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A DESCRIPTION OF THE IMMATURE STAGES OF *KIRKIOESTRUS MINUTUS* (RODHAIN & BEQUAERT, 1915) (DIPTERA: OESTRIDAE), AND THE LIFE CYCLE AND SEASONAL PREVALENCE OF THIS FLY IN BLUE WILDEBEEST

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ABSTRACT

HORAK, I. G., BOOMKER, J. & DE VOS, V., 1980. A description of the immature stages of *Kirkioestrus minutus* (Rodhain & Bequaert, 1915) (Diptera: Oestridae), and the life cycle and seasonal prevalence of this fly in blue wildebeest. *Onderstepoort Journal of Veterinary Research*, 47, 23–30 (1980)

Descriptions of the 1st, 2nd and 3rd instar larvae and the puparium of *Kirkioestrus minutus* are given. First instar larvae, which have not previously been described, can be distinguished from other oestrid larvae by the ventral spinulation of segments IV–XII and the spinulation of the anal protuberance.

Of 55 blue wildebeest examined in the Kruger National Park all but two 1-month-old and one 2-month-old animals were infested. First stage larvae are probably deposited in or on the nostrils and may develop within 30 days, initially in the nasal passages and then in the frontal sinuses to mature 3rd stage larvae. Development within the host appears to take longer during the cooler months of the year. Pupal periods vary from approximately 32 days in early or late summer to more than 50 days in winter.

Three of 6 blesbok examined at Badplaas in the eastern Transvaal were infested with 1st instar larvae only of *K. minutus* and it is suggested that blesbok may not be suitable hosts of this fly. Four black wildebeest in the Golden Gate National Park in the eastern Orange Free State were not infested.

Résumé

UNE DESCRIPTION DES STADES D'IMMATURITÉ DU KIRKIOESTRUS MINUTUS *(RODHAIN & BEQUAERT,* 1915) *(DIPTERA: OESTRIDAE), ET DU CYCLE DE VIE AVEC PRÉVALENCE SAISONNIÈRE DE CETTE MOUCHE CHEZ LE GNOU*

Des descriptions des 1er, 2d et 3me stades des larves et chrysalides du Kirkioestrus minutus (Rodhain & Bequaert, 1915) *sont données. Les larves de premier stade qui n'avaient pas été décrites antérieurement peuvent se distinguer des autres larves d'oestrides par la spinulation ventrale des segments IV–XII et par la spinulation de la protuberance anale. A la suite de l'examen de 55 gnous observés au Park National Kruger, tous les animaux, à l'exception de deux d'entr'eux, l'un agé de 1 mois et l'autre de 2 mois, se trouvaient infestés. Les larves du premier stade sont probablement déposées à l'intérieur ou sur les narines et peuvent se développer en 30 jours, initialement dans les passages nasaux et alors dans les sinus frontaux pour y mûrir en larves du 3me stade. Le développement à l'intérieur de l'hôte paraît prendre plus longtemps pendant les mois frais de l'années. Les périodes de chrysalide varient d'approximativement 32 jours au début ou à la fin de l'été jusqu'à 50 jours en hiver.*

Trois des blesboks examinés à Badplaas dans l'est du Transvaal étaient infestés avec des larves de K. minutus *du premier stade et il en est suggéré que le blesbok pourrait ne pas être un hôte adéquat pour cette mouche. Quatre gnous du Parc National Golden Gate dans l'est de l'Etat Libre d'Orange n'étaient pas infestés.*

INTRODUCTION

The larvae of *Kirkioestrus minutus* (Rodhain & Bequaert, 1915) are parasites of the nasal passages and para-nasal sinuses of the blue wildebeest (*Connochaetes taurinus*), korrigum (*Damaliscus korrigum*), common hartebeest (*Alcelaphus buselaphus*) and Lichtenstein's hartebeest (*Alcelaphus lichtensteini*) (Zumpt, 1965) and are also found in the tsessebe (*Damaliscus lunatus*) (Wetzel, 1970).

The 2nd and 3rd stage larvae and a female fly were described by Zumpt (1965), who stated that the 1st stage larva and life cycle were unknown and that few flies hatched from larvae that had been allowed to pupate. Wetzel (1970) mentioned that mature 3rd instar larvae are dark brown in colour, a feature not recorded by Zumpt (1965), and that the life cycle is probably similar to that of other Oestrinae in that the 1st stage larvae are laid around the nasal openings and in the eyes and migrate from there to the nasal and sinus cavities where they develop to 2nd and 3rd stage larvae. He also stated, without giving exact figures, that the pupal period lasted a month and that the life cycle is not seasonally influenced since 3rd stage larvae are present in February, March, July, October and December.

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In Zambia, Howard (1977) found that 8 out of 9 Lichtenstein's hartebeest harboured 24–34 3rd stage larvae of a *Kirkioestrus* species, and these he considered to be near *K. minutus*. As he was unable to identify the 1st and 2nd stage larvae specifically, he included these with the *Oestrus* spp. larvae, which were also present.

A survey conducted to determine the seasonal prevalence of the internal and external parasites of blue wildebeest in the Kruger National Park afforded an opportunity to study the oestrid flies parasitizing these animals. Nearly all the wildebeest examined were infested with *K. minutus*, and once the 1st stage larvae had been differentiated from those of other flies and the mature 3rd instar larvae had been allowed to pupate and flies to hatch, it became possible to describe the various developmental stages, the life history of the fly and its seasonal occurrence.

MATERIALS AND METHODS

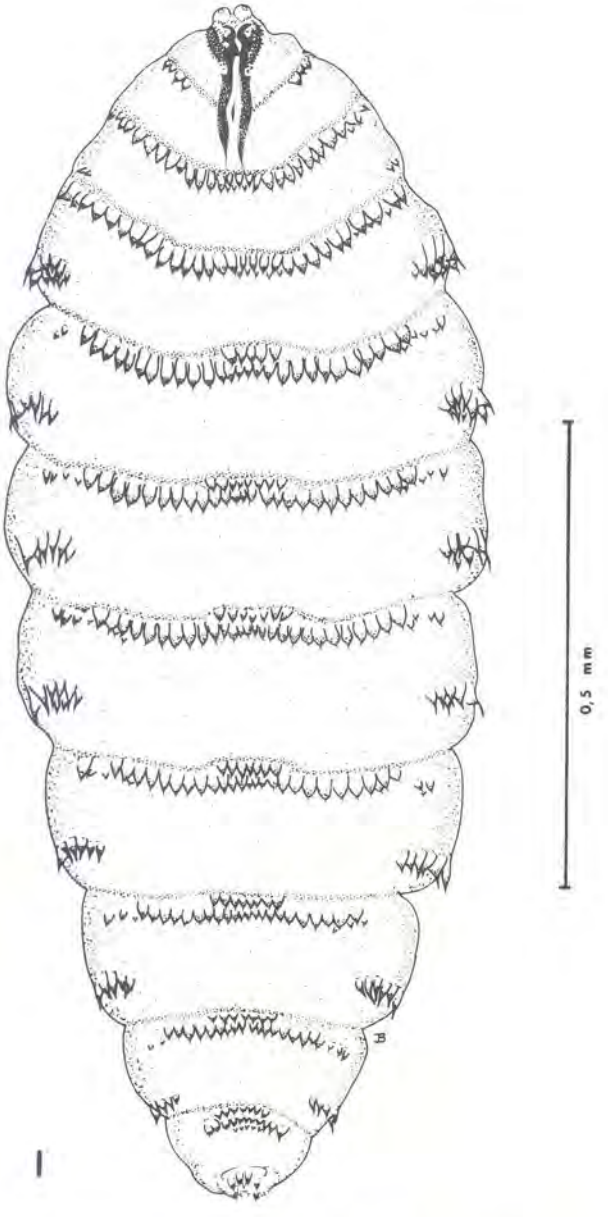
Each month from November 1977 to November 1978 at least 4 wildebeest were shot in the southern half of the Kruger National Park. The majority of wildebeest in the Park are born during December and an attempt was made each month to shoot 2 animals from the latest calf crop plus 2 from the previous year's crop. This culling procedure meant that animals ranging in age from 1–24 months were ultimately examined. Sometimes older animals were also shot.

As soon after death as possible the eyes of the animals were examined for oestrid larvae and the heads, severed from the carcasses, placed in plastic bags. The carcasses were eviscerated and the viscera placed in plastic bags and transported with the carcasses and heads to the laboratory at Skukuza.

The skin and ears were removed from each head, which was then divided sagittally by means of a bowsaw. All larvae present on the mucosa of the nasal septum, nasal passages and conchae were removed with fine-tipped forceps and placed in 70% ethyl alcohol. Thereafter the septum, conchae and half of the brain were removed for closer examination. The dura on the side from which the brain had been removed was stripped from the cranial cavity and placed in 70% alcohol. The sinus cavities were opened and all immature larvae removed and preserved in alcohol. The tracheae and the bronchial trees of the right lungs, the hearts and major blood vessels were opened and thoroughly washed. The washings were poured through sieves with 38μm apertures and the contents of the sieves were collected and preserved by adding 10% formaldehyde solution.

Whenever mature 3rd instar larvae were present in the sinus cavities, they were specifically identified under a stereoscopic microscope. The larvae of each species were placed separately in approximately 60 mm of vermiculite in glass bottles with nylon gauze tops and allowed to pupate. The flies hatched in these bottles, which were kept on a shelf in the necropsy room. This room had a single solid wall and three sides constructed of fine wire gauze on wooden supports. The bottles were examined daily and the dates of larval collection and fly emergence noted. Newly-emerged flies were left for approximately 2 h to expand and dry their wings and were then placed in 70% alcohol.

Six blesbok (*Damaliscus dorcas phillipsi*), shot at Badplaas in the eastern Transvaal, and 4 black wildebeest (*Connochaetes gnou*), shot in the Golden Gate National Park in the eastern Orange Free State, were examined in the same way.



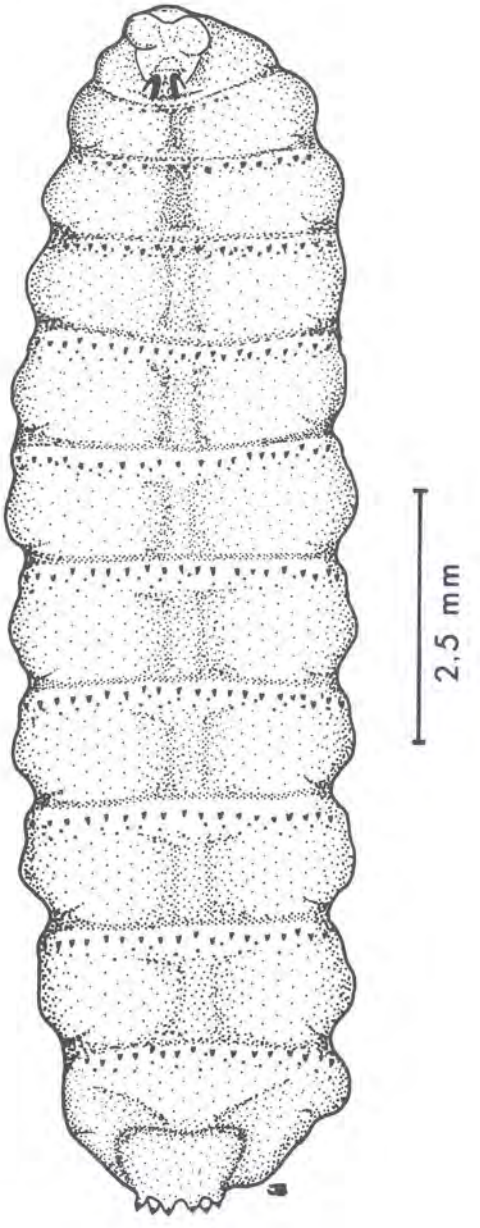
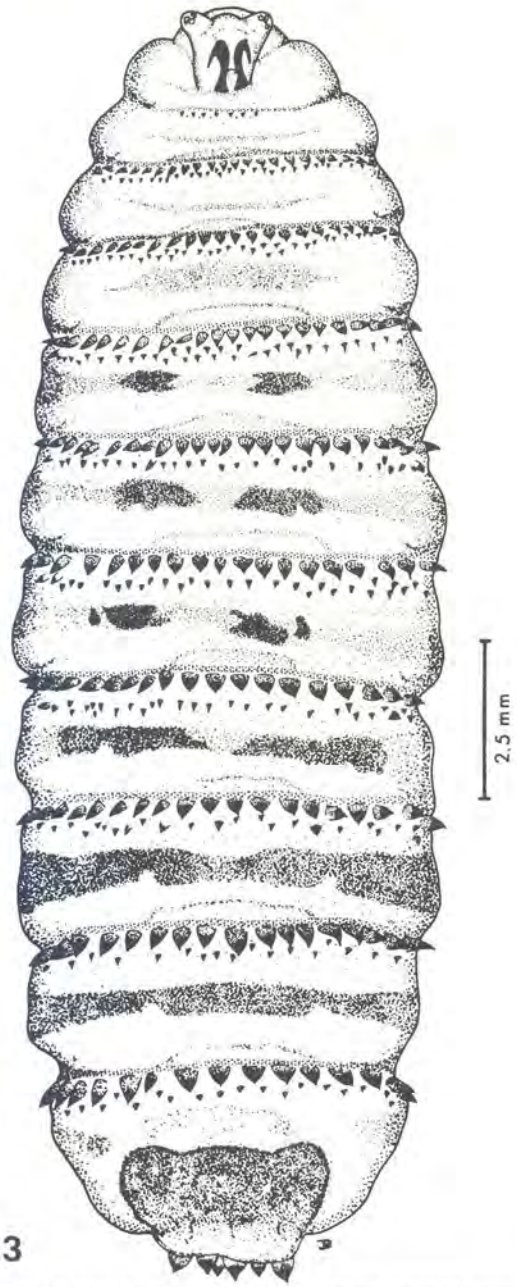


FIG. 1 First instar larva of *K. minutus*, ventral view
FIG. 2 Second instar larva of *K. minutus*, ventral view



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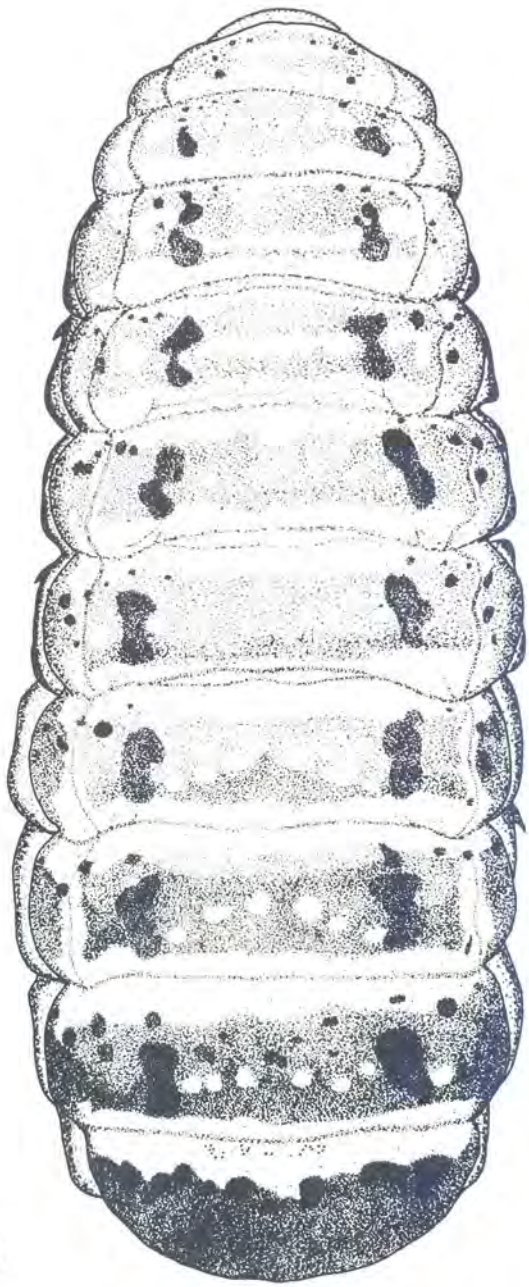

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FIG. 3 Third instar larva of *K. minutus*, ventral view
FIG. 4 Third instar larva of *K. minutus* dorsal view; scale as for Fig. 3

All the material collected was examined under a stereoscopic microscope for oestrid larvae which were identified according to species and stage of development. The body lengths of the larval stages of *K. minutus* were measured and these larvae and the pupal stage are illustrated and described below.

KIRKIOESTRUS MINUTUS (RODHAIN & BEQUAERT, 1915)

DESCRIPTION

The body lengths of the various larval stages are summarized in Table 1.

First instar larva (Fig. 1)

The semi-transparent, white 1st instar larva, which is broadly-rounded anteriorly widens progressively to the level of the 6th segment, then tapers gradually to a blunt point posteriorly. The antennal lobes each have one small pseudocellus. Ventrally, each of the segments IV–XII bears a band of large pointed spines, arranged in a short anterior row and a longer posterior row on its anterior border. Occasionally a short 3rd row of spines is present. The

TABLE 1 The ranges in length of the various larval stages of *K. minutus* recovered from blue wildebeest

Stage of development	Range in length (mm)	No. of larvae measured
1st stage larvae...	1,1– 4,8	111
2nd stage larvae..	3,1–13,4	106
2nd moult.....	10,5–13,9	22
3rd stage larvae..	10,1–28,0	142

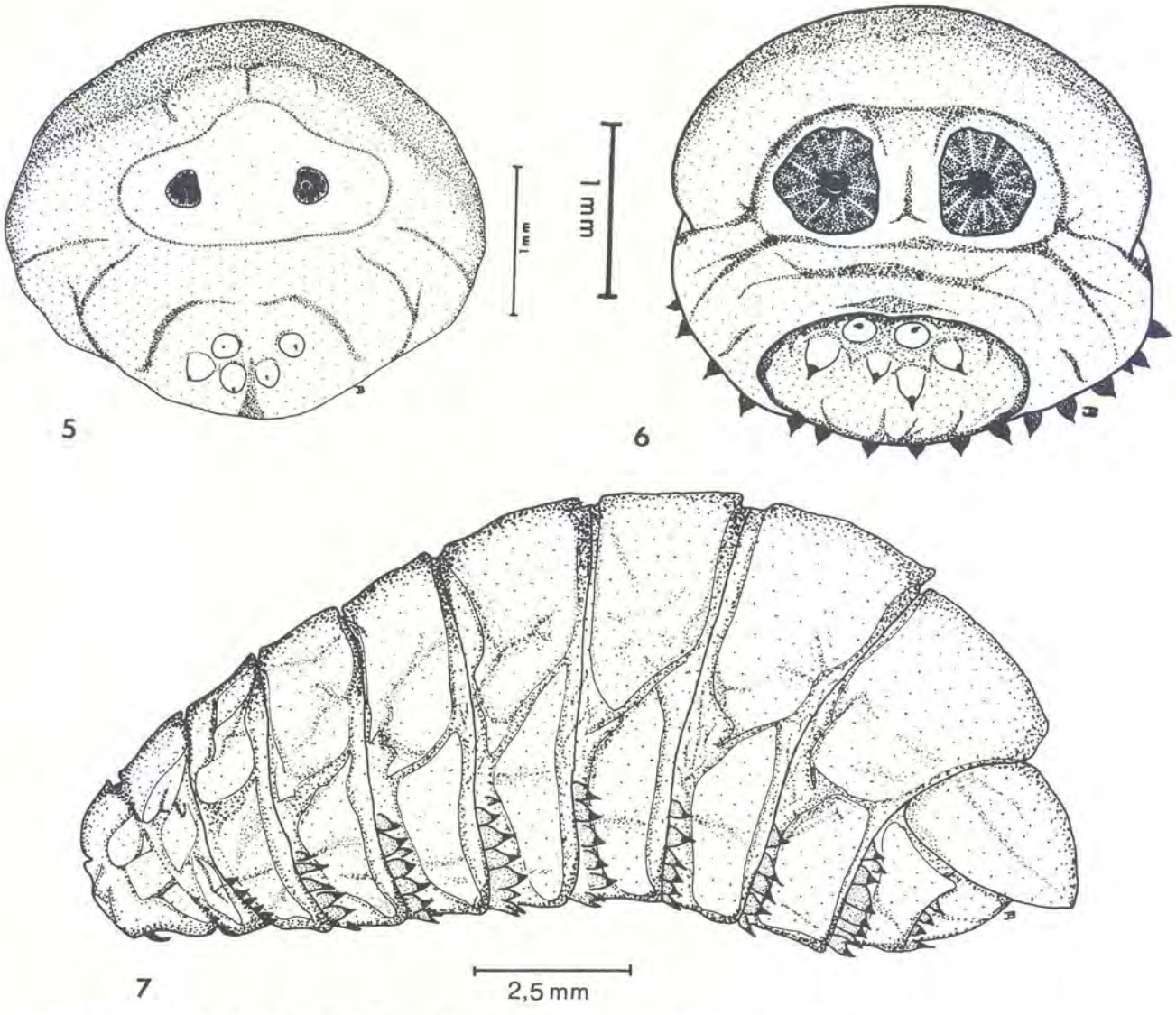

FIG. 5 Posterior end of 2nd instar of *K. minutus* larva, showing peritremes and spinulation
FIG. 6 Posterior end of 3rd instar larva of *K. minutus*, showing peritremes and spinulation
FIG. 7 Puparium of *K. minutus*, lateral view

posterior part of the 4th segment bears a few small spines lateroventrally, whereas segments V–XI bear a cluster of large spines in this position. The posterior spiracles lie in a shallow depression and are difficult to see. The anal protuberance bears about 7 small ventral and 2 large lateral pointed spines.

Second instar larva (Fig. 2, 5)

Larvae in the second instar (Fig. 2) are creamy-white in colour. The cephalic end is approximately as wide as the posterior end. The spinulation is the same as that of the 3rd instar larva and the latero-ventral spines present posteriorly on segments IV–XI of the 1st instar larva are absent. The peritremes are small, and the anal protuberance is armed with about 5–6 large spines (Fig. 5).

Third instar larva (Fig. 3, 4, 6)

The mature 3rd instar larva is yellow-brown in colour and slightly wider posteriorly than anteriorly (Fig. 3, 4). The antennal lobes each have 3 pseudo-celli. Segments III–XII have dark brown patches laterally and segments IV–XI are each encircled by a dark brown band. The bands on the anterior segments are lighter in colour and narrower than those on the posterior segments. Ventrally, segment III bears only a short row of small spines, whereas segments IV–XII bear bands of spines anteriorly, each band consisting of an anterior row of large spines plus a posterior row of short spines. The posterior peritremes are fairly large and lie in a shallow depression. The dorsal margin of this depression is spineless, whereas the well-developed anal protuberance, which forms the ventral margin of the depression, bears approximately 6 large pointed spines (Fig. 6).

Pupa (Fig. 7)

The puparium is about 17 mm long, dark brown or black in colour, flat ventrally and markedly convex dorsally, and bears the spines of the unshed integument of the 3rd instar larva.

Life Cycle and Seasonal Prevalence in Blue Wildebeest

The burdens of *K. minutus* larvae recovered from 1–12-month-old wildebeest are summarized in Table 2.

TABLE 2 The numbers of *K. minutus* larvae recovered from 1- to 12-month-old blue wildebeest in the Kruger National Park

Date slaughtered	Age in months	Number and stage of development of *K. minutus* larvae recovered			
		1st	2nd	3rd	Total
1978					
16 January	1	0	0	0	0
16 January	1	0	0	0	0
14 February	2	0	0	0	0
14 February	2	0	1	0	1
13 March	3	0	0	1	1
13 March	3	0	1	1	2
3 April	4	0	1	11	12
3 April	4	0	5	8	13
17 April	4	20	1	13	34
17 April	4	0	11	6	17
8 May	5	0	14	11	25
8 May	5	0	8	5	13
5 June	6	4	21	53	78
5 June	6	68	1	0	69
3 July	7	0	8	29	37
3 July	7	0	11	47	58
7 August	8	0	6	15	21
7 August	8	0	6	25	31
11 September	9	0	6	89	95
11 September	9	0	3	6	9
16 October	10	0	22	51	73
16 October	10	0	17	88	105
15 November	11	0	17	86	103
15 November	11	0	7	138	145
1977					
15 November	11	0	2	30	32
16 November	11	0	0	33	33
13 December	12	7	1	31	39
14 December	12	0	0	8	8

TABLE 3 The mean numbers of *K. minutus* larvae recovered from blue wildebeest older than 3 months in the Kruger National Park

Month killed	No. of wildebeest examined	Mean number of *K. minutus* larvae recovered				
		1st	2nd	3rd	Total	1st and 2nd stage larvae as a % of the total
1977						
November	4	3,25	1,5	24,5	29,25	16,2
December	4	2,5	0,8	22,5	25,8	12,8
1978						
January	2	44,5	2,5	33,0	80,0	58,8
February	2	0,0	0,5	25,0	25,5	2,0
March	2	35,5	0,0	11,5	47,0	75,5
April	6	4,7	6,1	10,0	20,8	51,9
May	4	2,0	10,5	14,5	27,0	46,3
June	4	18,25	6,0	26,25	50,5	48,0
July	5	10,4	4,2	30,8	45,4	32,2
August	4	4,5	3,5	17,5	25,5	31,4
September	4	0,0	6,75	29,75	36,5	18,5
October	4	0,0	11,5	56,0	67,5	17,0
November	4	0,5	6,25	89,25	96,0	7,0

Except for the two 1-month-old animals and 1 of the 2-month-old animals, all the other wildebeest examined were infested. The 2-month-old and 3-month-old wildebeest shot during February and March 1978 harboured only 1 or 2 larvae. Thereafter larval burdens increased in number, reached a peak in the 6-month-old animals shot during June 1978, decreased slightly and then rose again to reach a major peak in the 11-month-old animals slaughtered during November 1978. The latter animals harboured considerably more larvae than the wildebeest of equal age killed the previous November.

Excluding the larval burdens of the animals 1–3 months of age, the mean monthly burdens of *K. minutus* larvae recovered from all the wildebeest examined are summarized in Table 3.

No 1st stage larvae were recovered during February, September or October 1978, while 2nd and 3rd stage larvae were present throughout the survey period. Except in November and December 1977 and February 1978, mature 3rd instar larvae were recovered in every month.

TABLE 4 The length of the pupal period of *K. minutus* in the Kruger National Park

Date larvae collected	No. collected	Date flies hatched	No. of flies hatched	Pupal period in days
1978				
16 Jan.	3	Failed to hatch	0	—
13 March	5	13 April (1), 14 April (3)	4	31–32
17 April	2	Failed to hatch	0	—
8 May	1	Failed to hatch	0	—
5 June	6	Failed to hatch	0	—
3 July	3	*25–30 August (1)	1	*53–58
7 August	7	20 September (2), 22 September (1)	3	44–46
11 Sept	4	18 October (1)	1	37
16 Oct	4	18 November (1), 19 November (1), 23 November (1)	3	33–38
15 Nov	1	Failed to hatch	0	—

* The exact day on which the fly hatched was not recorded.
( ) =Brackets indicate number of flies hatched on a particular date.

TABLE 5 Oestrid larvae recovered from blesbok at Badplaas

Date blesbok killed	Number and stage of development of larvae recovered						
	K. minutus	*Gedoelstia* sp.			*O. macdonaldi*		
	1st	1st	2nd	3rd	1st	2nd	3rd
1978							
17 May	2	138	5	45	0	18	43
17 May	67	128	6	29	0	0	0
19 June	0	7	13	21	0	0	0
19 June	2	67	4	29	0	0	0
19 July	0	6	32	27	0	1	0
19 July	0	1	2	14	0	0	0

Although larval burdens varied considerably, larger proportions of the total burdens were in the 1st and 2nd stage of development from April–August than during September–December. The findings for January–March are difficult to assess as only 2 older animals were examined in each of these months. Large numbers of 1st stage larvae were present, however, during January and March.

First stage larvae were recovered from the nasal septa, ventral conchae and ventral and median nasal passages, 2nd and 3rd stage larvae from the frontal sinuses, and the nasal passages and conchae surrounding the sinus entrances. No *K. minutus* larvae were recovered from the eyes, brain surfaces, dura, hearts and major blood vessels, or lungs and tracheae.

A constant, although subjective observation, was that the mature 3rd instar larvae of *K. minutus* appeared sluggish when compared with similar larvae of the other oestrid species, namely, *Gedoelstia cristata, Gedoelstia hässleri, Oestrus aureoargentatus* and *Oestrus variolosus,* recovered from the wildebeest.

The dates of larval collection and fly emergence and the duration of the pupal periods are summarized in Table 4.

Few flies hatched in comparison with the total number of mature larvae collected. Pupal periods increased from 31–32 days for larvae collected during March 1978 to 53–58 days for the larva collected during July and subsequently decreased to 33–38 days for larvae collected during October.

The larval burdens of the blesbok shot at Badplaas are summarized in Table 5.

Three of the 6 blesbok were infested with 1st stage larvae of *K. minutus*, but harboured no 2nd or 3rd stage larvae of this species. Larvae of *Gedoelstia* sp. near *G. hässleri* in all 3 stages of larval development were present, however. Two animals were infested with *Oestrus macdonaldi*, 1 harbouring a 2nd stage larva and the other 2nd and 3rd stage larvae.

The 4 black wildebeest shot in the Golden Gate National Park harboured only larvae of *G. hässleri.*

Discussion

Larval identification

The 1st instar larva of *K. minutus* has to be differentiated from those of *Oestrus* spp. (*O. aureoargentatus* and *O. variolosus*) and *Gedoelstia* spp. (*G. cristata* and *G. hässleri*), which may also be found in the nasal passages of blue wildebeest (Zumpt, 1965). In *K. minutus* segments IV–XII each bear 2 rows of spines on their antero-ventral borders and the anal protuberance is armed with approximately 7 small ventral and 2 large lateral pointed spines. In *Oestrus* spp. the anterior borders of segments III–XII each bear 3–5 rows of ventral spines and the ventral aspect of the last segment has about 18–54 terminal hooklets arranged in 2 scallops (Basson, 1962; Zumpt, 1965; Nevill & Basson, 1966). In *Gedoelstia* spp. the antero-ventral borders of segments IV–XII each carry 3–4 rows of spines and the anal protuberance of segment XII is nude (Basson, 1962).

Life cycle

The recovery of 1st stage larvae from the nasal septa and passages of the wildebeest and not from the eyes, brain surfaces or dura implies that the life cycle is similar to that of *Oestrus ovis* in sheep, with the flies depositing larvae on or in the nostrils (Bedford, 1925; Capelle, 1966), and not like that of *Gedoelstia* spp., in which the larvae are deposited in the eyes and make their way to the brain and dura (Basson, 1966; Horak & Butt, 1977). The larvae may be deposited singly or in either small or large batches as indicated by the single larva recovered from the 2 and 3-month-old animals and the large numbers of 1st instar larvae recovered from older individuals.

Development of the 1st stage larvae takes place on the mucosa of the nasal passages and conchae and they grow from approximately 1,1 mm–4,8 mm during this process. The first moult probably occurs soon after this length has been reached but, since no larvae in the 1st ecdysis were recovered, this cannot be verified. This moult probably takes place on the median conchae as is the case with *O. ovis* (Cobbett & Mitchell, 1941; Horak, 1977). The newly emerged 2nd instar larvae, which may initially be shorter than larvae of the preceding stage, migrate to the frontal sinuses, where they grow to approximately 13,4 mm before commencing the 2nd ecdysis. During this moult the larvae also shrink slightly, as larvae at the commencement of the ecdysis usually exceeded 13,0 mm in length, while those at the point of emergence measured little more than 10,0 mm. Third stage larvae may grow to approximately 28,0 mm in length, but mature larvae considerably shorter than this were recovered. As the larvae mature their integument darkens to form bands around segments III–XII.

The total time taken for development in the host animal may be as short as 30 days. This period can be deduced from the fact that young wildebeest, shot during a particular month, often harboured considerably more 3rd stage larvae than the total larval burdens of animals shot during the previous month.

Mature 3rd instar larvae leave the host and pupate in the soil, pupal periods varying from approximately 32 days for larvae collected during October (early summer) and March (late summer) to more than 50 days for larvae collected during July (mid-winter). The pupal periods of the mature larvae collected during mid-summer would probably have been shorter than 30 days had they given rise to flies. The freed mature larvae or the pupae apparently required particular conditions for subsequent maximum eclosion of the flies. Only 12 flies hatched from a total of 36 mature larvae collected, while 29 of 37 *G. hässleri* larvae and 22 of 31 *O. aureoargentatus* larvae collected during the same period hatched. Zumpt (1965) commented on the small number of flies resulting from *K. minutus* larvae he had allowed to pupate. It is not clear from his description of the 3rd instar larvae whether he realized that these larvae are only mature once they exhibit dark circular bands, and he may have used immature 3rd stage larvae in his experiments.

Seasonal fluctuation

No clear seasonal fluctuations in the composition of the larval burdens were apparent, probably because the comparatively warm winter temperatures in the Kruger Park made development throughout the year possible. The increase in the proportion of 1st and 2nd stage larvae during the cooler months does indicate, however, a slower rate of development then, than in spring and summer. Similar observations have been made on the development of *O. ovis* in sheep (Cobbett & Mitchell, 1941; Rogers & Knapp, 1973; Horak, 1977).

A marked increase in infestation compared with the level of infestation during 1977 appeared imminent during the summer of 1978/79. Three out of the 4 animals shot during November 1978 harboured more than 100 larvae compared with the 25–33 larvae harboured by the 4 animals shot during the previous November. The reason for this increase cannot be deduced from the available data.

The pupal periods of *K. minutus* were generally similar to those of *G. cristata* and *O. aureoargentatus* larvae collected at the same time. However, *K. minutus* larvae collected during April–June failed to develop into flies, while the other 2 flies had pupal periods of approximately 70 days for larvae collected during May and June. The inability of *K. minutus* to develop to adulthood from mature larvae collected during this period is a finding apparently only applicable to the laboratory. The burdens of 1st instar larvae in wildebeest shot during July and August implied that mature larvae had successfully pupated in the field and flies hatched and deposited larvae during this time.

The seasonal fluctuations noted in the lengths of the pupal periods indicate that atmospheric temperature played an important role. Pupal periods were short during the warm months and considerably longer during the cooler months. Similar observations have been made for the pupal periods of *O. ovis* on the Transvaal Highveld (Horak, 1977). The shortest pupal period recorded for *K. minutus* in this study being 31 days compares favourably with the period of 1 month mentioned by Zumpt (1965) and Wetzel (1970), although they gave no exact figures nor the month in which the larvae had been collected.

Host specificity

Although a number of alcelaphine antelope have been listed as hosts of *K. minutus* (Zumpt, 1965; Wetzel, 1970), *K. minutus* had not previously been recovered from blesbok. The presence of 1st instar larvae only in blesbok at Badplaas suggests that these animals are not suitable hosts. Infestation in this area may have been maintained in tsessebe or in black wildebeest running in the same camp as the blesbok, although black wildebeest have not been described as hosts of this fly, nor did those in the Golden Gate National Park harbour its larvae.

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