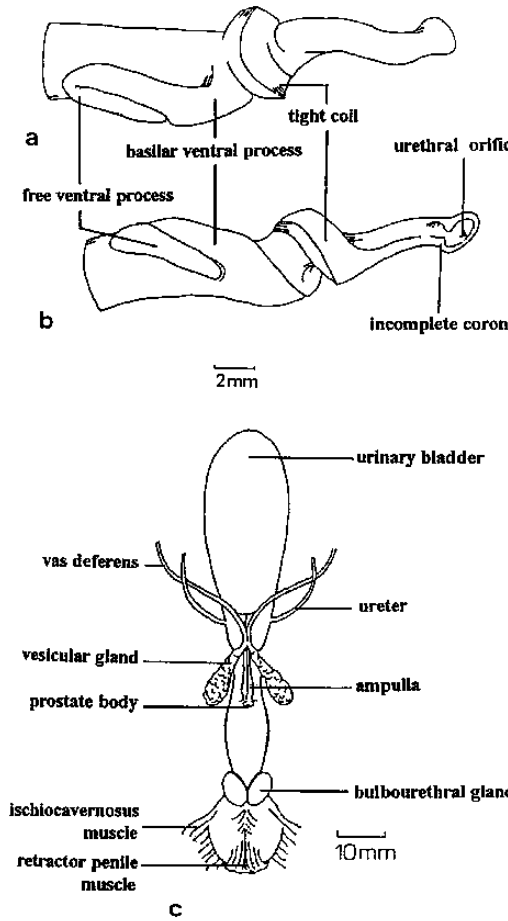

FIG. 1.—Right a) lateral and b) ventral aspects of the pars libera penis, and c) dorsal aspect of the male urinogenital tract of *T. javanicus*.

(Table 1). The cranial extent of the pars libera was coiled to form two and one-half turns, with the first coil tight and subsequent coils stretched (Fig. 1). The tip of the penis carried a corona that was prominent on the dorsum but ended incomplete on the ventral aspect. The urethra opened on the tip of the pars libera on a papilla. Near the vicinity of the tight coil of the penis, on the right ventrolateral aspect, laid a large process (referred to as the ventral process). It took the form of a tight U and consisted of two main parts—a basilar, which was rounded and directed caudally, and a free part, which was more flattened and directed

TABLE 2.—*Linear measurements ($\bar{X} \pm SD$) in millimeters and weight in grams of the testis and epididymis of five* T. javanicus.

Section	Parameter	Right	Left
Caput epididymis	Length	10.7 ± 0.7	8.6 ± 0.9
	Width	5.7 ± 0.5	5.3 ± 0.5
	Weight	0.12 ± 0.02	0.11 ± 0.01
Corpus epididymis	Length	13.8 ± 1.3	11.7 ± 1.4
	Width	1.9 ± 0.2	1.9 ± 0.2
	Weight	0.03 ± 0.004	0.03 ± 0.007
Cauda epididymis	Length	13.7 ± 1.6	14.3 ± 1.2
	Width	5.3 ± 0.7	5.6 ± 0.6
	Weight	0.10 ± 0.03	0.10 ± 0.02
Testis	Length	16.3 ± 0.7	15.8 ± 0.8
	Width	11.2 ± 0.8	11.2 ± 0.5
	Weight	0.73 ± 0.1	0.71 ± 0.1

cranioventrally. Collectively, the length of the corpus and radix accounted for 67% of the length of the penis (Table 1). The corpus folded on itself to form a prominent, prescrotal, sigmoid flexure. This flexure was in the form of a tight fold, ca. 20 mm from the anus. Retractor penile muscles attached on the corpus, on both sides of the penis, and extended caudodorsally to the bulbospongiosus. The radix arose from paired crura, dorsal to the bulbospongiosus muscle.

Scrotum.—The thin, smooth, unpigmented scrotum was prominent and located in the perineal region, ca. 15 mm cranioventral from the anus. It laid flat, close to the body, and was devoid of a prominent neck. Although hair surrounding the scrotum was thick and long, the scrotum itself was devoid of hair. Skin around the caudal vicinity of the scrotum was thick and rough. The scrotum carried a medial groove that divided it into right and left halves.

Testes and epididymis.—The paired, oval, white-colored testes were contained in the scrotum. The long axis of the testis was obliquely orientated, with the extremitas caudata close to the anus and the caput against the caudal thigh muscles. The cranial pole of the testis was wider than the caudal pole. Right and left testes were not significantly different in size or weight ($P > 0.05$; Table 2).

The epididymis consisted of a caput, corpus, and cauda. The caput capped the anterior pole of the testis and occupied ca. 33% of the testis. Right and left caput epididymis accounted for 48% and 46% of the weight, and 28% and 25% of the total length of their respective epididymis. The left cauda comprised 42% of total weight and 41% of total length of the left epididymis, and the right cauda 40% and 36% of total weight and length of the right epididymis, respectively. Weight, length, and width of the right and left caput, corpus, and cauda epididymis were not significantly different ($P > 0.05$; Table 2).

Ductus deferens and ampulla.—The ductus deferens passed through the inguinal ring to reach the dorsal aspect of the bladder. A well-defined ampulla was not observed. However, a slight thickening of the wall of the terminal portion of the ductus deferens was present, forming a thin ampulla (Table 1).

Accessory glands.—The accessory genital glands of *T. javanicus* comprised the vesicular, prostate, and bulbourethral (Fig. 1; Table 1). The vesicular gland was paired, club-shaped, and lobulated. It was positioned cranial to the ampulla, at the base of the bladder, and directed cranioventrally. Although a well-defined prostate gland was not observed on the surface of the pelvic urethra, a small, flat mass was present that

TABLE 3.—*Comparative anatomical features of the male genital organs and accessory genital glands of certain artiodactylan families.*

Structures	Suidae[a]	Tragulidae[b]	Camelidae[c]	Bovidae[a]
Pars libera	Screw-shaped	Screw-shaped	Curved tip	Straight
Glans penis	Present-reduced	Present-reduced	Reduced-absent	Reduced-absent
Penile process	Absent	Ventral process	Cutaneous folds	Absent
Flexure	Sigmoid	Sigmoid	Sigmoid	Sigmoid
Scrotum	Smooth	Smooth	Smooth	Haired
Scrotal position	Perineal	Perineal	Perineal	Pendulous
Testes	Oblique	Oblique	Oblique	Perpendicular
Epididymis	Cauda	Caput-cauda	Corpus	Cauda
Vesicular	Pyramidal	Lobulated	Absent	Lobulated
Bulbourethral	Cyclindrical	Ovoid	Almond	Club-shaped
Prostate	Visible	Visible-reduced	Visible	Visible

[a] Schummer and Nickel (1979).
[b] This study.
[c] Degen and Lee (1982), Nagpal et al. (1987).

resembled the body of the prostate of male pigs and cattle. The paired bulbourethral glands were ovoid, with a smooth surface. They laid dorsal to the bulbospongiosus, close to the radix of the penis. These glands were attached to the bulbospongiosus muscle in a V-shaped orientation, with the apex directed caudally.

DISCUSSION

Evolutionary evidence suggests that the Suidae and Camelidae share features common to the Tragulidae and other ruminant artiodactyls (Table 3). The Suina that existed during the early Eocene are believed to have given rise to the Tylopoda (camelids and the like) and Ruminantia (Janis, 1984; Webb and Taylor, 1980). In a review of the family Tragulidae, Janis (1984) provided evidence that members of this family possess many artiodactylan features, common to the suids, but unlike that of today's higher ruminants.

Additional evidence for this relationship has surfaced through our studies of the male genital organs of *T. javanicus* (Table 3). In contrast to male cattle, the screw-shaped pars libera and the tight, prescrotal sigmoid flexure of *T. javanicus* closely resemble those of the male pig. A spiral-shaped, hooklike, free penis, and prescrotal sigmoid flexure also has been reported in the camel (Merkt et al., 1990). The pars libera, which constitutes ca. 33% the length of the penis of *T. javanicus*, shares similar proportions with the penis of the male pig (Schummer and Nickel, 1979). Absence of a prominent glans penis in *T. javanicus* also is a feature common in the male pig (Schummer and Nickel, 1979) and male camel (Degen and Lee, 1982). The ventral process, which is attached to the pars libera, is unique to the lesser mouse deer. Similar structures, however, are present in certain mammals. These include the lateral processes of the Sumatran rhinoceros, *Dicerorhinus sumatrensis* (Zainal-Zahari, 1995) and the curved terminal tip of the dromedary camel, *Camelus dromedarius* (Degen and Lee, 1982; Moobarak et al., 1972; Nagpal et al., 1987). The screw shaped pars libera and the ventral process may be involved in mating competition; however, the proximate selective mechanism is yet to be determined.

The scrotum and testes of the lesser mouse deer have many features common to the male pig, namely the smooth hairless skin of the scrotum, the oblique orientation of the testes, and the absence of a prominent scrotal neck. Conversely, these structures do not resemble the pendulous scrotum and vertically orientated testes of male cattle or sheep. Position of the scrotum high in the perineal region also is a feature com-

mon to the male pig and camel (Merkt et al., 1990).

The caput and cauda epididymis of *T. javanicus* are large (Table 2) compared with the corpus epididymis. These large structures, like that in many other artiodactyls, may be important in storing the spermatozoa. In this respect, the epididymis of *T. javanicus* is unlike that of the camel, in which the corpus accounts for ca. 50% of total epididymal weight (Merkt et al., 1990), and predominantly stores spermatozoa (Wilson, 1984). The epididymis of *T. javanicus* also is unlike that of the male pig or cattle, in which only the cauda is prominently large and protrudes distally beyond the extremitas caudata. It is, however, comparable to that of small ruminants, like domestic sheep, which possesses a larger caput that extends beyond the extremitas capitata, onto the craniolateral surface of the testis (Schummer and Nickel, 1979). As the epididymal size of many artiodactyls changes seasonally, a comprehensive study over a longer duration (encompassing breeding and non-breeding phases) may be necessary to confirm our observations on the epididymal characteristics of *T. javanicus.*

The lobulated vesicular gland resembles that of male cattle and is unlike the pyramidal-shaped vesicular gland of the pig. The camel does not possess vesicular glands (Ali et al., 1978). The bulbourethral glands, however, are unique in their ovoid shape and resemble neither the cylindrical glands of the pig nor the club-shaped glands of male cattle (Schummer and Nickel, 1979). They are comparable to the almond-shaped bulbourethral glands of the camel (Yagil, 1985).

In contrast to that of the camel, the prostate gland of *T. javanicus,* like that of the pig and cattle, is not markedly visible on the dorsal surface of the pelvic urethra. It is possible that both corpus prostatae (as represented by the small mass on the dorsum of the urethra) and pars disseminata prostatae may be present. This, however, requires further investigation with histological sections of the pelvic urethral region.

Gross morphology of the penis, scrotum, and testes of the lesser mouse deer closely resembles that of the Suidae and Camelidae and lacks many features present in the Bovidae (Table 3). A perusal of the accessory genital glands, in contrast, reveals mixed features, with the vesicular gland resembling that of cattle, the prostate gland resembling that of cattle and pig, and the bulbourethral gland comparable to that of the camel. It is possible that the tragulids have retained elements of the original anatomical features possessed by mammalian stock ancestral to its lineage.

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