One of the most important findings in the small intestines was a previously unrecognized coccidium, *Isospora papionis* (McConnell, De Vos, Basson & De Vos,, 1971). It was found in 3 animals (B1, B4 and B16), all adult males, in which it did not produce any macroscopically recognizable lesions. It was observed mainly in the jejunum and ileum and to a lesser extent in the duodenum. Macrogametes and sporulated oocysts were found deep in the mucosa, near the base of the crypts of Lieberkühn, either within or immediately adjacent to the epithelial cells (Fig. 139 and 140). They did not appear to stimulate much of an inflammatory response. Of even greater importance was the finding of the oocysts in the skeletal muscles of 2 baboons, B1 and B39 (see *Skeletal muscle* for a description of the lesion). Interestingly, the coccidia could not be found in the intestine of B39, either on histological examination or in scrapings of the mucosa.

Even though this coccidium differed morphologically from those found in other primates, including man, the possiblility of it being associated with a zoonosis was considered. Another consideration was the significance of the muscle location in the life-cycle. Frenkel & Dubey (1972) have proved that rodents may act as intermediate hosts of feline coccidiosis and Dubey & Frenkel (1972) have found asexual stages of *Isospora felis* and *I. rivolta* in extra-intestinal tissues, including skeletal muscles. Application of these findings to *I. papionis* leads to speculation as to whether carnivores such as leopards and lions, which are the primary predators of baboons in the KNP, might be involved in the life-cycle.

Portions of ectopic pancreas were found in the wall of the duodenum of 3 animals (see *Pancreas* for a description of this finding). Two cases of multiple post-mortem intussusceptions were observed.

Large intestine

One hundred were examined macroscopically and microscopically. The only lesions observed were parasitic in origin.

Oesophagostomum bifurcum adults were found in 82 cases and their developing nodules were observed in the wall of the intestine in 68 animals. Very young baboons (<2 kg) were not affected. A majority of the adult nematodes were found in the caecum and proximal half of the colon. They were usually lying free on the mucosa or admixed with the ingesta. The nodules were also more prevalent in the proximal portions of the large intestine. They were uniform in size (6–8 mm diameter) and usually black, although a few red ones were noted, and appeared to be more frequent along *taenia* (Fig. 141). On cut surface the nodules contained a black tarry material in which an immature stage of the parasite was often present. Microscopically these nodules usually occurred within the submucosa (Fig. 142), but involvement of the muscle layer was not uncommon. The lesion consisted of central necropurulent material in which the offending parasite was found (Fig. 143). Bright red polygonal (often hexagonal) crystals sometimes seen scattered within this necrotic mass (Fig. 144) were comparable to those of the *Hepatocystis*-induced lesions in the liver and were therefore also considered to be Charcot-Leyden crystals. The wall of each nodule comprised an internal layer, almost entirely composed of brownish-grey pigment-laden macrophages and multinucleated foreign-body giant cells, surrounded by a mixture of smaller mononuclear cells and eosinophiles. The entire lesion was enclosed in a fairly well-developed fibrous capsule. Occasionally, an old scar with pigment-laden macrophages was found in the submucosa and/or muscle.

Oesophagostomum spp. have been found with a high frequency in most studies of the parasitic fauna of the baboon (Myers & Kuntz, 1965; Kuntz *et al.*, in press). Ruch (1959) thought that oesophagostomiasis was one of the most serious of all parasitic diseases of primates. The results of the present study confirm the high infestation rate, but even the most heavily infested of our baboons were in a good state of nutrition, indicating that a fairly good host-parasite relationship existed at this infestation rate. Untoward effects, however, can be foreseen with more severe infestations, especially under unhygienic circumstances.

The other parasite (more probably a commensal) of interest in the large intestine was *Balantidium*. These large ciliated protozoa were found on the mucosa or in the crypts (Fig. 145), mainly in the caecum and proximal colon, of 47 animals of both sexes. As a group, only the very young (<2 kg) appeared to be free from the infection. Although *Balantidium* has been incriminated as the cause of dysentery in several species of primates (Ruch, 1959), it did not appear to cause any lesion in the animals studied. One interesting feature concerning the epidemiology was that only 4 of the last 20 baboons examined were infested. The KNP had received good rains the season prior to examination of this group and the veld was in an extremely favourable condition, with plenty of food available, so the levels of infestation may have been inversely proportional to the level of nutrition.

Schistosomes were observed in the large intestine of 5 animals, 4 males and 1 female (3 adults and 2 larger adolescents). Adult parasites were found in the mesenteric vessels, usually close to the intestine itself (Fig. 146 and 147). Microscopic lesions attributable to this trematode were observed only in 2 cases. These consisted of well-developed multifocal granulomas surrounding ova in the lamina propria, usually near the base of the crypts (Fig. 148 and 149). There were numerous eosinophiles in the inflammatory reaction. The importance of this parasite is discussed in the section on the *Liver*. The lesion in the large intestine clearly indicated that the ova were in a position to be voided (at least in 2 cases), thus completing the life-cycle. The other important feature is that the infestation rate based on macroscopical and histopathological observations was much higher than on faecal examination, where ova were only found in 1 of 99 samples (Table 4).

Faecal examination

Protozoa

Protozoan parasites and commensals are listed in Table 4. Because permanently stained slides were lacking, recognition of protozoa at the specific level was difficult. Those assigned to *Entamoeba* sp. constitute a group of mixed species, including *Entamoeba histolytica, Entamoeba hartmanni* and *Entamoeba chattoni,* as well as other nondescript amoebae, which are commonly reported as parasites of the baboon.

Faecal studies on other groups of baboons (Powell & Elsdon-Dew, 1961; Myers *et al.*, 1971) have included observations on different species morphologically indistinguishable from those of man. In all the studies, including the present one, the incidence of *Balantidium* was high.

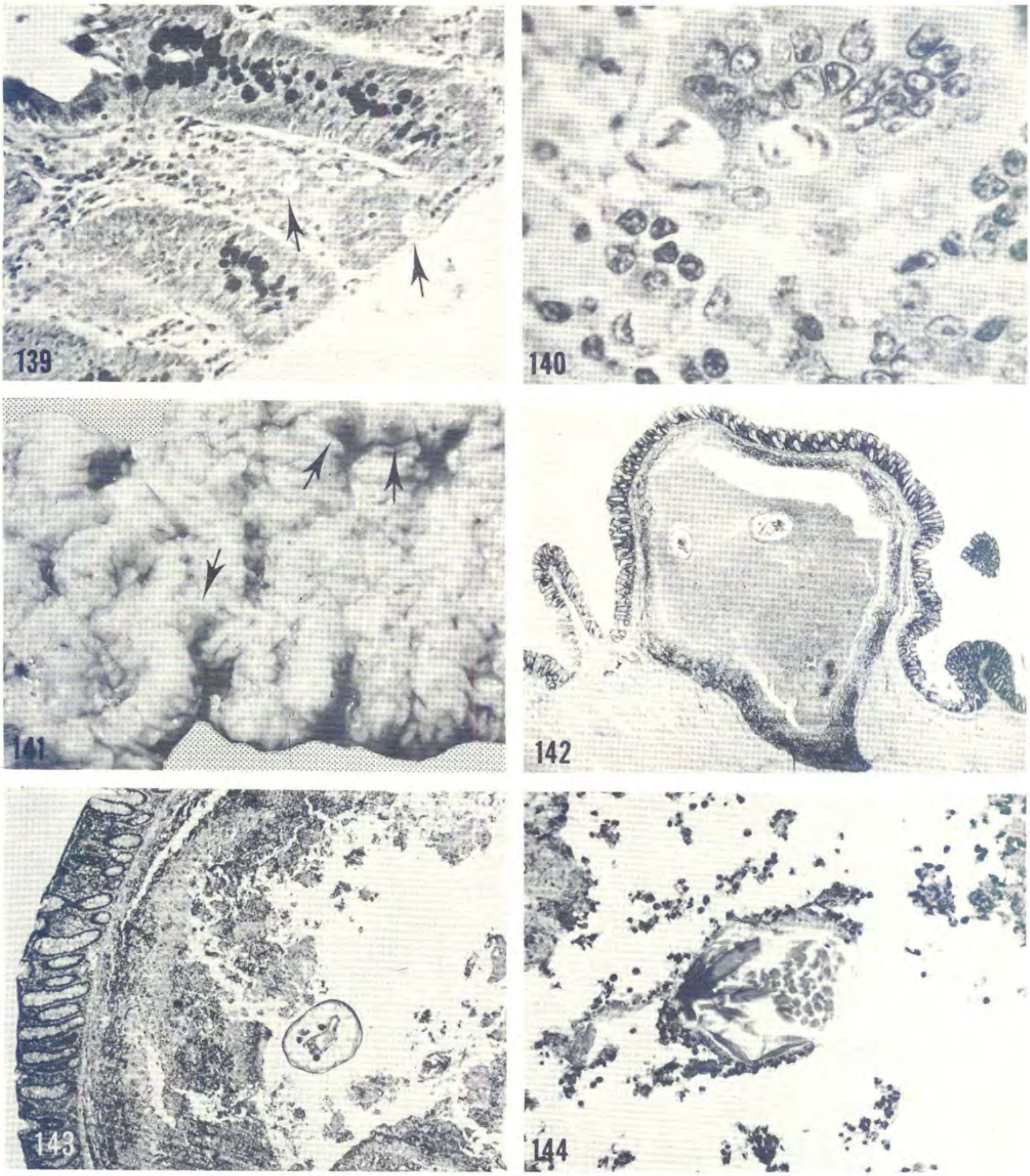

FIG. 139–144. 139. Jejunum from B4 showing developing stages of *Isospora papionis* (arrows). Giemsa ×75
140. Section showing two sporulated oocysts. HE×200
141. A portion of B77 showing dark nodules (arrows) caused by *Oesophagostomum* sp.
142. Section through *Oesophagostomum* sp. nodule showing its position in the submocosa. Note the cross sections of the parasite. HE×12
143. Higher magnification showing intact epithelium and cross section of parasite surrounded by muco-purulent debris. HE×30
144. Photomicrograph of a group of Charcot-Leyden-like crystals within the debris. HE×200

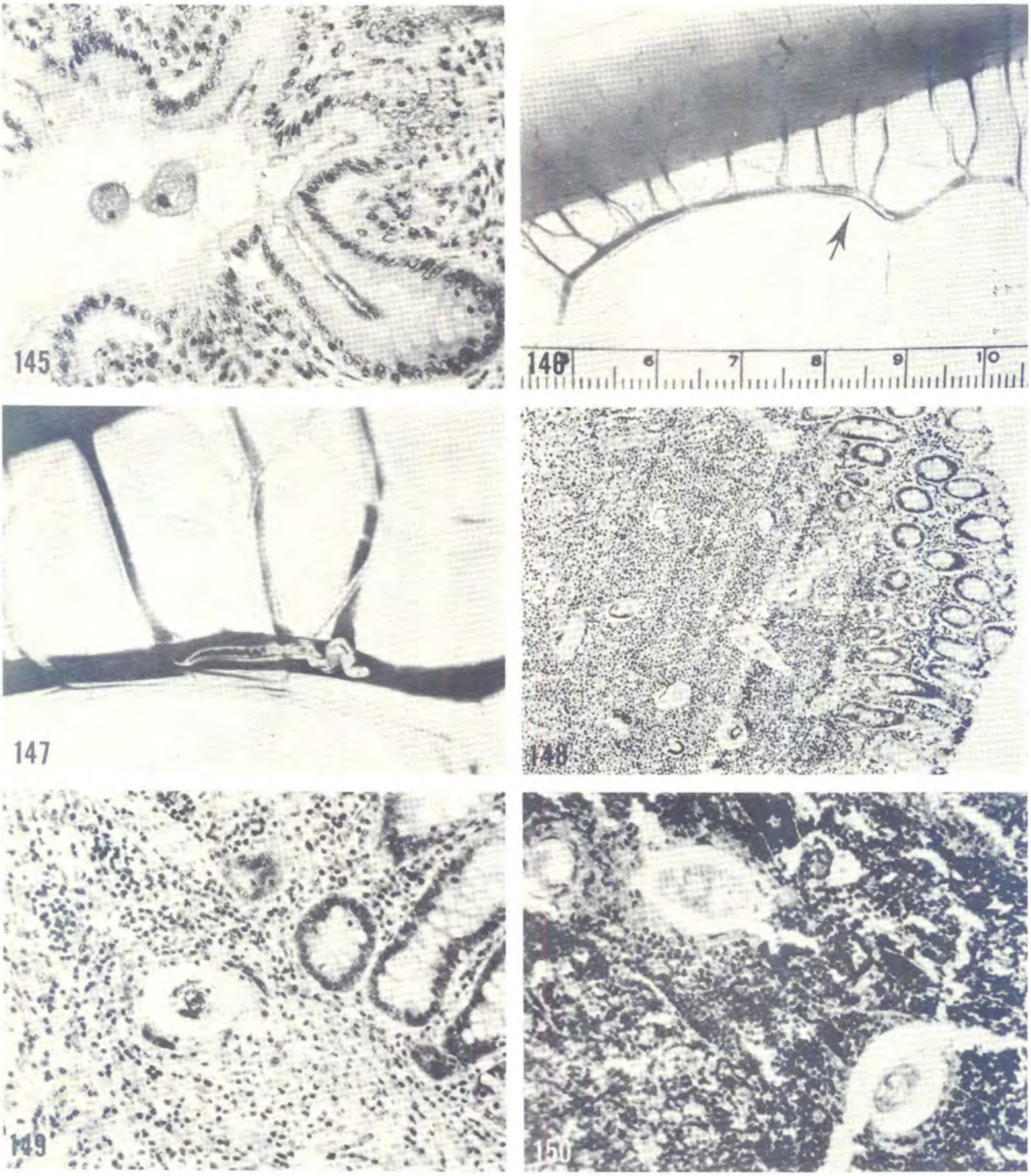

FIG. 145–150. 145. Superficial mucosa of the colon of B26 showing two *Balantidium*. HE × 200
146. Mesenteric vessel from B64 which contains a pair of adult schistosomes (arrow).
147. Closer view of parasites in Fig. 146. × 2
148. Section of mucosa from the colon of B64. Several schistosome ova (*S. mattheei*) are seen scattered in the dense inflammatory infiltrate. HE × 75
149. A higher magnification showing one ovum. Note the multinucleated giant cell at one edge. HE × 200
150. Two ova of *S. mattheei* in a mesenteric lymph node of B63. HE × 200

Helminths

The baboon serves as a host to a broad spectrum of helminths (Myers & Kuntz, 1965). Identification of helminths from their eggs is far from satisfactory (Myers, 1970; Orihel, 1970); most of the nematode eggs encountered have been grouped together simply as strongyle eggs (Table 4) and these were seen at varying stages of development. A more careful, critical analysis is necessary at the time of stool collections to identify the strongyle group on the basis of Harada-Mori culture (Myers, 1970). *Strongyloides* sp. infections, however, were based on the recognition of larvae in the faecal specimens.

There was a complete absence of *Trichuris* in both stools and autopsy, in contrast to the findings in other studies of South African baboons (Myers *et al.*, 1971).

Mesenteric lymph nodes

One hundred were examined macroscopically and 99 microscopically. The commonest lesion (37) was the presence of large amounts of pigment within the macrophages of the medulla. It corresponded mostly to the pigment associated with oesophagostomiasis. In the 2 cases with intestinal lesions due to schistosomes, typical pigment was found in the associated mesenteric lymph nodes and in 1 of these (B63), schistosome ova were found in granulomas within the lymph node (Fig. 150). Increased numbers of eosinophiles were observed in 4 cases, all of which had abnormal amounts of pigment, and it was felt that this might have been the cause.

Hyalinized germinal centres, as described in the spleen and other lymph nodes, were observed in 5 baboons, 1 of them (B56) a youngish female (3,2 kg). These centres undoubtedly have the same importance as those described in other areas. There was also 1 case (B5) with a macroscopically visible abscess of unknown origin.

Urinary system

Kidney

One hundred were examined macroscopically and microscopically. The right and left kidneys were mass measured individually (Table 2) and the masses given below refer to a single kidney. There was a moderate variation in masses from 0,108–0,327% BM (B95, with a mass of 0,444% BM, was not considered part of the normal range because it was enlarged and oedematous). The mean% BM of the right kidney (0,191) was slightly more than that of the left (0,188) (Table 3). Most of the masses (84%) fell within the relatively small range of 0,15–0,25% BM. There was a significant decrease in % BM from immature to mature animals.

Macroscopically visible cortical cysts were found in the kidneys of 16 adult baboons, 13 males and 3 females, varying in mass from 16,6–30,9 kg. They were usually on the external surface just beneath the capsule, were dark brown, varied in diameter from 2–10 mm and contained a clear slightly brownish fluid (Fig. 151). Microscopically they were lined by a single layer of flat epithelium and tended to compress the surrounding parenchyma (Fig. 152). They contained a pale basophilic serous-like material. A further 9 animals, 2 males and 7 females, showed a few microscopic, morphologically similar cysts but these were clearly identified as cystic dilatations of tubules (Fig. 153). This finding supported the theory that the cysts were of tubular origin, similar to those described by Maruffo & Cramer (1967) in monkeys, and should have a continuous lumen both proximally and distally (Osathanondh & Potter, 1964). There were no inflammatory lesions associated with either the macro- or microcysts. According to the classification by Anderson (1966) these cysts would be of the solitary or retention type and therefore either congenital or the result of tubular obstruction. As there were very few of them, and there were no tubular casts, concomitant inflammatory disease or scarring, the majority were considered to be congenital. Being so few they would have had no effect on the general renal efficacy.

The commonest lesions were scattered foci of very mild interstitial nephritis found in 24 baboons, 18 males and 6 females. With the exception of 1 baboon (B99, mass 5,0 kg) all were sexually mature. The inflammatory infiltrate consisted of from 1 to several poorly circumscribed foci located near the arcuate arteries, often circumferentially (Fig. 154). These foci were composed almost entirely of lymphocytes with a few plasma cells and an occasional histiocyte. There was no evidence of associated connective tissue proliferation and scarring or glomerular and tubular damage.

Subacute interstitial nephritis, as described above, is the commonest type of nephritis in animals (Smith & Jones, 1966) but is rather rare in man (Anderson, 1966). In animals it has been associated with viruses, protozoa and bacteria, especially *Leptospira* spp., and even with helminths. A parasitic origin for the cases in this study can probably be ruled out because eosinophiles were absent. A possible relationship with leptospirosis was examined by evaluating the specific antibody levels against several *Leptospira* spp. Since none of the 100 animals tested had positive titres, it was immediately obvious that there was no correlation. The same was true for toxoplasmosis. Although there were 11 baboons with positive toxoplasma titres only 4 had interstitial nephritis. It became apparent, however, that the renal lesions were part of a more widespread manifestation of lymhocytic proliferation because similar mononuclear reactions occurred in the hearts of 75% (18 of 24). It is unfortunate that the initial virological studies had to be discontinued, as a virus appeared to be the most plausible explanation for the lymphocytic reaction in these organs. Similar lesions were observed by Henderson *et al.* (1970) in their series of 8 woolly monkeys and by Kim *et al.* (1968), who found the lesion in 8,6% of 99 baboons. They were unable to determine a causative agent.

Frank nephrosis was observed in 5 adults, 4 females and 1 male. Four cases were similar microscopically but varied in the degree of involvement, while the remaining case was entirely different. These 2 types will therefore be described and discussed separately.

The group of 4 (B41, B62, B71, B95) showed tubular changes ranging from mild cloudy swelling to necrosis with the formation of hyaline and granular casts in the most severely affected baboon (B95) (Fig. 155 and 156). In this latter animal the kidneys were obviously enlarged macroscopically and the right and left kidney measured 0,444 and 0,424% BM respectively, which was double the average for adults. The casts were bright red, resembling haemoglobin. This animal also had severe capture myopathy and it was therefore assumed that this lesion was probably myoglobinuric nephrosis. Two of the other 3 baboons in this group also had capture myopathy but to a milder degree (see *Skeletal muscle*).

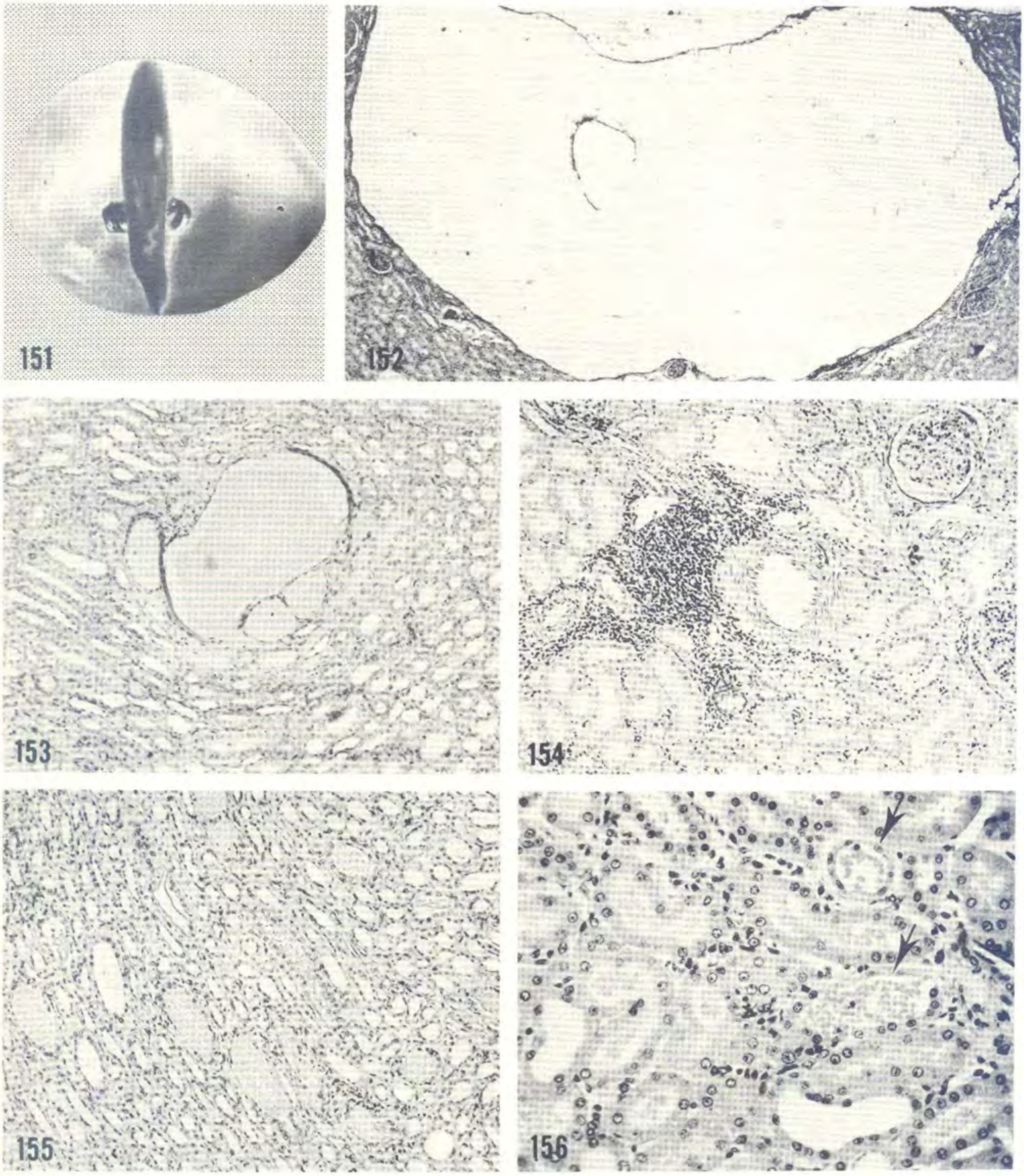

FIG. 151–156. 151. Kidney from B39 showing cyst on surface. The cut surface shows that the cyst extends into the parenchyma for approximately the same distance as the surface diameter

152. Photomicrograph of similar cyst from B27. Note the delicate thin wall and compression of the adjacent parenchyma. HE × 30

153. Section through a renal microcyst near the corticomedullary junction. These were thought to be tubular dilatations (B72). HE × 75

154. Poorly circumscribed focus of lymphocytes near a small artery (B2). HE × 75

155. Section of renal medulla of B95 showing numerous dilated tubules filled with casts. HE × 75

156. Higher magnification showing granular nature of this material (arrows). The material was thought to be myoglobin. HE × 200

The kidneys of the other baboon (B59) differed macroscopically as they were not distinctly swollen but had large well-demarcated pallid areas. Microscopically they revealed sharply delineated wedge-shaped areas of tubular dilatation with the apices pointing toward the medulla (Fig. 157). Many hyaline casts were present but the most striking feature was the presence of numerous transparent refractile anisotropic rosette-like crystals (Fig. 158). These were identified as calcium oxalate crystals by the microincineration technique described by Thompson (1966). One group of plants containing oxalic acid known to be eaten in quantity by baboons in the KNP is that of wild grapes (*Cissus* spp.) (Steyn, 1949).

Karyomegaly of the epithelial-lining cells of the convoluted tubules was observed in 10 adult baboons, 7 males and 3 females. These enlarged nuclei were slightly more vesicular, twice or three times normal size and tended to become more oval (Fig. 159). The cell as a whole also tended to be enlarged, but this was difficult to judge because of the indistinct cell outlines. All 10 cases also had megalocytic changes in the liver (see *Liver*). Similar changes were found in the kidneys of vervet monkeys (*Cercopithecus aethiops*) after chronic exposure to retrorsine, a pyrrolizidine alkaloid (Purchase *et al.*, in press).

Six animals (1 male and 5 females) had mild sclerotic changes in the larger renal arteries. All were adults varying in mass from 13,6–26,4 kg. The lesions consisted of an uneven fibromuscular proliferation between the endothelium and the internal elastic membrane (Fig. 160). Unlike the aortic lesions the elastic membrane remained intact in the renal vessels. Evidence of mineralization was absent. Only the last 20 baboons were examined in detail for this lesion and the true incidence should therefore be higher than is suggested by these results. Van der Watt (1972), in a study of baboons from the KNP specifically designed to determine the natural incidence of arteriosclerosis, found similar arterial lesions in the kidney in 11 of 77 (14,3%) animals (see *Heart* for a discussion of arteriosclerosis.)

Interstitial mineralization in the renal medulla, especially near the pelvis, was observed in 6 adults, 3 males and 3 females, which varied in mass from 10,9–30,9 kg. The mineral was in the form of discrete foci which displaced the adjacent fibrous connective tissue and there was no associated inflammatory reaction (Fig. 161). It stained red with Alizarin-Red-S, which characterized it as a calcium salt. Involvement was never severe enough to cause renal dysfunction. According to Jubb & Kennedy (1970) this lesion is common in animals and is of no pathological significance.

Eosinophilic intracytoplasmic "inclusions" of the type occurring in the urinary bladder (see below) were found in the epithelial cells of the renal pelvis (Fig. 162) of 20 cases (10 males and 10 females) measuring from 1,8–30,5 kg. They were also noted in the distal portion of the collecting tubules in several of these cases (Fig. 163). (See *Urinary Bladder* for discussion.)

Urinary Bladder

One hundred were examined macroscopically and 80 microscopically. The only important macroscopic finding was in 3 adult males that had white semisolid jelly-like material in the urinary bladder and proximal urethra (Fig. 164). It was comparable to and interpreted as being coagulated ejaculate, which has been observed by one of us (E.E.M.) in other primates. Evidently there was retrograde passage of the ejaculate back into the bladder, where stasis and coagulation occurred. No pathological changes were associated with this finding. In zoological gardens and other places where monkeys are kept in captivity, pieces of this coagulum are often found on the floor of the cage.

There were 9 cases of very mild or mild lymphocytic cystitis, 8 of them in males, both young and old. The lesion consisted of diffuse accumulations of lymphocytes and a few plasma cells in the lamina propria (Fig. 165). There was no evidence of epithelial thickening or ulceration. Seven of the 9 affected baboons also showed mononuclear infiltrates in the kidney; these lesions therefore appeared to be related.

Numerous eosinophilic, round, homogeneous intracytoplasmic inclusions were observed in the transitional epithelium in 61 (76,2%) animals. They were most evident in the superficial cells and were also larger in this area (Fig. 166). In the deeper layers they tended to be smaller and fewer in number. They frequently contained small vacuoles and appeared to be surrounded by a clear halo. Tinctorially the inclusions resembled erythrocytes, but their usually smaller and variable size, intracytoplasmic location and other characteristic features made them clearly distinguishable. As noted in other portions of this paper, the inclusions were found in all areas of the urinary tract, from the distal collecting ducts to the penile urethra. Identical inclusions were found in the urinary bladder epithelium of Rhesus monkeys (*Macaca mulatta*) by Lucas, Moser & Schardein (1972). They determined by electron microscopic studies that the inclusions are aggregates of fibrils indistinguishable in structures from tonofilaments, but their function or significance could not be determined. Similar intracytoplasmic inclusions were observed by Basson, McCully, De Vos, Young & Kruger (1971) in the urinary bladder of elephants (*Loxodonta africanus*), but they were also unable to determine the significance of these structures.

Male Genital System

An effort was made to determine sexual maturity based on spermatogenesis. The male chacma baboon in the KNP apparently reaches the stage of active spermatogenesis at about 13 kg because B33 (13,2 kg) showed active spermatogenesis while B80 (13,4 kg) was still infertile (based on testicular histology). This does not mean, however, that these baboons were allowed to breed at this age. Saayman (1970) has shown that only the older males, which have established a fairly dominant position in the hierarchy of a troop, mate with females during their fertile period.

Testicle

Sixty three were examined macroscopically and microscopically. Mild disseminated foci of chronic periorchitis was found in 6 older males (23,6–31,1 kg). It appeared usually as multiple small tags (2–3 mm thick), which sometimes adhered to the visceral and parietal layers of the *tunica vaginalis* (Fig. 167), and was either unilateral or bilateral. Microscopically, each tag consisted of a dense band of mature fibrous connective tissue containing a few scattered plasma cells and lymphocytes (Fig. 168). It was invariably mild and could not have impaired fertility. There was no evidence of concomitant lesions in the seminiferous tubules.

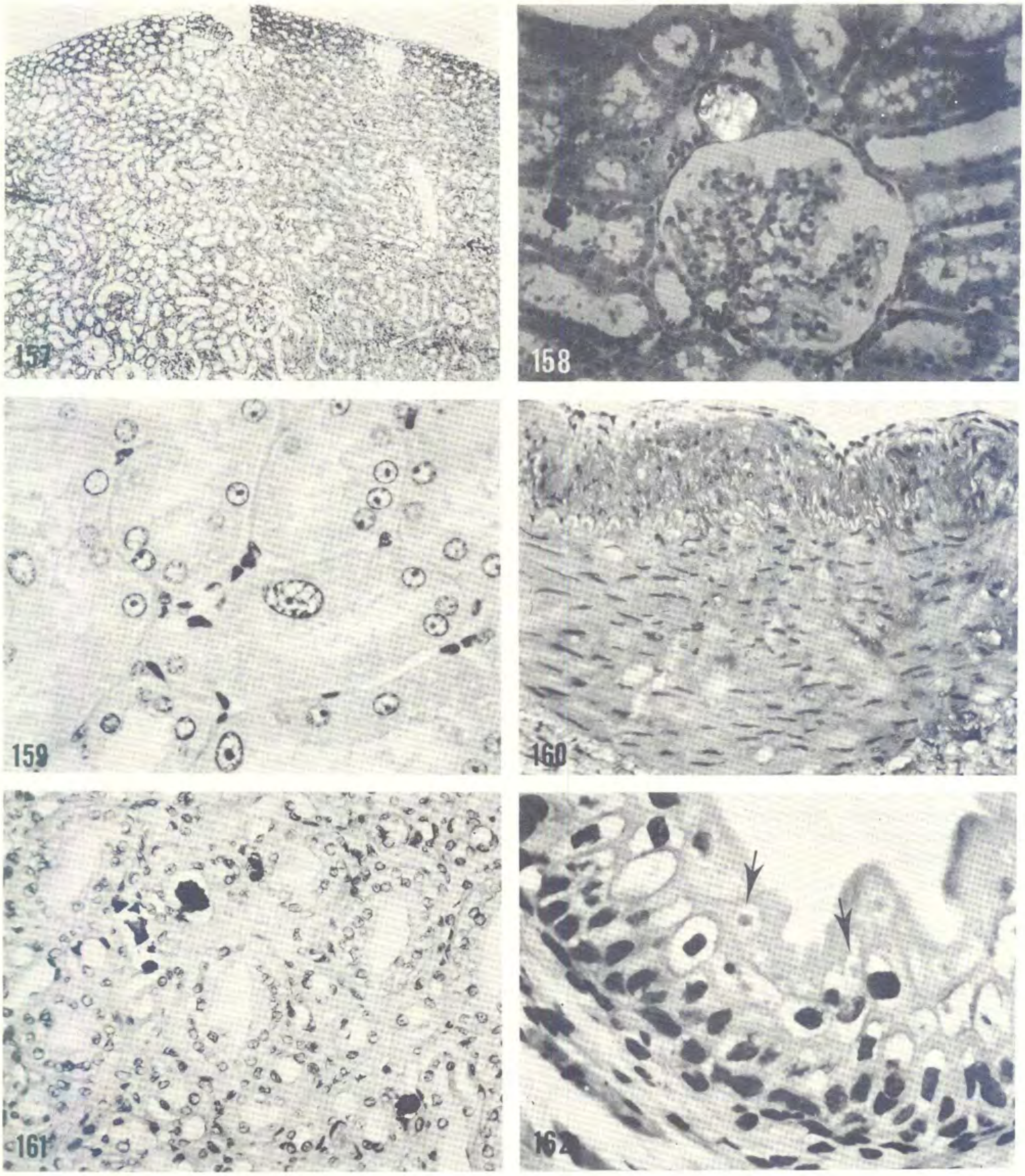

FIG. 157–162. 157. Section from the renal cortex of B59 which shows a well delineated area of tubular dilatation on left. This lesion was caused by oxylate crystals which blocked the tubules. HE × 30

158. Section of oxylate crystal (arrows) in a tubule adjacent to a glomerulus as seen with polarized light. HE × 200
159. Karyomegaly of the renal tubular epithelium in B32. This lesion was invariably associated with megalocytosis in the liver. HE × 500
160. Moderate fibromuscular proliferation between the endothelium and the internal elastic membrane of a renal artery (B88). HE × 200
161. Foci of interstitial mineralization in the renal medulla of B26. HE × 200
162. Numerous intracytoplasmic inclusions in the transitional epithelial lining the renal pelvis (arrows). HE × 500

One case (B37) had mild focal atrophy of the seminiferous tubules, in which there were microscopic areas where the tubules consisted only of a single layer of spermatogonia and a few Sertoli cells (Fig. 169). Adjacent tubules were normal. The epididymis contained numerous spermatozoa and the animal was probably still fertile.

Epididymis

Sixty three were examined macroscopically and microscopically. A single cyst was found in the epididymis of B92. The thin fibrous capsule, whose wall was almost non-existent in parts, was filled with spermatozoa and a few inflammatory cells, some of which were multinucleated giant cells. Several of the older baboons had intracytoplasmic accumulations of a fine granular yellowish-brown isotropic pigment in the epithelial cells (Fig. 170). It was PAS positive, pink with the 24-hour ORO and negative with Prussian blue, thus suggesting a lipochrome nature. It probably represents an aging change similar to lipofuscinosis in other organs. One baboon (B32) had several well-defined intranuclear eosinophilic and frequently angular inclusions in the epithelial cells (Fig. 171). The explanation of this finding is not known, although this same animal had megalocytosis of the liver with the associated intranuclear inclusions, and it may be related to that syndrome (see *Liver*).

Prostate

Sixty three were examined macroscopically and 53 microscopically. Twenty baboons (37,7%) showed mild prostatitis with focal accumulations of lymphocytes and plasma cells randomly distributed throughout the interstitium. These tended to be centred mostly around degenerated and necrotic glands (Fig. 172) which probably provoked the reaction. Fourteen (70%) of these baboons, however, also had a lymphocytic myocarditis, 9 (45%) had lymphocytic nephritis and 8 had both myocardial and renal lesions. These correlations, however, are not very convincing, and either a systemic disease or a localized lesion is therefore possible.

While statistics on chronic prostatitis in non-human primates are not available, it is known to be relatively common among old dogs (Jubb & Kennedy, 1970). According to Anderson (1966), over 70% of men over the age of 50 years show a similar change. In the present study the incidence of this lesion in sexually mature baboons was 46,5% (20 of 43) and this clearly showed that, whatever the cause, mild prostatitis is certainly common among older males.

Cystic dilatation of the glands with flattening of the epithelium to an almost squamous type was found in 12 (22,6%) large adults (21,8–37,3 kg) (Fig. 173). These spaces contained a fine pink granular material resembling the normal secretion. There was little increase in the interglandular connective tissue, but 8 of these baboons with cystic changes (66,7%) had concomitant lymphocytic infiltration. An interesting aspect was the much more pronounced cystic changes in the caudal lobe, especially the lateral portion. Overall it resembled the prostatic lesion in old dogs which Smith & Jones (1966) referred to as "cystic glandular hyperplasia". In the baboon it was more diffuse and therefore could not be compared to nodular hyperplasia of man as described by Dixon & Moore (1952). The lesion was probably related to aging, much the same as in other animals and man. There was no suggestion of neoplasia or even serious effects from this cystic degeneration.

Seminal vesicles

Sixty three were examined macroscopically and 52 microscopically. The only abnormality observed was the presence of small bodies at the base of the glands, somewhat resembling corpora amylacea (Fig. 174), in 12 older adults (23,1%) measuring 20,0–30,5 kg. Rather than being true corpora amylacea, these bodies were interpreted more as an inspissated secretion, since they were apparently not laminated. They were undoubtedly of little pathological or clinical importance.

Penis

Sixty three were examined macroscopically and 17 microscopically. One baboon (B86) showed polymorphonuclear infiltration in the epithelium of the terminal penile urethra. It was interpreted as probably resulting from a subacute urethritis of unknown origin and little consequence. The only other abnormality was the presence in a few cases of intracytoplasmic inclusions of the urethral epithelium identical to those described earlier (see *Urinary bladder*).

Female Genital System

There were 37 females in this study. An effort was made to correlate puberty with body mass. This proved to be somewhat difficult because the criteria used for determining puberty, *viz.*, Graafian follicular development, corpora lutea, the presence of a heat syndrome and evidence of past pregnancy, were not—taken individually— entirely reliable for the following reasons. Firstly, the finding of either a Graafian follicle or corpus luteum (CL) was considered a positive indication of sexual maturity; a receding CL, however, could easily be missed both macroscopically and microscopically. Secondly, the absence of the heat syndrome at autopsy was not necessarily indicative of sexual immaturity. Thirdly, past pregnancy was readily detectable by the presence of vascular lesions (pregnancy sclerosis) in the uterus (see below), but absence of these lesions did not necessarily imply immaturity. Nevertheless, an overall impression of the onset of puberty was gained by comparing these 3 criteria. For instance, a heat syndrome with an associated Graafian follicle was found in a 10,7 kg animal (B61). The smallest baboon (11,8 kg) with evidence of past pregnancy was B54. It would appear, therefore, that puberty may be attained in any female at about 11 kg live mass in the KNP. Three females [B25 (12,3 kg), B45 (12,7 kg) and B89 (14,1 kg)] did not show evidence of past pregnancy. This is significant when one considers the studies on the menstrual cycle of the chacma baboon by Saayman (1970). The promiscuous nature of the female baboon in oestrus, if this is accompanied by ovulation, should result in pregnancy in every cycle. An investigation by Gilbert & Gillman (1960a) lends credence to our observations. They studied a series of 15 female chacma baboons born in captivity to determine the onset of puberty based on turgescence of the sex skin. Their results showed that there was little correlation between age and puberty since it occurred between 2½ and 3½ years of age. With 1 exception, however, all animals were between 10 and 13 kg in mass at the onset of puberty. Our findings are in accordance with theirs and it is evident that mass is a more reliable factor than age in determining the onset of puberty.

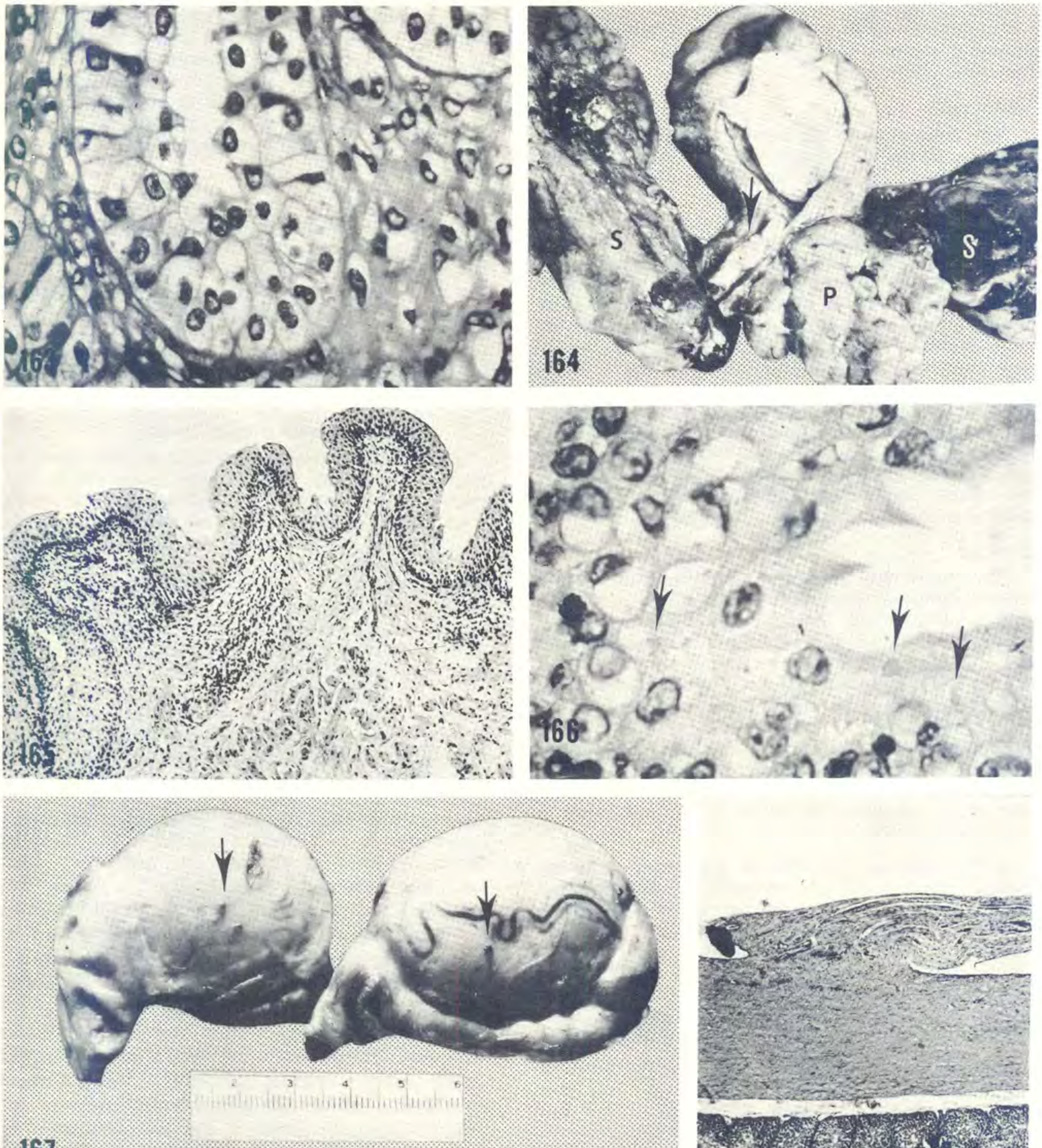

FIG. 163–168. 163. Section through renal collecting ducts showing intracytoplasmic inclusions similar to those in Fig. 162 (B94). HE × 500

164. Opened urinary bladder containing coagulated ejaculate. (Arrow points to same material in the urethra). S—seminal vesicles; P—prostate

165. Portion of urinary bladder mucosa showing diffuse infiltration of lymphocytes in the subepithelial connective tissue (B61). HE × 75

166. Urinary bladder mucosa of B86 showing numerous intracytoplasmic inclusions similar to those in Fig. 162 and 163. HE × 500

167. Testicles from B38 showing focal fibrous tags (arrows) on the visceral layer of the *tunica vaginalis*

168. Section from the above lesion showing its fibrous nature. HE × 30

Ovary

Thirty-seven were examined macroscopically and 32 microscopically. One baboon had a paraovarian cyst (B61 of 10,7 kg). This was present in the wall of the proximal left fallopian tube as a thin-walled cyst 1 cm in diameter containing a clear watery fluid (Fig. 175). Microscopically, it was located next to the fimbriae and was lined by a single layer of columnar epithelium comparable to that normally lining the fallopian tube (Fig. 176 and 177). Paraovarian cysts are known to occur commonly in all species of animals (Jubb & Kennedy, 1970).

The ovaries of 5 females contained blood vessels with a thick wall where the media were completely replaced by hyalin-like material but without any evidence of mineralization. The lumen of the affected vessel was still patent but appeared smaller in diameter than normal. This lesion was comparable to pregnancy sclerosis in the ovary and uterus as described by Cohrs (1967) in domestic animals and Henderson *et al.* (1970) in woolly monkeys. It was reported to occur as an involutionary change of the hyperplastic arteries of pregnancy and consequently as proof that pregnancy had occurred. A related lesion was found approximately 2–3 cm from the ovary in the ovarian veins of a baboon (B81) that had recently parturated. These involuting vessels contained large hard dense thrombi which must have completeley occluded the vessel (Fig. 178). However, the ovary did not appear congested or altered in any way, so collateral drainage must have been adequate.

The only other finding in the ovary which deserved special attention was the presence of mineralized ova in 10 animals. In most cases the *zona pellucida* remained intact with only the internal structures showing mineralization (Fig. 179). Many remnants of degenerated *zona pellucida* were scattered throughout most ovaries (Fig. 179). Both the above features were unrelated to old age since they were found in young females with a mass 8,2 kg (B70). They were easily distinguishable from the glassy membranes of atretic follicles and were therefore considered to be remnants of degenerating primary follicles.

Uterus

Thirty seven were examined macroscopically and 32 microscopically. Pregnancy sclerosis, similar to but much more pronounced than that in the ovary, was found in 18 baboons (Fig. 180). It was found in all areas of the uterus from the endometrium to the outer muscle layers. In 1 case (B54) there was evidence of mineralization in the walls of a few of these altered vessels. These changes were closely comparable to those described by Henderson *et al.* (1970) in woolly monkeys and by Ramsey (1960) in women.

An interesting feature in the uterus of the baboon was the hypercellular appearance of the non-gravid (Fig. 181) compared to the gravid uterus (Fig. 182). The myometrial cells of the former appeared to have very little cytoplasm. Another physiological observation warranting comment was the presence of lymphocytes and plasma cells in the submucosa of the cervix. In most cases very few of these cells were observed but during oestrus this area became so infiltrated that it mimicked an inflammatory lesion (Fig. 183). Numerous melanocytes were found routinely in the submucosa of the cervix.

Vagina

Thirty seven were examined macroscopically and 21 microscopically. No lesions were observed in the vagina. One striking feature, however, was the marked parakeratosis that occurred during oestrus (Fig. 185 and 186). It was accompanied by a mild lymphocytic infiltrate in the submucosa. This change has been correlated previously with vaginal smears by Gillman (1937).

Sex skin

During oestrus the skin around the vulva and anus became extremely swollen and blister-like and was identical to that in captive baboons as described by Gillman (1935). Microscopically, this was shown to be caused by an extreme proliferation of a delicate myxomatous tissue in the dermis and hypodermis (Fig. 184). According to Rienits (1960) this tissue contains considerable amounts of mucopolysaccharides (hyaluronic acid). Gillman (1938) showed that turgescence was directly related to oestrogen stimulation and that deturgescence was related to both a lack of oestrogen and active stimulation of progesterone (Gillman, 1940).

Mammary gland

Thirty seven were examined macroscopically and 13 microscopically. Both active and inactive glands were examined. No lesions were observed.

Central Nervous System

Brain

One hundred were examined macroscopically and 99 microscopically. The mean mass of the brain was 2,147% BM with a range of 0,540–11,416% BM (Table 3). There was an inverse ratio of % BM to total BM (age), *viz.*, the very young (<2,99 kg) averaged 7,894% BM while the adult males averaged 0,753% BM and the adult females 1,087% BM. There was a relatively small difference in brain mass of young baboons as compared to those of old ones. This compares favourably with the work of Riese, Riese & Von Bonin (1952), who found the coefficient for adult male baboons to be 0,78% BM. They did not have enough females and young baboons for comparison.

The most conspicuous macroscopical lesion observed was a large axonal hamartoma in the medulla oblongata of 2 cases (B20 and B91). In both it appeared to arise at the level of the reticular formation (immediately dorsal to the olives) just posterior to the anterior border of the medulla oblongata. It progressed through the medulla posteriorly in a slightly spiral fashion to the anterior cervical spinal cord for an unknown distance (Fig. 187 and 188). Its largest diameter (12 mm) was in the vicinity of the obex.

On coronal section the lesion was white, ovoid and of uniform consistency. It considerably distorted the normal architecture and displaced adjacent tissues. *The medial lemniscus* was markedly deviated convexly to the unafffected side (Fig. 187). Microscopically the lesion consisted of a bundle of well-myelinated normal-looking nerve fibres that were directed antero-posteriorly in a slight spiral (Fig. 189–192).

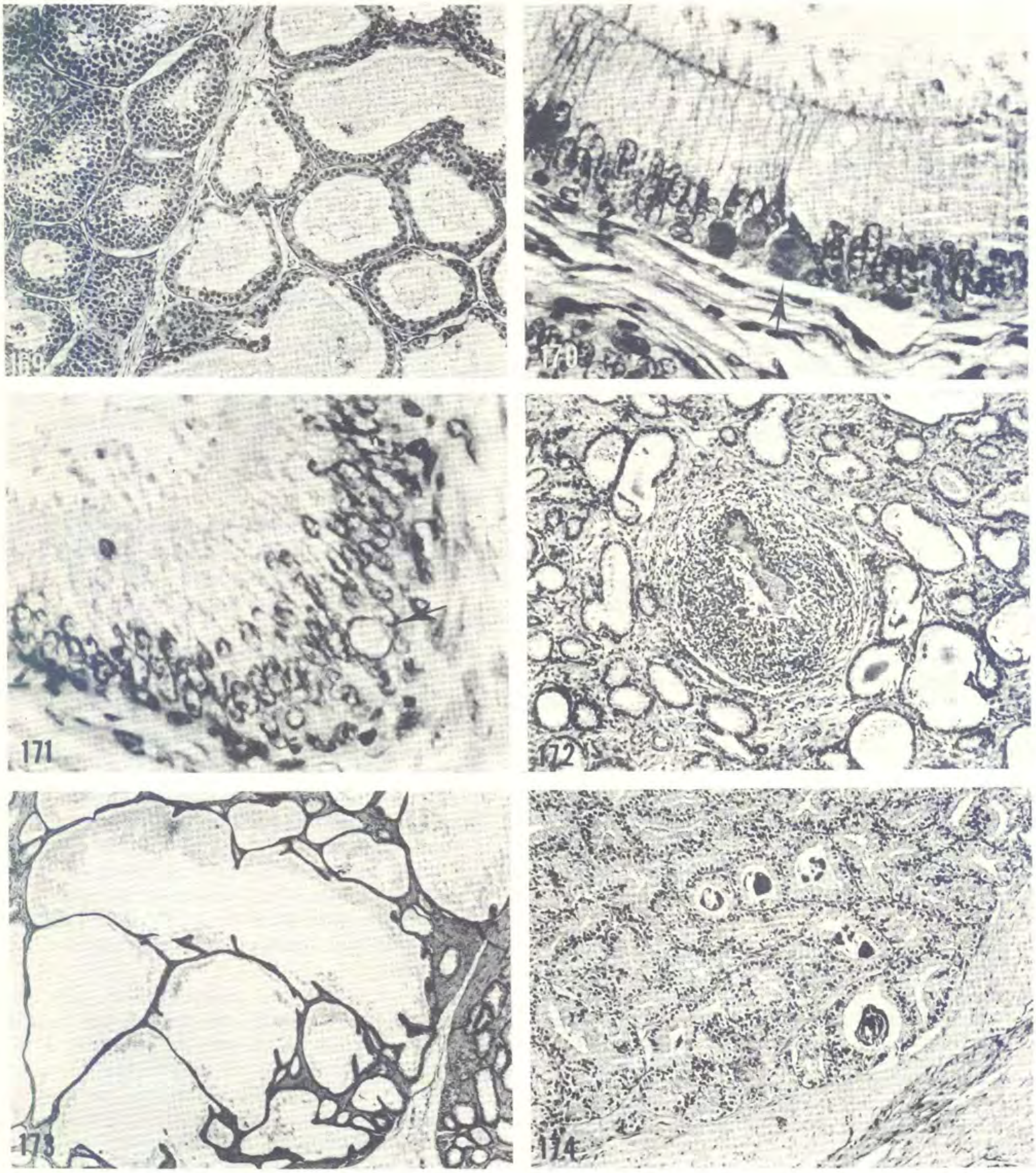

FIG. 169–174. 169. Section from the testicle of B37 showing a focal area of atrophy of the seminiferous tubules. Only a few spermatogonia and Sertoli cells remain. HE × 75

170. Epithelial lining from the epididymis of B32 showing large cells containing lipofuscin pigment (arrow). HE × 500

171. Large intranuclear inclusion (arrow) in epididymis of B32. HE × 500

172. Section of prostate containing focal area of mononuclear cells surrounding a degenerative gland (B15). HE × 75

173. An area of cystic glandular hypertrophy of the prostate of B39. HE × 30

174. Section of the seminal vesicles from B31 showing corpora amylacea-like bodies in the lumen of some glands HE × 75

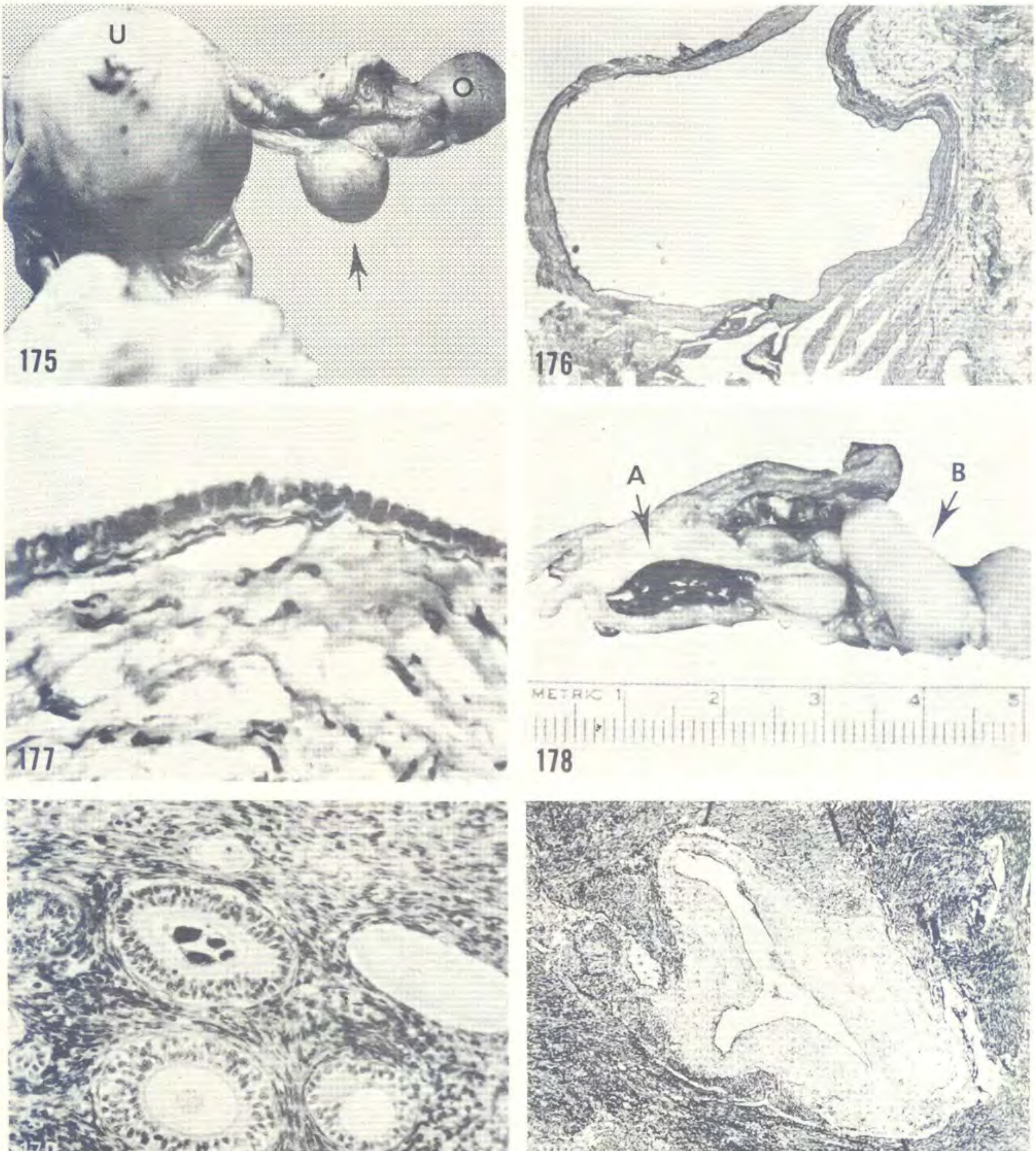

FIG. 175–180. 175. Parovarian cyst (arrow) adjacent to the left ovary (B61). O—ovary; U—uterus

176. Histopathological section from above cyst showing thin wall. Portions of the fimbria are at the bottom of photomicrograph. HE × 12

177. Higher magnification of the cyst wall which illustrates the columnar appearance of lining epithelium. HE × 500

178. Portions of an ovarian vessel from B81 with segmental thrombosis. Arrow A points to opened segment containing a thrombus. Arrow B points to an enlarged unopened segment

179. Section from the ovary of B89 containing a mineralized ovum. Note the residual *zona pellucida* to the right. HE × 200

180. Portion of uterine vessel with thickened hyalinized wall (pregnancy sclerosis) (B14). HE × 30

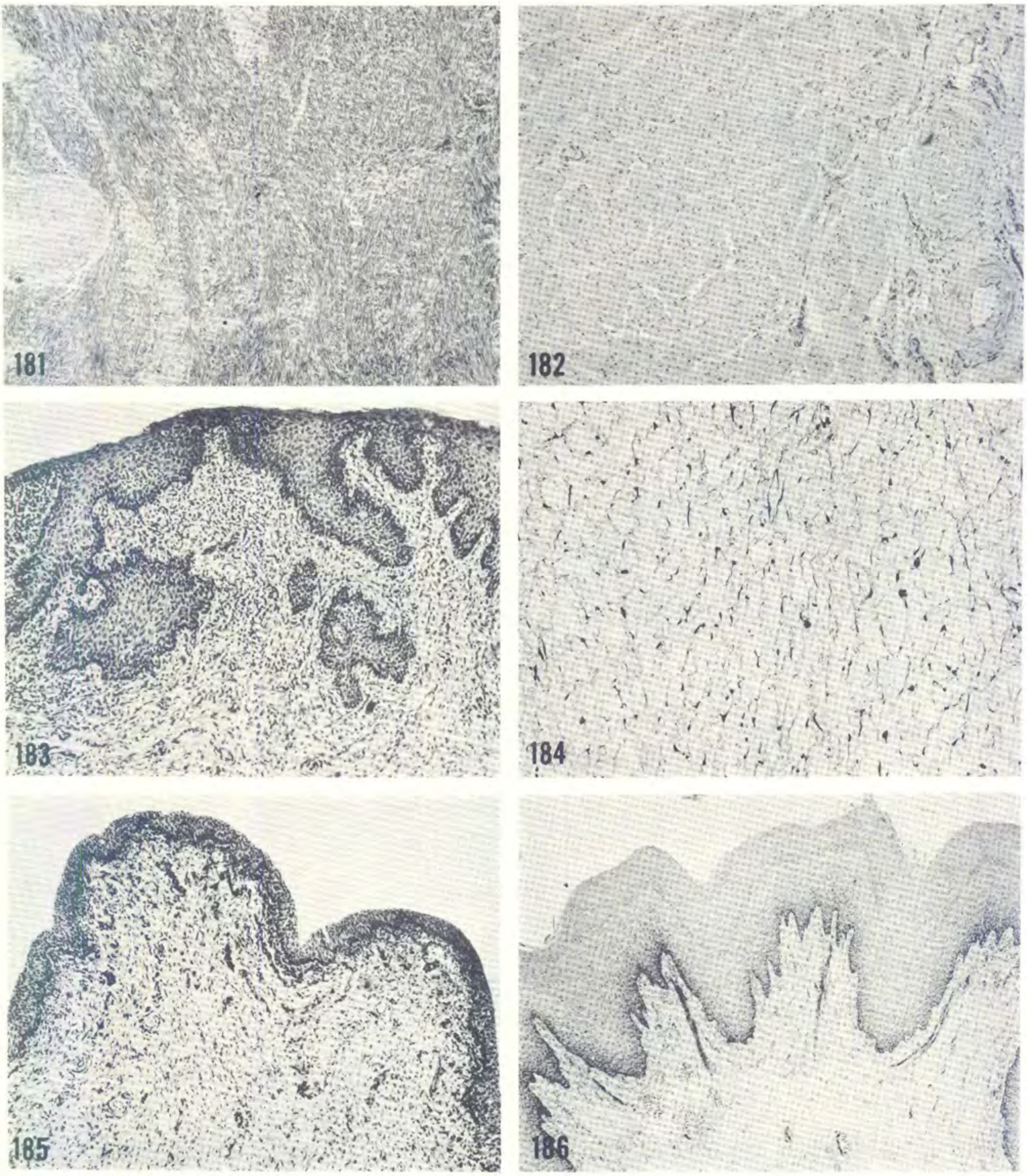

FIG. 181–186. 181. Section from a non-gravid uterus (B43) showing hypercellular appearance of the myometrium. HE×75
182. Similar area of uterus from a gravid baboon (B67) at the same magnification as Fig. 181. Note that in contrast to the former the sarcoplasma is readily apparent. HE×75
183. Cervix from a gravid female (B9) showing lymphocytic infiltrate of submucosa. HE×75
184. Section showing the myxomatous appearance of the perivulvar "Sex skin" during oestrus (B 28). H E x 75
185. Section from the vagina during anoestrus (B51). HE×75
186. Same magnification of vagina during oestrus (B28). Note the marked hyperplastic and parakeratotic epithelium. HE×75

The lesion was well circumscribed but not encapsulated. Adjacent tissues were compressed and distorted, with indications of swollen degenerating axis cylinders and a few necrotic neurones. No evidence of an inflammatory reaction was observed. Overall it resembled a very enlarged myelinated nerve tract. It did not look like any of the recognized anomalous lesions (Blackwood, McMenemey, Meyer, Norman & Russell, 1963; Innes & Saunders, 1962). The term axonal hamartoma was chosen to denote an abnormal but non-neoplastic growth of myelinated nerve fibres. No sections of the anterior portions of the cervical spinal cord were available for study in either case, but the impression was gained that the axonal hamartoma could have developed from the cortico-spinal tracts and pyramidal decussation with protrusion into the reticular formation.

The aetiology of the hamartoma was not determined, but certain facts are worth mentioning. Firstly, B20 was a large adult male from near Skukuza while B91 was an adolescent female from near Shingwidzi, over 200 km away. This indicated that if a genetic factor is involved, it is not restricted to a specific troop or area of the KNP, nor is it related to sex. A lesion of this size involving the brain stem should have manifested itself in some clinical abnormality. Although this was not observed it cannot be ruled out since only cursory observations of this type were made. If adverse effects were severe, however, these animals surely would have been eliminated by predators.

Another macroscopic finding in the brain was a bilateral spherical cystic lesion 10 mm in diameter in B69, an adult female, affecting the most ventral aspects of the piriform lobes (bilateral). On section both cysts contained clear watery fluid and the thin outer wall collapsed to fill the defect (Fig. 193). Microscopically, each cavity was lined by a thin but well-defined fibrous capsule with only slight compression of the adjacent nervous tissue. Overall they appeared to be old malacic areas. The cause could not be determined.

There was a small linear enlargement (2 mm × 10 mm) in the *falx cerebelli* of B95. It had a homogeneous dense fibrous texture and appeared to be encapsulated. Microscopically, it was seen to be surrounded by a dense fibrous capsule and was uniformly composed of large polyhedral cells with indistinct cell outlines (Fig. 194 and 195). Their nuclei were of moderate size with reticulated chromatin and indistinct nucleoli. The cytoplasm was eosinophilic and finely granular. These cells were interspersed in a moderately vascular fibrous stroma in which occasional psammoma bodies were found (Fig. 196). Overall this lesion resembled a meningioma of the meningotheliomatous type as described by Robbins (1967). According to Moulton (1961) and Innes & Saunders (1962) meningiomas in animals are rare and to our knowledge this is the 1st observed in a baboon.

Eleven cases (9 males and 2 females) showed perivascular cuffing with small mononuclear cells (Fig. 197 and 198). This cuffing varied from a very minimal localized involvement with only a few scattered foci to a moderate generalized one with an associated leptomeningitis. The lesion in the brain stem was usually more pronounced than in the cortex. The cerebellum was rarely affected. Six of the 11 cases (54,5%) also had a lymphocytic myocarditis and 3 (27,3%) showed lymphocytic nephritis. Thus, although there is little evidence that the encephalitis was part of a generalized disease, the 2 most severe cases (B2 and B15) also showed similar lesions in the heart and kidney. An aetiological agent was not observed; however, the overall pattern, especially in those cases with heart and kidney involvement, suggested a viral origin. There were 2 baboons (B57 and B66) with a few typical *Toxoplasma* cysts in the outer cortex (Fig. 199). There was no inflammatory reaction involving the parasites nor any in any other part of the brain (see *Heart* for a discussion of toxoplasmosis).

There was 1 case (B70) of a small spherical caseous lesion (3–4 mm diameter) in the cerebral cortex (Fig. 200). Microscopically it consisted of a fibrous encapsulated foreign-body granuloma containing numerous foreign-body giant cells surrounding microfoci of mineralization (Fig. 201). It also contained numerous Charcot-Leyden crystals, suggesting that it may have been an old parasitic lesion.

There were 37 cases (25 males and 12 females) of microcavitation by small vacuoles scattered throughout the white matter of the brain, especially in the cortex and base of the cerebellum (Fig. 202). A definitive observation as to the exact location of the vacuoles was impossible, but they appeared to be in the oligodendroglia or myelin sheaths.

Another interesting change was varying degrees of "brain swelling." This was manifested as swelling and eosinophilia of the cytoplasm of glial cells, particularly the astrocytes (Fig. 203 and 204). It was most evident in the white matter of the cerebral hemispheres but could also be found in white matter in other areas. It was a fairly conspicuous change in 39 animals (males and females of all ages) but could be found to some degree in practically all animals. While a specific cause was not determined, this oedema, and the microcavitation, may have been sequelae to the anaesthetic.

Varying amounts of an isotropic yellowish-brown pigment (lipofuscin) were found in the cytoplasm of various neurones (Fig. 205). The largest quantities occurred in the nuclei at the base of the cerebellum and in the medulla oblongata. The affected neurones appeared normal in other respects. This pigment was present in the brain of 17 adult baboons, 12 males and 5 females, and according to Innes & Saunders (1962) is commonly found in many old animals. A similar pigment was found in several cases in the walls of cerebral blood vessels.

Grey laminated corpora amylacea of various sizes were found in several animals (Fig. 206). They were usually in the grey matter, especially that of the pons and thalamus, of baboons of all ages, the youngest being 5,0 kg mass (male, B99). These structures have been seen in a variety of animals as well as in man and may be related to aging (Innes & Saunders, 1962). It would appear, though, that age is not an important criterion in baboons since they were also found in relatively young ones.

An unusual eosinophilic granular change was present in the neuropile of the latero-ventral nuclei (olives) of 4 adult males and 1 adult female (B1, B36, B65, B75 and B78). These granules appeared to be within the cytoplasm of swollen oligodendroglia and varied in numbers from a few to a mass completely replacing the affected cells (Fig. 207 and 208). These inclusions are probably related to geriatric changes since they were found only in large adult animals.

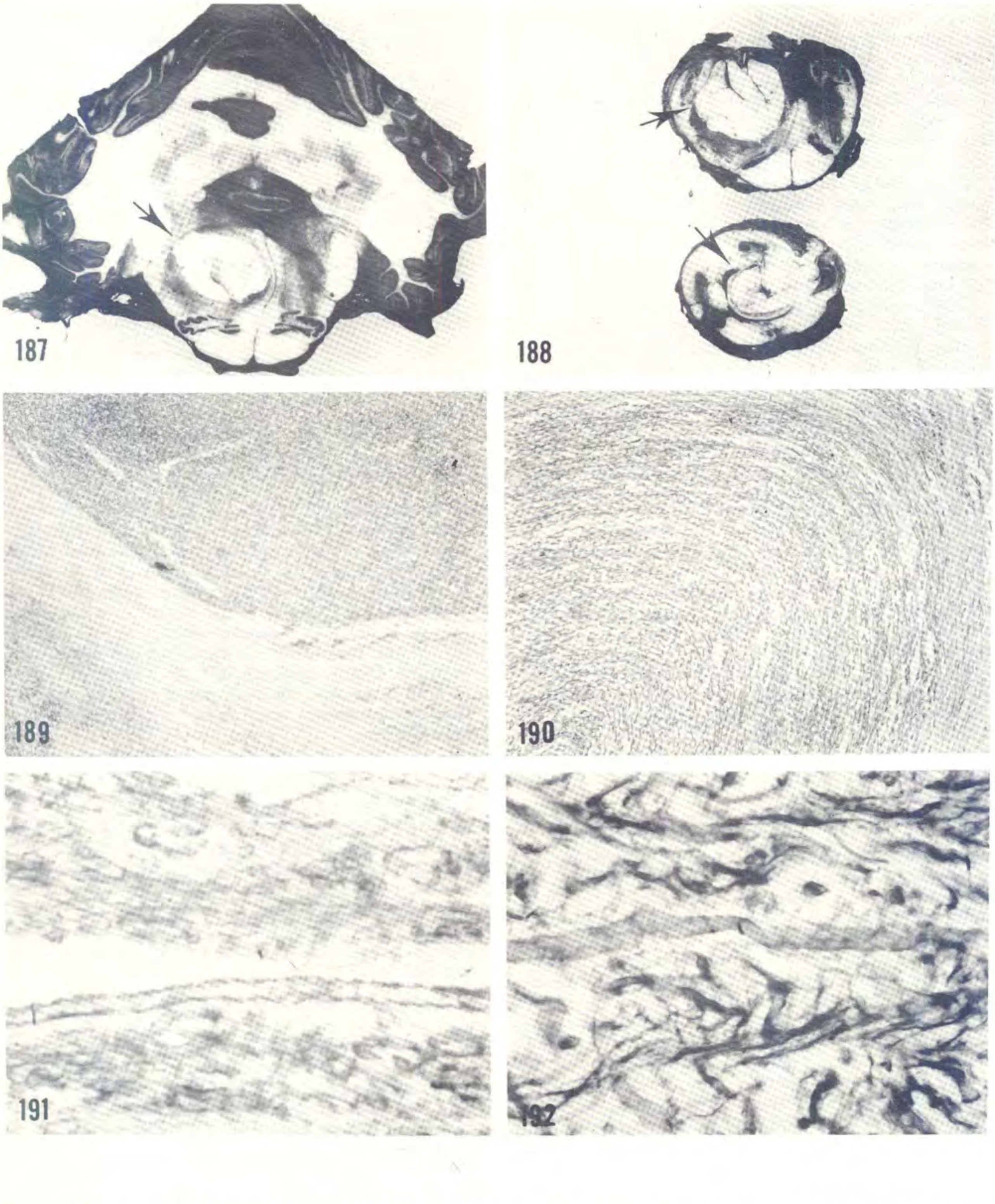

FIG. 187–192. 187. Coronal section of brain through cerebellum showing large round axonal hamartoma in left side of stem (arrow) Note deviation of *medial lemniscus* to the right. Nuclear stain

188. Coronal section through medulla at two different levels showing the same lesion (arrows). Portion at bottom (posterior medulla) has been reversed giving the false impression that the lesion is on the right side at that level
189. Photomicrograph demonstrating the well circumscribed lesion (top half). LFB × 30
190. Higher magnification which illustrates spiral nature of hamartoma. Holme's stain × 75
191. Typical myelinated fibre of which the lesion was almost entirely composed. LFB × 75
192. Similar photomicrograph showing fibres containing well defined axons (centre). Holme's stain × 750

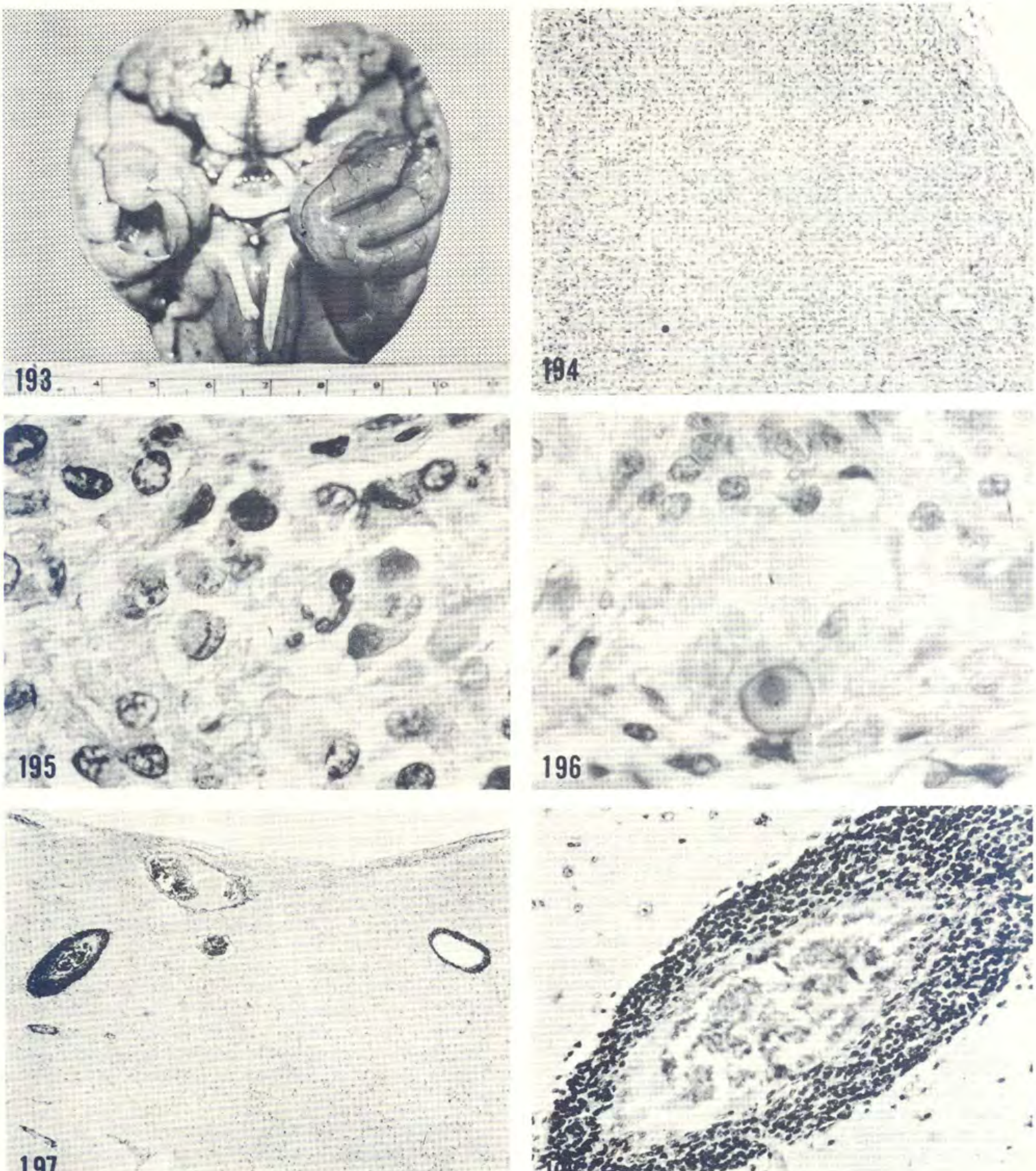

FIG. 193–198. 193. Brain from B69 with collapsed cyst in piriform lobe (left). Similar lesion was also on the opposite lobe
194. Section from tumour (meningioma) in falx cerebelli (B95). Note the uniform appearance. HE $\times$ 30
195. Higher magnification illustrating large granular cells which were characteristic of the tumour. HE $\times$ 750
196. One of the numerous psammoma bodies found in the tumour. HE $\times$ 750
197. Section from thalamus of B2 with two veins surrounded by thick perivascular cuffs of mononuclear cells. HE $\times$ 30
198. Higher magnification of vessel at left of Fig. 195. HE $\times$ 75

Innes & Saunders (1962) describe "eosinophilic granules" as occurring in neurones in different parts of the sheep brain and in the *locus coeruleus* of monkeys. Similar granules were also found in neurones in the medulla in most of the baboons in this study; they were much smaller, however, and were not restricted to older animals as were those in the micropile of the olives.

Spinal cord

One hundred were examined macroscopically and microscopically. The posterior thoracic and lumbar cords were examined in 80 baboons while the anterior thoracic was examined in the remainder. No macroscopical lesions were observed. A non-suppurative myelitis was seen in 2 adult males (B21 and B22). As in the brain it was characterized principally by a monuclear (mainly lymphocytic) perivascular infiltration in the grey matter. In both cases there were similar lesions in the brain. It is noteworthy that the other 9 cases with similar brain lesions did not show lesions in the spinal cord.

Corpora amylacea were found in 22 animals, 16 males and 6 females. Unlike their distribution in the brain, they were found in the spinal cord only in adult animals and were more numerous in the grey than in the white matter. Usually they were light blue to violet and either homogeneous or with 2–3 concentric layers of varying colour intensity. They were usually seen only with oil immersion.

Accumulations of neuronal lipofuscin were found in 19 baboons, 14 males and 5 females. In those animals where sections of both lumbar and thoracic areas were examined, more were found in the former. The pigment was found in mature animals only.

Eyes

One hundred were examined macroscopically, 80 microscopically. Macroscopic lesions were observed in 4 animals. One baboon (B66, 10,5 kg, male) showed a unilateral microphthalmia with an associated posterior polar cataract (Fig. 209). There was no other associated lesion, which suggested a congenital origin. Two other animals (B4 and B15) had abnormally thin lenses unilaterally (Fig. 210 and 211) and one of these (B15) also showed an anterior synechia (Fig. 211). Microscopically, all that remained were the lens capsule and a few lenticular fragments. This, together with the anterior synechia, suggested that the lesion probably resulted from traumatic rupture of the lens by a thorn or other object. A more severe lesion, probably of the same origin, occurred in B53 (Fig. 212). This baboon's right eye was smaller than normal and on cut section, in addition to a ruptured lens, revealed panophthalmitis, a detached retina, haemorrhage into the vitreous and a complete adhesion of the iris to the cornea (Fig. 214).

It is considered that an incidence of 3% traumatic lesions was relatively low considering the hazardous nature of the environment. The true incidence is expected to be higher since those with severe loss of sight would probably be eliminated by predators. Schmidt (1971), in the only other systematic study of baboon eyes, found traumatic lesions of the lens in 1 of 82 randomly selected captive baboons. The higher rate among free-ranging ones is understandable.

The only microscopic lesion that was not attributed to trauma was the presence of cystoid degeneration (Blessig-Iwanoff cysts) of the retina. It was uniformly restricted to the peripheral portions, more pronounced near the ora serrata (Fig. 213) and distributed circumferentially. It occurred in 24 baboons (30%), 13 males and 11 females, which varied in mass from 4,1–32,7 kg; the more pronounced lesions were in the older animals. According to Hogan & Zimmerman (1962) this lesion in man is a continuous change with advancing age but may be found in young persons with local disease. It did not appear to be associated with other diseases in the young baboons, but it should be emphasized that the lesion was very small in these particular animals.

Overall, the rate of eye disease was low, but as noted before, any animal with marked loss of sight would be caught more easily by predators. Baboons from the KNP would be good candidates for eye research because of the low incidence of significant spontaneous disease.

General Discussion

The KNP contains 273 troops comprising 5 100 baboons (Pienaar, 1964—augmented by subsequent game census) and the group of 100 animals from 29 troops used in this study consequently represents a survey of approximately 2% of the individuals and 10,5% of the troops. These animals were selected from many areas in the KNP; the findings, therefore, should be representative of the entire baboon population.

In a study of a social animal such as the chacma baboon that lives in well-defined groups many individuals in various troops have to be sampled to determine the number, true range and incidence of the disease parameters. Stoltz & Saayman (1970) found no evidence of interchange between troops and this probably explains the limited distribution of certain parasites such as the nasal mites, which depend on direct contact for spread. This is in contrast to the intestinal nematodes, which can be spread between troops scavenging over overlapping ranges (Aldrich-Blake, Bunn, Dunbar & Headley, 1971) and contaminating the environment for each other. It is also true for other parasites such as tapeworms that require an intermediate host, as indicated by the random distribution of *Bertiella* sp. There was a definite geographical limitation with regard to hepatocystosis, all the cases being confined to the Shingwidzi area. The natural invertebrate host for *Hepatocystis simiae* is thought to be a species of *Culicoides* (Garnham, 1966) and the presence of *H. simiae* is very probably related to the distribution of its insect vector, which may be limited to that area. This finding emphasizes the need for sampling animals from a variety of habitats in different geographical areas.

Another important observation was that an examination of faecal specimens alone provides a relatively poor index of the parasites in hosts from a given area. For example, *Isospora papionis* would not have been found without the histopathological investigations. Detection of filarids and cysticerci, on the other hand, would have been fortuitous without a careful postmor'en examination. It becomes apparent, therefore, that the establishment of a reasonable parasitological profile for hosts in a given area depends on the use of a combination of accepted parasitological examinations and techniques. These should include the accepted parasitology techniques, but even the most sophisticated ones are no substitute for careful postmortem and histopathological examinations.

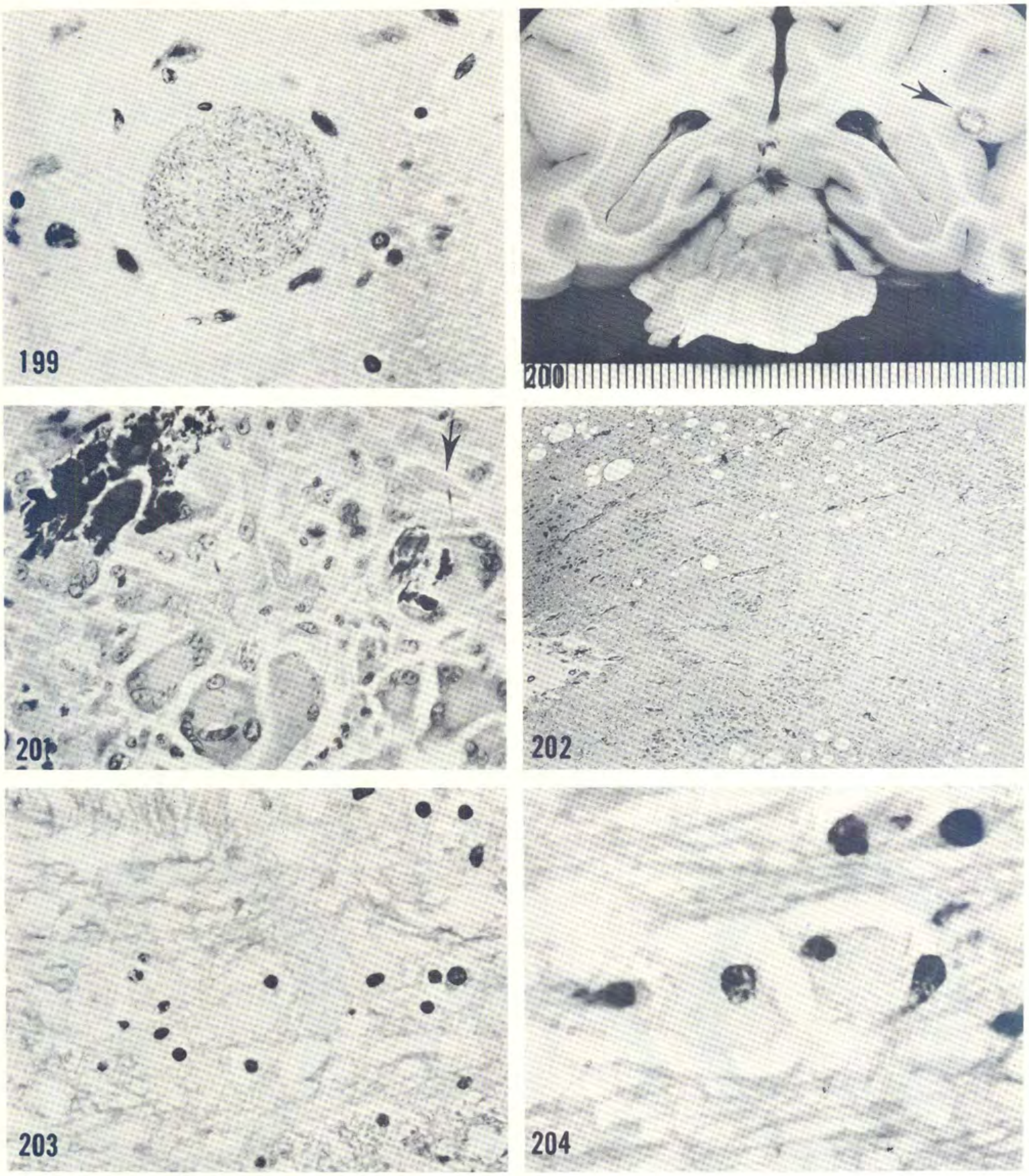

FIG. 199–204. 199. *Toxoplasma* cyst found in the cerebral cortex of B66. HE × 500
200. Small granuloma in cortex of B70
201. Section from lesion in Fig. 200 composed of multinucleated giant cells surrounding mineralized debris (upper left). Note the Charcot-Leyden-like crystal (arrow). HE × 375
202. Section of cerebral cortex showing an area of microcavitation. HE × 30
203. Portion of cerebral cortical white tract which contains numerous swollen glial cells (brain swelling or oedema). HE × 500
204. Higher magnification of Fig. 203. HE × 1 200

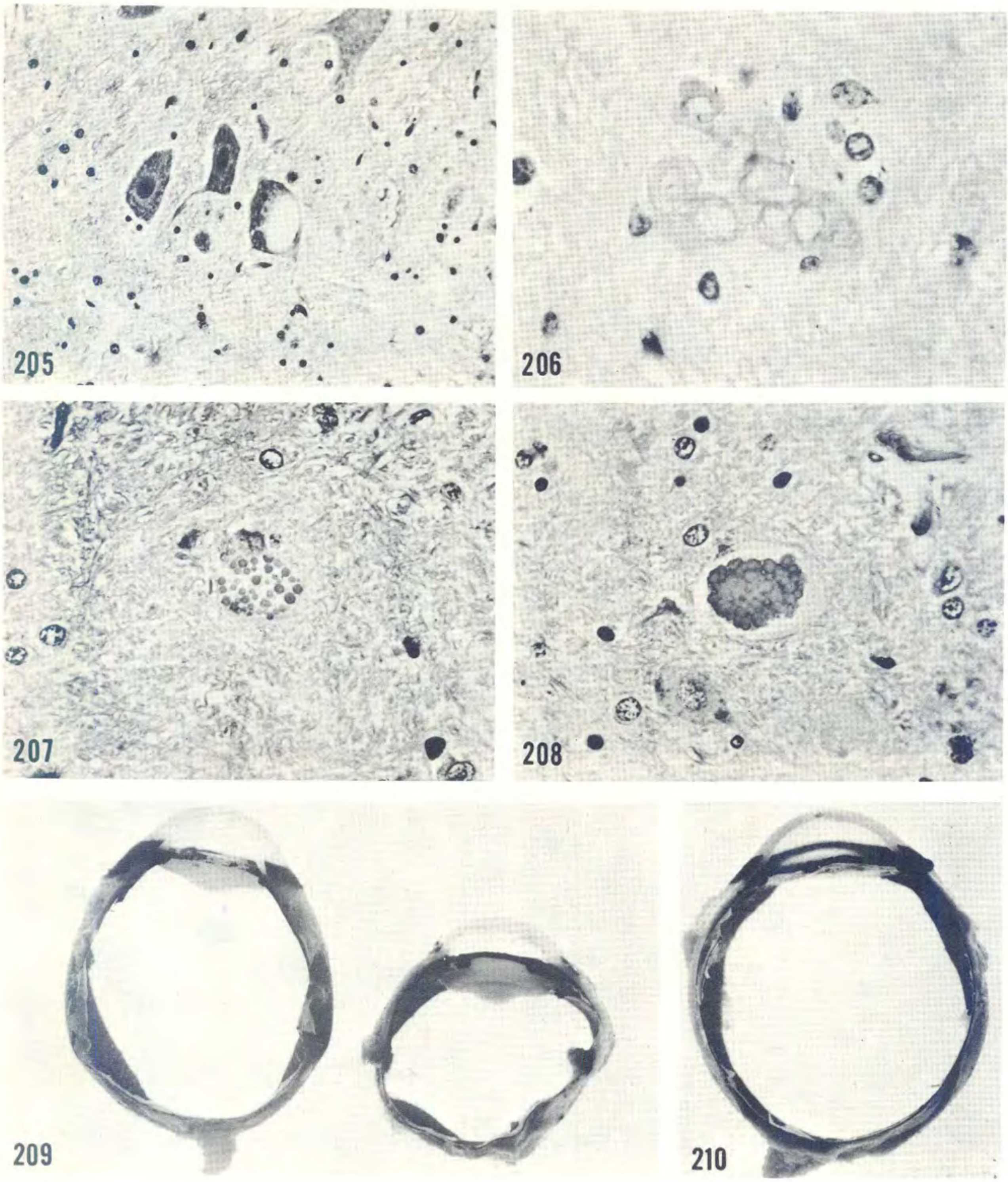

FIG. 205–210. 205. Section through a neurone which contains a large mass of lipofuscin pigment. HE × 200
206. Multiple laminated psammoma bodies in pons of B6. HE × 750
207. Early eosinophilic granular body in white matter of medulla. HE × 500
208. Fully developed eosinophilic granular body. HE × 500
209. Normal eye on left and microphthalmia with posterior polar cataract on right (B66)
210. Eye from B4 showing extremely thin lens

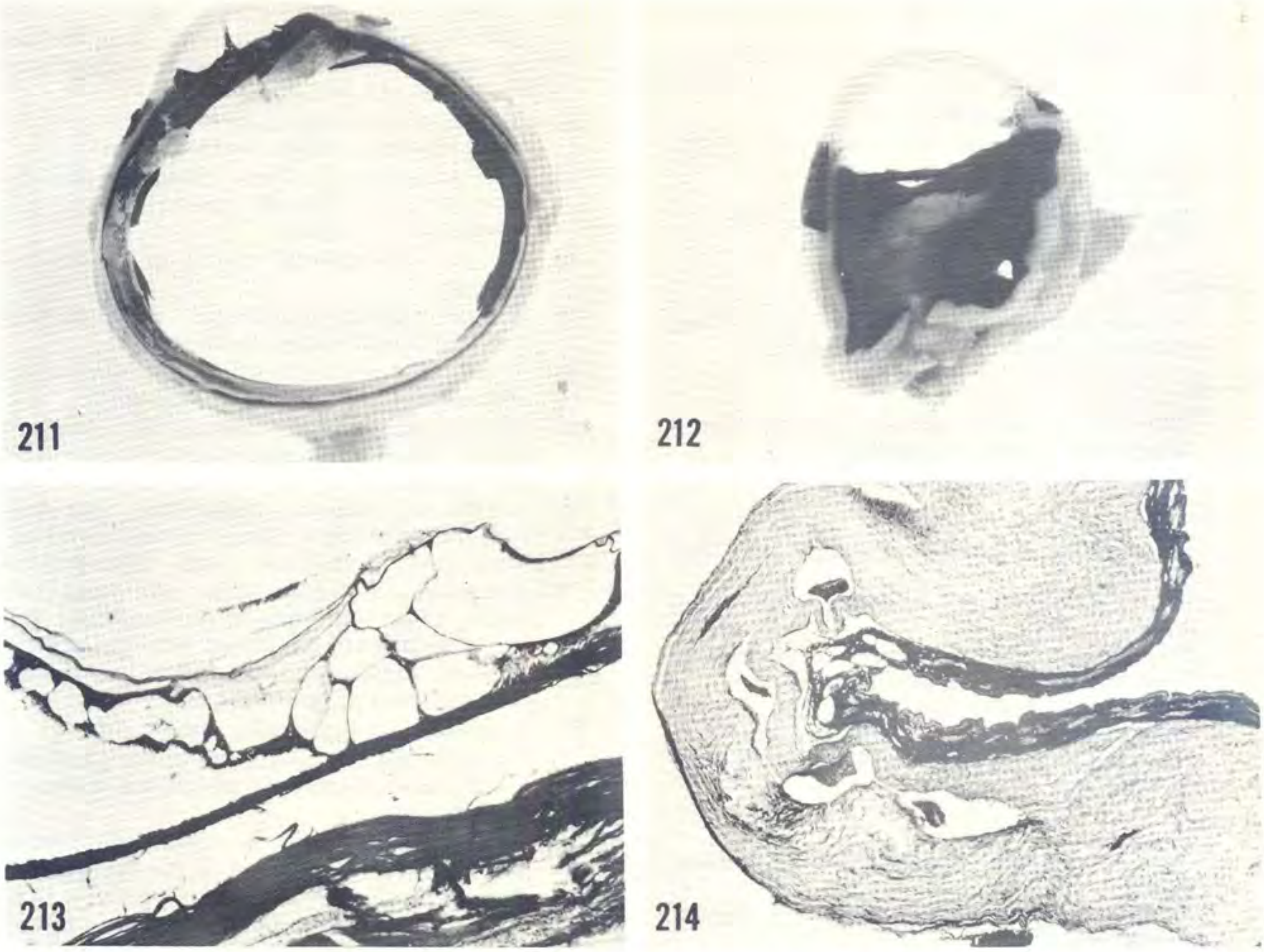

FIG. 211–214. 211. Eye from B15 with distorted lens and anterior synechia
212. Microphthalmic eye from B53 with enlarged posterior chamber, detached retina and black haemorrhagic vitreous. Distorted outline of sclera is an artefact
213. Photomicrograph of retina illustrating cystoid degeneration near ora serrata (B41). HE $\times$ 75
214. Cornea of B53 (Fig. 212) showing scarring, disorganization and complete adhesion of iris. HE $\times$ 75

It goes without saying that many of these parasites and pathological findings would not be observed during a routine clinical examination, either prior to importation or prior to experimental use of the baboons. This was one of the most important aspects of the study. In this respect the finding of schistosomes would necessitate extreme care whenever animals are translocated to and quarantined in non-infected areas, particularly with regard to waste disposal and general hygiene. It may even be advisable to treat baboons routinely for the disease after capture and before translocation into an area where suitable intermediate snail hosts exist.

A point which deserves consideration is the choice of baboons for use in various experimental protocols. If one chooses to use animals caught in the wild, their naturally occurring disease parameters should be taken into account. Thus baboons from the KNP would be of questionable value for pulmonary studies because of the high rate of infestation with *Pneumonyssus* sp. In contrast, these baboons would be relatively safe for studies of the central nervous system and kidneys, since neither of these tissues revealed a high incidence of significant changes. The baboon might prove to be unsurpassed in its value for studying a disease such as capture myopathy.

The findings in this study suggest that mass measuring organs to establish total body mass is only marginally useful in baboons (Table 3). Only the heart appeared to have a linear increase in mass paralleling the overall body mass. Masses might be of value in determining whether or not an organ is of normal size, provided the total body mass, sex and general condition of the animal are known. It must be remembered that the figures shown in Table 3 may not be applicable to baboons raised in captivity, since these tend to become heavier than those in the wild.

SUMMARY

A list of the parasites found in this study is as follows:

Arachnida

1. *Amblyomma hebraeum*—skin
2. *Rhinophaga papionis*—nasal cavity (maxillary recess)
3. *R. elongata*—nasal cavity
4. *Pneumonyssus vocalis*—laryngeal ventricle
5. *P. mossambicensis*—lung

Trematoda

1. *Schistosoma mattheei*—mesenteric veins, liver, mesenteric lymph nodes and intestine

Cestoda

1. Cysticerci of *Taenia crocutae*—skeletal muscles
2. *Spargana* sp.—skeletal muscles
3. *Bertiella studeri*—small intestine

Nematoda

1. *Streptopharagus armatus*—stomach and small intestine
2. *Abbreviata caucasica*—stomach and small intestine
3. *Trichostrongylus colubriformis*—small intestine
4. *Strongyloides* spp.—small intestine
5. *Ternidens deminutus*—small intestine
6. *Oesophagostomum bifurcum*—large intestine
7. *Tetrapetalonema papionis*—skin and skeletal muscle fascia

Protozoa

1. *Isospora papionis*—small intestine and skeletal muscle
2. *Toxoplasma gondii*—brain, heart and skeletal muscle
3. *Sarcocystis* sp.—skeletal muscle, tongue and heart
4. *Hepatocystis simiae*—liver and blood
5. *Entamoeba* spp.—large intestine
6. *Entamoeba coli*—large intestine
7. *Iodamoeba* spp.—large intestine
8. *Balantidium* spp.—large intestine

The following is a list of the non-parasitic lesions of specific organs:

1. *Skin*—scars, especially about the face and limbs, ulcerative cheilitis, phytogenous foreign-body granulomas, fibroma and basal cell carcinoma
2. *Skeletal muscle*—capture myopathy
3. *Bones and joints*—femoral and costal fractures, osteoarthritis and joint swelling
4. *Trachea*—lymphocytic tracheitis and mineralization of cartilage
5. *Lung*—pleuritis, suppurative pneumonia and silicosis
6. *Heart and aorta*—hydropericardium, arteriosclerosis, lymphocytic myocarditis and lipofuscinosis
7. *Thymus*—microcysts
8. *Spleen*—accessory spleen, hyperplastic white pulp, focal perisplenitis, hyalinized germinal centres and microgranulomas of unknown origin
9. *Liver*—lymphocytic periportal inflammation, cytomegaly, fatty metamorphosis, Councilman-like bodies and focal perihepatitis
10. *Gall bladder*—lymphocytic cholecystitis and cystic epithelial hypertrophy
11. *Pancreas*—ectopic pancreas in the duodenum
12. *Adrenalcortex*—haemorrhage of the zona fasciculata, fatty metamorphosis, focal nodular hypertrophy of the zona glomerulosa and zona reticularis and lymphocytic foci
13. *Adrenalmedulla*—intracytoplasmic eosinophilic hyaline globules and lymphocytic foci
14. *Thyroid*—abberant thymic tissue, lymphocytic thyroiditis, interfollicular cell hyperplasia and extrafollicular colloid
15. *Parathyroid*—abberant thymic tissue and microcysts
16. *Pituitary* (*adenohypophysis*) megalocytosis, microcysts and foamy chromophobes
17. *Teeth and gums*—broken teeth with associated abscessation and hypertrophic gingivitis
18. *Tongue*—ranula of the ducts of the glands of Ebner, lymphocytic glossitis and foreign-body granulomas
19. *Tonsils and pharynx*—suppurative and non-suppurative tonsilitis, foreign bodies, keratinaceous cyst formation, and inflammation
20. *Submandibular, infrascapular, and mesenteric lymph nodes*—hyperplasia, eosinophilia, microgranuloma and hyalinized germinal centres
21. *Salivary glands*—cytomegalovirus inclusions and lymphocytic sialoadenitis
22. *Oesophagus*—lymphocytic oesophagitis.
23. *Stomach*—microcystic change in the glandular mucosa and foreign-body granuloma of phytogenous origin
24. *Small intestine*—ectopic pancreas in duodenum
25. *Brain*—axonal hamartoma in the brain stem, meningioma in the falx cerebelli, microcavitation, brain swelling, lipofuscinosis, non-suppurative meningoencephalitis, corpora amylacea and eosinophilic globular degeneration in the medulla
26. *Spinal cord*—corpora amylacea and lipofuscinosis
27. *Eye*—microphthalmia, panophthalmitis, traumatic rupture of the lens, anterior synechia and cystic degeneration of the ora serrata

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