# III—THE HYDATIDS OF MORGAGNI UNDER NORMAL AND EXPERIMENTAL CONDITIONS

*By* S. ZUCKERMAN* AND P. L. KROHN
*From the Department of Human Anatomy, Oxford*

(*Communicated by W. E. Le Gros Clark, F.R.S.—Received* 12 *January, Read* 29 *April* 1937)

[PLATES 15—20]

CONTENTS

## 1—INTRODUCTION

Anatomical investigations of the appendages attached to the testis and epididymis began with enquiries into the origin of the fluid found in hydrocoeles. MORGAGNI (1682–1771), who was the first to draw attention to these minute structures, was opposed to the hypothesis that the tunica vaginalis is a secreting membrane. In place of that view, he advocated the opinion (1769) that the fluid is derived from ruptured testicular and epididymal hydatids.

The several investigations which followed MORGAGNI's observations showed clearly that his designation of these bodies as hydatids is fundamentally incorrect. Partly because of alternative descriptions advanced by subsequent workers, and partly because the subject has not been seriously considered since the earlier years of the present century, textbook descriptions of the testicular and epididymal appendages vary greatly with respect to the number, nomenclature, topography and embryological

---

* Beit Memorial Research Fellow.

significance of these bodies. The following synthesis of available views regarding the hydatids in man provides a necessary background to the consideration of the corresponding structures in monkeys, from which the material for the experimental work recorded in this paper was obtained.

## 2—The Hydatids of Morgagni in Man

The appendages of the human testis and epididymis comprise (*a*) the so-called hydatids found on the upper pole of the testis and on the head of the epididymis, (*b*) certain occasional appendages of the rete testis and vasa efferentia, (*c*) the ductuli aberrantes (usually associated with the name of Haller) and (*d*) the paradidymis. In addition to these, Eberth (1904) refers to the occasional presence, in the tunica vaginalis, (*a*) of chromaffin tissue, (*b*) of ectodermal tissue which occurs in relation to vestiges of the Wolffian body found in the spermatic cord and on the epididymis, and (*c*) of some small vesicles derived from the serous tunic of the testis and epididymis. Diversity in description applies mainly to the appendages found on the upper pole of the testis and the head of the epididymis.

The paradidymis, or organ of Giraldès, which is situated on the spermatic cord immediately above the head of the epididymis,* is generally agreed to be homologous with the paroöphoron, and to be representative of blind caudal mesonephric tubules. There is also general agreement about the ductuli aberrantes, which vary in number, but of which one, situated near the junction of the epididymis and the ductus deferens, is fairly constant. They are generally stated to represent mesonephric tubules, or the fused collecting parts of such tubules (Felix 1912), which have effected a connexion with the Wolffian duct.

The confusion about the appendages associated with the name of Morgagni mainly concerns the question of their separate identity. Luschka (1854) first suggested that a pedunculated type of hydatid should be distinguished from a sessile kind. A sessile hydatid is usually found on the upper pole of the testis immediately below the head of the epididymis; two such bodies may occasionally be present in that situation. The position of the sessile hydatid (or hydatids) is not, however, constant, since similar hydatids may be found attached to the head of the epididymis. The pedunculated hydatid is invariably described as being attached to the head of the epididymis. It is not always single; as many as four such bodies have been found, attached close together on the head of the epididymis. A sessile hydatid is of more frequent occurrence than a pedunculated appendage. Thus it was present in ninety-three, and the pedunculated form only in twenty-nine, of 105 testes studied by Toldt (1891).

The so-called sessile hydatid is variable in size and appearance. It is usually red owing to a rich blood supply, and it consists of loose connective tissue covered by ciliated columnar epithelium. Numerous tubular ingrowths of its surface epithelium

---

* Felix (1912) makes the unusual statement that the paradidymis is situated between the testis and epididymis.

make it appear a somewhat glandular body. PIERSOL (1930) describes the surface as "dentated", and as suggesting "the fimbriated end of the oviduct in miniature". Not unusually the appendage contains a small duct whose lining epithelium of ciliated columnar cells may either be flat, or thrown into extensive folds. The duct is variable in its development. Usually it comprises only a small blind cyst, distension of which may flatten its lining epithelium. In rare instances it is relatively long and tortuous, and may open on the surface of the hydatid; even more rarely it may pass back through the pedicle of the hydatid to run laterally to, and as far caudally as the middle of, the body of the epididymis. As a rule, the duct, when present, ends either within or at the base of the pedicle.

The pedunculated hydatids characteristically appear in adults as small vesicles of inconstant shape attached by pedicles of varying length to the head of the epididymis. The vesicle is usually stated to be covered externally by a flattened, and internally by a columnar epithelium. It is also said that the pedicle, which may be as long as 10 mm., is never canalized.

The embryological derivation of the sessile hydatid from the Müllerian duct has been thoroughly established. This view was originally suggested by KOBELT in 1857, and is strongly supported by the evidence brought forward by WALDEYER (1877), by LÖWE (1879), by ROTH (1880) and by TOLDT (1891). On the other hand, there is little agreement about the embryological significance of the pedunculated hydatids (appendices epididymis). Certain authors, for example KOBELT, regard them as isolated, blind, mesonephric tubules. ROTH suggests that they represent the peritoneal funnels of pronephric tubules. WATSON (1902), again, states that they are derivatives of either the mesonephros or the anterior end of the Wolffian duct. None of these suggestions, however, is supported by adequate embryological evidence.

TOLDT has advanced an alternative view that the pedunculated hydatids are derived, like those that are sessile, from the cranial end of the Müllerian duct. According to him, they develop, in the manner first described by MIHALKOVICS (1885), as small excrescences of the funnel-like opening of the duct. Their development is intimately linked with that of the sessile hydatid, which in turn is derived from the funnel-like opening itself. TOLDT's view, which is accepted by EBERTH (1904), is well supported by the following facts. There are numerous "intermediate" forms between typical sessile and typical pedunculated hydatids. Indeed on the basis of their investigation of fifty-three testes, WRIGHT and BROWN (1912) declare that the histological structure of even typical specimens of the two classes of hydatid is identical. Furthermore, it is known that the degree to which a hydatid is sessile or pedunculated varies and that sometimes only pedunculated appendages can be found. The distinction between the testicular and epididymal appendages appears, in short, to be only a topographical one.

In earlier embryonic life the Müllerian duct always ends on the upper pole of the epididymis, where it develops as the "sessile appendage", and where it may bud off one or more "pedunculated" hydatids (Toldt). The "sessile" hydatid gradually moves downwards with the growth of the head of the epididymis, until it is eventually attached, as a rule, in the interval between the epididymis and the testis. The pedunculated hydatid, which has already budded off from the Müllerian duct, is not affected by the caudal shift of the sessile hydatid. Where more than one pedunculated hydatid is found—apparently a frequent occurrence in embryos—their ducts often communicate with each other (Eberth). It may be noted that the caudal shift of the sessile hydatid begins about the sixth or seventh month of embryonic life (Toldt), and that at this stage a part of the Müllerian duct, which may still be patent, is usually to be recognized on the lateral side of the body of the epididymis. It may also be noted that the most rapid rate of growth of the hydatids occurs in the first years of life, and that between the fourth and tenth years the appendages are at their maximum size. Their variable shape during maturity and later life is due, according to Toldt, not to continued growth but to variable degrees of distension occasioned by products of secretion.

The earlier investigators of the hydatids—Luschka, Lewin,* Becker* and Roth—described the occasional passage through the sessile hydatid of a vas aberrans which began either in the rete testis, in the vasa efferentia, or in a lobule of the epididymis. They also frequently reported the discovery of sperms within a duct—presumably such a vas aberrans—which opened on the surface of the hydatid. When fully patent, vasa aberrentia, which are generally believed to represent the remains of mesonephric tubules, permit the passage of spermatozoa, and as the ducts sometimes end blindly in the region of the head of the epididymis, they provide an anatomical basis for the development of sperm cysts in that region. Roth describes several instances of ducts passing either from the head of the epididymis or from a vas efferens into a sessile hydatid, and suggests that the occasional presence of sperms in the fluid of the tunica vaginalis is due to their passage through these ducts. Roth also points out that the ducts occasionally end blindly in sessile hydatids, which they can, by their distension, transform into sperm cysts. He also remarks on the occasional passage of two ducts through the same hydatid—the one a vas aberrans of the type described above, and the other the vestige of the Müllerian duct. Two such ducts have never been described as communicating. Richmond (1883) also refers to the combination in the sessile hydatid of Müllerian and Wolffian rudiments, stating that a minute fibrous body which is sometimes attached to the sessile hydatid is a derivative of the Wolffian body.

Considerable doubt has been cast on these observations by the failure of successive investigators to confirm them. Waldeyer (1877), for example, refers to his failure to demonstrate in any testis a connexion between a sessile hydatid and a seminiferous tubule. Toldt again, whose material comprised 132 testes, also records his failure to demonstrate such a connexion, or to find spermatozoa in any duct or cyst within the

---

* Quoted by Toldt.

sessile hydatid. GRIFFITHS (1893) also failed to find such a connexion, and he declares that all small spermatozoa-containing cysts originate in dilatations of the tubules of the coni vasculosi, and that all large cysts of similar character develop as dilatations of vasa efferentia.

We have discussed this matter somewhat fully, since in one of the specimens we ourselves examined (O.M. 135 B, p. 158) there undoubtedly was a connexion between a tubule of the epididymis and a hydatid whose form was typical of those that are derived from the cranial end of the Müllerian duct. The difficulty of explaining a communication between derivatives of the Müllerian and Wolffian ducts was fully realized by ROTH. According to him, however, such an intercommunicating vas aberrans is occasionally present in the female, and connects a fimbria of the Fallopian tube with the epoöphoron.* In spite of the fact that in normal development the Wolffian duct never communicates with the coelomic cavity, ROTH, following WALDEYER (1877), therefore found it necessary to postulate that the Wolffian and Müllerian ducts can form a secondary communication at their cranial ends—such as occurs normally in selachians.

The observations we have considered above may be summarized as follows. Usually one, occasionally two, and rarely more, minute appendages are attached to either the upper pole of the testis, to the tissue filling the interval between the testis and the head of the epididymis, or to the head of the epididymis. These structures are usually sessile, but may occasionally be pedunculated. Their form varies from minute cysts, lined by ciliated columnar epithelium, to small bodies closely resembling a miniature fimbriated end of a Fallopian tube. Every form of hydatid which falls under this general description is in all likelihood derived from the cranial end of the Müllerian duct. Occasionally the hydatids may be traversed by a duct, arising from either the head of the epididymis or from the vasa efferentia, which is embryologically related to the Wolffian system.

## 3—THE HYDATIDS OF MORGAGNI IN MONKEYS

Little is known of the appendages of the testis and epididymis in mammals other than man. GRIFFITHS (1893) states that he found a hydatid of Morgagni only in the horse, but he does not mention the number of types he investigated. CURLING (1852) compares the sessile hydatid with "the remarkable omental processes attached to the superior part of the testicle in the Rodentia and other animals". The literature apparently does not contain any mention of the occurrence of these structures in subhuman primates. None, for example, occurs in SONNTAG's work on the morphology of the apes (1924) or in the volume on the anatomy of the rhesus monkey edited by HARTMAN and STRAUS (1933).

---

* Called by ROTH "paroöphoron". His figures make it clear that he meant the epoöphoron.

The material available for investigation in the present study comprised the testes of:

One langur (*Presbytis entellus*).
One green monkey (*Cercopithecus aethiops sabaeus*).
Eighty-two rhesus macaques (*Macaca mulatta*).
Two pig-tailed macaques (*Macaca nemestrina*).
One common macaque (*Macaca irus*).
One mandrill (*Mandrillus sphinx*).
One drill (*Mandrillus leucophaeus*).
One guinea baboon (*Papio papio*).
One common marmoset (*Hapale jacchus*).

Testicular and epididymal appendages (hydatids of Morgagni) were found in all nine species investigated.

Certain of the testes studied were recovered from animals that had not been subjected to any experimental procedures connected with the physiology of the reproductive organs. The remaining specimens were taken from animals which for varying periods previous to autopsy had been injected with sex hormones or related substances. The primary purpose of these injections, which are indicated in Table I, was the investigation of the endocrine control of the prostate.

TABLE I—LIST OF ANIMALS WHOSE HYDATIDS OF MORGAGNI WERE STUDIED. THE FIGURES GIVE THE NUMBER OF NORMAL SPECIMENS, AND SPECIMENS WHICH HAD BEEN INJECTED WITH THE SUBSTANCES NOTED IN THE COLUMN HEADS

| Species | Normal | Oestrone | Male hormone | Progesterone | Extract of anterior pituitary | Oestrone and male hormone | Oestrone and progesterone | Oestrone and cholesterol | Oestrone and epicholestanol |
|---|---|---|---|---|---|---|---|---|---|
| *Presbytis entellus* | — | 1 | — | — | — | — | — | — | — |
| *Cercopithecus aethiops sabaeus* | 1 | — | — | — | — | — | — | — | — |
| *Macaca mulatta* | 17 | 17 | 3 | 2 | 3 | 20 | 12 | 6 | 2 |
| *Macaca nemestrina* | 2 | — | — | — | — | — | — | — | — |
| *Macaca irus* | — | 1 | — | — | — | — | — | — | — |
| *Mandrillus sphinx* | 1 | — | — | — | — | — | — | — | — |
| *Mandrillus leucophaeus* | — | 1 | — | — | — | — | — | — | — |
| *Papio papio* | 1 | — | — | — | — | — | — | — | — |
| *Hapale jacchus* | 1 | — | — | — | — | — | — | — | — |

The hydatids of the langur, one of the pig-tailed macaques, the mandrill, the marmoset, and thirty-one of the rhesus monkeys were studied under the dissecting microscope. Those of the langur, the green monkey, the two pig-tailed macaques, the common macaque, the drill, the Guinea baboon, and sixty-one rhesus monkeys were studied histologically. After fixation in Bouin's fluid, the hydatids, together with a piece of testis and epididymis, were removed and serially sectioned at 10 $\mu$. Most of the sections were stained with haemalum and eosin. A representative series was also stained with iron haematoxylin and van Gieson. Like the specimens studied histologically, those examined under the dissecting microscope had been fixed in Bouin's fluid.

A paradidymis was not seen in any specimen, but as no special steps were taken to demonstrate it, our failure to do so does not imply that it is invariably absent. Ductuli aberrantes were not sought for, and the only appendages seen were those which come under the definition of hydatids of Morgagni.

## *The Rhesus Monkey* (Macaca mulatta)

### (*a*) *Macroscopic Observations.*

Hydatids are found attached to the head and to the body of the epididymis (179 R, fig. 1, Plate 15), to the serosa between the head of the testis and the epididymis (148 R, fig. 1, Plate 15), and to the testis itself (151 R, fig. 1, Plate 15). The way they are attached provides no basis for differentiating between epididymal and testicular appendages, for the degree to which hydatids are sessile or pedunculated varies considerably, and extremes of both types are found attached to both the testis and the epididymis. On this point our histological observations are fully in accord with those made with the help of the dissecting microscope. It is also idle to try to differentiate the hydatids on the basis of their sites of attachment, since precisely the same types of appendage, both in general form and histological structure, are found on the testis and the epididymis.

When present on the testis, the hydatids are almost invariably attached to its upper pole, and often in relation to the fold of serosa that constitutes the superior ligament of the epididymis. Sometimes the pedicle of a hydatid attached in this region passes into what appears to be a duct connecting the testis and the head of the epididymis (170 R, 148 R, fig. 1, Plate 15). Histological examination generally failed to show that this "duct" is canalized. Appendages of the epididymis are almost always attached to the inferior margin of its head and to its antero-lateral border. Under the dissecting microscope a slightly raised ridge, with which the pedicle of a hydatid may be continuous, is sometimes seen on the extreme lateral margin of the body of the epididymis (163 R, 179 R, fig. 1, Plate 15). This ridge evidently represents the obliterated Müllerian duct. Its histological character is considered in a later section.

The most usual point of attachment of an epididymal appendage is the region of the junction between the head and body of the epididymis, where the "Müllerian ridge", when present, usually ends (179 R, fig. 1, Plate 15). The second most frequent point of attachment is the lower end of the body, at the caudal end of the ridge (170 R, fig. 1, Plate 15). Occasionally vesicular swellings can be seen on the presumed obliterated duct (163 R, 179 R, fig. 1, Plate 15); these vesicles may be raised to form small pedunculated hydatids. Hydatids also occur on the antero-inferior margin of the head of the epididymis. Very rarely they may be found on the testicular surface of either the head or the upper part of the body (163 L), such appendages projecting into the sinus of the epididymis which, too, is very inconstant in its appearance (fig. 5, Plate 16).

As a general rule only one hydatid is present on each testis and epididymis. Not more than two were seen on any of the present specimens. There was no trace of a hydatid on eleven of the sixty testes examined under the dissecting microscope, and in all, fifty-nine hydatids were found in this series of testes. Thirty-eight of these were attached to the epididymis, and twenty-one to the testis or to the superior ligament of the epididymis. When present on both testes of a single animal, hydatids are occasionally attached in corresponding places.

The hydatids vary in form from small knob-like bodies to relatively large foliated structures of completely irregular shape. Their pedicles are very variable in length, and in size the hydatids range according to the dimensions given in Tables III, IV, and V. As will be shown later, those hydatids removed from animals which had been injected with oestrone are generally larger than those removed from normal monkeys, a difference which is sometimes obvious to direct observation. The only testes on which hydatids were not found under the dissecting microscope were those of uninjected animals. It is not unlikely that hydatids, which normally would be invisible under a dissecting microscope, become large enough to be seen after stimulation with oestrone.

It is usually stated that the hydatids found in man decrease in size with age. Whether or not similar age changes occur in the rhesus monkey could not be determined with the available material.

The following hydatids are of special interest:

*O.M.* 151. *Right testis* (151 R, fig. 1, Plate 15)—Two hydatids, the one somewhat larger than the other, were attached to the upper pole of the testis slightly in front of the head of the epididymis. The appendages, which were 3 mm. apart, had short pedicles, that of the larger emerging from what might be termed a hilum (cf. 170 R, fig. 1, Plate 15). The pedicles were duct-like in appearance, and passed into a raised tubular ridge on the testis. The ridge extended on either side beyond the attachment of the hydatid, and blended with the serosa covering the tunica albuginea. Histological examination showed that this ridge was not canalized. The larger and fimbriated hydatid was divided into three fairly separate lobules by relatively deep clefts, and its surface was pitted by the openings of numerous glands.

Two hydatids were present on the left testis, but only one was attached to the testis itself, the second appendage being connected to the epididymis at the junction of the body and the tail.

*O.M.* 163. *Left testis*—Towards the lateral side of the inferior surface of the head of the epididymis, under which it is completely hidden from view, was a large bilobed sessile hydatid with serrated margins and a pitted surface (fig. 5, Plate 16).

*O.M.* 179. *Right testis*—Two knob-like slightly pedunculated hydatids were attached to the antero-lateral border of the epididymis, the one at the junction of the body and head, the other at the junction of the body and tail. In between the two was to be seen the apparent remains of an obliterated duct. A canal which may have been the remains of the Müllerian duct was actually present in this ridge (see below).

### (*b*) *Microscopic Observations.*

As in man, the Müllerian duct may be represented in the male rhesus monkey by appendages which vary from simple tags of fibro-muscular tissue to bodies with a complex epithelial structure. In order to simplify their histological description we have therefore subdivided the hydatids into four types.

*Type I*—The first type comprises small tongues of fibro-muscular tissue covered by flattened epithelium that is continuous with the serosa covering the testis and epididymis.

*Type II*—Type II comprises small bodies which in general structure are similar to those defined as Type I, but which enclose a central duct lined by columnar epithelium.

*Type III*—This type of appendage is composed of loose fibro-muscular tissue covered by ciliated columnar epithelium. A definite central duct is not enclosed within this type of hydatid.

*Type IV*—The fourth type of hydatid is similar in structure to the third, and in addition encloses a central duct of variable complexity.

The relative frequency of these types of appendage is indicated in Table II. In this table the specimens are separately grouped according to the experimental treatment given the animals from which they were recovered.

TABLE II—THE DIFFERENT TYPES OF HYDATID OF MORGAGNI IN THE RHESUS MONKEY AS DETERMINED FROM SERIAL SECTIONS. THE SPECIMENS ARE SEPARATELY GROUPED ACCORDING TO THE EXPERIMENTAL TREATMENT GIVEN THE ANIMALS FROM WHICH THEY WERE RECOVERED.

*Type I*—Fibro-muscular tags.
*Type II*—Fibro-muscular bodies containing a central cyst lined by columnar cells.
*Type III*—Fibro-muscular bodies covered by columnar epithelium.
*Type IV*—Similar to Type III, but containing a central cyst lined by columnar epithelium.

| | Types | | | | |
|---|---|---|---|---|---|
| | I | II | III | IV | Total |
| Normal | 2 | 0 | 9 | 3 | 14 |
| Oestrone | 1 | 1 | 13 | 10 | 25 |
| Oestrone and delay* | 0 | 0 | 1 | 2 | 3 |
| Male hormone | 0 | 0 | 3 | 1 | 4 |
| Progesterone | 0 | 0 | 2 | 1 | 3 |
| Anterior pituitary | 0 | 0 | 3 | 3 | 6 |
| Oestrone and male hormone | 0 | 5 | 8 | 9 | 22 |
| Oestrone and progesterone | 2 | 6 | 9 | 4 | 21 |
| Oestrone and cholesterol | 0 | 0 | 5 | 3 | 8 |
| Oestrone and epicholestanol | 0 | 0 | 2 | 0 | 2 |
| Totals | 5 | 12 | 55 | 36 | 108 |

* Animals autopsied 11 and 20 days after the cessation of a course of oestrone injections.

*Type I*—Little need be said about the structure of appendages of this kind beyond the fact that they comprise minute tag-like condensations of fibro-muscular tissue whose covering of flattened epithelial cells, which is continuous with the visceral layer of the tunica vaginalis, sometimes appears to be deficient.

*Type II*—Hydatids of this type are usually attached to the antero-lateral margin of the epididymis. When present in conjunction with an appendage belonging to Type III or Type IV they are more caudally disposed on the epididymis.

As a rule they comprise fairly close condensations of fibro-muscular tissue, which is irregularly covered by flattened epithelial cells, and which encloses a blind duct lined by columnar epithelium (figs. 3 and 4, Plate 16). The muscle fibres immediately surrounding the duct are usually circularly disposed. The duct is lined by a single layer of columnar epithelium which is set on a well-defined basement membrane. In many sections the cells lining the duct appear to be ciliated. Usually too, the duct epithelium is regularly disposed, but in two specimens (O.M. 42 C and 160 R) it was folded in a manner reminiscent of the epithelial foldings of the Fallopian tube. The "duct" is often merely a blind cyst containing some secretion, and in such cases its epithelium may be flattened. Both the epithelium of the central duct and the muscle fibres of this type of hydatid respond in the same way to the injection of oestrone as do the hydatids of Types III and IV (see below).

There can be little doubt that epididymal appendages of the above kind are persistent parts of the Müllerian duct itself. Thus the vesicular swellings of the ridge found on the antero-lateral border of the epididymis are invariably of this form. Fig. 4, Plate 16, for example, is a photomicrograph of the swelling seen on the lower part of the antero-lateral border of the epididymis of O.M. 163 R, fig. 1, Plate 15. Similar structures were seen on both sides in O.M. 161. The "Müllerian" ridge itself is rarely canalized. O.M. 179 R, fig. 1, Plate 15, shows a testis with a small fimbriated appendage on the upper part of the lateral border of the epididymis, and a vesicular swelling some distance below it. The upper hydatid has a relatively long non-canalized pedicle, and in form it is similar to hydatids of Type III. The lower swelling is merely a blind duct 0·5 mm. long and 0·2 mm. in widest diameter. The ridge intervening between the upper hydatid and the vesicular swelling was also sectioned but a properly differentiated duct was not found within it. It does, however, contain a vertical channel of minute diameter, blind at both ends, and some 0·5 mm. in length. This duct is lined by irregularly disposed cuboidal epithelium, which in places is wanting. It neither contains any blood cells nor communicates with any obvious vascular or lymphatic channels. While it is impossible to decide with certainty about the identity of this channel, there is a strong likelihood that it also represents part of the Müllerian duct.

In only one specimen, O.M. 151 R, fig. 1, Plate 15, was an appendage of Type II not in relation to the antero-lateral border of the epididymis. The macroscopic appearance of this testis has been detailed above (see p. 154). The smaller of the two hydatids on this testis proved to be a hollow fibro-muscular body covered only by flattened serous epithelium. The fibrous ridge to which its pedicle was attached is not canalized. The second hydatid was also attached to this ridge, and is of the kind referred to as Type III.

The tubular structure to which testicular hydatids are sometimes connected (O.M. 148R, O.M. 170R, fig. 1, Plate 15), and which generally passes in the superior epididymal ligament between the testis and the epididymis (see p. 153), was found to be canalized in only one specimen, O.M. 160R. Fig. 2, Plate 16, shows the hydatid in question attached to a fibrous band (superior epididymal ligament) passing between the testis and the head of the epididymis. In this band is a blind cyst, 0·8 mm. long and 0·5 mm. in diameter, whose epithelium is slightly folded. A few millimetres distal to this cyst there is a second cyst, similar in size and structure, lying in the fibrous tissue between the testis and the epididymis (fig. 3, Plate 16).

*Type III*—Most testicular and epididymal appendages are of the kind defined as Type III. An appendage which comes under this definition has a non-canalized pedicle of variable length which is covered by a flattened epithelium that is continuous with the serosa of either the testis or the epididymis, depending on its site of attachment. The hydatid itself is usually leaf-like in section, and comprises a vascular fibromuscular stroma covered by columnar epithelium (figs. 8, 9, and 10, Plate 17) that is sharply differentiated from the flat epithelium of the pedicle (fig. 16, Plate 18). The separate elements of the stroma are relatively widely dispersed in monkeys that have not been injected with oestrone, and the vascular channels, which can frequently be traced to the base of the surface epithelium (fig. 20, Plate 19), are conspicuous and widely dilated. The surface epithelium consists of a moderately high and sometimes irregular layer of columnar cells set upon a definite basement membrane. The nuclei are relatively large (figs. 17 and 18, Plate 19), and in many sections the glandular and surface cells appear ciliated (cf. fig. 19, Plate 19). Mitotic figures are rarely present in the epithelium of hydatids removed from normal control animals. In many specimens the surface epithelium dips into the stroma to form tubular glands of varying depth (fig. 12, Plate 17), but like the surface epithelium, the glandular cells are rarely found to be secreting in hydatids recovered from normal control animals.

*Type IV*—The thirty-six hydatids of this type have the same general character as Type III, but in addition they enclose a central duct. The epithelium of the duct forms an even layer in thirty of the thirty-six specimens, and is thrown into folds reminiscent of those of the Fallopian tube in the remaining six (fig. 14, Plate 18). In three of the latter six, and four of the thirty, the duct passes completely through the hydatid to open into the sac of the tunica vaginalis (fig. 11, Plate 17; fig. 16, Plate 18). The duct frequently penetrates deeply into the pedicle (cf. figs. 13 and 15, Plate 18), and in a few cases reaches into epididymal tissue beyond the point of pedicular attachment.

In two specimens (O.M. 124 and O.M. 144), two separate central ducts were found in a single hydatid, one duct being confined to the pedicle, and the second to the body of the hydatid. Presumably both represent separated parts of the embryonic Müllerian duct. Sometimes the central duct is much coiled and bent. In one specimen, O.M. 143A, the two ends of a blind duct almost meet to form a tubular ring. In two other specimens (O.M. 23 and O.M. 36) the hydatid contains a solid mass of epithelial cells—presumably derived from the epithelium of an obliterated part of the Müllerian duct. In one of these specimens (O.M. 23) a patent central duct is also present.

As a general rule, and almost always when the duct is well developed, the duct epithelium is surrounded by a condensation of circularly disposed muscle fibres. The epithelium of the duct is composed of columnar cells, between which leucocytes may occasionally be seen passing. In specimens that have not been subjected to the influence of oestrone, little secretion is present, and the nuclei are relatively large. A delicate vascular stroma supports the duct epithelium when it is thrown into folds. The resemblance of a hydatid to a minute Fallopian tube can be very close, as for example M.M. 18, fig. 14, Plate 18, in which a well-differentiated duct ends by traversing a cap of fibro-muscular tissue that is covered by ciliated columnar epithelium.

The following three hydatids present unusual characters:

*O.M.* 109*B*—The blind central duct of this specimen extends back through the pedicle and ends deeply in the midst of lobules of the epididymis.

*O.M.* 23*A*—This hydatid contains a blind central cyst which is situated between lobules of the epididymis, and which extends slightly into the pedicle. The pedicle also contains a solid mass of epithelial cells that are presumably derived from the obliterated Müllerian duct. Some of these cells are disposed in the form of non-canalized tubular glands.

*O.M.* 135*B*—As noted earlier on, a duct of Müllerian origin which opens on the surface of a human hydatid of Morgagni may on rare occasions communicate with a seminiferous tubule. The hydatid found on the left testis of O.M. 135 presented a similar anomaly.

The hydatid is of the kind described as Type IV, and comprises a fibro-muscular stroma with an indented surface covered by high columnar epithelium. The base of the hydatid is attached to a relatively large cyst formed by the expansion of one end of a highly convoluted epididymal tubule (fig. 25, Plate 20). This epididymal tubule does not communicate with the vas deferens, and by definition it must be regarded as a vas aberrans of the head of the epididymis.

Passing through the hydatid is a duct which at its one extremity opens on the surface of the hydatid into the tunica vaginalis, and at its other opens into the cyst of the vas aberrans. In order to study these relations tracings were made of projections of each section of the serially sectioned specimen.

The aberrant conus vasculosus is 2·31 mm. in greatest diameter (fig. 22, Plate 20). The maximum diameter of the ovoid cyst it contains is 2·09 mm., its transverse diameter being 1·6 mm. The tubule of the abnormal conus vasculosus cannot be differentiated under the low power of the microscope from that of any normal epididymal lobule. Its epithelium is composed of moderately high columnar cells which are set upon a definite basement membrane and which have basally disposed nuclei. Under the high power of the microscope, however, the epithelium of the vas aberrans can be distinguished from that of normal epididymal tissue by the diffuseness of its inner borders, a change which was probably due to the greater pressure that existed within the aberrant lobule. The epithelium of the cyst is in general somewhat flattened.

The cyst becomes somewhat abruptly constricted about 0·5 mm. from the pole opposite the entry of the vas aberrans. Its muscular wall in the region of constriction is markedly thicker than elsewhere, and its epithelium is unusually high, and more obviously ciliated. In most places the epithelium in this region is either heaped or thrown into folds (fig. 26, Plate 20). Stromal tissue extends only into the proximal parts of the folds, whose free ends consist of cells lying end to end and separated only by opposed basement membranes.

The interior of the large cyst is empty; whatever material it might once have contained would have been washed out, however, during the process of histological preparation.

Lying lateral to the distal constricted part of the cyst are two much smaller intercommunicating blind cysts, each containing several leucocytes (fig. 26, Plate 20). These smaller cysts have a maximum diameter of 0·25 mm., and neither communicates with the main cyst from which they presumably budded. Their epithelium is cuboidal.

The general structure of the hydatid itself does not require special description. The tall ciliated columnar epithelium of its central duct is continuous both with that covering the surface of the hydatid (fig. 23, Plate 20) and with that lining the epididymal cyst (fig. 25, Plate 20). The duct makes a right-angle bend before it opens on the surface of the hydatid.

The central duct is identical in appearance with those that usually end blindly within a hydatid, and there is no reason to question its Müllerian origin. The epididymal nature of the structure which has been described as a vas aberrans is equally plain, and consequently it is necessary to draw the conclusion that in this specimen structures derived from the Müllerian and Wolffian ducts respectively communicate with each other. Available data provide no safe ground for speculating on the phylogenetic significance of such a communication, and in the circumstances the present abnormality should be regarded, as WALDEYER and ROTH regarded corresponding human anomalies, as a secondary communication between the Müllerian and Wolffian ducts.

### *Species other than* Macaca mulatta

### (*a*) *Macroscopic Observations.*

The hydatids found in species of monkey other than the rhesus macaque (*Macaca mulatta*) appear to have the same topographical relations, general form, and histology. They are accordingly only briefly described.

*O.M.* 82. *Presbytis entellus*, Hanuman langur. Immature animal. O.M. 82R, fig. 1, Plate 15—A faintly marked ridge is present on the antero-lateral margin of the body of the epididymis. The "Müllerian" ridge ends below at the junction of the body and tail of the epididymis, and at its termination is attached a flat and oval hydatid with serrated margins. A corresponding hydatid is present on the opposite testis, to the upper pole of which a second appendage is connected by a long pedicle.

*P.* 5. *Macaca nemestrina*, pig-tailed macaque. Mature animal—Attached laterally to the lower margin of the head of the epididymis is a small wart-like hydatid which is divided by clefts into numerous folds. The base of the hydatid is attached to a ridge which seems to represent an obliterated duct, the ridge continuing caudally in the antero-lateral border of the epididymis, and medially along the inferior margin of the head of the epididymis. Microscopic examination showed that the ridge is not canalized. A somewhat similar hydatid is present on the opposite side.

*Mandrillus sphinx*, mandrill. Mature animal—A thin foliated hydatid is attached by a long pedicle to the superior ligament of the epididymis. Two somewhat hemispherical excrescences are present on the testis in the region where the pedicle is connected. A smaller but somewhat similar hydatid is present on the opposite side.

*O.M.* 51. *Hapale jacchus*, common marmoset. Mature animal—On the left side a relatively large and flattened sessile hydatid is attached by a broad base to the superior epididymal ligament, through which it gains attachment to both the testis and the lower part of the head of the epididymis. Two hydatids are present on the opposite side, one being attached to the testis, the other to the epididymis.

### (*b*) *Microscopic Observations.*

*O.M.* 82. *Presbytis entellus*, Hanuman langur. Immature animal—The hydatid shown on the lower part of the epididymis of O.M. 82R, fig. 1, Plate 15, is similar in structure to Type IV of the rhesus monkey. It encloses both a minute central duct which opens on its surface (fig. 6, Plate 16), and a blind cyst which is situated more deeply, close to the point where the pedicle of the hydatid is attached to the "Müllerian ridge". About 1 mm. cranial to the point of attachment of the hydatid, the ridge contains a blind duct 0·23 mm. long, which is lined by cuboidal cells (fig. 7, Plate 16). The two deeply lying ducts neither communicate with each other nor with the duct that opens into the sac of the tunica vaginalis; there cannot, however, be any doubt that they all represent parts of the Müllerian duct.

*O.M.* 35. *Cercopithecus aethiops sabaeus*, green monkey. Immature animal—A large hydatid was attached to the tunica of the testis, and in general character it is the same as the fourth type of rhesus hydatid. There are fewer indentations of the surface epithelium, but the hydatid contains a central duct which passes from its pedicle and opens on its surface into the sac of the tunica vaginalis. The duct bent abruptly on itself before passing to the surface (fig. 11, Plate 17).

*P.* 6. *Macaca nemestrina*, pig-tailed macaque. Mature animal—On the right side a large hydatid, divided by deep clefts into several lobes, was attached to the fibrous tissue between the testis and the head of the epididymis. On the left a similar appendage was connected by a long pedicle to the epididymis. The left hydatid contains a central duct, lined by regularly disposed epithelium which opens into the sac of the tunica vaginalis. The inactive low columnar epithelium covering this hydatid is shown in fig. 17, Plate 19.

*O.M.* 34. *Macaca irus*, common macaque. Immature animal—No hydatid was found on the right testis. A small appendage similar to the third type of rhesus hydatid was attached in the angle between the left testis and epididymis.

*M.M.* 22. *Papio papio*, Guinea baboon. Immature animal—A single hydatid was attached to the antero-lateral margin of the head of the epididymis. In general character it is the same as the fourth type of rhesus hydatid. The central duct is blind, and its epithelium is folded.

*O.M.* 114. *Mandrillus leucophaeus*, drill. Immature animal—A single hydatid was attached on each side in the angle between the testis and the head of the epididymis. Both hydatids contain a large central duct lined by folded epithelium, which is separated by a distinct basement membrane from a condensation of circularly disposed muscle fibres. On the right side the duct opens into the sac of the tunica vaginalis.

## 4—The Effect of Sex Hormones on the Hydatids of Morgagni

The thickness of each of the 108 hydatids that were serially cut was estimated from the number of sections in which it appeared; the greatest cross-sectional area of each hydatid was calculated from projections on to squared paper. The figures obtained, as well as their products, provide rough measures of the sizes of the hydatids in the various experimental groups studied. The hydatids are arranged in the following tables according to age, the ages of the animals being estimated on the basis of Schultz's figures for weight-age and dentition-age relationships in the rhesus monkey (1933, 1935).

### (*a*) *Gonadotropic extract of Anterior Pituitary*

Six hydatids were recovered from three animals that had been injected with 20 mg. of anterior pituitary extract daily, injections being continued for 24 days in the case

TABLE III—DIMENSIONS OF NORMAL HYDATIDS ARRANGED ACCORDING TO APPROXIMATE AGES OF ANIMALS FROM WHICH THEY WERE RECOVERED

| No. of animal | Species | Weight (g.) | Age (months) | Thickness of hydatid (mm.) = *a* | Max. cross-sectional area (sq. mm.) = *b* | Size index = *ab* |
|---|---|---|---|---|---|---|
| O.M. 112 | *Macaca mulatta* | 1000 | 18 | 0·78 | 2·1 | 1·6 |
| O.M. 118 | ,, | 1300 | 19 | 0·4 | 3·2 | 1·3 |
| O.M. 38A | ,, | 2360 | 24 | 0·29 | 6·5 | 1·9 |
| O.M. 38B | ,, | 2360 | 24 | | Minute | |
| O.M. 39A | ,, | 2700 | 28 | | Minute | |
| O.M. 39B | ,, | 2700 | 28 | | Minute | |
| O.M. 124B | ,, | 2840 | 30 | 0·85 | 6·0 | 5·1 |
| M.M. 27A | ,, | 2700 | 32 | 0·46 | 3·9 | 1·8 |
| M.M. 27B | ,, | 2700 | 32 | 0·32 | 12·2 | 3·9 |
| O.M. 163B | ,, | — | 40 | 0·74 | 10·35 | 7·7 |
| O.M. 89 | ,, | 4200 | 44 | 1·0 | 19·6 | 19·6 |
| O.M. 90A | ,, | 5000 | 50 | 0·5 | 4·2 | 2·1 |
| O.M. 90B | ,, | 5000 | 50 | 0·35 | 3·6 | 1·3 |
| O.M. 20 | ,, | 6720 | *c.* 120 | 1·64 | 78·3 | 128·0 |
| M.M. 22 | *Papio papio* | — | 26 | 0·77 | 43·8 | 33·7 |
| O.M. 35 | *Cercopithecus aethiops sabaeus* | — | Immature | 1·61 | 17·8 | 28·7 |
| P. 6 A | *Macaca nemestrina* | — | Mature | 2·38 | 58·5 | 139·2 |
| P. 6 B | ,, | — | Mature | 2·2 | 76·5 | 168·3 |

TABLE IV—DIMENSIONS OF HYDATIDS AFTER INJECTION OF GONADOTROPIC EXTRACT OF ANTERIOR PITUITARY, MALE HORMONE, OR PROGESTERONE, ARRANGED ACCORDING TO THE APPROXIMATE AGES OF THE ANIMALS STUDIED

| No. of animal | Weight (g.) | Approx. age (months) | Substance injected | Amount of substance injected daily (mg.) | Days injected | Thickness of hydatid (mm.) = *a* | Max. cross-sectional area (sq. mm.) = *b* | Size index = *ab* |
|---|---|---|---|---|---|---|---|---|
| O.M. 81A | 2480 | 22 | Gonadotropic extract of anterior pituitary | 20 | 24 | 0·52 | 5·0 | 2·6 |
| O.M. 81B | 2480 | 22 | | 20 | 24 | 0·6 | 7·3 | 4·4 |
| O.M. 66A | 3060 | 23 | | 20 | 15 | 1·41 | 139·3 | 196·4 |
| O.M. 66B | 3060 | 23 | | 20 | 15 | 1·14 | 66·0 | 75·2 |
| O.M. 65A | 3260 | 32 | | 20 | 15 | 0·45 | 4·6 | 2·1 |
| O.M. 65B | 3260 | 32 | | 20 | 15 | 0·63 | 4·5 | 2·8 |
| M.M. 24A | 1800 | 20 | Male hormone preparation | 10 | 10 | 0·38 | 14·3 | 5·4 |
| M.M. 24B | 1800 | 20 | | 10 | 10 | 0·25 | 9·2 | 2·3 |
| O.M. 67 | 2700 | 24 | | 5 | 12 | 0·75 | 17·5 | 13·1 |
| O.M. 47 | 2680 | 24 | | 5 | 28 | 0·44 | 10·6 | 4·7 |
| O.M. 52 | 3220 | 37 | Progesterone | 0·3 | 14 | 0·7 | 5·8 | 4·1 |
| O.M. 48A | 4560 | 48 | | 0·5 | 14 | 0·57 | 6·6 | 3·8 |
| O.M. 48B | 4560 | 48 | | 0·5 | 14 | 0·6 | 4·3 | 2·6 |

of one animal (O.M. 81) and for 15 days in the case of the other two (O.M. 65 and O.M. 66). The dimensions of the hydatids are given in Table IV. Those removed from O.M. 66 are relatively enormous, but on the available data this fact must be regarded as an individual anomaly, and in the main not an effect of the injections. The other hydatids are slightly larger than normal (Table III), but whether the slight difference is significant is doubtful.

Histologically the hydatids appear to be little, if at all, different from the normal. Those recovered from O.M. 65 and from O.M. 81, the animal which had received most of the hormone, show no definite distinguishing characteristics. Those of O.M. 66 contain large central ducts, and the epithelium of the right duct, which opens into the sac of the tunica vaginalis, is extensively folded. A few mitotic figures were seen in the epithelium of this duct, and one dividing cell was found in the surface epithelium. The nuclei of the more superficial stromal cells are somewhat swollen, and there is a layer of amorphous eosinophilic extracellular material beneath the surface epithelium. It is, however, unlikely that the individual characteristics of these two hydatids were the result of the anterior pituitary injections; the other four hydatids recovered from animals that had been similarly treated resemble those of O.M. 66 far less than they do the hydatids of normal animals.

### (*b*) *Male Hormone*

The four hydatids removed from monkeys that had been injected with male hormone (M.M. 24, O.M. 67, O.M. 47) are not distinguishable from normal specimens. The dimensions of the hydatids are given in Table IV. While the wide variability in the dimensions of the normal appendages (Table III) precludes close comparison with those of other series, it is plain that the hydatids had not increased in size as a result of the injections. None of the specimens provides any evidence of active cellular growth in either the epithelial or stromal tissue. The latter is as vascular, and in general as sparsely packed, as in the normal specimen.

The columnar epithelium of a very folded central duct of one of these four hydatids (O.M. 67) is taller than normal. The duct also contains some secretion. As in the case of O.M. 66 (above), it is likely that this appearance of activity is a normal characteristic of well-differentiated central ducts, and that it does not result from endocrine treatment.

### (*c*) *Progesterone*

Three hydatids were recovered from two animals that had been injected for 14 days with progesterone, the one with 0·3 mg. and the other with 0·5 mg. daily. The dimensions of these hydatids are given in Table IV; they are little bigger than the smaller of the normal hydatids. In general, too, their histological appearance is not different from the normal.

### (*d*) *Oestrone*

Oestrone stimulates considerable growth in the hydatid,* as can be seen both in the obvious increase in size (Table V) and in the frequency of mitotic figures in histological preparations. Of the fourteen normal rhesus hydatids listed in Table III, only three have a size index greater than 6, while only two of the twenty hydatids from monkeys that had been injected with oestrone for a period of 14 days or more

---

* This fact was referred to elsewhere in connexion with a suggested interpretation of the changes induced by oestrogens in the male reproductive tract (ZUCKERMAN 1936*a*).

had a size index less than 6. The abnormally large hydatids found in two normal specimens, O.M. 20 and O.M. 89, raise the mean size index of the normal hydatids to 12·5. The mean size index of monkeys that had been injected with oestrone for 14 or more days was 24·5, and as noted above (p. 154) the greater size of the hydatids removed from animals that had been injected with oestrone was often apparent under the dissecting microscope. One animal, O.M. 124, was unilaterally castrated before it was subjected to a 14-day course of oestrone injections. The size index of the normal hydatid was 5·1, that of the hydatid which had been stimulated by oestrone, 20·2.

Table V—Dimensions of Hydatids After Injections of Oestrone, Arranged According to the Time Oestrone was Administered

| No. of animal | Species | Weight (g.) | Approx. age (months) | Amount of oestrone injected daily (mg.) | Days injected | Thickness of hydatid $= a$ | Max. cross-sectional area (sq. mm.) $= b$ | Size index $= ab$ |
|---|---|---|---|---|---|---|---|---|
| M.M. 16 | *Macaca mulatta* | 3500 | 40 | 1 | 6 | 0·56 | 32 | 17·9 |
| M.M. 20A | ,, | 1800 | 15 | 5 | 6 | 0·22 | 2·25 | 0·5 |
| M.M. 20B | ,, | 1800 | 15 | 5 | 6 | 0·56 | 6·75 | 3·8 |
| M.M. 1A | ,, | 4300 | 43 | 5 | 6 | 0·44 | 4·65 | 2·0 |
| M.M. 1B | ,, | 4300 | 43 | 5 | 6 | 0·29 | 3·05 | 0·88 |
| O.M. 36 | ,, | 2440 | 28 | 0·05 | 14 | 0·43 | 17·35 | 7·5 |
| O.M. 24A | ,, | 3440 | 36 | 0·05 | 14 | 0·45 | 15·3 | 6·9 |
| O.M. 24B | ,, | 3440 | 36 | 0·05 | 14 | | Minute | |
| O.M. 148A | ,, | 2560 | 32 | 0·1 | 14 | 1·0 | 42·9 | 42·9 |
| O.M. 148B | ,, | 2560 | 32 | 0·1 | 14 | 0·97 | 39·4 | 38·2 |
| O.M. 124 | ,, | 2840 | 30 | 0·1 | 14 | 1·18 | 17·1 | 20·2 |
| O.M. 79A | ,, | 2900 | 30 | 0·1 | 15 | 0·9 | 18·3 | 16·5 |
| O.M. 79B | ,, | 2900 | 30 | 0·1 | 15 | 1·55 | 66·5 | 103·1 |
| M.M. 26 | ,, | 2500 | 30 | 1 | 16 | 0·5 | 17·0 | 8·5 |
| O.M. 153 | ,, | 2400 | 19 | 0·1 | 22 | 0·39 | 2·7 | 1·05 |
| O.M. 16A | ,, | 2160 | 18 | 0·2 | 28 | 0·76 | 14·75 | 11·2 |
| O.M. 16B | ,, | 2160 | 18 | 0·2 | 28 | 0·80 | 11·7 | 9·4 |
| O.M. 16C | ,, | 2160 | 18 | 0·2 | 28 | 0·81 | 7·6 | 6·2 |
| M.M. 18A | ,, | 4800 | 48 | 0·2 | 28 | 1·0 | 49·2 | 49·2 |
| M.M. 18B | ,, | 4800 | 48 | 0·2 | 28 | 1·0 | 46·5 | 46·5 |
| M.M. 19A | ,, | 4800 | 48 | 1 | 28 | 0·55 | 14·5 | 8·0 |
| M.M. 19B | ,, | 4800 | 48 | 1 | 28 | 0·80 | 47·4 | 37·9 |
| O.M. 151A | ,, | 2500 | 22 | 0·1 | 37 | 0·76 | 11·7 | 8·9 |
| O.M. 101A | ,, | 2900 | 30 | 0·1 | 62 | 0·8 | 12·7 | 10·2 |
| O.M. 101B | ,, | 2900 | 30 | 0·1 | 62 | 1·32 | 43·9 | 57·9 |
| O.M. 34 | *Macaca irus* | 1180 | 36 | 0·1 | 14 | 0·8 | 26·2 | 21·0 |
| O.M. 114A | *Mandrillus leucophaeus* | 3450 | 24 | 0·2 | 25 | 2·58 | 75·0 | 193·5 |
| O.M. 114B | ,, | 3450 | 24 | 0·2 | 25 | 2·0 | 78·7 | 157·4 |
| O.M. 82A | *Presbytis entellus* | 4060 | 26 | 0·2 | 39 | 1·28 | 7·1 | 9·1 |

The histological character of the oestrone-stimulated hydatids is different from the normal. In general they give considerable evidence of activity and growth, mitotic figures being frequently observed, both in the epithelium and in the stroma. The epithelial cells are much taller than normal, and they are occasionally heaped. In the normal specimens the nuclei of the epithelial cells fill the greater part of the cell bodies (figs. 17 and 18, Plate 19). In the oestrone-stimulated specimens their size becomes relatively reduced as the cytoplasm increases in amount, and they are frequently displaced from their normal basal positions (figs. 20 and 21, Plate 19). The ciliated character of the cells is often evident (fig. 19, Plate 19), and the cells are usually secreting. This description applies not only to the surface epithelium itself, and its glandular invaginations, but also to the epithelium lining the central ducts. The surface invaginations appear more numerous in the oestrone-stimulated than in normal specimens.

The stroma of the hydatids that have reacted to the injection of oestrone is much more densely packed than is normal, and its greater density gives an appearance of relative avascularity. Frequently, too, the stromal nuclei are swollen, and in some specimens zones of sub-epithelial oedema were encountered. Extracellular granules of blood pigment were also seen in some specimens.

Unless an increase in the number of surface glandular invaginations be regarded as definite evidence of increased organization, it is difficult to decide whether oestrone promotes the differentiation as well as the growth of the hydatids of Morgagni. Only three of the fourteen normal hydatids which were histologically studied contained central ducts. Such a duct was present in eleven of the twenty-five animals that had been injected with oestrone. Moreover the epithelium of the central ducts as a rule appears more active in the oestrone-stimulated hydatids than in either the normal or the other experimental groups, even though in general the ducts do not appear to be better differentiated structures. Although these various differences may have been due to chance, there does seem to be some indication that oestrone is able to promote the differentiation as well as the growth of structures derived from the Müllerian duct.

### (*e*) *The Reversibility of the Effects of Oestrone*

Three hydatids were recovered from two animals, O.M. 43 and O.M. 44, that were autopsied 11 and 20 days respectively after the end of 14-day courses of daily oestrone injections. Their histological appearance gives little evidence of the effects of oestrone-stimulation, and in general they resemble the hydatids recovered from normal animals.

### (*f*) *The Inhibition of the Effects of Oestrone on the Hydatid*

A number of hydatids were recovered from animals which in addition to oestrone had been injected with some substance whose effects, it was hoped, would counteract those which oestrone induces in the prostate (ZUCKERMAN and PARKES 1936; ZUCKERMAN 1936*b*). Twenty-one hydatids were recovered from ten animals which had received oestrone and progesterone in different amounts, twenty-two from eleven animals which had received oestrone and some male hormone compound, eight from four animals which had received oestrone and cholesterol, and two from one animal which had received oestrone and epi-cholestanol.

The attempt to inhibit the prostatic effects of oestrone had been successful in some cases and unsuccessful in others. The degree to which they had been suppressed was roughly estimated and tabulated according to an arbitrary notational scale (see Zuckerman and Parkes 1936 and Zuckerman 1936 *b*). In general it was found that the hydatids show the same degree of oestrogenic stimulation as do the prostates of the animals from which they were removed. In no case was there any unusual and specific effect that could be related to the combination of substances which the animal had received.

### (*g*) *The Influence of Oestrone on the Hydatids of Monkeys other than* Macaca mulatta

One hydatid was recovered from a common macaque (*Macaca irus*) that had been injected with oestrone for 14 days, and two from a drill (*Mandrillus leucophaeus*) that had been injected with oestrone for 25 days. The hydatids show the same effects of oestrogenic stimulation as do those from the rhesus monkey.

## 5—Discussion

The hydatids of Morgagni are attached in man either to the upper pole of the testis or to the head of the epididymis, the testicular attachment being by far the commoner. The hydatids of monkeys, while often found on the testis, are on the other hand more frequently attached to the epididymis, and not only to its head, but also to its body or to the point of junction of body and tail. It is noteworthy, too, that the point of attachment is almost invariably the antero-lateral border of the body, or the antero-inferior border of the head. In no single case was a hydatid attached to the lateral surface itself.

The epididymal and testicular hydatids of monkeys cannot be distinguished from each other either macroscopically or microscopically. Moreover, clear evidence was obtained of the relation of both kinds of hydatid to remnants of a canal which on topographical grounds was taken to be the Müllerian duct. Doubts about the embryological identity of the testicular and epididymal hydatids do not therefore arise.

The testicular attachment of the hydatids in man is secondary, growth in the head of the epididymis displacing the cranial end of the Müllerian duct from the head of the epididymis where it is found in early embryonic life. It thus follows that there is a greater tendency for the embryonic condition of the Müllerian duct to persist in male monkeys than in males of the human species. A similar tendency is reflected in the fact that as a rule relatively more of the Müllerian duct appears to persist in the male monkey than in the human male. The carrying over of embryonic characters into post-natal and adult life is referred to in evolutionary discussion as neoteny, and, in general, man is regarded as being neotenic in relation to subhuman primates (Bolk 1926). In detail, however, the picture of man's neoteny or "foetalization" is an illusory one (Zuckerman 1936*d*), and it is thus not surprising to find that, so far as the persistence of the Müllerian duct is concerned, it is the male monkey which is neotenic with respect to man, and not man who is neotenic with respect to the monkey.

Remnants of the Müllerian duct are as a rule found more caudally on the testis and epididymis than are the hydatids themselves (which the duct sometimes traverses to open into the sac of the tunica vaginalis). In a few instances, however, the opposite condition held, and a fimbriated hydatid covered by ciliated columnar epithelium was situated distal to a blind duct embedded in what we have termed the Müllerian ridge of the epididymis (e.g. O.M. 82R, p. 160). This fact raises an interesting problem.

The hydatids found on the human testis and epididymis have always been regarded as derivatives of the extreme cranial end of the Müllerian duct, and their external covering of ciliated columnar epithelium has been easy to understand on the basis of the direct homology of the hydatids with the fimbriae of the Fallopian tube. The occurrence of such an external layer of epithelium would normally appear to be restricted in both male and female to the specific region where the Müllerian duct opens into the coelomic cavity. It would seem unlikely, however, that the point of attachment of "fimbriated" hydatids need necessarily be taken in all cases to represent the cranial limit of the primitive Müllerian duct. If it did, we should have to assume that during development the Müllerian duct had become considerably displaced from the Wolffian duct in those instances when a single fimbriated hydatid that is present is attached distal to a remnant of the Müllerian duct itself. In the case of O.M. 82R, for example, it would be necessary to assume first, that the cranial end of the Müllerian duct had become displaced, and second, that the duct had then doubled back on its original course.

This, however, is not the only possibility that suggests itself. It is well known that more than one fimbriated opening may occur on the same Fallopian tube, and that these accessory sets of fimbriae are sometimes found as far as 3 cm. medial to the normal opening. Richard (1851), who was the first to describe the condition, found such accessory openings in five out of thirty women. In his description of the development of the Fallopian tube, Felix (1912) refers to the presence of two to four accessory "funnels" that bud in the neighbourhood of the principal funnel of the tube, with which they later fuse, the fimbriae of the ostium abdominale developing from the scattered dentations of their outer margins. He also writes of accessory "tubes", at most four in number, that occasionally appear more caudally, and that do not unite with the principal funnel. The hydatid of Morgagni which is sometimes found in the female near the ostium abdominale is said to develop from these accessory tubes, and presumably accessory openings of the tube (which are not discussed by Felix) do the same. In the circumstances it is not unlikely that caudally disposed hydatids of Morgagni in the male monkey are derived from accessory tubes. Such a view is not supported, however, by Felix's further observation that accessory funnels and accessory tubes do not occur in the male human embryo. On the other hand, Felix also maintains that the male Müllerian tubes do not develop fimbriae, a statement which it is difficult to accept in view of the occasional fimbriated character of the appendages attached to the human testis and epididymis.

The endocrinological conditions under which testicular and epididymal vestiges of the Müllerian duct persist in the male, and the sensitivity of these structures to sex hormones, are of considerable interest from the point of view of the wider problem of sex differentiation. WITSCHI (1932) has recently given an authoritative account of the investigations which have dealt with the latter question. It would appear that male and female accessory reproductive organs develop simultaneously, and grow at the same pace, during a "self-differentiating period" of embryonic life. This period ends when the gonads, by way of the "male" or "female" hormone they elaborate, assume control of the growth of the accessory organs. The duration of the self-differentiating period varies from species to species, and from organ to organ, but the effects of this period make it clear, according to WITSCHI, that "the secondary sex characters are not entirely under the control of hormones". During the "sex-controlled period" of differentiation, male or female hormones, elaborated by the developing gonads, stimulate the development of the Wolffian and Müllerian systems respectively, and the particular endocrine environment induced by the gonads leads, in some way as yet unknown, to the disappearance of the primordial reproductive system that is not being stimulated. Observations on free-martins, as well as the results of experimental parabiosis in Amphibia, show that male hormone is more dominant than female hormone, and that when a zygotic female embryo is exposed to the influence of male hormone, its Wolffian system develops at the expense of its Müllerian system, which ceases to differentiate.

The precise nature of the "male" and "female" hormones concerned in sexual differentiation has not, to our knowledge, been demonstrated. Such male hormones as were used on the animals we studied were apparently without effect on the hydatids of Morgagni, whereas they caused profound changes in organs derived from the Wolffian duct. This result is in keeping with present knowledge of embryonic development, and with the fact that none of the male hormones we used has any marked oestrogenic activity. Furthermore, the refractoriness of the hydatids to male hormone suggests that such differentiation as some of these appendages display in post-uterine life (e.g. O.M. 18) must have been effected, independently of endocrine influence, during the sexually indifferent phase of embryonic life. For, as is widely believed, male hormone is normally produced relatively earlier by genotypic male embryos than female hormone is by genotypic female embryos, and once the endocrine environment has become masculine in character the Müllerian ducts begin to retrogress, and no further differentiation is possible.

WIESNER (1935) has suggested an alternative theory of sexual differentiation which is at variance with the one expounded by WITSCHI. According to him, the Müllerian system differentiates completely in virtue of its genic constitution alone, and independently of any endocrine influence. On the other hand, male differentiation is controlled by secretions of the testes. When "male hormone" acts on a developing female organism, it suppresses the further development of the Müllerian ducts, and promotes that of the Wolffian system. "Female hormone", having no action on the undifferentiated reproductive organs of a developing female organism, has no power to alter the course of development of the male accessory organs.

Such differentiation of the Müllerian ducts as the male monkey may show is as readily understandable on the basis of this hypothesis as it is on the basis of that advanced by Witschi. A corollary of Wiesner's theory, which at the same time is one of its central supports, is the belief that oestrin cannot act on imperfectly differentiated structures derived from the Müllerian ducts. This belief is, however, contrary to the facts presented in this paper,* unless one assumes that the hydatids of Morgagni are fully differentiated structures.

Oestrone stimulates both fibro-muscular and epithelial growth in the hydatids. The response of the fibro-muscular tissue can be regarded as part of a general sensitivity to oestrogenic substances of mesodermal structures derived from the urogenital ridge and genital cord. Such a view makes it possible to relate the fact that the fibro-muscular tissue of apparently the entire genital tract is responsive to oestrone (Zuckerman 1936*c*). Similarly, the proliferation of the epithelium of the hydatid can be related to the growth which occurs under similar conditions in the uterus masculinus. This response was first demonstrated in monkeys (Parkes and Zuckerman 1935; Courrier and Gros 1935; van Wagenen 1935), but it has since been shown to occur in the dog (de Jongh and Kok 1935), and in the guinea-pig (van der Woerd 1936; Courrier and Cohen-Solal 1936). In general it may be said that both the cranial and caudal parts of the primordial female reproductive tract which survive in the male mammal react to oestrone. A similar response has been shown to occur in the fowl; thus Juhn and Gustavson (1932) found that the occasional vestigial remains of the Müllerian duct in the male bird also respond to oestrin. The oestrogenic sensitivity of the uterus masculinus and the hydatids of Morgagni may perhaps also be related to the occasional presence in mice which have been treated for prolonged periods with oestrone (Burrows 1935) of keratinized cysts that lie both dorsal to the prostatic urethra and in relation to the epididymis. In this instance, however, the correspondence is not entirely clear, for the anatomical and embryological significance of the cysts observed by Burrows is unknown; there is only presumptive evidence that they too are derivatives of the primordial female reproductive tract.

The fact that none of the Müllerian vestiges found in the male reacts to progesterone alone is of interest in view of previous observations which show that this hormone has

---

* The epithelial stratification observed by Wiesner in the proximal part of the urogenital sinus of the new-born rat would itself appear to be the result of oestrogenic action, and a fact at variance with his hypothesis. In the development of his hypothesis Wiesner does not consider the fact that oestrin may cause extensive changes in the male reproductive organs.

no effect on tissues that have not been previously sensitized by oestrone. The ineffectivity of progesterone is also of interest in so far as it indicates that this hormone cannot be concerned in the embryonic differentiation of the female reproductive tract. Whether or not the hormone that is concerned is an oestrogenic substance is yet to be determined. It is difficult to believe that it can be in view of the fact that these substances are not sex specific in their action.

As has been implied above, the monhormonic hypothesis of sexual differentiation would not conflict with the fact of the reactivity of the uterus masculinus and of the hydatids of Morgagni to oestrone if it were assumed that these regions of the primordial female reproductive tract became fully differentiated and determined during the sexually indifferent phase of embryonic life. The strength of such an assumption would, however, necessarily depend on the strength of this particular hypothesis, into whose experimental basis it is not necessary to enquire here. But neither on this view nor on the more conservative dihormonic hypothesis is it understandable why the cranial and caudal parts of the Müllerian ducts should continue to survive in the males of so many species after the disappearance of the rest of the ducts. These regions of the ducts, it is stated, persist in vertebrates as widely different as selachians and primates. This particular problem, however, like that of the occasional simultaneous presence in mammals of normal-sized male and female internal reproductive organs, is open only to speculation, and it is unlikely to be answered until much more is known than at present both about sex-hormone antagonisms and about the endocrine basis of sexual differentiation.

We wish to record our best thanks to Dr. A. S. Parkes, F.R.S., for his interest and help. We also wish to express our thanks to Professor W. E. Le Gros Clark, F.R.S., for providing the general facilities which allowed this study to be carried out. The hydatids were recovered from animals which were purchased and kept with the aid of a grant to S. Z. from the Medical Research Council.

## 6—Summary

1—Testicular and epididymal appendages of the kind described as hydatids of Morgagni were found in the following species of subhuman primate:

| | |
|---|---|
| *Presbytis entellus*, Hanuman langur ... ... | 1 |
| *Cercopithecus aethiops sabaeus*, green monkey ... | 1 |
| *Macaca mulatta*, rhesus monkey ... ... ... | 82 |
| *Macaca irus*, common macaque ... ... ... | 1 |
| *Macaca nemestrina*, pig-tailed macaque ... ... | 2 |
| *Mandrillus sphinx*, mandrill ... ... ... | 1 |
| *Mandrillus leucophaeus*, drill ... ... ... | 1 |
| *Papio papio*, Guinea baboon ... ... ... | 1 |
| *Hapale jacchus*, common marmoset ... ... | 1 |

The figures refer to the number of animals examined; 108 hydatids were serially sectioned.

2—No more than two hydatids were found on any single testis. As a rule only one is present, and occasionally none can be found. The epididymal and testicular hydatids are identical in structure, and both varieties may be either sessile or pedunculated, the pedicles varying greatly in size. Both "types" of hydatid are presumably derived from the Müllerian duct.

3—Epididymal are more common than testicular appendages. Their most frequent points of attachment are (*a*) the junction of the body and the head of the epididymis, and (*b*) the junction of the body and tail.

The antero-lateral border of the body is frequently raised in the form of a ridge which appears to represent the obliterated Müllerian duct. Testicular hydatids are always attached to the upper pole of the testis.

4—Remnants of the Müllerian duct are frequently found (*a*) within the hydatids, which they may traverse to open into the sac of the tunica vaginalis, (*b*) in the pedicle of the hydatids, and (*c*) in the "Müllerian" ridge on the antero-lateral border of the epididymis. Occasionally a hydatid and its duct are so well differentiated that they resemble a miniature Fallopian tube.

5—In one specimen the remains of the Müllerian duct communicated with both the sac of the tunica vaginalis and a cyst formed by the expansion of a vas aberrans of the head of the epididymis.

6—Oestrone stimulates growth in both the epithelial and stromal elements of the hydatids; the evidence was insufficient to decide whether or not it also promotes their differentiation. No definite effect on the hydatids could be noticed after treatment with either a gonadotropic extract of the anterior lobe of the pituitary, or progesterone, or male hormone.

## REFERENCES

Bolk, L. 1926 "Das Problem der Menschwerdung." Jena: Fischer.

Burrows, H. 1935 *Proc. Roy. Soc.* B, **118**, 485.

Courrier, R. and Cohen-Solal, G. 1936 *C.R. Soc. Biol., Paris*, **121**, 903.

Courrier, R. and Gros, G. 1935 *C.R. Soc. Biol., Paris*, **118**, 686.

Curling, T. B. 1849–52 In "The Cyclopedia of Anatomy and Physiology", vol. **4**, ed. R. B. Todd. London: Longman, Brown, Green, Longmans and Roberts.

Eberth, C. J. 1904 In "Handbuch der Anatomie des Menschen", edited by K. von Bardeleben. Jena: G. Fischer.

Felix, W. 1912 In "Manual of Human Embryology", vol. **2**, edited by F. Keibel and F. P. Mall. London: J. B. Lippincott.

Griffiths, J. 1893 *J. Anat., Lond.*, **28**, 107.

Hartman, C. G. and Straus, W. J. 1933 (edited by) "The Anatomy of the Rhesus Monkey." Baltimore: Williams and Wilkins.

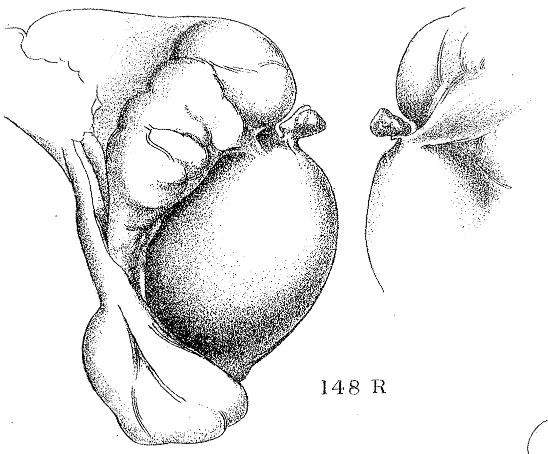
de Jongh, S. E. and Kok, D. J. 1935 *Acta brev. neerl. Physiol.*, **5**, 177.
Juhn, M. and Gustavson, R. G. 1932 *Anat. Rec.* **52**, 299.
Kobelt, G. L. 1857 "Nebeneierstock des Weibes." Heidelberg.
Löwe, L. 1879 *Arch. mikr. Anat.* **16**, 15.
Luschka, H. 1854 *Virchows Arch.* **6**, 310.
Mihalkovics, G. V. von 1885 *Int. Mschr. Anat. Physiol.* **2**, 435.
Morgagni, J. B. 1769 "The Seat and Causes of Disease", vol. **2**. Translated by B. Alexander. London: Millar, Cadell, Johnson and Payne.
Parkes, A. S. and Zuckerman, S. 1935 *J. Physiol.* **84**, 15*P*.
Piersol, G. A. 1930 "Human Anatomy", 9th ed., Philadelphia: J. B. Lippincott.
Richard 1851 Thèse, "Anatomie des Trompes de utérus chez la Femme." Paris.
Richmond, W. S. 1883 *J. Anat., Lond.*, **17**, 538.
Roth, M. 1880 *Virchows Arch.* **81**, 47.
Schultz, A. H. 1933 In "The Anatomy of the Rhesus Monkey", edited by C. G. Hartman and W. L. Straus. Baltimore: Williams and Wilkins.
Schultz, A. H. 1935 *Amer. J. phys. Anthrop.* **19**, 489.
Sonntag, C. F. 1924 "The Morphology and Evolution of the Apes and Man." London: Bale, Sons and Danielsson.
Toldt, C. 1891 *S.B. Akad. Wiss. Wien*, **100**, 189.
van Wagenen, G. 1935 *Anat. Rec.* **63**, 387.
Waldeyer, W. 1877 *Arch. mikr. Anat.* **13**, 278.
Watson, J. H. 1902 *J. Anat., Lond.*, **36**, 147.
Wiesner, B. P. 1935 *J. Obstet. Gynaec.* **41**, 867; **42**, 8.
Witschi, E. 1932 In "Sex and Internal Secretions", edited by E. Allen. Baltimore: Williams and Wilkins.
Woerd, L. A. van der 1936 *Acta brev. neerl. Physiol.* **6**, 55.
Wright, W. and Brown, R. G. 1912 *Brit. Med. J.* **2**, 770.
Zuckerman, S. 1936*a* *Lancet*, No. 230, 135.
— 1936*b* *Lancet*, No. 231, 1259.
— 1936*c* *Brit. Med. J.* **2**, 864.
— 1936*d* *Man*, **36**, 129.
Zuckerman, S. and Parkes, A. S. 1936 *Lancet*, No. 230, 242.

---

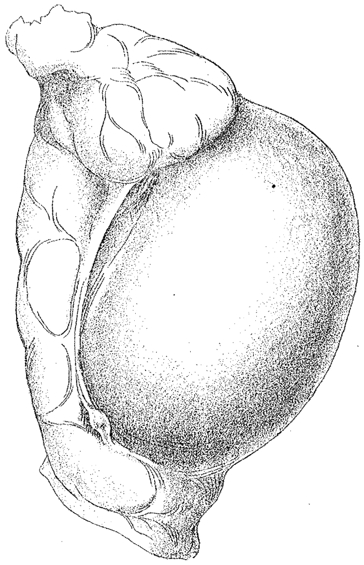
## DESCRIPTION OF PLATES

### PLATE 15

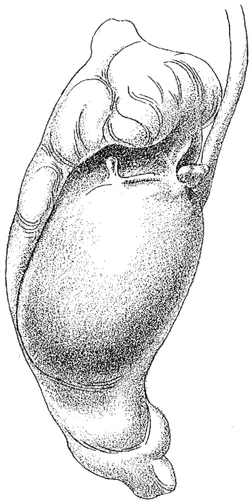
FIG. 1—Hydatids of Morgagni in normal and experimental monkeys. × 3. 148R, after oestrone injections; 151R, after oestrone injections; 163R, normal; 179R, after oestrone and male hormone injections; 170R, after oestrone and male hormone injections; 82R, after oestrone injections.



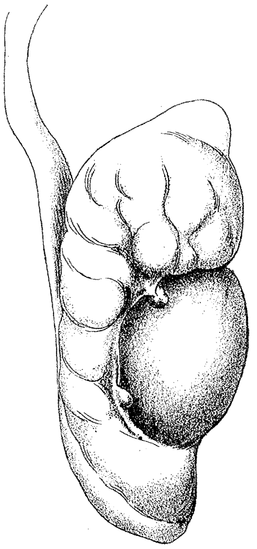
148 R



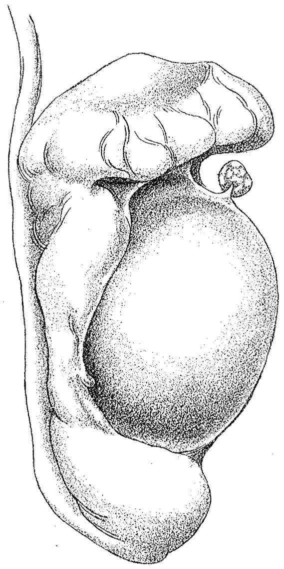
163 R



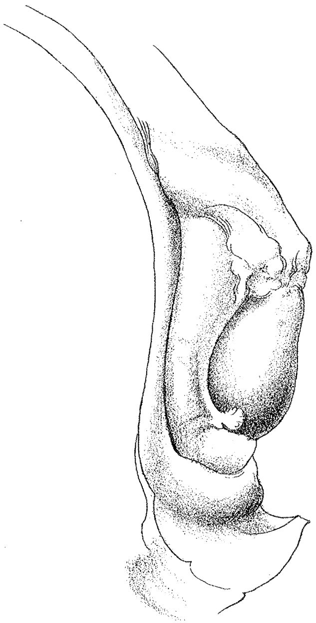
151 R



179 R



170 R



82 R

Huth, Stubbs X. Kent.

## PLATE 16

Remains of the Müllerian duct in the male monkey

FIG. 2—O.M. 160. A hydatid of Morgagni attached to the superior epididymal ligament, which contains a remnant of the Müllerian duct. × 29.

FIG. 3—O.M. 160. A more caudally disposed second remnant of the same Müllerian duct. There is no sinus epididymis. × 29.

FIG. 4—O.M. 163R. A cross-section of the vesicle shown on the "Müllerian" ridge of the epididymis in fig. 1, 163R. The vesicle represents part of the Müllerian duct. × 56.

FIG. 5—O.M. 163L. A hydatid of Morgagni deeply embedded between the upper pole of the testis and the head of the epididymis. × 29.

FIG. 6—O.M. 82R. Cross-section of the hydatid 82R, fig. 1, at the junction of the body and tail of the epididymis. A central duct in the hydatid, remains of the Müllerian duct, is shown opening into the sac of the tunica vaginalis. × 56.

FIG. 7—O.M. 82R. Remains of the Müllerian duct in the "Müllerian" ridge of the epididymis, cranial to the attachment of the hydatid shown in fig. 6. × 56.

Fig. 2

Fig. 3

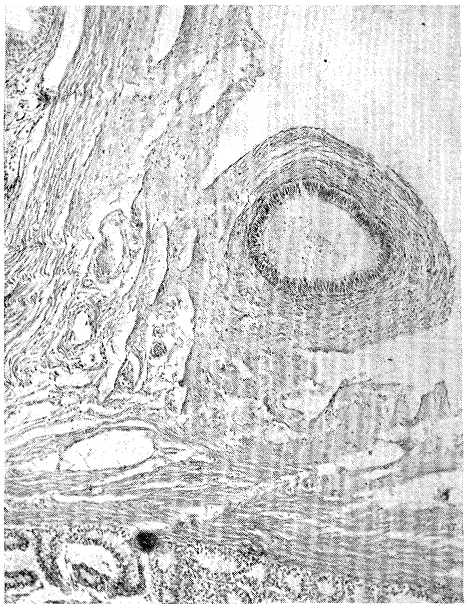


Fig. 4

Fig. 5

Fig. 6

Fig. 7

# PLATE 17

## The normal hydatid of Morgagni in different species of monkey

FIG. 8—O.M. 90. Immature rhesus monkey, *Macaca mulatta*. Hydatid of Morgagni of Type III. Note the sparse stroma, and the line of junction of the columnar epithelium of the hydatid, with the flat serous epithelium of the pedicle. × 78.

FIG. 9—M.M. 22. Similar to fig. 8, but from a Guinea baboon, *Papio papio*. × 50.

FIG. 10—O.M. 20. Hydatid of Type III from a mature rhesus monkey, *M. mulatta*. × 40.

FIG. 11—O.M. 35. Hydatid of Type IV from a green monkey, *Cercopithecus aethiops sabaeus*. The hydatid is attached to the testis and has a central duct that opens into the sac of the tunica vaginalis. × 70.

FIG. 12—O.M. 144. Hydatid of Type III from a rhesus monkey that had been injected with oestrone. Note the large number of tubular invaginations of the surface columnar epithelium. The folds they produce are to be distinguished from the more prominent ones shown in fig. 10, and which give the hydatid a fimbriated appearance. Note also the fact that the stroma is more densely packed than it is in normal specimens. × 75.

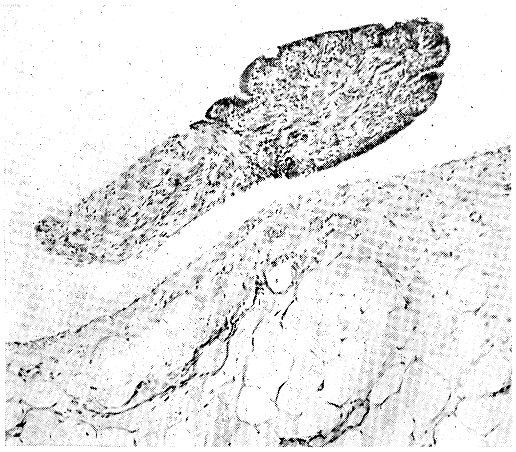


FIG. 8

FIG. 9

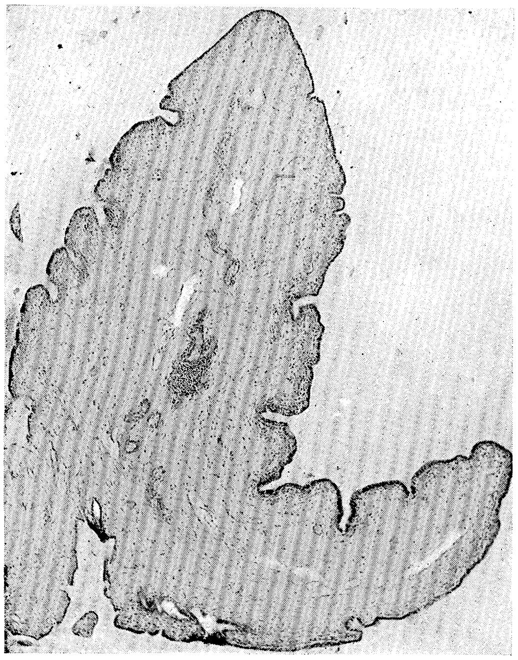


FIG. 10

FIG. 11

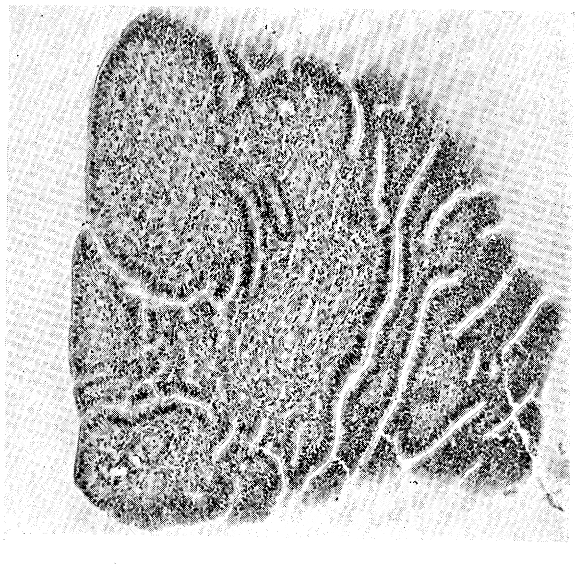


FIG. 12

## PLATE 18

Remains of Müllerian duct found in the hydatids themselves: rhesus monkeys

FIG. 13—M.M. 18. Large blind cyst in pedicle of hydatid. The animal had been injected with oestrone. × 20.

FIG. 14—M.M. 18. Hydatid on opposite testis of same monkey, showing a large, coiled and folded central duct which opens into the sac of the tunica vaginalis. × 29.

FIG. 15—O.M. 16. A blind central duct within a hydatid itself. × 50.

FIG. 16—O.M. 114. The opening of a central duct into the sac of the tunica vaginalis. The distinction between the central duct and the tubular invagination of the surface epithelium on the right side can be readily made out. The line of junction between the columnar epithelium of the hydatid and the flat serous epithelium of the pedicle is clearly shown. × 50.

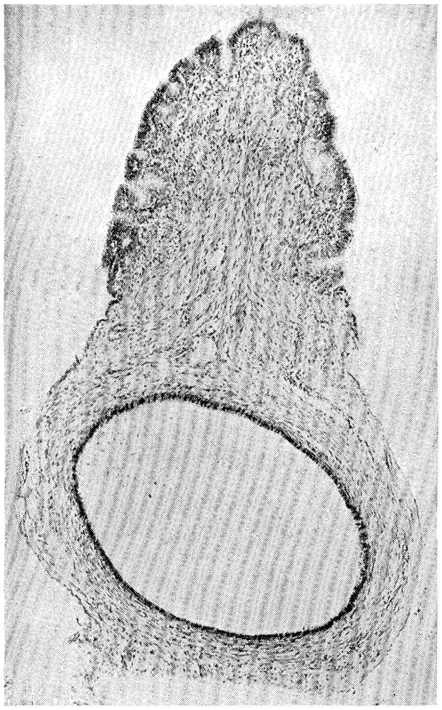


Fig. 13

Fig. 14

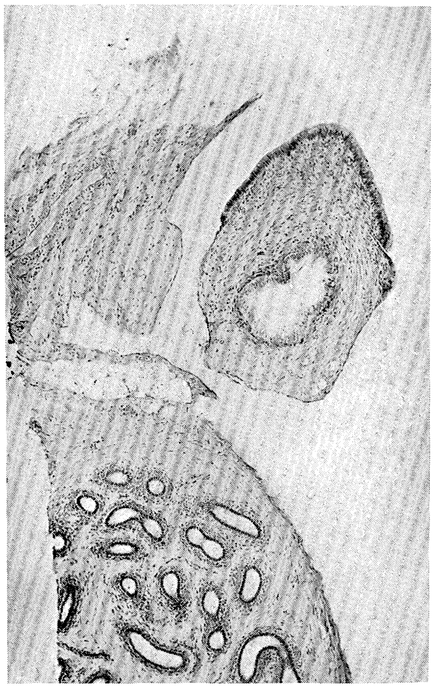


Fig. 15

Fig. 16

## PLATE 19

Normal and oestrone-stimulated epithelium of hydatids. × 600.

FIG. 17—P. 6. Surface epithelium of hydatid of normal pig-tailed macaque, *Macaca nemestrina*. The nuclei are relatively large. The dispersion and fibrillar nature of the stromal elements is also shown.

FIG. 18—O.M. 90. Rhesus monkey. Same as fig. 17.

FIG. 19—O.M. 101. Rhesus monkey, after oestrone injections. The ciliated character of the cells lining the numerous tubular invaginations of the surface epithelium can be seen.

FIG. 20—O.M. 79. Rhesus monkey. The figure shows the tall surface epithelium following oestrone injections. The nuclei are no longer basally disposed. Two of the cells are in process of division.

FIG. 21—O.M. 16. The tall columnar epithelium of the central duct of a hydatid of a rhesus monkey following oestrone injections, showing a mitotic figure.

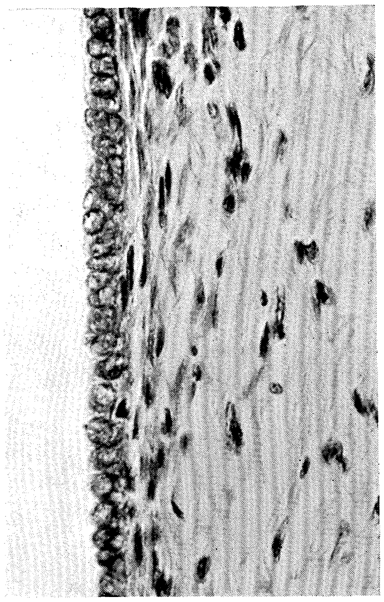


FIG. 17

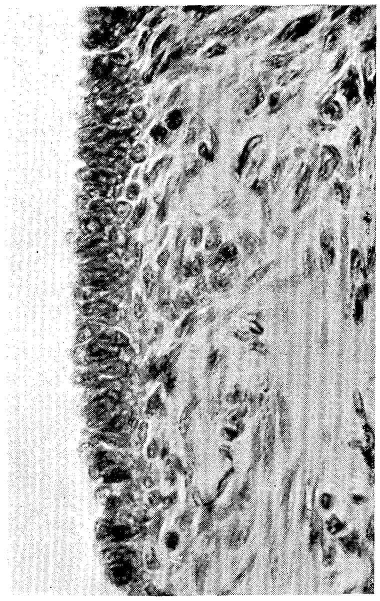


FIG. 18

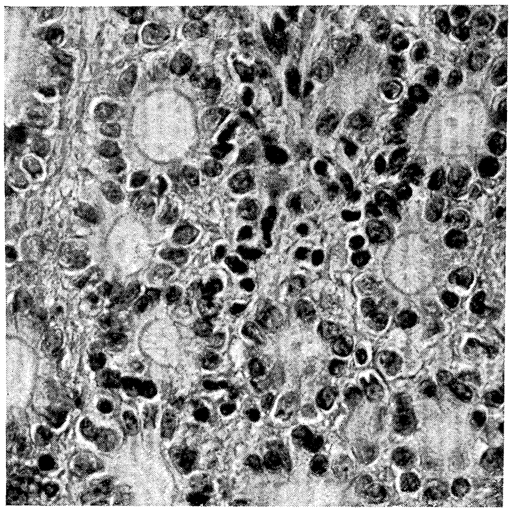


FIG. 19

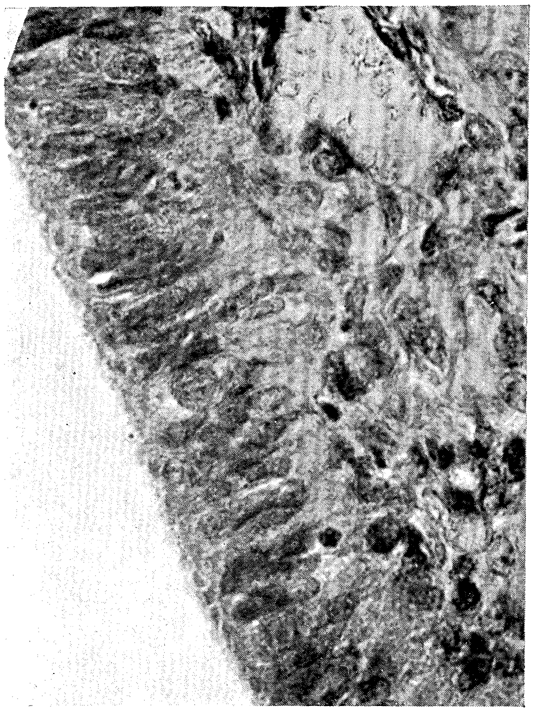


FIG. 20

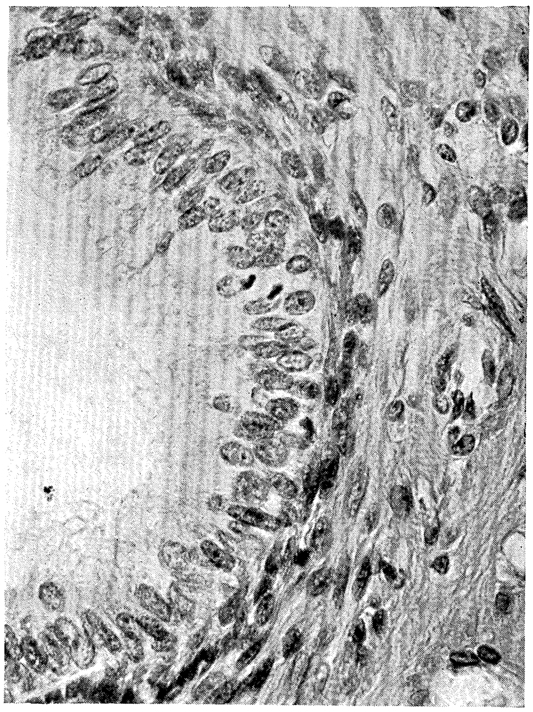


FIG. 21

## PLATE 20

The intercommunication of Müllerian and Wolffian structures. O.M. 135. × 22.

FIG. 22—The lowermost epididymal lobule seen in the figure is a blind coiled duct which expands to form a cyst.

FIG. 23—The cyst is shown in this figure, and closely applied to it is a hydatid of Morgagni. The deepest tubular gland in the hydatid is a central duct, presumably the cranial end of the Müllerian duct, which connects the cavity of the cyst with that of the tunica vaginalis.

FIG. 24—The central duct is seen in the centre of the hydatid.

FIG. 25—This figure shows the central Müllerian duct opening into the epididymal cyst, to which the hydatid is attached.

FIG. 26—The epithelium of the distal part of the cyst is folded; the figure shows one of the two accessory cysts which are situated in this region.

Fig. 22

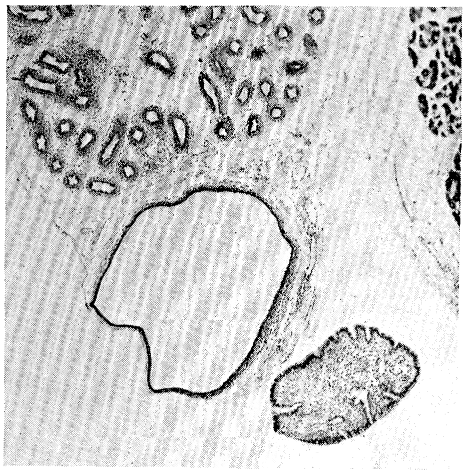


Fig. 23

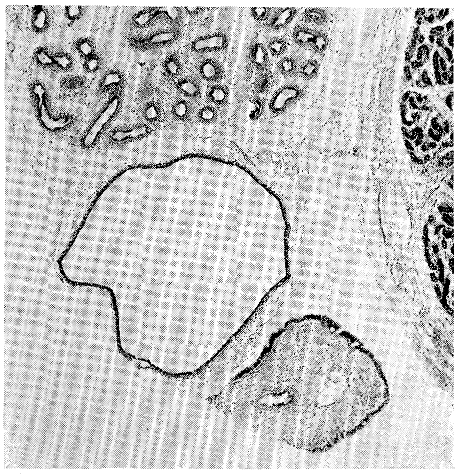


Fig. 24

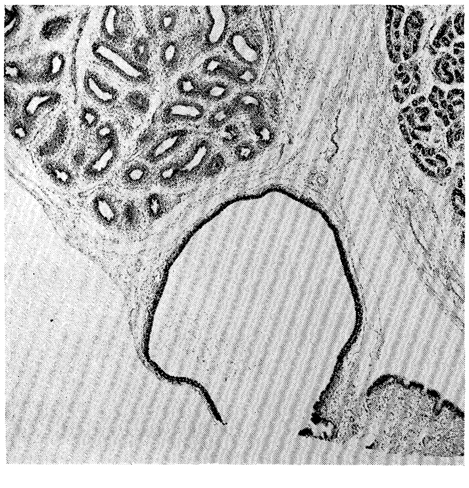


Fig. 25

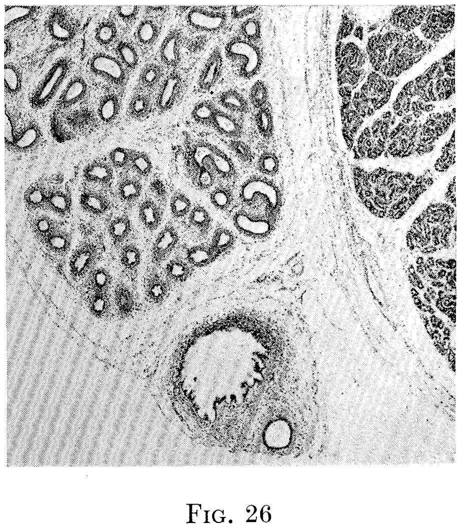
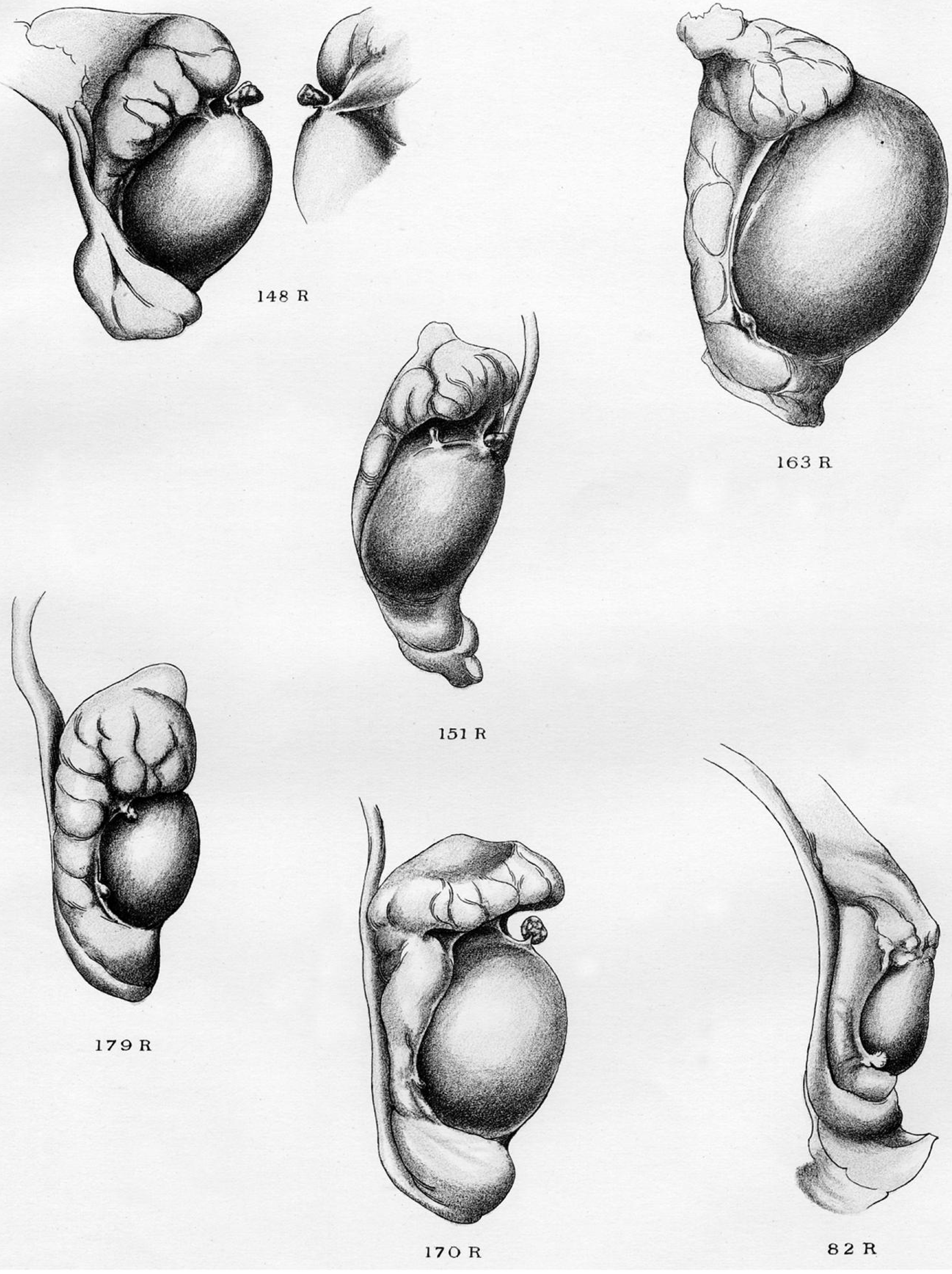


Fig. 26



148 R

163 R

151 R

179 R

170 R

82 R

PLATE 15

FIG. 1—Hydatids of Morgagni in normal and experimental monkeys. × 3. 148 R, after oestrone injections; 151 R, after oestrone injections; 163 R, normal; 179 R, after oestrone and male hormone injections; 170 R, after oestrone and male hormone injections; 82 R, after oestrone injections.

FIG. 2

FIG. 3

FIG. 4

FIG. 5

FIG. 6

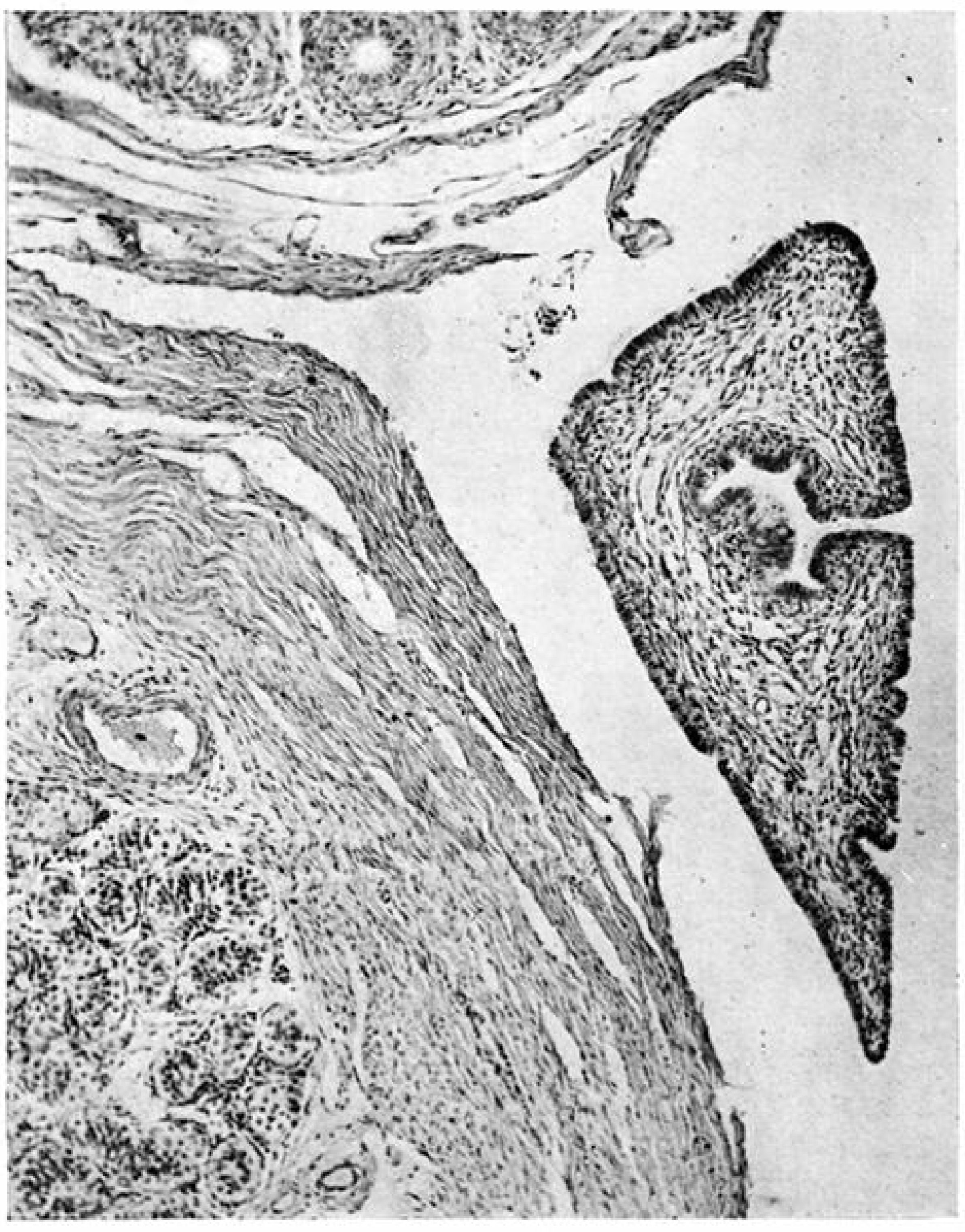


FIG. 7

PLATE 16

Remains of the Müllerian duct in the male monkey

FIG. 2—O.M. 160. A hydatid of Morgagni attached to the superior epididymal ligament, which contains a remnant of the Müllerian duct. × 29.

FIG. 3—O.M. 160. A more caudally disposed second remnant of the same Müllerian duct. There is no sinus epididymis. × 29.

FIG. 4—O.M. 163R. A cross-section of the vesicle shown on the "Müllerian" ridge of the epididymis in fig. 1, 163R. The vesicle represents part of the Müllerian duct. × 56.

FIG. 5—O.M. 163L. A hydatid of Morgagni deeply embedded between the upper pole of the testis and the head of the epididymis. × 29.

FIG. 6—O.M. 82R. Cross-section of the hydatid 82R, fig. 1, at the junction of the body and tail of the epididymis. A central duct in the hydatid, remains of the Müllerian duct, is shown opening into the sac of the tunica vaginalis. × 56.

FIG. 7—O.M. 82R. Remains of the Müllerian duct in the "Müllerian" ridge of the epididymis, cranial to the attachment of the hydatid shown in fig. 6. × 56.

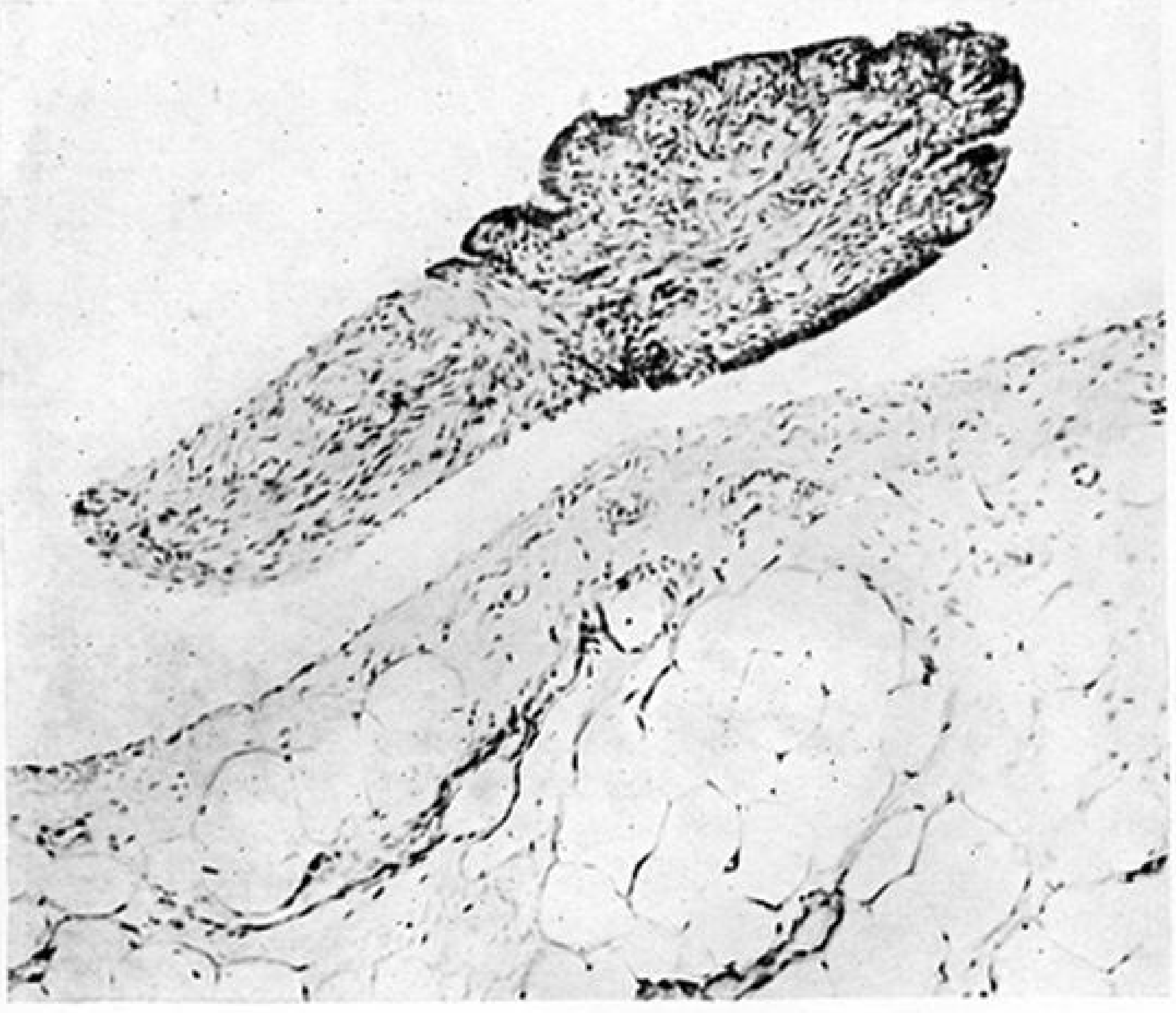


FIG. 8

FIG. 9

FIG. 10

FIG. 11

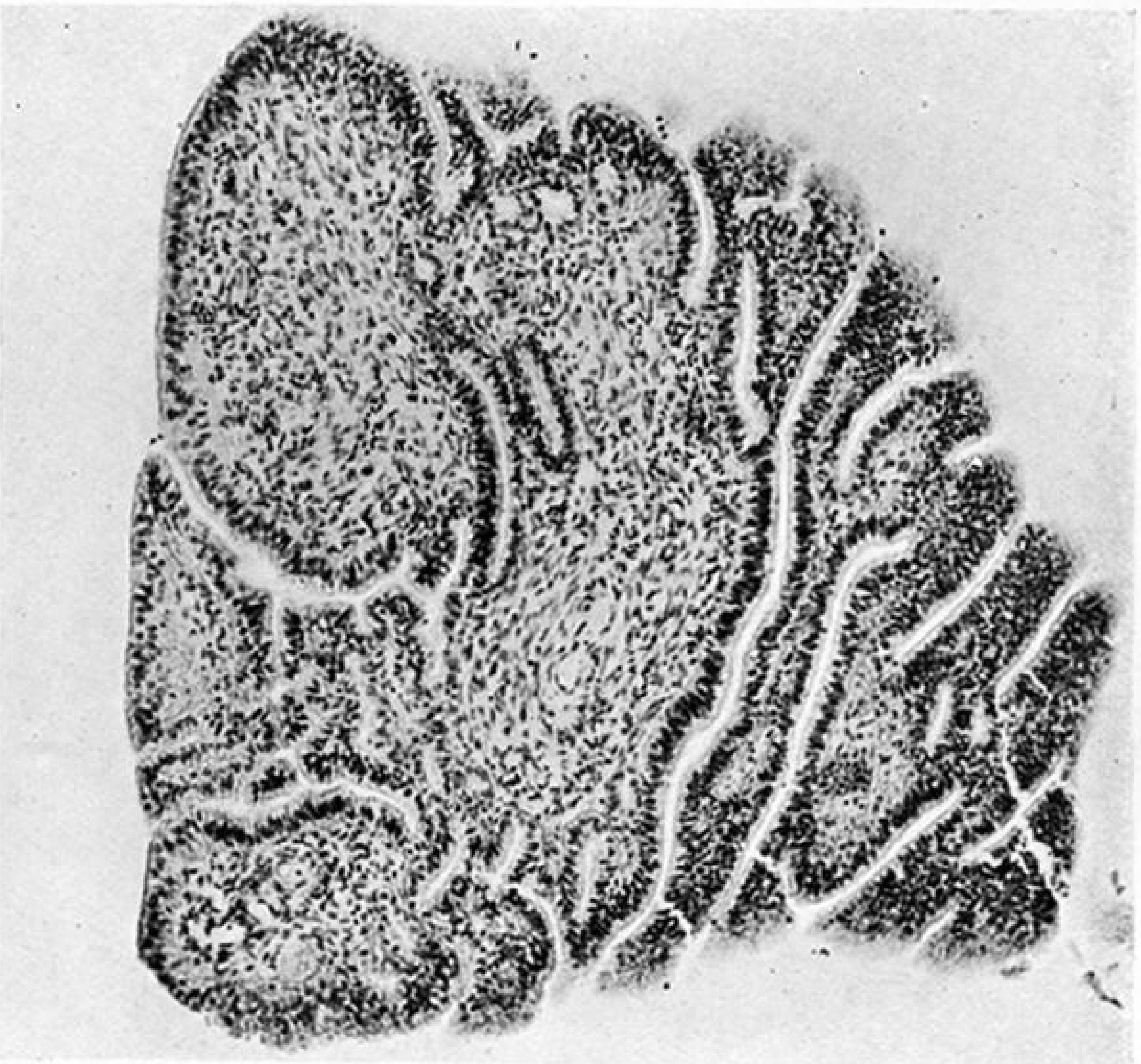


FIG. 12

PLATE 17

The normal hydatid of Morgagni in different species of monkey

FIG. 8—O.M. 90. Immature rhesus monkey, *Macaca mulatta*. Hydatid of Morgagni of Type III. Note the sparse stroma, and the line of junction of the columnar epithelium of the hydatid, with the flat serous epithelium of the pedicle. × 78.

FIG. 9—M.M. 22. Similar to fig. 8, but from a Guinea baboon, *Papio papio*. × 50.

FIG. 10—O.M. 20. Hydatid of Type III from a mature rhesus monkey, *M. mulatta*. × 40.

FIG. 11—O.M. 35. Hydatid of Type IV from a green monkey, *Cercopithecus aethiops sabaeus*. The hydatid is attached to the testis and has a central duct that opens into the sac of the tunica vaginalis. × 70.

FIG. 12—O.M. 144. Hydatid of Type III from a rhesus monkey that had been injected with oestrone. Note the large number of tubular invaginations of the surface columnar epithelium. The folds they produce are to be distinguished from the more prominent ones shown in fig. 10, and which give the hydatid a fimbriated appearance. Note also the fact that the stroma is more densely packed than it is in normal specimens. × 75.

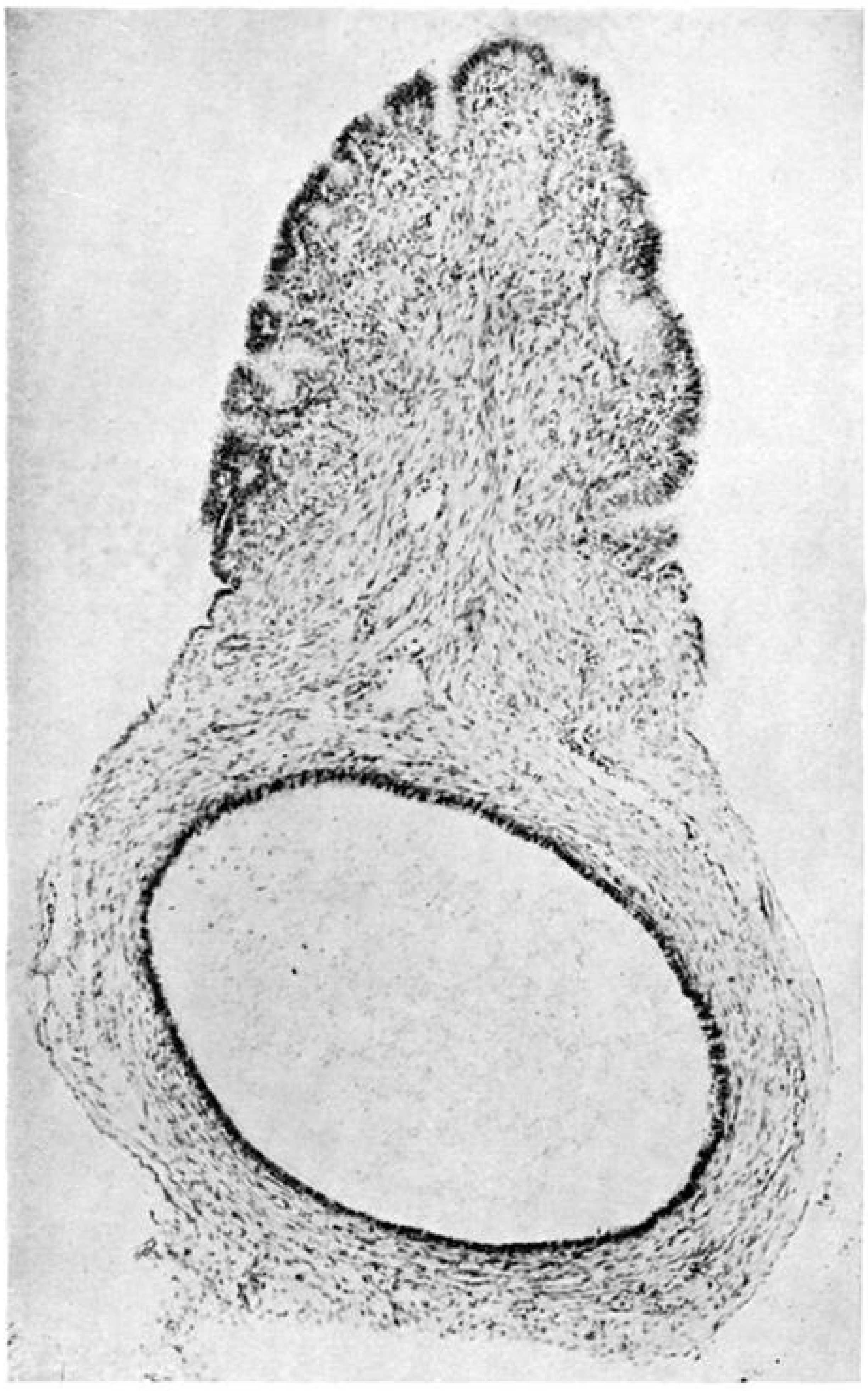


FIG. 13

FIG. 14

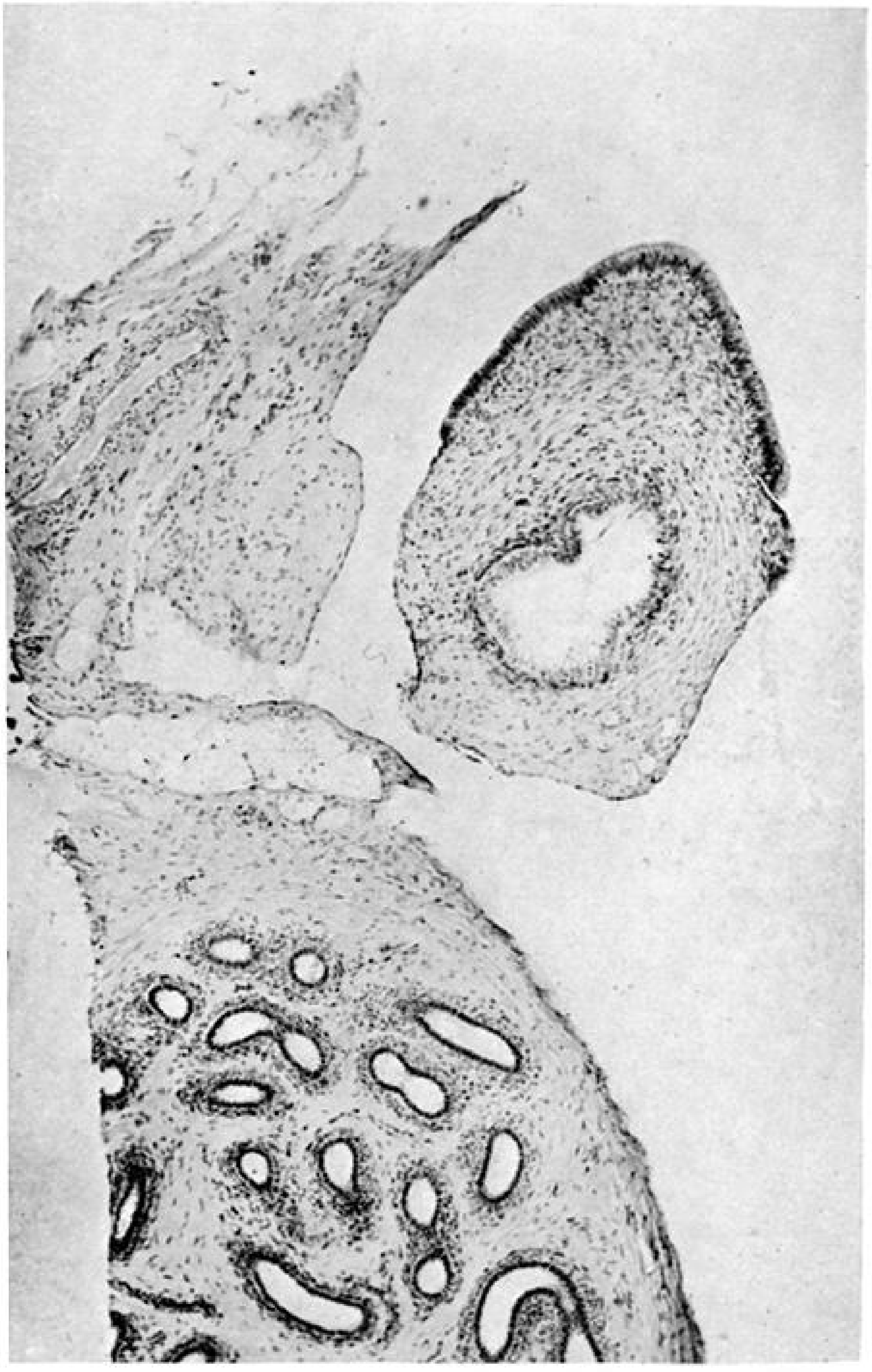


FIG. 15

FIG. 16

PLATE 18

Remains of Müllerian duct found in the hydatids themselves: rhesus monkeys

FIG. 13—M.M. 18. Large blind cyst in pedicle of hydatid. The animal had been injected with oestrone. × 20.

FIG. 14—M.M. 18. Hydatid on opposite testis of same monkey, showing a large, coiled and folded central duct which opens into the sac of the tunica vaginalis. × 29.

FIG. 15—O.M. 16. A blind central duct within a hydatid itself. × 50.

FIG. 16—O.M. 114. The opening of a central duct into the sac of the tunica vaginalis. The distinction between the central duct and the tubular invagination of the surface epithelium on the right side can be readily made out. The line of junction between the columnar epithelium of the hydatid and the flat serous epithelium of the pedicle is clearly shown. × 50.

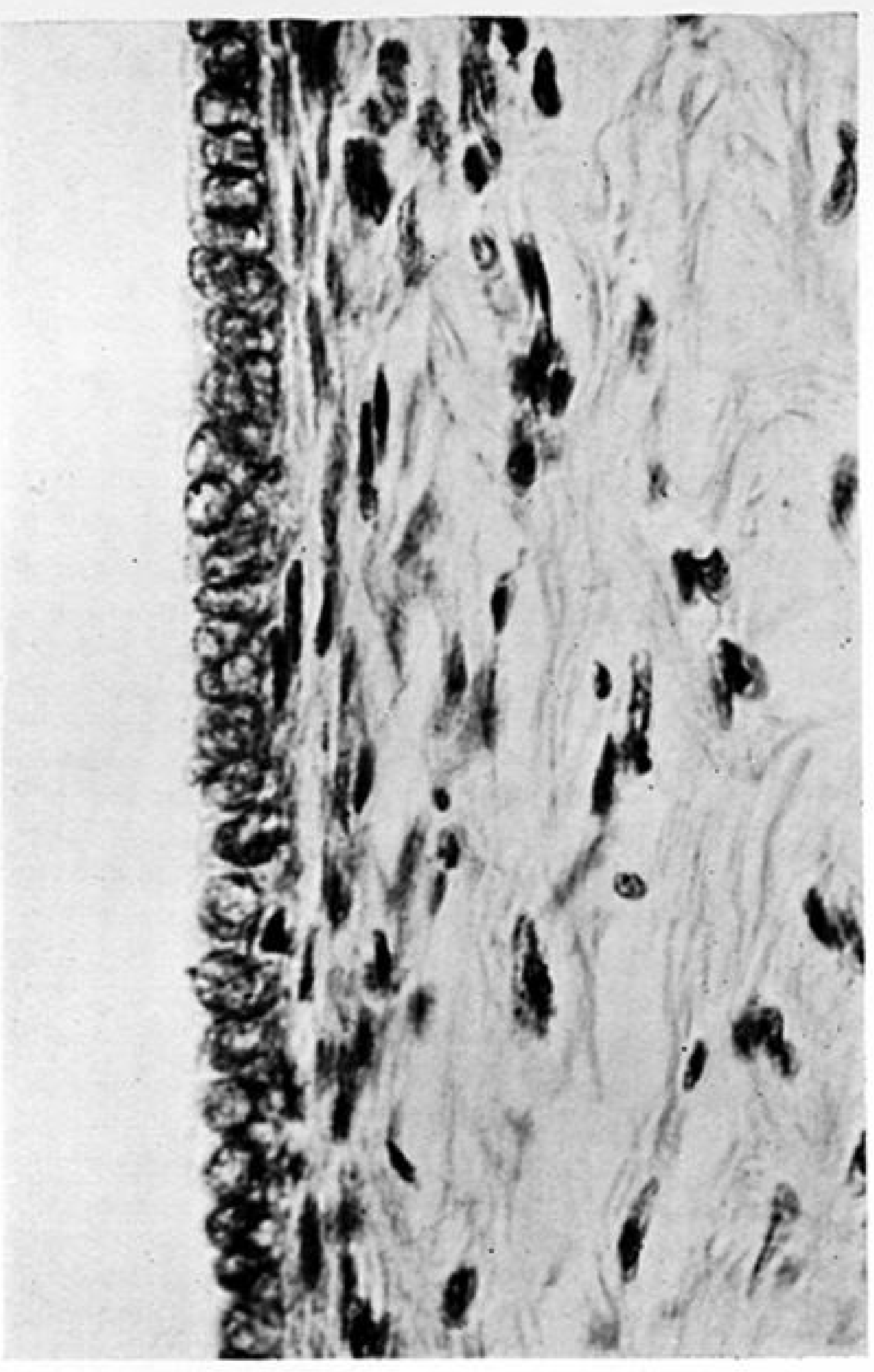


FIG. 17

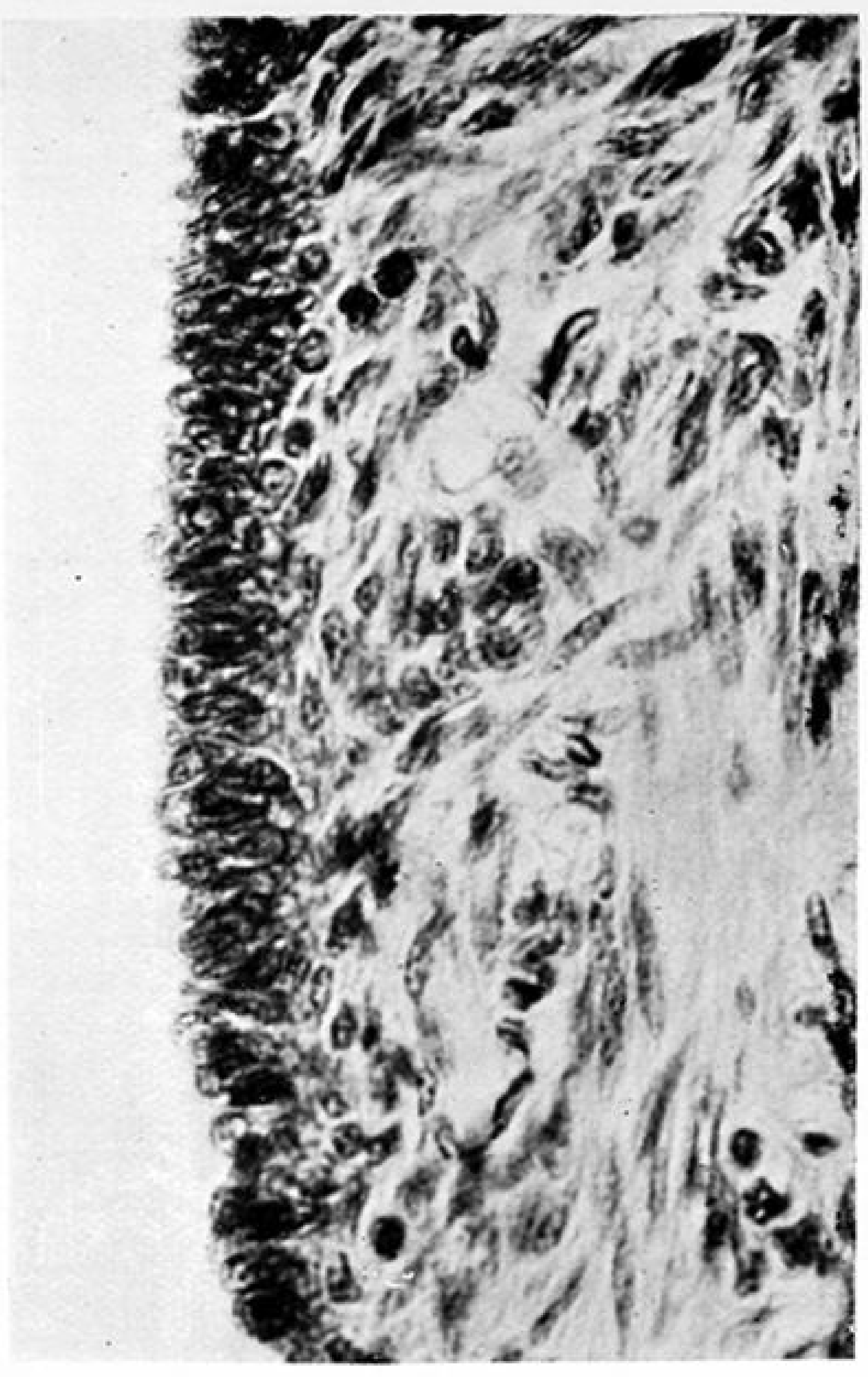


FIG. 18

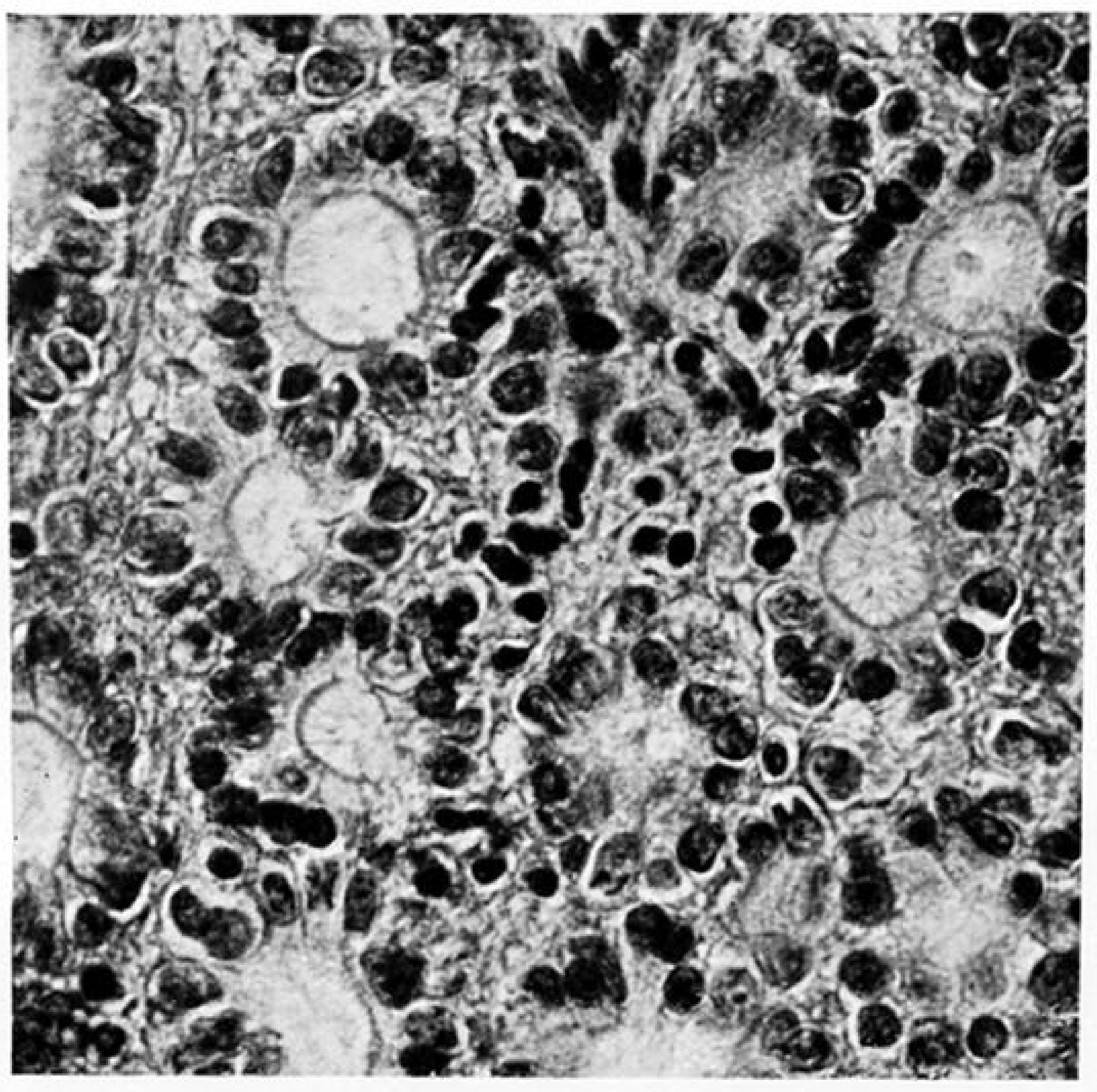


FIG. 19

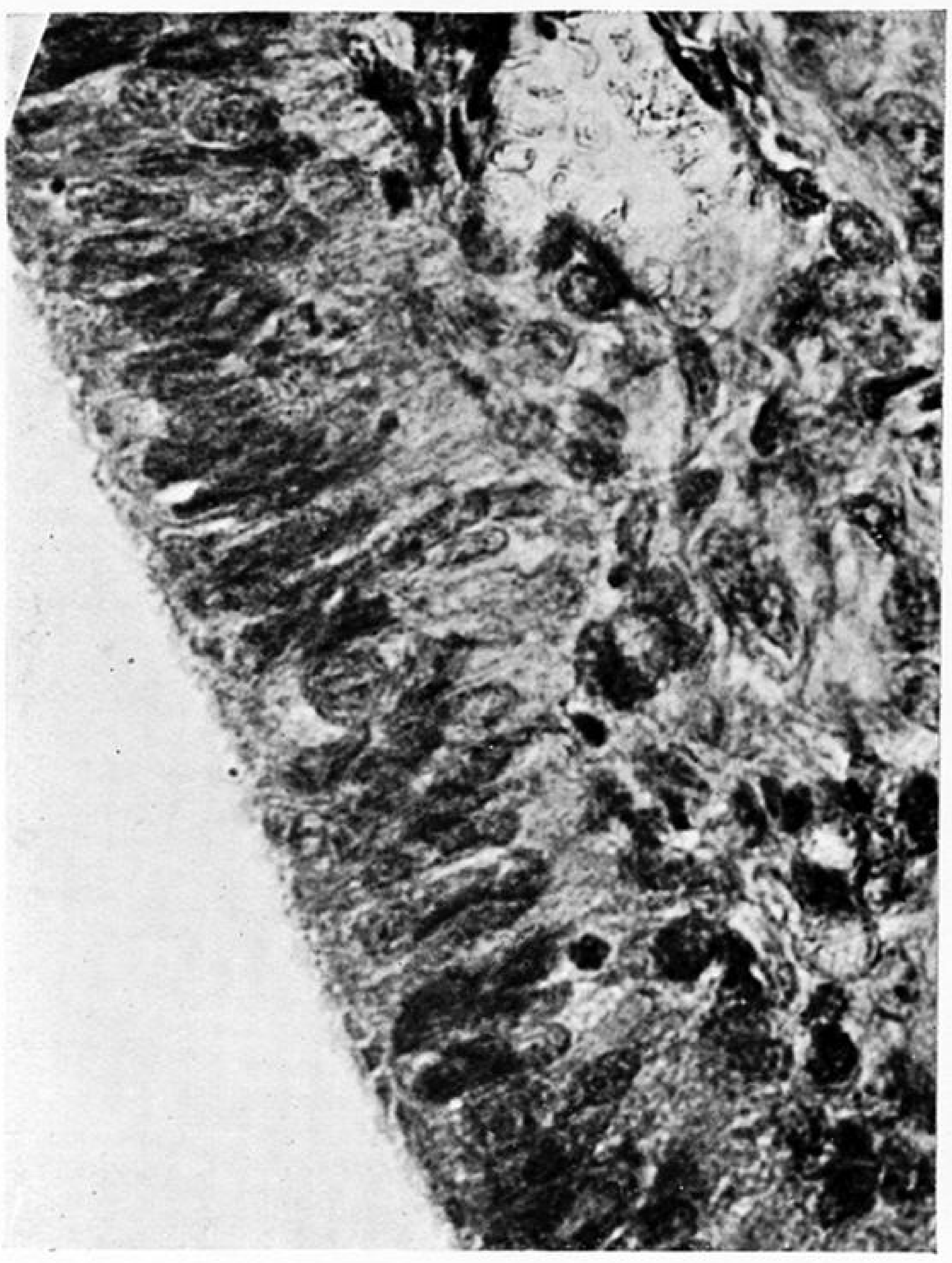


FIG. 20

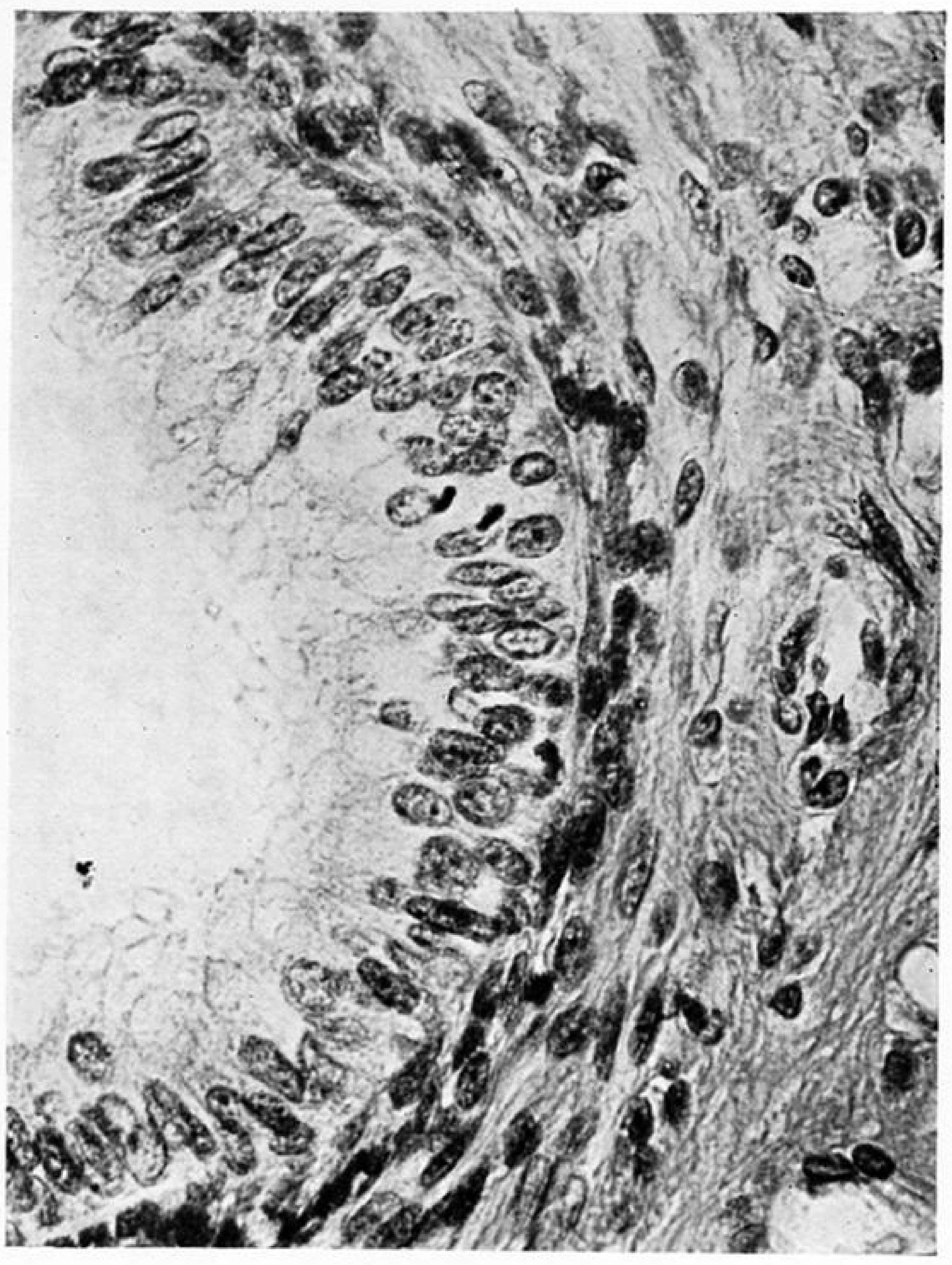


FIG. 21

## PLATE 19

Normal and oestrone-stimulated epithelium of hydatids. × 600.

FIG. 17—P. 6. Surface epithelium of hydatid of normal pig-tailed macaque, *Macaca nemestrina*. The nuclei are relatively large. The dispersion and fibrillar nature of the stromal elements is also shown.

FIG. 18—O.M. 90. Rhesus monkey. Same as fig. 17.

FIG. 19—O.M. 101. Rhesus monkey, after oestrone injections. The ciliated character of the cells lining the numerous tubular invaginations of the surface epithelium can be seen.

FIG. 20—O.M. 79. Rhesus monkey. The figure shows the tall surface epithelium following oestrone injections. The nuclei are no longer basally disposed. Two of the cells are in process of division.

FIG. 21—O.M. 16. The tall columnar epithelium of the central duct of a hydatid of a rhesus monkey following oestrone injections, showing a mitotic figure.

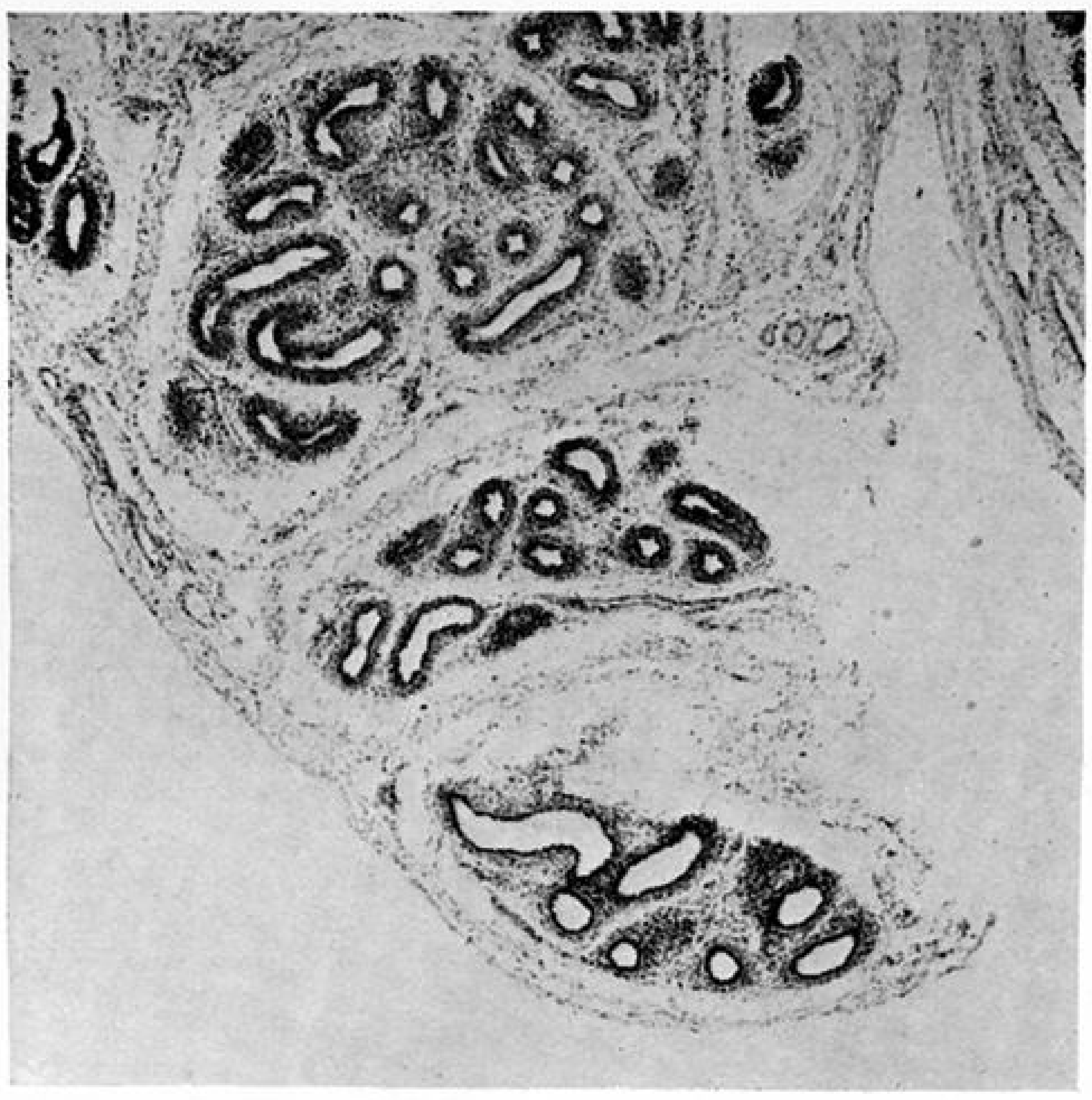


FIG. 22

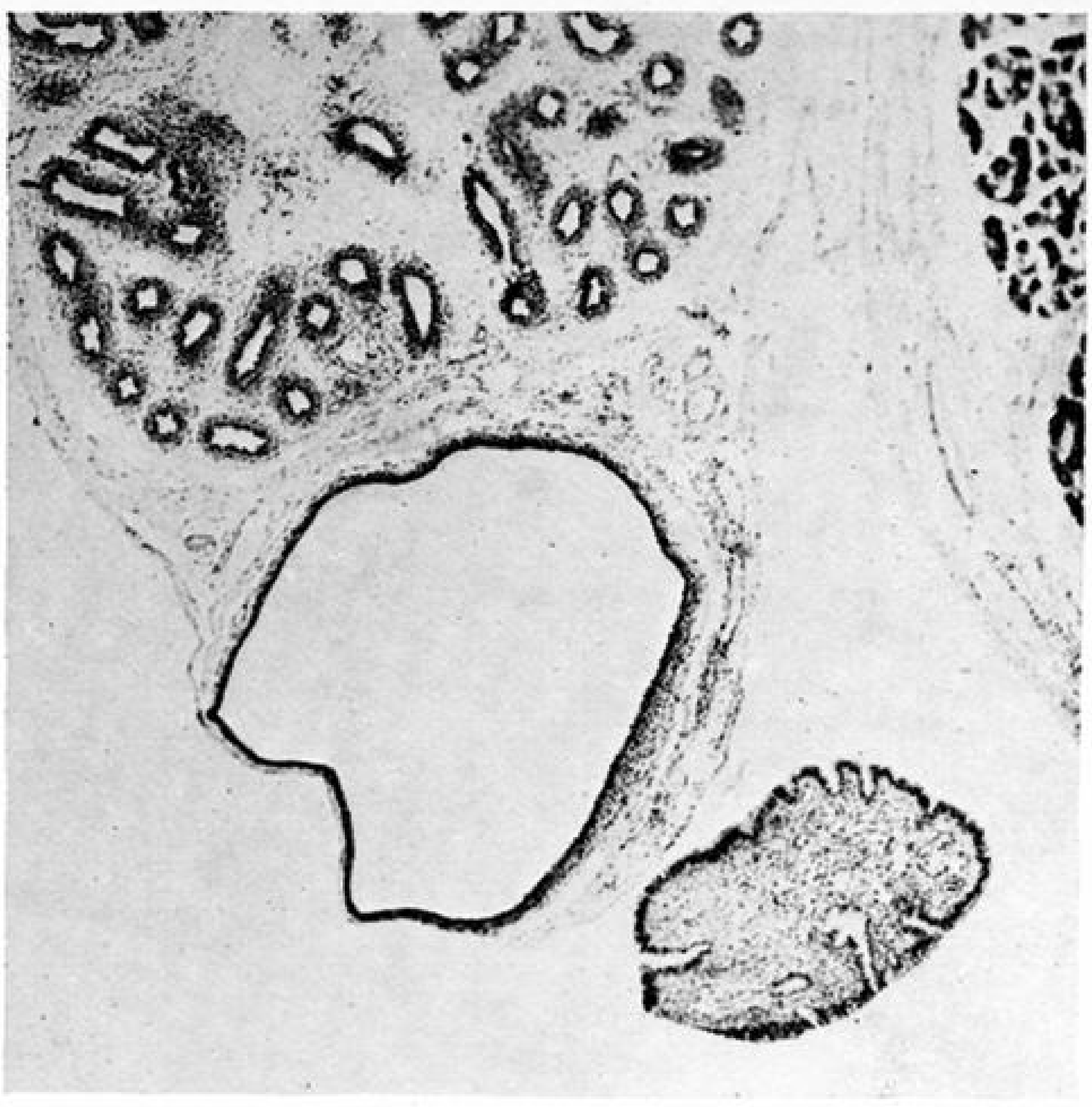


FIG. 23

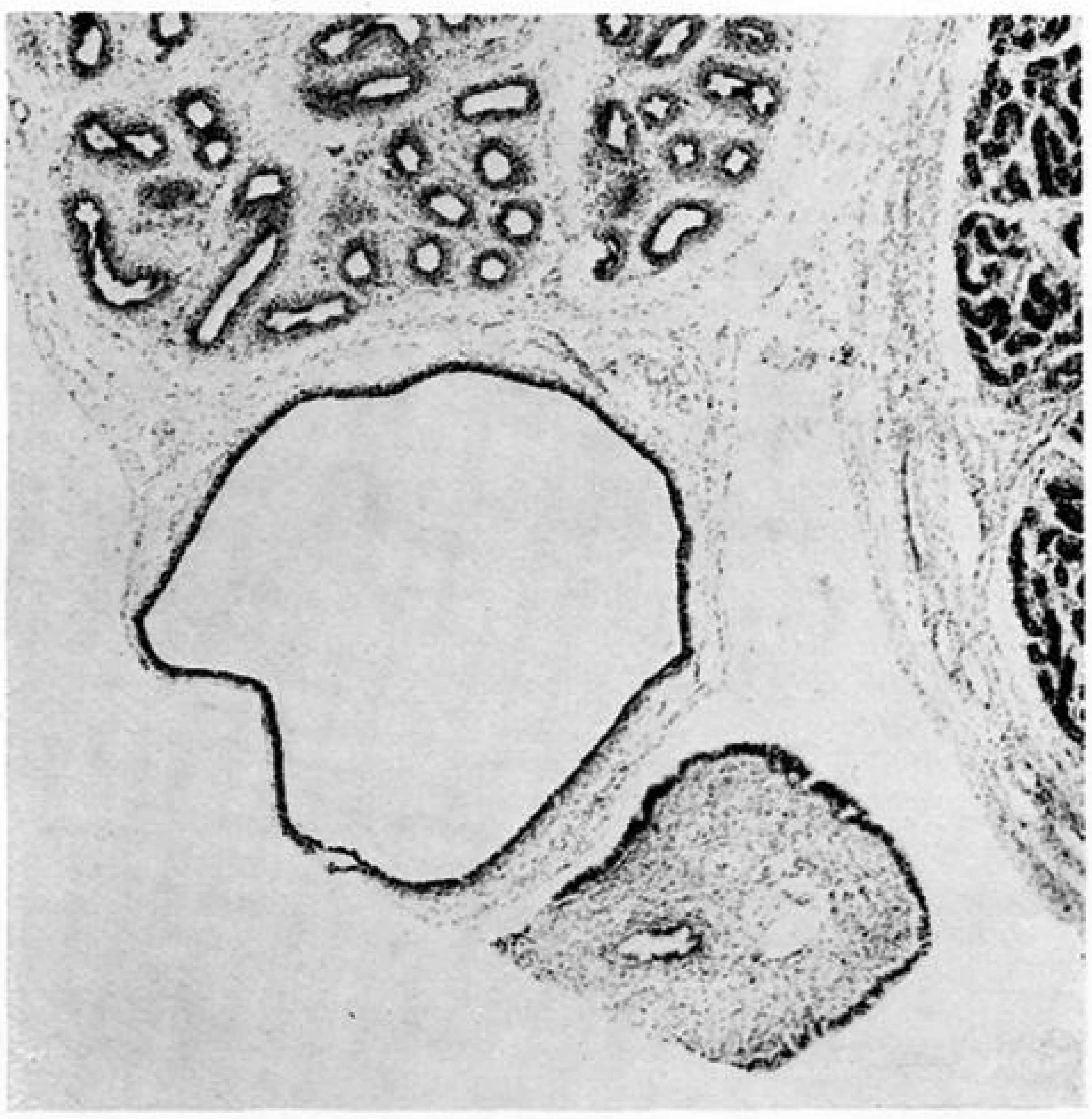


FIG. 24

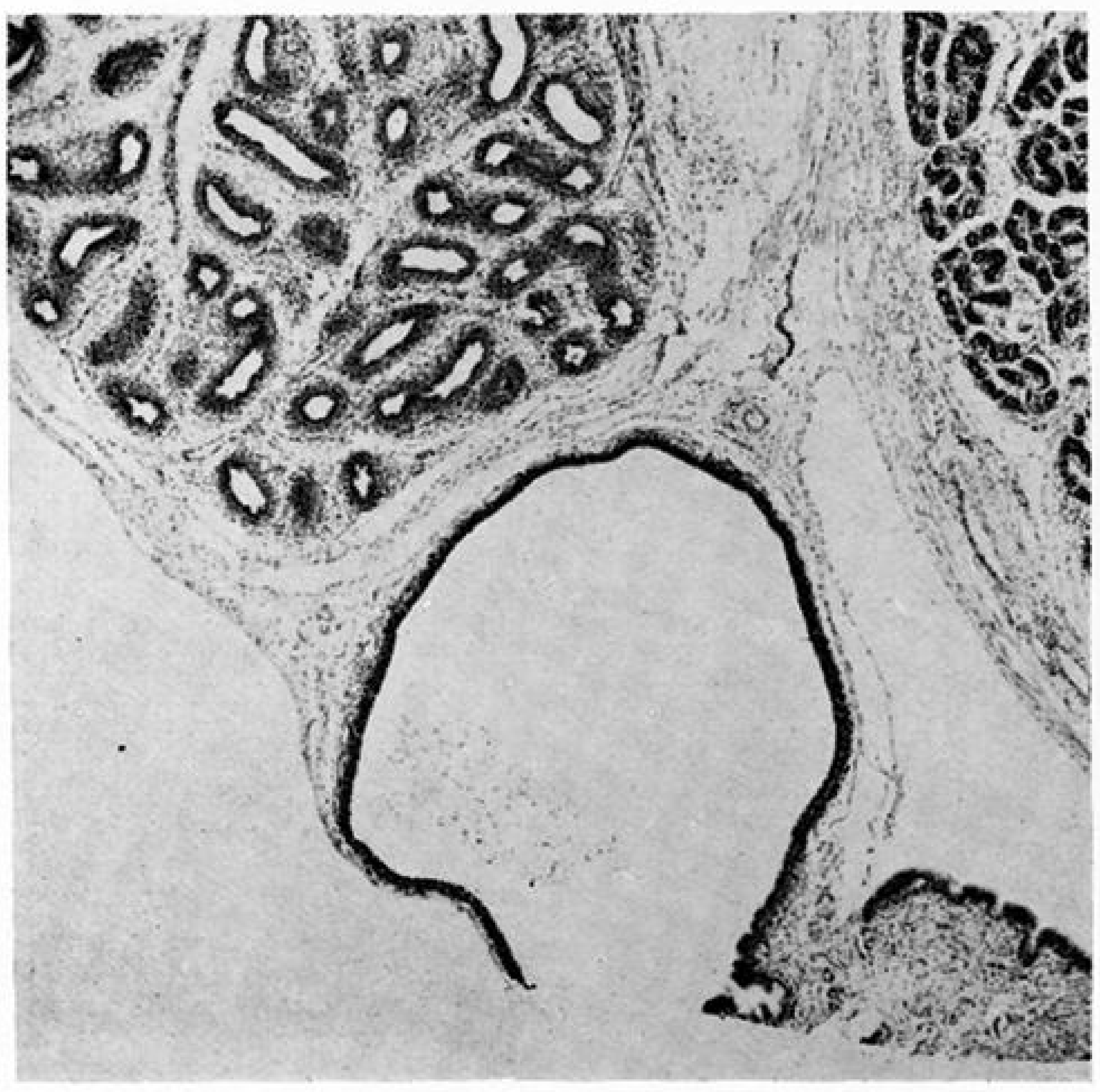


FIG. 25

FIG. 26

PLATE 20

The intercommunication of Müllerian and Wolffian structures. O.M. 135. ×22.

FIG. 22—The lowermost epididymal lobule seen in the figure is a blind coiled duct which expands to form a cyst.

FIG. 23—The cyst is shown in this figure, and closely applied to it is a hydatid of Morgagni. The deepest tubular gland in the hydatid is a central duct, presumably the cranial end of the Müllerian duct, which connects the cavity of the cyst with that of the tunica vaginalis.

FIG. 24—The central duct is seen in the centre of the hydatid.

FIG. 25—This figure shows the central Müllerian duct opening into the epididymal cyst, to which the hydatid is attached.

FIG. 26—The epithelium of the distal part of the cyst is folded; the figure shows one of the two accessory cysts which are situated in this region.