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Clinical and epidemiological studies on screwworm infestation in Qassim region, Saudi Arabia

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Abstract. A prevalence study of skin myiasis in small ruminants was carried over a one year period. Animals, which were admitted to the Veterinary Teaching Hospital of Qassim region, Saudi Arabia, were examined for wound myiasis and the larvae collected were identified as *Chrysomyia bezziana*. Prevalence of 13.0% and 10.0% were recorded in sheep and goats respectively. Sites of infestation, gender and age were concerned during the investigation. Fixed flocks (animals reared completely indoors) showed higher prevalence than semi-fixed ones particularly in winter. No cases of myiasis was observed during summer. Female animals were more significantly infested ($p = 0.0001$) than males, age seems to have no role with infestation rates. Surgical and medicinal intervention were successfully carried out and recommendations were given to avoid repeated infestation.

INTRODUCTION

Screwworm myiasis is an obligatory (serious) ectoparasite of man and warm-blooded animals throughout the tropics and sub-tropics. It is distributed in an arc, spreading from South Africa, through the Middle East, India, South East Asia and New Guinea (Sutherst *et al.*, 1989; Wall & Shearer, 1997).

There are at least 20 species of obligate myiasis-producing Diptera (James, 1947). Two of the most important obligate myiasis producing flies are the Old World screwworm fly (*Chrysomya bezziana*) and the New World screwworm fly (*Cochliomyia hominivorax*). Adult females lay their eggs in wounds or body orifices, of all warm-blooded animals, where the larvae cause serious tissue damage, resulting in loss of condition, injury to the hide and often death (Humphrey *et al.*, 1980; Brown *et al.*, 1998).

Reports on myiasis producing flies from different regions in Saudi Arabia were mainly concerned with their classification without referring to other factors affecting the disease conditions (Buttiker & Zumpt, 1982; Hussein *et al.*, 1982; Amoudi *et al.*, 1989; Omar & Abdalla, 1992; Amoudi, 1993; Eesa & El-Sibae, 1993; Fatani & Hilali, 1994; Alahmed, 2000; Al-Misned, 2003; Alahmed, 2004; El-Azazy & El-Metenawy, 2004; Gad Allah & Bosly, 2006; Bosly, 2010).

Control of screwworm infestation mainly depends on treatment of infested animals and prevent flies from biting the animals by using attractants and traps. Where, there is no commercial vaccine available for prophylaxis, vaccination trials with recombinant antigens should be recommended through production of protein in either bacteria or a eukaryotic system in a quantity that is sufficient for large animal trials. It should also be in high purity and with

structure should be as close as possible to the native structure (Pearson *et al*., 2000).

To the authors' knowledge, in Saudi Arabia, there are only a few studies done regarding the clinical aspects, treatment and control of skin myiasis in animals. Most of the previous studies were focused on the identification and characterization of the fly. The most recent study by Kenawy *et al.* (2014) studied on syanthropic flies that are mechanical vectors of diseases to animals and humans. They identified 19 adult dipterous species but no skin producing myiasis flies were encountered. Therefore, the present study was carried out to deal with the clinical and epidemiological factors that correlates with screwworm myiasis in small ruminants at Qassim region, Saudi Arabia.

MATERIALS AND METHODS

Frequency of screwworm and Clinical examination

This study was conducted over a one-year period (September 2015 to August 2016) on 1170 small ruminants (990 sheep and 180 goats) admitted to the Veterinary Teaching Hospital of Qassim University. These animals come from different localities in Qassim region, Saudi Arabia. They were examined clinically for screwworm infestation and detailed information from the owners were obtained. Breeding categories of 10 flocks were described as fixed in which animals always kept indoors or fixed-mobile (semi-fixed) flocks where animals graze all the day and spend night in fixed pens. All animals under study were subjected to careful clinical examination.

Epidemiological examination

Epidemiological data were estimated according to Martin *et al.* (1987).

Parasitological examination

Larvae which collected from the skin lesions were immediately transferred in glycerin alcohol to the parasitology laboratory. They were prepared for identification after Pritchard & Kruse (1982). Larvae were morphologically identified according to Wall and Shearer (1997) and Spradbery (2002).

Therapeutic trials

Surgical and medicinal managements of the affected animals were applied. Thorough cleaning of the wound was performed using hydrogen peroxide and povidone iodine 5% W/V (Iodosav spray, Saudi Pharmaceutical Industries) daily for 10 days and finally the wound was sprayed using oxytetracycline spray. Both healthy and diseased animals were daily sprayed with Permethrin 2%. Animals with deep wound were not sprayed. All diseased animals and healthy adjacent ones were subcutaneously injected with Doramectin (Dectomax, Pfizer), two doses, 15 days apart. Killing of the recovered larvae and environmental disinfection was done using diazinon (Nucedol Ultra 60 EC, Bioagripharm, Germany) two times, one week apart.

In case of deep wounds and to avoid secondary bacterial infection, penicillin-streptomycin (Pen & Strep/Nor Brook company) was administered by deep intramuscular once daily for 5 consecutive days at doses of 8 mg procaine penicillin and 10 mg dihydrostreptomycin sulphate per kg body weight achieved by administering 1 ml Pen & Strep per 25 kg body weight.

Statistical analysis

Data were analysed using Chi square test. *P*-values less than 0.05 were considered signicant.

RESULTS AND DISCUSSION

Out of 1170 small ruminants examined clinically, 147 animals were infested with screwworm representing an overall prevalence rate of 12.5% (Table 1). As shown in Table 2, 13.0% and 10.0% of sheep and goats suffered from skin myiasis.

The most commonly affected areas were the perineum and under the tail were in animals with diarrhoea (Fig. 1A), Lesions in the limbs, abdomen, head and udder were also observed. Early cases were difficult to

Table 1. Screwworm prevalence in examined flocks from September 2015 to August 2016

Flock No.	Breeding system and (seasons)	Animals		Prevalence (%)
		Examined	Diseased	
1	Fixed flock (sheep) (Winter)	100	35	35.0
2	Fixed flock (sheep) (Spring)	200	30	15.0
3	Fixed flock (goats) (Winter)	70	12	17.1
4	Semi-fixed flock (sheep) (Winter)	90	15	16.6
5	Semi-fixed flock (sheep) (Winter)	90	20	22.2
6	Semi-fixed flock (sheep) (Winter)	300	10	3.3
7	Semi-fixed flock (sheep) (Winter)	160	15	9.3
8	Semi-fixed flock (sheep) (Spring)	50	4	6.1
9	Semi-fixed flock (goats) (Spring)	80	5	6.2
10	Semi-fixed flock (goats) (Autumn)	30	1	3.3
Total		1170	147	12.5

Table 2. System of breeding, species, sex and age predisposition of screwworm infestation in examined animals from September 2015 to August 2016

	Animals		Prevalence (%)
	Examined	Diseased	
System			
Fixed	370	77	20.8*
Semi-fixed	800	70	8.7
Species			
Sheep	990	129	13.0
Goats	180	18	10.0
Sex			
Males	135	3	2.2*
Females	1035	144	13.9
Age			
Young	263	29	11.0
Adults	907	118	13.0

$P \leq 0.0001$

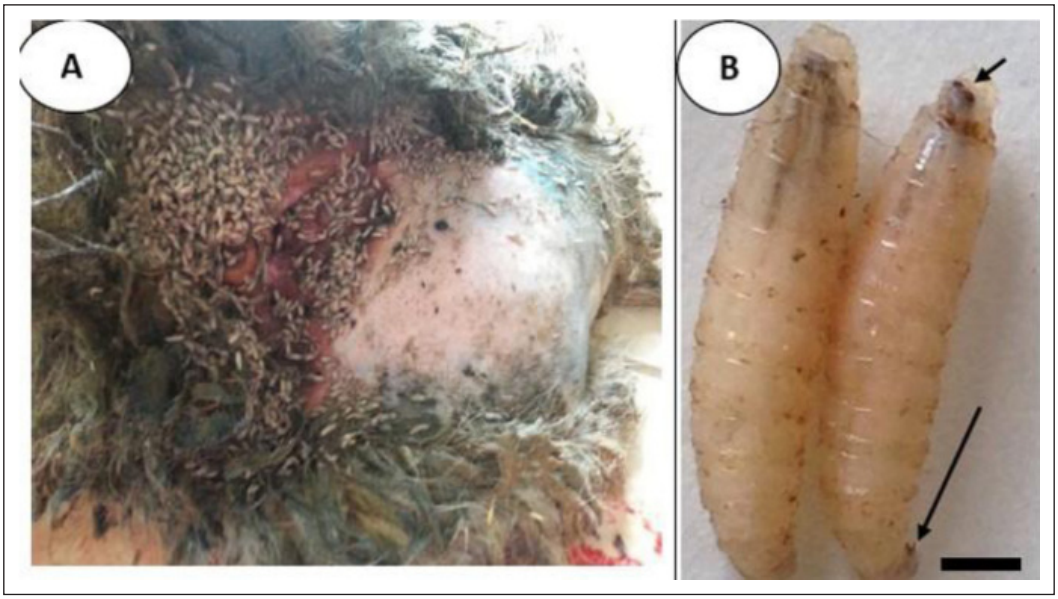

Figure 1. A. Massive screwworm myiasis in a sheep tail. B. Two fresh larvae each shows pair of oral hooks (long arrow), two posterior spiracles (short arrow) from each a faint tracheal tube originates (scale bar = 2 mm).

detect, following that after that many larvae were seen coming out of the wound. The number of larvae recovered varied from few to thousands. The wounds had exudate, sero-sanguineous discharge with a foul-smelling odour. Two animals with deep wound died after 12 days. Multiple lesions were observed in 37 (25.1%) animals. Similar results were recorded by Wyss (2000) and Bowman (2006) who reported that the screw worm produced deep myiasis on hosts and created formidable economic and animal welfare problems.

Where humidity was high in spring and winter, the prevalence of infestation was significantly increased to 12.6% and 12.8% respectively. However during autumn a rate of 3.3% was recorded. During summer, the animals were kept indoors all day where the indoor humidity (10–13%) was low in Qassim, animals to avoid the outdoor very hot and dry climate (42–50°C). Such conditions are enough to kill and degenerate pupae as confirmed by Spradbery (1992). The present study is in agreement with those of El-Kholany & Omer (1999) and El-Azazy & El-Metenawy (2004) where only a few larvae or none were collected during summer. Similar observations were recorded previously by Al-Helfi (2002); Siddig *et al.* (2005) and Abass & Abdulla (2006) who recorded highest infestation rate during winter months and found that the animal infestation was correlated with low temperature and high percent of humidity. However, Madeira *et al.* (1998) found that the infestation is higher in summer and spring and lowest in the fall and winter. Also, Eesa & El-Sibae (1993) recorded a maximum abundance of *Chrysomia* flies in May and minimum in January.

The management styles for flocks also predispose for infestation where 20.8% and 8.7% of fixed and semi-fixed animals were found infested (Table 2). Such infestation rate was significantly higher ($p = 0.0001$) in fixed flocks than semi-fixed flocks. Under fixed conditions both humidity and temperature favour flies to invade animals.

Species variation was not statistically ($p = 0.3$) different among sheep and goats, where, out of the 990 sheep and 180 goats examined, 129 and 18 were infected with screwworm representing prevalence rates of 13.0% and 10.0% for sheep and goats respectively. Females were significantly

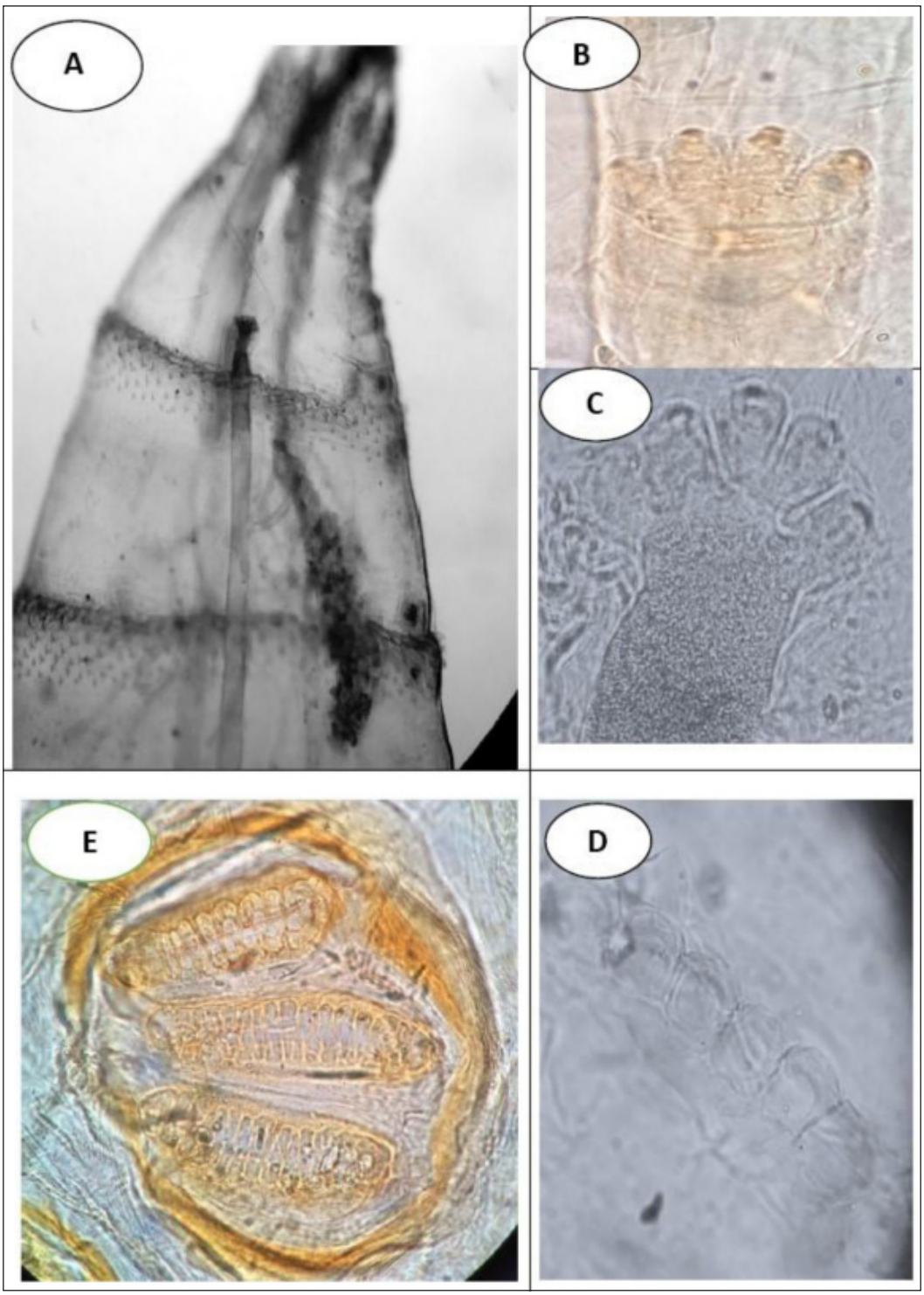

Figure 2. *Chrysomyia bezziana* 3rd larva. A, anterior end shows anterior spiracles with the backwardly directed tracheal tubes and several rows of strongly developed spines encircling each segment (X4). B, C and D are anterior spiracles with 4, 5 and 6 branches or papillae (X40). D (10) and E (X40) Posterior spiracles show incomplete peritreme and 3 slit-like spiracular openings.

($p = 0.0001$) more affected than males, the age seems to play no role for infestation. A prevalence rate of 11.0% and 13.0% were found for young and adults respectively (Table 2). The result of gender-related pattern may be due to hormonal changes and sedentary habits of females particularly under fixed system where flies get more chance to invade wounded or diarrheic animals. In ewes urine-soiled buttocks attract flies and invade the skin. Madeira *et al.* (1998) found that the age at amputation had significant effect on the appearance of screwworm, being most frequent in animals that were older than one month when docked.

The collected larvae measured 18–20 mm (Fig. 1B) and were whitish to creamy with slightly pinkish coloration. Rows of thorn-like black spines encircle each segment (Fig. 2A). The anterior spiracles are fan-shaped with 5 pale-brown finger-like branches (Fig. 2C). However, some specimens showed spiracles with 4 or 6 papillae (Fig. 2B and D). Tracheae from posterior spiracles are not heavily pigmented. The posterior spiracles are not deeply located, each surrounded by a heavily sclerotized dark brown peritreme which is open medio-ventrally, and with 3 slit-like spiracular openings (Fig. 2E). Such morphological characteristics are the same given for *Chrysomya bezziana* larvae by Wall & Shearer (1997) and Spradbery (2002).

Permethrin spray was effective in killing the screwworm larvae in the wound and as fly repellent on healthy areas. In addition, diazinon was effective for killing the recovered larvae in the surrounding environments. In cases with deep wounds and to avoid secondary bacterial infections Penicillin-streptomycin was administered. Two doses of doramectin, 15 days apart was administered to all diseased and healthy animals. All the diseased flocks were effective to the prophylactic measures. Similar results were recorded by Moya-Borja *et al.* (1997) who proved that doramectin was 100% effective in preventing the development of the New World screwworm, *C. hominivorax* for 21 days post treatment and showed partial activity at 28 days post treatment. Anziani *et al.* (2000) reported that doramectin provided reduction in myiasis of 90.9% and 83.3% at 12 and 15 days after treatment, respectively, compared to the saline control treatment ($P < 0.0001$). In contrast, there were no significant differences in the number of calves with myiasis between those treated with ivermectin formulations and the saline control.

Treatment of infected animals surgically and medicinally via cleaning of the wound using hydrogen peroxide and povidone iodine 5% and finally sprayed using oxytetracycline spray were effective in the treatment of infested animals. Clipping the area around the wound must be done before treatment. Periodical observation of the infected flocks is essential for rapid detection and treatment.

In conclusion, farm outbreaks represent a significant challenge where infection is an autochthonous particularly under fixed system of management. Infestations generally reflect behavioral, environmental and husbandry factors rather than innate differences in susceptibility. A particularly important feature of the disease in sheep is the ability of *C. bezziana* to invade the intact perineal region of ewes in the absence of overt trauma or haemorrhage which has been repeatedly encountered in the present study. Owner awareness about screwworm myiasis is strongly recommended particularly during spring and winter.

Conflict of interest

The authors declare that they have no conflict of interest.

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