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A Review on Sheep Ked (*Melophagus ovinus*) Infestation: Biology, Epidemiology, Pathogenesis, Economic Impact, and Control

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Abstractc

The sheep ked (*Melophagus ovinus*) is a wingless, obligate, blood-feeding dipteran fly of the family Hippoboscidae that infests sheep worldwide, with its entire life cycle completed on the host. Infestation causes blood loss and anaemia, pruritus, restlessness, fleece and skin damage, reduced growth and carcass weight, and marked downgrading and rejection of skins, resulting in substantial economic losses to sheep production and the tanning industry. Transmission occurs mainly through direct contact, particularly from ewes to lambs, and is modulated by environmental conditions, wool type, host body condition, and management practices. Prevalence and intensity are typically highest in cooler seasons and in long- or dense-wooled breeds, with lambs more heavily infested than adults. Diagnosis relies on recovery and morphological identification of adult keds from the fleece. Control depends largely on chemical acaricides applied by dipping, spraying, or pour-on, together with strategic shearing and improved husbandry; however, high costs, emerging resistance, and concerns about drug residues and environmental contamination limit their sustainability. Integrated, evidence-based control programs tailored to local ecology and epidemiology, supported by surveillance, farmer education, and research into alternative and complementary strategies, are essential to reduce the impact of sheep ked infestation on animal health, welfare, and productivity. Therefore, this review synthesizes current knowledge on the biology, epidemiology, veterinary significance, economic impact, and control of *M. ovinus*.

Introduction

An estimated 42.9 million sheep are raised in different agroecologies and production systems in Ethiopia for various purposes, such as meat production, income generation, and skin production, contributing significantly to the livelihoods of small-scale farmers [1]. However, the contribution of sheep production to the Ethiopian economy is adversely affected by several constraints, including ectoparasites such as sheep keds. The sheep ked, *Melophagus ovinus*, is a wingless dipteran fly of the family Hippoboscidae that feeds on host blood through its piercing mouthparts. Its relationship with the host is intimate and obligatory, and its entire reproductive cycle takes place on the host. The female ked periodically produces a single, fully grown larva, which becomes firmly attached to the wool and forms a puparium [2]. Sheep keds feed on the blood of their hosts, causing blood loss and potentially leading to anaemia [3]. They also cause skin irritation and stimulate scratching, rubbing, and licking, resulting in restlessness, fleece and skin damage, and reduced carcass weight [4].

Furthermore, sheep ked infestation causes the downgrading and rejection of sheep skins [5], thereby adversely affecting productivity and reproductive efficiency [6]. Notably, the epidemiology of sheep ked infestation is influenced by environmental conditions and host factors. Transmission of *M. ovinus* occurs through direct contact with an infested sheep or through contact with environmental materials contaminated by keds that have dropped from infested sheep. Transmission occurs most frequently from ewes to their lambs [7]. Moreover, host factors, such as wool type, appear to be important determinants of infestation rates. Long-wooled breeds appear to be particularly susceptible [8]. In general, the prevalence and intensity of sheep ked infestation are highest during the wet season and lowest during the dry season [9]. Moreover, sheep in poor body condition, those that are improperly fed, and those exposed to cold conditions or debilitating diseases tend to carry heavier infestations because debilitated animals groom themselves less frequently, leaving the keds undisturbed [8].

Sheep ked infestations can have detrimental effects on animal health and productivity and may also contribute to the transmission of pathogenic bacteria and at least one virus associated with a serious sheep disease, bluetongue [10,11]. Small ruminants contribute significantly to household stability and income through the production of meat, milk, skin, and wool, while also fulfilling customary social and religious responsibilities. Sheep are the most dominant small ruminants in Ethiopia, contributing up to 63% of the country's cash income and 23% of the value of food subsistence derived from livestock production [12].

Understanding the ecology and epidemiology of sheep ked infestation, including interactions between the parasite and its host under specific climatic, management, and production conditions, is essential for implementing sustainable sheep ked control programs in grazing sheep [13]. Thus, chemical control and good management practices are important methods for preventing and controlling sheep ked infestation [8]. Therefore, this review aims to provide an

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overview of sheep ked (*M. ovinus*) infestation in sheep, focusing on its epidemiology, effects on sheep health, productivity, and skin quality, as well as available control and prevention strategies.

Insights to The Literature

General Description and Morphology

Melophagus ovinus are wingless, blood-feeding flies. The Family Hippoboscidae includes *M. ovinus* and approximately three hundred species of winged forest flies (also known as louse flies) that infest sheep population [14]. As indicated in **(Figure 1)**, *M. ovinus* are up to approximately 5 mm in length, and are leathery, brownish, hairy, dorso-ventrally flattened with six strong legs with obvious terminal claws and have no wings [15].

Life Cycle

The entire life cycle of the sheep ked is completed on the host, with no free-living stages. Adult female *M. ovinus* mate within hours of emergence from the puparium and, after about fourteen days — the period required for ovarian development, egg production, and hatching to release the larva within the female's abdomen — deposit a single, fully developed larva into the fleece. A female then produces approximately one larva per week for up to fifteen weeks. Each larva is glued to the wool and pupates within a few hours, and the adult emerges after a further three to four weeks and begins to blood-feed. Pupal development is temperature-dependent, with an optimum of 20–30°C, and the life cycle can be completed in four to five weeks [16].

Epidemiology and Host Range

Melophagus ovinus is a parasite of sheep worldwide, although very occasional records exist from other domestic and free-ranging animals. Transmission occurs either through direct contact with an infested sheep — most often from ewes to their lambs, possibly resulting in a gradual transfer of the ked population to the lambs — or through contact with an environment containing adults that have dropped from the fleece [7]. Crowding therefore enhances transmission. Ked numbers on ewes often peak during pregnancy, although the reasons for this remain unknown. Wool type appears to be an important determinant of infestation rates, with long-wooled breeds being particularly susceptible [8]. In general, the prevalence and intensity of keds on sheep are highest in winter and lowest in summer, and highest on lambs and lowest on adult sheep [9]. Fleece type also influences ked populations; lambs are generally infested with young keds, whereas adult sheep carry older ones [7].

Summer shearing removes most or all of the ked population on a sheep. Some keds may fall from the fleece and die, and grooming by the sheep may further reduce ked numbers. *M. ovinus* infestation and distribution are restricted to cooler highlands in hot and humid tropics, with temperature playing a key role in its dynamics [3].

Pathogenesis

The major significance of keds lies in the damage they cause to the fleece and the resulting downgrading of skin value. The activities of adult keds cause irritation, and the sheep's attempts to relieve this may further damage the fleece and reduce production. In addition, very heavy burdens of *M. ovinus* may lead to anaemia through blood

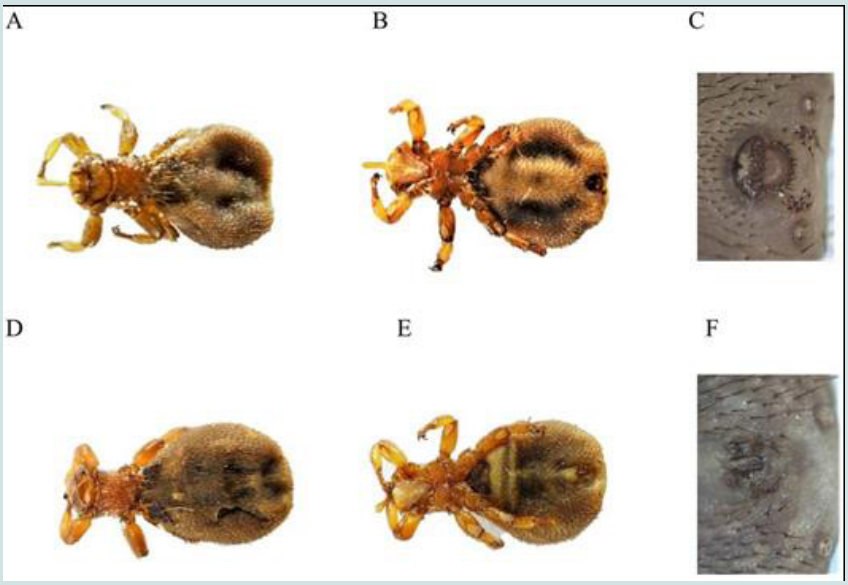


Figure 1: Morphology of sheep ked: Female *M. ovinus* in dorsal (A) and ventral (B) views, and posterior end (C); male *M. ovinus* in dorsal (D) and ventral (E) views, and posterior end (F) (Source: [2]).

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loss [17]. Sheep ked feeding reduces live weight and wool quality and causes restlessness, irritation, severe dermatitis, anaemia, and severe physical harm, while direct injury reduces skin quality [18].

Diagnosis

History and clinical signs may be helpful, but recovery and identification of adult keds from the fleece confirm the diagnosis.

Collection of sheep ked from hosts

Sheep ked specimens are usually obtained from their hosts. It is rarely possible to examine the entire body of a sheep thoroughly, but in some studies the animal is well restrained on the ground or held in a standing position and the whole body is then searched. It is often more efficient to examine a sample of fixed areas of the host, which is particularly useful for sheep ked, as they are known to have preferred predilection sites [19].

Preservation of sheep ked samples

Following proper restraint of the sheep, clinical examination can be performed as described by Kumsa et al. [9]. The skin can be palpated across all parts of the animal for the presence of parasites, and gross lesions suggestive of clinical sheep ked infestation are recorded, with infested animals considered positive [9]. Visual inspection of the skin and wool should also be conducted to detect parasites.

During these physical examinations, the sex, age group, and physical condition of each sampled animal are recorded. Parasites are removed carefully and gently by hand and forceps to avoid damage to the body. Keds collected from their attachment sites can be placed in universal bottles containing 70% alcohol for preservation or transport for further identification [2].

Laboratory identification of sheep ked

Sheep ked can be identified with the naked eye or a simple ×10 magnification hand lens based on their morphological features; a stereomicroscope with low magnification (×10 to ×40, preferably up to ×80) is required [15]. Keds are kept in a petri dish under the preserving liquid for preliminary sorting, as some characteristics, such as the hairy appearance, are frequently best observed when immersed in liquid. For final identification, it is critical to examine keds that are dry and free of glycerol deposits from the preservative; they should be blotted dry with tissue paper. Sheep keds frequently appear dirty when dry, and the best way to clean them is to use an ultrasonic cleaner for 5 minutes while immersed in a water solution containing 5% sodium or potassium hydroxide [3].

Control Methods

Understanding the ecology and epidemiology of the sheep ked, as it interacts with the host in specific climatic, management, and production environments, is required for the successful implementation of rational and sustainable control programs in grazing sheep [13]. Ked infestations may be reduced by shearing and

Table 1: Ways of application of acaricides for control of sheep ked.

Group of Compound	Generic Name	Concentration (%) of Active Substance and Ways of Application			Residual Effect (days)
		Dipping	Spray	Pour-on	
Chlorinated	Toxaphen	0.5	0.75		20-40
Hydrocarbons	CHC	0.75	0.75		30-50
Organic	Coumaphos	0.1	0.1		7
Phosphorus	Trichlorphon			0.15	2
	Quinthiophos	0.08	0.08		4
	Chlorphenvin		0.05		2
	Phos				
	Dioxathion	0.06	0.05		4-7
	Malathion	0.05	0.15		2
	Famphur			2.6mg/Kgbm	4-7
Carbamates	Carbaryl		0.2		
Pyrethroids	Flumethrin	0.5	0.5	0.75	30
Cyclic amidins	Cymiazole		0.03		7
	Amitraz	0.25	0.25		7
Avermectines	Ivermectin			1ml/50 Kgbm	14

Source: [2].

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Table 2: Prevalence of sheep ked infestation in different parts of Ethiopia.

Study Area	Species	Prevalence	Reference
Wogera District	*M. ovinus*	33.57%	[19]
Tigray	*M. ovinus*	6.7%	[22]
Bahir Dar	*M. ovinus*	3%	[22]
Kombolcha	*M. ovinus*	20.1%	[22]
Central Oromia	*M. ovinus*	16.4%	[22]
South Gondar Zone, Northwest Ethiopia	*M. ovinus*	11.6%	[23]

by a wide range of pesticides. Shearing removes many puparia and adults; however, in most cases, efficient and reliable control of sheep ked is based on chemical treatment (acaricide application), which is frequently applied without a local understanding of the appropriate ecology or epidemiology [20]. The most common control methods are briefly described below.

Chemical control

In Ethiopia, the traditional method of controlling sheep ked infestation is the application of acaricides, either by hand spraying or hand dressing. Appropriate and timely strategic control measures are essential to reduce the negative effects of sheep ked [2]. Acaricides are required to control sheep ked infestations (**Table 1**); however, their use is limited by high costs, resistance, and concerns about residues in food and the environment. Thus, decisions should be made on whether to use intensive, strategic, threshold, or other acaricide application systems [21].

Economic Impact

The feeding of keds causes widespread pruritus, exacerbated by rubbing, scratching, and biting in response to the irritation. In young lambs, blood loss to keds may be sufficient to cause patent anaemia, with consequent reduction in growth rates; higher body weights have been recorded in control Merino sheep compared with infested sheep [2]. Sheep ked can affect skin and wool quality by piercing the mouthparts and creating holes in processed skin; feeding may also allow bacteria to pass through the skin, resulting in local abscesses that damage skin quality more severely than the feeding hole itself [12]. According to estimates, one million USD is lost each year in Ethiopia due to the rejection of downgraded skins attributed to sheep ked damage [18].

Current Status of Sheep ked Infestation in Ethiopia

The prevalence of sheep ked infestation has been reported from various parts of Ethiopia over different years. For instance, a prevalence of 33.57% was recorded in Wogera district, while an overall prevalence of 7.55% was reported in Berehet woreda, Tigray region, among sheep reared under the extensive production system. According to Shiferaw [22], the prevalence of sheep ked in different parts of Ethiopia was 6.70%, 3%, 20.10%, 32.57%, 11.67%, 16.40%, and 14.2% in Tigray, Bahir Dar, Gondar, Kombolcha, Tigray region, Central Oromia, and Southern Ethiopia, respectively [22] (**Table 2**).

Conclusions and Recommendations

Sheep ked *(M. ovinus)* infestation remains a persistent and economically important threat to sheep health, welfare, and productivity, and to the tanning industry, while its control is complicated by over-reliance on chemical acaricides, rising costs and resistance. Sustainable reduction of this burden therefore requires a shift from reactive treatment to integrated, evidence-based management. Therefore, the following measures are forwarded as recommendations: (1) implement integrated control combining strategic shearing, targeted acaricide use, and improved husbandry; (2) strengthen surveillance to map prevalence and guide timely interventions; (3) educate farmers and extension workers on early detection, correct acaricide application, and shearing; (4) promote research on alternative and complementary tools, including biological and botanical agents and vaccines; (5) monitor acaricide resistance and enforce rational, quality-assured acaricide use; and (6) foster collaboration among researchers, veterinary services, the tanning industry, and farmer organizations to deliver coordinated, sustainable control programs.

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