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Notes on the Female Urogenital System of *Tarsipes spenserae* (Marsupialia).[1]

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(With 9 Figures)

SUMMARY

Two specimens of the female urogenital system of *Tarsipes spenserae* are described. One of these is parous, the other non-parous. In both examples the cul-de-sac is very long and in the parous specimen a patent connexion exists between it and the urogenital sinus. A patent connexion in the non-parous specimen is doubtful. The parous urogenital system displays a singular example of postponed regression of the Wolffian duct.

In 1900 the female urogenital system of *Tarsipes rostratus*(2) was described for the first time by Hill. Hill based his description upon two females, one parous and the other probably parous, both of which, had a permanent connexion between the cul-de-sac and the urogenital sinus. This represents a condition unique among the Phalangeridae and, with the exception of certain Macropods, among the Marsupialia generally. As this is a point of considerable significance it was decided to re-examine the question(3).

The information obtained in this way completely confirms Hill's observations and in some respects supplements them.

The literature on *Tarsipes* is meagre and apparently no full description of its structure exists. Described originally by Gray (1842) and almost simultaneously by Gervais and Verreaux (1842) *Tarsipes* has, despite its structural peculiarities, received little attention from comparative anatomists. However, sufficient is known to indicate that *Tarsipes* occupies a special position among the Phalangeridae, being in some ways the most specialized member of that family.

The snout is long and curved and, accordingly, well adapted to searching flowers for the pollen and nectar upon which it chiefly subsists. Its degenerate dentition, too, reflects a diet which needs little mastication, the cheek teeth being variable in number, haplodont in form and completely vestigial (Bensley, 1903). Parker (1890) noted several aberrant features in the skull and concluded 'in the general form of the skull . . . *Tarsipes* differs from all the other Phalangistidae'.

(1) The investigations dealt with in this paper have been assisted by a grant provided equally by the Trustees of the Commonwealth Science and Industry Endowment Fund and the Tasmanian State Government.

(2) The specific name *spenserae* is now considered to have priority over *rostratus*.

(3) This was made possible through the kindness of the Director of the National Museum, Melbourne.

In its pes, *Tarsipes* shows the greatest modifications of any of the Phalangeridae. Bensley (1903) says "the second and third digits being greatly reduced, and almost completely enclosed in a common integument; while the fourth digit is greatly enlarged, and like the fifth is provided with a nail instead of a claw, as in the placental Primates. In addition to these obviously progressive characters, *Tarsipes* presents other peculiarities. The terminal pad of the hallux is not swollen to the same extent as is usual in arboreal forms. The hallucal planter pad is short. The second digital plantar pad is subdivided and its outer portion has migrated to the fourth digit".

In its female urogenital system, too, *Tarsipes* would appear to differ from the other members of its family.

Two spirit specimens may years old provided the material for this investigation and have been numbered 316 and 317(4). Their measurements are as follows:—

	No. 316	*No. 317*
Head (snout to ear-notch)	27 mm.	24·5 mm.
Head (D.C.L.)[5]	37 mm.	36 mm.
Head and body (D.C.L.)	93 mm.	95 mm.
Tail	94 mm.	95 mm.
Ear	11 mm.	11 mm.
Pes	15 mm.	14·5 mm.

Unfortunately Hill does not give the measurements of his specimens so a comparison cannot be made.

The pouch of No. 316 is very definite and possesses four nipples, two of them very prominent; the other two are small and insignificant. This specimen is almost certainly parous. The pouch of No. 317 is scarcely discernible and the nipples quite indistinguishable. This specimen is quite definitely non-parous. These two females, then, nearly indentical in size differ in their sexual condition and this difference might be expected to be demonstrated in their respective reproductive systems.

Serial transverse sections 10μ in thickness were cut of each specimen. Despite their long immersion in spirit the histology of both specimens is surprisingly good, especially that of No. 317.

While Hill's account generally is scarcely to be improved upon, for the sake of completeness some repetition will be made here. Following is a table of the significant measurements of No. 316 and No. 317.

	No. 316	*% a.f.*	*No. 317*	*% a.f.*
Total length of urogenital system	24·83 mm.	....	19·86 mm.	....
Length a.f.(6) = combined length of vaginal system and urogenital sinus ...	15·01 mm.	....	11·99 mm.	....
Length of vaginal system(7)	4·43 mm.	29·51	3·11 mm.	26
Length of urogenital sinus(8)	10·58 mm.	70·55	8·88 mm.	74·06
Length of cloaca(9)	4·86 mm.	32·38	3·63 mm.	30·27
Length of urethra(10)	2·22 mm.	14·79	1·37 mm.	11·43
Length of uterine papilla	890μ	5·93	660μ	5·6

(4) From specimens R12267 and R13016 respectively, belonging to the National Museum, Melbourne.

(5) D.C.L. = Dorsal contour length.

(6) See Figure 3.

(7) The vaginal length is taken as extending from the cranial extremity of the lateral vaginae to the anterior limit of the urogenital sinus.

(8) The tip of the clitoris is taken as marking the posterior extremity of the urogenital sinus.

(9) The cloaca is taken as beginning from the point of junction of rectum and urogenital sinus and extending to the posterior limit of the vent.

(10) The urethra is regarded as commencing from the point of entry of the ureters into the bladder and extending to the anterior limit of the urogenital sinus.

Ovaries

These are small triangular to ovoid bodies about 1·05 mm. long by 0·93 mm. broad, situated near the mid-line, immediately dorsal to and in close contact with the uteri.

Large, apparently mature, ova are present in the ovaries of both No. 316 and No. 317, but those of the latter contain a relatively greater number of very small ova.

Fallopian Tubes

These are quite short and little complicated. In No. 317 the proximal part of the tubes runs forward a short distance within the wall of the uterus and parallel to the uterine cavity. The lining of the Fallopian tubes is a single layer of cubical cells with dense cytoplasm.

Uteri and uterine necks

The uteri are pearshoped bodies dorso-ventrally compressed. In No. 316 the epithelium is compact and columnar with a vacuolated cytoplasm and has mostly separated from the endometrium. The uterine glands are long and well developed. There appears to be a physiological difference between the left and right uteri. The uterine gland cells of the left uterus have deeply staining nuclei, contrasting strongly with those of the right uterus which are scarcely visible, and even with those of the histologically superior No. 317. The left uterus also contains considerable strongly staining debris, much of it membranous and possibly foetal.

The uterine epithelium of No. 317 is similar to that of No. 316 but more cubical and has remained attached to the endometrium. There is comparatively little debris in the uterine cavities and no differentiation between right and left uterine glands.

The *uterine necks*, distinguished from the uteri by the absence of uterine glands, contract gradually to run caudally within a common sheath of connective and muscular tissue. They open upon a single very prominent uterine papilla of conical form which projects backwards into the median vagina (figs. 3, 5) by two apertures in No. 317 but by only one in No. 316. This later case is undoubtedly due to a certain amount of destruction of the intervening tissue. Although not insisted upon, it is quite possible, despite it being called so here, that this conical projection does not represent the uterine papillae, but rather the wall of the anterior vaginal canal. Pearson (1950) defines the cul-de-sac (median vagina) as having its anterior limits at the level of the ora uterorum. Extensions anterior to the cul-de-sac correspond, then, to Hill's 'anterior vaginal canals' and it is this view which is adopted in the present case. In No. 316 the width of the lumen in the left uterine neck is about eight times that in the right. It is probable that this feature and the common os uterorum in this specimen are the result of foetal passage. (fig. 5).

Cul-de-sac

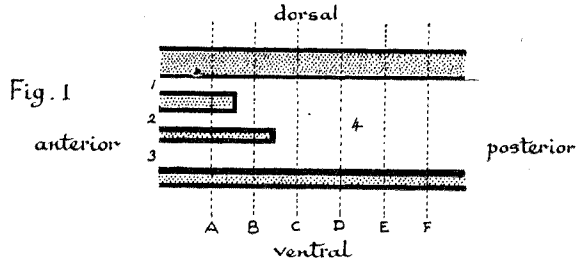
This is a dorso-ventrally compressed chamber surrounding anteriorly the uterine papilla and from the sides of which arise the lateral vaginae. Its epithelium consists of a single layer of small cubical cells which in parts are very much elongated and flattened.

There is a complete absence of a septum in both specimens, except for a vestige at the base of the uterine papilla.

The cul-de-sac passes caudally as a wide shallow chamber which, posteriorly, lies between the lateral vaginae and the urethra, communicating, in the case of No. 316, by a narrow fissure with the short posterior vaginal sinus. The latter

itself opens into the urogenital sinus a few sections later. It will be seen then that in No. 316 the cul-de-sac has become a true median vagina, thus confirming Hill's observations made fifty years earlier.

In the case of No. 317, however, the posterior end of the cul-de-sac is separated from the urethra by a solid plate of cells (fig. 8), but within this solid plate there is evidence of a future perforation that will ultimately convert the cul-de-sac into a functional median vagina having a permanent opening into the urethra.



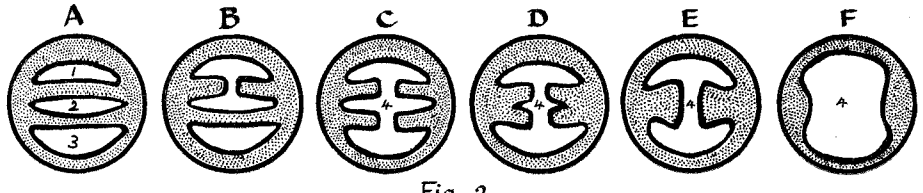


Fig. 2

FIG. 1.—Diagrammatic sagittal section showing the relations of the posterior vaginal sinus (1) and median vagina (2) with the urethra (3) and urogenital sinus (4).

FIG. 2.—Transverse sections illustrating successive levels as shown in fig. 1.

Lateral Vaginae

The lateral vaginae arise from the cul-de-sac at about the level of the ora uterorum. They curve gently caudally, converging to form a short posterior vaginal sinus before finally joining the urogenital sinus. The posterior part of each lateral vagina and a portion of the posterior vaginal sinus are occluded in both specimens, the occlusion in No. 317, however, being much greater. (figs. 4, 7, 8.)

Because they are arranged one on top of another, the true relationship between lateral vaginae, cul-de-sac and urethra is difficult to demonstrate by means of drawings. Figs. 1 and 2, show in diagramatic form the disposition of the cul-de-sac with respect to the urethra and lateral vaginae.

In the parous specimen No. 316 the lateral vaginae present a most unusual feature. (figs. 4, 5, 6 and 7.) From the posterior third of each lateral vagina a long duct passes cranially within the walls of the lateral vaginae, anterior vaginal canals and uterine necks to terminate as a small cyst or swelling.

Each duct possesses a distinct lumen for most of its length and in its course rotates around the lateral vagina in a loose spiral. It should be noted that this duct, undoubtedly the Wolffian duct, is absent in No. 317. The lateral vaginae of No. 316 have a less strongly developed muscular sheath than those of the non-parous No. 317, and present in comparison with the latter a relatively embryonic appearance.

Bladder, Urethra, Urogenital Sinus

Rotenberg, in her description of the male urogenital system of *Tarsipes* remarked on the extreme smallness of the bladder. Hill's drawing of the female system tends to confirm this. However, in the present specimens, both female, the bladder is relatively no smaller than is usual in marsupials.

The urethra is comparatively long, forming 14·79 per cent (No. 316) and 11·43 per cent (No. 317) of the combined length of vaginal system and urogenital sinus.

The urogenital sinus is slender and unusually long forming 70·55 per cent (No. 316) and 74·06 per cent (No. 317) of the above distance.

Referring to the urogenital sinus Hill says 'At its posterior end, ventrally, is the clitoris, attached throughout its length and deeply grooved dorsally, but devoid of an internal septum. A distinct cloaca is present. The cloacal opening is of characteristic form, being long, narrow and spout-like (fig. 5). A cloacal sphincter muscle is not present. A pair of large anal glands open far back into the cloaca'. This statement describes precisely the condition observed in the present specimens (fig. 9). It is probable that the deep groove on the dorsal aspect of the clitoris represents the excavated cloacal septum.

Summary of Results and Discussion

The two salient features that emerge from this study of *Tarsipes* are, first, as was noted by Hill, the existence in a parous female of a true median vagina, and secondly, the persistence of the Wolffian duct in a parous female of a highly specialized animal.

Hill referring to the presence in his doubtfully parous specimen of *Tarsipes* of a patent connexion between cul-de-sac and urogenital sinus concluded, by analogy with certain Macropods, that since this passage was open the animal had bred some time previously. He contended that '*Tarsipes* thus agrees . . . with certain species of the family Macropodinae in the possession of a direct and, after the first parturition a permanent passage for the birth of the young'. The evidence supplied by the present specimens supports this conclusion. Thus out of the two specimens described here, and the two described by Hill, three possess a true median vagina while the fourth shows signs of acquiring one.

The long duct which runs alongside each lateral vagina in No. 316, is almost certainly a vestige of the Wolffian duct. In most female marsupials the Wolffian duct degenerates long before maturity is attained, but it has been found in the course of the investigations which have been proceeding in the Tasmanian Museum for a number of years that among the Dasyuridae a vestige of the Wolffian duct persists as a very short solid rod or hollow diverticulum towards the posterior end of each lateral vagina, but never before in the course of this work has a Marsupial female urogenital system shown such a striking example of postponed regression of this embryonic structure. Its persistence in such a specialized animal is undoubtedly abnormal.

The occlusion of the posterior part of the lateral vaginae is a feature now known to be widespread among the different Marsupial families. It is mentioned here only briefly for research in the Tasmanian Museum has indicated that it is a broad question significant enough to require that a separate paper be devoted to it.

I should like gratefully to acknowledge the advice and encouragement given me in the preparation of this paper by the Director of the Tasmanian Museum, Dr. Joseph Pearson.

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Explanation of Figures

a.f.—Combined length of the vaginal system and the urogenital sinus.
bl.—Bladder.
b.s.—Blood sinus.
cl.—Clitoris.
conn.—Connexion between the median vagina and urogenital sinus.
d.—Debris within uterine neck.
d.gr.—Dorsal groove in the clitoris.
ect.t.—Erectile tissue.
l.v.—Lateral vagina.
l.l.v.—Left lateral vagina.
l.ur.—Left ureter.
m.v.c.—Median vaginal cul-de-sac.
l.ur.—Left ureter.
m.v.c.—Median vaginal cul-de-sac.
oc.l.v.—Occluded lateral vagina.
oc.p.v.s.—Occluded posterior vaginal sinus.
os.ut.—Common os uterorum.
r.l.v.—Right lateral vagina.
r.ur.—Right ureter.
s.—Septum.
s.conn.—Solid connexion of posterior vaginal sinus and urethra.
s.l.—Suspensory ligament of the clitoris.
t.cy.—Terminal cyst of the Wolffian duct.
ur.—Ureter.
ureth.—Urethra.
u.g.s.—Urogenital sinus.
ut.—Uterus.
ut.n.—Uterine neck.
ut.p.—Uterine papilla.
W.d.—Wolffian duct.

Fig. 3 Fig. 4

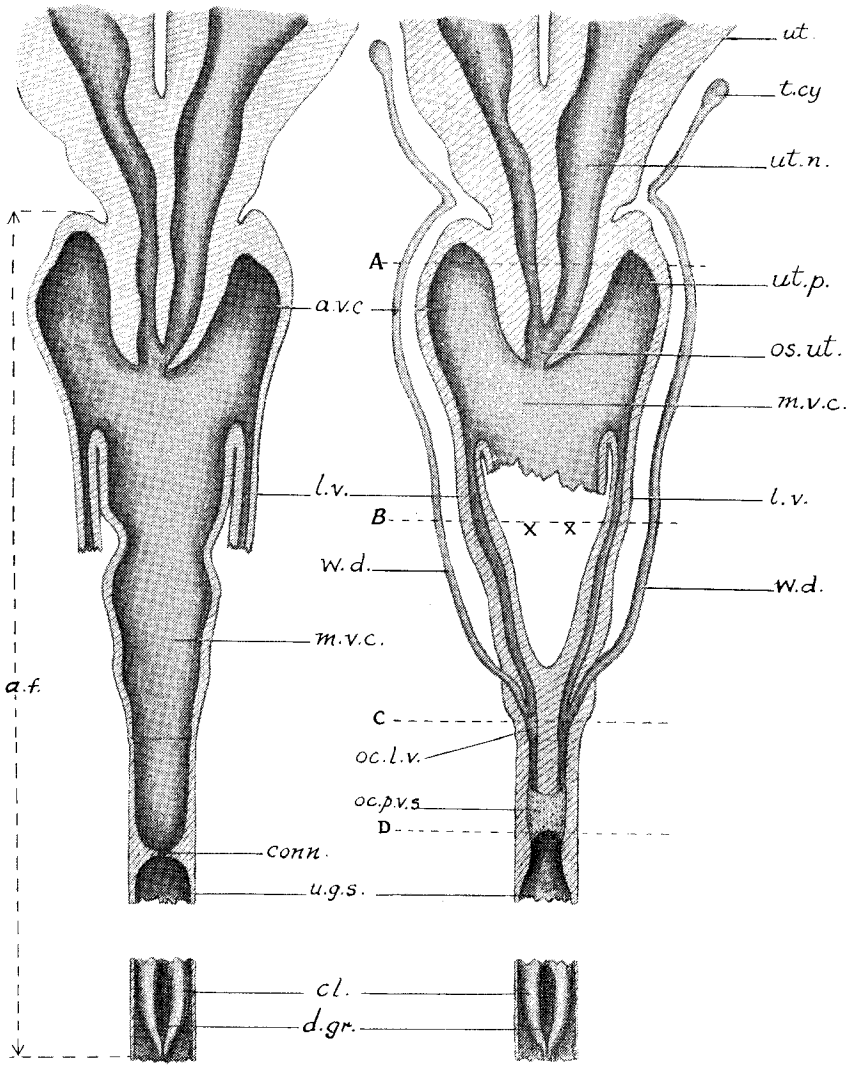
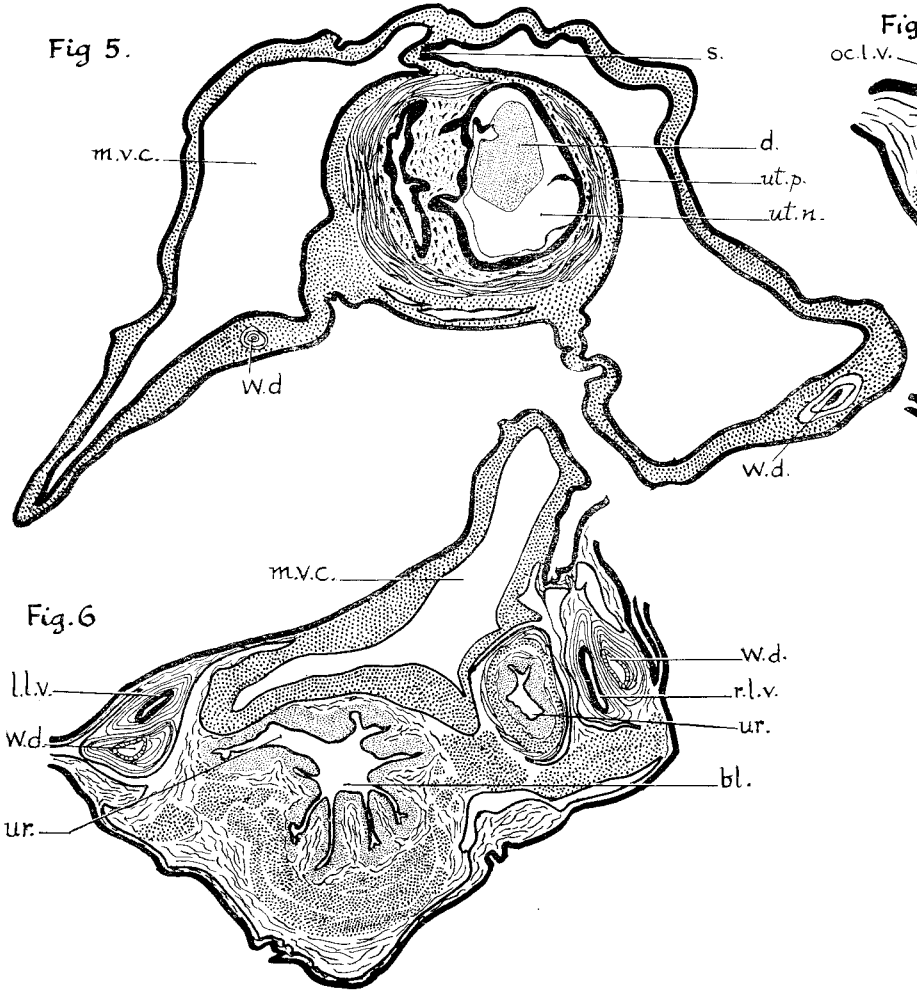
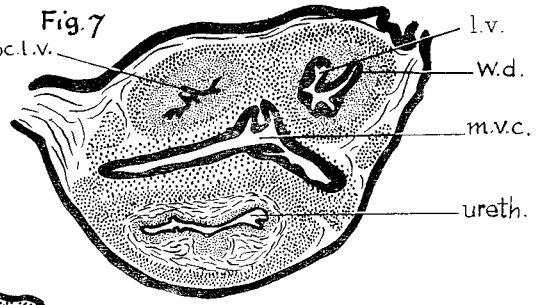
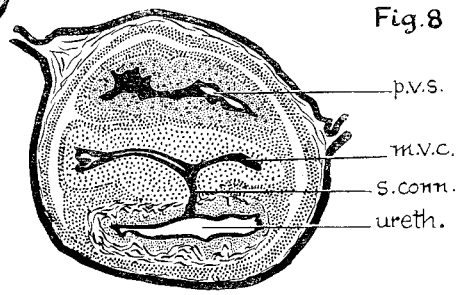


FIG. 3.—Dorsal view of the vaginal system in No. 316 showing the long cul-de-sac (m.v.c.) opening into the urogenital sinus (u.g.s.). A single prominent uterine papilla (ut.p.) projects backwards into the cul-de-sac and upon which in this specimen the uterine necks (ut.n.) open by a common os uterorum (os.ut.). The lateral vaginae have been cut away to expose the cul-de-sac lying immediately ventral to them. × 19.

FIG. 4.—Dorsal view of the vaginal system in No. 316 showing the lateral vaginae (l.v.). In this figure the posterior part of the cul-de-sac (m.v.c.) has been cut away. The Wolffian ducts, (w.d.) which actually run within the walls of the lateral vaginae, anterior vaginal canal and uterine neck, are for clarity shown separated from these structures. The two crosses mark the connexion of the ureters with the neck of the bladder. × 19.







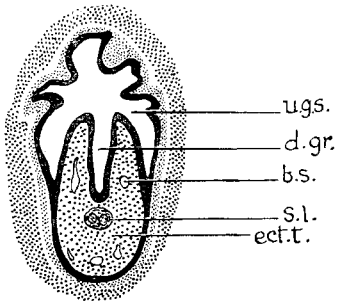


Fig. 9

For reference to figures see opposite page

Explanation of Plate II

Fig. 5.—No. 316. Transverse section through A in fig. 4 showing the distended right uterine neck (ut.n.) containing a certain amount of debris (d.). At this level the Wolffian duct (W.d.) runs within the floor of the anterior vaginal canal (a.v.c.). × 60.

Fig. 6.—No. 316. Transverse section through B in fig. 4 showing the intimate association of the lateral vagina (l.v.) with the Wolffian ducts (W.d.). The left ureter (l.ur.) is just opening into the bladder (bl.).

Fig. 7.—No. 316. Transverse section through C in fig. 4 showing fusion of the right Wolffian duct (W.d.) with the right lateral vagina (r.l.v.) and the occlusion of the left lateral vagina (occ.l.v.). × 60

Fig. 8.—No. 317. Transverse section corresponding to a section through D in fig. 4 (No. 316). Right and left lateral vaginae have fused to form a posterior vaginal sinus (p.v.s.) and this is largely occluded. The cul-de-sac (m.v.c.) is also partially occluded and is joined to the urethra (ureth.) by a sheet of cells (s.conn.). × 60.

Fig. 9.—No. 316. Transverse section through the clitoris showing the deep dorsal groove. × 60.