Introduction

Goat warble fly infestation (GWFI), improperly named goat hypodermosis, is a myiasis caused by larvae of *Przhevalskiana silenus* Brauer, 1858, an insect belonging to Order *Diptera*, Suborder *Brachycera*, Family *Oestridae*, Subfamily *Hypoderminae*. This myiasis is characterised by the presence of warbles under the skin of the back and flanks of the animals. Its economic impact is severe, nevertheless GWFI is often underestimated because of the difficulties in evaluating the damage to goat production.

Aetiology

Although in the literature documentation on the presence of this parasite dates back to the second half of the nineteenth century, goat warble fly aetiology has remained uncertain till recent times and several entomologists reported the existence of more than one specie. On the basis of the morphological differences the existence of three different species was suggested by Zumpt [1]: *P. silenus* Brauer, 1858, *P. crossii* Patton, 1922 and *P. aegagri* Brauer, 1863. More recently careful morphological analyses [2-4] and gene-enzyme studies [5] indicated that the differences between the three morphotypes (*P. crossi*, *P. silenus* and *P. aegagri*) are biological variations within the specie *P. silenus* (Fig. 1).

![Figure 1. Przhevalskiana silenus: adult recently emerged from puparium.](https://www.ivis.org)

Morphology and Biological Cycle

The adult flies are 8 - 14 mm in length, have large eyes on the head and a grey thorax [4]; they are active from April to June, lack mouth parts, and survive only 5 - 10 days on resources accumulated during the larval period [6,7]. After mating, the females lay about 100 ebony ellipsoidal eggs (0.76 x 0.32 mm), 1 - 4 on each hair [6]; first instar larvae (L1) emerge from the eggs in 5 - 6 days penetrating into the subcutaneous tissue by means of the collagenolytic enzymes of salivary and intestinal glands [8]. L1 have a club-shaped body thinner in the posterior part ending with a pair of spiracles, and is subdivided into 11 segments with spines at the conjunction of segments [9]. At this larval stage the spiracles (breathing organs) have no functions because the larvae are anaerobic.

L1 in the subcutaneous tissue of the back develop into their second and third stage. The third instar larvae (L3) are found in the subcutaneous tissue of the animals’ backs and flanks between the end of December and the beginning of February thus causing warbles (Fig. 2). During its mutation from L2 to L3 the body of larvae (8 x 15-18 mm) becomes dark because of chitin accumulation; the spiracles function as breath organs since the larvae are aerobic in this stage and breathe by means of skin hides produced by collagenolytic enzymes accumulated during migration. The L3 drop on the ground becoming pupae enveloped in a tough barrel structure in which the adult fly develops. The dropping and pupation season of L3 takes place from February
to April according to weather conditions [7]. Studies carried out on the external phase of the parasite life cycle showed that the time needed for the larvae to pupate ranges from 2 to 22 days in the external protected environment; while it takes between 60 - 72 hours under laboratory conditions [10]. The adults emerge from the puparia after reaching the sum of temperature of about 6,500°C in 88 - 90 days in the environment (the sum of temperature is calculated by subtracting 12°C, i.e. the threshold temperature for pupal development, from the temperature at which pupae have been cultured and by multiplying the difference by the number of hours during which pupae have developed) [7].

![Figure 2. Przhevalskiana silenus: larvae in subcutaneous warbles. - To view this image in full size go to the IVIS website at www.ivis.org ](image)

As far as the endogenous phase of the parasite is concerned, Sayin et al. [6] reported a larval migration pattern exclusively inside the body of animals, from the tarsal and femoral regions to the back while Soni [11] and Grunin [2] reported that the first instar larvae emerge from eggs laid directly on the back of the animal and penetrate into the subcutaneous tissue without migrating internally. A recent study has confirmed that *P. silenus* larvae do not migrate in internal organs unlike *Hypoderma bovis* and *H. lineatum* in cattle [12]. Necroscopic observations have also demonstrated that *P. silenus* larvae penetrate directly into the subcutaneous tissue from the site where the eggs are laid.

**Diffusion**

GWFI occurs in many countries: Siberia, Israel, Cyprus, Punjab, Pakistan, Afghanistan, Iran, Iraq, Saudi Arabia, Syria, Turkey, Pamir, former Yugoslavia, Albania, Greece and Italy as recently reviewed by Giangaspero and Lia [13]. In these countries goat breeding is a very important activity not only for meat, milk and cheese production but also because this specie can utilise vast areas of marginal land that is not suitable for other species. In Italy goat breeding is particularly common in the southernmost regions [14], with a flock prevalence rate ranging from 30 to 90% [15].

**Prevalence**

The data on the prevalence of this infestation are fragmentary. In Anatolia (Turkey) the infestation rate ranges from 53 to 94% of flock [6], in Albania it is 24% [16], and in Iraq 22 to 25% [17]. In Italy and in Greece the rate exceeds 70% [18,19].

**Symptomatology and Lesions**

GWFI is characterised by generic symptoms depending on the intensity of infestation and on the number of larvae in the subcutaneous tissue. Goats are restless and do not feed enough; production losses have been reported. First instar larvae migration causes milder lesions than those caused by the presence of third instar in the subcutaneous tissue. Thick walled grubs (2 cm in diameter) appear in the lombo-sacral region of the animals during January and February. A little yellow-red scab forms at the skin holes. A hyalinized and eosinophilic cuff, infiltrated by granulocytes, surrounds L3. After granulocyte infiltration, there may be a second infiltration by lymphocytes, plasma cells, macrophages and giant cells [20]. Histologically, the cavity is formed by granulation tissue in which there are many granulocytes, while externally there is a fibrous and thick wall. If pyogenic bacteria burst into the grubs, a suppurative cavity may form, in which the L3 is immersed in a pus-like liquid [20].

**Economic Losses**

Economic losses have been reported (body weight loss, growth retardation, decrease in milk/meat production, carcass depreciation) although studies on milk/meat production decrease and hide damages have never been carried out. In Iraq, the tanning industry has met with severe losses due to the holes in animals' hide [17] (Fig. 3).
Greek researchers have provided some data concerning weight loss caused by this myiasis: over a period of 133 days, the average weight measured in infested goats was about 2.6 ± 1.3 Kg lower than the average weight of non-infested goats [21].

**Clinical Parasitological Examination**

Goat warble fly diagnosis is performed by palpating the back of animals in January - February; it is possible to detect 15 - 20 mm long and 8 - 9 mm wide grubs, with a respiratory hole covered by dried exudate. The L3 can be pulled out by a slight pressure on the lower part of the grub or by hydrogen peroxide instillation.

**Serological Diagnosis**

In the past few years, on the basis of the knowledge acquired on bovine hypodermosis immunology [22,23] and the antigenic similarities between *H. lineatum* larvae and other larvae causing myiasis, the ELISA technique has been used to assess: a) the presence of a serological cross-reactivity between *H. lineatum* antigen and anti-*P. silenus* antibodies [24], b) the correlation between the kinetic development of anti-*P. silenus* antibodies and the natural course of infestation in naturally infested goats [24]. More recently the possibility of employing a Bovine Hypodermosis ELISA-kit (Vétoquinol Diagnostics France) for the immunological diagnosis of goat warble fly infestation on serum and milk samples has also been reported [25].

Immunological studies carried out on naturally infested goats in Southern Italy demonstrated that there is a good correlation between serological results and parasitological status. The highest anti-*P. silenus* antibody concentration was found from October through December [24,25]. These months are a favourable sampling period for early serological diagnosis and are the best time to institute treatment against the parasite when the larvae have not yet damaged the animal’s hide.

**Prophylaxis and Therapy**

Many molecules have been tested for chemical prophylaxis: trichlorphon [26], famphur [27], and recently ivermectin [28] and doramectin [29]. In 1976, Sayin et al. [30] carried out two trials; animals sponged with trichlorphon (50 mg/Kg) showed an infestation reduction of 57 - 92% in December and of 63 - 99% in January. Trichlorphon administered *per os* (at same dose) three times/month starting in September, produced an infestation reduction of 93% in 1972 and of 74% in 1976. These data show that organophosphoric agents used to treat goat warble fly infestation are less effective than for bovine hypodermosis.

The efficacy of ivermectin on *P. silenus* natural infestation has been evaluated in Italy by Tassi et al. [28]. In October 1985, 61 animals were treated with a single subcutaneous administration (50 µg/Kg, 100 µg/Kg, 200 µg/Kg); none of these animals proved to be infested at the parasitological examination in February of the following year. Recently, trials carried out in Pakistan showed that ivermectin (200 µg/Kg) is 100% effective against *P. silenus* infestation [31]. Microdosed doramectin has also been tested [29], and it proved to be very effective in preventing *P. silenus* infestation.

**References**


25. Otranto D, Boulard C, Giangaspro A, Caringella MP, Rimmele D, Puccini V. Serodiagnosis of goat warble fly infestation by Przhevalskiana silenus with a commercial ELISA Kit. Vet Rec, 1999b; 144 (26):726-729. - PubMed -


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