Inventory and identification of ectoparasites lice on sheep in the Magetan regency, East-Java

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Abstract. Sheep are farm animals that have long been cultivated and become abundant food resources for humans. Sheep are particularly susceptible to ectoparasite attacks. One of ectoparasites that could infect sheep is lice, it can reduce the production of meat and decrease quality of leather and fleece. Therefore this research aims to inventory, identify, and study the existence of lice in sheep. Lice samples were collected in four districts in Magetan i.e Karas, Parang, Panekan, and Plaosan. Preparations of lice were done by whole-mount with Hoyer's solution. Results showed that species of lice infesting sheep in four districts in Magetan was Damalinia ovis. The prevalence value of D. ovis infested sheep was 100%, it means that all examined sheep were infested by D. ovis. The largest prevalence value was found on the sheep body (77.86%). The number of individual D. ovis found was not affected by the altitude, air temperature, and humidity.

Keywords: ectoparasites, Damalinia ovis, infestation, production

1. Introduction
Sheep are farmed animals for a long time and become one of the food resources for humans. Sheep were classified into the Family of Bovidae, Genus Ovis, and Species Ovis aries [1]. There are three types of sheep in Indonesia where can grow and develop well i.e., thin-tailed sheep, thick-tailed sheep, and Garut or Priangan sheep [2]. Some provinces in Indonesia are suitable areas for sheep farming. Besides West Java and Central Java, East Java is one of the provinces in Indonesia that has great potential to be used as sheep farming [3]. One area in East Java with the potential to be used as sheep farming is the Magetan Regency [4]. Geographical location and environmental conditions of the Regency are suitable for sheep farming. Its geographical location is in the lowland area of Mount Lawu called the Lawu green belt (Lawu green circle). It consists of mountainous regions and lowland areas. The air temperature in the mountainous region ranges from 16-20°C, while in the lowland areas ranges from 22-26°C [5]. This cool air temperature is suitable for farming the sheep.

The growth and development of sheep was influenced by several environmental factors, such as temperature and humidity. Sheep has a thermoneutral zone (TNZ) where is an area with a comfortable ambient temperature for life. The TNZ i.e., 29- 30°C for newborn sheep, 22-31°C for relatively mature sheep. Humidity of 60-70% is optimal for sheep reproduction [6]. The main production of sheep farms is lamb meat, whereas its by-products such as skin and fleece have begun to be utilized in other industries [7]. Sheepskin and fleece are susceptible infected by several types of ectoparasites which can cause disease [8].
Ectoparasites are invertebrates living outside and depend on the host's body. Ectoparasites found in the body of sheep are lice [8] that are members of blood-sucking insects [9]. Lice can grow and develop in many species of animals, not only sheep [8]. The ectoparasite infected a sheep can reduce meat production and quality of wool produced [10]. Sheep infested by lice has characteristics, such as the color becomes more yellow for white-haired, more dreadlocks, and the decline of wool production [11]. Some authors reported lice infecting sheep were Damalinia ovis, Linognathus pedalis, and Linognathus ovillus [17, 18, 19]. In Indonesia, information about ectoparasite lice in sheep is not fully known. This study aims to inventory, identify, and measure the prevalence of ectoparasite lice in sheep at the Magetan Regency, East Java.

2. Materials and methods

2.1. Sampling of ectoparasite lice
Sampling of ectoparasite lice were carried out in four subdistricts in the Magetan Regency, East Java i.e., Parang (7.7046°23'S and 111033°49'E), Panekan (7.616°26 "S and 111029°67"E), Plaosan (7.6083°79"S and 111025°14 "E), and Karas (7.34°20"S 111022°50"S) in January-March 2015. Sampling were conducted around 10.00am-14.00pm. Ectoparasite lice were collected from 39 individuals of sheep i.e., Karas (10 individuals), Parang (9 individuals), Panekan (12 individuals), and Plaosan (8 individuals). We observed about one hour per sheep from various body parts, i.e., head, body, legs, and tail. Collected lice then were stored in tubes containing 70% ethanol and labeled. The environmental parameters recorded at the time of sampling i.e., the altitude, the air temperature, and the humidity by using Eiger Digital Compass art ILL01.

2.2. Slides preparation and specimen identification
Preparations and identification of lice was carried out in the Microtechnic Laboratory, Biosystematics and Animal Ecology Laboratory, Department of Biology, IPB University, Bogor. Lice preserved in 70% ethanol and rehydrated with 50% and 30% ethanol, then soaked in 10% KOH for 1-1.5 hours to dilute the chitin layer. Thereafter, lice were placed on the object-glass and dropped with Hoyer’s solution (2-3 drops) and covered with a cover glass [15]. The Hoyer’s solution consists of 25 ml distilled water, 15g Arabic gum, 100 ml chloral hydrate, and 10 ml glycerin. The object-glass with specimen then was placed on the hot plate for one week. Specimen identification based on the identification key for family [13] and species [14]. The specimen then was measured for its body parts, such as the head length and width and the length of the thorax, abdomen, antenna, and legs.

2.3. Data analysis
The presence of lice in sheep was calculated as the prevalence value (P) [16] that showed the percentage of sheep infested by lice. The relationship between the number of lice infested on sheep with environmental factors i.e., the altitude (m asl), the air temperature (°C), and the humidity (%) were analyzed by Spearman’s correlation using Past Statistics program.

3. Results and discussion

3.1. Ectoparasite lice in sheep
Results showed that all 402 individuals of ectoparasite lice collected was D. ovis. The lice were characterized by a segmented body coated by a chitin layer. The character belongs to arthropods. Body of D. ovis consists of three parts, i.e., head, thorax and abdomen as the main characteristics of Insecta Class (figure 1a). The lice belong to Pterygota Subclass, but their wings reduced and do not have additional appendages in the abdomen. The lice have a simple metamorphosis and no pupae phase was found and belong to Exopterygota division [13]. The lice were characterized by small-size (1.73-1.87 mm) and dorsoventral flat-shaped body.
The head is rounded and larger than thorax with head lengths ranged 0.38-0.39 mm and width ranged 0.36-0.37 mm (figure 1b). They have a pair of antennas that do not exceed the length of the head. These characteristics belong to Order of Phthiraptera [13]. They have a pair of filiform antennae consisting of 3 segments (size 0.28-0.31 mm) and a pair of mandible without maxilla in the mouth that serves to bite vertically (figure 1c). These characteristics belong to Ischnocera Subordo. The lice found in sheep have one claw that belongs to Trichodectidae family [13].

![Figure 1](image1)

**Figure 1.** Morphology of *D. ovis*: (a) full body, (b) head, and thorax (c) mouth parts, (d) abdominal parts.

Trichodectidae family consists of three genera, i.e., *Felicola*, *Tricodectes*, and *Damalinia*. Genus *Damalinia* characterized by the rounded head front, the enlarged 1st and 3rd segments of the antenna and the abdomen with brown transverse-lines in adults. Genus *Damalinia* consists of three species, i.e., *D. bovis*, *D. caprae*, and *D. ovis*. Species of *D. ovis* has a specific host in sheep. In addition, *D. ovis* has head size larger than the thorax and the body is longer than that of the other species [14]. The thorax consists of three segments, i.e., the first two segments were converged, while between the segment and the 3rd one separated by a boundary (figure 1b). The thorax has 0.19-0.23 mm length and 0.29-0.32 mm width and each segment has a pair of legs. Each leg consists of 5 segments, i.e., coxa, trochanter, femur, tibia, and tarsus with a claw (figure 1b). Pair of legs have different sizes i.e., the 1st legs (0.4-0.45 mm), the 2nd legs (0.5-0.55 mm), and the 3rd legs (0.6-0.65 mm). The abdomen consists of 11 segments and 1st-2nd and 9th-10th segments are fused. The abdomen has 1-1.4 mm length and 0.6-0.7 mm width. The border among body segments there are rigid setae on the lateral part (figure 1d). The lateral part of the 4th-9th segment have spiracles which functions as a ventilator. There are brown ventral lines on the abdomen that extends posteriorly in adult lice (Figure 1d).

*D. ovis* is an obligate ectoparasite on sheep. All life cycle of the lice only in one host (sheep) [17]. The lice have a simple metamorphosis, i.e., egg, nymph (1-3 instars), and adult [12]. The eggs have no color and tend to be transparent (figure 2) [18]. Females of *D. ovis* lay eggs with rarely 12 mm from the skin. Eggs require 9-11 days to hatch as nymph [19]. The nymph shape is like an adult. The development of nymph-1 is about 7 days after hatching and takes 5 days to develop into nymphs-2.
The nymph-2 takes 9 days develop to nymph-3 and nymph-3 takes about 4 days to imago (adult) and ready to lay eggs [20].

In this study, we found all phases of *D. ovis* life cycle (figure 2). Body size of nymph-1 ranges 1.1-1.2 mm, nymph-2 ranges 1.4-1.5 mm, and nymph-3 ranges 1.6-1.7 mm (figure 2d). The nymph phase can be identified by the size and color of the body [21]. In older nymph, body size is bigger and has a brown color by thickening of chitin layer. The adult has a body size of 1.73-1.87 mm with a brown head and brown line on the dorsal part of the abdomen (figure 2). The female has a larger size than the male and has an ovipositor. The female laid two eggs in three days. Under normal conditions, life cycle of *D. ovis* occurred in 34-36 days [22].

![Figure 2. Simple metamorphosis of *D. ovis* i.e. egg, nymph-1, nymph-2, nymph-3, adult.](image)

3.2. Prevalence of *D. ovis* on sheep

All examined individuals of sheep (39 individuals) were infested by *D. ovis* (prevalence value was 100%). The high prevalence of *D. ovis* infestation was due to poor hygiene of the sheep. In this condition, the animal were rarely or never shaved causing the lice to reproduce more easily. Lice population was growing slowly after shaving and took about 3-5 months to increase population [12]. The main product of sheep in the Magetan regency is meat (not fleece), so the farmer has less concerned about sheep hygiene. In addition to the hygiene of sheep as the lice host, the population of *D. ovis* also was influenced by environmental factors [23].

The highest number of *D. ovis* was found in the body of sheep (78%) (figure 3). Other authors have also reported the ectoparasite in a high number in the sheep body [21]. However, *D. ovis* was also found in the head and legs. The existence of *D. ovis* on the head and legs were only temporary i.e., at the beginning of infesting on sheep since it has thinner fleece than the body. The Lice will then move from one to another sheep and disperse easily. The transfer of lice mostly through body contact among the sheep [24]. There are two other species of lice commonly found in sheep, i.e., *Linognathus ovillus* in the head and *Linognathus pedalis* in the legs [25]. This study only found one species, *D. ovis*. 


Two other species of lice *L. pedalis* and *L. ovillus* were not found in the observed area may be caused by inappropriate environmental conditions. Most of the areas sampled had temperature below 30°C. The optimal reproduction of *Linognathus* genera occurred in temperature below 30°C [26]. In addition, the head and legs of the sheep examined have thinner fleece, so lack of protection against environmental changes. In contrast to *D. ovis*, which is in the body with thick fleece, it will be far more protected from environmental changes.

**Table 1.** Environmental factors of sampling location

| Location | Altitude (masl) | Temperature (°C)* | Humidity (%)* |
|----------|-----------------|-------------------|---------------|
| Karas    | <100            | 29.3 (27.7-30.3)  | 66.6 (64-69)  |
| Parang   | 100-500         | 26.6 (25.4-27.3)  | 68.2 (67-69)  |
| Panekan  | 500-1000        | 26.4 (26.0-27.9)  | 69.1 (65-75)  |
| Plaosan  | >1000           | 24.6 (23.9-25.8)  | 79.0 (77-81)  |

*The value in the range showed minimum and maximum

The measurement environment factors that the lowest altitude and humidity were in Karas Subdistrict, while the highest altitude and humidity were in Plaosan District. The highest air temperature occurred in Karas Subdistrict and the lowest air temperature occurred in Plaosan District (table 1). Spearman's correlation analysis showed that the altitude (r=-0.194, p=0.314), the air temperature (r=0.149, p=0.440), and the humidity (r=-0.236, p=0.218) were not correlated with the number of lice. These results are different from James *et al* [21] and James *et al* [23] that found the temperature and humidity greatly affect the number of lice that infested on sheep. The result differences may be due to the differences in the characteristics of the research locations. In four-season countries, like Australia and United State, the temperature and humidity affect greatly the lice populations. In such countries, temperature changes drastically from one to another season [27]. Whereas, in countries with tropical climates, changes in the temperature and humidity between the dry and rainy seasons do not differ significantly and does not affect the lice population on sheep.

**4. Conclusion**

Ectoparasitic lice found on the sheep at the Magetan Regency was *D. ovis*. The prevalence value of sheep infected by *D. ovis* was 100%. The highest individual number of *D. ovis* (77.86%) infected in the body part of the sheep. The altitude location, air temperature, and humidity of the location did not significantly affect the number of *D. ovis* infected on sheep.
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