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GEDOELSTIAL MYIASIS IN ANTELOPES OF SOUTHERN AFRICA

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Introduction

The normal hosts of *Gedoelstia* spp. are antelopes of the subfamily Alcelaphinae (Zumpt, 1965), which include blue wildebeest [*Connochaetes taurinus* (Burchell, 1823)] and hartebeest [*Alcelaphus buselaphus* (Pallas, 1766)]. Until recently very little was known about the life cycle of both *Gedoelstia cristata* Rodhain and Bequaert (1913) and *Gedoelstia hässleri* Gedoelst (1915). It was generally accepted to be similar to the life cycle of *Oestrus ovis* Linnaeus (1758), where the gravid female usually deposits her larvae in the nostrils of her host; the entire larval cycle being started and completed within the nasal cavity and paranasal sinuses and the mature larvae eventually leave the host to pupate in the soil from where the imagines emerge after 21 to 66 days (Bedford, 1925). Basson (1962 a, b, c) described *oculo-vascular myiasis* in domestic animals caused by the first stage larvae of *Gedoelstia* spp. The same first stage larvae were subsequently recovered from the eyes, cardiovascular system, subdural cavity and dura mater of the two natural hosts, the blue wildebeest and the hartebeest (Basson, 1962). First stage larvae from suspected hybrids of *Gedoelstia cristata* and *Gedoelstia hässleri* (Basson, Zumpt and Bauristhene, 1963) were found in the same localities as the purebred first stage *Gedoelstia* larvae and were similarly responsible for myiasis in domestic animals. Surveys conducted in South West Africa (Basson, 1962) indicate that the blue wildebeest is probably the usual natural host. Hartebeest were invariably parasitized only when present within the same area as blue wildebeest. In spite of the completion of the life cycle in the hartebeest, the subdural cavity is practically never infested. The presence of larvae along the optic nerve tract in aberrant hosts was regarded as evidence that either of these routes was normally used to reach the subdural cavity. It was further suggested by Basson (1963) that the foramina in the cribriform plate serve as gateways to the nasal cavity and paranasal sinuses.

Materials and Methods

For the past ten years seven different kinds of antelopes have been autopsied and examined for pathological changes and the presence of first stage larvae of *Gedoelstia* spp. These antelopes included 54 blue wildebeest [*Connochaetes taurinus* (Burchell, 1823)], 31 hartebeest [*Alcelaphus buselaphus* (Pallas, 1766)], 18 springbuck [*Antidorcas marsupialis* (Zimmermann, 1780)], five impala [*Aepyceros melampus* (Lichtenstein, 1812)], four gemsbuck [*Oryx gazella* (Linnaeus, 1758)] and two kudu [*Tragelaphus strepsiceros* (Pallas, 1766)]. The investigation was conducted in South West Africa where most of these animals were obtained and in the Kalahari Gemsbok National Park and the Kruger National Park. Special attention was given

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to the eyes, cardiovascular system, brain, meninges, nasal cavity, paranasal sinuses and respiratory system. Tissues from infested and normal antelopes were collected in 10 per cent formalin for microscopic examination. These usually included the eyes, optic nerve, brain, meninges, myocard, arteries and lungs. In some of the antelopes specimens were collected from all the various tissues. After fixation the specimens were embedded in paraffin wax, sectioned at either 3 or 6μ thickness and stained with haematoxylin and eosin. Eye sections varied from 8 to 15μ in thickness. Various tissues from a total of 17 blue wildebeest, six hartebeest, five impala and two kudu were examined microscopically. The dura mater of ten blue wildebeest and one hartebeest and the eyes of eight blue wildebeest and two hartebeest were studied histologically.

The first stage larvae were preserved in either 10 per cent formalin or 70 per cent alcohol. All those obtained from the cardiovascular system and eyes and some recovered from the subdural cavity were mounted in gum arabic or Berlese's solution for identification.

RESULTS

(*a*) *Incidence of* Gedoelstia *larvae*

Only blue wildebeest and hartebeest were found to be infested with first stage larvae. Hartebeest remotely separated from blue wildebeest were unparasitized. The tissues most frequently parasitized were the cardiovascular system (all the *Gedoelstia* spp.)—anterior venous circulation and right heart—and the dura mater of the brain including the subdural cavity (*G. hässleri* only) (Table 1). In addition first stage larvae were recovered from the eyes of two blue wildebeest and two hartebeest (*G. hässleri*); intravenously in the olfactory mucosa of the nasal turbinates in two out of four blue wildebeest; in the arachnoid of the optic nerve of one blue wildebeest; in the trachea of one hartebeest (*G. cristata*) and in the lachrymal duct of one blue wildebeest. Larvae were obtained from the cardiovascular system of only three out of 13 blue wildebeest in the Kruger National Park. Larvae of *Gedoelstia cristata* and hybrids were never isolated from the subdural cavity or dura mater.

TABLE 1.—*The incidence of* Gedoelstia *larvae in game*

Antelope	Dura mater or Subdural cavity		Cardiovascular system		Paranasal sinuses
	Total examined	Pos.	Total examined	Pos.	
Blue wildebeest	54	54	34	20	Pos.
Hartebeest	31	1	15	10	Pos.
Gemsbuck	4	0	2	1	Neg.
Springbuck	18	0	11	0	Neg.
Impala	5	0	5	0	Neg.
Kudu	2	0	2	0	Neg.

(*b*) *Macroscopic findings*

The following lesions were noticed in blue wildebeest and hartebeest:

(i) *Eyes:* Mild chemosis and petechial haemorrhages were present in the conjunctiva and the periorbital tissues of one recently infested blue wildebeest.

(ii) *Cardiovascular system:* Mild vascular lesions were observed in only one blue wildebeest and one hartebeest. The lesions in the hartebeest were found in the initial portion of the arteria pulmonalis and the pulmonary sinuses. It was unevenly thickened and resembled a chronic endarteritis. A few areas of nodular endophlebitis were detected in the jugular vein of one blue wildebeest in Ovamboland, South West Africa. Unfortunately the affected tissue from this antelope were not collected for histopathological studies.

Fibrotic areas resembling healed infarcts were present in the myocard of one blue wildebeest but this need not necessarily be related to the myiasis caused by *Gedoelstia* larvae. Mildly thickened greyish areas were noticeable on the conus arteriosus of the right ventricle of one blue wildebeest and one hartebeest.

(iii) *Brain:* Both the pachy- and leptomeninx seemed thickened in some of the blue wildebeest. In view of the fact that no unparasitized blue wildebeest were found, it was rather difficult to recognise such a lesion and to correlate it with dural myiasis. A comparison with the meninges of other antelopes and domestic stock indicated a mild subacute meningitis to be present. No lesions were found within the brain substance.

(iv) *Paranasal sinuses:* Frequently mild and occasionally advanced muco-catarrhal and muco-purulent sinusitis in association with dead larvae were noticed in both blue wildebeest and hartebeest. More or less circular foci of necrosis were observed on the nasal mucosa of two young blue wildebeest.

No other lesions were present in any of the other organs or tissues.

(*c*) *Microscopic findings*

(i) *Eyes:* The eyes of all the blue wildebeest and hartebeest (within the blue wildebeest habitats) that were studied, showed various stages of a mild, subacute episcleritis and conjunctivitis profunda around and following the course of the anterior ciliary and episcleral vessels (cf. Plate 5). Plasma cells and eosinophils were mainly involved. The lesions were very mild in young antelopes. One larva, in an early stage of mineralization, was located within the arachnoid of the optic nerve tract of a blue wildebeest (cf. Plate 5). The almost complete absence of a host response to this dead larva was quite remarkable, only a few round cells being found in serial sections.

(ii) *Cardiovascular system:* Mild subacute endocarditis was present in some of both types of antelopes concerned. The cell reaction consisted of mainly plasma cells and round cells. Eosinophils were present in the lesions of some of the younger animals. No lesions were found in the myocard, with the exception of one fibrotic area in a blue wildebeest.

The initial portion of the art. pulmonalis, its semilunar valves and the pulmonary sinuses showed mild inflammatory changes in some of the antelopes. The cell reaction was essentially the same as in the endocardium. However, in one hartebeest advanced subacute endarteritis was found. The intima in the pulmonary sinuses and initial portion of the pulmonary artery was substantially thickened and proliferative. The inner layer was uneven and consisted of spindle-shaped cells resembling fibroblasts which were oriented perpendicularly to the surface (cf. Plate 6). One first stage

larva, measuring about 0·5 mm was found within the intima (cf. Plate 4). It was situated extravascularly and presumably in the act of burrowing its way towards one of the bloodvessels. A dead larva, surrounded by epithelioid and giant cells, was present within the intima opposing the pulmonary sinuses (cf. Plate 4). Granulomatous foci with epithelioid, plasma cell and lymphocitic reactions were scattered throughout the intima. Proliferating and thick-walled bloodvessels were very conspicuous. Collagen fibres were increased and the lesions evidently represented an organised mural thrombus with an active granulomatous response to the presence of dead and migrating larvae.

Two out of four blue wildebeest from which the turbinates were studied microscopically, harboured larvae in the veins of the olfactory mucosa (cf. Plate 9). These larvae were somewhat smaller than the average in the pachymeninx. A characteristic proliferative endophlebitis was present in several of these vessels in all four antelopes; the cells of the intima frequently showing a tendency toward pallisading and formation of villous projections (cf. Plate 9). Some of the smaller dural veins showed similar vascular lesions (cf. Plate 7, C). An eosinophil reaction was present in the intima of a few veins (cf. Plate 8) and round cell infiltrations around certain arteries within the olfactory mucosa (cf. Plate 9).

(iii) *Brain:* The meninges and brain of ten blue wildebeest were studied. All of them showed various degrees of pachymeningitis (cf. Plate 7) as well as proliferation of the dural and arachnoid meningothelium (cf. Plate 8, C, D). The cell reaction consisted mainly of lymphocytes and plasma cells but eosinophils and Russell-body plasma cells were also occasionally involved. The lymphocytic reaction was sometimes very marked (cf. Plate 7, A). Mild haemorrhages were seen in the meninges of two young antelopes. First stage larvae of *Gedoelstia hässleri*, measuring up to 3·7 mm in length, were frequently found in the superficial inner layer of the dura mater (cf. Plate 7, D). Some appeared to be within small blood sinuses or potential spaces between the laminated layers. Perivascular cell infiltration and proliferative endophlebitis with giant cells were noticed in some of the smaller dural vessels (cf. Plate, B). In a few antelopes very mild cell reactions were present in the leptomeninx. One larva was found within the arachnoid.

Proliferation of the arachnoid was striking in all the cases examined. The arachnoid of the entire brain as well as the optic nerve tract were involved (cf. Plates 5 and 8). One hartebeest was free of the lesions described.

(iv) *Nasal and paranasal cavities:* In the olfactory mucosa of the four blue wildebeest studied a very mild rhinitis and endophlebitis were present. Two animals showed larvae in these mucosal vessels as well as focal disseminated areas of degeneration and necrosis of the epithelial layer. Lymphocytic perineuritis (cf. Plate 8, B) was found in the tunica propria of one animal and mild mucocatarrhal and muco-purulent sinusitis in another. Eosinophils usually predominated in the inflammatory changes.

Discussion

Without exception the 54 blue wildebeest examined during the past ten years showed the presence of *Gedoelstia* larvae in the pachymeninx or subdural cavity. In addition the cardiovascular system of 59 per cent of the blue wildebeest and 67 per cent of the hartebeest was also infested. This constant presence of parasites in the dura mater and high incidence of cardiovascular myiasis in one of Southern Africa's most numerous antelopes which apparently shows no obvious clinical manifestations of such myiasis, point to a most unique parasite-host relationship. The microscopical

studies reported, however, prove that this myiasis is not completely without adverse effects to the usual host, the blue wildebeest, or to the unusual host, the hartebeest. The association should therefore be regarded as parasitism rather than commensalism, but may indicate an evolutionary trend towards the latter state. The lesions set up by the larvae, nevertheless, are generally mild and do not appear to cause the antelope serious discomfort.

The histopathological findings have supplied further evidence on the migratory pattern of these *Gedoelstia* larvae. Their presence and the concomitant lesions within the eyes of the natural hosts confirm previous observations (Basson, 1962) and suggest that the female deposits her young in the eyes rather than in the nostrils, as *Oestrus* spp. usually do. The eye lesions following the course of the anterior ciliary and episcleral vessels, as well as the high larval incidence in the anterior venous circulation could indicate that either a venous or arterial route is ultimately taken, at least by *G. hässleri*, to reach the subdural cavity. Their shortest vascular route to this locality would seem to be via the communication of the ophthalmic emissary vein with the cavernous sinus, but they regularly wander down the jugular veins towards the heart. Unless this phenomenon has become a habitual aberrance, their frequent occurrence within the blood circulation cannot be regarded as merely fortuitous. The lower incidence of larvae within the cardiovascular system of blue wildebeest in the Kruger National Park is in this respect a possible exception, but the seasonal incidence, which has so far not been thoroughly investigated, could account for such an apparent anomaly and merits further investigation. The presence of first stage larvae in the bloodstream of one gemsbuck in South West Africa is regarded as aberrant, merely on the absence of such parasites in the nasal cavity and paranasal sinuses.

The optic nerve tract is a second possible route from the eye to the subdural cavity in the case of *G. hässleri*. Its involvement in domestic animals (Basson, 1962) and the localization of one larva in the optic arachnoid of a blue wildebeest may be of significance in this respect.

The most likely routes from the subdural cavity and dura mater to the nasal cavity would appear to be through the vascular system, the foramina of the cribriform plate or those foramina permitting passage to the nerves. The larvae could either migrate within and along the dura or via the subdural space. This would entail migration through tissues or partly through tissues and for the rest through blood vessels. The finding of some larvae within the veins of the olfactory mucosa and their association with the presence of a proliferative endophlebitis is regarded as very significant and strongly suggestive of the vascular route being followed to the ultimate destination in the nasal passages and paranasal sinuses. Similar lesions within some of the dural vessels support this view. The smaller size of the larvae within the olfactory mucosa may be purely incidental, but this aspect necessitates further investigation. The involvement of certain nerves and arteries could imply further possible routes or mere migration through tissues. It becomes obvious, therefore, that migration through both vessels and tissues is undertaken.

The detection of a few larvae in the trachea and lachrymal duct could denote either further normal routes or possible deviations. The localization of one larva in the arachnoid is regarded as erratic and exceptional mainly on the lack of macroscopic evidence of their presence. None of the larvae from either *G. cristata* or *Gedoelstia* hybrids has ever been recovered from the subdural cavity of game. This is apparently a very important difference between the life cycles of these species and *G. hässleri*.

It is clear from the current observations that *Gedoelstia* larvae either use several normal migratory routes towards the nasal cavities or they show a very regular aberrance in their migratory pattern. The former is evidently the most logical deduction, but it should be emphasized that in spite of all these findings, which have considerably clarified the life cycle of *Gedoelstia* spp., further work is needed for a better assessment of the newly established localities and histopathological changes. Zumpt (1965) suggested that the evolution in the life cycle of the highly specilized *Oestrinae* probably started with a blood-sucking stage. The present observations on *Gedoelstia* larvae which are responsible for ocular, vascular, dural and nasal myiasis may well support this view and could indicate an evolutionary trend from the sanguiniferous root to a specialized endoparasitic, nasal mode of life.

Summary

Myiasis in the blue wildebeest [*Connochaetes taurinus* (Burchell, 1923)] and the hartebeest [*Alcelaphus buselaphus* (Pallas, 1766)] caused by *Gedoelstia* spp. is described. The incidence of the first stage larvae within various tissues is recorded and further evidence submitted to elucidate their migratory pattern. The most important histological lesions including pachymeningitis and periophthalmitis are recorded. In spite of the constant dural myiasis and frequent pachymeningitis the affected antelopes show no apparent serious clinical manifestations.

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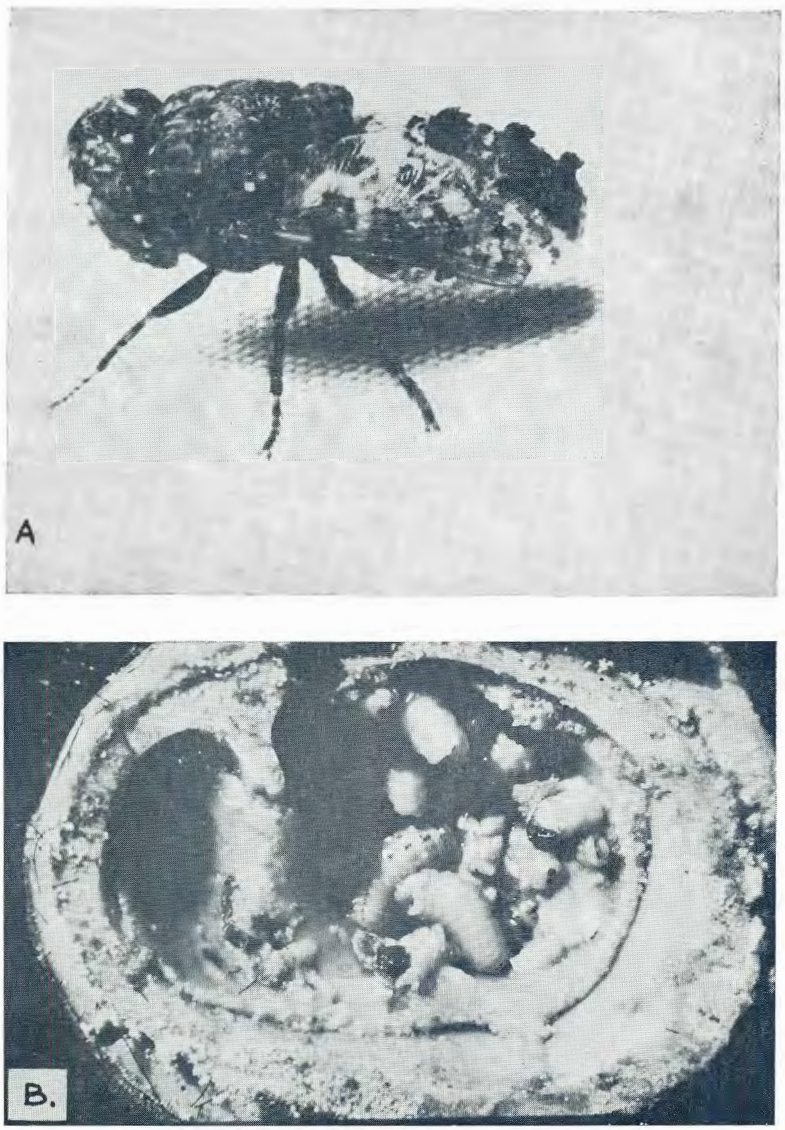

PLATE 1. A.—*Gedoelstia cristata* imago

B.—The cornual sinus of a blue wildebeest with a mixed infestation of *Oestrus*, *Kirkioestrus* and *Gedoelstia* spp. and a muco-purulent exudate


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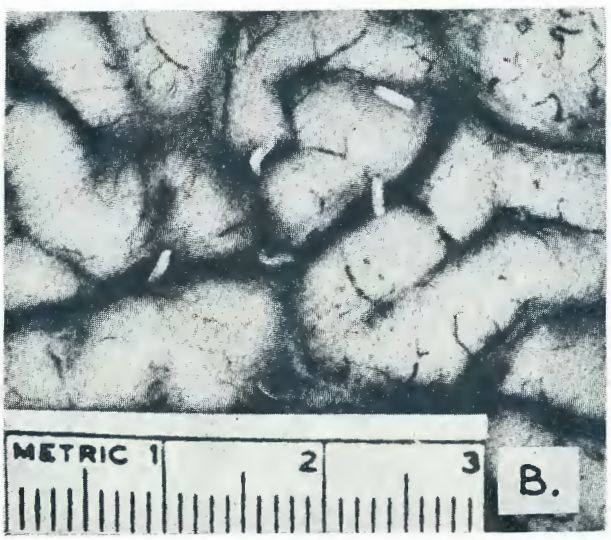
METRIC 1
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← PLATE 2. A.—Brain of a blue wildebeest with a few developed first stage larvae of *G. hässleri* grouped and lying loosely on the leptomeninx
B.—do. Area enlarged

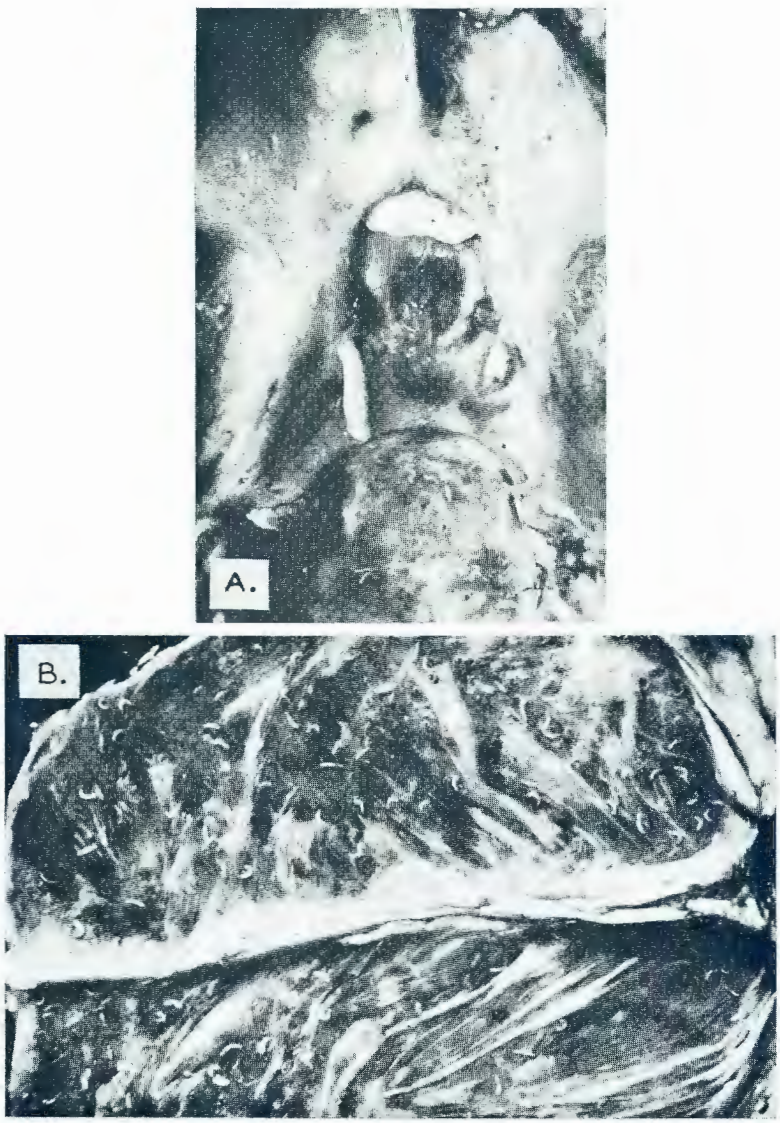
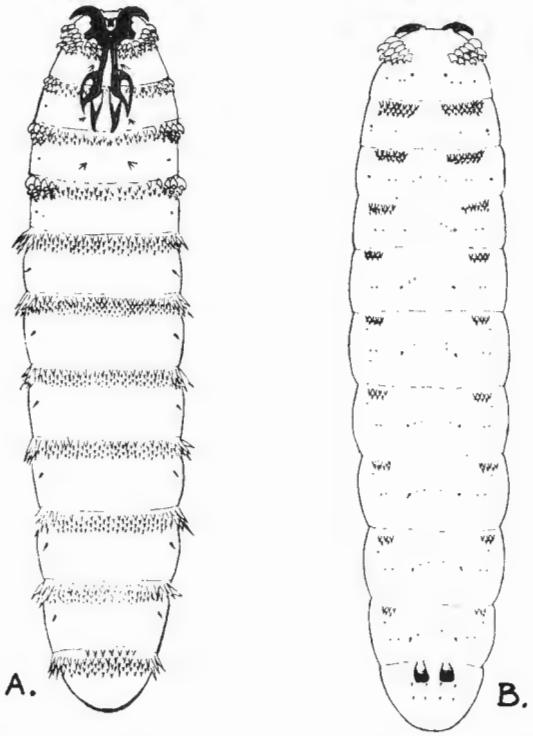


PLATE 3.—Parasitized pachymeninx of a blue wildebeest
A.—Intact ventral portion of the dura mater with about 45 developed first stage larvae of *G. hässleri*. The severed optic chiasma can be identified in the centre with the sella turcica immediately below
B.—Dura mater removed from the cranium. Numerous larvae can be seen either loosely adherent to or embedded within the dura. The falx cerebri can be identified as the lighter longitudinal strip



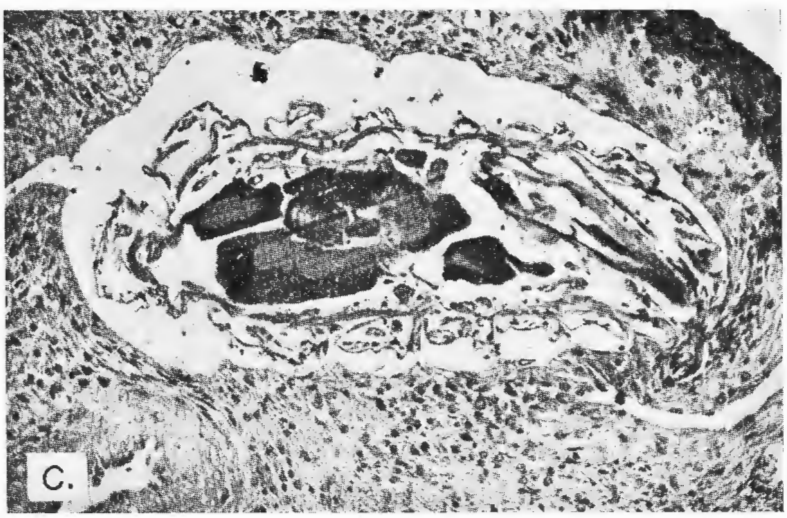


PLATE 4. A.—*Gedoelstia hässleri* first stage larva, ventral view
B.—do. Dorsal view
C.—Larva in longitudinal section within the pulmonary artery of a hartebeest. H. & E. × 192

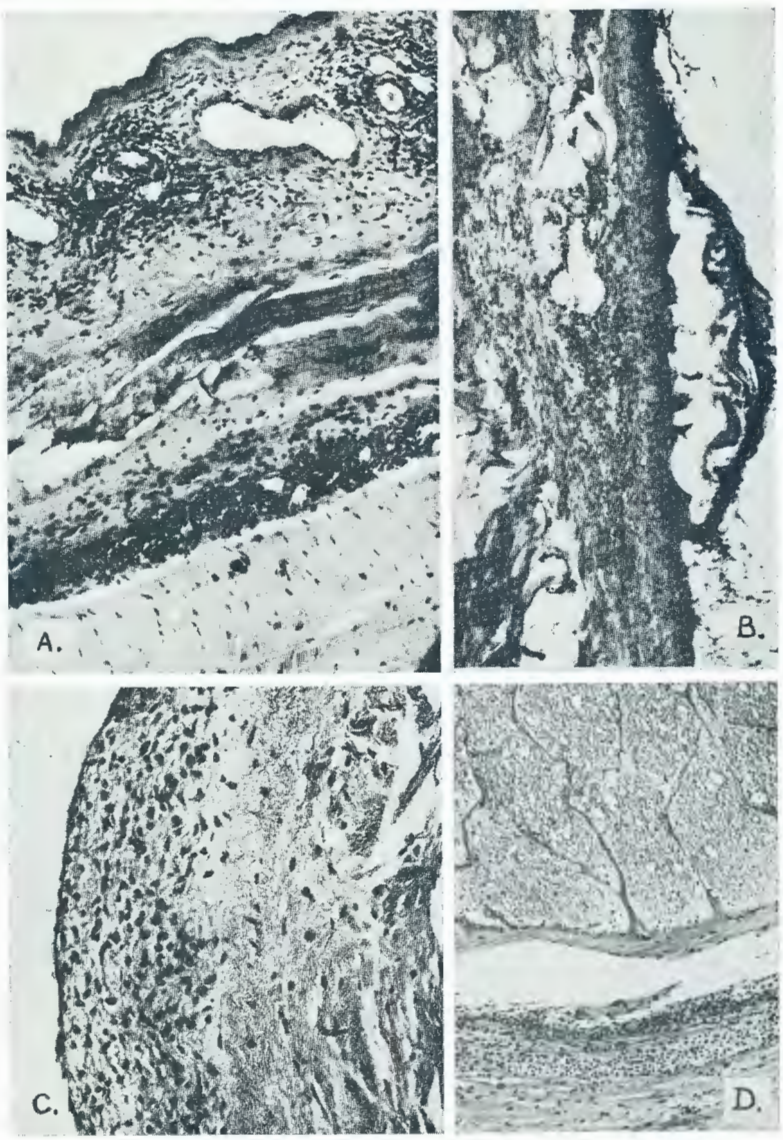


PLATE 5.—H. & E. sections of four different blue wildebeest

A.—Conjunctiva and part of the sclera showing the characteristic perivascular cell infiltration. H. & E. × 120·9

B.—Optic arachnoid with part of a dead larva. Mildly proliferated arachnoid with mild, focal round cell infiltration on the left. H. & E. × 120·9

C.—Pulmonary sinus with a mild proliferative endarteritis. H. & E. × 192

D.—Cross section of the optic nerve showing a proliferated arachnoid. H. & E. × 75·6

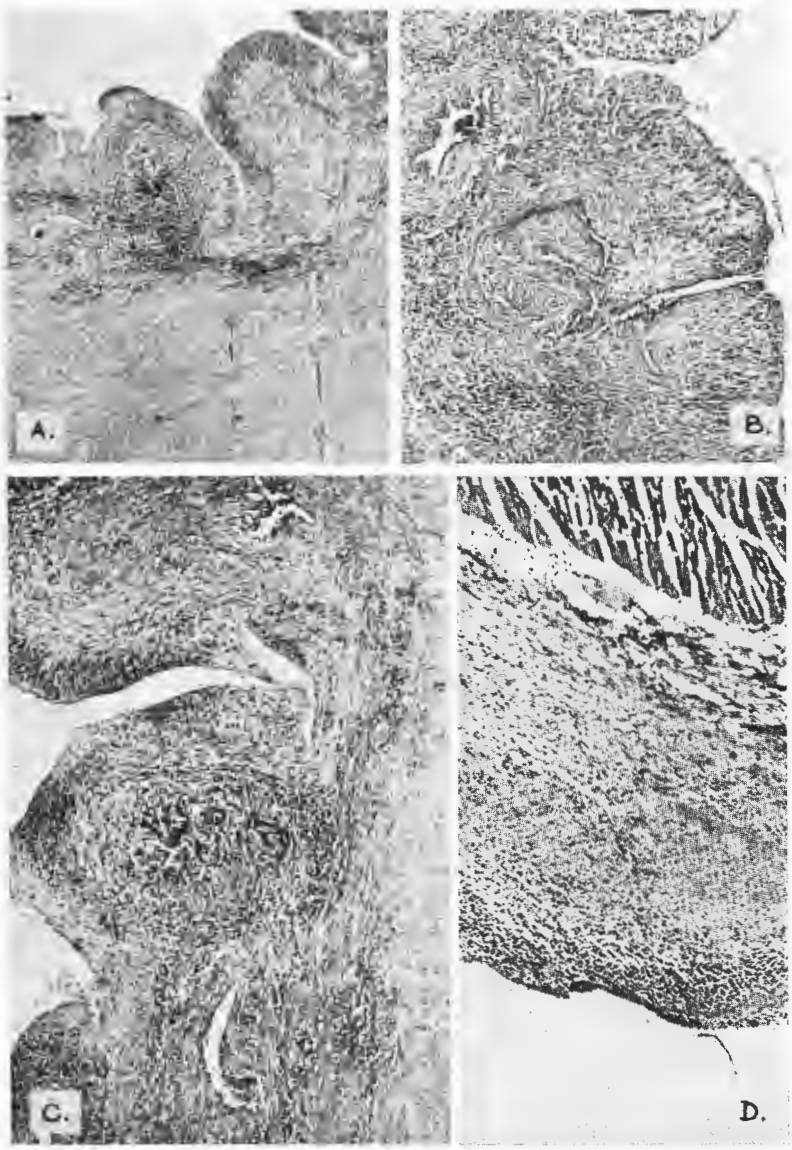


PLATE 6.—Pulmonary sinus of the art. pulmonalis of one hartebeest (A, B, C) and the endocardium of another (D)

A.—Pulmonary sinus with a dead larva on the left and a marked intimal proliferation. H. & E. × 38·4

B.—do. Marked vascular proliferation within the intima. H. & E. × 75·6

C.—do. Dead larva within intima surrounded by epitheliod cells, giant cells and round cells. Inner layer of intima oriented perpendicularly towards the lumen. H. & E. × 75·6

D.—Mild endocarditis. H. & E. X 75·6

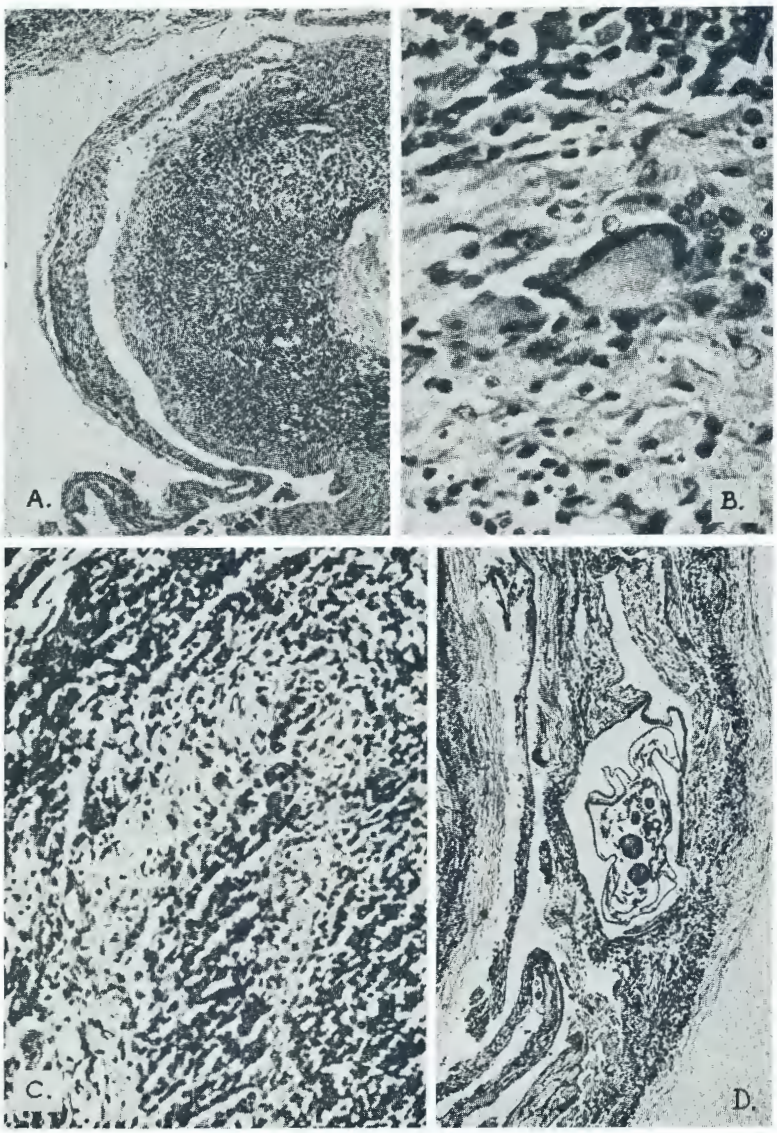


PLATE 7.—Dura mater of three different blue wildebeest, A & B being of the same antelope

A.—Dura showing a marked round cell reaction. H. & E. × 75·6

B.—Vein within the dura showing a giant cell reaction. H. & E. × 480

C.—Another vein with a marked proliferative, villous endophlebitis. H. & E. × 193·5

D.—A double, coiled layer of pachymeninx (one layer incomplete) with one larva apparently within a blood sinus. Pachymeningitis also noticeable. H. & E. × 75·6

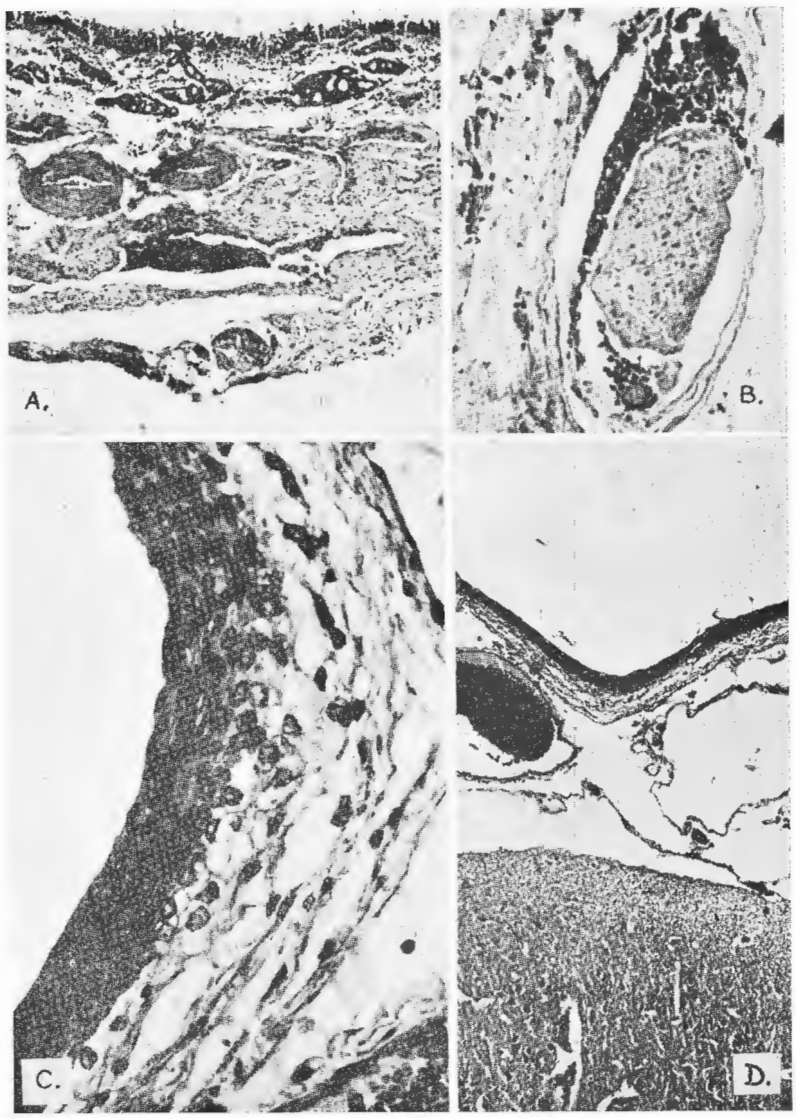


PLATE 8.—A.—Vein in the olfactory mucosa of a blue wildebeest showing an acute endophlebitis. H. & E. × 75·6

B.—Perineuritis in the olfactory mucosa of a blue wildebeest. H. & E. × 192

C.—Proliferated arachnoid. Enlarged central portion of D. H. & E. × 480

D.—Cerebral cortex of a blue wildebeest covered by a proliferated arachnoid. H. & E. × 75·6

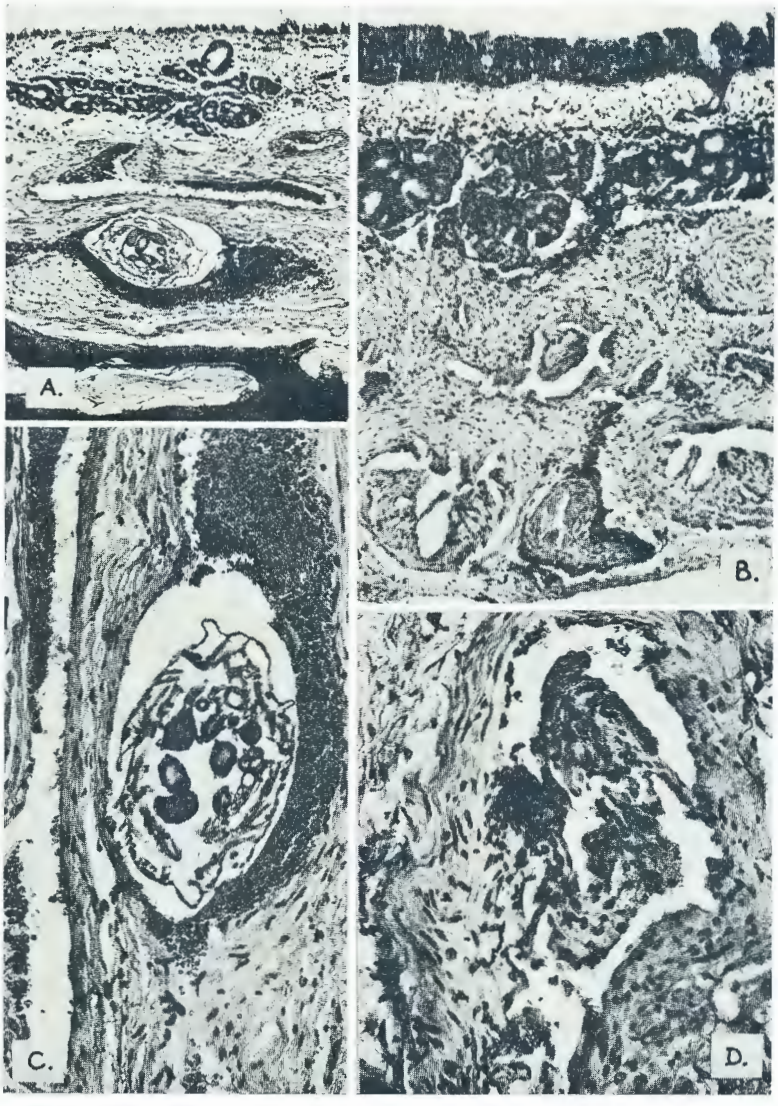


PLATE 9.—Olfactory mucosa of two blue wildebeest (A, C and D belonging to the same antelope)

A.—Section through the turbinate and adjacent mucosa showing one larva in cross section within a vein and necrosis of the epithelium. H. & E. × 75·6

B.—Olfactory mucosa with a proliferative endophlebitis and formation of vascular villi. Periarteritis around two arteries is also noticeable. H. & E. × 96·7

C.—The same parasite as in A. H. & E. × 192

D.—Vein in the olfactory mucosa showing endophlebitis. H. & E. × 192