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OVERBERG RESEARCH PROJECTS. V1. THE BIOLOGY AND CONTROL OF *OESTRUS OVIS* IN SHEEP IN THE WINTER RAINFALL AREAS OF THE SOUTHERN CAPE

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ABSTRACT

LOUW, J. P., 1989. The biology and control of *Oestrus ovis* in sheep in the winter rainfall areas of the southern Cape. *Onderstepoort Journal of Veterinary Research*, 56, 239–244 (1989).

Oestrus ovis was endemic on all the farms included in a survey conducted in the southern Cape, but each farm had its own unique seasonal pattern of infestation. Flock sheep were infested 10–12 months and tracers 5–9 months of the year.

Sporadic infestations occurred in winter and spring, while peaks were reached in summer and autumn. Development of *O. ovis* larvae deposited in autumn was retarded for up to 5½ months.

Pupae of *O. ovis* formed from 27 April–9 August, with the exception of a single pupae formed on 29 June, failed to produce flies. Pupal periods ranged from 30 days in January to 80 days in June.

Strategic anthelmintic treatments in May, August and November and a tactical treatment in March are recommended.

INTRODUCTION

Oestrus ovis, the nasal bot fly which infests the nasal cavities and sinuses of sheep and goats with its larvae, is endemic in many parts of southern Africa (Bedford, 1925; Horak, 1977; Reinecke, Kirkpatrick, Swart, Kriel & Frank, 1987; Biggs & Anthonissen, 1982). According to Bedford (1925), flies of *O. ovis* are active in South Africa from September–May, while Zumpt (1965) states that spring and autumn are the periods of fly activity in areas with long, hot and dry summers. In the summer rainfall regions of South Africa, flies are active from October–June, after which survival is dependent on quiescent larvae in the nasal cavities of the host (Horak, 1977).

Larvae of *O. ovis* cause production losses in sheep (Horak & Snijders, 1974) and warrant control. Relevant information to form the basis for a control programme in the southern Cape, did not exist. The aims of the present study in the southern Cape were, therefore, to determine the seasonal incidence of *O. ovis*, indicated by the presence of larvae in tracer animals necropsied at regular intervals, the prevalence of infestation in tracer as well as in flock sheep, quantified by the number of sheep infested and the number of larvae present at each necropsy, and the life cycle of *O. ovis*, by studying the aetiology of infestations in untreated and tracer sheep and the development of pupae. For this purpose 4 serveys were conducted on 6 farms in the southern Cape (Fig. 1), and the information used to develop a nasal bot control programme for sheep in the southern Cape, as was done for roundworms (Louw, 1989).

SURVEY 1 THE SEASONAL INCIDENCE OF *O. OVIS* AND ITS PREVALENCE IN SHEEP IN THE CALEDON DISTRICT

Materials and Methods

From January 1987–December 1988 surveys were carried out on 4 different farms, all within a 20 km radius of Caledon (34° 14′ S, 19° 25′ E).

Boontjieskraal (10 km west of Caledon). Every 6 weeks from 18 June 1987–3 December 1988, 6 lambs from a flock of 250 Merino lambs grazing on lucerne pastures in winter and wheat stubble fields in summer, were slaughtered and the *O. ovis* larvae recovered. The lambs, only 2 weeks old when the 1st group was slaughtered, were progressively older as the survey progressed. These animals were treated on 6 September 1988 and 24 November 1988 with morantel and ivermectin, respectively, and were used to study the course of infestation in a largely untreated flock.

Six 18-month-old Merino wethers were treated with ivermectin, exposed to infestation together with the flock, slaughtered after 6 weeks and replaced by a similar group of sheep from 30 November 1987–3 December 1988. The *O. ovis* larvae recovered from this group of tracer sheep served as indicators of the seasonal incidence of infestation by this insect.

Klipfontein (15 km west of Caledon). Every 12 weeks from 4 February 1987–28 October 1987, 6 weaned Merino wethers, treated with ivermectin 12 weeks earlier and exposed to infestation, were slaughtered, and the *O. ovis* larvae recovered. These animals were confined to the same dryland lucerne pasture for the duration of the survey.

Dunghye Park (12 km south-east of Caledon). Every 12 weeks from 4 February 1987–28 October 1987, 6 sheep, treated like the sheep at Klipfontein, were slaughtered, and the *O. ovis* larvae recovered. The animals were confined to the same lucerne pasture for the duration of the survey.

Elandskloof (30 km north of Caledon). Every 6 weeks from 21 December 1987–13 October 1988, 6 Dormer wethers, treated with ivermectin 6 weeks earlier and exposed to infestation together with the flock for 6 weeks, were slaughtered together with 6 untreated sheep and the *O. ovis* larvae recovered. The tracers slaughtered on 21 December 1987 and 3

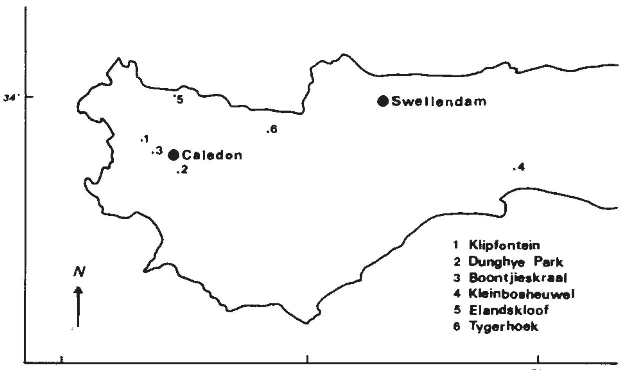

FIG. 1 The Southern Cape region and the location of the farms on which the survey was carried out.

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February 1988 were exposed for 3 and 9 weeks, respectively, prior to slaughter. All the animals were kept on grass/clover pastures from 11 November 1987–30 January 1988 and were then stabled until 28 February 1988 and returned to the grass/clover pasture until 20 June 1988, when the untreated and tracer groups were moved to 2 separate kikuyu pastures.

Post-mortem recovery of larvae

The heads of the slaughtered sheep were collected with the ear numbers intact, opened sagitally with a bone saw. The septum, air passages as well as the turbinate and ethmoid bones were examined with the aid of a hand lens. The sinuses and the cornual cavities were subsequently opened with a bone cutter. All larvae were removed, placed in formalin and counted.

Temperature

The daily maximum and minimum atmospheric temperatures, recorded at Boontjieskraal by the Agrometeorology Section of the Department of Agriculture and Water Supply were used in conjunction with the infestation patterns on the different farms.

Results

Boontjieskraal (Fig. 2). The first *O. ovis* larvae (6) recovered from the lambs born in June 1987 were recovered from lambs exposed on 10 September

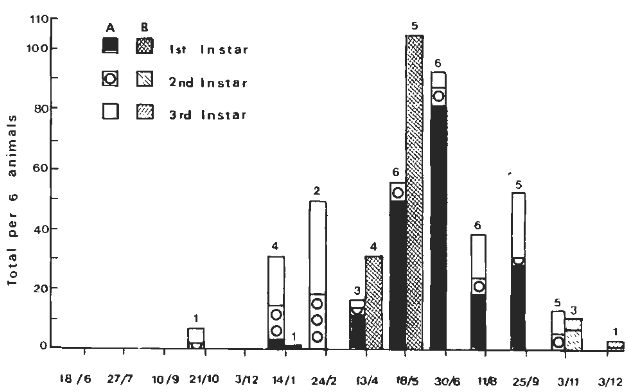


FIG. 2 The total number of *Oestrus ovis* larvae recovered from 6 untreated (A) and 6 tracer (B) sheep slaughtered every 6 weeks from 18 June 1987–3 December 1988 at Boontjieskraal. The number of infected sheep in each group is indicated.

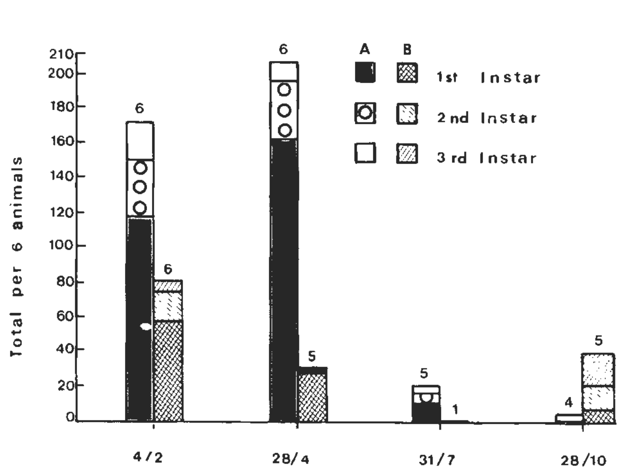


FIG. 3 The total number of *Oestrus ovis* larvae recovered from 6 tracers slaughtered every 12 weeks from 4 February–28 October 1987 at Dunghye Park (A) and Klipfontein (B). The number of infected sheep in each group is indicated.

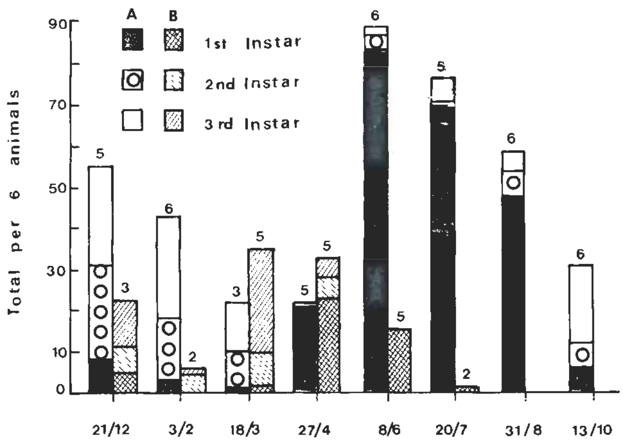


FIG. 4 The toal number of *Oestrus ovis* larvae recovered from 6 untreated (A) and 6 tracer (B) sheep slaughtered every 6 weeks from 21 December 1987–13 October 1988 at Elandskloof. The number of infected sheep in each group is indicated.

FIG. 5 The mean monthly temperatures recorded from May 1987—December 1988 at Boontjieskraal.

1987 and slaughtered on 21 October 1987. However, on this occation, only 1 of a group of 6 lambs was infested, while no further infestations were recorded from these lambs until 14 January 1988. On this date, 1 of the 6 tracers exposed with the untreated group for the first time on 3 December 1987 was infested with 3 larvae, otherwise the tracers were not infested until 13 April 1988. From this date, the prevalence of infestation in the tracers slaughtered until 18 May 1988 was 66–83 %, and 31–105 larvae were recovered. Between 18 May and 25 September 1988 none of the tracers slaughtered were infested, but 3 and 1 tracers were infested on 3 October 1988 and 3 December 1988, when 11 and 3 larvae were recovered, respectively. In the untreated lambs, however, infestations with a prevalence of 33–100 % persisted from 14 January 1988 until these lambs were treated with ivermectin on 24 November 1988. The overwintering larvae in this group of sheep failed to complete their life cycle and produce a new generation in the tracers before the survey terminated on 3 December 1988.

During summer, the majority (> 50 %) of larvae recovered from the untreated lambs were 3rd instars, while the majority (> 80 %) of larvae recovered during winter were 1st instars. During spring a relative decline of 1st instar larvae and an increase in the number of 3rd instar larvae were recorded (Fig. 2).

Mean maximum and minimum temperatures are presented in Fig. 5.

Klipfontein and Dunghye Park (Fig. 3). At Klipfontein, only 1 sheep was infested in winter, but in summer, autumn and spring the prevalence of infested sheep was 83—100 % and the total number of larvae recovered 33–82. Post-winter infestation started before 28 October, while a peak was reached in January. Infestation also commenced at Dunghye Park before 28 October. The prevalence of infested sheep was 100 % during summer and autumn, when 172 and 206 *O. ovis* larvae, respectively, were recovered. In winter 83 % of the sheep were infested and 21 larvae recovered.

Elandskloof (Fig. 4). Post-winter infestation in the tracer animals had not started by 13 October. The prevalence of infestation in the tracers did not exceed 50 % during summer, but increased to 83 % in autumn. In the untreated lambs, the majority (> 80 %) of larvae recovered during winter, were 1st instars but decreased to < 20 % in spring. Although tracers were not infested after 20 July, 59 and 31 larvae were recovered from the untreated animals on 31 August and 13 October, respectively, while 100 % of these animals were infested.

SURVEY 2 THE SEASONAL INCIDENCE OF *O. OVIS* AND ITS PREVALENCE IN SHEEP AT THE TYGERHOEK EXPERIMENTAL FARM

Materials and Methods

At Tygerhoek Experimental Farm near Riviersonderend (34° 10′ S, 19° 55′ E), 60 Merino weaners were divided into a control and tracer group, respectively. The 2 groups of lambs grazed on adjacent grass/lucerne pastures, which were spray-irrigated 3 times per week. On 2 June 1988 an additional 61 lambs were treated with invermectin and added to the surviving lambs in the 2 groups.

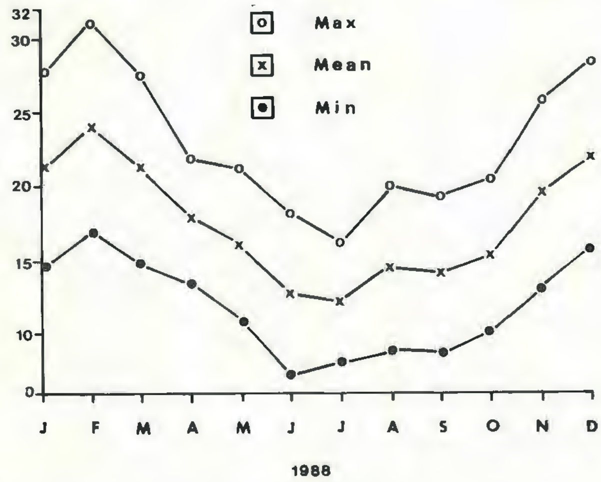
From 27 January 1988–4 January 1989, 6 control and 6 tracer lambs were slaughtered every 6 weeks, and the *O. ovis* larvae recovered. The control animals were treated with ivermectin on 28 December 1987 and again on 28 February 1988, and with rafoxanide on 16 February 1988. Each group of 6 tracers was treated with ivermectin and 6 weeks later, slaughtered together with 6 controls. *O. ovis* larvae were recovered according to procedures described in Survey 1.

The montly mean maximum and minimum atmospheric temperatures, recorded at Tygerhoek Experimental Farm by the Agrometeorology Section of the Department of Agriculture and Water Supply, were used in conjunction with infestation patterns.

Results

The total numbers of *O. ovis* larvae recovered from each group of sheep slaughtered every 6 weeks, as well as the mean atmospheric temperatures, are presented in Fig. 6.

The prevalence of infestation in the tracer group was 100 % during the summers of 1988 and 1989, 49–156 larvae being recovered. Post-winter infestation started between 5 October and 18 November. Infestation from 8 March–5 October was limited to mild infestations between 7 June 1988 and 13 July 1988, when 4 of the 6 tracers slaughtered on 13 July 1988 were infested. The untreated lambs harboured *O. ovis* larvae in every necropsy, excepting that on 5 October 1988, when the overwintering infestation had matured and had left the animals. Infestation with a prevalence of 100 % and a total of 334 larvae



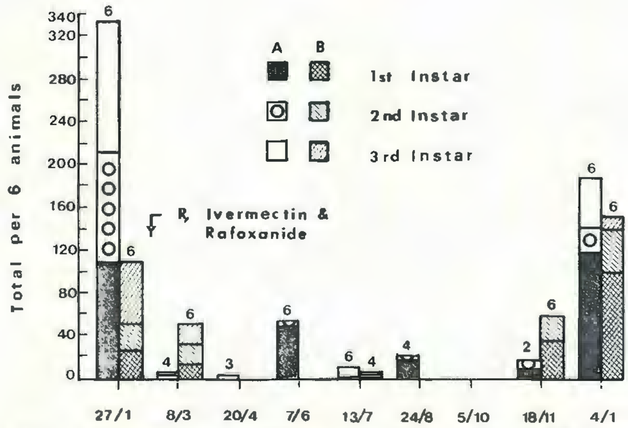


FIG. 6 The toal number of *Oestrus ovis* larvae recovered from 6 untreated (A) and 6 tracer (B) sheep slaughtered every 6 weeks from 27 January 1988–4 January 1989 and the mean monthly temperatures recorded at Tygerhoek. The number of infected sheep in each group is indicated.

was recorded in untreated lambs slaughtered on 27 January 1988. Anthelmintic treatments in February, however, reduced infestation to relatively low levels for the remainder of that year.

SURVEY 3 THE PREVALENCE OF *O. OVIS* INFESTATIONS IN UNTREATED SHEEP AT KLEINBOSHEUWEL

Materials and Methods

The farm Kleinbosheuwel (34° 15′ S, 20° 45′ E) is situated on the periphery of the coastal dune veld, approximately 76 km from Swellendam in the Heidelberg district. Weaned Merino lambs were treated with ivermectin and killed in successive groups of 6 every 6 weeks from 7 January–22 September 1987. The *O. ovis* larvae were recovered by soaking the split heads in saline for a few hours, after which the nasal cavities were rinsed into the bucket containing the saline. The saline was washed through a 150 micron sieve, and the *O. ovis* larvae collected. To these were added all larvae found in the sinous and cornual cavities of the head, after these had been opened with bone cutters.

Results

The total number of *O. ovis* larvae recovered from each group of sheep slaughtered are presented in

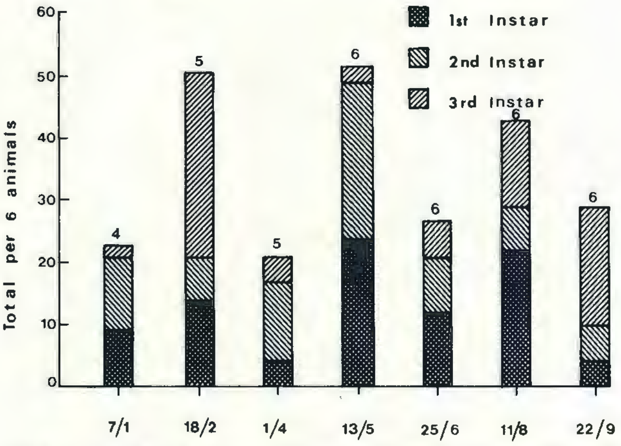


FIG. 7 The total number of *Oestrus ovis* larvae recovered from 6 untreated sheep slaughtered every 6 weeks from 7 January–22 September 1987 at Kleinbosheuwel.

Fig. 7, but no climatic data were recorded on this farm. No tracer animals were used, and consequently, the seasonal incidence of *O. ovis* infestation could not be determined. The prevalence of infection in the untreated controls ranged from 66–100 % during the survey period.

SURVEY 4 THE LENGTH OF THE PUPAL PHASE OF *O. OVIS*

Materials and Methods

Mature, live 3rd instar larvae of *O. ovis*, collected from sheep killed in Surveys 1 and 2, were placed in a jar half filled with vermiculite and covered with a piece of nylon gauze secured with a rubber band. The jar was then kept in a ventilated wooden box in an outside shaded sport at Hermanus (34° 26′ S, 19° 15′ E).

The incubation periods of the pupae in days and the percentage of pupae developing into flies were recorded. The longevity of the flies was regarded as the period between the day the first fly emerged and the day the first dead fly was spotted in that batch.

The montly mean maximum and minimum atmospheric temperatures recorded by the CSIR Observatory, approximately 2 km from the site, were used in conjunction with the pupal periods in order to determine any possible dependence.

Results

Pupal periods and the mean maximum and minimum temperatures are presented in Fig. 8.

Pupae were formed throughout the year, but those incubated from 27 April–9 August 1988 did not develop into flies. A notable exception was a single pupa incubated on 29 June, which hatched after 80 days and the imago lived a record 25 days.

The pupal periods were shortest during the months of January and February, when mean monthly temperatures were 20,4 and 20,8 °C, respectively. The shortest pupal periods of 30 and 31 days were recorded from pupae incubated on 14 January 1988 and 24 January 1989, respectively. The pupae incubated on 9 August 1988 were the first post-winter pupae to develop into flies. These flies hatched in October after an incubation period of 66 days.

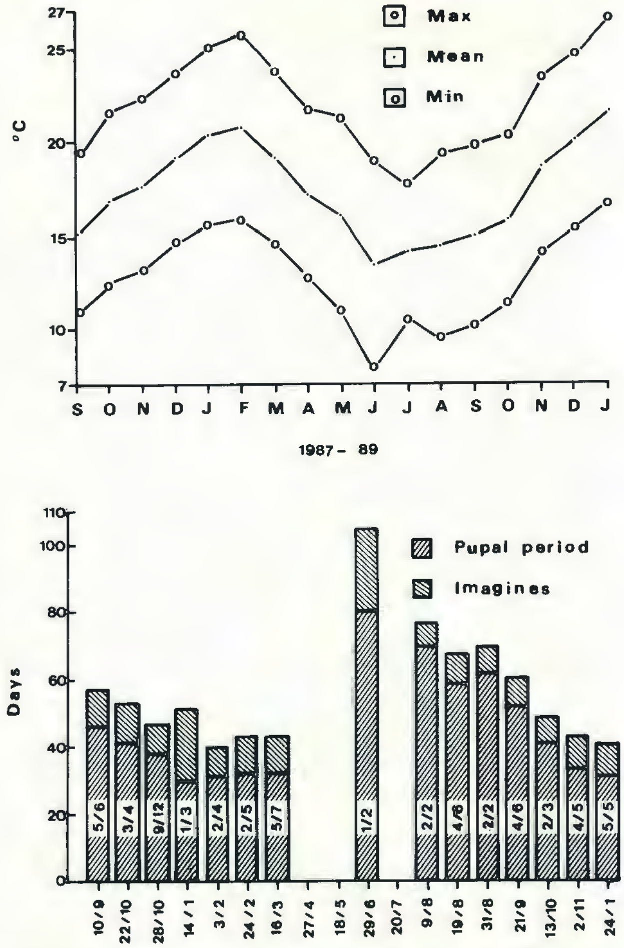


FIG. 8 The mean monthly temperatures recorded at Hermanus from September 1987–January 1989 and the length of the pupal period and imagine life recorded during this period. The proportions of imagine producing pupae are indicated.

DISCUSSION

Seasonal incidence of O. ovis *infestations in the southern Cape*

The larval phase of *O. ovis* in sheep may be as short as 25–35 days in summer and as long as 9 months when overwintering in the host (Zumpt. 1965). This phenomenon complicates the planning of surveys and the interpratation of the results. In the present study, where tracers were exposed for 6–12 weeks, infestations may have been missed if the larval period was shorter than the period of exposure. A further defect of this study was that some infestations may have been blocked for an unknown number of days by residual activity of the anthelmintics (Snijders, Horak & Louw, 1973).

At Boontjieskraal, Elandskloof and Tygerhoek, where observations were made simultaneously on tracers and untreated animals (Fig. 2, 4 & 6), the results indicate that untreated animals or animals with unknown history of treatment are not reliable indicators of the seasonal incidence of *O. ovis*, because larvae may survive in these animals for long periods. At Boontjieskraal, for instance, where the tracers and the untreated animals grazed together, the tracers were not infested after 18 May 1988, but infestations with a prevalence of 83–100 % were recorded from the untreated animals until 3 November 1988. Untreated animals at Elandskloof were still infested on 13 October, although no infestations occurred in the tracers after 20 July.

O. ovis infestations were common on all 6 farms included in this survey. Every farm, however, had its own unique seasonal pattern and prevalence of infestation. Nevertheless, certain general trends in the seasonal incidence were established of this parasite of sheep in the southern Cape.

On the 3 farms where tracers were used (Survey 1 & 2), no post-winter infestations occurred before 3 October. Moreover, the untreated lambs born at Boontjieskraal during June were not infested until 21 October 1987. Rogers & Knapp (1973) regarded the sudden appearance of 1st instar larvae of *O. ovis* in animals as an indication of the arrival of a new generation of the insect. The appearance of 1st instar larvae in tracers during October was, therefore, regarded as the first post-winter generation of *O. ovis*, while subsequent peaks of 1st instar larvae in the tracers marked the arrival of new generations of the insect.

A gradual decline, stretching over a period of 5½ months, was noticed in the numbers of larvae recovered from the untreated animals during the winter. Rogers & Knapp (1973) indicated that the viability of pupae was dramatically reduced if the larval development phase in the host had been prolonged like in an overwintering population. The apparent slow rate of larval development during winter with the resultant reduced viability of the pupae formed by these larvae in spring, together with the extremely low survival rate of pupae formed between April and August (Fig. 8), may explain why infeststion of the tracers in the present study gained momentum only late in summer, although infestation commenced in October (Fig. 2–4 & 6).

On all the farms, with the exception of Boontjieskraal, infestations reached high summer peaks. These infestations were probably caused by the last of the overwintering larvae, pupating in October/November (Fig. 2) and hatching in November/December after a pupal period of 30–40 days (Fig. 8). It is also possible, however, that the summer peak was caused by a 2nd generation of *O. ovis* flies, originating from larvae deposited by the first flies to emerge after the winter, during October (Fig. 2). It seems unlikely, however, that the extremely high prevalence of infestation and large numbers of larvae recovered from tracers slaughtered during December and January (Fig. 3, 4 & 6) could be generated by flies produced from the small number of 2nd generation larvae harboured by the tracers during spring (Fig. 2–4 & 6). This summer peak was more likely to be the result of infestations caused by these 2 early generations combined.

On 24 November 1988, the animals at Boontjieskraal were removed from the lucerne pastures and placed on wheat stubble 1–2 km away, thereby preventing the summer infestation peak. Infestation in those tracers slaughtered during summer was limited to a single infested animal killed on 14 January 1988, but those slaughtered after 24 February 1988 were heavily infested (Fig. 2). This indicates that pupae of *O. ovis* survived the hot and dry conditions prevailing on the bare and inhospitable wheat stubble fields during summer and managed to produce a new generation of flies.

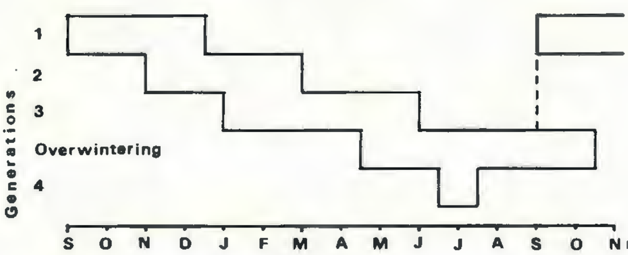
On all the farms, with the exception of Tygerhoek, where the animals were treated in December and again in February, infestation reached a 2nd peak in the tracers during March and April (Fig 2–4). This could be regarded as a next generation of the insect. This generation of larvae remained in the untreated animals throughout winter. Fig. 2 and 4 show that the untreated animals at Boontjieskraal and Elandskloof harboured predominantly 1st instar larvae in 83 %–100 % of the slaughtered animals for 3–5½ months after the last pre-winter infestations occurred in the tracer animals. This phenomenon of overwintering as 1st instar larvae in the nasal and sinous cavities of the host is a common feature in the dynamics of this parasite (Cobbett & Mitchell, 1941; Horak, 1977). The gradually declining numbers of larvae as well as the increase in the numbers of the 3rd instar larvae recovered from the untreated animals after the winter, however, indicate that a slow but continuous development was taking place in the overwintering population during winter and spring and that pupae were in all probability being formed all the time.

At Elandskloof and Tygerhoek, that tracers were infested during the winter indicated the reality of a winter generation of *O. ovis* (Fig. 4 & 6). Infestation during winter, however, was limited to sporadic cases from June–September, while the mean monthly temperature was below 15 °C.

The conjecture is that 4 generations, with considerable overlapping between generations, are produced by the insect annually and that the 4 waves of infestation identified in spring, summer, autumn and winter were a manifestation of these cycles.

Life cycle of O. ovis

Schematically, the following life cycle is proposed for *O. ovis* in the winter rainfall area.



Development of the pupae and imagines of O. ovis

Pupae were formed throughout the year, but those formed between 16 March and 9 August did not hatch and no imagines were produced from 17 April–13 October (Survey 4). The onset and duration of the period during which no imagines were produced, coincide with a similar period recorded in the summer rainfall area of South Africa (Horak, 1977). Between these dates, fly strikes are likely to occur only sporadically if pupae hatch during winter, as happened on 29 June 1988 (Fig. 8). The infestation in tracer animals slaughtered at Tygerhoek on 13 July 1988 is proof of mid-winter infestations occurring (Fig. 6).

The pupal periods in this study ranged from 80 days in winter to 30 days in summer (Fig. 8), compared with 77 and 21 days respectively, in the summer rainfall region of South Africa (Horak, 1977). The 21-day pupal period was recorded while the mean temperature exceeded 25 °C, while the shortest pupation periods in the present study were recorded when the mean temperature was 20,4 and 20,8 °C. Rogers & Knapp (1973) regarded 27 °C as optimal for the development of *O. ovis* pupae, while temperatures constantly below 16 °C or above 32 °C are fatal. From April–July, the mean monthly temperature in the present study ranged from 13,4–17,2 °C and only 1 pupae hatched (Fig. 8).

The imagines lived from 7–25 days (Fig. 8).

Survival of O. ovis *in the winter rainfall region of South Africa*

As *O. ovis* pupae failed to develop during the winter and pupal periods increased dramatically during periods of low temperature, it can be concluded that the external phase of *O. ovis* is sensitive to low temperatures and that the insect has to survive cold conditions by means of dormancy as 1st instar larvae inside the host. Dormancy in a moderate climate is not absolute (Rogers & Knapp, 1973; Horak, 1977) and in the present study, larvae developed at slow but differing rates over a period of 3–5½ months (Fig. 2 & 4), ensuring that pupae were produced continuously.

In the winter rainfall region, sheep graze on stubble lands during the hot and dry summer months. The present study indicated that *O. ovis* pupae were able to survive these severe conditions, because tracers at Boontjieskraal became infested while on these pastures (Fig. 2).

The considerable variation in the length of the larval and pupal periods will ensure the overlapping of generations, and the internal and external phases of the insect will serve as back-up for each other should conditions for either phase become unfavourable for survival.

On the farms Boontjieskraal, Elandskloof and Tygerhoek, tracers were infested with *O. ovis* during 5, 8 and 8 months of the year, respectively. With the exception of November 1987 at Boontjieskraal and September 1988 at Tygerhoek, untreated animals harboured *O. ovis* larvae throughout the year. Once infested, animals therefore serve as a reservoir of infection.

Control of O. ovis

For survival, *O. ovis* is totally dependent on its dormant overwintering phase in the host, because the pupae do not survive the winter. For this reason, strategic control of the parasite should be concentrated on the total elimination of overwintering larvae.

For the summer rainfall areas of South Africa, Horak (1977) recommends treatments in March, June/July and November. In the present study, as heavy infestations still occurred in March and April, however, the following treatments which will coincide with the roundworm treatments proposed for this area (Louw, 1989), are recommended.

May	—	Treat to eliminate larvae destined to overwinter in the host
August	—	Treat to eliminate larvae deposited in mid-winter
November	—	Treat to eliminate larvae deposited in spring and so prevent contamination and infestation peak on summer pasture
March	—	Tactical treatment, if required, on heavily contaminated farms

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