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Różnice gatunkowe w budowie żeńskich narządów rozrodczych rodzaju *Polydrosus* Germ. *(Coleoptera, Curculionidae)*

Specific differences in the structure of the female reproductive organs of the genus *Polydrosus* Germ. (*Coleoptera, Curculionidae*)

napisała

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Introduction

The detailed study of the female reproductive organs of *Polydrosus mollis* Ström., *P. sericeus* Schall. and *P. pilosus* Gredler submitted in my former paper on weevils showed some differences in the structure of the gonads of these species. Consequently the following questions arise: 1) What do the gonads of other species of the genus *Polydrosus* Germ. look like? 2) Do these differences indicate the degrees of relationship among the particular species, and do these connections correspond to the systematic division based upon the similarity of external morphological characters? 3) Is it possible to draw any general conclusions on this basis relating to the species as such, and thus to offer some elucidations of problems connected with the origin of species, the transformation of one species into another, etc.

A number of authors working on the systematics of certain groups of insects use, with considerable success, the method of comparing certain parts of the reproductive organs and especially of the copulatory organs. In the literature hitherto available to me I have not met any publications concerning the genus *Poly-*

drosus Germ. which, being represented in Poland by several species, seemed to me an excellent material for such studies, especially since it is divided into a number of clearly distinguished subspecies.

The Material and the Methods

Fifteen species of the genus *Polydrosus* Germ. form the subject of the present work. Data concerning the time and place of collection of these weevils and the plants on which they feed are presented in the table I.

Having cut off their heads, legs and elytrae, I prepared the insects in Ringer's solution. For histological purposes the isolated organs were fixed in Bouin's solution, dehydrated in the usual way, cleared in terpene oil, and embedded in paraffin. Histological sections 6 μ thick were stained in Delafield's haematoxylin and in a 1% solution of eosin. At least 10 series of microscopic preparations were made of each species of weevils.

In order to observe them „in toto" the freshly isolated gonads were studied in the Ringer's solution. This method enables us to study the mechanism of the movements of the uterine muscles, and those running from the sclerosed rod etc., but does not permit the investigation of the internal layers. In order to study the course of the internal ducts in the organs investigated, the gonads were slightly stained with borax carmine and placed in a mixture of gelatin, distilled water and glycerine. Dried specimens of weevils were also used, the abdomina of which were boiled in 10% KOH. After rinsing in water the receptacula seminis and the rods together with the 7th sternit were removed and prepared with gelatin and glycerine.

General description of a female gonad

As is generally known, the female reproductive organs consist of the ovaries, the deference ducts, the accessory organs and the external organs (Weber [15], Szwanwicz [14], Leńkowa [7], Natali [8]).

According to Weber's classification, the ovaries of weevils belong to the double-tubed, paired type, i. e. they consist of two

TABLE I

Time and place of collection of weevils

Species	Locality	Food plants	Time of catch
P. amoenus Germ.	slopes of Babia Góra, environments of Hucisko	*Rubus sp.*	July
P. atomarius Ol.	Mydlniki near Cracow, Ojców	*Pinus silvestris* L.	May, June
P. cervinus L.	Las Wolski near Cracow	*Betula verrucosa* Ehrh., *Quercus sp.*	May, June
P. confluens Steph.	Wierzchowice near Ojców, Kalina Mała near Miechów, rocks at Tyniec near Cracow	*Genista sp.*	May
P. coruscus Germ.	Radziszów	*Salix purpurea* L.	May, June, July
P. impar Gozis	Mydlniki near Cracow	*Pinus silvestris* L.	May, June
P. impressifrons Gyll.	Radziszów	*Salix purpurea* L.	May, June
P. inustus Germ.	Kościuszko Mound in Cracow	*Gramineae*	May
P. mollis Ström.	Las Wolski near Cracow, Pieniny	*Corylus avellana* L. *Quercus sp.*, *Fagus silvatica* L., *Carpinus betulus* L.	May, June
P. picus F.	Las Wolski near Cracow	*Quercus sp.*	June
P. pilosus Gredler	Pieniny, Skała Kmity near Zabierzów	*Corylus avellana* L.	May
P. pterygomalis Boh.	Radziszów	*Quercus sp.*	May
P. ruficornis Bonsd.	Radziszów	*Alnus incana* Moench.	May, June
P. sericeus Schall.	Las Wolski near Cracow, Radziszów	*Corylus avellana* L. *Alnus glutinosa* Gaertn.	June
P. tereticollis Degeer	Las Wolski near Cracow	*Corylus avellana* L. *Betula sp.*	May, June

tubes and a single calix on each side of the abdomen. Within the tube (fig. 1 — *ov* — *ovariola*) may be distinguished the terminal filament (*filum terminale*), the top chamber (*germarium*) and the egg-tube (*vitellarium*). The terminal filament is an elastic ligament which fastens the tube to the dorsal diaphragm (*diaphragma dorsale*) which divides the pericardial sinus from the abdominal cavity proper. This filament is a prolongation of the external epithelial sheath (*tunica propria*) of the tube and has nothing in common with the generative epithelium. In the top chamber the nurse cells (trophocytes) are formed, as well as the sex elements proper (oocytes). The initial growth of the oocytes proceeds at the expense of the trophocytes, from which the oocytes receive nourishing substances by means of the protoplasmatic ducts, i. e. very thin tubes linking the two kinds of cell. Such a way of nourishing the oocytes is characteristic of the tubes of the meroistic and telotrophic types. The egg-tube is the organ through which the oocytes pass, enclosed in follicular walls, and in which they attain their final size. From both tubes of the given half of the body mature eggs gather in the ample calix (fig. 1 — *cx*), after having cast off the follicular sheaths at the end of the ovariole. The degenerating remains of the follicles form a ring-like protuberance called the corpus luteum (fig. 1 — *cl*).

The deference ducts consist of a pair of oviducts (*oviducti*) which unite into a common oviduct (*oviductus communis*, fig. 1 — *oc*); this passes more distally into the strongly muscular uterus and farther on into the vagina. The nomenclature of the parts just mentioned is troublesome, as it has not been established at which point the uterus ends and the vagina begins; moreover some authors, e. g. Weber, use the term vagina to denote the whole section constituting the prolongation of the common oviduct. Stein [12] in his extensive monography on the female reproductive organs of the *Coleoptera* goes so far as to include in the vagina not only the terminal parts of the deference organs but also the diverticulum inclined forwards, which corresponds to the copulatory sac. Natali [8] reports that the paired oviducts unite into one duct, the distal section of which, in his opinion incorrectly, is called the vagina. He does not

however propose any other term. Szwanwicz [14] distinguishes a genital chamber or vagina in most of the higher insects and states that in those species whose eggs accumulate or young larvae develop in this section, the vagina is transformed into the uterus. Simm [11] and Schröder [10] use the term uterus for that part of the single duct which lies close to the ovaries, and vagina for the terminal, posterior section.

In the face of such varying interpretations it is difficult to decide upon the terminology of these organs in the weevils. When looking at the gonad from outside it is easy to distinguish the common oviduct from the markedly wider and more strongly muscular distal parts, (fig. 2 — *oc*). Its internal tube, however, does not end here, but keeping the same shape of lumen and character of epithelium, it continues to run posteriorly in the interior of the next section (fig. 2 — *du*). If we accept the opinion of certain authors (Weber, Szwanwicz) that the vagina begins where the oviduct ends (fig. 2 — point *B*) we might include this section also in the common oviduct. On the other hand, besides the oviduct there are found in the same section the copulatory sac (*bursa copulatrix*, fig. 2 — *bc*) and the duct of the receptaculum seminis (*ductus receptaculi*, fig. 2 — *dr*); therefore the inclusion of the farther section in the notion of a common oviduct would not be justified. For the same reason the converse, i. e. using the term vagina for the distal deference ducts (fig. 2 — distance from point *A* to *C*), seems unsuitable for the genus *Polydrosus* Germ. According to Simm the copulatory sac is a product of the uterus. Accepting the opinion of this author, I use the term uterus for the section of the deference ducts from the point at which the duct of the receptaculum seminis forces its way outwards, or at which the protruding part of the copulatory sac separates, to the point at which the prolongation of the lumen of the oviduct ends (fig. 2 — distance from point *A* to *B*). I keep the term vagina for the terminal part (fig. 2 — distance from point *B* to *C*). In the present paper I call the prolongation of the oviduct the uterine duct (fig. 2 — *du*) and for a common definition of the uterus and vagina the expression terminal deference ducts is used.

The accessory organs include the copulatory sac (*bursa copu-*

latrix, fig. 2 — *bc*), the receptaculum seminis (fig. 1 — *r*), the duct of the receptaculum seminis (*ductus receptaculi*) and the additional gland (*glandula accessoria*, fig. 1 — *ga*). The bursa copulatrix may have the shape of a sac bent in the form of a small roove, or it may be composed of 2 parts, a tube-like channel with a bladder-like receptacle fixed on it (fig. 2 — *cc* and *rbc*). It plays a double role, as a copulatory organ and as a temporary receptacle for the sperm. It is from here that the spermatozoa travel along a very thin, long duct to the receptaculum seminis proper, where they can be preserved for a long time. Into the receptaculum seminis opens the duct of the accessory gland, which produces substances necessary to keep the spermatozoa alive.

The female reproductive organs end with the ovipositor, which is usually folded like a telescope and hidden in the cloaca. The cloaca is protected on the dorsal side by the 8th tergit and on the ventral side by the 7th sternit. From the latter a long and highly sclerosed rod projects into the interior of the abdomen, and on this rod the deference ducts of the gonad are suspended by means of muscles.

In the 15 species of *Polydrosus* Germ. studied by the present author there is perfect conformity in the structure of the ovary (*ovarium*). Certain differences are observed in the length of the terminal filaments and in the size of the top chambers; but these are so insignificant that they are of no major importance in the problem as a whole. The situation is quite different in the deference ducts and the accessory organs, i. e. with the parts of ectodermal origin. The oviducts of insects are essentially mesodermal, but many authors (Heberdey, Demandt, Johannsen and Butt, Szwanwicz) report that cases occur in which the origin of the oviducts is ectodermal. It is to the latter kind of insects that the weevils belong [7].

The paired oviducts have a similar structure in all species. Certain differences may be observed only in the common oviduct, in the duct of the uterus, and in the form of the epithelial folds (fig. 3). At the end of the uterus is found an apparatus which closes its duct and may be of various forms. In some species, e. g. *P. tereticollis* Degeer there is a separate sphincter formed of

a bundle of muscles (fig. 4 — *sph*), in others only the folds of the intima close the entrance to the duct. In all species the end of the uterine duct is fastened by means of separate muscles to the top of a stiff rod (fig. 2 — *s*) but the way these muscles pierce the wall, and their contact with the epithelial folds, may differ.

In the weevils under investigation two principal types of structure of the terminal deference ducts may be distinguished. In some cases there is a straight, wide, strongly muscular and usually short formation supported from below by a hard, short rod (fig. 1 and 2). In other cases the structure is narrow, long, and forms a more or less pronounced loop lying dorsal on the left side of the weevil's body. A considerable role in the formation of the bending of the terminal deference ducts is played by eight bundles of muscles growing out of the walls of these organs. Of these, three pairs of muscular bundles are attached to the apex of the long rod, and the remaining pair is attached to the end of the abdomen (fig. 2). The loop of the terminal deference ducts, which is very well formed in young specimens, may be much less distinct after copulation, when the ejaculation fills its whole interior.

The copulatory sac also presents a great variability of shape, and sometimes even of histological structure. The formation of the receptaculum seminis (fig. 5) and the way in which the sclerosed rod (fig. 6) grows out of the last sternal plate may be very varied, in this way constituting certain taxonomic characters.

In this paper I omit a description of the ovary, the oviducts and the ovipositor, and present only the remaining parts of the reproductive organs, in the structure of which I have succeeded in observing some essential differences among the species of the genus *Polydrosus* Germ.

Detailed description

The simplest type of structure of the terminal deference ducts occurs in *Polydrosus amoenus* Germ., *P. mollis* Ström. and *P. sericeus* Schall. In these species they are merely a prolongation of the common oviduct, but have a much stronger

musculature and are divided into a short uterus and vagina of almost egual length. In all these three species the copulatory sac is found dorsal in the wall of the uterus. Between the uterus and the uterine duct runs the duct of the receptaculum seminis, which at the beginning of the uterus pierces the muscular wall and farther on lies loosely in the body cavity. The uterus passes into the vagina towards the back of the body without any distinct exterior border line. Within, however, it starts where the copulatory sac begins and the uterine duct ends. The walls of the vagina become gradually less muscular. Its lumen is lined with a thick layer of plicated intima, and narrows towards the back of the abdomen, passing into the ovipositor.

In *P. amoenus* Germ. the uterus, vagina and even the ovipositor are much more strongly muscular than in *P. mollis* Ström. and *P. sericeus* Schall. The walls of these organs are composed of a thick layer of circular muscles, and one layer of longitudinal muscles on the exterior. The copulatory sac and the ducts of the receptaculum seminis and uterus in *P. amoenus* Germ. are surrounded by a common muscular ring. These organs are separated from one another by a layer of epithelial cells, and there are no muscular fibres between them. The uterine duct passes entirely to the ventral side. Its walls are arranged in characteristic longitudinal folds (fig. 3 — *am*) covered with a thin layer of intima. Towards the end its lumen becomes gradually narrower and the folds smaller. Close by, on the dorsal side, there runs the comparatively broad duct of the receptaculum seminis to which the copulatory sac is closely adherent. The sac is very ample. At the apex it bifurcates into two arms, of which the shorter is directed rather to the interior. In cross-sections, besides the uterine duct and that of the receptaculum seminis, two lumina are visible, which are those of the arms of the copulatory sac. The walls of the sac are lined with a layer of soft intima and there no sclerosis is seen in any part. The intima is markedly plicated, and its germinal epithelium forms at the sides of the sac two thin folds which unite dorsally to create the inner arm of the sac already mentioned. When the ejaculation fills the interior of the copulatory sac its walls are much stretched, but the sac never protrudes autside the uterus.

At the site where the uterus ends, its wall is pierced by a thick bundle of muscles running from the top of the rod (fig. 7) so causing a complete interruption in the tight ring of circular muscles. The muscular bundle is divided into two branches which distinctly enter the lumen of the vagina; however, they are not united directly, but by means of epithelial cells. Thus the duct of the uterus has no sphincter in the strict sense of the word, but the whole arrangement gives good protection to the entrance to the duct during copulation.

The receptaculum seminis in *P. amoenus* Germ. is small, crescent-like and divided in the basal part into two arms (fig. 5 — *am*); from the shorter of these the duct of the receptaculum seminis takes its origin, while the accessory gland adheres to the longer. The gland is very small; its length hardly equals the length of the receptaculum seminis itself.

P. mollis Ström. and *P. sericeus* Schall. have much larger but less muscular terminal deference ducts than *P. amoenus* Germ. The copulatory sac is more simply built, as it has no convexities, and is also much longer. The copulatory sac of *P. amoenus* Germ. is a small concave groove immediately surrounding the uterine duct on three sides, while in *P. mollis* Ström. and *P. sericeus* Schall. it is shallower and separated from the latter by a muscular wall. This wall is at first thin but becomes considerably thicker proximally. It is pierced by the very slender duct of the receptaculum seminis. The copulatory sacs in *P. mollis* Ström. and *P. sericeus* Schall. are alike in form. They differ only in size, in consequence of the much larger dimensions of *P. mollis* Ström. as compared to *P. sericeus* Schall., and by the fact that in *P. sericeus* Schall. the external wall of the copulatory sac as well as its apex are markedly sclerosed (fig. 8 — *chd*), while in *P. mollis* Ström. they are lined with soft intima all over their surface.

In both species described, the duct in the initial part of the uterus is plicated much like that of *P. amoenus* Germ. and is characterized by one thick fold running along the dorsal side (fig. 3 — *mol*, *ser*). At the moment when the egg passes, the walls of the duct become completely straight but immediately after the passage of the egg the dorsal fold and other smaller

folds usually revert to their former shape. The end of the uterine duct is screaned by large thin folds of epithelium provided with a thick layer of intima. They protrude from the ventral side of the vagina; their base is reached by a bundle of muscles running from the apex of the rod.

As far as the structure of the receptaculum seminis is concerned, there are no essential differences between these two species, except that this organ is larger in *P. mollis* Ström. The accessory glands, however, differ much in length; in *P. sericeus* Schall. this gland is more or less three times as long as the receptaculum seminis, and in *P. mollis* Ström. about ten times as long.

Another species of the genus *Polydrosus* Germ. characterized by a simple structure of the terminal deference ducts is *P. atomarius* Ol. But even a macroscopic view of the isolated organs shows certain striking differences in comparison with the weevils just described. First of all the whole organ is considerably broadened where the uterus borders the vagina. Here a dark brown ring is visible through the tissue. When the thin muscular wall is removed, a sclerosed spinose formation may be seen almost entirely filling the lumen (fig. 9). Here the uterine duct ends and the copulatory sac and the duct of the receptaculum seminis begin, both running towards the anterior of the body. This formation is saddle-shaped, placed laterally and strongly bent; the concave surface is ventral of the abdomen. From the margin of this formation protrude markedly sclerosed projections two slanting backwards, and four forwards, looking like partly closed, elongated crenate leaves. In particular specimens various degrees of sclerosis of these formations may be observed. In some they are softer and less developed, in others markedly sclerosed and pronouncedly crenate. Sometimes they are dark brown, sometimes lighter and almost yellow. Among the upper spinose projections is situated the funnel-shaped, broad, thickwalled origin of the duct of the receptaculum seminis. Its walls are formed of a thick layer of sclerosed substance which passes into soft intima towards the interior. The duct of the receptaculum seminis is throughout its length a fairly thick, stiff tube.

The concave side of the saddle-shaped formation which at the same time constitutes the end of the uterine duct has a completely smooth surface; this is of great importance for the passage of eggs alongside of this unique natural obstacle. In cross-sections broad, sheet-like folds of intima are visible more distally; these diminish gradually and divide into much smaller ones. A thick fold of the intima is longest maintained on the ventral side, although in its interior long fine streaks are formed which then divide into separate folds. At this point the diameter of the vagina is half as small as that of the uterus, but the ring of circular muscles surrounding it is much thicker than in the latter.

The rod of *P. atomarius* Ol. is short, much as in the species mentioned above, and adheres to the outer wall of the uterus by means of a muscular bundle more or less at the height of the sclerosed formation in the interior of this organ. I failed to establish whether any fibres of this bundle enter into the end of the duct of the uterus.

The copulatory sac of *P. atomarius* Ol. is of an entirely different structure to that of the species described above. It is composed of two parts; a long tube-like duct, and a globose, bladder-like receptacle. The ample tube-like duct, called the copulatory channel (*canalis copulatrix*) runs beside the uterine duct as far as the beginning of the uterus, and then separates and protrudes far outwards, passing into a globose receptacle (fig. 9 — *rbc*). In the initial lumen of the copulatory channel there protrude from the lower wall the two above-mentioned projections of the sclerosed formation, which are joined more proximally by a third, rather shorter, but also hardened spine. In general the entire lower wall of the copulatory channel is lined with a thick and much plicated layer of intima. Just below this runs the duct of the receptaculum seminis, and still lower the uterine duct. These are divided by a band of epithelial cells; there are no muscles between them.

The globose receptacle or the copulatory sac proper is a thin-walled pouch which constantly keeps its shape, whether empty or when filled with ejaculation after copulation. On its surface a thin network of muscular fibres is discernible with difficulty. Its

walls are built of simple epithelium composed of very high cells, the plasma of which stains greyish-pink with eosin. The cell nuclei stain weakly with haematoxylin, except the small granulations contained in them which take a much darker stain. These nuclei are always placed at the very base of the epithelium. When the copulatory sac is maximally filled, the cells of the epithelium flatten in consequence of the pressure. They never form folds, as is the case in the receptacles of this type in other species. In the ejaculation small pieces of sclerosed matter are sometimes found. These may be particles of the unique formation described in the female, which are torn off during copulation.

After having pierced the muscles at the very beginning of the uterus at the point where the copulatory channel emerges, (fig. 9 — *dr*) the duct of the receptaculum seminis again attains a considerable length before reaching the receptaculum seminis. The latter is bent (fig. 5 — *at*), and its base divided into two arms; of these that joined by the duct is especially long and strongly flexed. The accessory gland is not very long; it is more or less 2-3 times the length of the receptaculum seminis.

The last species characterized by a simple structure of the terminal deference ducts is *P. impar* Gozis. The uterus of this species has a moderate musculature. Farther on the wall of the vagina becomes thicker, but only on the ventral side. In cross-section, four thin, long, upright folds are visible; at their base there is a flat thick muscular bundle which at the other end adheres to the apex of the rod. When we study successive preparations we see how the arcuated folds approach one another. The two internal folds are the first to unite, thus closing the lumen of the uterus; the two remaining folds unite and separate the copulatory channel from the receptaculum seminis. The latter begins as a sort of funnel with walls of thick intima. The width of the funnel is so considerable that it occupies the better part of the inner space of the uterus. In this respect it recalls *P. atomarius* Ol. Although no spinose projections are visible here, and the walls of the funnel are always soft, its diameter rapidly decreasing proximally, yet the broad sheets of intima with borders hardening at the entrance to the copulatory channel point to the resemblance of both species in this respect.

In *P. impar* Gozis the copulatory channel is fairly ample and long. It protrudes outside the uterus, but not to such an extent as in *P. atomarius* Ol., and ends in a very large globose receptacle the epithelium of which is of the same structure as in the former species. In the section of the uterus between the copulatory channel and its duct there exists a muscular wall through the centre of which runs the duct of the receptaculum seminis.

The receptaculum seminis (fig 5 — *im*) is large, pronouncedly bent in its apical part and divided at the base in a similar way as in *P. atomarius* Ol. The accessory gland is short, measuring $1^1/_2$—2 the length of the receptaculum seminis, and has the shape of a pyramid with a broad base.

All the other species of *Polydrosus* Germ. investigated have more or less S-shaped terminal deference ducts. The bending depends to a considerable degree on the extent to which they are filled with ejaculation; in young females, therefore, this is easily visible while in older ones, when the copulatory sac cannot contain the ejaculation, which overflows into the vagina, these organs straighten considerably.

There are two types of flexion in the terminal deference ducts. In one case the flexion is formed very near the beginning of the uterus, and includes a part of the common deference duct; in the other case it is shifted considerably more posteriorly and is S-shaped.

The former type is represented only by *P. coruscus* Germ. In this species the flexion occurs in the unusually short uterine section, whereas the vagina is quite straight throughout its length (fig. 11). In the majority of specimens of *P. coruscus* Germ. which I have examined, the long vagina was swelled to its maximum extent because its lumen was filled with a white, very dense mass shining in the freshly isolated reproductive organs through the thin muscular walls. This mass stains a deep pink with eosin. In cross-sections (fig. 12) a sort of sac, perhaps of mucus, is visible, which stains bright brick with eosin. Inside this again is a substance containing numerous spermatozoa.

P. coruscus Germ. has an outer copulatory sac, which gives the impression of being a vestigial organ. It is composed of a short copulatory channel and a small spherical bladder at the

end, quite inconspicuous in comparison with the copulatory sacs of other species. The lumen of the copulatory channel is very narrow, much smaller than that of the uterine duct. This is also worth emphasizing since this relation is the reverse in all other species. The bladder-like receptacle of the copulatory sac is often empty or only partly filled with a compact mass of spermatozoa. Very rarely besides spermatozoa a small amount of secretion may be found probably derived from the male deference ducts. The wall of the spherical part of the copulatory sac is formed of high epithelium with an exterior covering of a delicate network of muscular fibres. In the epithelium the nuclei of the cells are placed at the base, as in both the species described above.

The copulatory sac of *P. coruscus* Germ. is poorly developed and its functions seem to have been taken over by the strongly developed vagina into which the ejaculation is laid. Besides circular muscles, the vagina also possesses an external ring of longitudinal muscles which are especially well developed in the terminal section of the vagina.

The uterine duct is very short and divided from the adjacent organs by a thin muscular wall over the whole area up to the end. Near-by, but considerably before the termination of the uterine duct, that of the receptaculum seminis begins; it is formed like a broad, markedly flattened funnel. This duct is short. The receptaculum seminis (fig. 5 — *cor*) is normally filled with spermatozoa after copulation, although the copulatory sac in *P. coruscus* Germ. plays a similar part. The accessory gland is set on the receptaculum seminis at some distance from the end of the duct of the receptaculum seminis. The gland is 3-4 times longer than the receptaculum seminis.

The other type of flexion of the terminal deference ducts is found in the remaining nine species of weevils. Two sub-types may be distinguished; one is characterized by the flexion of these organs like the letter S directed towards the longitudinal axis of the insect, in the other it is directed diagonally to the axis. In the structure of the terminal deference ducts of the first sub-type the flexion is comparatively insignificant, but reaches the common oviduct; this recalls the relations in *P. coruscus* Germ.

Such a structure is found in *P. confluens* Steph., *P. inustus* Germ. and *P. ruficornis* Bonsd. The other sub-type, characterized by a considerable meandering of the terminal deference ducts occurs in its most typical form in *P. tereticollis* Degeer, and to a lesser degree in the remaining species of the genus *Polydrosus* Germ. under investigation.

Another characteristic feature of the species discussed is the division of the vagina into two successive sections, which I have failed to discern in the species previously described. The division of the vagina into two sections consists in a different histological structure of the walls in the terminal parts, and in that near the uterus. The walls in that part of the vagina near the uterus do not differ much from the walls of the uterus proper; in the terminal part, however, they are pronouncedly thinner, lined with flat epithelium and a less plicated layer of intima. Exteriorly the terminal part is surrounded by the wrinkled tunica, which adheres to the border of both distinguishable parts (fig. 13). S t e i n, describing an analogous part in the weevil *Brachyderes incanus* L., calls this the cloacal tube (Kloakrohr), but to me the term *atrium vaginae* seems more suitable. I use this term in the following text of the present work.

In different species the atrium vaginae is variously formed. In some it is very short, almost invisible and is marked by the wrinkles of the tunica only on the exterior. Usually such a form of the atrium vaginae corresponds to the former sub-type of structure of the terminal deference ducts; but the species with very long and meandering sections of the organs mentioned above have also the atrium vaginae prounouncedly marked and distinct from the part near the uterus.

Passing to a more detailed description of the female reproductive organs of the remaining species of weevils, *P. confluens* Steph. should be mentioned in the first place. Its terminal deference ducts are very reminiscent of the analogous organs in *P. coruscus* Germ. They are slightly flexed at the distal part, whereas in the uterine section they are markedly bent. The uterus of *P. confluens* Steph. is short. The epithelium lining its duct preserves the characteristic form of eight longitudinal folds, of which in cross-sections (fig. 3 — *con*) four are large and four

are smaller. It is of interest to note that there are thin muscular fibres lying at the base of the epithelial cells of the uterus. These lie parallel to the uterine duct and touch the basal parts of the cells. In cross-sections, therefore, a kind of axis is distinctly visible in the centre of each fold, because the epithelial cells forming a given fold are placed in two rows with their bases touching, and at the base (fig. 14) of each cell lies a muscular fibre oval in cross-section. I have not noticed a similar feature in any other species of weevil.

In the common oviduct, as well as in the duct of the uterus, the attention is attracted by small, dark, highly sclerosed scales [7] which as a rule are much softer in other species. The vagina of *P. confluens* Steph. is long, with an initial bulbous enlargement. The folds of the intima hang down from the uterus into the lumen of the vagina. At this place the exterior wall is pierced by two thin bands of muscles which enter far into the interior of the two parallel folds of the epithelium projecting from the ventral side towards the lumen. In cross-section, it may be seen that halway down the muscle bundles there emerge two off-shoots, which join together closing the lumen of the uterus as a compact sphincter. More proximally the free ends of the branches also unite, thus separating the rather wide entrance to the duct of the receptaculum seminis from the lumen of the copulatory sac. The uterine duct is separated from these organs by a muscular wall. The copulatory sac begins with a short channel within the uterus and protrudes far out of this organ, in the shape of a club. The epithelium in region of the channel is covered with a markedly sclerosed layer, but in the broadened part there is only soft intima which lies flat without forming any folds. Exteriorly, the sac is covered by an unusually thick layer of muscles, such as is not seen in other species.

The duct of the receptaculum seminis is very short, scarcely projecting beyond the uterus only a little. The receptaculum seminis is small, and greatly sclerosed. In its slightly broadened base the openings of the gland and of the duct of the receptaculum seminis (fig. 5 — *con*) are found near each other. The accessory gland is 2-3 times as long as the receptaculum seminis, and is fairly broad.

P. inustus Germ. is very similar to the foregoing species in respect to the structure of the female reproductive organs. The sphincter of the uterus, however, is formed in a different manner. It originates in a very thick bundle of muscles running from the apex of the rod. After having pierced the wall of the uterus, this bundle arches towards the back of the abdomen; it splits into separate fibres and surrounds the end of the uterine duct with a broad band.

The copulatory sac of *P. inustus* Germ. after leaving the uterus is somewhat different from that in *P. confluens* Steph. It is less swollen and so usually narrowed at the base and at the apex. It is especially distinguished by the strange structure of the epithelium, which is formed of very high cells, as in *P. atomarius* Ol., though their nuclei are placed not at the base but more or less in the longitudinal centre of these cells. The basal part of each cell of the epithelium, or the space below the nucleus, is characterized by a transparent structure which looks as if the interior of the cell were empty in that part. The apical part of the cell contains thick plasma, staining weakly with haematoxylin, and on the exterior is separated by a layer of intima (fig. 15). The nuclei take the same stain, but more intensively. It seems specially interesting that the borders of the cells are very distinct and coloured dark brown, which in cross-section, especially when tangential, gives the impression of a tissue similar to that of plants (fig. 16).

The copulatory sac is lined inside with a thin layer of intima, distinctly darker on its borders, and therefore to a certain degree sclerosed. Exteriorly the sac is enclosed in a loose net of muscular fibres. The shape of the receptaculum seminis (fig. 5 — *in*) is different in *P. inustus* Germ. from that in *P. confluens* Steph. It is characterized by a deep division of the base into two arms which recalls the analogous organ in *P. atomarius* Ol. The accessory gland is narrow and short, hardly as long as the receptaculum seminis.

P. impressifrons Gyll., *P. pterygomalis* Boh., *P. cervinus* L., *P. pilosus* Gredler and *P. picus* F. have deference ducts essentially similar to those of the species described above, but their organs are considerably more looped, viz., near the uterus and

the anterior part of the vagina. The vagina of these species is not very muscular, and is fairly long and narrow. Its final section is usually straight; exteriorly, it is surrounded by a small wrinkled sheath formed of intima or partly sclerosed matter. In *P. cervinus* L. two dark, markedly sclerosed, longitudinal bands are visible on the sides of this small sheath, giving it rigidity. Within, the walls are lined with a much plicated epithelium. In *P. picus* F. and *P. impressifrons* Gyll. this is characterized by a superficial sclerosed layer. In the first of these species the whole lumen is lined with such a layer; in cross-section the edge of this layer is pronouncedly dentate. In *P. impressifrons* Gyll. the vaginal epithelium secretes a sclerosed substance, brown or sometimes yellow in colour, only on that ventral wall on which runs the uterine duct. This part of the wall is strengthened on the exterior by a thick band of longitudinal muscles.

In all species the lumen is wider at the beginning of the vagina than farther back, and in this place the folds of epithelium surrounding the end of the uterine duct hang from the uterus towards the lumen. These folds, which are especially well developed in *P. cervinus* L. and *P. pilosus* Gredler, are provided with thin hair-like projections protruding from the edge of the intima. These are thin, sclerosed processes of the intima, and in *P. pilosus* Gredler are clustered by 3-5 together. In *P. pilosus* Gredler the funnel-shaped fold has been erroneously described [7] as in the copulatory channel, while this is actually the ending of the uterine duct.

The uterine duct in all species ends in an entire sphincter, except in *P. picus* F., in which the muscles taking their origin from the rod are divided into two branches, after they have pierced the wall of the uterus, but these do not unite directly. They adhere to the folds of the epithelium, as e. g. in *P. amoenus* Germ., and it is these which close the lumen of the duct. The bundle which pierces the wall in *P. picus* F. consists of only a few fibres. In *P. impressifrons* Gyll., on the contrary, this bundle is very thick and forms the strong sphincter of the uterine duct. In the remaining species the sphincter is fairly thin, but thicker than in *P. picus* F.

In all five species, the duct of the receptaculum seminis begins before the end of the uterine duct, and runs anteriorly in the muscular wall between this and the copulatory sac. In *P. impressifrons* Gyll. the lumen of the duct of the receptaculum seminis is star-shaped, in which it differs from other species. Beyond the uterus this duct is thin and fairly long. Only in *P. pterygomalis* Boh. it is short and very thick owing to the high epithelium of which its walls are formed. At the entrance to the receptaculum seminis the duct has especially high and narrow cells, so that a thick broad base is formed round its tube-like lumen (fig. 5 — *pt*).

The copulatory sac of the species discussed is composed of the copulatory channel and of an external part markedly projecting beyond the uterus. The copulatory channel is lined with wrinkled epithelium and a thick layer of intima. In *P. impressifrons* Gyll. the intima in the copulatory channel becomes hard at the edges. In the copulatory channel of *P. picus* F. there exists a short, blind diverticulum adjacent to the duct of the receptaculum seminis. The external copulatory sac is large; there may be distinguished in it a narrower and highly muscular channel and a farther part which is usually spherically broadened at the end. In the terminal part of the copulatory sac of *P. impressifrons* Gyll. a dark brown body may be seen, which attracts attention even in a macroscopic view of the reproductive organs. When microscopic preparations are made this body usually breaks into pieces, but whenever it proved to be less hard and of a brighter colour it appeared that this was a sort of amorphous sac containing a dense mass of spermatozoa. Most probably this is a very dense secretion deposited in the sac during copulation.

The receptaculum seminis is short in all five species, spherical at the basal part, with openings into the deference duct and into the duct of the accessory gland, set rather apart. This is especially easily visible in *P. picus* F. (fig. 5 — *pic*). The accessory gland is narrow in all species. Its length varies on the average from 2-3 times the length of the receptaculum seminis, being much larger only in *P. pilosus* Gredler and *P. cervinus* L., in which it amounts to 9-10 times the length of the receptacle.

The deference ducts of *P. tereticollis* Degeer present the best example of the second sub-type of structure of these organs. They are very long and tortuous. The common oviduct as well as the uterus are arched, and the vagina forms two loops. In *P. ruficornis* Bonsd., the terminal ducts are much less curved, but as it possesses numerous other characters in common with *P. tereticollis* Degeer they are discussed jointly. In both these species the vagina is composed of two parts (fig. 13). As in the weevils previously described, it has a bulbous broadening at the beginning (fig. 17). Long folds of epithelium and intima hang from the uterus into the vagina. On one side the wall is pierced not by one—as in other species— but by two muscular bundles, which in the interior arch backwards (fig. 17 — *m*). These bundles unite, forming at the end of the uterine a sphincter which is thin in *P. tereticollis* Degeer (fig. 4 — *sph*), and much thicker in *P. ruficornis* Bonsd. The copulatory sac of both these species is really internal, having the shape of a long broad sac, adjacent to the uterine duct. In young females this sac is almost entirely situated in the wall of the uterus, especially in *P. ruficornis* Bonsd., and only in older females it bulges outside when filled with ejaculation. In *P. ruficornis* Bonsd. the copulatory sac protrudes slightly after copulation (fig. 18 — *bc*); over the whole of the external surface it possesses circular muscles, which also surround the uterus. In *P. tereticollis* Degeer this protrusion takes a spherical shape when wholly filled. On the surface of such a copulatory sac a network of muscles is visible. In both species the charakter of the epithelium in the interior of the copulatory sac is the same in the initial part of the sac as in the apical.

The copulatory sac of *P. ruficornis* Bonsd. or even of *P. tereticollis* Degeer may be regarded as a sort of an intermediate form between the internal sac of *P. amoenus* Germ., *P. mollis* Ström. or *P. sericeus* Schall., and the external type of structure of the copulatory sac such as is possessed by all other species investigated by the author. But such conception meets with an essential difficulty in the fact that the duct of the receptaculum seminis in *P. ruficornis* Bonsd. and *P. tereticollis* Degeer is situated quite differently. These species, therefore, are discussed at the very end of this paper.

In all species except the two mentioned above, the duct of the receptaculum seminis begins at the end of the uterus and always runs in the wall between the uterine duct and the copulatory sac. Further on this duct pierces the wall of the uterus either above the apex of the copulatory sac, as in *P. amoenus* Germ., or between the common oviduct and the copulatory channel growing from the uterus exteriorly as e. g. in *P. atomarius* Ol., etc. It is entirely different in *P. tereticollis* Degeer and *P. ruficornis* Bonsd. The duct of their receptaculum seminis begins in the copulatory sac itself and for a fairly long distance runs in its exterior wall, i. e. on the side opposite to the uterine duct. It is especially distinctly visible in *P. ruficornis* Bonsd. because the duct of its receptaculum seminis has a wide lumen (fig. 19 — *dr*). Its initial form is that of an ellipse but then it decreases somewhat and becomes oval. After having pierced the wall exterior to the copulatory sac, the duct, which is still fairly thick, gradually becomes thin and enters the receptaculum seminis. In *P. tereticollis* Degeer this duct is much narrower but twice as long.

The receptaculum seminis (fig. 5 — *ruf*, *ter*) differs somewhat in these two species. In *P. ruficornis* Bonsd. its base is considerably distended and the ends of the gland and of the duct are side by side, while in *P. tereticollis* Degeer the base is narrow and divided into two arms; the gland passes into one of these and the duct into the other.

The accessory gland is similar in both species, but differs in form from that of other species. The glands in the rest of the species are either of uniform breadth, or broader at the base than at the end, while in *P. ruficornis* Bonsd. and *P. tereticollis* Degeer the reverse occurs: the gland is narrow at the base, or near the receptacle, and broadens towards its end. It is fairly long and attains 5-6 times the length of the receptaculum seminis.

Discussion of common characters and of differences

In the author's opinion, those female organs and characters of their reproductive apparatus which may, to a certain extent, testify to the degree of relationship of the species investigated, are as follows: 1) The form of the copulatory sac, 2) the location

of the duct of the receptaculum seminis, 3) the form of the receptaculum seminis, 4) the arrangement of the folds of the epithelium in the final section of the common oviduct or at the beginning of the uterus, 5) the manner in which the uterine duct is closed, 6) the length and degree of flexion of the terminal deference ducts, 7) the structure of the epithelium of the apical part of the copulatory sac, 8) the appearance of the 7th sternit and of the rod growing from it.

Even on the basis of an analysis of the data concerning the first two items, we may distinguish three groups among the fifteen species of the genus *Polydrosus* Germ. under investigation, and these may in turn be divided into further groups. The first group includes the species which possess an internal copulatory sac, i. e. *P. amoenus* Germ., *P. mollis* Ström. and *P. sericeus* Schall. To the second group belong the species which have a partially external copulatory sac and the duct of the receptaculum seminis located between the latter and the uterine duct, i. e. all the remaining species except *P. ruficornis* Bonsd. and *P. tereticollis* Degeer. These two weevils form a third group because in them the duct of the receptaculum seminis is found in the external wall of the copulatory sac, in which they differ essentially from other species.

After having gathered all the data of this description it seems certain that some species are actually closely related; of such at least four pairs may be chosen from the material elaborated, i. e. *P. mollis* Ström. *and P. sericeus* Schall., *P. pilosus* Gredler and *P. cervinus* L., *P. atomarius* Ol. and *P. impar* Gozis, *P. ruficornis* Bonsd. and *P. tereticollis* Degeer.

The first pair, that is *P. mollis* Ström. and *P. sericeus* Schall. have deceptively similar reproductive organs. The structure of the copulatory sac, its shape, the form of the receptaculum seminis and of the 7th sternal plate, as well as the similar arrangement of the epithelial folds in the uterine duct, apparently give cogent proof that both species are systematically closely related. *P. amoenus* Germ., which somewhat resembles them in respect to the structure of its deference ducts, has quite a different shape of the receptaculum seminis, a different sternal plate and a slightly different copulatory sac. On account of this and

of the lack of resemblance to other species, *P. amoenus* Germ. seems to stand rather apart in this group of weevils.

P. atomarius Ol. and *P. impar* Gozis do not form a group so closely related with respect to the resemblance of the reproductive organs as the former group. There is not much correspondence between the sclerosed formation on the border line of the uterus and vagina in *P. atomarius* Ol., and the two transversal folds, slightly hardened at the edges, at the entrance to the copulatory sac of *P. impar* Gozis. On the other hand, the thick wall of the funnel-shaped entrance to the duct of the receptaculum seminis and the deeply forked base of this receptacle, the copulatory sac of almost the same shape and the similar nature of the epithelium within this sac, indicate a certain resemblance between these two species. It would then follow that in respect to the structure of their reproductive organs they should be included in the same sub-genus, but it is not out of the question that there exist other species having the same type of organs, which have not been investigated by the author and which might be placed between *P. atomarius* Ol. and *P. impar* Gozis.

P. pilosus Gredler and *P. cervinus* L. are again an example of closely related species because they are very much alike in every respect. The fourth and last pair, *P. ruficornis* Bonsd. and *P. tereticollis* Degeer have numerous characters on common, but they differ in the shape of their sternal plates and the length and manner of flexion of their deference ducts. It seems then that both species should be included in one sub-genus, but there may exist a number of other hitherto unstudied species.

P. coruscus Germ. and *P. picus* F. stand quite apart. The former recalls *P. atomarius* Ol. in respect to the structure of the epithelium of the copulatory sac, while in the shape of its receptaculum seminis and 7th sternal plate it approaches *P. impressifrons* Gyll., and in the epithelial folds in the uterus it corresponds to *P. confluens* Steph. At the same time, its short uterus and the fact that its copulatory sac does not seem to play a normal part differentiates it from all the species investigated. *P. picus* F. resembles *P. pilosus* Gredler and *P. cervinus* L. with regard to the external shape of the copulatory sac, but the existence of the curious diverticulum in the co-

pulatory channel, as well as other characters such as the arrangement of the folds in the uterine duct and the different shape of the receptaculum seminis determine the separation of this species from the other weevils mentioned. The remaining five species of *Polydrosus* Germ. possess numerous characters in common, or in common with the preceding species, but the differences are equally numerous, therefore, the estimation of the degree of relationship on the basis of the structure of the female reproductive organs seems very difficult.

According to the list the genus *Polydrosus* Germ. includes 167 species [16] or even 186 [6] distributed in various countries; most of them inhabit areas in southern Europe, northern Africa and Asia Minor. This large number of species has been divided into 19 sub-genera. The species forming the material of the present work belong to 7 sub-genera, comprising altogether 98 species, according to Junk; they thus form only a small part of the groups distinguished.

The classification based upon the resemblance of the endoskeleton of these insects only partially coincides with the division outlined by the author. *P. mollis* Ström. and *P. sericeus* Schall. were e. g. classed in two different sub-genera, although the observations of the present author suggest that they are more closely related. *P. mollis* Ström. belongs to the sub-genus *Eudipnus* Thoms. including 7 more species which have not been discussed in the present paper. *P. sericeus* Schall. together with 8 other species, also not discussed here are included in the sub-genus *Thomsoneonymus* Desbr. *P. atomarius* Ol. and *P. impar* Gozis belong to the sub-genus *Metallites* Germ. which comprises 18 species. The writer's observations on the female reproductive organs do not preclude the placing of *P. atomarius* Ol. and *P. impar* Gozis together in one group, although they do not confirm any very close relationship between these species. *P. coruscus* Germ. and *P. pterygomalis* Boh. together with nine other species are classed in the sub-genus *Tylodrusus* Stierl.; Reitter and Hoffmann also include *P. impressifrons* Gyll. in this group. For reasons previously discussed such a classification is not completely justified.

TABLE II

The degree of relationship according to the systematic arrangement by different authors according to internal morphological characters

Sub-genus	Author			
	Junk	Reitter	Winkler	Hoffmann
Metallites Germ.	*P. atomarius* Ol. *P. impar* Gozis	*P. impar* Gozis *P. atomarius* Ol.	*P. impar* Gozis *P. atomarius* Ol.	*P. impar* Gozis *P. atomarius* Ol.
Tylodrusus Stierl.	*P. coruscus* Germ. *P. pterygomalis* Boh.	*P. coruscus* Germ. *P. pterygomalis* Boh. *P. impressifrons* Gyll.	*P. pterygomalis* Boh. *P. coruscus* Germ.	*P. pterygomalis* Boh. *P. coruscus* Germ. *P. impressifrons* Gyll.
Eustolus Thoms.	*P. cervinus* L. *P. confluens* Steph. *P. impressifrons* Gyll. *P. inustus* Germ. *P. pilosus* Gredler	*P. confluens* Steph. *P. cervinus* L. *P. pilosus* Gredler *P. ruficornis* Bonsd. *P. tereticollis* Degeer *P. impressifrons* Gyll.	*P. impressifrons* Gyll. *P. cervinus* L. *P. pilosus* Gredler *P. inustus* Germ. *P. confluens* Steph.	*P. confluens* Steph. *P. cervinus* L. *P. pilosus* Gredler *P. ruficornis* Bonsd. *P. tereticollis* Degeer
Polydrosus s. s.	*P. picus* F. *P. ruficornis* Bonsd. *P. tereticollis* Degeer	*P. picus* F.	*P. tereticollis* Degeer *P. picus* F.	*P. picus* F.
Metadrosus Schils.			*P. ruficornis* Bonsd.	
Chlorodrosus Dan.	*P. amoenus* Germ.	*P. amoenus* Germ.	*P. amoenus* Germ.	*P. amoenus* Germ.
Thomsoneonymus Desbr.	*P. sericeus* Schall.	*P. sericeus* Schall.	*P. sericeus* Schall.	*P. sericeus* Schall.
Eudipnus Thoms.	*P. mollis* Ström.	*P. mollis* Ström.	*P. mollis* Ström.	*P. mollis* Ström.

Kind of character*				
form of *receptaculum seminis*	shape of 7th sternal plate and rod	arrangement of uterine folds	structure of uterus and vagina	shape of sphincter of uterine duct
P. mollis Ström.	*P. amoenus* Germ.	*P. amoenus* Germ.	*P. amoenus* Germ.	*P. mollis* Ström.
P. sericeus Schall.	*P. picus* F.	*P. mollis* Ström.	*P. mollis* Ström.	*P. sericeus* Schall.
P. amoenus Germ.	*P. confluens* Steph.	*P. picus* F.	*P. sericeus* Schall.	*P. amoenus* Germ.
P. impar Gozis	*P. pterygomalis* Boh.	*P. sericeus* Schall.	*P. atomarius* Ol.	*P. picus* F.
P. atomarius Ol.	*P. impressifrons* Gyll.	*P. inustus* Germ.	*P. impar* Gozis	*P. atomarius* Ol.
P. inustus Germ.	*P. coruscus* Germ.	*P. ruficornis* Bonsd.	*P. coruscus* Germ.	*P. impar* Gozis
P. picus F.	*P. impar* Gozis	*P. tereticollis* Degeer	*P. confluens* Steph.	*P. confluens* Steph.
P. coruscus Germ.	*P. atomarius* Ol.	*P. cervinus* L.	*P. inustus* Germ.	*P. inustus* Germ.
P. impressifrons Gyll.	*P. sericeus* Schall.	*P. pilosus* Gredler	*P. impressifrons* Gyll.	*P. impressifrons* Gyll.
P. cervinus L.	*P. mollis* Ström.	*P. confluens* Steph.	*P. pterygomalis* Boh.	*P. pterygomalis* Boh.
P. pilosus Gredler	*P. tereticollis* Degeer	*P. coruscus* Germ.	*P. picus* F.	*P. cervinus* L.
P. confluens Steph.	*P. pilosus* Gredler	*P. pterygomalis* Boh.	*P. cervinus* L.	*P. pilosus* Gredler
P. pterygomalis Boh.	*P. cervinus* L.	*P. impressifrons* Gyll.	*P. pilosus* Gredler	*P. coruscus* Germ.
P. ruficornis Bonsd.	*P. inustus* Germ.	*P. atomarius* Ol.	*P. tereticollis* Degeer	*P. tereticollis* Degeer
P. tereticollis Degeer	*P. ruficornis* Bonsd.	*P. impar* Gozis	*P. ruficornis* Bonsd.	*P. ruficornis* Bonsd.

* Species are arranged in columns according to the degree of resemblance of particular organs of these species.

The sub-genus *Eustolus* Thoms., comprising 41 species, is the largest group in the genus *Polydrosus* Germ. In the present material, it has the most numerous representatives. In the first place, *P. pilosus* Gredler, *P. cervinus* L., *P. confluens* Steph. and *P. inustus* Germ. belong to it, while Reitter and Hoffmann include also *P. ruficornis* Bonsd. and *P. tereticollis* Degeer. From the point of view of the internal structure of the reproductive organs the opinion of Winkler and Junk, who place the two latter species in separate sub-genera, seems more justified. But Junk places them together with *P. picus* F. in the sub-genus *Polydrosus s. s.* comprising only 6 species, which is not in conformity with the observations of the present author, and Winkler differentiates still another sub-genus, but includes in it only *P. ruficornis* Bonsd., approximating *P. tereticollis* Degeer with regard to the structure of the female reproductive organs, but differing very much in this respect from *P. picus* F.

The results of investigations on the internal reproductive organs, both female and male, may be of practical value in the systematics of the genus *Polydrosus* Germ. especially in those cases in which for certain reasons it is difficult to class a species in a given group only on the basis of the morphology of the insect's exoskeleton.

Final conclusions

A detailed elaboration of the female reproductive organs of 15 species of the genus *Polydrosus* Germ. and a comparison of the results with the systematic classification based on the external morphology of the weevils allows the following conclusions to be drawn:

1) The differences in the structure of the reproductive organs occur in the females of the species investigated only in the formations of ectodermal origin, as distinctly opposed to the complete uniformity of the organs derived from the mesoderm.
2) The range of individual variability is very narrow and affects exclusively the size of the reproductive organs and the degree of sclerosis.

3) The differences between the characters of the female reproductive organs in particular species are very distinct, and vary within extensive limits, in contrast to the individual variability of these organs, which is markedly slight.
4) The diversity of certains parts of the female reproductive organs is not correlated with differences in the structure of the exoskeleton of the insect. In the systematics, various species are grouped in particular sub-genera on the basis of the resemblance of external morphological characters. It might be expected that in related species an analogous similarity would occur in the structure of the reproductive organs; however, the results of the present work do not corroborate such a supposition. On the contrary, the observations show a certain independence in the formation of particular morphological characters, by which the difference in the specific structure of these forms and the correctness of the distinction of species is emphasized.

This research has been carried out in the Department of Zoology of the Jagiellonian University in Cracow. In the course of my work I have repeatedly profited by the unusually benevolent help of Professor Stanisław Smreczyński and his valuable advice on the determination of the particular species of weevils and the distribution of the representatives of the genus *Polydrosus* Germ., for which I wish to express my hearty thanks.

STRESZCZENIE

W pracy podano szczegółowy opis żeńskich narządów rozrodczych 15 następujących gatunków ryjkowców: *Polydrosus amoenus* Germ., *P. atomarius* Ol., *P. cervinus* L., *P. confluens* Steph., *P. coruscus* Germ., *P. impar* Gozis, *P. impressifrons* Gyl., *P. inustus* Germ., *P. mollis* Ström., *P. picus* F., *P. pilosus* Gredler, *P. pterygomalis* Boh., *P. ruficornis* Bonsd., *P. sericeus* Schall., *P. tereticollis* Degeer.

Jajniki tych gatunków składają się z dwu cewek (*ovariolae*) po każdej stronie ciała owada i wraz z parą kielichów (*calix*), do których uchodzą, odznaczają się zupełną zgodnością budowy. Natomiast następujące części pochodzenia ektodermalnego od-

znaczają się dużą zmiennością formy: drogi wyprowadzające składające się z pary jajowodów (*oviducti*), które z kolei łączą się we wspólny przewód jajowodowy (*oviductus communis*), a dalej ku tyłowi odwłoka przechodzą w macicę (*uterus*) i pochwę (*vagina*) oraz narządy dodatkowe, tj. kieszeń płciowa (*bursa copulatrix*), zbiornik nasienny (*receptaculum seminis*), przewód zbiornika nasiennego (*ductus receptaculi*) i gruczoł dodatkowy (*glandula accessoria*).

Można przy tym wyróżnić następujące cechy taksonomiczne:

1. Kształt kieszeni płciowej. Kieszeń płciowa może mieścić się w ścianie macicy albo wystawać na zewnątrz tego organu w postaci buławy lub trzonu zakończonego kulistym zbiornikiem. Istnieje też forma pośrednia.

2. Umiejscowienie przewodu zbiornika nasiennego. Może on przebiegać w ścianie między przewodem macicy a kieszenią płciową lub też w zewnętrznej ścianie kieszeni płciowej, a więc po przeciwnej stronie przewodu macicy.

3. Kształt zbiornika nasiennego. Jest on niezawodną stałą cechą każdego gatunku.

4. Ułożenie fałdów nabłonka w końcowym odcinku wspólnego przewodu jajowodowego lub na początku macicy. Przy nierozciągniętym świetle tych narządów fałdy nabłonka układają się zazwyczaj w charakterystyczny dla każdego gatunku sposób.

5. Rodzaj zamknięcia przewodu macicy. U jednych gatunków zamknięcie tego narządu wykształca się w postaci rzeczywistego zwieracza mięśniowego; u innych tylko fałdy nabłonka zasłaniają wejście do przewodu.

6. Długość i stopień wygięcia końcowych dróg wyprowadzających. Drogi te mogą być krótkie i prosto zbudowane lub w różnym stopniu wygięte w pętlę.

7. Rodzaj struktury nabłonka szczytowej części kieszeni płciowej. U jednych gatunków nie różni się on od nabłonka w początkowym odcinku kieszeni płciowej, u drugich zaś zbudowany jest z wysokich komórek, zupełnie odmiennych niż poprzednie.

8. Wygląd 7 sternitu i wyrastającego z niego w głąb odwłoka sklerotyzowanego pręcika, na którym za pomocą mięśni zawieszo-

ne są końcowe drogi wyprowadzające. Sposób wrastania pręcika w 7 płytkę sternalną może być rozmaity.

Szczegółowe opracowanie żeńskich narządów rozrodczych 15 przebadanych gatunków oraz porównanie poczynionych obserwacji z podziałem systematycznym opartym na morfologii zewnętrznego szkieletu owadów pozwala na wyciągnięcie szeregu wniosków:

1. Różnice budowy narządów rozrodczych pomiędzy badanymi gatunkami występują u samic jedynie w obrębie utworów pochodzenia ektodermalnego, czemu dobitnie przeciwstawia się zupełna jednolitość organów powstałych z mezodermy.

2. Zakres zmienności indywidualnej jest bardzo wąski i dotyczy wyłącznie tylko rozmiarów narządów rozrodczych oraz stopnia ich zesklerotyzowania.

3. Różnice między cechami żeńskich narządów rozrodczych poszczególnych gatunków, w przeciwieństwie do słabo zaznaczonej zmienności osobniczej tych narządów, występują bardzo wyraźnie.

4. Różnorodność pewnych części żeńskich narządów rozrodczych nie jest skorelowana z różnicami budowy zewnętrznego szkieletu owada. Systematyka grupuje różne gatunki w poszczególne podrodzaje na podstawie podobieństwa zewnętrznych cech morfologicznych. Można by się zatem spodziewać, że u gatunków pokrewnych wystąpi analogiczne podobieństwo w budowie narządów rozrodczych, jednakże wyniki powyższej pracy nie potwierdzają takiego przypuszczenia.

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EXPLANATION OF FIGURES

Fig. 1. External view of female reproductive organs in *Polydrosus sericeus* Schall.; *ft* — terminal filament (*filum terminale*), *g* — top chamber (*germarium*), a the narrowing of the tube, *ov* — egg tube (*ovariola*), *cl* — yellow body (*corpus luteum*), *cx* — calix, *ovd* — oviduct (*oviductus*), *oc* — common oviduct (*oviductus communis*), *u* — *uterus*, *v* — *vagina*, *r* — *receptaculum seminis*, *ga* — accessory gland (*glandula accessoria*), *s* — sclerosed rod, *bc* — copulatory sac (*bursa copulatrix*).

Fig. 2. Two schemes of structure of terminal deference duct; *oc* — common oviduct (*oviductus communis*), *du* — duct of uterus, *u* — *uterus*, *dr* — duct of receptaculum seminis (*ductus receptaculi*), *bc* — copulatory sac (*bursa copulatrix*), *cc* — copulatory channel (*canalis copulatrix*), *rbc* — broadened part of copulatory sac, *m* — muscles, *s* — rod, *v* — vagina.

Fig. 3. Schemes of transversal cross-sections of initial section of uterus. Layer of epithelium with folds characteristic of each species are dotted; *am* — *P. amoenus* Germ., *mol* — *P. molis* Ström., *pic* — *P. picus* F., *ser* — *P. sericeus* Schall., *in* — *P. inustus* Germ., *ruf* — *P. ruficornis* Bonsd.,

ter — *P. tereticollis* Degeer, *cer* — *P. cervinus* L., *pil* — *P. pilosus* Gredler, *con* — *P. confluens* Steph., *cor* — *P. coruscus* Germ., *pt* — *P. pterygomalis* Boh., *ims* — *P. impressifrons* Gyll., *at* — *P. atomarius* Ol., *im.* — *P. impar* Gozis.

Fig. 4. Serial transversal cross-sections of uterus (1, 2) and vagina (3, 4) in *P. tereticollis* Degeer; phot. 1 — in the middle epithelial wall separating the copulatory sac (*bc* — *bursa copulatrix*) from duct of uterus (*du* — *ductus uteri);* phot. 2 — *sph* — sphincter at the end of duct of uterus; phot. 3 — *m* — fibres of two muscular bundles running from apex of rod, forming sphincter in the former phot.; phot. 4 — in middle folds of epithelium hanging from uterus to the lumen of vagina.

Fig. 5. Schemes of *receptaculi seminis: mol* — *P. mollis* Ström., *ser* — *P. sericeus* Schall., *am* — *P. amoenus* Germ., *im* — *P. impar* Gozis, *at* — *P. atomarius* Ol., *in* — *P. inustus* Germ., *pic* — *P. picus* F., *cor* — *P. coruscus* Germ., *ims* — *P. impressifrons* Gyll., *cer* — *P. cervinus* L., *pil* — *P. pilosus*, Gredler, *con* — *P. confluens* Steph., *pt.* — *P. pterygomalis* Boh., *ruf* — *P. ruficornis* Bonsd., *ter* — *P. tereticollis* Degeer.

Fig. 6. Schemes of 7th sternal plates and of accreting sclerosed rods; initial section of hard rods marked black, less sclerosed part are dotted; *am* — *P. amoenus* Germ., *pic* — *P. picus* F., *con* — *P. confluens* Steph., *pt* — *P. pterygomalis* Boh., *ims* — *P impressifrons* Gyll., *cor* — *P. coruscus* L., *im* — *P. impar* Gozis, *at* — *P. atomarius* Ol., *ser* — *P. sericeus* Schall., *moll* — *P. mollis* Ström., *ter* — *P. tereticollis* Degeer, *pil* — *P. pilosus* Gredler, *cer* — *P. cervinus* L., *in* — *P. inustus* Germ., *ruf* — *P. ruficornis* Bonsd.

Fig. 7. Transversal cross-section of uterus *P. amoenus* Germ.; *bc* — copulatory sac (*bursa copulatrix*), *sph* — bundle of muscles piercing compact ring of circular muscles.

Fig. 8. Transversal cross-section of uterus *P. sericeus* Schall.; *bc* — copulatory sac (*bursa copulatrix*), *du* — duct of uterus (*ductus uteri*), *dr* — duct of *receptaculum seminis* (*ductus receptaculi*), *mc* — circular muscles, *ml* — longitudinal muscles, *chd* — sclerosed substance, *chm* — soft intima, *chc* — epithelial cells.

Fig. 9. Terminal deference ducts in *P. atomarius* Ol. with sclerosed formation visible inside; *ovd* — oviduct (*oviductus*), *oc* — common oviduct (*oviductus communis*), *u* — uterus, *v* — vagina, *dr* — duct of *receptaculum seminis* (*ductus receptaculi*), *cc* — copulatory channel (*canalis copulatrix*), *rbc* — copulatory sac (*bursa copulatrix*), *r* — *receptaculum seminis*, *ga* — accessory gland (*glandula accesoria*).

Fig. 10. Transversal cross-section of uterus in *P. atomarius* Ol.; *bc* — copulatory sac (*bursa copulatrix*), *dr* — duct of *receptaculum seminis* in middle of sclerosed formation (*ductus receptaculi*), *du*—duct of uterus (*ductus uteri*).

Fig. 11. Generative ducts in *P. coruscus* Germ.; *ov* — egg tube (*ovariola*), *cl* — yellow body (*corpus luteum*), *cx* — calix, *ovd* — oviduct (*oviductus*), *oc* — common oviduct (*oviductus communis*), *bc* — copulatory sac (*bursa*

copulatrix), *r* — *receptaculum seminis*, *ga* — accessory gland (*glandula accessoria*), *u* — uterus, *v* — vagina, *m* — muscles, *s* — rod.

Fig. 12. Serial transversal cross-sections of vagina in *P. coruscus* Germ.; phot. 1 *du* — end of duct of uterus, *sp* — spermatozoa surrounded by sheath of substance strongly stained with eosin; photos 2, 3, 4, 5, vagina filled with ejaculation, in middle substance stained with eosin is visible, phot. 6, *dv* — lumen of terminal section of vagina.

Fig. 13. Longitudinal cross-section of vagina in *P. tereticollis* Degeer.; arrows point to border between part of vagina near uterus and atrium vaginae.

Fig. 14. Transversal cross-section of uterus in *P. confluens* Steph.; characteristic arrangement of 8 folds of epithelium; in middle of each fold dark outlines of muscular fibres cut transversally. Enlarged 500 times.

Fig. 15. Longitudinal cross-section through epithelium of copulatory sac of *P. inustus* Germ.; borders of cells and layer of intima distinctly visible. Enlarged 500 times.

Fig. 16. Tangential cross-section of epithelium of copulatory sac of *P. inustus* Germ.; dark borders of cells distinctly visible, in the upper left corner the fat cells. Enlarged 500 times.

Fig. 17. Longitudinal cross-section of vagina in *P. tereticollis* Degeer.; into butt-like broadened vagina folds of epithelium from uterus are hanging; *m* — muscles forming sphincter of duct of uterus.

Fig. 18. Longitudinal cross-section of terminal deference ducts in *P. ruficornis* Bonsd., *bc* — copulatory sac filled with ejaculation (*bursa copulatrix*), *dr* — duct of receptaculum seminis (*ductus receptaculi*), *du* — duct of uterus (*ductus uteri*) very thin in comparison with copulatory sac, *v* — vagina.

Fig. 19. Serial transversal cross-sections of uterus in *P. ruficornis* Bonds. illustrating course of duct of receptaculum seminis; initially duct of receptacle — *dr* — lies inside ring of muscles of uterus (phot. 1), *bc* — copulatory sac filled with ejaculation, du — duct of uterus (*ductus uteri*).

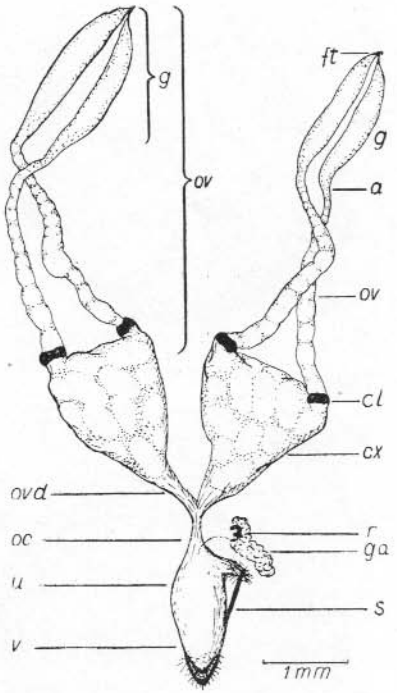


Fig. 1

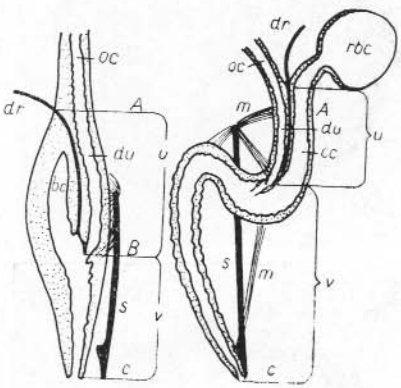


Fig. 2

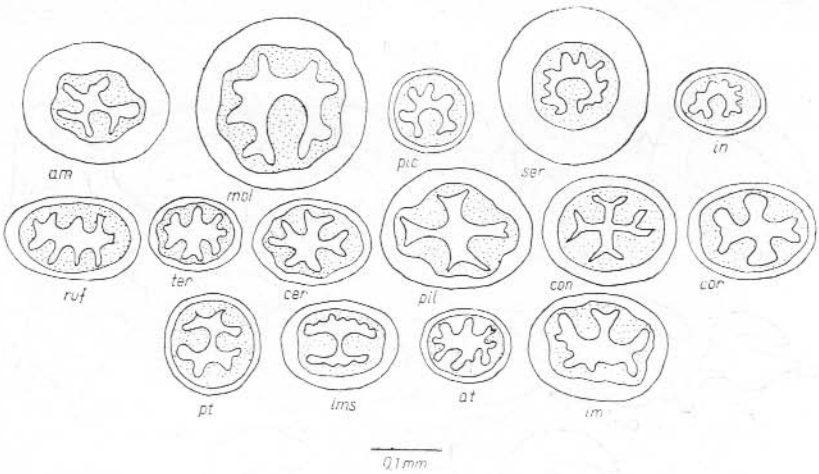


Fig. 3

TABLE II

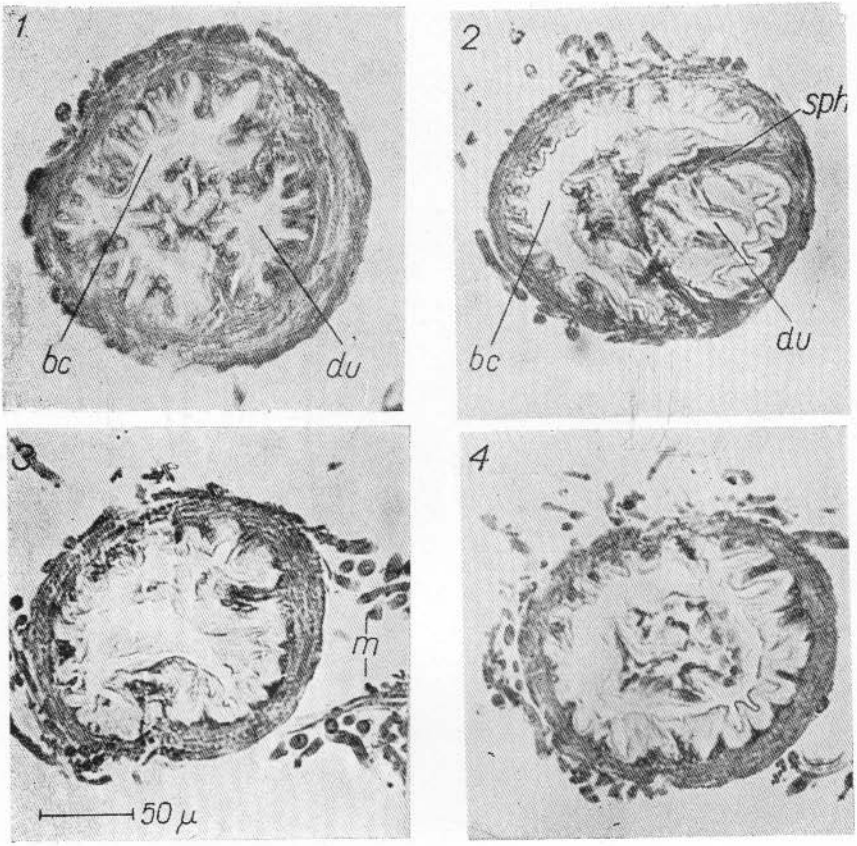


Fig. 4

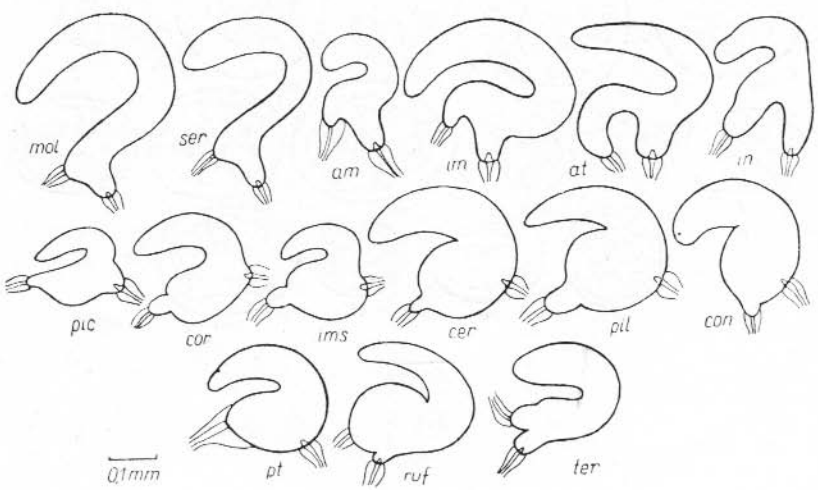


Fig. 5

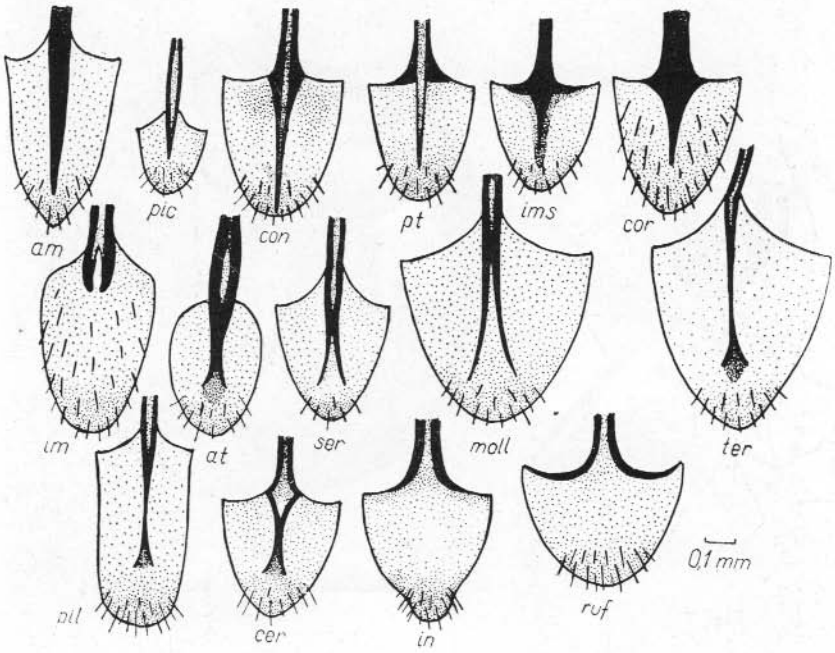


Fig. 6

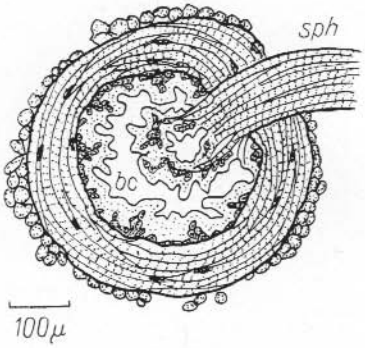


Fig. 7

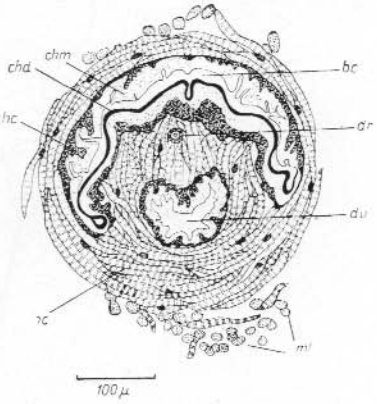


Fig. 8

TABLE IV

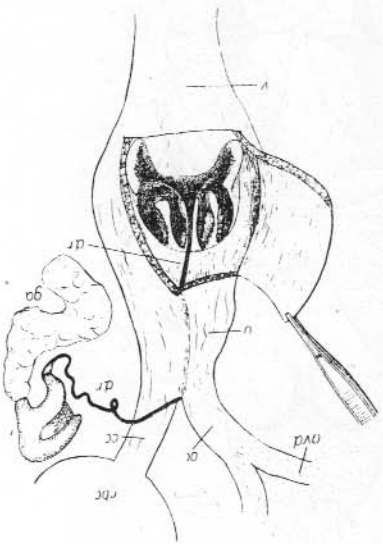


Fig. 9

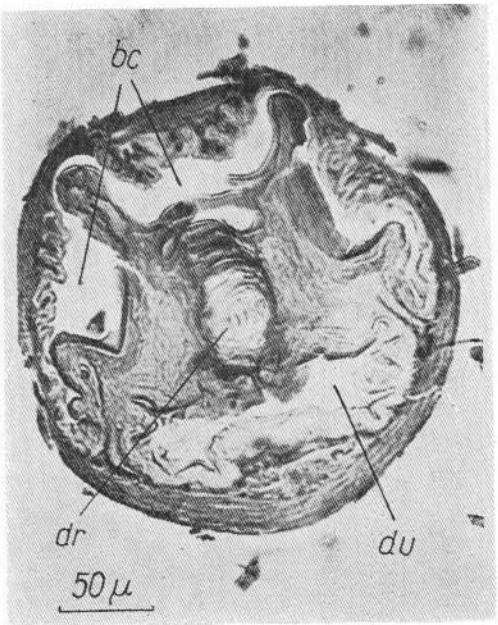


Fig. 10

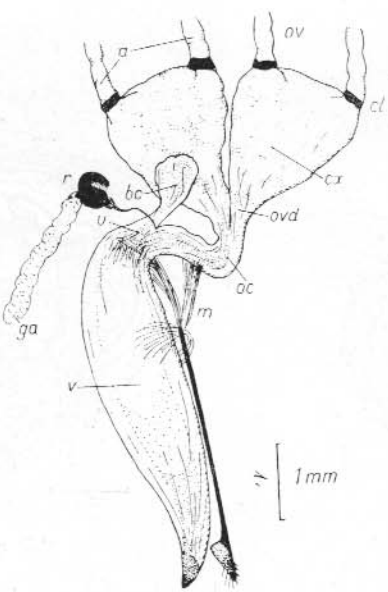


Fig. 11

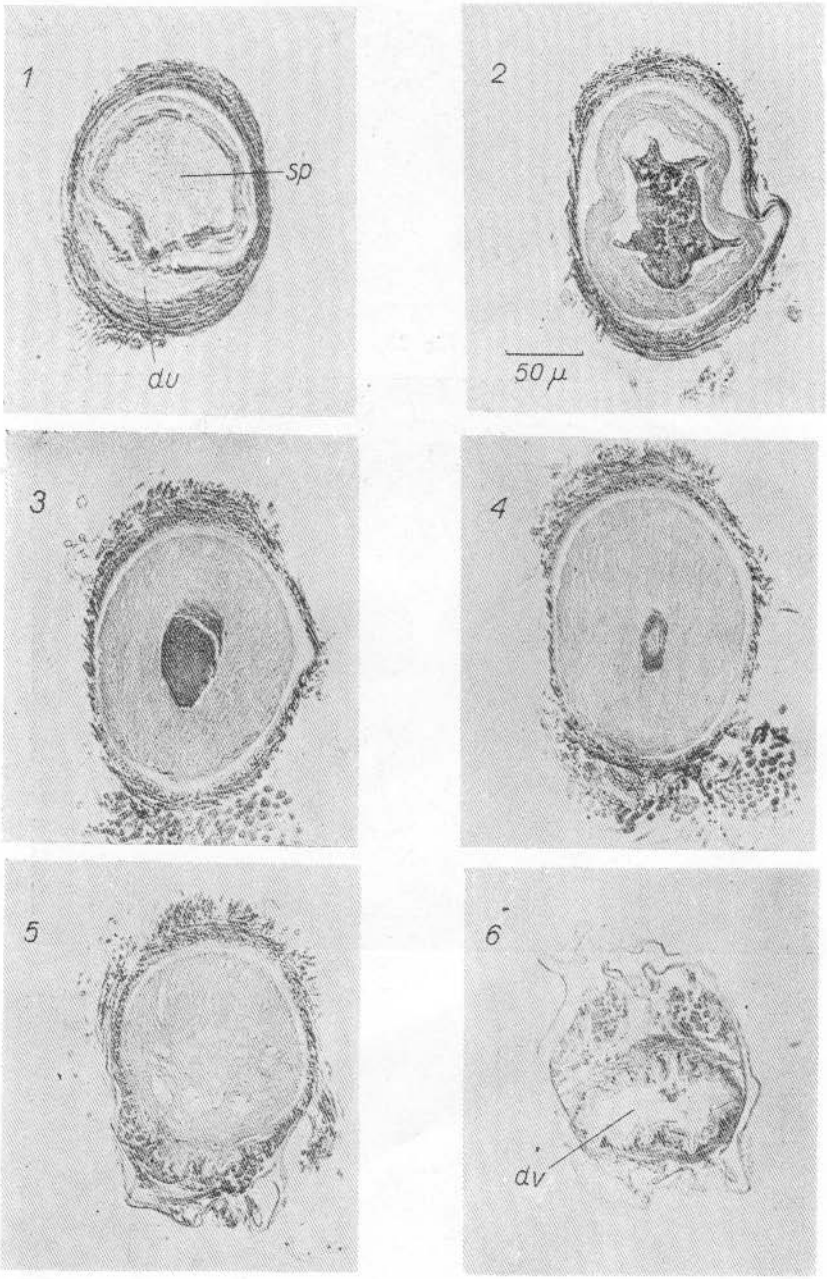


Fig. 12

TABLE VI

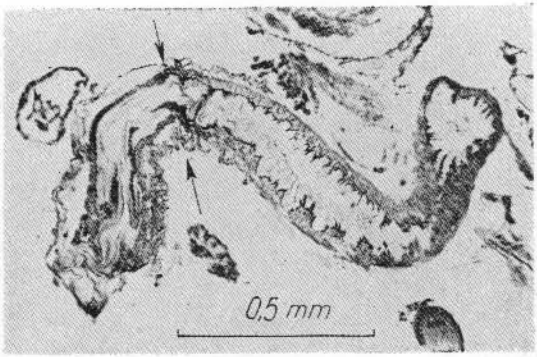


Fig. 13

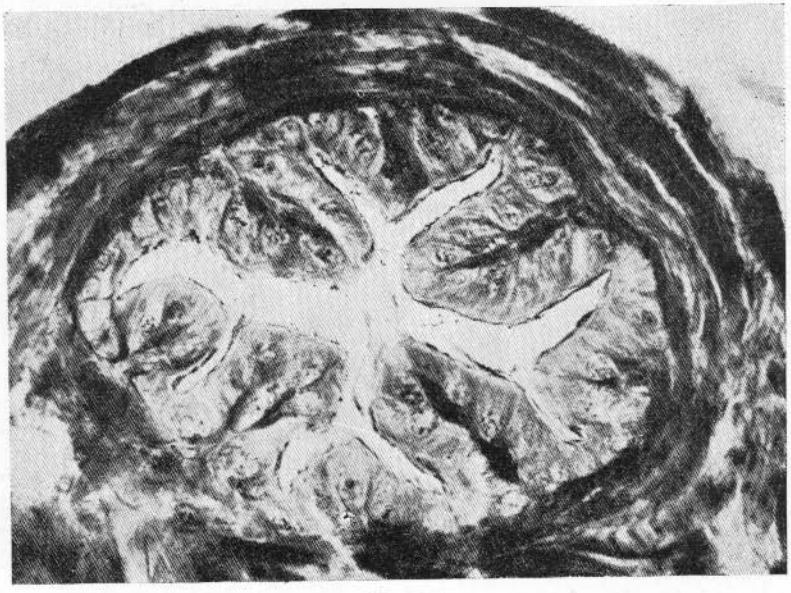
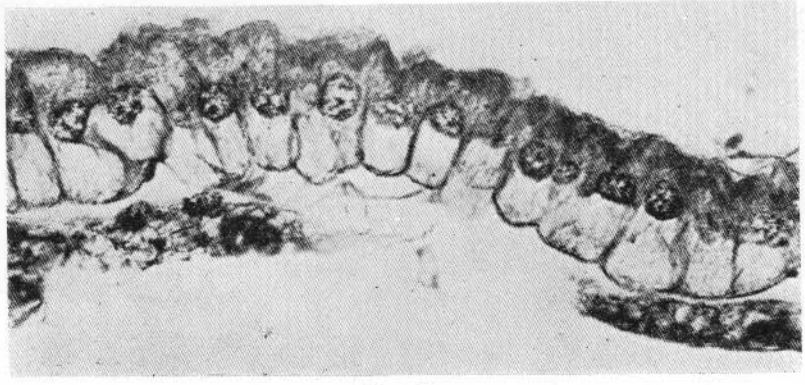


Fig. 14



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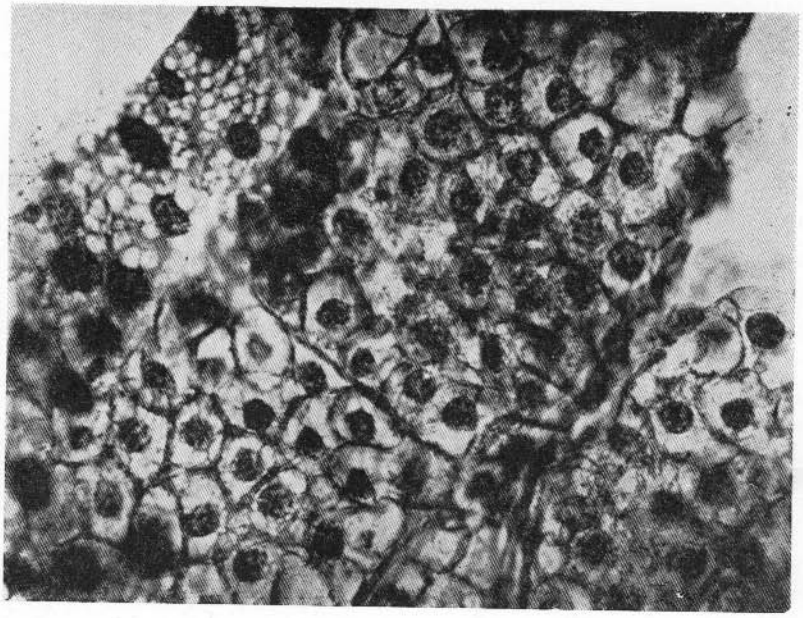

Fig. 16

Fig. 17

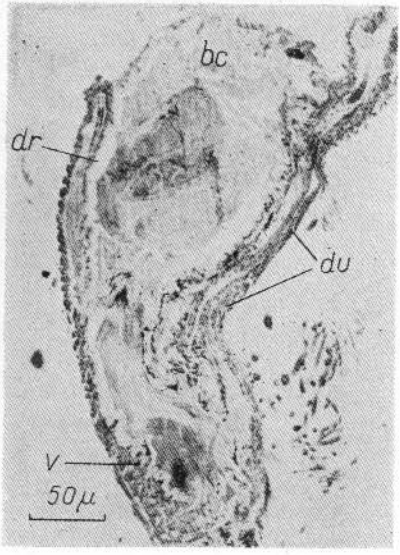

Fig. 18

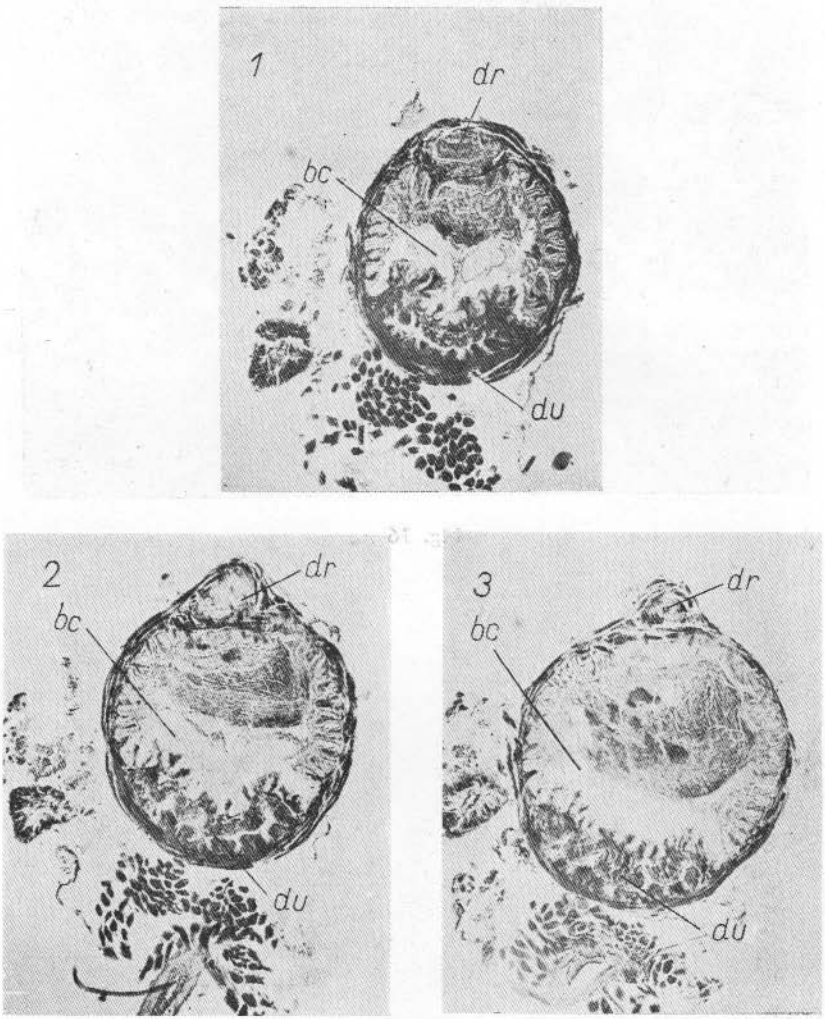

Fig. 19