On-host ecology and off-host survival of the sheep scab mite *Psoroptes ovis*

T. MEINTJES*, L.J. FOURIE and I.G. HORAK

Department of Zoology and Entomology, University of the Free State
P.O. Box 339, Bloemfontein, 9300 South Africa

ABSTRACT

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These studies were conducted to investigate the possible role of certain aspects of the on-host ecology and off-host survival of the sheep scab mite, *Psoroptes ovis*, in the dissemination of infestation. All developmental stages of the mite occurred in the fleece both proximally or distal to the skin of infested Merino and Dorper sheep. A larger proportion of mites was present in the fleece of Dorper sheep distal to the skin in the late afternoon and early morning than at other times during the day. Immature and adult mites readily transferred to tufts of wool or hair placed on infested sheep of both breeds. No mites could be found on wool or hair rubbed off onto tree trunks or branches or other structures in enclosures housing heavily infested sheep, nor could any mites be collected from the soil of these enclosures, whereas more than 80 % of mites artificially seeded onto soil samples were recovered.

The longest mean off-host survival times for larvae, nymphs, and male and ovigerous female mites were recorded at 10 °C, and were 9.25 days (RH = 90 %), 15 days (RH = 33 % and 75 %), 10.5 days (RH = 75 % and 90 %) and 11.25 days (RH = 90 %) respectively. Under natural climatic conditions ovigerous females in glass vials containing Merino wool survived for 17 days compared to 15 days for females in vials without wool; this difference was, however, not significant. The mean off-host pre-hatch period for eggs varied between 5.9 days (T = 25 °C and RH = 33 %) and 22.1 days (T = 10 °C and RH = 75 %), while the longest time individual eggs took to hatch at the latter temperature and RH was 31 days.

Keywords: Dorper sheep, Merino sheep, off-host survival, on-host ecology, *Psoroptes ovis*

INTRODUCTION

The epizootiology of sheep scab caused by the mite *Psoroptes ovis* presents certain features that are of considerable importance when contemplating control of the disease. The insidious nature of infestation, its prevalence at particular localities and the seeming ease with which dissemination takes place, all contribute to speculation regarding the mechanism of transmission between sheep, or between sheep and other entities. Early workers noted that direct contact between animals was the chief way by which disease spread, although indirect transmission could not be excluded. Later authors have to a large extent been content to accept the first assertion and few attempts have been made to ascertain whether indirect transmission plays a role in the recurrence of the disease.

* Present address: P.O. Box 70646, Die Wilgers, 0041 South Africa

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The development of scab on apparently healthy sheep at localities where no sheep had been kept for 2 years led many farmers to believe that the mites can survive off the host for this period of time (Du Toit 1924). This has resulted in several researchers attempting to determine the length of time that *P. ovis* can survive off the host. Three strategies have been followed in studies on this facet, one involved separation of mites from sheep and observations on the time required for all of them to die (Bedford 1915; Shilston 1915; Kirkwood 1986). The second followed the same procedure, but the infectivity of the mites was tested after they had spent various periods away from the host (Wilson, Blachut & Roberts 1977; O'Brien, Grey & O'Reilly 1994). In the third the infectivity of sheep enclosures that had housed heavily infested sheep, was tested at various times after removal of the sheep (Bedford 1915; Du Toit 1924). Most of these studies revealed that mites could survive for approximately 14–16 days apart from a host, but that their infectivity was severely impaired thereafter. However, there is still considerable doubt pertaining to the off-host longevity and infectivity of *P. ovis.* Consequently it would be unwise to attempt the eradication of a contagious disease such as sheep scab without reliable information on the survival time of mites separated from a host.

The scepticism of farmers regarding the manner of transmission and the paucity of evidence that indirect transmission could lead to sheep scab prompted the present studies. One of the aims of the investigation was to compare the on-host spatial distribution of *P. ovis* on Merino and Dorper sheep and the diurnal rhythm of mites in the wool or hair proximal or distal to the skin of both breeds. Another was to determine the off-host spatial distribution of mites in sheep enclosures, and a third to assess the interaction between abiotic factors and the off-host survival of all developmental stages of the mite and the length of the pre-hatch period of its eggs under controlled and quantifiable laboratory conditions.

MATERIALS AND METHODS

All experiments were conducted on the premises of the University of the Free State in Bloemfontein, Free State Province, South Africa.

Distribution of mites in the fleece

Two scab infested Merino sheep and two similarly infested Dorper sheep were individually confined in steel cages (1.7 m x 1.2 m), and supplied with maintenance pills (Senwesco: South Africa) and water *ad libitum* for the 24 h duration of the study. The Merino sheep had scab lesions measuring 1 000 cm^2 and 1 700 cm^2 on the withers and back, whereas, as is normally the case, the lesions on the Dorper sheep were considerably smaller, measuring 550 cm^2 and 720 cm^2. A 10 cm x 10 cm segment of the lesion on each sheep was demarcated with masking tape, and at 2-hourly intervals, for a period of 24 h, tufts of wool or hair, approximately 1.5 cm^2 at the base, were snipped off close to the skin within this area. Immediately after removal each tuft was cut in half to separate the section closest to the skin (proximal) from that furthest (distal) from the skin. Each portion of fleece or hair was placed in a separate, labelled sample bottle, and the contents of the bottles were subsequently digested in 10 % KOH solution heated to between 40 °C and 50 °C. The digested material was filtered through Watman No. 5 filter paper and the residue on the paper examined under a stereoscopic microscope. The numbers of eggs, immature and mature mites in the residues were compared for the two sheep breeds.

Superficial occurrence of mites

Wool or hair tufts, ± 2 cm^2 at their base, were collected from uninfested Merino and Dorper sheep. Every 4 h, for a period of 24 h, three of these wool or hair tufts were placed on the wool or hair directly above scab lesions outside the demarcated area on the infested Merino and Dorper sheep mentioned above. After 5 min the tufts were carefully removed and placed separately in labelled sample bottles. They were digested, the digests filtered and examined as described above, and the numbers of mites that had transferred from the infested sheep onto the tufts were determined.

Mites on wool in sheep enclosures

Ten severely infested Merino sheep and nine similarly infested Dorper sheep were housed in separate quarantine camps each approximately 1 ha in size. All visible wool or hair was collected daily from tree trunks and branches and other structures within the camps for the calendar month of June 1997. The wool and hair samples from the two enclosures were placed separately in labelled plastic bags, their mass was measured and they were then digested in a 10 % KOH solution in the laboratory. The digested material was filtered through gauze with 75 µm apertures, and the residue on the gauze

was rinsed with water and examined under a stereoscopic microscope.

Occurrence of mites in soil

Soil from enclosures inhabited by scab-infested sheep was processed in a modified Berlese apparatus during June 1997. The sieve that held the soil samples was placed 10 cm below a 60 W light bulb, and a black plastic funnel below the sieve was fastened to the sieve with masking tape. A collection bottle below the funnel was attached to the latter with masking tape to prevent mites that had migrated through the sieve from escaping. The Berlese apparatus is based on the principle that mites or insects present in soil will move away from the light source through the sieve and into the funnel and thence into the collecting bottle. Soil samples (4 cm of the top layer) were taken from two enclosures, each ± 1 ha in size and each housing ten sheep heavily infested with scab. Special attention was paid to areas where the sheep spent most time, such as that around the feed-trough, under trees, and where they rested during the day. A total mass of 4 508 g of soil was collected from these areas. The soil samples were placed in the modified Berlese apparatus taking care to prevent excessive spillage through the sieve into the collecting bottle below the funnel. In addition, mite-free soil was seeded with 20 mites and placed in a similarly modified Berlese apparatus. Both sets of samples were left undisturbed under the light in the Berlese apparatus for 3 days. The experiment was repeated approximately 5 weeks later during July 1997, and 1 586 g of soil was collected from the enclosures, and ten mites were seeded onto mite-free soil.

Off-host longevity

Scrapings from scab lesions were collected from a heavily infested donor Merino sheep and the wool fibres within the scrapings were removed. Nymphs and male and ovigerous female mites in the scrapings were separated from each other with the aid of a fine brush, grouped into nine groups of ten mites each for each developmental stage and each group of mites was placed in a separate glass vial (15 mm x 50 mm). A hole was drilled through the plastic lid of each vial and the opening sealed with 75 µm aperture gauze to allow free airflow but prevent mites from escaping.

The vials of mites were placed in desiccators in cabinets maintained at 10 °C, 15 °C or 25 °C. For each temperature three desiccators with relative humidities (RH) of 33 ± 2%, 75 ± 2%, and 90 ± 2% respectively, were used (Fig. 1).

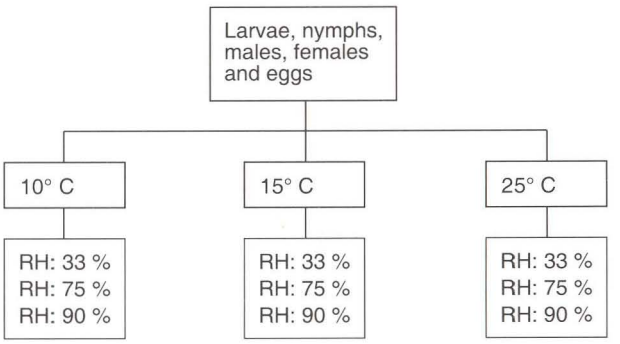

FIG. 1 Schematic representation of temperature and relative humidity regimes at which the off-host longevity of *Psoroptes ovis* and the pre-hatch period of its eggs were determined

Saturated salt ($MgCl_2$, NaCl and K_2SO_4) solutions were used to establish the various RH (Young, 1967). Every 2nd, 3rd or 4th day, between 11:00 and 12:00, the mites were observed through the wall of the vial by means of a stereoscopic microscope to determine whether they were still alive. In order to distinguish between live and dead mites the vials were briefly placed on a magnetic stirrer with a hot plate set at 35 °C, and the vibration combined with the heat stimulated the mites to move. Obvious dehydration, manifested by curled up legs and complete lack of movement, signified that mites were dead. Observations were terminated once all the mites in a vial were dead. Survival times and percentage of live nymphs, male and ovigerous female mites at the various combinations of temperature and RH humidity were determined on the designated observation days. Four replicates were performed.

Pre-hatch period of eggs and larval longevity

Eggs were separated from scab scrapings with the aid of a fine brush and divided into 18 groups of ten eggs each. The groups of eggs were placed in glass vials and exposed to various combinations of temperature and RH humidity (Fig. 1). The eggs were examined every 2nd or 3rd day for 56 days and the length of the pre-hatch period and subsequent survival of larvae recorded. The experiment was repeated four times. The observations on pre-hatch period were repeated a further three times using glycerol/water dilutions to obtain the required RH. Observations extended over a 35-day period.

Longevity of ovigerous females at everyday temperatures

Ovigerous female mites were separated from scrapings made from a heavily infested donor Merino sheep in early April 1997. These mites were divided into 60 groups of ten each and each group of ten mites was placed in a cylindrical glass vial (30 mm x 30 mm) of which the open ends were covered with 75 µm aperture nylon gauze to allow free airflow and yet prevent mites from escaping. Tufts of Merino wool were placed with the mites in 30 of the vials, while the other 30 vials contained only mites. All the vials were subsequently placed on a sieve approximately 10 cm above soil surface in a field on the premises of the University of the Free State. The sieve and vials were loosely covered with layers of dried grass to ensure ample shade for the mites. Every 3 or 4 days the mites were examined under a stereoscopic microscope and the number of live mites was recorded until all had died. Rainfall and temperature data during the assessment period were obtained from the National Weather Bureau.

Analysis

The data were subjected to a one-way analysis of variance (ANOVA) followed by Tukey's multiple comparison tests. In addition the data on the pre-hatch periods of eggs were subjected to a one-way ANOVA to determine whether these times differed significantly between RH obtained with saturated salt solutions and those obtained with glycerol/water. The programme PRISM™, Version 2.01 of GraphPad Software, Inc., was used for statistical analysis of the data.

RESULTS

Distribution of mites in the fleece

The number of eggs and mites collected from the proximal and distal fleece sections are summarized in Fig. 2. The mean number of eggs, nymphs, male and female mites on the proximal and distal sections of fleece on Merino sheep always exceeded those on Dorper sheep.

The percentage of mites (nymphs, males and ovigerous females) on the distal section of the fleece clippings of Merino sheep varied between 1 % and 46 %, and the greatest percentage was recorded at 10:00 (Fig. 3A). The percentage of mites on the distal fleece section of Dorper sheep varied between 6 % and 70 %, and the largest percentages were recorded from 04:00–08:00 and at 16:00 (Fig. 3B).

Superficial occurrence of mites

The numbers of mites that transferred to tufts of wool or hair placed on infested sheep are summarised in

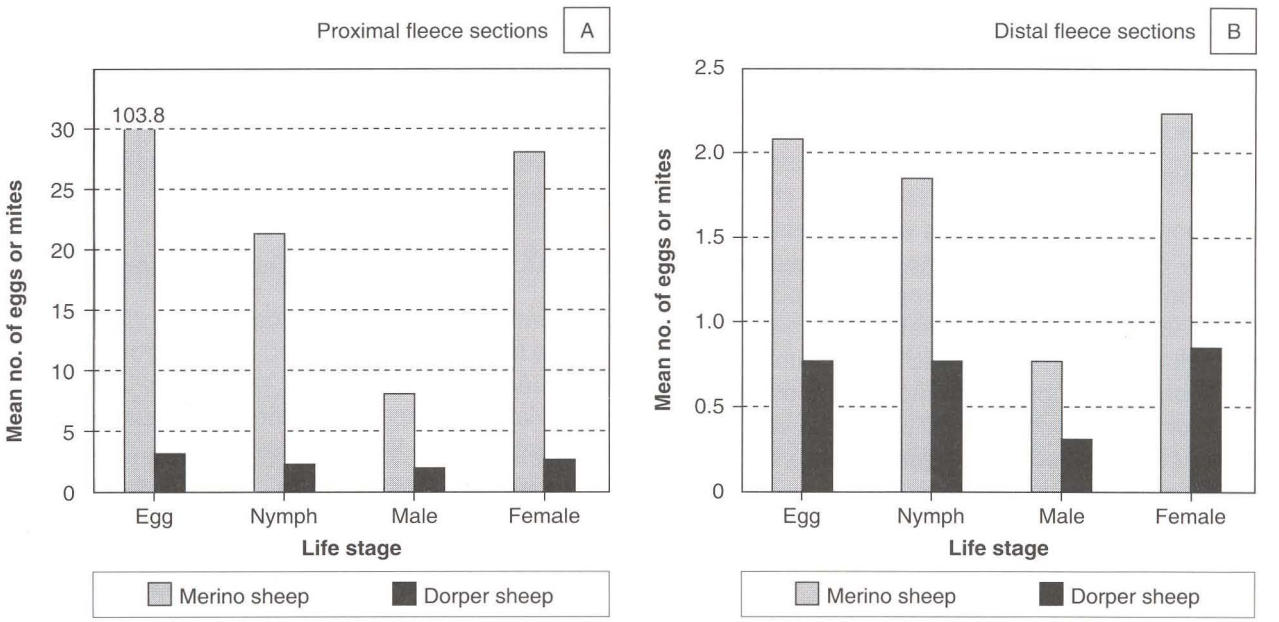

FIG. 2 Life stages of *Psoroptes ovis* collected from sections of fleece (A) proximal and (B) distal to the skin of Merino and Dorper sheep. (Thirteen replicates for each breed)

Table 1. A mean maximum of 0.67 and 1.67 immature mites transferred to the wool or hair tufts on the Merino and Dorper sheep respectively, while the mean maximum numbers of adult mites were 1.5 and 0.33 respectively (Table 1).

Infective stages on wool in enclosures

A total of 42.12 g of wool was collected from the camp of the infested Merino sheep and 134.46 g of hair from the camp of the Dorper sheep. No mites were found in either the wool or hair.

Occurrence of mites in soil

No mites were found in the soil samples collected in the camps stocked with scab-infested sheep, while 85% and 90% of the mites seeded onto mite-free soil were recovered.

Off-host longevity

A few dead nymphs were recorded at the time of the first observation 3 days after separation from a host. Mean survival time decreased with an increase in temperature (Fig. 4A). The longest mean survival time for nymphs was 15 days at 10 °C and RH of 33% and 75%, while all were dead by 3 days at 25 °C and RH of 33%. The longest survival time for individual nymphs was 19 days at 10 °C at all combinations of RH (Fig. 4B).

The mean survival times of nymphs exposed at 10 °C to various RH differed significantly ($P < 0.05$) from those of nymphs exposed at 25 °C. Relative humidity had no significant effect on the survival time of nymphs at 10 °C, 15 °C, or 25 °C ($P \geq 0.68$).

Some dead males were present 3 days after separation from a host and the longest mean survival

TABLE 1 *Psoroptes ovis* collected from tufts of wool or hair placed every 4 h for 24 h on infested Merino or Dorper sheep respectively

Sheep breed	No. of samples	Mean No. of immature mites collected		
		Minimum	Maximum	Mean (± S.D.)
Merino	21	0	0.667	0.14 (± 0.24)
Dorper	21	0	1.667	0.43 (± 0.58)
		Mean No. of adult mites collected		
		Minimum	Maximum	Mean (± S.D.)
Merino	21	0	1.5	0.48 (± 0.52)
Dorper	21	0	0.33	0.17 (± 0.17)

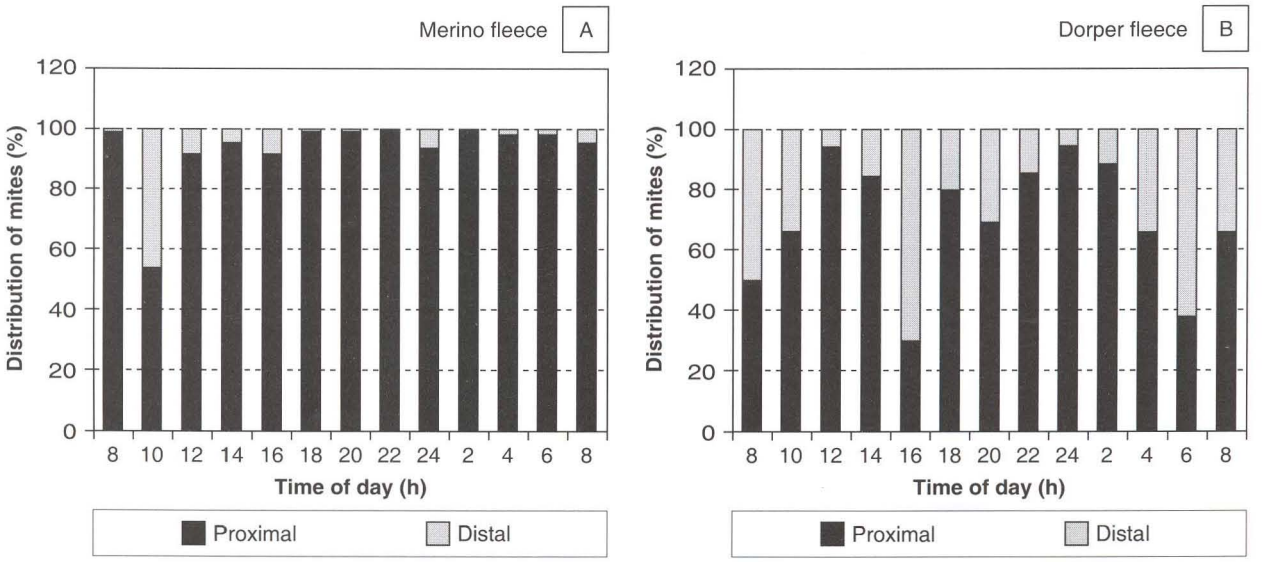

FIG. 3 Time specific occurrence (%) of *Psoroptes ovis* (all instars) in proximal and distal sections of (A) Merino fleece and (B) Dorper fleece

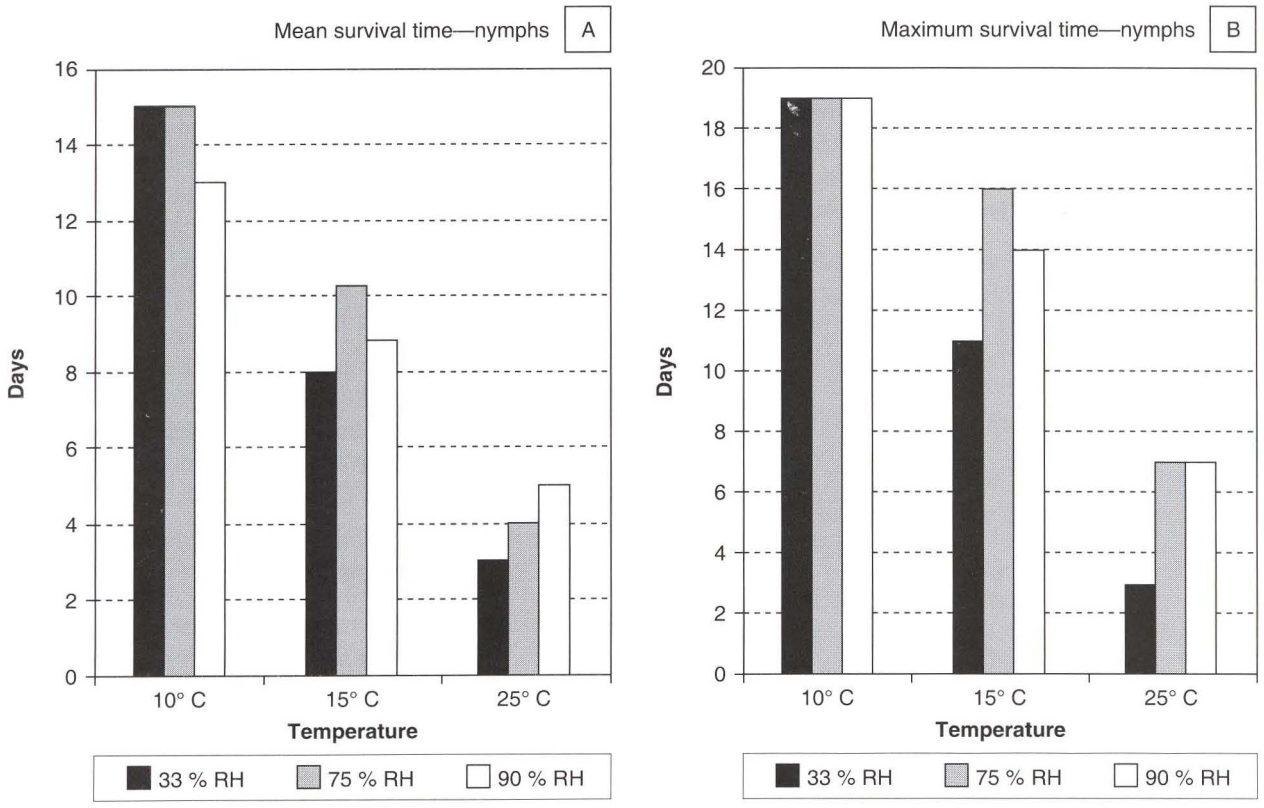

FIG. 4 Off-host survival times of *Psoroptes ovis* nymphs at various combinations of relative humidity and temperature (A) mean survival and (B) maximum survival time. (Four replicates with ten nymphs at each temperature and relative humidity)

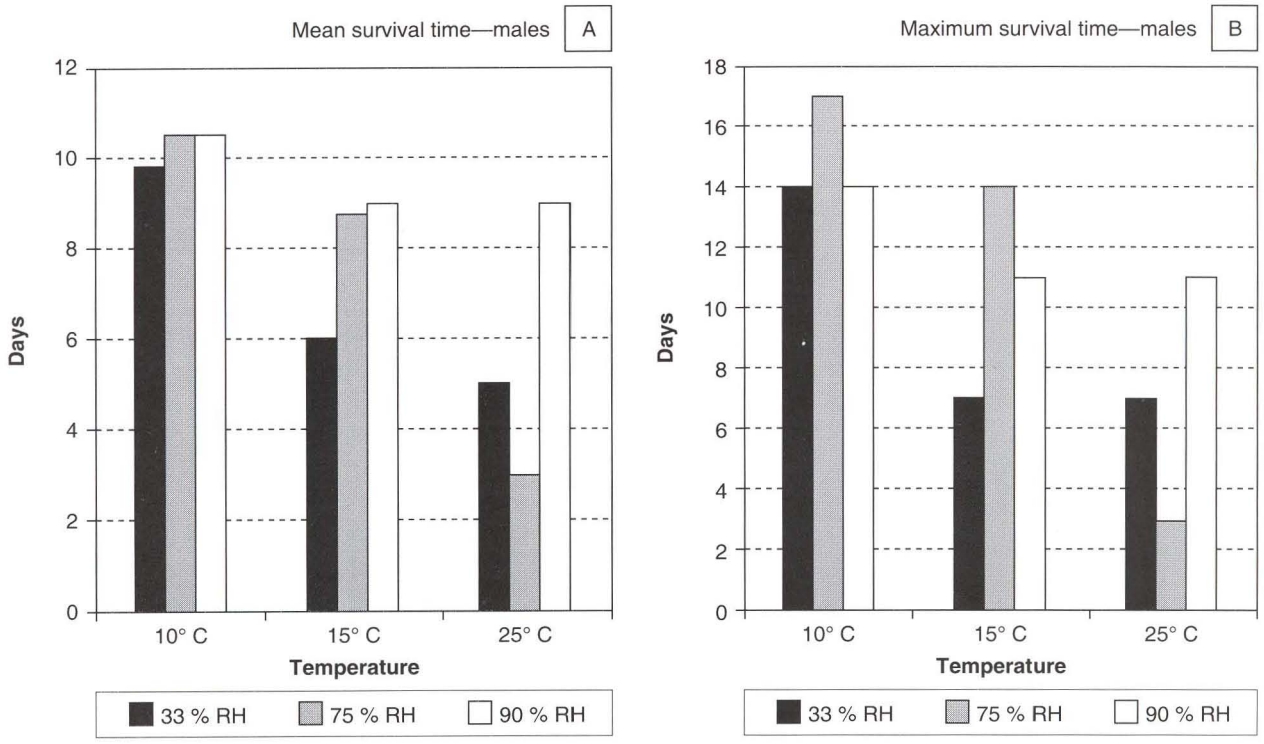

FIG. 5 Off-host survival times of male *Psoroptes ovis* at various combinations of relative humidity and temperature (A) mean survival and (B) maximum survival time. (Four replicates with ten males at each temperature and relative humidity)

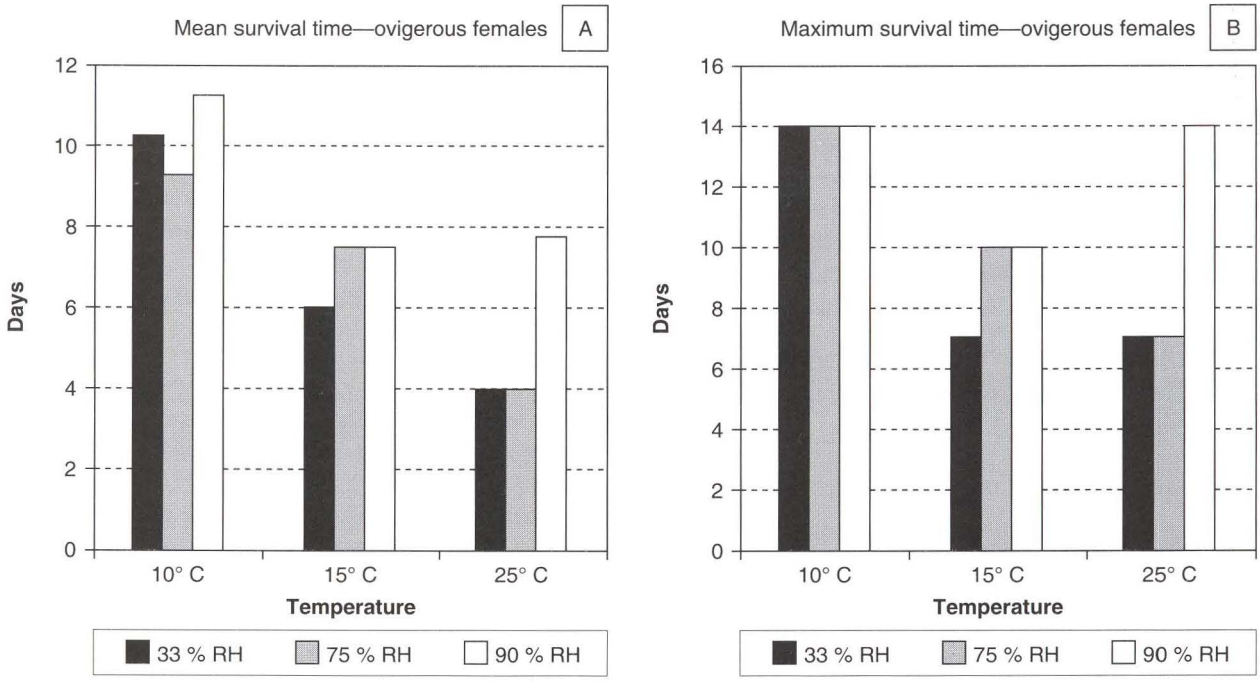

FIG. 6 Off-host survival times of ovigerous female *Psoroptes ovis* at various combinations of relative humidity and temperature (A) mean survival and (B) maximum survival time. (Four replicates with ten ovigerous females at each temperature and relative humidity)

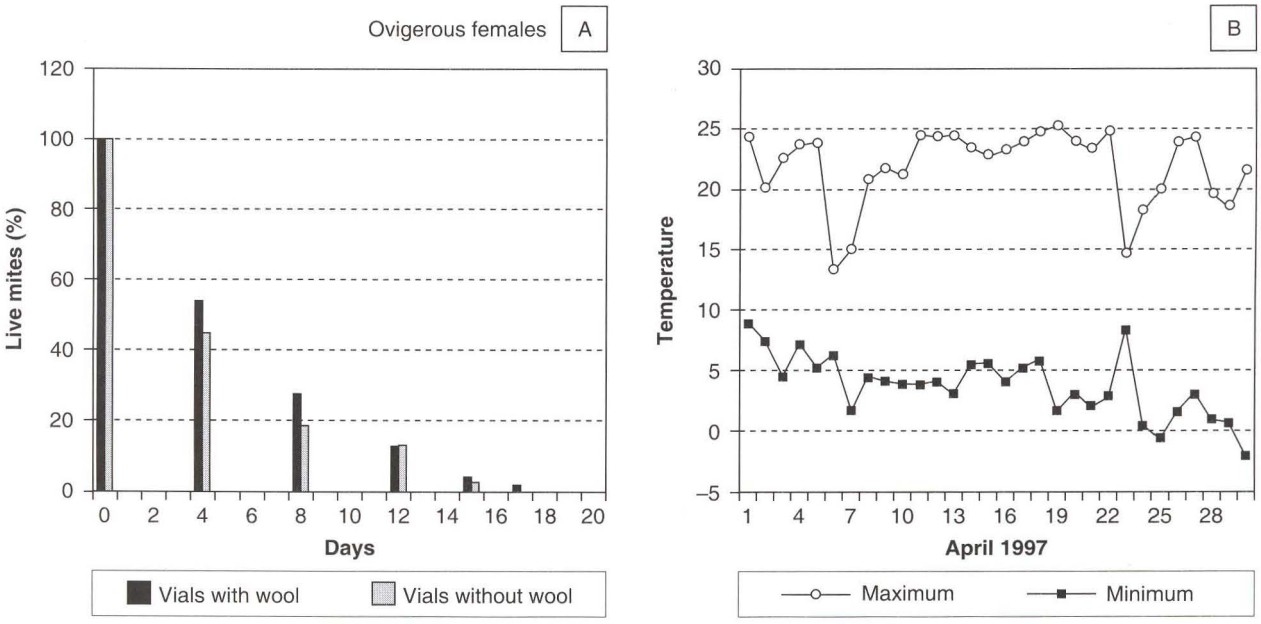

FIG. 7 (A) Off-host survival times of ovigerous female *Psoroptes ovis* exposed in glass vails to naturally fluctuating conditions with wool and without wool (30 x ten mites with wool, and 30 x ten mites without), and (B) daily minimum and maximum temperatures recorded in Bloemfontein during April 1997

time of males was 10.5 days at 10 °C and RH of 75 % and 90 % (Fig. 5A). Their longevity decreased with an increase in temperature. The longest survival time for individual males was 17 days at 10 °C and RH of 75 % (Fig. 5B).

Temperature had a significant effect on the survival of males ($P = 0.0425$), whereas the effect of RH on their survival at any temperature was not significant ($P \geq 0.90$).

The longest mean survival time of ovigerous females was 11.25 days at 10 °C and RH of 90 %, and the shortest 4 days at 25 °C and RH of 33 % and 75 % (Fig. 6A). Mean survival times of ovigerous females decreased with an increase in temperature. The maximum survival time of individual females was 14 days at 10 °C and all RH, and at 25 °C and RH of 90 % (Fig. 6B). Relative humidity had no significant effect on the survival time of ovigerous females at any temperature ($P \geq 0.83$).

The survival time of ovigerous females at 10 °C and RH of 90% differed significantly from that of females at 15 °C and RH of 33 %.

Pre-hatch period of eggs and larval longevity

The pre-hatch periods of eggs at RH obtained by saturated salt solutions and those obtained by glycerol/water dilutions did not differ significantly ($P > 0.05$), and the data were pooled. Hatching success varied between 7.14 % (T = 10 °C, RH = 33 %) and 35.71 % (T = 25 °C, RH = 90 %), and mean pre-hatch time varied between 5.9 days and 22.14 days (Table 2). Eggs at 15 °C and all RH and at 25 °C and RH of 90 % had hatched by day 3 after separation from a host. The longest pre-hatch period was 31 days at 10 °C and RH of 75 %.

Larval longevity varied between 2 days and 14 days. The longest mean larval survival (9.25 days) was recorded at 10 °C and RH of 90 % and the shortest (4.44 days) at 25 °C and RH of 33 % (Table 3).

Longevity of ovigerous females at everyday temperatures

Less than half (45 %) of the ovigerous female population in the vials without Merino wool survived for 4 days, compared to 54 % in the vials containing wool. At 15 days 2.6 % of females in the vials without wool were still alive and at 17 days all were dead. In the vials containing wool 2 % of ovigerous females were still alive at 17 days, but all were dead by 20 days (Fig. 7A). These results did not differ significantly ($P > 0.05$).

Fluctuations in atmospheric temperature during the assessment period are illustrated in Fig. 7B, and 35 mm of rain fell during this period (April 1997).

TABLE 2 Pre-hatch periods of *Psoroptes ovis* eggs at various combinations of temperature and relative humidity

Temp. (°C)	RH (%)	No. of eggs	Hatching success (%)	Pre-hatch period (days)		
				Minimum	Maximum	Mean (± S.D.)
10	33	70	7.14	7	9	7.5 (± 1.0)
10	75	70	22.8	14	31	22.14 (± 6.53)
10	90	70	12.5	17	18	17.50 (± 0.57)
15	33	70	14.28	3	13	8.7 (± 4.26)
15	75	70	12.85	3	18	9.75 (± 5.49)
15	90	70	30	3	28	12.6 (± 10.15)
25	33	70	12.85	4	11	5.9 (± 2.58)
25	75	70	21.42	4	16	7.43 (± 4.89)
25	90	70	35.71	3	16	7.43 (± 3.58)

TABLE 3 Longevity of *Psoroptes ovis* larvae at various combinations of temperature and relative humidity

Temp. (°C)	RH (%)	No. of eggs originally exposed	Larval longevity (days)		
			Minimum	Maximum	Mean (± S.D.)
10	33	70	4	11	5.75 (± 3.5)
10	75	70	2	10	5.71 (± 2.75)
10	90	70	6	14	9.25 (± 3.59)
15	33	70	3	11	7.33 (± 3.42)
15	75	70	3	12	8.12 (± 3.42)
15	90	70	2	11	5.21 (± 3.15)
25	33	70	3	7	4.44 (± 1.33)
25	75	70	2	7	4.68 (± 1.95)
25	90	70	2	8	5.17 (± 1.82)

DISCUSSION

Large numbers of mites and eggs were recorded close to the skin of both Merino and Dorper sheep. This was to be expected as the mites feed on secretions on the skin of the host around the moist periphery of the lesions (Bates 1997), and body heat is required for the hatching of eggs (Bedford 1915; Shilston 1915). Several mites were, however, found on the distal sections of the wool or hair tufts of both breeds, and this would presumably increase the potential for their successful transfer to other hosts. No discernible time-specific pattern of mites on the distal sections of the wool tufts of Merino sheep was observed. On the other hand the proportion of mites on the distal sections of hair tufts of Dorper sheep increased during the late afternoon and early morning. This corresponds to the time that Dorper sheep huddle together, and could increase the rate of spread between individuals of this particular breed of sheep. Furthermore the gregarious habits of sheep of all breeds provide adequate opportunities for direct contact between animals and perpetuation of infestation is thus ensured.

During the course of the current investigation numerous simulations of a bird walking on an infested sheep's back were performed using the feet of a dead cattle egret (*Bubulcus ibis*), but no mites transferred to them. However, birds cannot be ignored as a potential mechanical means of mite transmission between sheep. In the Free State Province of South Africa it is common for birds to walk on the backs of sheep, and those closely associated with sheep in this manner include the cattle egret, the African pied starling (*Spreo bicolor*) and the wattled starling (*Creatophora cinerea*). In England it has been noted that starlings can carry off loose wool from scab-infested sheep (Kirkwood, cited by Tarry 1974), and the risk of dissemination by this means may thus be real.

The absence of mites in wool, hair or soil collected from enclosures housing severely infested sheep lessens the likelihood of these items being important sources or reservoirs of infestation. In Texas Babcock & Black (1933) found that direct summer sunlight killed scab mites within 10 min to 3 h, and that they are also vulnerable to desiccation. During winter in the Free State Province, the time of year in which the wool, hair and soil samples were collected, there is virtually no cloud cover during the day and rainfall is rare. These could also account for the absence of mites in both wool and soil samples.

The lifespan of ovigerous female mites on sheep is 30–40 days (Shilston 1915). Hertwig (1835, cited by Meintjes 1999) stated that mites separated from the host lived for 17–21 days, while Dill (1920) concluded that if mites were protected from the sun they might live for years off the host. Kirkwood (1986) claimed that in exceptional cases mites survived on scab material or on dead sheep for 3 weeks, and that at 10 °C survival periods of up to 48 days had been recorded. During the current study no mites survived for longer than 14 days at a constant temperature of 25 °C. It must, however, be borne in mind that the periods of survival recorded are approximations since the exact ages of the mites were not known at the times that the skin scrapings from which they were collected were made. A possible reason for the shorter survival of mites at higher temperatures is that their increased activity may result in the exhaustion of their physiological reserves at these temperatures (Wilson *et al.* 1977). Babcock & Black (1933) found that scab mites are capable of surviving a wide range of temperatures, but perished from a lack of food when removed from a host. On the other hand, Shilston (1915) stated that scab mites soon perished if exposed either to low (0 °C) or high (37 °C) temperatures. Wilson *et al.* (1977) evaluated the effect of prevailing temperatures, humidity and other environmental factors on mite longevity and found that low temperatures and high humidity are conducive to longevity, while the results obtained in the current study indicated that low temperatures (10 °C) favoured the survival of mites irrespective of RH. Some mites in all stages of development were dead by the time they were examined for the first time 3 days after removal from the host; consequently the minimum survival time is considered as less than 3 days.

Since the ages of the eggs collected from scrapings were unknown (they were probably in different stages of embryonic development, with some very likely already containing pre-larvae), it is difficult to draw definite conclusions on the length of the pre-hatch period. It is possible that 10 °C, and perhaps the other temperatures tested, are too low for embryonic development, and that the few larvae that did hatch were in the pre-larval stage at the commencement of the experiments. The results on larval longevity are more reliable as the ages of the larvae that hatched from the eggs were known. The infectivity of these larvae was, however, not tested. The prolonged presence of infestation in the absence of scabby sheep is possibly due to eggs that retain their viability for long periods off the host

before hatching. The present results demonstrate that eggs could still hatch a month (31 days) after separation from a host and can therefore act as a potential source of re-infestation.

The slightly longer off-host survival times of ovigerous females maintained under natural climatic conditions compared to those in the laboratory are difficult to explain. It is possible that the desiccators containing the glass vials in the incubators created an artificial atmosphere not conducive to the survival of mites. The use, under natural climatic conditions, of glass tubes with both openings gauze-stopperred probably permitted free airflow and contributed to an equitable distribution of temperature and humidity and thus enhanced survival. It is also possible that the fluctuations in atmospheric temperature experienced during the observation period (April) contributed to extended longevity of the ovigerous females.

Differences in experimental methodology, as well as in mite strains and humidity between South Africa and the Northern Hemisphere, where most of the research has been conducted, might account for variations in the results obtained. Roberts & Meleney (1971) demonstrated that certain mite strains are more virulent than others and can withstand factors leading to population reduction on hosts more successfully than others could, and this may possibly also apply to their off-host survival. The variation in findings on off-host longevity demonstrates that many factors are involved in the survival of scab mites and that experimental results are not necessarily predictable.

Shilston (1915) placed a single female mite that had been separated from a host for 20 days on a sheep, but discovered on the following day that it had died. Stockman (cited by Shilston 1915) was unable in three attempts to infest sheep with mites that had been isolated for 14 days despite large numbers being employed. Wilson *et al.* (1977) and O'Brien *et al.* (1994) found that scab mites could successfully infest sheep 17 days and 16 days respectively after removal from a host. O'Brien *et al.* (1994) noted that in general mites were infective for a period equalling a day less than their longevity.

Bedford (1915) and Du Toit (1924) housed sheep, severely infested with scab, in camps during the day and in stone kraals at night. In Du Toit's experiment several of the sheep died during the ensuing 2 months due to scab and concomitant helminth infection. The remaining sheep were shorn in the kraal and the wool and scabs were left on the kraal floor, while Bedford placed 100 mites in the wool that had accumulated in the kraals on the day that the infested sheep were moved. Bedford found that clean sheep introduced into the kraals 8 or 9 days after removal of the scab-infested sheep became infected, whereas those placed in the kraals 10 or 15 days, and in the case of Du Toit 17 days after removal of the infested sheep remained free of mites.

In a concurrent experiment Du Toit (1924) housed 68 severely infested sheep in a camp during the day and in a stone kraal at night. Fifty of these sheep died from scab and coincidental helminth infections during the ensuing 2 months. The remaining sheep were shorn in the kraal and the wool and scabs left on the kraal floor. The shorn sheep were immersed for 2 min in a lime/sulphur bath and immediately returned to the infected camp and kraal. Nine days later they were again dipped in lime/sulphur and returned to the camp and kraal, where they remained for a year. Only nine sheep eventually survived, but no mites were detected on any of these sheep during the course of the year.

Psoroptes ovis is an obligatory parasite and the entire life cycle is spent on sheep, and direct transmission of mites from one sheep to another ensures successful maintenance of the disease. When the number of mites becomes excessive, and the hosts are thus able to remove both mites and eggs effectively through grooming, the recurrence of sheep scab in apparently healthy flocks may be due to delayed off-host egg development and subsequent larval hatching.

Our results have demonstrated that mites, and particularly eggs, can survive for a considerable time off the host and consequently we suggest that pens, in which infested sheep have been housed, should be left vacant for at least 17 days, but preferably for 30 days in winter as a precautionary measure.

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