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STUDIES ON SPECIFIC OCULO-VASCULAR MYIASIS (UITPEULOOG). III. SYMPTOMATOLOGY, PATHOLOGY, AETIOLOGY AND EPIZOOTIOLOGY

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As time and the pressure of other veterinary duties permitted, an effort was made, over a period of several years, to examine as carefully as possible under the somewhat primitive conditions, every definite or suspected case of uitpeuloog in any species of animal with a view to collecting the maximum possible data. In due course the accumulated records were analysed to form the basis of this report.

A.—Pathogenicity

Of the domestic animals, sheep, cattle, goats and equines were found to be susceptible in that order of frequency and severity. Several cases have been reported in man, but these could not be confirmed by personal investigation. Cases have also been reported in the springbuck [*Antidorcas marsupialis marsupialis* (Zimmermann)] and the steenbuck [*Raphicerus campestris steinhardti* (Zukowsky)].

Morbidity varied from 1 to 30 per cent and the incidence did not appear to be correlated with either age or sex.

B.—Symptomatology

Initially some clinically affected animals were collected from several farms, placed in a small camp and kept under observation for three weeks. Temperatures were recorded twice daily and blood smears and eye smears were examined periodically. Special attention was paid to examination of the eyes for the presence of parasites.

Of these sheep 30 per cent showed a mild febrile reaction, 21 per cent in the early stage and 9 per cent in the later stage but it must be borne in mind that some of the cases were advanced when first examined. Hyperthermia lasted for one to five days and the highest temperature recorded was 104·7°F.

Symptoms in individual animals varied considerably but three main forms of the disease were clearly distinguishable viz.:—

(1) Ophthalmic form,

(2) Encephalitic form,

(3) Cardiac form.

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Ophthalmic form

One is tempted to subdivide this form into a mild form showing slight swelling and inconspicuous conjunctival and intra-ocular haemorrhages, and an exophthalmic form characterised by marked protrusion of the eye ball with complications—the symptom which prompted the common name of the disease. However, the gradation between these two extremes is so gradual that a clear demarcation is not possible. Further, in the mildest cases, lesions may be microscopic and not detectable by ordinary clinical examination.

Approximately 96 per cent of affected sheep showed clinical eye lesions. The relative incidence of detectable, unilateral or bilateral eye lesions varied within wide limits from farm to farm, from flock to flock and from herd to herd. Approximately 70 to 90 per cent were unilateral. The number of clinically affected sheep that were subsequently found to be totally blind in one eye varied from 30 to 45 per cent, and those blind in both eyes from 3 to 12 per cent. Blindness was far more common in sheep than in goats, cattle or horses.

The first detectable symptom was invariably lachrymation which varied from slight to profuse, together with a variable degree of chemosis and oedema of the orbital and peri-orbital tissues. In very mild cases no further symptoms might develop and careful examination over a number of days might reveal no lesions other than small conjunctival, subconjunctival or intra-ocular haemorrhages, lesions which might be detectable in apparently normal eyes in sheep subsequently shown by post-mortem examination to have been infected. When further symptoms did appear their onset and development was invariably exceedingly rapid.

Additional symptoms varied from a mild conjunctivitis and keratitis with intra-ocular haemorrhages and opacities, to diffuse swelling of the peri-orbital tissue with exophthalmos (cf. Plate I). Prolapse of the swollen conjunctiva and membrana nictitans was fairly common. The eye lids might be immobilized by the protruding eye ball, leading to marked keratitis and pannus or corneal xerosis. This was often followed by staphyloma and rupture of the eye with expulsion of some or all of its contents. Staphylomas occurred less frequently in cattle, goats and equines. Secondary bacterial infection of the affected tissues was common, being due frequently to the animal rubbing the affected eye against objects or alternatively to stumbling into obstacles.

It will be seen, therefore, that the eye lesions may vary from an almost inapparent infection over the entire range of conceivable lesions to rupture of the eye ball with or without secondary bacterial contamination and orbital or peri-orbital abscessation.

Exceptional cases were seen where thrombosis of both jugular veins caused extension of the oedematous swellings to the head, lips, tongue and neck and even extending to the brisket and down the fore-legs.

In the later stages, in animals which recover persistent corneal opacities, synechiae and cataracts are common, together with permanent defects in the retina. In extreme cases part or the whole of the cornea may be opaque and black, probably the aftermath of corneal vascularization. This condition is known locally as black eye (swartoog) and the animal may be blind in that eye.

PLATE I.—Ophthalmic form of uitpeuloog

The encephalitic form

This form of the disease was found to be far more common in sheep than in other animals, in fact only two calves and one goat showed these symptoms. The incidence in sheep was as high as 15 to 30 per cent.

The nervous symptoms varied considerably, being determined by the level at which the central nervous system was involved. There was no correlation between the severity of the eye lesions and the incidence of nervous symptoms. in fact many of the most marked nervous cases were seen in animals showing the mildest or no clinical eye lesions. Usually nervous symptoms appeared shortly after the first detectable eye lesions but their appearance might be delayed for up to eight days, though the onset was usually sudden.

The first symptom was usually ataxia followed, by a staggering gait with spasms, and a tendency to sway or to move in circles, invariably to the same side. Individual muscles or groups of muscles, particularly of the head and neck, might show clonic spasms. This would result in certain animals showing a peculiar jerking action of the head and neck. Should the spasms be tonic rather than clonic, the result would be the adoption of a peculiar star gazing attitude sometimes for days on end. Alternatively the dorsal aspect of the head might be twisted ventrally or semi-ventrally, or there might be a variable torticollis.

As stated previously the onset of nervous symptoms was usually sudden, so much so that an apparently normal animal might suddenly show spasms and drop to the ground in a lateral recumbent position. It was noticed repeatedly that if an animal was down on one side and was turned over onto the other side, it would make every effort to get back onto the original side again. Recumbent animals might show intermittent tetanic spasms for several days with or without any exciting cause. Alternatively there might be shown those aimless galloping movements so typical of the terminal stages of heartwater. Finally paresis or paralysis might supervene.

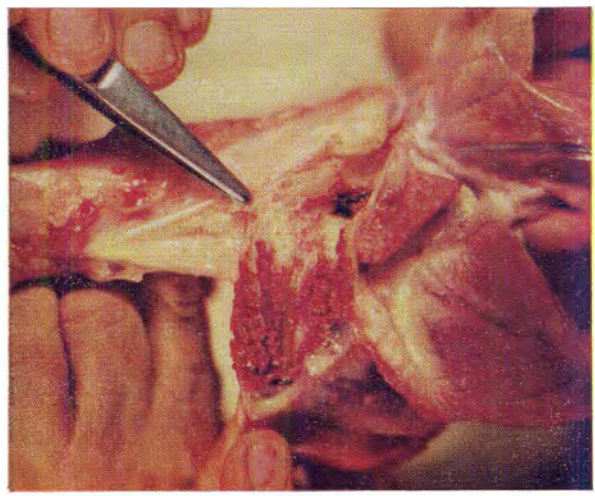
The nervous symptoms were usually accompanied by grinding of the teeth, groaning or almost continuous painful bleating. Inability to eat, drink or swallow was common. Concurrent nystagmus, mydriasis and amaurosis were noted.

The prognosis in animals showing nervous symptoms is invariably grave. The few animals which did recover, often after a course of as long as two months, were usually left with a permanent defect such as ataxia, partial or total imbalance, paresis or paralysis, a peculiar crossing of the legs, or blindness. Usually early destruction of affected animals appeared to be the most humane course. Some animals, however, recovered without any defects.

Cardiac form

This form of the disease comprised 5 to 22 per cent of the total cases examined, and again was confined almost exclusively to sheep. Apart from sheep, only a very limited number of cases were seen in goats and in only one bovine, a four months old calf.

If it is permissible to refer to sudden death as a symptom, then that is practically the only symptom shown in this form of the disease. Usually the animal merely staggers, falls forward onto its side and gives a few kicks and gasps before it dies. Occasionally the sheep would give a painful bleat, leap into the air and fall over dead. It was noted that these sudden deaths often occurred after watering. In other instances the animal was found dead in the morning lying in the normal resting attitude.



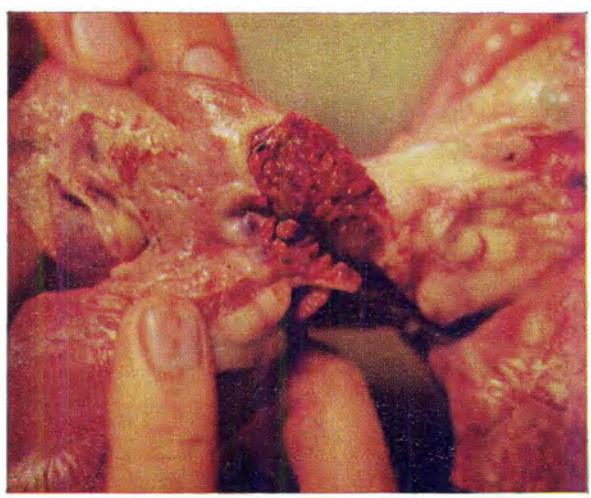


PLATE II.—Cardiac form of *uitpeuloog* showing thrombo-endocarditis.

Although the cardiac form was noted in animals showing typical ophthalmic and encephalitic symptoms many sheep died suddenly without showing any symptoms of either. Only careful post-mortem examination would show the pathognomonic thrombo-endophlebitis which is the precursor of coronary venous thrombosis. Animals whose eyes were affected might die within 30 days of the onset of symptoms, but others might survive for periods up to six or nine months. It was quite clear that any combination of the three forms described might occur.

C.—Pathology

Macroscopic

The macroscopic pathological findings are based upon data accumulated from post-mortem examination of many animals that had died after showing frank symptoms of disease. Frequently, however, animals were slaughtered for examination.

It was found that the pathognomonic lesion in uitpeuloog is a thrombo-endophlebitis which varies in intensity, location and distribution and is frequently accompanied by thrombo-endarteritis.

It has been mentioned that approximately 96 per cent of affected sheep showed clinically detectable lesions of one or both eyes. It is believed that if it had been possible to carry out more careful and detailed pathological examination in all cases, the percentage of primary eye lesions would approximate 100. With this in mind it may be stated that conjunctival, sub-conjunctival and intra-ocular haemorrhages are the first constant lesions. Thereafter there developed oedema of the orbital and peri-orbital tissues followed by keratitis and necrosis of the cornea, conjunctivitis and primary aseptic ophthalmitis.

Endophlebitis accompanied by thrombosis commenced in the ophthalmic vein from where it progressed caudally towards the jugular vein and might even extend to the endocardium of the heart, the pulmonary artery, and the root of the aorta. The extent to which the thrombo-phlebitis became disseminated, determined the incidence of other clinical forms of uitpeuloog. For instance a bilateral jugular affection would result in oedema of the lips, face, head and neck, and possibly also of the brisket and fore-limbs. Extension of the thrombosis into the lungs caused pulmonary infarcts and could be accompanied by tumor splenis and nephrosis with renal infarcts. Should the coronary vessels be involved the cardiac form of the disease characterised by sudden death, the result of coronary thrombosis, would occur. Should the central nervous system be involved then encephalitic symptoms would have been manifest and there would be seen encephalomalacia, encephalitis, focal pinpoint encephalomeningitis, haemorrhages and discolorations in the cerebrum, cerebellum, hippocampus, caudate nucleus and more rarely in the midbrain and medulla.

Perineuritis of the optic nerve with haemorrhages was frequently encountered.

Lesions of thrombo-endophlebitis and thrombo-endarteritis have been found in the ophthalmic, angular, superficial temporal, buccinator, reflex, facial, internal maxillary, external maxillary and jugular veins, the anterior vena cava, pulmonary artery and aorta but rarely even mildly in the posterior vena cava. The condition invariably started in the vessels of the head and was characterised by irregular, elevated, beaded, linear, hyaline streaks or beads, of fibrinous material progressing to form a long unevenly light reddish grey parietal or obstructive thrombus. Considerable areas of the endocardium including the valves of the heart might be affected (cf. Plate II). Coronary thrombosis caused myocarditis or myomalacia cordis.

Occasionally in cattle and horses, and only rarely in sheep discrete pin point yellowish foci were seen in the conjunctiva. Peri-orbital petechiae were occasionally found without any lesions in the eyes.

No attempt is made to describe the gross pathological lesions resulting from secondary bacterial contamination of affected eyes since such descriptions would appear to be superfluous.

Microscopic

No facilities were available for the histological examination of specimens.

Smears made from the discrete yellow foci referred to above, showed that they were due to an accumulation of eosinophiles. Microscopic examination of stained smears of the thrombi also showed this accumulation of eosinophiles.

D.—Aetiology

In 1957, during the course of routine daily inspection of flocks and herds in the enzootically affected area, it was noticed that an ox showed signs of nervousness, irritability, and restlessness, accompanied by lachrymation, winking, and obviously painful irritation of one eye. The animal was secured for immediate examination and several minute insect larvae, less than a millimetre in length, were found in the affected eye. They were in the act of penetrating the cornea and conjunctiva. One larva was secured for examination by dissection from the conjunctiva.

Some time later a similar larva was found in the endocardium of a sheep and shortly after that a larva in the anterior eye chamber of another sheep found in the veld with mild ophthalmic lesions. This larva disappeared within a matter of minutes into the interior of the eye.

Since that time only three similar cases have been seen in sheep. The larvae disappear exceedingly rapidly into the depth of the eye and are lost to sight. In a few cases in cattle and also in horses these larvae were detectable for periods up to three days after penetration of the cornea.

The detection of identical larvae in the cardio-vascular system associated with the endothrombosis, and in the subdural cavity, prompted a detailed entomological investigation which for convenience of description is divided into three phases, viz.:—

(1) A taxonomic survey of the larvae found in domestic animals.

(2) The collection of insects with particular reference to Oestridae.

(3) The association of Oestridae with game:—

(*a*) A survey of first stage larvae in game.

(*b*) Rearing adult insects from larvae.

A taxonomic survey of the larvae found in domestic animals

Insect larvae were found constantly, frequently in large numbers, in association with the vascular thrombi. On tearing the thrombus from the intima of an affected blood vessel they were found adherent or loosely adherent to either the thrombus or to any portion of the affected intima. They were also found in the thrombus and the semilunar valves. In the central nervous system the same larvae, though apparently somewhat more developed, were found in the subdural cavity and in the brain substance. Some larvae were found in the lungs and on the optic nerve of a sheep (cf. Table 2).

All the larvae that were collected from sheep, goats, cattle and horses were mounted in gum arabic or Berlese's solution and examined microscopically. As a result it has been possible to classify these larvae into three groups which differ slightly from one another.

Type A (Plate III)

Type A larvae were isolated from both sheep and cattle.

The cylindrical spinous larvae, 0·8 to 0·9 mm in length are made up of 12 segments, which, except for the first, second, and last are approximately equal in size.

Segment 1.—This is the smallest segment. It is retractile and has a pair of large oral hooks connected to a typical internal cephalopharyngeal skeleton (cf. Plate V). A pair of short, knob-shaped, sucker-like protrusions are situated anteriorly.

Segment 2.—There are three rows of sharply pointed hook-shaped spines situated on the antero-ventral aspect, almost continuous with three rows of larger, very prominent, latero-dorsal hooks shaped like extruded cat's nails; posterior to the hooks are two tufts of triplet bristles ventrally.

Segment 3.—Two complete rows and one indistinct incomplete row of sharp, straight, antero-ventral spines with larger, prominent cat nail hooks laterally; three incomplete rows of slightly curved dorsal spines; two tufts of triplet bristles latero-ventrally.

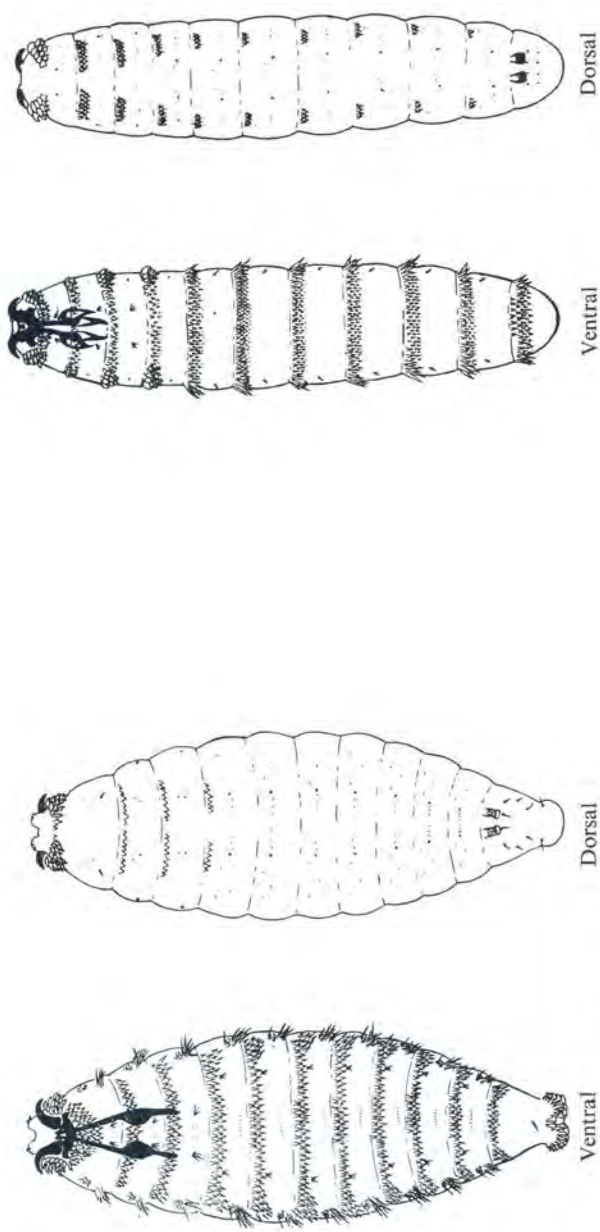
Segment 4.—Three complete rows of straight, pointed, antero-ventral spines with large, cat nail hooks laterally; three incomplete rows of dorsal spines of which some are slightly curved; two tufts of latero-ventral triplet bristles.

Segment 5.—Three complete and one indistinct row of straight, pointed, antero-ventral spines with larger curved cat nail lateral hooks; two distinct and one indistinct, incomplete row of straight dorsal spines.

Segments 6–11.—Four complete and one indistinct, incomplete row of straight, sharply pointed, antero-ventral spines; two incomplete rows of similar spines dorsally; one pair of lateral bristles.

Segment 12.—Four complete and one incomplete anterior row of straight, sharp, antero-ventral spines; eight dorsal bristles and one pair of small, dorsal, bell-shaped, posterior spiracles (cf. Plate VI).

It will be seen that each segment except the first have rows of sharp, pointed spines placed antero-ventrally, the number of rows of each segment increasing gradually posteriorly. Except for those of the second segment the spines in the anterior rows of each segment are longer than those of the posterior row of the same segment. The latero-ventral spines on Segments 3, 4 and 5, are large, prominent, and shaped like cat's nails. The dorsal spines decrease in numbers and numbers of rows posteriorly and are straight except for those of Segments 3 and 4 where some are curved.



Gedoelstia hassleri larva Type A

Oestrus ovis larva

PLATE III.—First stage larvae of *Gedoelstia hassleri* and *Oestrus ovis* (ventral and dorsal views)

Type B (cf. Plate IV)

This type of larva was found in the vascular system of a fatal case of uitpeuloog in a calf.

Morphologically these larvae closely resemble Type A larvae. The main points of difference are the slightly smaller size—0·7 mm; the somewhat different cephalo-pharyngeal skeleton especially basal segment " a " (cf. Plate V); the large bell-shaped posterior spiracles (cf. Plate VI); the longer rows of incomplete dorsal spines and in general the shorter spines; the absence of dorsal spines on Segment 11; the poorly developed lateral hooks on Segments 3, 4 and 5 but particularly on Segment 5; curvature of some of the spines in the posterior rows of all segments but especially the anterior segments. Other points of differentiation are the presence of four rows of ventral spines on Segment 2; three complete and one incomplete rows of dorsal spines on Segment 3; three complete and one indistinct rows of ventral spines on Segments 4–12.

Some of the larvae had longer dorsal rows and dorsal spines on Segment 11.

Type C (cf. Plate IV).

Type C larvae were found in the cardiovascular system of sheep and goats.

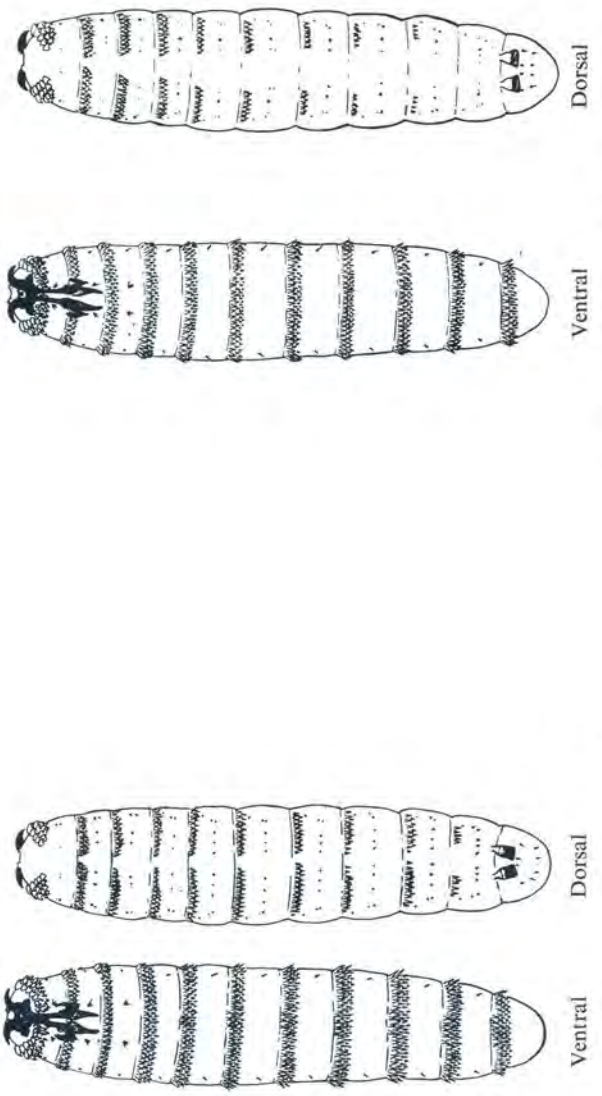
These resemble the Type B larvae closely except for the far more conspicuous nature of the spines which are longer; the rather different cephalo-pharyngeal skeleton especially the basal segment " a " (cf. Plate V) and the small posterior spiracles (cf. Plate VI); three or four ventral rows of spines on segment 4; four or five ventral rows on Segment 12; the presence of dorsal rows on Segment 11; short incomplete rows of varying numbers of spines (2–7) situated in front of the complete rows of ventral spines on all, or some of Segments 6 to 12.

Comment

The study of the morphology of the larvae found in the lesions of domestic animals suggested that they were first stage larvae of a genus of the family Oestridae. A visit was paid to the Onderstepoort library but a careful scrutiny of the literature failed to throw any light on the identity of the larvae since they conformed in no respect to the descriptions of larvae associated with ophthalmomyiasis of man, and myiasis in domestic animals or game.

Lewis (1933) described ocular myiasis in sheep in Uganda caused by *Chrysomyia bezziana*. In regard to ophthalmomyiasis in man the literature abounds with references to cases caused by the first stage larvae of *Oestrus ovis* (Lin). Although the myiasis may be exceedingly irritating, there is no record of its being other than benign with complete spontaneous recovery within a period of three to ten days. Similarly there are numerous records of myiasis caused by larvae of *Rhinoestrus purpureus* (Brauer). Species of *Hypoderma*, though usually causing no more than a transient creeping dermal myiasis, are recorded as having caused malignant ophthalmomyiasis in man (Krummel & Brauns, 1956). Larvae of other insects have also been reported as the cause of ophthalmomyiasis in man viz. *Sarcophaga* spp., *Lucilia sericata*, *Wohlfahrtia magnifica*, *Cordylobia anthropophaga*, *Callitroga americana*, *Chrysomyia bezziana*, *Gasterophilus* spp. and *Megaselia scalaris*.

Since the descriptions of the larvae of the above-mentioned genera and species of insects did not correspond in any way with the morphological characteristics of the first stage larvae found in association with uitpeuloog, it was decided to carry out a careful survey of insects in the enzootic area, paying attention not only to insects found in the open veld but also to those encountered in the vicinity of groups of domestic animals and concentrations of wild game. Interest was to be focused upon insects of the family Oestridae in the hope that any larvae collected from gravid females might be compared with those described above and thus lead to their identification.



Gedoelstia cristata Type I: larva type B *Gedoelstia cristata* Type II. larva type C

PLATE IV.—First-stage larvae of *Gedoelstia cristata* Types I and II larvae Types B and C

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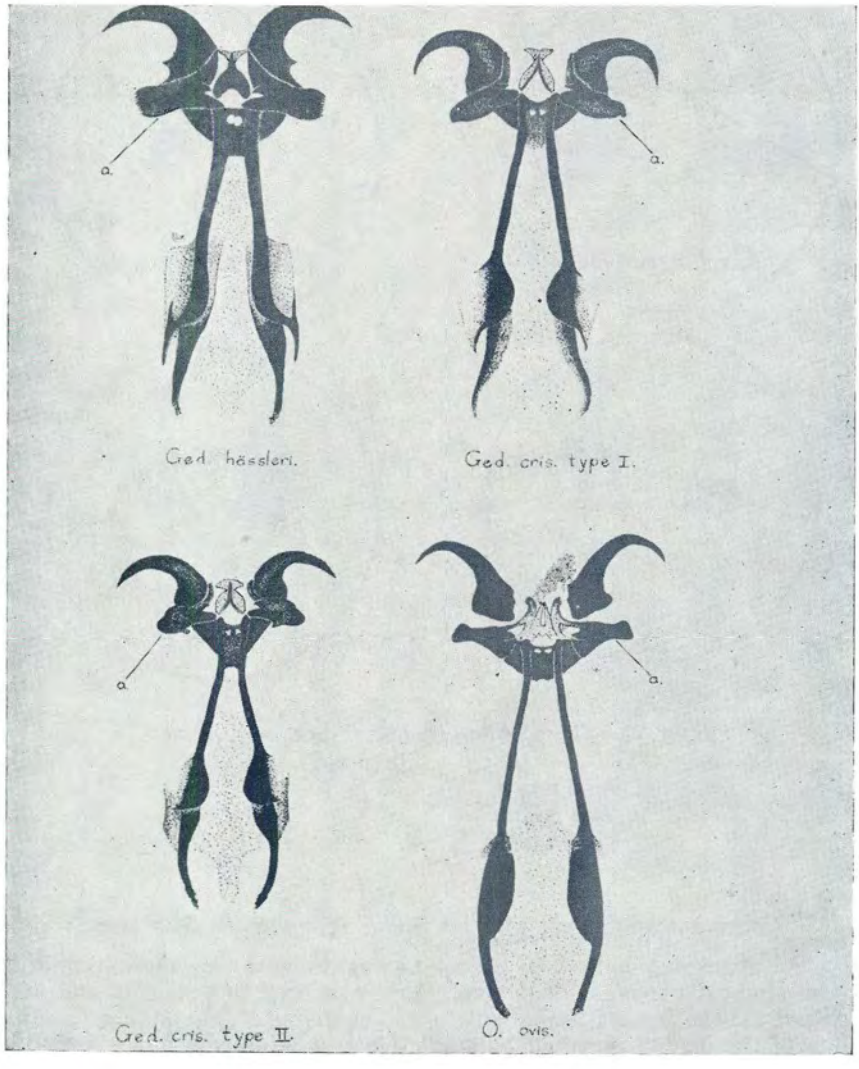

3 4

PLATE V.—Cephalo-pharyngeal skeleton of *Gedoelstia* species

1. *Gedoelstia hassleri*
   Type A larva
2. *Gedoelstia cristata*
   Type I: Type B larva
3. *Gedoelstia cristata*
   Type II: Type C larva
4. *Oestrus ovis*

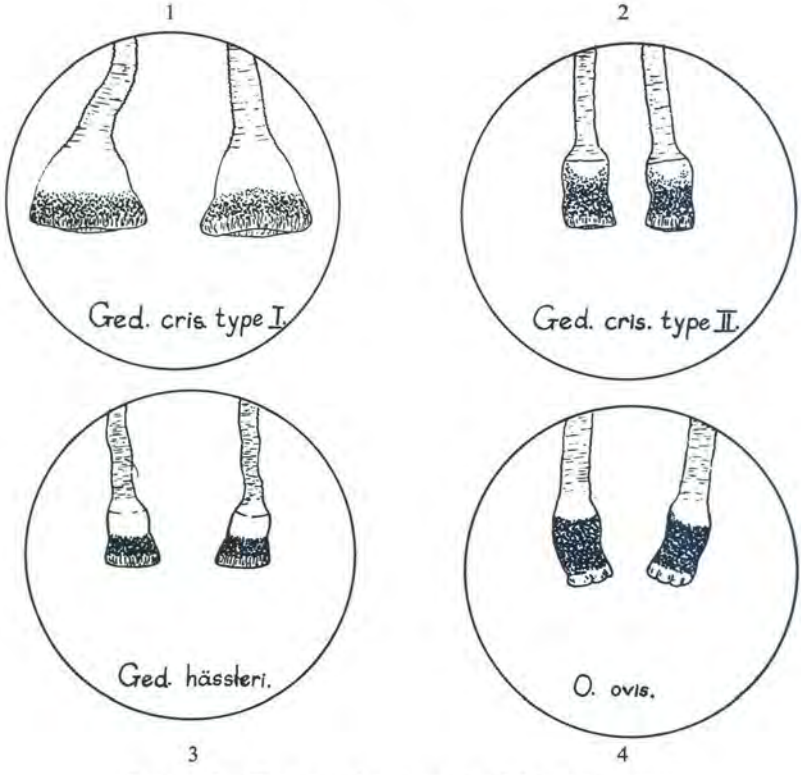

PLATE VI.—The posterior spiracles of first stage larvae

1. Type B larva
2. Type C larva
3. Type A larva

Collection of insects, with particular reference to Oestridae

The first attempted method of collection was to drive a motor vehicle at fairly high speed along the socalled farm road, then from time to time stop and without delay collect all the insects found on the radiator grill. It was found, however, that none of the insects captured by this method were of any importance.

Another method was to examine the sides of buildings and the surface of uneven walls and to catch any insects by hand. Many Oestridae were captured from their resting place on uneven walls. The majority were found to be *Oestrus ovis* but *O. aureoargentatus* were taken as well.

Eventually it was found that the most profitable method was to keep a flock of sheep under close observation and to catch by hand any insect which was noticed. Several farmers volunteered to assist with this operation and they were supplied with specimen bottles containing 10 per cent formalin in which to preserve insects for future examination and identification. No conventional insect nets were available.

The following Oestridae were captured and identified:—

Oestrus ovis (Linnaeus)

Oestrus aureoargentatus (Rodhain and Bequaert)

Oestrus bassoni (Zumpt)

Gedoelstia cristata (Rodhain and Bequaert)

Gedoelstia hässleri (Gedoelst)

Of these the *Gedoelstia* species are of particular interest in that one gravid *G. hässleri* and seven gravid *G. cristata* females that attacked either man or sheep were collected.

Gedoelstia hässleri

This gravid female was captured in a kraal in the Aminius Corridor area. The fly was noticed at least 15 feet from a sheep as it headed like a bomber for the eye of her host. The movement towards and away from the eye was so fast as to appear uninterrupted. The fly was captured with a hat when it came to rest on the floor of the kraal in which the sheep were being examined. No larvae could be expressed from the abdomen but after dissection of the preserved specimen 668 were counted. These larvae were identical to the Type A larvae described above. A tiresome effort to find the sheep in a flock of 1,000 proved unsuccessful.

Gedoelstia cristata

Two distinct varieties of this species were captured, the one being considerably larger than the other. They have been designated provisionally Type I and Type II. Both the first stage larvae and the adults show minor morphological differences.

(*a*) *Gedoelstia cristata* Type I.—This gravid female was captured on the wing at sunset on the farm Uitspan in the Aranos area.

One of a herd of blue wildebeest had been shot with a view to the possible collection of larvae. It was in the vicinity of this carcass that the fly was noticed, captured and identified as *G. cristata*. No first stage larvae could be expressed from the abdomen but a large number was collected by dissection. Incidentally it was these larvae that were used for a successful artificial transmission experiment to two sheep by deposition on the conjunctiva and cornea as described in detail below.

It is of interest to note that, after the capture of this female fly close to the wildebeest, a local farmer, who had accompanied the author, complained that he had been worried by the attention paid to his ear by a flying insect. A close examination showed the presence of about 50 tiny larvae above and behind his ear. These were subsequently identified as Type B larvae, identical with those dissected from the abdomen of the captured fly.

(*b*) *Gedoelstia cristata* Type I.—This gravid female was captured by a farmer near the homestead of his farm Oorwinning in the Aranos district. The farmer said that " the fly had troubled him by its attentions ". A total of 219 larvae were expressed from the abdomen. These larvae were identical with the Type B specimens.

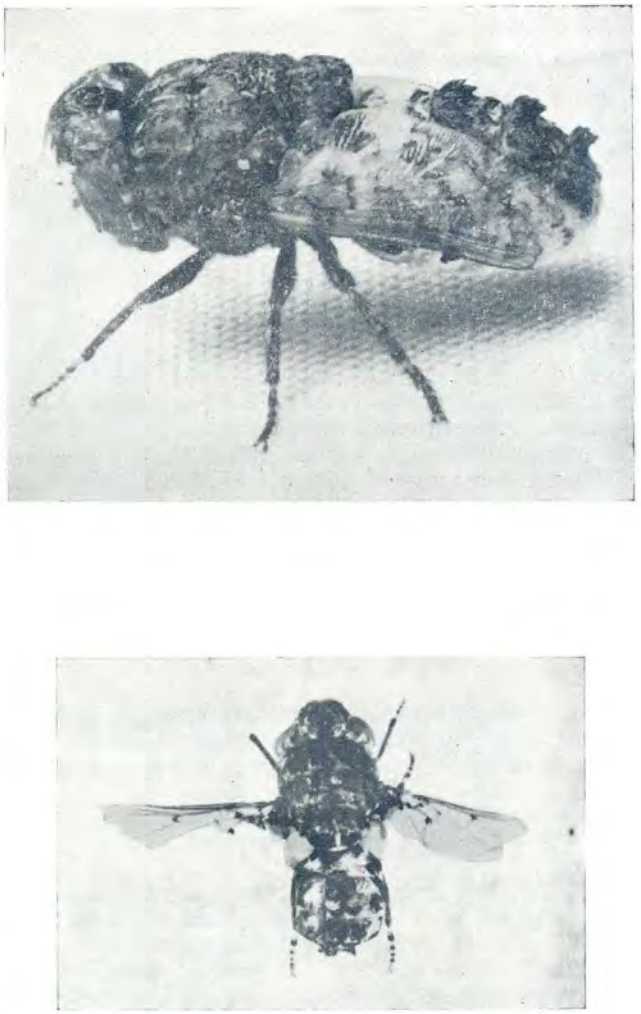

PLATE VII.—*Gedoelstia cristata* Type I adult fly

(*c*) *Gedoelstia cristata* Type II.—This specimen was captured by the same farmer at approximately the same place on a later occasion. It resembled the previous specimen except for the larger size and the absence of the glossy black spots situated on the mesonotum laterally to the glossy black weals. Only three larvae were expressed from the abdomen and these resembled Type C.

(*d*) *Gedoelstia cristata* Type II.—This fly was captured by a farmer in the Klein Nossop area close to his homestead after it had been seen depositing larvae behind the ear of his small son. No larvae could be found in the abdomen and, most unfortunately those deposited were lost.

(*e*) *Gedoelstia cristata* Type II.—This specimen was captured on the farm Pniel in the Aranos district in the act of depositing larvae in the corner of the mouth of a Bantu. The same Bantu volunteered the information that on a previous occasion a fly had deposited material on his arm. None of the larvae deposited in the mouth were obtained but 2,464 were dissected from the abdomen after preservation and were found to be identical with Type C.

(*f*) *Gedoelstia cristata* Type II.—This fly was captured by hand by a farmer when seen hovering over some sheep in a kraal on the farm Swerweling in the Aranos district. A total of 294 first stage larvae was expressed from the abdomen and 2,062 were dissected out after preservation. They were identical with Type C.

(*g*) *Gedoelstia cristata* Type II.—This fly was caught by a farmer on the farm Geluk in the Aranos area when it was seen among some cattle in a kraal. Some larvae were obtained from the badly preserved specimen and these proved to be identical with Type C.

In addition to the *Gedoelstia* spp. one gravid *Oestrus ovis* female was captured. The larvae expressed from the abdomen were distinguishable from the *Gedoelstia* larvae without difficulty by the oval shape and the dorso-ventrally flattened body (cf. Plate III). In addition there is present on the last segment a pair of protuberances each with 9 to 11 hooklets. Dorsal spines are present on Segments 2, 3, 4 and 5 and curved spines on Segment 2. Each segment has two complete and one or more incomplete anterior or posterior rows antero-ventrally. The incomplete rows varied in number and localisation, even in larvae from the same female, as follows:—

Segments 3–5: 1 to 2 postero-ventral rows

Segments 7–12: Nil or 1 postero-ventral row

Segment 4: 1 to 2 postero-latero-ventral rows

Segment 5: 2 postero-latero-ventral rows

Segments 6–11: 3 postero-latero-ventral rows

Segment 12: Nil or 1 to 3 postero-latero-ventral rows

Segments 6–12: 1 antero-ventral row

Segment 2: 7 to 10 rows of pointed straight or slightly curved spines ventrally and curved hooks dorsally

Segments 2–11: 1 tuft of 3 to 15 thick spiny bristles latero-ventrally on each side posterior to the spines

Segment 12: 10 fine bristles on the dorsal aspect

Segments 2, 3 and 4: Some of the spines had 2 or 3 points with one always prominent

Segments 5–11: 1 pair of small, ventral protuberances each with 3 very fine hairs.

The cephalo-pharyngeal skeleton, especially the basal segment " a " of the oral hooks and the posterior spiracles of *Oestrus ovis* larvae differ considerably from those of the *Gedoelstia* species (cf. Plate V).

Comment

From the above it is apparent that the first stage larvae isolated from affected domestic animals emanated from *Gedoelstia* species of Oestridae. *G. hässleri* produces the Type A larvae, *G. cristata* Type I the Type B larva and *G. cristata* Type II the Type C larvae.

It is not the intention to describe either the adult *O. ovis* or either of the three adult species of *Gedoelstia* because there is nothing to add to the descriptions which have appeared in the literature or are in press.

The first stage larvae of the *Gedoelstia* species have been described for the first time and it is of particular interest to note how these larvae were identified by comparison with those collected from captured adult flies which were readily identifiable from previous descriptions. This sequence of events paved the way for the investigation and clarification of the aetiology of the disease.

The association of Oestridae with game

(*a*) *Survey of first stage larvae found in game*

From time to time blue wildebeest [*Gorgon taurinus taurinus* (Burchell)], hartebeest [*Alcelaphus caama selbornei* (Lydekker)], gemsbuck (*Oryx gazella* Linnaeus) and springbuck [*Antidorcas marsupialis marsupialis* (Zimmermann)] were available for examination. The incidence of first stage *Gedoelstia* larvae is summarised in Table 1.

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

	Subdural Cavity		Cardiovascular System	
	Total Examined	Positive	Total Examined	Positive
Blue wildebeest	38	38	14	11
Hartebeest	27	1	11	8
Gemsbuck	4	0	2	1
Springbuck	16	0	9	0

It will be seen that each of 38 blue wildebeest examined showed the presence of first stage *Gedoelstia* larvae in the subdural cavity, whereas only one larva could be found in 27 hartebeest and none in four gemsbuck and 16 springbuck in this site. Of 14 blue wildebeest and 11 hartebeest, larvae were found in 11 and eight respectively in the cardiovascular system. Only one out of two gemsbuck examined carefully showed cardiovascular involvement. No larvae could be found in nine springbuck. Two larvae were found in the trachea of one hartebeest.

The distribution of the larvae closely followed the pattern seen in domestic animals. They were found in the eyes, both externally on the cornea, sclera and conjunctiva and in the peri-orbital tissue; in the cardiovascular system they were found in the ophthalmic, angular, superficial temporal, internal maxillary and jugular veins, in the right auricle, right ventricle and pulmonary artery; in the subdural cavity only in blue wildebeest and one hartebeest and finally in the paranasal sinuses of only blue wildebeest and hartebeest. Various unidentified first stage *Oestrus* larvae were recovered from the nasal cavity—most frequently in the folds of the turbinate bones—of springbuck, gemsbuck, hartebeest and blue wildebeest. Two peculiar unidentified first stage larvae were also obtained from the trachea of springbuck and hartebeest.

Mature first stage *Gedoelstia* larvae were found usually on the ethmoid bone, in the ethmoid meatuses and paranasal sinuses but not in the folds of the turbinate bones.

By comparing the *Gedoelstia* larvae from game with the suggested Types A, B and C it was possible again to classify them as *G. hässleri* and *G. cristata* Types I and II.

There were, however, a few minor variations. A sub-type of *Gedoelstia cristata* Type I was characterised by its longer dorsal rows, the presence of one or two dorsal spines on Segment 11 and medium sized bell-shaped spiracles. The medial protuberance on the basal segment of the oral hooks was sometimes inconspicuous. Some of the larvae of Type II had only four complete rows and one incomplete row of antero-ventral spines on Segment 12 and the posterior protuberance of the basal segment was absent in others (cf. Plate IV).

The findings are summarised in tabular form in Table 2. For the sake of completeness, data in regard to cattle, sheep and goats are included.

TABLE 2.—*Summary of first stage* Oestrid *larvae found in game and domestic animals*

Animal species	Oestrid species	Localisation			
		Eyes	Cardio-vascular system	Sub-dural cavity	Nasal cavity or paranasal sinuses
Blue wildebeest	*D. hässleri*	+	+	+	+
	G. cristata Type I	−	+	−	+
	G. cristata Type II	−	+	−	+
	Oestrus species	−	−	−	+
Hartebeest	*G. hässleri*	+	−	+ (one only)	+
	G. cristata Type I	−	+	−	+
	G. cristata Type II	−	+	−	+
	Oestrus species	−	−	−	+
Gemsbuck	*G. hässleri*	−	−	−	−
	G. cristata Type I	−	+	−	−
	G. cristata Type II	−	−	−	−
	Oestrus species	−	−	−	+
Springbuck	*G. hässleri*	−	−	−	−
	G. cristata Type I	−	−	−	−
	G. cristata Type II	−	−	−	−
	Oestrus species	−	−	−	+
Bovine	*G. hässleri*	+	−	−	−
	G. cristata Type I	−	+	−	−
	G. cristata Type II	−	−	−	−
	Oestrus ovis	−	−	−	−
Ovine	*G. hässleri*	+	+	+	−
	G. cristata Type I	−	−	−	−
	G. cristata Type II	−	+	−	−
	Oestrus ovis	−	−	−	+
Caprine	*G. hässleri*	−	−	−	−
	G. cristata Type I	−	−	−	−
	G. cristata Type II	−	+	−	−
	Oestrus ovis	−	−	−	+

NOTE.—*G. cristata* Type I and II found in trachea of one hartebeest. *G. hässleri* larvae were recovered also from the brain and lungs of sheep.

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The larvae in the blood stream were slightly longer (0·8 to 1·4 mm) than freshly deposited larvae or those expressed from the abdomens of captured gravid females (0·7 to 1·0 mm). Those found in the subdural cavity were larger still, varying in length from 1·0 to 3·7 mm. A single large larva 2·0 mm in length was obtained from the eye of a sheep.

The larvae in the blood stream of game were either free in the blood or loosely adherent to the intima of the blood vessels. In the subdural cavity they were usually loosely adherent to the dura mater. Occasionally they were found loosely adherent to the pia mater and very rarely embedded in the dura mater.

In contradistinction to the pathological changes found in affected domestic animals, well defined acute or chronic lesions in game were conspicuous by their absence. An occasional blue wildebeest and hartebeest was found to be unilaterally blind but the lesions were long standing and no opinion as to their specificity can be expressed. Very mild, scarcely detectable, pulmonary arteritis was seen in one wildebeest and one hartebeest. In one blue wildebeest a few chronic infarcts of unknown aetiology were present in the myocardium. No lesions whatever were found in the subdural cavity. Slight chemosis with pin point conjunctival haemorrhages was seen in the eye of a blue wildebeest, from which eye several *G. hässleri* larvae were collected. On the other hand paranasal sinusitis, often purulent in nature, was not uncommon.

It should be mentioned that Wessels (1937) in describing an unknown disease in bontebuck [*Damaliscus pygargus* (Pallas)] characterised by spinal paralysis, recorded the presence of an unidentified dipteran larva in the right atrium and anterior vena cava, at its entrance into the auricle, in five successive autopsies. The pathological lesions consisted of chronic focal fibrous endocarditis, accompanied by a thickening of the wall of the vena cava. The larvae were adherent and firmly attached to the intima and endocardium. It was suggested that these larvae, during migration in the body, cause injury to the spinal cord and so produce paralysis. It is most unfortunate, in view of the current investigations, that no detailed description of the morphology of the unidentified larvae is available.

(*b*) *Rearing adult insects from larvae*

Mature larvae were collected from the paranasal sinuses of sheep and the indicated species of game. These were transferred to 3 inches of sand for pupation. The pupal period varied from about 21 to 33 days, but in cold weather might be prolonged up to about two months or more. The adult flies that emerged were identified as indicated in Table 3.

TABLE 3.—*Species of* Oestridae *reared from mature larvae*

	Sheep	Blue Wilde-beest	Harte-beest	Gems-buck	Spring-buck	Pupal period (days)
G. hässleri	−	+	+	−	−	21–32
G. cristata Type I	−	+	+	−	−	22–35
G. cristata Type II	−	+	+	−	−	22–44
O. ovis	+	−	−	−	−	22
O. variolosus	−	+	+	−	−	22–32
O. aureo-argentatus	−	+	+	−	−	22–34
O. bassoni	−	−	+	−	−	30
R. vanzyli	−	−	−	−	+	40

Only a limited number of *G. hässleri* was reared from pupae collected from hartebeest and of these the majority were *G. cristata* Type II. Unidentified oestrid larvae were collected from hartebeest, blue wildebeest, gemsbuck and springbuck. Only *Rhinoestrus vanzyli* could be reared from springbuck.

In the non-enzootic areas where hartebeest were found, only *Oestrus* and *Kirki-oestrus* larvae were found and reared to the adult stage.

All attempts to colonise any of the genera of Oestridae were failures and, therefore, up to the present it has not been possible to produce gravid females under artificial conditions with a view to investigating their pathogenicity or to follow in detail the life cycle of the fly in either domestic animals or game.

Conclusion

A systematic survey of Oestridae in the enzootically affected area revealed the presence of three separate genera—*Oestrus*, *Rhinoestrus* and *Gedoelstia*.

Larvae emanating from three species of *Gedoelstia* only were found to be identical with the larvae found in domestic animals; these species are *G. hässleri* and *G. cristata* Type I and Type II.

Four species of the genus *Oestrus* were reared or collected—*O. ovis*, *aureoargentatus*, *variolosus* and *bassoni*. Their larvae were limited to the paranasal sinuses of sheep, goats, hartebeest, blue wildebeest and gemsbuck.

Rhinoestrus vanzyli was reared from springbuck.

Unidentified adult larvae, and first stage larvae were obtained from the paranasal sinuses of blue wildebeest, hartebeest and springbuck, and from the trachea of hartebeest and springbuck respectively.

A survey of Oestrid larvae in the species of game abounding in the area showed that, in an uitpeuloog enzootic area, *Gedoelstia* larvae were present in the paranasal sinuses of blue wildebeest and hartebeest, also constantly in the subdural cavity of blue wildebeest but were found only once in that site in hartebeest, though never in springbuck and gemsbuck. In the cardio-vascular system they were detected in the majority of blue wildebeest and hartebeest, in one gemsbuck but in none of nine springbuck examined.

It is concluded that the three species of *Gedoelstia* parasitise a wide range of hosts but that their natural hosts, in conjunction with whom they maintain a symbiotic existence, are the blue wildebeest and hartebeest. Other species of wild game such as gemsbuck and springbuck may be invaded but in them development to the mature larval stage does not take place. Domestic animals are to be regarded as aberrant hosts in which, not only is the larval life cycle not completed, but also no evidence of symbiosis is exhibited, with the result that parasitism is followed by the clinical manifestation of disease to which the name uitpeuloog has been given.

Artificial transmission of Gedoelstia *larvae*

Failure to colonise any of the species of *Gedoelstia* made an investigation of the artificial transmission of the disease somewhat difficult and complicated.

First stage larvae were collected from the cardio-vascular system of domestic animals and game. In transmission experiments with these larvae one was faced with the difficulty of collecting adequate numbers and also of keeping them alive

and active in the period between collection and ocular instillation. Nevertheless on three separate occasions experimental intra-ocular transmission was attempted on three different sheep. On each occasion the decreased motility and penetrative ability of the larvae were apparent. All three sheep developed conjunctivitis and keratitis without any of the additional clinical symptoms typical of uitpeuloog. Most unfortunately pressure of other duties made it impossible to slaughter the sheep subsequently for post-mortem examination. Consequently no conclusion may be drawn other than that the results of these experiments were inconclusive.

It was decided, therefore, to concentrate upon the use of larvae collected from captured adult gravid flies. Under the peculiar conditions under which this work was carried out a well-nigh insurmountable difficulty was to synchronize the capture of a fly with the availability of experimental sheep from a flock in which natural cases were not prevalent.

In 1960 the first *G. hässleri* female fly was captured but no larvae could be expressed from the abdomen. It was only after preservation and dissection that 668 larvae were obtained.

The second fly captured was the *G. cristata* Type I specimen referred to previously. All the larvae collected were obtained by dissection from the abdomen. Of these some were preserved for identification, while the balance were deposited with a minimum of delay onto the corneae of two sheep obtained from a local flock among which no cases of uitpeuloog had occurred. The work was done at night and no attempt was made to count the larvae as this might have resulted in either injury or loss. It was not possible to maintain the sheep under insect-free conditions.

Result

Sheep A.—Both eyes were infested.

After 12 hours. Both eyes appeared slightly swollen with haemorrhages into the conjunctiva. The left eye was more severely affected showing a chemotic conjunctiva and diffuse haemorrhages into the lower lid.

After 24 hours. No further development was noticed.

After 36 hours. One larva, not previously detectable, was seen in the anterior chamber of the right eye. The lesions had not progressed, in fact resorption of the haemorrhages had commenced.

After 2½ days. The one larva was still visible in the right eye but it appeared to be inactive. Resorption of the haemorrhages had progressed.

After 3½ days. The inactive larva was still visible. The eyes appeared normal. The sheep was listless with a tendency to walk in a circle.

After 4½ days. Larva still visible; sheep listless and not feeding; there was an inclination either to twist the head and neck or alternatively to stand with the head and neck lowered almost onto the ground, and to move in a circle. The sheep appeared to be in pain and repeatedly nibbled at the wool behind the elbow.

After 5 days. The sheep was down quite oblivious to its surroundings, grinding its teeth and showing dyspnoea. Galloping movements of the limbs were noted before death which occurred five days and six hours after instillation of the larvae.

On post-mortem examination the macroscopic pathological lesions were general cyanosis and congestion; thrombo-endophlebitis of both jugular veins and their various branches from the head; disseminated focal endocarditis of the right auricle and ventricle; thrombo-endarteritis of the pulmonary artery, thoracic and abdominal portions of the aorta and both carotid and internal maxillary arteries; encephalomalacia and encephalitis of the thalami and latero-posterior portions of both cerebral hemispheres; pulmonary oedema; nephritis; lymphadenitis of the thoracic lymph glands. First stage *G. cristata* Type I larvae were found in the anterior chamber of the right eye, right auricle and ventricle, pulmonary artery and aorta. These larvae were still alive. The eyes appeared quite normal except for the presence of the one larva.

Sheep B.—Larvae were instilled onto the right eye only.

After 12 hours. There was lachrymation from the right eye which was swollen and partially closed with petechial haemorrhages in the conjunctiva.

After 36 hours. The swelling of the eye was not increased but severe haemorrhages were present in the conjunctiva of the upper eye lid.

After 3½ days. The sheep was slightly listless, occasionally bleated mournfully and showed a tendency to move in a circle. Resorption of the haemorrhages was in progress.

After 4½ days. The sheep appeared perfectly normal.

No further symptoms developed up to the time the animal was slaughtered for post-mortem examination on the seventeenth day.

On post-mortem examination there was found a marked thrombo-endophlebitis mainly of the vessels of the right side namely ophthalmic, supraorbital, reflex, buccinator, external maxillary, internal maxillary and jugular veins but involving also the left jugular, internal maxillary and reflex veins, and the anterior vena cava. Focal disseminated endocarditis was present in the right auricle and ventricle. Thrombo-endarteritis was found in the pulmonary artery and the right internal maxillary artery. In the myocardium were two old standing infarcts; in the centre of the left cerebral hemisphere there was a small area of encephalomalacia half-an-inch in diameter. First stage *G. cristata* Type I larvae were collected from both jugular veins and the pulmonary artery; these larvae were still active. The eyes appeared to be quite normal.

In view of the previous failures to set up the disease with larvae from the cardiovascular system of other animals no attempt was made to maintain the condition by passage.

Conclusion

It is concluded that as a result of the instillation of living first stage larvae dissected from the abdomen of a gravid *G. cristata* Type I female, two cases of uitpeuloog with the pathognomonic vascular and encephalitic lesions were produced but that the ophthalmic lesions were comparatively mild and transient in nature.

From the result of this experiment, viewed in the light of previous recorded observations, it is felt that the following conclusions are justified.

1. Uitpeuloog is caused by first stage *Gedoelstia* larvae that invade the eyes of an aberrant host and subsequently migrate to the cardiovascular and central nervous system.

2. Lesions in the eye are detectable in a period of less than 12 hours after deposition of the larvae.

3. Symptoms of the encephalitic form of the disease may appear five days after ocular invasion, by which time the eye lesions may be resolved.

4. The encephalitic form is caused not only by *G. hässleri* larvae but also by *G. cristata* Type I larvae which, up to this stage of the investigations, had been conspicuous by their absence from the subdural cavity of both domestic animals and game.

5. The involvement of the carotid and internal maxillary arteries in Sheep A suggests that this is one of the routes of migration of the larvae to the brain. Migration via the optic nerve, in view of its involvement in many previous cases, is believed to be another route.

6. Larvae which are deposited in one eye may reach the veins on the other side of the head and neck either via anastomotic vascular branches or by migration through the tissues.

7. The life cycle of *Gedoelstia* is not completed in domestic animals.

E.—Epizootiology

As the association of blue wildebeest and hartebeest with the incidence of uitpeuloog had been proved, particular attention was paid to the examination of these two species of game both within and without the enzootically affected area. Wherever possible detailed post-mortem examinations were carried out with a view to collecting larvae for identification and for rearing. From time to time other species of game were available for examination and these were not neglected.

It was found that the mere presence of blue wildebeest and hartebeest was not the only requisite for an outbreak of uitpeuloog; in other words the disease only occurred in an area where the game were found to harbour *Gedoelstia* larvae. This was particularly noticeable on one farm in the Kalahari and on several farms in the Windhoek, Gobabis and Otjiwarongo districts. Hartebeest and blue wildebeest were present on these farms—the hartebeest often in large numbers—but not a single case of uitpeuloog occurred. A careful search failed to reveal the presence of *Gedoelstia* larvae in any of the game examined. Also both species of game occur in other parts of South Africa, yet no case of uitpeuloog has been recorded.

Morbidity appeared to be highest amongst animals grazing in pans or thickets, but outbreaks were encountered frequently on open grazing; it was noticed that infection might take place in kraals.

Apart from the life cycle of the incriminated flies, which in general is similar to that of other species of Oestridae, little is known of the habits of the *Gedoelstia* species. They are diurnal in habit and less active during rainy and inclement weather. The density of flies appears to be uneven but the factors responsible for variations in density are not known. Most of the outbreaks investigated occurred during August to October and again during March and April, that is, during early spring and in the autumn. The period of larval pupation was found to be about 21 to 44 days but might be prolonged by a month or more during the cold winter months. This may account for the incidence of cases in the spring which are due to parasitism by flies emerging from the pupae of mature larvae reaching the ground during the winter months.

The distance that adult flies might travel could not be determined with any degree of accuracy. A rough estimate is 10 miles but this may well be an underestimate particularly during the seasons of high winds. Apart from the movement of adult flies the fact that game will migrate many miles in search of grazing and water indicates that infection may be disseminated over vast tracts of country. The establishment of an area of enzootic infection will then depend upon the ability of the fly to maintain itself. Fresh cases of uitpeuloog were not encountered for periods longer than about two months after game had migrated out of a given area. From this it is concluded that the *Gedoelstia* are unable to maintain themselves in the absence of those species of game which are their natural hosts. Persistence of infection will then depend upon the period of larval pupation and the longevity of the adult flies.

In regard to the animals affected it was noted that there was a higher incidence in sheep which are in poor condition, in ewes with lambs at foot and in sheep recently introduced. Apparently the poor conditioned sheep are less alert and active and, therefore, less likely to protect themselves or avoid the unwelcome attention of the flies. The ewes with lambs less frequently assemble in groups with their heads under one another's bellies, which would afford protection for the vulnerable eyes. The newly introduced sheep have no previous experience of attack by flies. Healthy alert animals are by no means excluded from the possibility of infection as evidenced bythe rapid bomberlike method of attack, particularly of *G. hässleri*.

Discussion

The sequence of events which led to a solution of the salient features of the aetiology of uitpeuloog is clear.

Associated with the constant pathological lesion in domestic animals—thromboendophlebitis and endarteritis—were found minute dipteran larvae which could not be identified in spite of a diligent search through the literature which it is not the intention to review though the publications consulted are shown in the bibliography. However, a taxonomic survey of the Oestridae in the region showed that these larvae emanated from two species of the genus *Gedoelstia*, *G. hässleri* and *G. cristata*, of which there are two main types. Two cases of uitpeuloog were produced in two sheep infected by the supra-corneal and conjunctival instillation of first stage larvae dissected from the abdomen of a captured *G. cristata* fly. Finally the association of game with the disease was shown by rearing *G. hässleri* and *G. cristata* from mature larvae collected from the paranasal sinuses of both blue wildebeest and hartebeest. The cycle of events in game and domestic animals was completed but it is admitted freely that there remains a number of important points which merit further investigation with a view to clarification.

In regard to domestic animals it is believed that the chief, if not the only portal of entry of the first stage larvae is the orbit. By virtue of their peculiar morphological features in the form of hooks and sharp pointed spines, combined with pulsating telescopic movements, the larvae penetrate into the periorbital tissue through which they migrate. Their ultimate goal would appear to be the subdural space but *en route* there are a number of alternative possibilities.

(*a*) Should the larvae penetrate a vein they would be carried passively in the blood stream, eventually to reach the heart but on the way attaching to the intima of larger veins to set up foci of endophlebitis. In the heart itself an endocarditis is set up and, should entrance by chance be gained to a coronary vessel the cardiac

form of the disease would result. From the right heart, larvae might be passively transported to the lungs where *G. hässleri* have been found in sheep. The path is now open to the arterial blood vessels and the frequent involvement of the aorta in natural cases and the carotid artery in the experimental cases indicates that this is a route either to the subdural cavity or to the brain to set up the encephalitic form of the disease.

(*b*) Should a larva penetrate an artery it might be carried direct to the brain.

(*c*) Should a larva penetrate the optic nerve, and the presence of larvae has been demonstrated in this nerve, the path is open either to the brain or to the subdural cavity.

As evidence that domestic animals are aberrant hosts in which these species of *Gedoelstia* are unable to complete the mammalian phase of the life cycle is the highly significant observation that larvae were never found in the paranasal sinuses or nasal cavity.

In regard to game, in those species in which the life cycle of the *Gedoelstia* species has been shown to be completed, namely the blue wildebeest and the hartebeest, some exact details of that cycle remain to be determined. These involve not only the species of fly but also the species of game.

First stage *G. hässleri* larvae were found in the eyes, cephalo-cervical circulation, heart, pulmonary circulation, subdural cavity, and paranasal sinuses of blue wildebeest. They were seldom found in hartebeest and, it should be noted, only one larva of this species was found in the subdural cavity of 27 hartebeest examined. This would appear to be a highly significant observation in an area where wildebeest and hartebeest mingle freely and continuously. Therefore, one is tempted to suggest that the blue wildebeest is the host of choice of *G. hassleri* though hartebeest cannot be excluded since a few adult flies were reared from larvae collected from hartebeest.

In the case of the two types of *G. cristata*, first stage larvae were found in the same sites as *G. hässleri* in both hartebeest and wildebeest with this notable exception that, out of 38 wildebeest and 27 hartebeest examined carefully they were never found in the subdural cavity of either species of game. Both types, however, were found in the trachea of one hartebeest. Since *G. cristata* adults were reared more frequently from hartebeest than from wildebeest it is suggested that hartebeest are the host of choice of this species of fly.

In a manner similar to that suggested for domestic animals, after invasion of the mammalian host through the eye, the *Gedoelstia* first stage larvae enter a vein for completion of at least part of the life cycle in the cardio-vascular system. *G. hassleri* larvae in wildebeest eventually migrate actively to the subdural cavity, thence via the foramina of the cribriform plate and ethmoid bone to the nasal cavity and the paranasal sinuses where the first ecdysis occurs. Whether they follow the same route in hartebeest is not clear since only one *G. hässleri* larvae has been found in the subdural cavity of that species of game. In the case of *G. cristata* it is believed that in hartebeest the route of migration to the nasal cavity is up the trachea. Again, whether the same path is taken in wildebeest is not known.

The presence of *G. cristata* Type I larvae in the cardiovascular system of one gemsbuck is regarded as invasion of an aberrant host because no larvae were found in the nasal cavities, though it should be noted that there was no tissue reaction to the invading parasite as in the case of domestic animals, for which no adequate explanation can be offered.

Gedoelstia first stage larvae were never found in the nasal cavities of domestic animals from which it is concluded that in an aberrant host the life cycle up to the first ecdysis cannot be completed.

In the nasal cavity of the true hosts, wildebeest and hartebeest, larvae were never found in the folds of the turbinate bones known to be the predilection site of first stage *Oestrus* species.

Summary

1. Of the domestic animals sheep, cattle, goats and equines are susceptible in that order of frequency and severity.

2. Three main forms of uitpeuloog are recognized—the ophthalmic, encephalitic and cardiac forms. The symptoms are described.

3. The pathognomonic pathological lesions are thrombo-endophlebitis and thrombo-endarteritis with encephalomalacia.

4. It is shown that the immediate cause of the disease is the invasion of an aberrant host by first stage larvae of *Gedoelstia hässleri*, and *G. cristata* Type I and Type II of the family Oestridae.

5. The portal of entry of the larvae is the eye. Two cases of the disease, one being the fatal encephalitic form, were produced by the supracorneal and conjunctival instillation of larvae dissected from the abdomen of a captured gravid female *G. cristata* Type I.

6. Three recognizable types of larvae, Types A, B and C, are described as emanating from *G. hässleri* and *G. cristata* Type I and Type II respectively.

7. The role of blue wildebeest and hartebeest in the aetiology is discussed and adult flies were reared from larvae collected from the nasal cavities of these species of game.

8. Attention is directed to the fact that in contra-distinction to the susceptible species of domestic animals no macroscopic pathological lesions are produced in game.

9. The epizootiology of the disease is discussed.

10. A suggested pathogenesis in domestic animals and game is outlined.

11. The presence of unidentified species of Oestridae in the trachea of game is recorded.

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