POPULATION DYNAMICS AND MORPHOLOGICAL IDENTIFICATION OF LICE IN COMMERCIAL LAYER CHICKEN

A Thesis

By

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CERTIFICATE

This is to certify that the thesis entitled "Population Dynamics and Morphological Identification of Lice in Commercial Layer Chicken" submitted to the Department of Microbiology and Parasitology, Sher-e-Bangla Agricultural University, Dhaka, in partial fulfillment of the requirements for the Degree of Master of Science in Parasitology, embodies the result of a piece of bona fide research work carried out by Sumaiya Islam, Registration no.14-05821 under my supervision and guidance. No part of the thesis has been submitted for any other degree or diploma.

I further certify that any help or source of information, received during the course of this investigation has been duly acknowledged.

Dated:

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The Author

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ACRONYMS AND ABBREVIATIONS

ABBREVIATION		FULL MEANING
MS	=	Master of Science
et al.	=	And others/Associates
<	=	Less than
P	=	Probability value
DLS	=	Department of Livestock Services
Linn.	=	Taxonomist, Linnaeus
±	=	Plus-minus sign
≈	=	Almost equal to
i.e.	=	id est (that is)

POPULATION DYNAMICS AND MORPHOLOGICAL IDENTIFICATION OF LICE IN COMMERCIAL LAYER CHICKEN

ABSTRACT

Poultry is a promising sector in Bangladesh that is growing at a rapid pace and has grown to become the most important and advanced segment of the livestock sector in the country. Commercial poultry is infected with a variety of parasites. As a result, the goal of this research was to look into the population dynamics and morphological identification of lice in commercial poultry farms of Kishoreganj, Gazipur, Mymensingh, Tangail and Narsingdi. From November 2020 to April 2021, a total of 245 layer chickens were examined for lice infestation. All the lice were identified microscopically at the Laboratory of Microbiology and Parasitology. A total of 149 chickens (60.81 %) were infested with lice out of 245 evaluated. During the study, four lice species were identified: *Menacanthus stramineus*, *Menopon gallinae* from sub-order Amblycera and *Gnoiocotes gallinae*, *Lipeurus caponis* from sub-order Ischinocera. Among them, *M. stramineus* was the most prevalent species (60.78%) detected in breast and thigh, followed by *M. gallinae* (49.02%) in body feathers, *L. caponis* (34.90%) in wing feather and *G. gallinae* (15.03%) in fluff. The highest prevalence of lice was found in Gazipur (83.93%) followed by Mymensingh (80.65%), Tangail (72.73%), Narsingdi (66.67%). No lice were detected in Kishoreganj. This research strongly suggests that poultry lice are a major problem in commercial poultry chicken. It is indeed necessary to develop an effective control measure to improve output of commercial poultry in Bangladesh.

Keywords: Population dynamics, Morphological identification, Lice, Commercial poultry, Bangladesh.

CHAPTER I

INTRODUCTION

Poultry is the most important and advanced segment of the livestock sector in Bangladesh, making it interesting for both domestic entrepreneurs and foreign investors. The sector accounts for 14% of the total value of livestock output and is growing rapidly (Raihan and Mahmud, 2008). The poultry sector is now playing a significant role in creating employment opportunities, improving food security, livelihood and nutrition, as well as contributing to the country's economic growth, and reducing poverty in this country. It is an integral part of the farming system in Bangladesh and has created direct, indirect employment opportunities including support services for about 6 million people (Ansarey, 2012).

Poultry is an economic and effective source of animal protein, playing a vital role in narrowing down the animal protein supply gap. In recent years, the poultry sector in Bangladesh has gained sufficiency against the current market demand (Raha, 2013). It is reported that poultry meat alone contributes 37% of the total meat production in Bangladesh (Hamid *et al*., 2016). Again, poultry contributes about 22-27% of the total animal protein supply in Bangladesh (Prabakaran, 2003). Most poultry species raised in Bangladesh are chickens (90%), ducks (8%), and other species such as quail, pigeons, and geese (2%) (Das *et al*., 2008). Over the years, the demand for poultry products in Bangladesh has grown significantly. Per capita consumption per year increased to 8.5 kg of poultry meat and 104 pieces of eggs in 2019 (DLS, 2019). However, poultry production needs to increase significantly in Bangladesh to meet the growing domestic demand.

Poultry can easily be infected with several types of bacterial, viral, fungal and parasitic diseases (Soulsby, 1982). Ectoparasites of poultry live on the skin or penetrate within the skin or even into the air sacs, and some live under the feathers. These ectoparasites consume dead cells of skin and tissue fluids, while others suck blood (Phillip, 1963; Urquhart, 1987).

Lice are an important ectoparasite of poultry that causes ill health in poultry and causes heavy morbidity by sucking blood and causing irritation to the birds, which adversely affects the production of poultry (Edgar and King, 1950). The lice reduce hemoglobin and erythrocyte values and hyperchromic anemia of chickens (Jungmann, 1970) of chicken. Lice infestation causes weight loss at the rate of about 711 gm per bird, and decreases the egg yield at the rate of about 66 eggs per bird in a year (El-Kifl *et al*., 1973), and sometimes, lameness is associated with heavy lice infestation (Okaeme, 1989), the infested birds are emaciated, indicated by the prominence of the keel bone, and atrophy of thigh muscle. The affected birds show rough plumages, and the skin palp consists of plenty of dandruff. Petechial hemorrhages may develop on the skin of birds with severe infestation with lice (Shanta *et al.*, 2006).

Although poultry lice are not known to transmit in any avian pathogens, the presence of lice frequently accompany poor health that attribute to other causes, and it is especially harmful to young birds where high number of lice may cause sleep disruption (Audi and Asmau, 2014). Amblyceran lice may cause irritation to the skin, restlessness, overall weakening and cessation of feeding (Mishra *et al.,* 2017). Therefore, there is loss of weight, inferior laying capacity, and skin lesions that may become the site for the secondary infections (Mullen and Durden, 2002). *Menacanthus straminieus* and *Menacanthus cornutus* Schommer may cause anemia, heavy multi-focal lesion or even death of infested birds (Njunga, 2003; Prelezov *et al*., 2006). Chewing lice living on feathers such as Ischnocerans, although causing damages to feathers, affect their host much less than the Amblycerans (Murlen and Durden, 2002 and Price *et al*., 2003).

There are a number of a species of lice infesting poultry. These include *Menacanthus stramineus, Menacanthus cornutus, Menacanthus pallidulus, Menacanthus cornutum, Menacanthus numidae, Cuclotogaster heterographus, Cuclotogaster occidentalis, Columbicola colombae, Lipeurus lawrensis tropicalis, Lipeurus caponis, Lipeurus tropicalis, Lipeurus heterographus, Menopon gallinae, Goniocotes gigas, Goniocotes hologaster, Goniocotes gallinae, Goniocotes hidentatus, Goniocotes bidentatus, Goniodes gigas, Goniodes dissimilis, Goniodes pavonis* (Khan *et al*., 2003).

The most common and economically important louse to both chickens and turkeys is *Menacanthus stramineus*, the chicken body louse. It punctures soft quills near their

base or gnaws the skin at the base of the feathers, and feeds on the blood. Chickens are less commonly infested with *Menopon gallinae* (on feather shafts), *Lipeurus caponis* (mainly on the wing feathers), *Cuclogaster hetrographus* (mainly on the head and neck), *Goniocotes gallinae* (very small in the fluff), *Goniocotes gigas* (the large chiken louse), *Goniocotes dissimilis* (the brown chicken louse), *Menacanthus cornutus* (the body louse), *Uchida pallidula* or *Oxylipeurus dentatus* (the small body louse). The heavy population of the chicken body louse decreases reproductive potential in males, egg production in females, and weight gain in growing chickens. The skin irritation also provides sites for secondary bacterial infections (Khan *et al*., 2003).

Incidence remains distinctly higher on older birds, the prevalence being distinctly higher during the summer months (Saxena *et al*., 1995). The major outbreaks of lice infestation occur in the hot dry period of February-May (Fabiyi, 1980). *Lipeurus caponis* infestations were diagnosed in April, July, August, November in Bangladesh (Islam *et al*., 1999). The optimum temperature for the development of *Manacanthus stramineus* is 37.7– 41.5ºC (Brown, 1970). *Menacanthus pallidulus, Menopon gallinae, Goniodes dissimilis* and *Goniocotes gallinae* were most abundant on the back region of the host, and *Lipeurus caponis* on the wing feathers (Manuel and Anceno, 1981).

Lice infestation in the commercial layer reduces egg production, which causes economic losses (Edgar and King, 1950). Unfortunately, there are very few works in Bangladesh on the prevalence and morphological identification of lice in the commercial layer. Keeping all the points mentioned above, the present piece of research work was undertaken with the following objectives.

- To study the detailed morphological properties of different lice species affecting the commercial layer chicken,
- To determine the prevalence of different species of lice infestation in the commercial layer chicken.

CHAPTER II

REVIEW OF LITERATURE

2.1. Prevalence of poultry lice around the world

Abafaji (2017) conducted an experiment in Kersa district of Jimma zone, Ethiopia and results revealed that three species of lice of the genus *Mallophaga* were identified. Experiment results also concluded that *Menopon gallinae* had the highest prevalence (46.7%) followed by *Menacanthus stramineus* (30%) and *Cuclotogaster heterographus* (16.7%).

Abdullah and Mohammed (2013) conducted a study on 65 local adult chickens (*Gallus domesticus*) to investigate macro and microscopically presence of external and internal parasites and their prevalence in the Sulaimani Region-Kurdistan/Iraq. Results showed that 90.77 % out of total examined chickens were infested with ectoparasites, out of that 81.36 % (48/59) were infested with lice where *Menacanthus stramineus* prevalence was 72.92% followed by *Goniocotes gallinae* 54.17%, *Menopon gallinae* 37.5%, *Goniodes gigas* 39.58%, *Cuclotogaster heterographus* 10.42%.

Arya *et al.* (2013) conducted an investigation to determine the prevalence of *Menopon gallinae* Linn. (Insecta, Phthiraptera, Menoponidae, Amblycera) upon poultry birds (*Gallus gallus domesticus*) of the selected locality of district Chamoli Garhwal (Uttarakhand), India. The study result concluded the hat Prevalence and intensity of infestation of *Menopon gallinae* (Linn.) was recorded from 688 poultry birds belonging to 30 selected locality of district Chamoli (Uttarakhand) from March 2012 to February 2013, out of which 310 were found infested (45.06%). They also reported that the prevalence rate was higher in female (46.8%) than male (42%) birds during the investigation.

Audi and Asmau (2014) conducted a study on the prevalence of bird lice in four selected farms in the Kano metropolis to determine the lice species richness, lice abundance and percent prevalence in the four poultry farms. Two hundred and forty (240) birds were examined from four poultry farms within Kano in Tofa, Fagge, Brigade and Gwarzo area respectively, during the month of February-March, 2013.

The study results revealed that the louse prevalence and mean abundance varied significantly (P<0.001) among the four Poultry farms examined with *Menacanthus cornutus* having 85.5% was more prevalent than *Goniodes gigas* (14.5%).

Fabiyi, *et al.* (2017) conducted a systematic survey during two consecutive years, August 2009 to July 2011, to study the prevalence, abundance and seasonal fluctuations of ectoparasites of turkeys in Sokoto and its environs. The results based on examination of 265 birds, revealed a high prevalence of four louse species (Phthiraptera: Ischnocera and Amblycera): *Lipeurus tropicalis* (78%, hitherto unknown from turkeys), *Menacanthus stramineus* (48%), *Goniocotes gallinae* (35%), and *Chelopistes meleagridis* (33%).

Kanshal and Singh (2014) conducted a study to observe the frequency and density of ectoparasites affecting Broiler chicken of the Meerut region. The study result concluded that the prevalence of *Menacanthus stramineus* was 3%, *Menacanthus cornutus* was 14%, *Lipeurus lawrensis tropicalis* was 22%, *Goniocotes gallinae* was 15%, *Goniocotes dissimilis* was 8% during the study.

Khan *et al.*, (2003) reviewed the studies on the prevalence, chemotherapeutic and biological control of lice. They found that *Menacanthus stramineus*, *Menopon gallinae*, *Goniodes gigas*, *Goniocotes gallinae*, *Lipeurus lawrensis tropicalis*, *Lipeurus caponis* and *Cuclutogaster heterographus* were the most commonly infesting lice of poultry.

Koroglu *et al.* (1999) examined 600 chickens and found that 56.5% of birds were infested with one or more species of lice in Turkey.

Kumar *et al.* (2004) determined the population composition of six phthirapteran ectoparasites infesting on 50 domestic hens, at different levels of infestation. Results revealed that an average of 357.4 *Menacanthus cornutus*, 402.1 *Lipeurus caponis*, 206.2 *Lipeurus lawrensis tropicalis*, 150.5 *Lipeurus heterographus*, 384.7 *Goniocotes gallinae* and 57.4 *Goniodes dissimilis* have been encountered on poultry birds of Rampur (India).

Lancaster and Meisch, (1986); Wall and Shearer, (2001) reported that *Menacanthus stramineus* has been commonly ranked as the commonest and most prevalent louse of turkeys.

Mansur *et al.* (2019) conducted a study on biodiversity and prevalence of chewing lice on local poultry (*Gallus gallus domesticus*, family: Phasianidae) in five selected sites around Qaser Bin Ghashir region, Libya between November 2017 and April 2018. The total investigated chicken samples are 135, and the infected samples were found to be 94. The obtained results show that Asuani has the lowest amount of ectoparasites, while Suq AL-kamees samples were infected completely by 100% prevalence of chewing lice. Three species of lice were detected and identified on the local poultry, *Menopon gallinae*, *Menacanthus stramineus* and *Lipeurus caponis*. The most abundant species in the study area is *Menopon gallinae* with a prevalence of ≈ 69.84%.

Martinez *et al.* (2001) reported that 91% poultry were affected with ectoparasites in Venezuela.

Mukaratirwa (2012) carried out a study on the prevalence of chewing lice in free-range chickens from selected rural localities of Kwazulu-Natal, South Africa. *Goniode sgigas, Menopon gallinae, Goniocotes gigas, Lipeurus caponis, Cuclotogaster heterographus* were recorded and most prevalent species across the four localities were *Menopon gallinae* with a mean prevalence of 96.8% followed by *Goniocotes gigas* 57.0% and *Goniodes gigas* 56.4%.

Nadeem *et al*., (2007) conducted an experiment to find out the influence of some epidemiological determinants on the prevalence of louse infestation on layers in Faisalabad (Pakistan). They were screened seventy layer farms to determine the prevalence of louse infestation and its determinants including the age of the bird, availability of space per bird and frequency of litter change. Experiment results concluded that the prevalence of *Lipeurus caponis* was the highest (53.2%), followed by *Menacanthus stramineus* (22.16%), *Goniodes dissimilis* (12.37%) and *Goniodes gallinae* (12.37%). They also reported that older birds (36 to 74 weeks of age) were found with a significantly higher prevalence of louse infestation than younger birds

and the month-wise prevalence of louse infestation was higher during the summer months (from April to August) and at older age.

Nandi and George (2010) conducted an investigation to identify and estimate the prevalence of ecto and endoparasites of village chicken between April and July 2008 in three local councils of Enugu state, Nigeria. A total of 1038 chickens comprising of 468 chicks, 207 growers and 363 adults were examined during the house to house survey for ectoparasites, gastrointestinal helminths and coccidia infections. Investigation results concluded that 41% were infected with ectoparasites with 62.2% lice prevalence.

Prelezov and Koinarski (2006) studied on the species variety and population structure of Mallophaga (Insecta: Phithiraptera) on chickens in the region of Stara Zagora. From 1994-2003, a total of 647 birds from both genders in the region were studied. Study result reported 4 species of lice infestation. Among them *Menopon gallinae* was 35.9% of all identified Mallophaga followed by *Goniocotes gallinae* (25.8%) and *Eomenacanthus stramineus* (23.3%), while *Menacanthus cornatus* had the lowest share of occurrence (15.0%).

Saikia *et al.* (2017) carried out a prevalence study to assess the ectoparasitic infestation of pigeon in Assam, India. Study result showed the overall percentage of ectoparasite infestation being 39.78%. Five species of lice infestation were recorded. Among them *Menopon gallinae* prevalence was 4.62%, *Lipeurus caponis* 2.16%, *Goniocotes gallinae* 1.85%, *Menacanthus stramineus* 2.77%, *Goniodes gigas* 1.23% and *Pseudolynchia canariens* is 15.12%.

Salam *et al.* (2009) carried out a study of ectoparasites for a period of two years from January 2005 to December 2006 in rural free-range chicken purchased from different areas of Kashmir valley. Screening of a total of 478 birds revealed only lice infestation with an overall prevalence of about 100% and 97.69% birds harboring multiple species. The prevalence for various species of lice, during winter, spring, summer, autumn and overall prevalence respectively, was 90.32%, 99.14%, 100%, 98.34% and 96.86% for *Lipeurus caponis*; 33.87%, 48.71%, 57.75%, 39.66% and 44.76% for *Goniodes gigas*; 29.83%, 32.47%, 45.68%, 32.23% and 34.93% for *Menopon gallinae*; 28.22%, 32.47%, 39.65%, 32.23% and 33.05% for *Menacanthus*

cornutus; 16.12%, 19.65%, 25%, 18.18% and 19.66% for *Goniocotes gallinae* and 6.45%, 12.82%, 13.79%, 4.95% and 9.41% for *Eomenacanthus stramineus*.

Santos *et al.* (2011) conducted an experiment to identify the species of chewing lice (Mallophaga) at different body sites in chickens (*Gallus gallus*), in isolated and mixed rearing systems, and to determine the dynamics and structure of the louse populations collected. The prevalence was 100 and 35% for chickens in the isolated and mixed systems, respectively. The species recorded were: *Menopon gallinae*, *Menacanthus stramineus*, *Goniodes gigas*, *Goniocotes gallinae* and *Lipeurus caponis*. The chickens in the isolated system presented more lice than did the ones in the mixed system. The most prevalent species were *Menopon gallinae* (30.58 and 62.31%) and *Lipeurus caponis* (29.12 and 14.49%), in the isolated and mixed systems, respectively.

Saxena *et al.* (2007) were undertaken a study to determine the rate of population expansion of an Ischnoceran Phthiraptera, *Goniocotes gallinae* (infesting the domestic fowl, *Gallus gallus domesticus*), on the basis of in vitro and in vivo studies. Result showed that the values of the gross reproductive rate (12.49 female eggs/female), net reproductive rate (8.31 female eggs/female), mean length of generation (36.91 days), precise generation time (35.65 days), finite rate of increase (1.06 female/days), and intrinsic rate of natural increase (0.059) of *G. gallinae* were determined.

Shanta *et al.* (2006) conducted an experiment to study the prevalence of ectoparasites and their clinicopathological effects on backyard poultry. 300 poultry of both sexes and different ages were examined in different areas of Patuakhali district from July 2005 to May 2006. Among them, 86.67% of poultry were infested with one or more species of ectoparasites. Experiment results showed the prevalence of six species of lice such as *Menacanthus stramineus* (74%), *Menopon gallinae* (63%), *Lipeurus caponis* (48%), *Cuclotogaster heterographus* (25%), *Goniodes gigas* (18%), and *Goniocotes gallinae* (14%). Among these, *Menacanthus stramineus* was the most common.

Sychra *et al*., (2008) examined one hundred and sixty chickens (*Gallus gallus*) from 31 small, private backyard flocks in the eastern part of the Czech Republic chewing lice (Phthiraptera: Amblycera, Ischnocera). Result showed that at least one species of chewing lice were found on every bird examined. Seven species of chewing lice were

identified in all; they had the following prevalence and mean intensities: *Goniocotes gallinae* (100%; 110 lice), *Menopon gallinae* (88%; 50), *Menacanthus stramineus* (48%; 17), *Lipeurus caponis* (35%; 12), *Menacanthus cornutus* (12%; 9), *Cuclotogaster heterographus* (1%; 4) and *Goniocotes microthorax* (1%; 3). Just two birds from a single flock were heavily infested with the ischnoceran species *G. gallinae.*

Tessema (2019) was conducted across-sectional study from November 2010 to April 2011 to identify and estimate the prevalence of ectoparasites of poultry managed under backyard system in Mareka Woreda of Dawurozone, SNNPR, Ethiopia. A total of 384 chickens of different age groups and both sexes were examined. Results revealed the prevalence of lice species *Menopon gallinae* (44.95%), *Menacanthus stramineus* (20.18%), *Lipeurus caponis* (15.6%), *Goniocotes gigas* (12.84%), and *Goniocotes gallinae* (6.42%).

Usman *et al*. (2012) conducted a study to determine the prevalence of ecto and haemoparasites of chicken was carried out in Sokoto metropolis, Nigeria. All chickens from the free-range production system were infested with ectoparasites and 12% had haemoparasites. Only 50% of the chickens in the commercial system had ectoparasites. Five lice species were identified in this study with the following prevalences (free-range % / commercial %): *Amyrsidea powelli* (50/0), *Goniocotes gallinae* (74/16), *Goniodes gigas* (56/16), *Lipeurus tropicalis* (94/34), *Menacanthus cornutus* (100/50).

Yevstafieva, (2015) studied chewing lice (Order Mallophaga, Suborders Amblycera and Ischnocera) fauna of domestic chicken (*Gallus gallu sdomesticus*) in Ukraine. Four species of chewing lice belonging to Menoponidae, Amblycera and Goniodidae, Ischnocera were identified. Of them, *Menopon gallinae* and *Menacantus stramineus* are dominant and *Menacantus cornutus* and *Goniocotes hologaster* are rarer. Infestation prevalence fluctuated widely in different districts: *Menopon gallinae* from 18.18 to 58.05 %, *Menacantus stramineus* from 17.40 to 35.83 %, *Menacantus cornutus* from 15.09 to 24.61 % and *Goniocotes hologaster* from 7.17 to 38.38 %.

2.2. Morphological identification of poultry lice

Marshall, (1981) stated that Mallophaga has mandibulate mouthparts which are located on the ventral side of their head. They use these mouthparts to feed on feathers, hair and epidermal skin scales.

Richard and David, (2000) reported that lice have large, rounded heads on which the eyes are reduced or absent; in Amblycera the four segmented antennae are protected in antennal grooves so that only the last segment is visible, in the Ischnocera the antennae are three to five segmented and are not hidden in grooves, at least the first two segments of the thorax are usually visible. They also stated that Mallophaga develop by gradual metamorphosis. Females will typically lay 150-300 eggs over an interval of 2-3 weeks. The eggs, commonly known as nits, are oblong and approximately 1mm long. The eggs are glued to the hairs or feathers of the host with a secretion from the female accessory gland. The eggs typically hatch several days or up to three weeks from the time they are laid. The nymphs that hatch from the eggs resemble the adults except for their smaller size and lighter color. These nymphs go through three nymphal instars during a 2-3 weeks period. After these three instars, they are considered adults. Most adult species are light tan to brown in color and are usually 1-4 mm in length although some livestock species can grow to be 5-7 mm and some wild bird species can even get to 10 mm.

Smart, (1943) reported that lice are clearly recognizable as insects since they have a segmented body divided into a head, thorax and abdomen. They have three pairs of jointed legs and a pairs of short antennae. All lice are dorsoventrally flattened and wingless, the sensory organs are poorly developed; the eyes are vestigial or absent. Adult Mallophaga (Amblycera and Ischnocera) are usually about 2-3 mm in length.

2.2.1. Reviews on Morphological Identification of *Menopon gallinae*

Saikia *et al.* (2017) studied the prevalence of ectoparasitic infestation of pigeon (*Columba livia domestica*) in Assam, India. The study stated that *Menopon gallinae* male is 1.5-2mm in length in and 1.71-2.5 mm in length in the case of female. The Head is broad and the antennae lying in grooves on the sides of the head, maxillary palps consisting of three segments. Tarsi have paired claws.

Yevstafieva, (2015) studied on the characteristic features of *Menopon gallinae*. Study results reported that: 1) head triangular, wider than it is long, forehead with flatly curved sides in the middle vaguely angular, temporal lobe extends as narrow, rounded blades; 2) abdomen elongated, conically narrowed posteriorly; 3) body length on average 2.23 ± 0.01 mm (Female: 2.5 ± 0.02 mm, Male: 1.96 ± 0.01 mm). Also to differentiate between female and male specimens of *Menopon gallinae* it is advisable to take into account not only the genital organs but also the shape of the abdomen, its last segment, and the presence or absence of hairs or bristles. In females, the last abdominal segment tapers away, edged with fine hairs. In males, it is parabolically rounded, has long lateral bristles. Egg chambers are quite visible on slides, while testes and ejaculatory ducts are much less defined.

2.2.2. Reviews on Morphological Identification of *Goniodes gallinae*

Kaufman *et al.* (2007) reported that the fluff louse is a small louse species approximately 1 mm in length.

Saikia *et al.* (2017) stated that *Goniodes gallinae* louse has a broad, rounded and short head. It measured 1.2-2 mm in length and was found at the base of the feathers of fowl. Spines in front of the insertion of the antennae in both sexes are lacking.

2.2.3. Reviews on Morphological Identification of *Menacantus stramineus*

Nasser *et al.* (2014) stated that *Menacantus stramineus* is characterized by a pair of spine-like processes on the ventral side of the head and a pointed mesosternum.

Saikia *et al.* (2017) studied on the prevalence of ectoparasitic infestation of pigeon (*Columba livia domestica*) in Assam, India. The study stated that *Menacantus stramineus* male is 2.5-3.5 mm long and female is 2.7-3.8 mm long. *Menacantus stramineus* antennae consist of five segments and lie in grooves on the sides of the broad head. They also stated that the third segment resembles the shape of an egg cup and holding the fourth segment.

Yevstafieva, (2015) studied the characteristic features of *Menacantus stramineus*. Study results revealed that *Menacantus stramineus* head is much wider than long, forehead is parabolically rounded. The abdomen is oblong-oval, the last segment with angular dorsal and rounded ventral surfaces, covered with fine hairs and with two

large setae. The study result also reported average body length of *Menacantus stramineus* is 2.88 ± 0.03 mm, where female body length is 3.12 ± 0.03 mm and male body length is 2.62 ± 0.03 mm. Males and females also can differentiate by genitals and shape of the abdomen. *Menacantus stramineus* female abdomen is more rounded than male. The abdomen is elongated and the last segment is narrowed.

2.2.4. Reviews on Morphological Identification of *Menacantus cornutus*

Yevstafieva, (2015) identify *Menacantus cornutus* consider the following features, head parabolic, much wider than long, parabolically rounded forehead; the shape of the abdomen is rounded-oval in females and oblong-oval in males, the last segment of the female abdomen is rounded and elongated in male with a fringe of long hairs that form a beam on each side; body length on average 2.28 ± 0.03 mm where female body length is 2.5 ± 0.03 mm and male body length is 1.92 ± 0.02 mm. In females the thorax is longer than the head, in males it is shorter. Both the egg chamber and the ejaculatory tracts are well visible.

2.2.5. Reviews on Morphological Identification of *Goniocotes hologaster*

Yevstafieva, (2015) studied the characteristic features of *Goniocotes hologaster*. Study results revealed that *Goniocotes hologaster* head is broad, the forehead is rounded, temporal edge almost parallel, occipital angles appear more acute, contain a spine each; the thorax is oval, the end of the abdomen is broader; average body length of *Goniocotes hologaster* is 1.44 ± 0.023 mm (Female: 1.54 ± 0.013 mm, Male: 1.32 ± 0.04 mm). Study results also showed that the last abdominal segment of female *Goniocotes hologaster* has mild fissures, in male last abdominal segment is blade-shaped. Females *Goniocotes hologaster* have quite visible egg chambers, while male genitals are not visible.

2.2.6. Reviews on Morphological Identification of *Goniocotes gigas*

Saikia *et al.* (2017) studied on the morphology of *Goniocotes gigas*. The average body length of *Goniocotes gigas* is 3-4 mm. The body is nearly black in color. The Head is broad. Antennae have five segmented and no maxillary palps.

2.2.7. Reviews on Morphological Identification of *Lipeurus caponis*

Saikia *et al.* (2017) reported that *Lipeurus caponis* body is slender and elongated, 2.5-3.0 mm in length. It was found in the wing feather of fowl, antennae consist of five segments and it is filiform and maxillary palps are absent.

CHAPTER III

MATERIALS AND METHODS

3.1 Study Area

This study was conducted in different districts starting from November, 2020 to April, 2021. Five neighboring districts near Dhaka were chosen to conduct this study, namedly, Kishoreganj, Gazipur, Mymensingh, Tangail and Narsingdi. These districts have low land areas where lots of poultry farms were established due to a very good transportation facilities. These areas had a tropical wet and dry climate. The annual temperature range of these areas were within 20-25 ºC. The monsoon season brings nearly 80% annual average rainfall of 1,854 millimeters (73 inch) occurs between May and September.

3.2 Study Population

The chicken kept under an intensive management system owned by individual farmers were considered as a study population. The study was conducted on layer hen of different age groups. A total of 245 commercial layer chicken were examined during this study, where around 2000 lice were collected.

3.3 Method of lice collection from birds and preservation

The birds were examined in the field and lice were collected by using forceps gently, and then put lice in separate containers with ethanol (70%) for each host (Figure 1). Then samples were transferred to the laboratory of the Department of Microbiology and Parasitology, Sher-e-Bangla Agricultural University, Dhaka. For future studies, the specimens were preserved in 70% alcohol in a plastic container. Parasites were identified by preparing permanent slides.

Figure 1:A. Searching for lice in chickens; **B**. Lesions of lice infestation in chicken; **C**. Collection of lice with forceps; **D**. Preservation of sample for morphological identification.

3.4 Permanent Slide Preparation

Permanent slide was needed for morphological identification of lice. Specimens were slide-mounted after staining and dehydrating before placing them in the final mounting medium.

3.4.1 Staining

Hematoxylin dye was used to stain the specimens. Specimens were kept in hematoxylin overnight. The specimen became darker and darker as time in the stain was increased. Some of the stains leached from the specimen in later stages of the dehydration series, so over staining was done to produce proper darkness of the specimen.

3.4.2 Dehydration and mounting

Dehydration was accomplished by passing the specimens through a series of increasingly concentrated grades of ethanol for 30 minutes in each step. After dehydration in 100% ethanol, the specimens were soaked in Xylene before mounting on slides. The length of time spent in each step depends on the thickness of the specimen. The dehydrated specimens were observed under the microscope just before mounting by Canada Balsam to observe whether it is cleaned. If clouding was visible, the specimen was returned to earlier stages in the dehydration series. After mounting, slides were dried very slowly by allowing them for several days. (Zajac and Conboy, 2012)

3.4.3 Microscopic examination for morphology study

All lice were identified microscopically at the laboratory, according to the keys and descriptions of Wall and Shearer, 2001 and Yevstafieva, 2015.

CHAPTER IV

RESULTS

Results

Through examination of different body parts like head, body, shaft, feather etc. of 245 commercial layer chicken, four lice species were recovered from 149 infected chickens namely *Menacanthus stramineus, Menopon gallinae, Goniocotes gallinae* and *Lipeurus caponis.*

4.1 Prevalence

4.1.1 Overall prevalence of lice in commercial layer chickens in Bangladesh

Out of the 245 commercial layer chicken examined, 149 (60.81%) were found to be infested with different species of lice. (Fig.6). Infested 149 were infected with four species of lice, comprising two species of sub-order Amblycera, two species of sub-order Ischinocera.

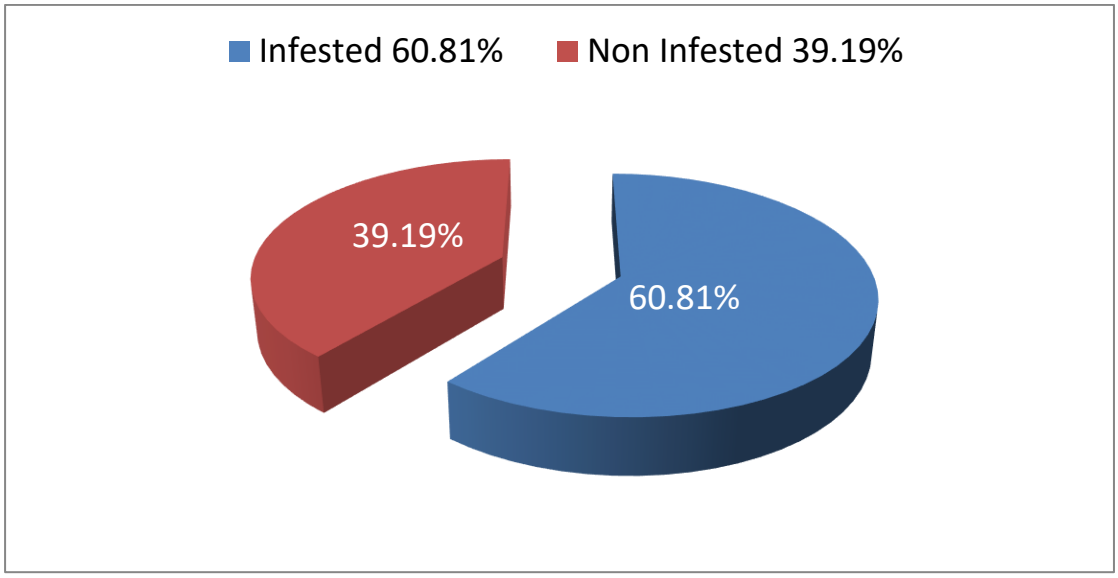

Figure 2: Overall prevalence of lice infestation in chicken

4.1.2 Prevalence of lice in commercial layer chickens in different locations of Bangladesh

The samples were collected from Gazipur (n=56), Mymensingh (n=62), Tangail (n=44), Narsingdi (n=30), Kishoreganj (n=53). Among the five areas, the prevalence was the highest in Gazipur (83.93%) while the least in Kishoreganj (0%) (Table 1).

Table 1. Overall prevalence of lice infestation according to different areas and ageof in commercial layer chickens

Location	Age	Total examined	Positive No. of Birds	Prevalence
Gazipur	11 months	56	47	83.93%
Mymensingh	4-5 months	62	50	80.65%
Tangail	4-5 months	44	32	72.73%
Narsingdi	2-3 months	30	20	66.67%
Kishoreganj	3-4 months	53	00	0.00%
Total		**245**	**149**	**60.81%**

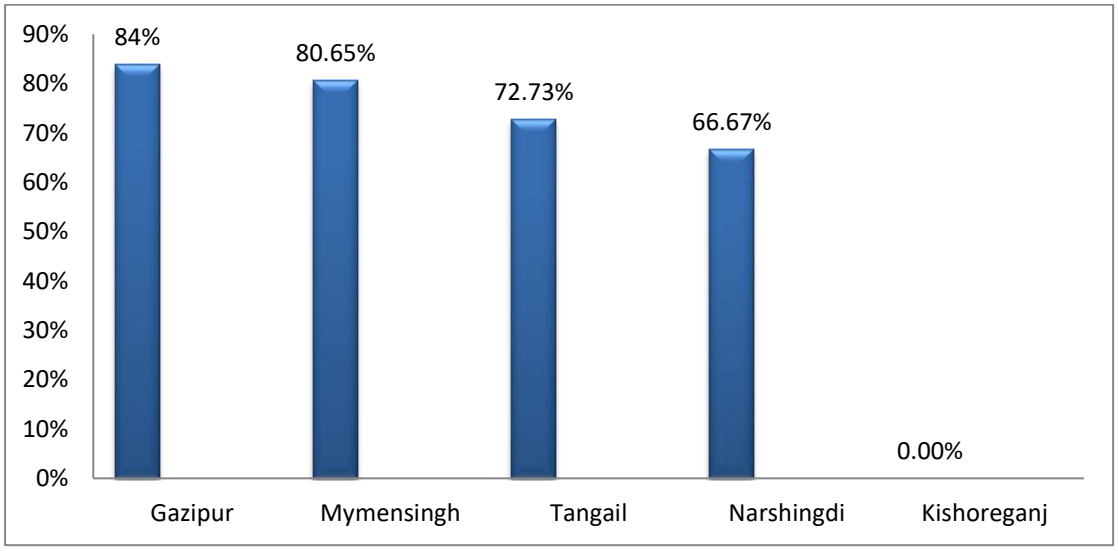

Figure 3: Prevalence of lice in different districts of Bangladesh

4.1.3 Location and overall prevalence of lice in commercial layer chicken

Regarding the species of lice in commercial layer chickens in the present study, four species, *Menacanthus stramineus, Menopon gallinae, Gonoicotes gallinae* and *Lipeurus caponis* were identified. Among them, *M. stramineus* was the most prevalent species (60.78%) and *G. gallinae* was the least prevalent species (15.03%) in this study (Table 2).

Table 2. Location and overall prevalence of lice in commercial layer chicken

Sub-order of Lice	Species name	Location	No. of infested birds	Prevalence
Amblycera	*Menacanthus stramineus*	Body	93	62.41%
	Menopon gallinae	Feathers	75	49.02%
Ischinocera	*Gonoicotes gallinae*	Fluff	20	13.42%
	Lipeurus caponis	Wing feather	52	34.90%

4.1.4 Medication history and population dynamics in different areas

Population dynamics of lice vary in this study according to the medication history of different farms. Mymensingh had the highest mean value while Kishoreganj had the least mean value.

Table 3. Population dynamics of lice and history of drug use in different farms

			Medication History			
Geography	Range	Mean±SE	Generic name of the drug	Form of the drug	Last drug applied	Age when last medicine applied
Kishoreganj	0	0±0.00	Ivermectin	Spray	1 month ago	2-3 month
Gazipur	2-11	6.5±0.39	Ziper Methyl	Spray	5 month ago	6 month
Mymensingh	6-21	13.5±0.55	Ivermectin	Spray	5 month ago	1 month
Tangail	2-10	6.0±0.42	NA	NA	NA	NA
Narsingdi	3-7	5.0±0.33	NA	NA	NA	NA

4.2 Morphological observations of detected lice

4.2.1 *Menacanthus stramineus*

The lice were collected from the body especially the chest and thigh of the chickens. They were relatively larger than other species adult being about 3.8 mm in length (Fig. 4A). The head was almost triangular-shaped much wider than long (Fig. 4B). The forehead was parabolically rounded (Fig. 4B). They had club-shaped antennae, which, were mostly concealed beneath the head (Fig. 4A). The flattened abdomen was elongated and broadly rounded posteriorly and covered with fine hairs and two large bristles (Fig. 4C). They had three pairs of short legs with two claws (Fig. 4A). With these morphological features, the specimen was identified as *M. stramineus.* (Wall and Shearer, 2001; Yevstafieva, 2015)

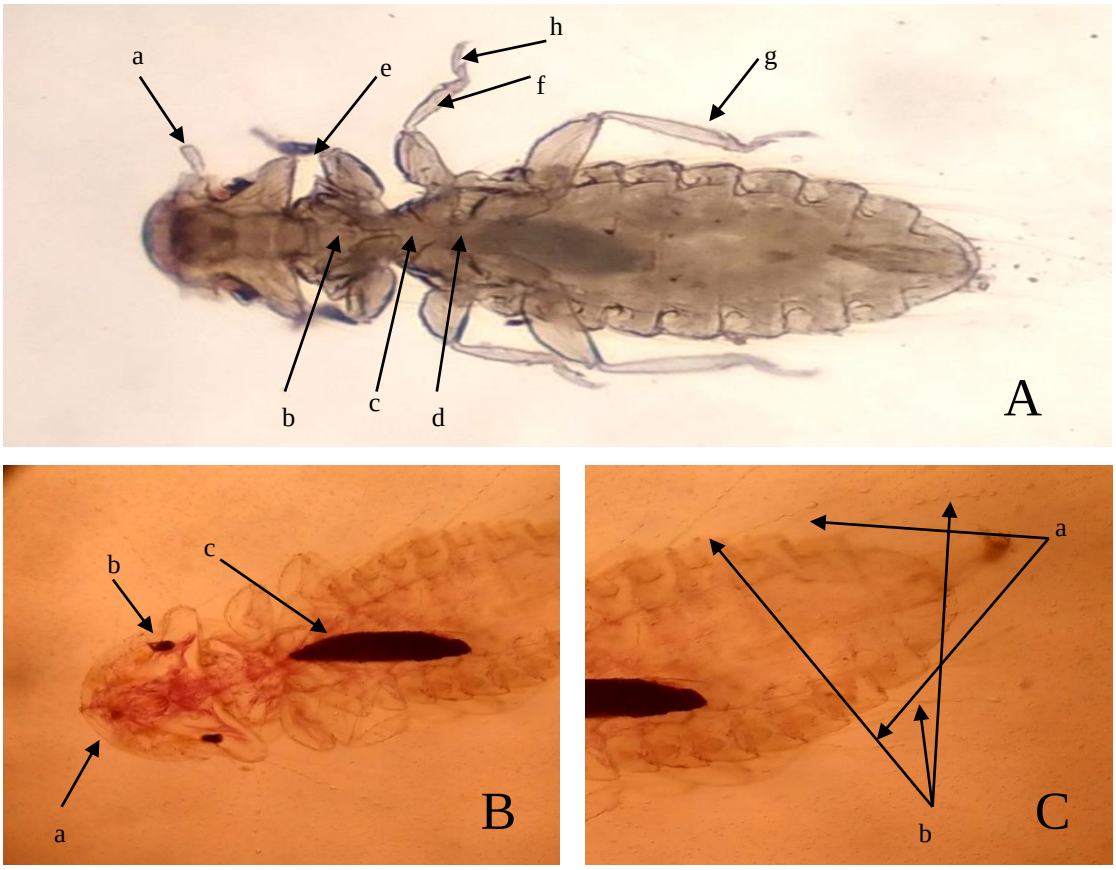

Figure 4: Different body parts of *Menacanthus stramineus*. **A.** Whole body of *M. stramineus* at 4x (a. Antennae, b. Prothorax, c. Mesothorax, d. Metathorax, e. Prothorax foot, f. Mesothorax foot, g. Metathorax foot, h. Tarse), **B.** Head of *M. stramineus* at 10x (a. Forehead, b. Eye, c. Crop,), **C.** Posterior part of *M. stramineus* at 10x (a. Abdomen, b. Bristle).

4.2.2 *Menopon gallinae*

The lice were collected from the feather of the chest and thigh of the chickens. They were small lice adults about 2.23 mm in length (Fig. 5A). The antennae folded into the groove of the head (Fig. 5B). The head was triangular, wider than its length (Fig. 5B). Forehead with flatly curved sides in the middle vaguely angular (Fig. 5B). It had three pairs of legs (Fig. 5A) The abdomen was tapered posteriorly in females (Fig. 5C). In males, the abdomen was rounded (Fig. 5D). It had a sparse covering of small to medium length setae on its dorsal surface (Fig. 5A). These morphological properties of the specimen in the study were identified in accordance with *M. gallinae.* (Wall and Shearer, 2001; Yevstafieva, 2015).

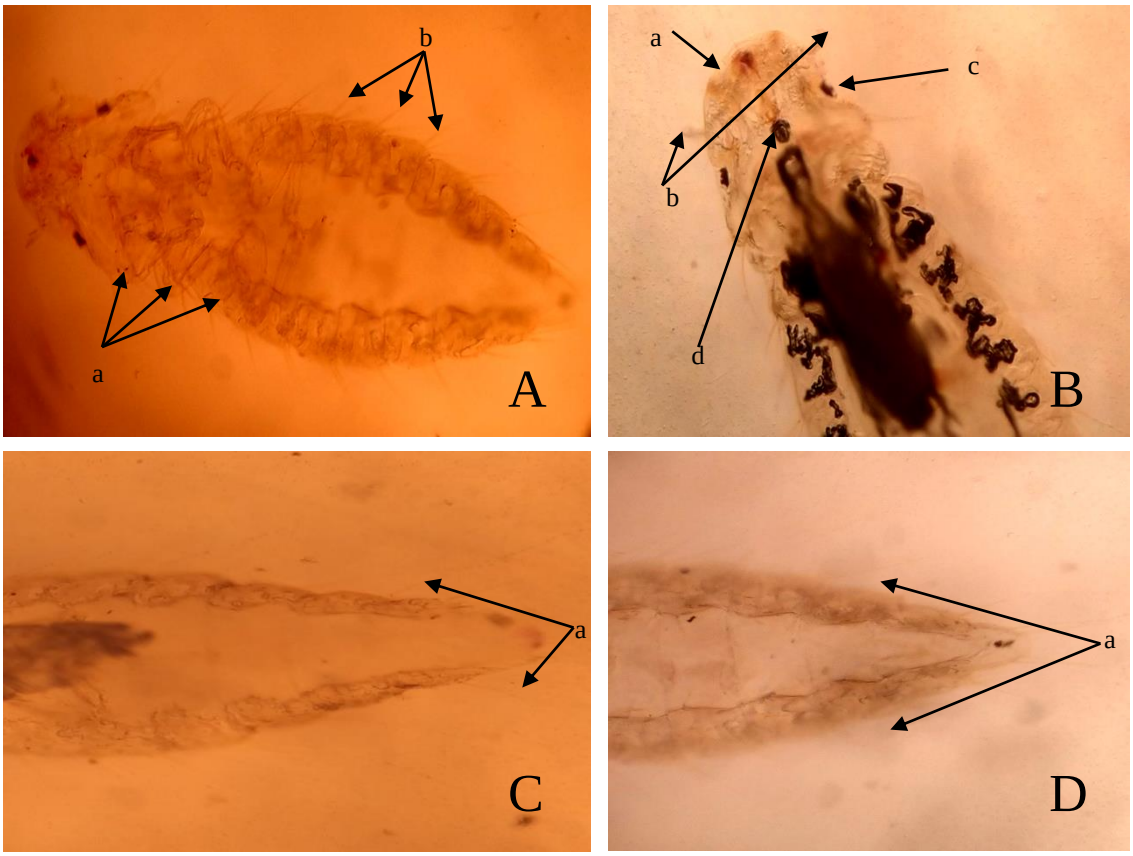

Figure 5: Different body parts of *Menopon gallinae.* A. Whole body of *M. gallinae* at 10x (a. Foot, b. Bristle), B. Head of *M. gallinae* at 10x (a. Forehead, b. Antennae, c. Eye, d. Temporal lobe), C. Abdomen of female *M. gallinae* at 10x (a. Abdomen), D. Abdomen of male *M. gallinae* at 10x (a. Abdomen)

4.2.3 *Goniocotes gallinae*

The lice were collected from the fluff of the chicken. They were pale yellow in color almost circular (Fig. 6A). They were the smallest lice measuring 0.7-1.3mm in length (Fig. 6A). The head was round and carried two large bristles projecting from each side of its dorsal surface (Fig. 6B). There were two tarsal claws in each leg (Fig. 6A). These findings are in agreement with those of *G. gallinae*. (Wall and Shearer, 2001; Yevstafieva, 2015)

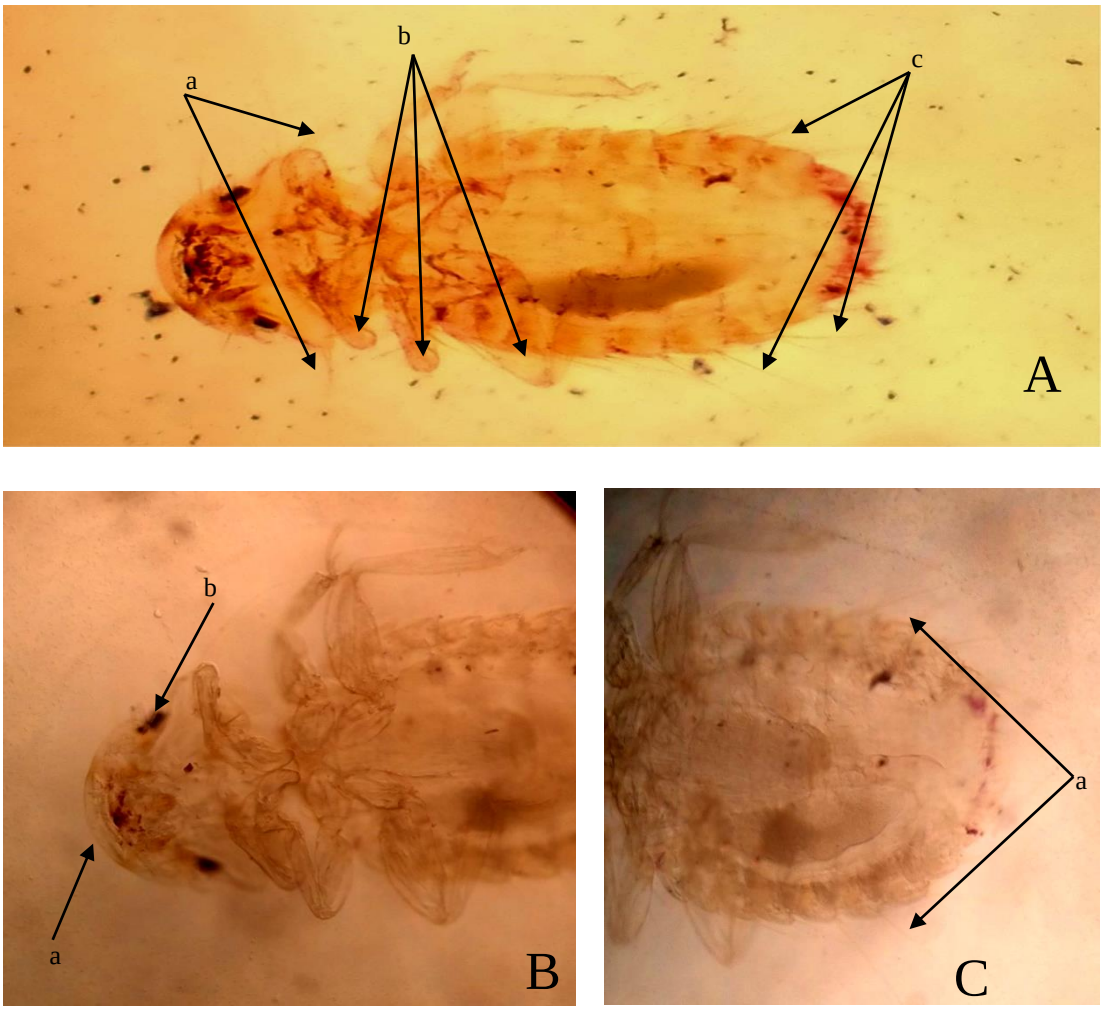

Figure 6: Different body parts of *Goniocotes gallinae*. **A.** Whole body of *G. gallinae* at 4x (a. Bristle of head, b. Foots, c. Bristle), **B.** Head of *G. gallinae* at 10x (a. Forehead, b. Eye), **C.** Posterior part of *G. gallinae* at 10x (a. Abdomen).

4.2.4 *Lipeurus caponis*

The lice were collected from the wings of the chickens. They were narrow and elongated, being 2.2 mm in length and 0.3 mm in width (Fig. 7A). Its head was long and rounded (Fig. 7B). There were characteristic small angular projections in front of the antennae (Fig. 7B). Its antennae are five segmented and fully exposed (Fig. 7B). The hind legs were about twice as long as the first two pairs (Fig. 7A). These findings are similar to the characteristics of *L. caponis.* (Wall and Shearer, 2001; Yevstafieva, 2015)

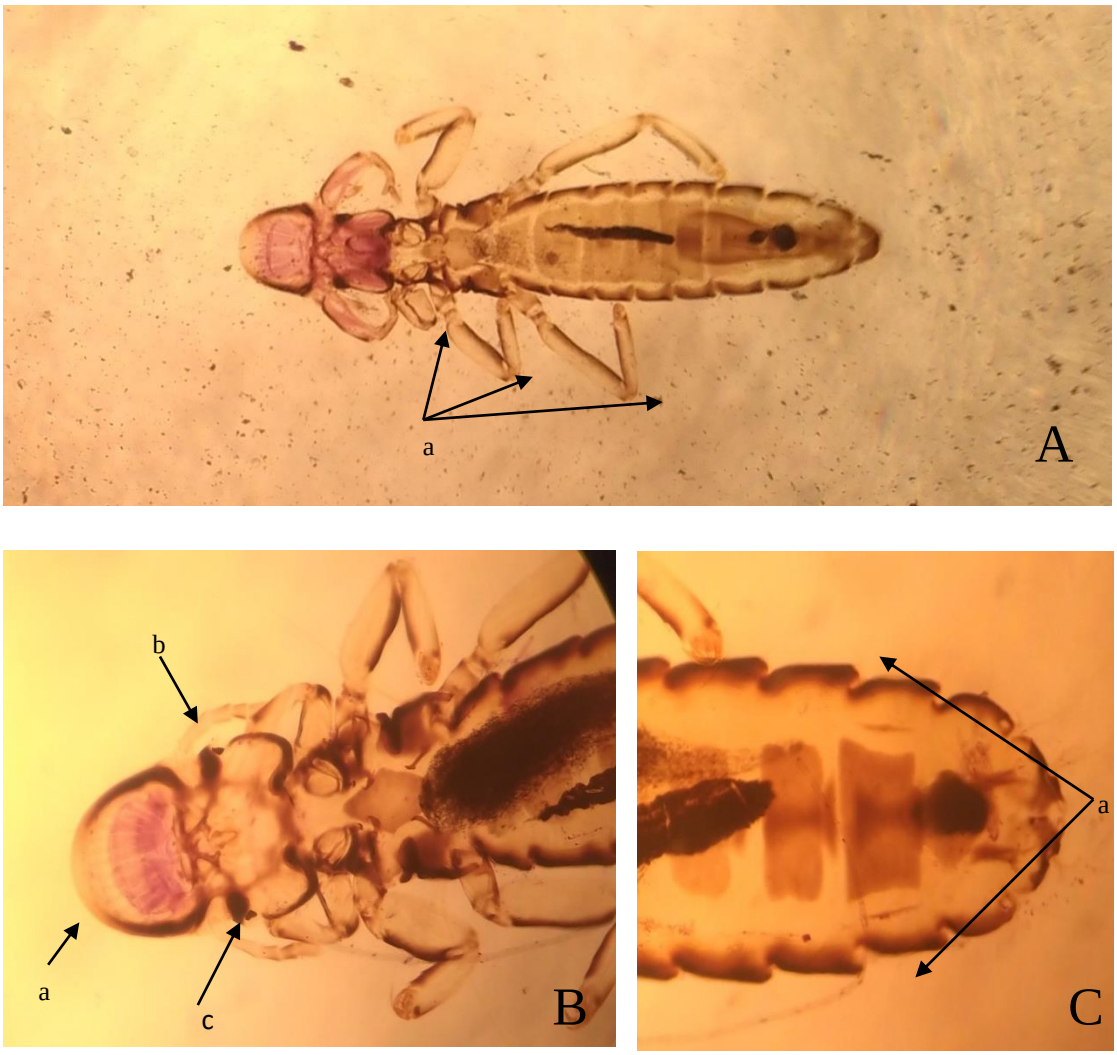

Figure 7: Different body parts of *Lipeurus caponis*. **A.** Whole Body of *L. caponis* at 4x (a. foots), **B.** Head of *L. caponis* at 10x (a. forehead, b. antennae, c. eye), **C.** Posterior part of *L. caponis* at 10x (a. abdomen)

CHAPTER V

DISCUSSION

Lice are the most common ectoparasite found in the backyard and free-range flocks of poultry. They might also be found in intensive poultry systems. Lice spread by direct contact. It causes great economic loss by hampering egg production of chicken, and weight gain in growing chickens. All lice cause severe irritation, and itching causing reactions by rubbing, restlessness, and discomfort. Often restlessness, focusing on their discomfort rather than eating. Areas of skin irritation are also sites for secondary bacterial infection. The most common and economically important louse of both chickens is the chicken body louse, *Menacanthus stramineus*.

Considering all the morphological characters following the keys and descriptions of Wall and Shearer, 2001 and Yevstafieva, 2015 the lice were identified. In morphological studies, several points like body shape and length, the shape of the head, location and segmentation of antennae, shape of abdomen; bristles on the body, number of legs, and claws of legs were considered for identification.

After the study of 245 commercial layer chickens from five districts of Bangladesh, four species of lice were found. All four species of lice belonged to two sub-orders, namely Amblycera and Ischinocera. The four species identified were *Menacanthus stramineu,* and *Menopon gallinae* (under the sub-order Amblycera), and *Goniocotes gallinae,* and *Lipeurus caponis* (under the sub-order Ischinocera). *Menacanthus stramineus* was the most prevalent (62.41%) species. *Menopon gallinae* was the second most prevalent (49.02%) species, followed by *Lipeurus caponis* was the third most prevalent (34.90%) species, whereas *Goniocotes gallinae* was the least prevalent (13.42%) species. This study gives an overview of the overall prevalence and population dynamics of lice infestation in commercial layer chickens in Bangladesh.

The overall prevalence of lice infestation in commercial layer chicken in this study was 60.81% which was supported by the study of Nandi and George (2010) where they found the prevalence of lice as 62.2% in Nigeria. On the other hand, the study of Salam *et al.* (2009) reported the of lice as prevalence 100% in Kashmir Valley, Abdullah and Mohammed (2013) reported prevalence 81.36% Sulaimini region Kurdistan/Iraq. The low prevalence recorded in this present study of lice may be

associated partly with the good husbandry practice. The proper feeding, sanitation, hygienic practice and medication in the intensive management system create an unconducive environment for the propagation and life cycle progression of the lice in the studied area. The apparent differences in the percentage of infestation are justified by the fact that the studies had been undertaken in different parts of the world and the methods of husbandry were different. Nevertheless, the climatic condition, method of study, age and breed/species of poultry and sample size also may be likely contributory factors. All these factors either alone or in combination might have an important role in the high prevalence of ectoparasites in backyard poultry (Shanta *et al*., 2006).

Among the five districts, the highest prevalence of lice was observed in Gazipur (83.93%) while the lowest prevalence was found in Narsingdi (66.67%). On the other hand, no lice infestation was found in Kishoreganj (0%). The other two districts, Mymensingh and Tangail showed the prevalence of 80.65% and 72.73%, respectively. The prevalence was nil in Kishoreganj because drug against lice was applied just one month before sample collection. But no drug was applied in chickens of Tangail and Narsingdi. In Gazipur and Mymensingh drug was applied 5 months before sample collection. The variation in the prevalence might be due to the application of drugs in the respective farms.

In this study, the most abundant species of lice was *M. stramineus,* the prevalence of this species was 62.41%. This present study is supported by the study of Shanta *et al.* (2006) and Abdullah and Mohammed (2013) where they found the prevalence of lice was 74% in different areas of Patuakhali, and 72.92% in Sulaimini region Kurdistan/Iraq, respectively. On the contrary, the study of Yevstafieva (2015), Abafaji (2017) and Tessema (2019) found the lower prevalence 17.4 to 35.83% in Ukraine, 30% in Kersa district of Jimma zone, Ethiopia, and 20.18% in Mareka Woreda of Dawurozone, SNNR Ethiopia, respectively.

In the study, the second most abundant species of lice were *Menopon gallinae,* the prevalence of this species were 49.02% which is supported by Arya *et al.* (2013), Abafaji (2017), and Tessema (2019) where they found 45.06% in selected district Chamoli Garwhal (Uttarkhand), 46.7% in Kersa district of Jimma zone, Ethiopia, and 44.95% in Mareka Woreda of Dawurozone, SNNR Ethiopia, respectively. But the

study of Shanta *et al.* (2006), Mukaratirwa (2012), and Mansur et al. (2019), found the higher prevalence 63% in different areas of Patuakhal, 96.8% in Kwazulu-Natal, South Africa, and 69.84% in Qaser Bin Ghashir Region, Libya, respectively.

In this study, the second least abundant species of lice were *Lipeurus caponis* the prevalence of this species was 34.90%. This study is supported by Sychra *et al*. (2008), and Salam *et al*. (2009) where they found 35% in the eastern part of the Czech Republic, and 33.05% in Kashmir Valley, respectively. But the study of Tessema (2019), showed less prevalence 15.6% in Mareka Woreda of Dawuoro zone, SNNPR, Ethiopia. On the other hand, the study of Shanta *et al.* (2006), and Nadeem *et al.* (2017) show higher prevalence 48% in different areas of Patuakhali, and 53.2% in Faisalabad Pakistan, respectively.

In this study, the least abundant species of lice was *G. gallinae*. The prevalence of this species was 13.42%. This study is supported by Shanta *et al.* (2006), Salam *et al.* (2009), and Kanshal and Singh (2014), where they found prevalence of lice 14% in different areas of Patuakhali, 9.41% in Kashmir Valley, and 15% in Meerut region, respectively. On the other hand, the study of Sychra *et al*. (2008), and Abdullah and Mohammed (2013) show higher prevalence 100% in the eastern part of the Czech Republic, and 54.17% in Sulaimani region Kurdistan/Iraq, respectively.

Though the present study is supported by many previous studies, there also found some dissimilarities with few studies. This might be found because the previous studies were conducted in backyard poultry systems but the present study was conducted in commercial intensive farming system. In commercial rearing systems, farmers maintain good feed quality, proper feeding system, proper hygienic system, proper sanitation, and also give medicine periodically. Overall, in intensive farming farmers maintain a good husbandry system, which is different from the backyard rearing system, which might affect the prevalence of infestation in chickens. So the present study is showing contradictory results with few previous studies.

CHAPTER VI

SUMMARY AND CONCLUSION

Poultry is a valuable source of protein in people's meals all around the world, as well as an essential source of egg production. Poultry lice are crucial in the transfer of infections that generate significant economic losses in the commercial poultry sector, in addition to the direct effect of causing morbidity by sucking blood and irritating the poultry. The present study was aimed at the population dynamics and morphological identification of commercial poultry lice indifferent districts of Dhaka and Mymensingh division (Kishoreganj, Gazipur, Mymensingh, Tangail, and Narsingdi). During the study four lice species were identified: *Menacanthus stramineus*, *Menopon gallinae*, *Gnoiocotes gallinae,* and *Lipeurus caponis* with an overall prevalence of 60.81 %. Among them, *M. stramineus* (60.78%) was the most common lice species and *G. gallinae* was the least prevalent species (15.03%) in this study area. Population dynamics of lice vary in this study according to the location and medication history of different farms. Among the five districts, the prevalence was the highest in Gazipur (83.93%) while the least in Narsingdi (66.67%). On the other hand, no prevalence was found in Kishoreganj (0%). During this study, different lice species were detected in different body parts of layer hen *i.e. M. stramineus* detected in breast and thigh, *M. gallinae* in body feathers, *L. caponis* in wing feather and *G. gallinae* in fluff. This study also revealed that lice infestation was higher in older layer hens compared to young layer hens. Also, drugs used in the flocks have an effect on the prevalence of lice. High prevalence of lice found in the farm where drug used long ago and low prevalence of lice found in the farm where drug used recently.

This study clearly shows that poultry lice are a major problem in commercial poultry chicken, necessitating the development of efficient control measures and management to improve commercial poultry farm productivity. As a result, further large-scale research is needed to identify and determine the prevalence of different lice species and measure the direct or indirect impact of lice infection on commercial layer hen productivity in Bangladesh.

REFERENCES

Abafaji, G. (2017).Assessment of poultry production constraints and evaluation of different concentrate on production performance and parasitic burden of exotic chickens in Kersa district of Jimma zone. MSc Thesis, Department of Veterinary Epidemiology. Jimma University College of Agriculture and Veterinary Medicine, Ethiopia.

Abdullah, S. H. and Mohammed, A. A. (2015). Ecto and Endo Parasites Prevalence in Domestic Chickens in Sulaimani Region. *Iraqi J. Vet. Med.* **37**(2): 149-155.

Ansarey, F. H. (2012). Prospects of poultry industry in Bangladesh. Proceedings of the Seminar and Reception on Animal Husbandry Education and Profession in Bangladesh- A Journey of 50 Years, (AHEPB'12), Dhaka, Bangladesh. pp: 62-65.

Arya, S., Negi, S. and Singh, S. K. (2013). Prevalence of *Menopon gallinae* Linn. (Insecta, Phthiraptera, Menoponidae, Amblycera) upon poultry birds (*Gallus gallus dom*esticus) of selected locality of district Chamoli Garhwal (Uttarakhand), India. *J. Appl. Nat. Sci.* **5** (2): 400-405.

Audi, A. H. and Asmau, A. M. (2014) Prevalence Of Bird Louse, *Menacanthus cornutus* (Pthiraptera: Amblycera) In Four Selected Poultry Farms In Kano State, Nigeria. *BAJOPAS.* **7**(1): 142 – 146.

Brown, N. S. (1970). Distribution of *M. stramineus* in relation to chicken surface temperature. *J. Parasitol. Res.* **56**: 1205.

Das, S. C., Chowdhury, S. D., Khatun, M. A., Nishibori, M., Isobe, N. and Yoshimura, Y. (2008). Poultry production profile and expected future projection in Bangladesh. *World's Poult. Sci. J.* **64**: 99–117.

DLS. (2019). Annual report on livestock 2018-19. Division of Livestock Statistics, Ministry of Fisheries and Livestock, Farmgate, Dhaka, Bangladesh.

El–Kifl, A. H., Wahab, A., Kamel, M. K. and Abdel, W. A. E. (1973). Poultry ectoparasites in sharikia Governorate. *Agric. Rev* **51**: 113–120.

Fabiyi, J. P. (1980). Survey of lice infesting domestic fowls of the Jos Plateau, Northern Nigeria. *Bull Anim Health Prod Afr*. **28**: 21–29.

Fabiyi, J. P., Alayande, M. O., Akintule, A. O., Lawal, M. D., Mahmuda, A. et Usman, M. (2017). Prévalence et variations saisonnières des infestations par les ectoparasites des dindons de basse-cour, Meleagrisgallopavo, à Sokoto, Nigeria. **70**(1): 21-24.

M.A. Hamid, Rahman, M.A., Ahmed, S. and Hossain, K. M.(2016). Status of poultry industry in Bangladesh and the role of private sector for itsdevelopment. *Asian J. Poult. Sci.* **11**: 1-13.

Islam, M. K., Mondal, M. M. H., Rehman, M. M., Haque, A. K. M. F. and Chaudhery, M. A. A. (1999). Effects of *Lipeurus caponis* Linnaeus, 1958 (Mallophaga: Philopteridae) on laying hens. *Vet. Rev.* **14**: 32–33.

Jungmann, R., Ribbeck, R., Blatter, S. E. and Schematus, H. (1970). Infestation of laying hens with *Dermanyssus gallinae* and feather lice: Harmful effects and control. *Mh. Ver. Med.* **25**: 28–32.

Kanshal, G. and Singh, H. S. (2014). Incidence of Ectoparasites in Broiler Chicken in Meerut. *IOSR J Agriculture and Veterinary Science.***7**(1): 55-58.

Kaufman, P. E., Koehler, P. G., Butler, J. F. (2007). *External Parasites of Poultry*. Gainesville, Fla, USA: University of Florida Institute of Food And Agricultural Sciences.

Khan, M. N., Nadeem, M., Iqbal, Z. Sajid, M. S. And Abbas, R. Z. (2003). *Review*: Lice Infestation in Poultry. *Int. J. Agri. Biol.* **5(**2): 213-215.

Koroglu, E., Saki, C. E., Aktas, M., Dumanli, N. and Argin, M. (1999). Distribution of lice in chicken in Elazig region. *Saglik Bilimleri Dergisi Firat Universiesi***.** **13**: 57-60.

Kumar, S., Gupta, N. and Saxena, A. K. (2004). Population Composition of selected Poultry lice (Phthiraptera). *Rev Iber Parasitol* pp. 49-54.

Lancaster, J. L., Meisch, M. V. (1986). Arthropods in livestock and poultry production. Ellis Horwood Publishers, Chichester, UK. pp. 402.

Mansur, M. K., Mahmoud, N. M., Allamoushi, S. M., Aziz, M. M. A. E. (2019) Biodiversity and prevalence of chewing lice on local poultry. *J. dairy vet. anim. res* **8**(1): 26–31.

Manuel, M. F. and Anceno, T. A. (1981). Distribution of biting lice (Mallophaga) on the body of native chickens (*Gallus gallus domesticus*). *J. Vet. Med.* **20**: 50–57.

Marshall, A. G. (1981). The ecology of ectoparasitic insects. Academic Press, London.

Martinez-de-Chirinos, N. I., Chirinos, A. R., Hinestroza, Y., Inicarte, M. F., Manco, M., Melendez, A. and De-Chirinos, N. I. (2001). Prevalence of ectoparasites in domestic fowls (*Gallus gallus domesticus*) from the San Francisco municipality in Zulia State, Venezuala. **11**: 348-354.

Mishra, S., Pednekar, R., Mohanty, B. S. and Gatne, M. (2017). Prevalence, economic loss and control of lice infestation in poultry. *Int. j. sci. environ. Technol* **6**(3): 1745-1757.

Mukaratirwa, S. (2012). Prevalence of chewing lice in free-range chickens from selected rural localities of Kwazulu-Natal, South Africa. *Intern. J. Appl. Vet. Med.* **10**(1): 85-89.

Mullen, G. R. and Durden, A. L. (2002) Medical and Veterinary Entomology. Academic Press, London. pp: 296.

Nadeem, M., Khan, M. N., Iqbal, Z., Sajid, M. S., Arshad, M. and Yaseen, M. (2007). Determinants influencing prevalence of louse infestations on layers of district Faisalabad (Pakistan). *Br. Poult. Sci*. **48**(5): 546-550.

Nasser, M., Al-Ahmed, A., Shobrak, M. and Aldryhim, Y. (2014). Identification key for chewing lice (Phthiraptera: Amblycera, Ischnocera) infesting the Indian Peafowl (*Pavo cristatus)* with one new country record and new host record for Saudi Arabia. *Turk. J. Zool.* **38**(1): 3-8.

Njunga, G. R. (2003). Ecto and haemoparasites of chickens in Malawi with emphasis on the effect of chicken louse, menacanthus cornutus. The royal veterinary and agriculture university, Frederiksberg, Denmark. pp. 173-195.

Nnadi, P. A. and George, S. O. (2010). A Cross-Sectional Survey on Parasites of Chickens in Selected Villages in the Sub-Humid Zones of South-Eastern Nigeria. *J. Parasitol. Res.* **2010**: 1-6.

Okaeme, A. N. (1989). Lameness associated with ectoparasitic infestation in *Numidia meleagris galeata, Gallus domestica, Pavomulticus* (Sic). *Bulletin Anim. Hlth. Prod.* **37**:189–190.

Phillip, C. B. (1963). In Naegele. J.A. (ed), Advances in Acarology, Cornel Univ. Press, Ithaca, N.Y. pp. 1285– 1325.

Prabakaran, R. (2003). Good practices in planning and management of integrated commercial poultry production in South Asia. FAO Animal Production and Health Paper 159, Food and Agriculture Organization of the United Nations, Rome, Italy.

Price, R. D., Hellenthal, R. A., Palma, R. L., Johnson, K. P. and Clayton, D. H. (2003). The Chewing Lice: World Checklist and Biological Overview, Illinois Natural History Survey Special Publication. pp. 511.

Raha, S. K. (2013). Poultry industry in Bangladesh: Ample opportunities for improvement. Proceedings the 8th international poultry show and seminar. World's poultry science association, Dhaka, Bangladesh Branch. pp. 13-19.

Raihan, S. and Mahmud, N. (2008). Trade and poverty linkages: A case study of the poultry industry in Bangladesh. Cuts Citee Working Paper No. 6.

Richard, W. and David, S. (2000). Veterinary Ectoparasites, Biology, Pathology and control. 2nd edition.

Saikia, M. Bhattacharjee, K., Sarmah, P. C., Deka, D. K. and Mushahary, D. (2017). Prevalence of ectoparasitic infestation of pigeon (*Columba livia dome*stica) in Assam, India. *J Entomol Zool Stud* **5**(4): 1286-1288.

Salam, S. T., Mir, M. S., Khan, A. R. (2009). Prevalence and seasonal variation of ectoparasite load in free-range chicken of Kashmir valley. *Tropical Animal Health and Production.* **41**(7): 1371-1376.

Santos, A. C. G., Rodrigues, A. L., Santos, S. B., Lima, R.C. A. and Guerra, R. M. S. N. C. (2011). Phthiraptera (Arthropoda, Insecta) in *Gallus gallus* from isolated and mixed backyard rearing systems. *Rev. Bras. Parasitol. Vet. Jaboticabal.* **20**(1): 17-21.

Saxena, A. K., Kumar, S., Gupta, N. and Singh, R. (2007). Population Expansion of the Poultry Fluff Louse, *Goniocotes gallinae* (De Geer, 1778) (Ischnocera, Phthiraptera). *J. Zool.* **24**: 327-330.

Shanta, I. S., Begum, N., Anisuzzaman, Bari, A. S. M and Karim, M. J. (2006). Prevalence and clinico-pathological effects of ectoparasites in backyard poultry. Bangl. *J. Vet. Med*. **4**(1): 19–26.

Smart, J. A. (1943). Handbook for the identification of Insects of medical importance. British museum (Nature History). London.

Soulsby, E. J. L. (1982). Helminths, Arthropods and Protozoa of Domesticated Animals, 7th Ed., Baillere Tindall and Cassell Ltd., London. pp: 366–87.

Sychra, O., Harmat, P. and Literák, I. (2008). Chewing lice (Phthiraptera) on chickens (*Gallus gallus*) from small backyard flocks in the eastern part of the Czech Republic. *Vet. Parasitol.* **152**(3-4): 344-348.

Tessema, W. (2019). Study on Prevalence of Ectoparasites in Poultry Managed Under Backyard System in Mareka Woreda of Dawuro Zone, Snnpr, Ethiopia. *ARC j. anim. vet. sci*. **5**(2): 1-8.

Urquhart, G. M. (1987). *Veterinary Parasitology,* 1st Ed., ELBS, Longman House, Burnt Mill, Harlow, England. pp: 256–7.

Usman, M., Fabiyi, J. P., Mohammed, A. A., Mera, U. M., Mahmuda, A., Alayand, M. O., Lawala, M. D. and Danmaigoro, A. (2012). Ectoparasites and haemoparasites of chickens in sokoto, northwestern Nigeria. *J. Zool.* **1**(3) 74-78.

Wall, R., Shearer, D. (2001). Veterinary ectoparasites: Biology, pathology and control, 2nd edition. Blackwell Science, London, UK. pp. 304.

Yevstafieva, V. A. (2015). Chewing Lice (Order: Mallophaga, Suborders: Amblycera and Ichnocera) Fauna of Domestic Chicken (*Gallus gallus domesticus*) In Ukraine. *Vestn. Zool*. **49**(5): 393–400.

Zajac A. M., Conboy G. A., (2012). Veterinary Clinical Parasitology, 8th edition. pp: 266.