A C T A T H E R I O L O G I C A

VOL. XIII, 14: 261—276. BIAŁOWIEŻA 20.V.1968

Franciszek INDYK

The Structure of the Prostatic Part of the Urethra and of Its Glands in Some *Microtinae*

[With 2 Tables & Plates X—XII]

A detailed analysis of the structure of *pars prostatica* of the urethra and its glands in three species of the *Microtinae* [*Microtus agrestis* (Linnaeus, 1761); *Clethrionomys glareolus* (Schreber, 1780); *Pitymys subterraneus* (de Sélys-Longchamps, 1835)] has been carried out. The structure of the *pars prostatica* is similar; in all cases the presence of prostatic pockets has been stated. In *C. glareolus* lateral and ventral groups of *gl. prostaticae* cannot be distinguished. Dorsal groups of the prostate have many deferent ducts, lateral groups have usually three ducts, while ventral groups have usually one pair. The observed changes in the number of ducts are due to individual differences. Dorsal group of the prostate distinctly differs from the remaining two groups of those glands having a different histological structure. Coagulating glands resemble in structure the dorsal prostate. Within ventral groups of the prostate in *P. subterraneus* the epithelium is thrown in numerous folds. The *gl. urethrales* with typical microscopic structure are present in all investigated species.

I. INTRODUCTION

Althought there are many papers dealing with genital glands in Mammals, their homology has not been solved. The accessory glands have been described in more or less detailed way in the following species of the *Microtinae: Microtus agrestis* (Linnaeus, 1761) — Raynaud (1951), *M. arvalis* (Pallas, 1779) — Delost (1955). From taxonomic point of view the morphology of *gl. accessoriae* in the genera *Microtus, Pitymys* and *Clethrionomys* have been also studied by Kratochvíl (1960) and Arata (1964).

The subject of the present paper is the structure of the *pars prostatica urethrae* and of its accessory glands in mature individuals, namely: *M. agrestis, C. glareolus, P. subterraneus*. Because of some differences in morphological structure of *gl. accessoriae* of those species (although they all belong to the same subfamily) the microscopic structure of those glands as well as the sites of the opening of their ducts have been thoroughly studied.

II. MATERIAL AND METHODS

The material consisted of genital organs of sexually mature individuals either raised in the Department of Comparative Anatomy of the Wrocław University in the years 1963—64, or captured.

For the investigations we used four males of each species at a time. Genital organs after being prepared were fixed in Bouin fluid. The series of paraffine slices 7—8 μ thick were stained with Delafield, Ehrlich and Mayer's hematoxylin and eosin, and with Mallory's method.

III. DESCRIPTION

The description refers to the three investigated species. If the differences occured they were distinctly accentuated.

1. Morphology of the Male Genital System

The structure of the male genital organs in *M. agrestis* is illustrated by Photos (1—3). The description of those organs may be also found in papers by Raynaud (1951) and Kratochvil (1960). The latter discusses also the morphology of *gl. accessoriae* in *P. subterraneus*. Ventral group of prostatic glands is in this species well developed and differentiated (Photos 6, 7), while in *C. glareolus* the glands corresponding to ventral and lateral groups of prostatic glands in the remaining species are somewhat different. Ventral group of those glands cannot be morphologically distinguished, one distinguishes instead a ventro-lateral group which corresponds in site to the ventral and lateral groups of the remaining species (Photos 4, prvl, 5).

2. *Pars prostatica urethrae*

Below the ampullae of *vasa deferentia* the *vasa deferentia* and *vesiculae seminales* approach each other and descend parallelly along the initial portion of the neck of bladder. At this site the tubes of prostatic glands adhere dorsally and laterally the neck of the bladder.

Vasa deferentia and the tubes of prostatic glands are surrounded with connective tissue and the layer of smooth muscle fibers that extend onto the neck of bladder. At the level the bladder neck passes into the urethra we see first bands of *m. urethralis*. Farther, caudally the *m. urethralis* surrounds from lateral, dorsal and then ventral sides the urethra with the ducts of *vasa deferentia*, the *vesiculae seminales*, *gl. coagulantes* and the prostate. The fibers of the muscle are disposed circularly and obliquely. This is the beginning of the *crista urethralis* (Photos 9, 10, mu).

The canal of the urethra is lined with striated (2—3 layers) epithel-

ium which may be thrown into longitudinal folds. The wall of the urethra is intensely vasculized. The blood vessels and sinuses as well as the *gl. urethrales* (which appear somewhat cranially to the *colliculus seminalis*) are lying in the meshes of the reticulum of connective tissue found between the epithelium of the canal and the *m. urethralis*. The tissue is deficient in muscular elements. The sizes of sinuses and blood vessels depend on the extent to which the canal of the urethra is widened.

The ducts of *gl. coagulantes*, the *vasa deferentia, vesiculae seminales* and the dorsal group of prostatic glands are coursing dorsally and parallelly to the canal (Photos 9, 10, dc, v, vs, dd). The ducts of lateral group of the prostate (Photos 9, 10, dl) course laterally, while the ducts of ventral prostate (Phot. 10, dv) run ventrally and sometimes ventro-laterally (Phot. 10, dv).

Somewhat more caudally we see in *crista urethralis* two cranially blind pockets whose lumen becomes wider while approaching the *colliculus seminalis* where it fuses with the lumen of the urethra.

The ducts of the *vasa deferentia, vesiculae seminales* and dorsal prostate approach the dorsal wall of epithelial canal of the urethra. Distal portions of the *vasa deferentia* fuse with the ducts of *vesiculae seminales* forming the *ductus ejaculatorii*. Those ducts are so short (about 20—90 μ in *M. agrestis*, 210 μ in *P. subterraneus* and 90 μ in 2 individuals of *C. glareolus*) that the term *ostia ejaculatoria* proposed by Szarski (1935) for *Mus musculus* (Linnaeus, 1758) seems to be more adequate. The *ductus ejaculatorii* empty to the mentioned above pockets and together with them open to the urethra. In case the *ductus ejaculatorii* are absent (the absence of *ductus ejaculatorii* has been stated in two individuals of *C. glareolus*) the ducts of *vesiculae seminales* and the *vasa deferentia* open to the pockets independently.

Most frequently the deferent ducts of the dorsal lobes of prostatic glands are opening on the *colliculus seminalis*, more rarerly they empty to the paired pockets either before or after or simultaneously with the *ductus ejaculatorii*.

The deferent ducts of *gl. coagulantes* while coursing along *crista urethralis* shift ventrolaterally with respect to the *vasa deferentia* in order to open into the mentioned above pockets close to the openings of the *ductus ejaculatorii* at the level of *colliculus seminalis*.

In the investigated individuals the lenght of prostatic portion of the urethra amounts to about 680 μ (*M. agrestis*), 530 μ (*C. glareolus*) and 210 μ (*P. subterraneus*).

In the investigated species the *utriculus prostaticus* has not been stated.

3. *Gl. prostaticae*

Gl. prostaticae in the investigated species consist of three paired lobes surrounding the *pars prostatica urethrae*. Each lobe is composed of a number of glandular tubes linked together by connective tissue. They are the following: a) dorsal, b) lateral, and c) ventral lobes of the prostate. In *C. glareolus* lateral and ventral lobes are fused and constitute a paired ventrolateral group (Phot. 12, prvl).

a) Dorsal lobes form two glandular masses disposed symmetrically on dorsal side of the urethra and on dorsal side of the basis of the *vesiculae seminales* (Photos 2, 8, prd). As they are fairly closely connected with *gl. coagulantes* the both groups of glands can hardly be distinguished; on the other hand, however, they are distinctly separated from lateral lobes (Photos 9, 10, prd, prl). Dorsal lobes are surrounded by a very thin capsule of connective tissue consisting of smooth muscle which enters also into the body of the gland penetrating between separate tubes. Secretory tubes are built of a single layer of prismatic or isoprismatic epithelium, which being thrown into folds forms slats which, in turn, form numerous crypts. The slats are built of epithelium lying on thin bands of connective tissue deficient in smooth muscle. In tubes lying more laterally and cranially lumina are usually greater and the folds are less distinct than in the remaining tubes.

The cytoplasm of glandular cells contains a great number of minute eosinophilous granules and few vacuolae. The nuclei lie in median or apical portion of the cell. They are of different shapes: round, oval, irregular. They are always basophilous.

The type of secretion is merocrine and apocrine, sometimes it is also holocrine (Phot. 13). First type of secretion prevails.

The secretion present in tubes is either heterogeneous, more or less granular or homogeneous staining pink with eosin.

In tubes passing into excretory ducts of the gland and in the excretory ducts one encounters only homogeneous secretion which is a definite product of the secretion and stains also pink with eosin. The excretory ducts of the gland are built of a single-layered isoprismatic epithelium. They are surrounded from outside by a thin layer of smooth muscle fibers disposed circularly. The number of excretory ducts is fairly large; it is however, difficult to determine it exactly since the ducts may become secondarily fused or disjoint. There are about ten ducts.

b) Lateral lobes of the prostate form two glandular masses lying symmetrically on both sides of the urethra (Phot. 8, prl). Lateral lobes being relatively well separated by connective tissue from dorsal lobes

are not always easily distinguished from the ventral ones. They are also in contact with *gl. coagulantes* (Phot. 3, prl, gc).

The epithelium of secretory tubes is single-layered, prismatic, being isoprismatic only in some tubes. It does not form so numerous and distinct slats as in tubes of the dorsal group of the prostate.

The cytoplasm of glandular cells is less eosinophilous than in dorsal group. It contains, however, a greater number of granules and vacuolae. Not all epithelial cells stain with the same intensity and this gives the epithelium a streaked appearence.

The shapes of the nuclei as well as their sizes and chemical affinity to staining substances are the same as in dorsal group. A distinct difference is observed in their position, since they are always lying in basal portion of cells. The dimensions of tubes in dorsal and lateral groups are overlapping, but the tubes filled more compactly with secretion are larger in the average than in dorsal group.

Both secretion and the manner it is discharged do not show any differences if compared with dorsal group of prostatic glands. In lateral group no holocrine secretion has been observed. The secretion does not stain pink with eosin and hematoxylin (like in dorsal group) but violet-blue.

The structure of the excretory ducts is similar to that in dorsal group. The ducts enter the lateral wall of the urethra (Photos 9, 10 dl) and empty into lumen, below the *colliculus seminalis*. Usually there are three pairs of ducts but sometimes their number is smaller (2) or greater (4). Smaller number of ducts is usually related with a secondary fusion of their terminal portions.

c) Ventral lobes are lying on the anterior (ventral) surface of the urethra. They are not always distinctly separated either from lateral lobes or from one another. Connective tissue penetrating between separate tubes is less abundant than in former groups.

The secretory epithelium is single-layered, high, prismatic and rarely isoprismatic. The cytoplasm does not differ from the former group except for a greater chemical affinity to eosin. The cells in this group stain with different intensity (different stages of secretion), this gives the epithelium a streaked appearance (Phot. 15, prv). In *C. glareolus*, however, the epithelium in tubes of ventro-lateral group is more similar to the epithelium of ventral group in *M. agrestis*. This refers to the height of cells as well as to its cytological structure.

The nuclei do not show differences in staining and position in cells, compared with lateral group. They, however, sometimes differ in size and shape: in ventral group they are smaller and more irregular.

The epithelium in ventral group is higher than in lateral one. Mean

Table 1.

The diameter of tubes and the height of epithelium in prostatic and coagulating glands in *M. agrestis* (μ).

	Ventral group				Lateral group				Dorsal group		Coagulating glands	
	Diameter		Height		Diameter		Height		Diameter	Height	Diameter	Height
	a	*b*	*a*	*b*	*a*	*b*	*a*	*b*				
$\bar{x}_1$	203—245	170—224	13.5	17.6	244—295	164—221	11.1	19.1	205—230	11.3	259—308	9.7
$\bar{x}_2$	280—342	177—214	15.5	23.6	265—332	185—237	14.3	23.8	200—240	10.7	235—295	10.3
$\bar{x}$	241—293	173—219	14.5	20.6	254—318	174—229	12.7	21.4	202—235	11.0	247—301	10.0
Y			9.9—19.8 13.2—19.8				13.2—23.1 19.8—26.4			6 6—13.2		6.6—13.2

$\bar{x}_1$ — arithmetical mean of 18 measurements taken from the individual N, $\bar{x}_2$ — arithmetical mean of 18 measurements taken from the individual N_1, $\bar{x}$ — arithmetical mean of the means $\bar{x}_1$, $\bar{x}_2$, Y — range of variability in the height of epithelium, *a* — resting cells, *b* — during secretion.

sizes do not differ remarkably from those obtained for lateral group (Table 1). Some differences are observed in shape and size of tubes. The tubes in ventral group are rather rectangular and polygonal while in lateral group they are wider and oval. This difference may be explained by a more compact arrangement of tubes of those glands and by the extent to which they are filled with secretion.

The manner in which the secretion is discharged and the character of secretion are analogical to the former group, except that in one specimen of *C. glareolus* we have observed holocrine secretion (Phot. 16). The discharged secretion stains more intensly pink-reddish with eosin.

The structure of excretory ducts resembles this stated in former groups. They, however vary in number, *e. g.:* one or two ducts on each side, or two left and one right ducts (Phot. 10, dv). Their openings are found in ventral wall of the urogenital canal. In *C. glareolus* only po-

Table 2.

The diameter of tubes and the height of epithelium in prostatic and coagulating glands in *C. glareolus* (μ).

	Ventro-lateral group				Dorsal group		Coagulating glands	
	Diameter		Height		Diameter	Height	Diameter	Height
	a	b	a	b				
$\bar{x}_1$	417—502	239—295	10.0	22.2	212—320	16.1	403—504	10.5
$\bar{x}_2$	313—377	181—269	8.2	22.7	223—373	14.3	380—460	11.3
$\bar{x}$	365—439	210—282	9.1	22.4	217—346	15.3	391—482	10.9
Y			6.6—13.2	16.5—29.7 16.5—26.4		6.6—23.1		6.6—23.1

$\bar{x}_1$ — arithmetical mean of 18 measurements taken from the individual Cl 1, $\bar{x}_2$ — arithmetical mean of 18 measurements taken from the individual Cl 2; for the remaining explanations, see Table 1.

sition and number of those ducts in ventro-lateral groups prove that this group corresponds to the two groups of the prostate occuring in, say, *M. agrestis*. Analogically to the ventral group one observes one pair of excretory ducts whose course and opening (Phot. 12, dv) are similar, and analogically to lobes of lateral prostate in *M. agrestis* we have stated a varying number of ducts (usually three pairs, and *e. g.* Phot. 12, dl, three on the left and four on the right sides).

Certain differences are observed in the manner in which the secretion present in the above ducts is staining. In ducts corresponding to the ventral group the secretion stains pink-reddish with eosin-hematoxylin, and in ducts corresponding to the lateral group it stains more

intensly (violet-blue, Phot. 12, dv, dl). Results of the measurements are given in Table 2.

Paired group of ventral tubes of the prostate being exceptionally well developed in *P. subterraneus* have a structure different from the ventral group of this gland in former species. The epithelium is thrown into distinct folds and forms numerous slats and crypts. Consequently, the tubes are irregular in shape. For this reason we could not take under consideration numerical data obtained from the measurements. This irregular shape is striking even when genital organs are seen in toto: the ventral prostate is different from the dorsal and lateral ones, having more rough and »tubercular« surface (Phot. 6, prv). The folds are sometimes so numerous and deep that the epithelium is arranged in numerous rosettes which gives impression of budding or that the epithelium is multiserial (Photos 17, prv, 18). So far such pictures have not been observed in prostatic glands in *Rodentia*, they are only encountered in tubes in the course of active secretion. Resting tubes filled tightly with secretion are »distened« and therefore the epithelium is not thrown into folds.

4. *Gl. coagulantes*

On the average, glandular epithelium in *gl. coagulantes* is lower than in dorsal group of the prostate its height varies however within the same ranges the diameter of tubes is greater on the average, but the numerical data are also overlapping (Tables 1, 2).

Within this group of glands, like in dorsal group of the prostate besides small tubes one observes also tubes with large lumen. In the latter the epithelium distinctly differs from the epithelium of the dorsal prostate, since the epithelial slats are more elongated. The slats contain less connective tissue than the slats found in dorsal prostate.

The manner in which the secretion is discharged and the appearence of the secretion are the same as in tubes of dorsal prostate. The holocrine secretion is pretty frequently observed (Phot. 14). It is possible that this group has also some other excretory ducts besides two ducts with large lumina (Photos 9, 10, dc).

Except the mentioned above differences the discussed glands are identical with the dorsal group of prostatic glands.

5. *Gl. urethrales*

Gl. urethrales appear on the level where the urethra is widening to accept the ejaculatory ducts and the accessory glands, farther caudally they occur in *pars muscularis urethrae*, and finally within the *bulbus*

penis. In this last region they appear in great quantity surrounding the *sinus urethrae bulbi*. Within *pars spongiosa urethrae* they are absent. Within the prostatic portion of the urethra and at the beginnig of the *pars muscularis* the groups of the *gl. urethrales* on ventral and lateral sides of the urogenital canal are larger than on its both lateral sides. Further caudally a uniform cuff of those glands encircles the urogenital canal (Photos 19, 20, gu, cug).

Gl. urethrales never appear on the surface of the *m. urethralis*. Single branches of this gland may only enter between the separate fibers of the *m. urethralis*. In *P. subterraneus* they penetrate deeply into this muscle and reach its surface (Phot. 21, gu). The mucous membrane of the urogenital canal has numerous blood vessels. Connective tissue entwines numerous blood vessels and sinuses and, before all, the *gl. urethrales* which do not possess muscular capsules of their own.

Most glandular cells stain dark with eosin-hematoxylin. The cytoplasm is characterized by granules of different sizes (some of them staining feebly with eosin) and by vacuolae. The nuclei irregular in shape are usually flattened and lie basally (Phot. 22).

The excretory ducts of those glands are small and narrow. The epithelium usually is variably being cubic. The nuclei of different shape lie in median or apical portion of the cell. The ducts are numerous, short they empty to the urogenital canal by wide openings (Phot. 20, dgu). They contain a small amount of secretion that sometimes stains weekly with eosin.

IV. DISCUSSION

1. *Pars prostatica urethrae*

The origin of paired pockets (described several times both in *Rodentia* and *Insectivora*) was explained by various authors in different ways (*e. g.* Oudemans, 1892; Rauther, 1904; Szarski, 1935). Large distensions in this region of the urogenital canal are observed in the males of many Mammals (*e.g. Marsupiala, Rodentia*, etc.), but they occur irregularly in different systematic groups. The whole difficulty in the interpretation of the origin of those pockets lies in marking the bounds between their eventual components (the participation of the epithelia od different origin). This problem could be solved only by very thoroughly conducted developmental studies carried out for many species. In *M. musculus* the pocket arise throughout a very intense outgrowth of the *colliculus seminalis*. It fuses with the opposite wall of the urogenital canal dividing it into three parts, namely: two dorsally lying pockets and the urethra which lies ventrally (Rauther, 1904).

It seems that the opinion of this author as to the origin of the pockets is also true for the *Microtidae*. In this family the *colliculus seminalis* is very well developed and has a form of a branched mushroom which enters into the lumen of the urethra. The branches of the colliculus fuse with the opposite wall of the urethra cutting off the pockets.

In the three investigated species the ejaculatory ducts empty to the lumen of the urethra in a similar way. Analogical situation has been described by Grosz (1905) in *M. musculus* and *A. sylvaticus* and by Szarski (1935) in *M. musculus* and *R. norvegicus*. The lack of the ejaculatory ducts in *C. glareolus* does not seem to be anything exceptional, since Hagemann (1960) has observed this phenomenon in *M. musculus*.

The position of the ducts of prostatic and coagulating glands on the *crista urethralis* as well as the manner they empty on the *colliculus seminalis* are in all investigated species similar, although there are differences in the number of ducts.

2. *Gl. prostaticae*

Morphological classification of prostatic glands in *Rodentia* as well as the type of their structure are differently presented by various authors. In view of the present investigations I follow the opinion expressed by Raynaud (1951) and Delost (1955) that lateral and ventral lobes of the prostate are similar. I have not observed, however, any subdivision of lateral lobes into three groups (described by the mentioned above authors). A certain difference between lateral and ventral lobes is manifested in their chemical affinity to different dyes. The cytoplasm in the tubes of ventral prostate stains intensly violet-pink-red with hematoxylin-eosin, staining violet blue in lateral prostate. This suggests that the lobes may differ from each other in the kind of secretion. Some differences are also seen in the sizes of nuclei which in ventral prostate are sometimes smaller and more irregular. According to Raynaud (1951) and Delost (1955) the essential differences between the two groups of the prostate are observed in the size of tubes and the height of epithelium. I cannot share their opinion, since I have shown (Tables 1 and 2) that the sizes of tubes are overlapping and that the arithmetical means are very similar. The height of epithelium depends on secretory state of cells, and their shape and size depend, in turn, on the extent to which the cells are filled with secretion. The fact that the tubes of ventral prostate are polygonal and those of lateral group are oval should be explained by their compactness: the greater the compactness the greater is their number.

The lobes of ventral prostate in *C. glareolus* are not separated from the lateral prostate, they nevertheless exist, as the openings of this portion of glands correspond to the openings of ventral prostate in other investigated species. Arata (1964) distinguishes in *C. gapperi* two groups of prostate. The first group is rather elongated and corresponds to ventral lebes, while the second one is smaller and corresponds to lateral lobes (in the sense assumed by Raynaud and Delost as well as by the author of the present paper). Only one pair of ventral prostate has been distinguished by Snell (1941, quoted after Arata, 1964), Szarski (1935) and Rauther (1904) in *M. musculus* and by Hagemann (1960) in *Rattus*. According to Arata (*l. c.*) the presence of only one group of ventral prostate (stated by the mentioned above authors) is an inborn abnormality since those species are characterized by the presence of two ventral groups. The same author, however, presents the scheme of male genital organs in *Rattus* (Arata, 1964, p. 38, Fig. 8e) and defines lateral group of the prostate as the second lobe of dorsal prostate (underlying that there is more than one pair of lateral lobes).

A peculiar structure of ventral prostate in *P. subterraneus* deserves a special attention. The epithelium lining the tubes being thrown into numerous tine fold forms rosettes. The arrangement of cells being disturbed gives an impression that the epithelium is multiserial. The above described characteristics distinguish this group from the glands of this type found in the remaining species. So far I have not encountered in the literature any data referring to the above mentioned structure of the prostate in *Rodenia*. It should be expected that histochemical studies accompanied by the studies on the development will explain this exceptional structure.

The greatest differences are observed between dorsal and remaining groups of the prostate. Some data given by Delost (1955) referring to this group of glands in *M. arvalis* have been confirmed in the present investigations. Dorsal lobes are distinctly separated from the remaining ones by connective tissue. The whole gland stains weekly. The epithelium of tubes is thrown into numerous folds. Considering the measurement data it should be emphasized that of all groups of the prostate the epithelium of this group of glands is the lowest one. The position of nuclei in cells (central) and the type of secretion (frequently holocrine) are the characteristics which distiguish this group from the remaining ones. Neither Raynaud (1951) nor Delost (1955) mention the holocrine secretion. Therefore more detailed and accurate histochemical data should be most essential.

In the present investigation I have stated that excretory ducts of lateral and ventral groups of the prostate vary in number. Similar relations have been described by Raynaud (1951) in ventral group of the prostate in *M. agrestis*. Those facts suggest that in separate individuals the above glands develop from a different number of buds. According to Arata (1964) in such genera as: *Mus, Rattus* and *Mesocricetus* the number and formation of accessory glands are not uniform either. It is not always possible to determine whether there are two pairs of prostatic glands or the prostate is composed of two lobes. Those deviation may arise from the age of the animal as well as from seasonal changes. Hence before drawing decisive conclusion the greatest possible number of individuals should be thoroughly examined.

As far as the paper by Arata (1964) is concerned earlier attempts of considering the structure of accessory glands in systematics (Kratochvil, 1960) have been mentioned. It is also astonishing that the author of such a good review characterizes the accessory glands in *Microtus* considering only one species, namely *M. pennsylvanicus* Ord. (worked out by him and Hamilton) not taking under account other fundamental papers, *e. g.* Raynaud (1951) and Delost (1955).

3. *Gl. coagulantes*

Those glands have been termed for the first time in *Rattus* (Walker, 1910). Price (1936, quoted after Arata, 1964) showed that the buds of prostatic gland in *Rattus* have form of three strings that give rise to three chief groups of this gland. Since the *gl. coagulantes* are the most anterior lobes, then, according to Arata (*l. c.*) they are prostatic glands. So they are defined as the prostata anterior. The above three groups are termed by Price (1936, quoted after Arata, 1964) as »coagulating«, »mid« and »posterior glands«. Althought the above author has shown that the most anterior lobes belong to the series of the prostate, he does not call them »prostatic glands« as many other authors, but »coagulating glands«. Rauther (1904), Szarski (1935) define those glands as the prostate I, while Kratochvil (1960) calls them »*glandulae prostaticae pars cranialis*« and distinguishes three farther lobes, namely: »*gl. prostaticae pars dorsalis, gl. prostaticae pars lateralis* and *gl. prostaticae pars ventralis*«.

Histological structure of those gland is similar to the structure of dorsal prostate (Raynaud, 1951; Delost, 1955; Arata, 1964). This resemblance is proved by different facts, *e. g.* Rauther (1904) and Szarski (1935) have described them as the prostate I.

Mann & Lutwak-Mann (1951) have stated that the secretion

of seminal vesicles and a catalytic agent present outside the vesicles participate in coagulation of spermic fluid. Camus and Gley were (according to the above authors) the first scientists who had shown enzymatic character of coagulating catalysers. Those enzymes have been given the term »vesiculase«. At first they were believed to be produced within prostatic glands, but later investigations allowed to state their more accurate localization. Walker (1910, quoted after Mann & Lutwak-Mann, 1951) has stated that in *Rattus* vesiculase is produced within a gland termed by him »coagulating gland« which is sometimes called the anterior prostate, since morphologically it constitutes a part of the complex of prostatic gland.

One of the experiments that have confirmed the presence of vesiculase within coagulating glands was the isolation of secretion from seminal vesicles and from coagulating glands and the statement that the latter caused coagulation of the first secretion (in ratio 1 : 20 000 and higher). Van Wagenen (1936, quoted after Mann & Lutwak-Mann, 1951) has stated that in *Macaca mulatta* coagulation results from the action of secretion coming from cranial lobes of the prostate on the secretion produced by seminal vesicles. Secretion produced by caudal lobe of the prostate is not able to coagulate vesicular fluid (in most monkeys the prostate consists of two different parts).

As far as the above problem is concerned it is of interest to mention the data referring to the distribution of fructose in accessory glands in *Rattus*. The data have shown that fructose is produced by dorsal prostate as well as by *gl. coagulantes*, while citric acid is produced by lateral and ventral lobes of the prostate (Mann & Lutwak-Mann, 1951). The prostate in man is also of interest since it seems to be uniform, while from chemical point of view it consists of distinctly different parts.

From the above facts it follows that sometimes the organs so far undistinguishable with respect to their structure and embryonic origin are in reality different with respect to the produced secretion.

The above given examples show that the introduction of other terms for coagulating glands is unnecessary and makes confusion. If the vesiculase is not produced beyond *gl. coagulantes* (and so far I have not encountered any evidence to this fact in *Rodentia*) then the term *gl. coagulantes* should be maintained.

Acknowledgements: I am deeply obliged to Professor Janina Orska, the head of the Department of Comparative Anatomy, for her valuable remarks and kind reading of the manuscript, as well as for to Dr. Alina Kowalska-Dyrcz who introduced me into the subject of this paper and gave the possibility of consultation.

REFERENCES

1. Arata A., 1964: The anatomy and taxonomic significance of the male accessory reproductive glands of muroid rodents. Bull. Florida State Museum, *9*, 1: 1—42.
2. Delost P., 1955: Anatomie et structure histologique de l'appareil génital du Campagnol des champs (*Microtus arvalis*, Pallas) adulte en activité sexuelle. Bull. Soc. Zool. France, *80*: 207—222.
3. Grosz S., 1905: Beiträge zur Anatomie der accessorischen Geschlechtsdrüsen der Insectivoren und Nager. Arch. mikr. Anat., *66*: 567—608. Berlin.
4. Hagemann E., 1960: Ratte und Maus Versuchstiere in der Forschung. 115—116, 251—254. Walter de Gruyter & Co. Berlin.
5. Kratochvíl J., 1960: Sexualdrüsen bei den Säugetieren mit Rücksicht auf Taxonomie. Symp. theriol., 175—187. Brno.
6. Mann T. T. & Lutwak-Mann C., 1951: Secretory function of male accessory organs of reproduction. Physiol. Rev., *31*, 1: 27—55.
7. Oudemans J. Th., 1892: Die accessorischen Geschlechtsdrüsen der Säugetiere. *91*, Haarlem.
8. Price D., 1936: Normal development of prostates and seminal vesicles of the rat with a study of experimental post-natal modifications. Am. Journ. Anat., *60*: 79—127 (cited after Arata, 1964).
9. Rauther M., 1904: Über den Genitalapparat einiger Nager und Insectivoren, insbesondere die akzessorischen Genitaldrüsen derselben. Jena. Z. Naturw., *38*: 377—472. Jena.
10. Raynaud A., 1951: Les glandes annexes du tractus urogénital des Campagnols agrestes (*Microtus agrestis* L.). Bull. Biol., *85*: 323—372.
11. Snell G., 1941: Biology of the laboratory mouse. Dover Publications: 1—497. N. Y. (cited after Arata, 1964).
12. Szarski K. W., 1935: Przyczynek do badań nad rozwojem i budową gruczołów dodatkowych (*gl. accessoriae*) dróg moczopłciowych myszy białej. Arch. Tow. Nauk. we Lwowie, *6*: 467—614.
13. Wagenen G., van, 1936: Anat. Rec. *66*: 411 (cited after Mann & Lutwak-Mann, 1951).
14. Walker G., 1910: A special function discovered in a glandular structure hitherto supposed to form a part of the prostate gland in rats and guinea-pigs. Johns Hopkins Bull., *21*: 182—185 (cited after Mann & Lutwak-Mann, 1951).

Received, July 27, 1967.

Wrocław University,
Department of Comparative Anatomy,
Wrocław, Sienkiewicza 21.

EXPLANATION OF PLATES

Plate X.

Photos 1—3. Urogenital system in *M. agrestis* ♂, ad. ventral, dorsal and ventro-lateral sides. Magn., see Phot. 7.

Photos 4—5. Urogenital system in *C. glareolus* ♂, ad. ventral and lateral views. Magn., see Phot. 5.

Photos 6—7. Urogenital system in *P. subterraneus* ♂, ad. ventral and dorsal views. Magnification, see Phot. 7.

Phot. 8. Cross-section through urogenital complex in *P. subterraneus* made below the *vas deferens* (v). The position of all prostatic groups and their mutual contact are well seen. Ventral group of the prostate (prv) is seen in resting stage, *i.e.* when the tubes are more regular. The arrow points dorsal direction. Magn., see Phot. 12.

Phot. 9. Cross-section through the urethra in *M. agrestis*, made in a level with the beginning of *crista urethralis*. The ducts of *gl. coagulantes* (dc) are seen dorso-laterally to the canal of the urethra (u). The ducts of *vasa deferentia* (v) and *vesiculae seminales* (vs) lie dorsally. All groups of the prostate are seen.

Phot. 10. Cross-section through the urethra in *M. agrestis*, made in a level with *crista urethralis*. Two left-hand deferent ducts of ventral prostate (dv) lie ventro--dorsally to the urethra (u), the ducts of *gl. coagulantes* (dc) lie dorsally to them, farther on there are the *vasa deferentia* (v), the ducts of dorsal prostate (dd); three ducts of lateral prostate (dl) are lying on the lateral side of the urethra.

Plate XI.

Phot. 11. Cross-section through the urethra in *M. agrestis*. The cuff of *gl. urethralis* (gu) surrounding the urogenital canal is well seen.

Phot. 12. Cross-section (slightly diagonal) throug the urogenital canal in *C. glareolus*, made in a level with *crista urethralis*. One sees ventro-lateral group of the prostate (prvl), deferent ducts corresponding to the ducts of ventral group in other species (dv) filled with light secretion, and four ducts corresponding to lateral group of the prostate (dl) filled with dark secretion.

Phot. 13. Cross-section through a tube of dorsal prostate *M. agrestis*.

Phot. 14. Cross-section through a tube of *gl. coagulantes* in *M. agrestis*.

Phot. 15. Cross-section through ventral (prv) and lateral (prl) prostates in *M. agrestis*. One sees that the epithelium differs in height and that the nuclei are of different shape and size. One sees also the striation of epithelium, the granules in cytoplasm, the manner in which the secretion is discharged and the secretion cracked due to fixation.

Phot. 16. Cross-section through ventro-lateral group of the prostate in *C. glareolus*.

Plate XII.

Phot. 17. A fragment of cross-section through ventral (prv) and lateral (prl) prostates in *P. subterraneus*. One sees differences in structure of both groups of glands.

Phot. 18. Epithelium of the tube of lateral prostate in *P. subterraneus*. The epithelium is thrown into folds. The arrangement of cells is disturbed.

Phot. 19. Cross-section through the urogenital canal (cug) in *M. agrestis* with the encircling cuff of *gl. urethrales* (gu).

Phot. 20. Cross-section through the urogenital canal (cug) in *M. agrestis*. *Gl. urethrales* (gu) and their deferent ducts (dgu) are well seen.

Phot. 21. Cross-section through the urogenital canal (cug) in *P. subterraneus*. One sees the *gl. urethrales* (gu) penetrating into *musculus urethralis* (mu) and reaching its surface.

Phot. 22. Cross-section through the *gl. urethrales* in *M. agrestis*.

THE EXPLANATION OF ABBREVIATIONS

bp — *bulbus penis*
cug — *canalis urogenitalis*
dc — deferent duct of the *gl. coagulantes*
dd — deferent duct of the dorsal prostate
dgu — deferent duct of the *gl. urethrales*
dl — deferent duct of the lateral prostate
dv — deferent duct of the ventral prostate
gc — *gl. coagulantes*
gu — *gl. urethrales*
mu — *m. urethralis*
prd — dorsal prostate
prl — lateral prostate
prv — ventral prostate
prvl — ventro-lateral prostate
u — urethra
v — *vas deferens*
vs — *vesicula seminalis*
vu — *vesica urinaria*

Franciszek INDYK

BUDOWA CZĘŚCI STERCZOWEJ CEWKI MOCZOWEJ I JEJ GRUCZOŁÓW U NIEKTÓRYCH *MICROTINAE*

Streszczenie

Przeprowadzono dokładną analizę budowy części sterczowej cewki moczowej i jej gruczołów u trzech gatunków *Microtinae: Microtus agrestis* (Linnaeus, 1761), *Clethrionomys glareolus* (Schreber, 1780) i *Pitymys subterraneus* (de Sélys-Longchamps, 1835).

U wszystkich badanych gatunków budowa *pars prostatica urethrae* jest podobna. We wszystkich przypadkach stwierdzono obecność kieszeni prostatycznych. Nie u wszystkich gatunków wszystkie trzy grupy gruczołów krokowych są dobrze wyodrębnione: u nornicy rudej nie można wyróżnić grupy bocznej i brzusznej (Fot. 12, prvl).

Grupy grzebietowe prostata uchodzą wieloma przewodami do cewki, grupy boczne zwykle trzema przewodami, a grupy brzuszne jedną parą. Spotyka się odchylenia od tych stosunków (większą lub mniejszą ilość przewodów), co wskazuje na różnice indywidualne spotykane również u innych ssaków. Grupa grzbietowa prostata u wymienionych gatunków pod względem budowy histologicznej wyodrębnia się wyraźnie od pozostałych grup tych gruczołów (Fot. 13).

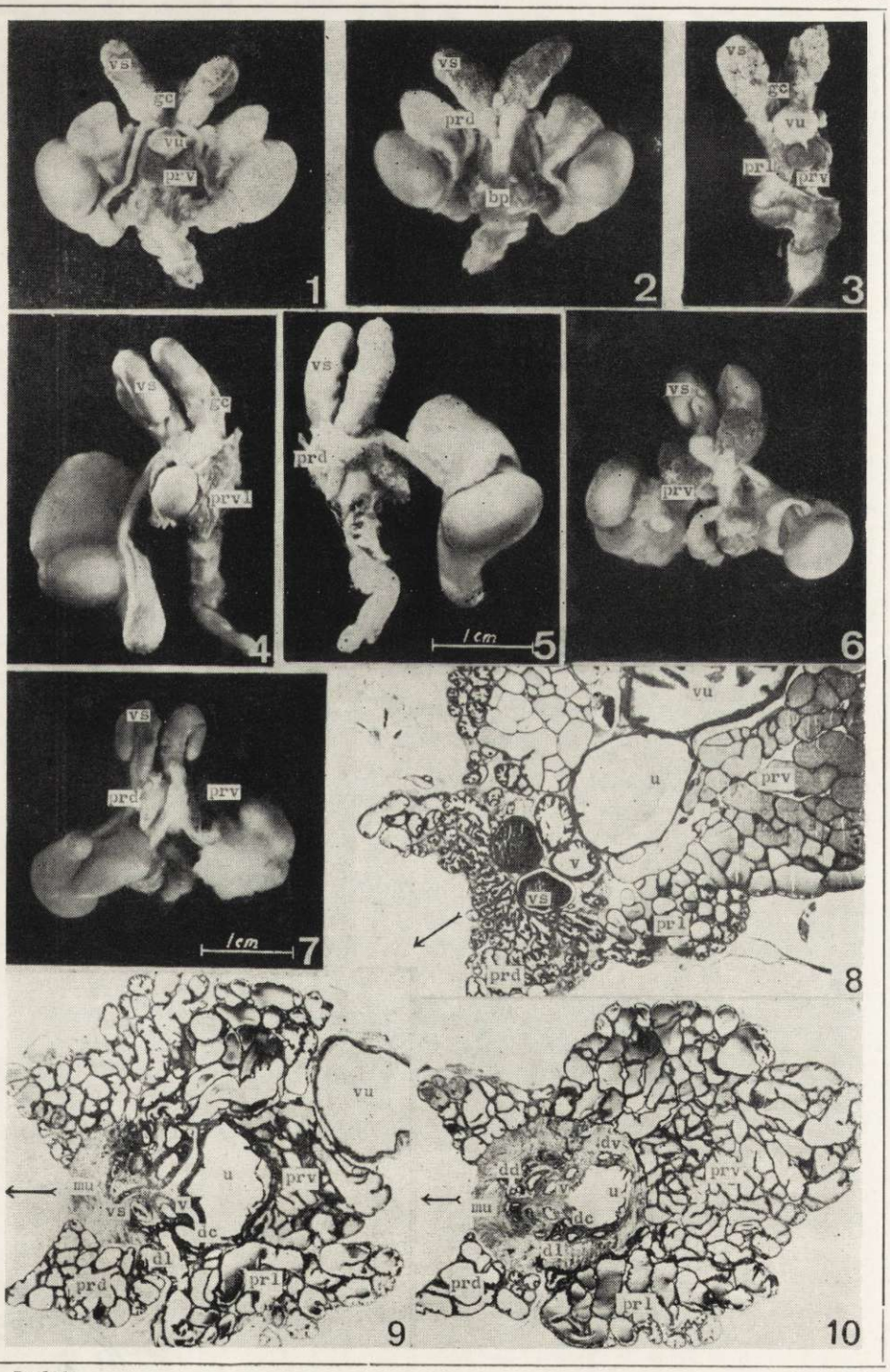
Gruczoły koagulujące w swej budowie podobne są do prostata grzbietowej (Fot. 14).

W brzusznych grupach prostata u darniówki występują liczne fałdy nabłonka (Fot. 17, prv, 18) co jest dowodem, że cewki te różnią się w wyglądzie z tego typu gruczołami u pozostałych gatunków (Fot. 15, prv. 17, prl).

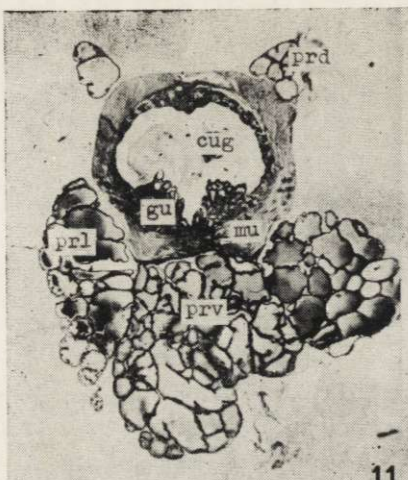
Odpowiednie grupy *gl. prostaticae* u tych trzech gatunków są sobie homologiczne. U nornicy rudej grupa brzuszno-boczna jest homologiczna grupom brzusznym i bocznym pozostałych *Microtinae*.

U wszystkich gatunków występują *gl. urethrales* o podobnej budowie mikroskopowej (Fot. 20, gu. 22). U darniówki leżą głęboko w mięśniu uretralnym sięgając jego powierzchni (Fot. 21, gu, mu).

U badanych gatunków nie stwierdzono obecności *utriculus prostaticus*.

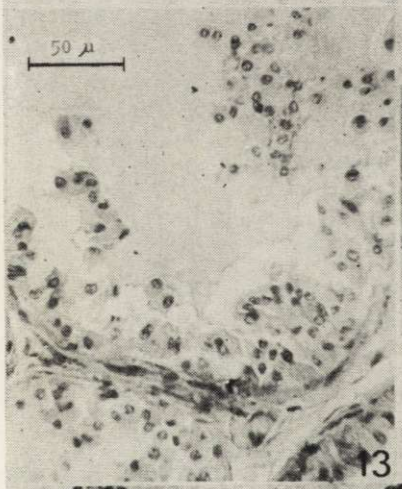


F. Indyk *auctor* phot.

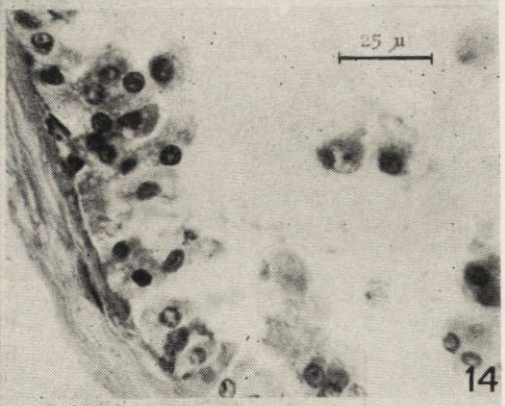


11

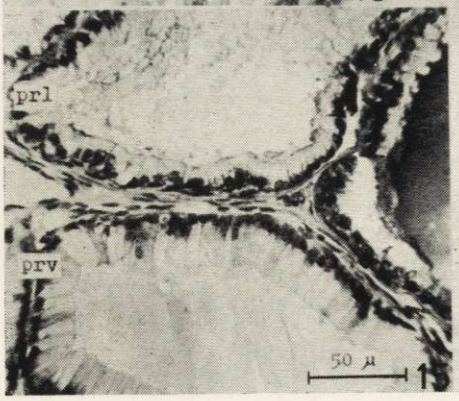
12



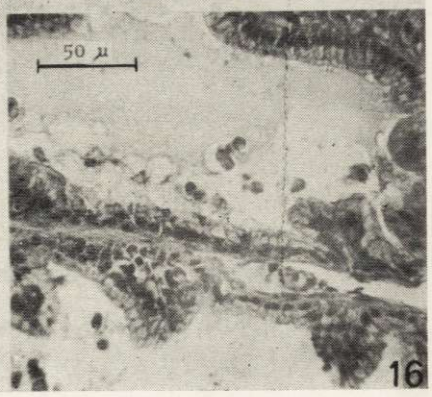
13



14



15



16

F. Indyk *auctor* phot.

F. Indyk *auctor* phot.