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Effect of *Gallacanthus cornutus* (Insecta, Phthiraptera, Amblycera, Menoponidae s. l.) on the meat production in chicken *Gallus gallus* forma domestica

ADESH KUMAR* & RAKESH KUMAR**

With 1 Figure

Summary

Lice infest wide range of livestock and incur loss of million dollars to poultry, leather and dairy industries. The parasites have also reservoir and spread pathogenic strain among host which indirectly increase the mortality and decline vitality host. The impact of chewing lice on live host confined equivocal and contradictory as cited in literature by previous phthirapterist. In the present work, impact of *Gallacanthus cornutus* (SCHÖMMER 1913) (Menoponidae s. l.) on meat production (weight gain) of domestic fowl has been accessed at Purola (Uttarkashi), India. The 100 birds of similar age and breed were kept in two separate pens (infested and uninfested flocks). The weight gain of two groups has been recorded and statistically analysed. The weight gains in uninfested categories were much quicker than infested categories. *G. cornutus* able to reduce as much as 900 gm body weight per bird. The young chickens (2 to 4 months) were found to be severely affected as compared to adult. Two tailed paired t-test was found significant between weight gain in uninfested and infested birds ($t(4) = 4.702, p = 0.005$). So, it causes great loss to the poultry industry as well as the economy of any country.

Zusammenfassung

Der Einfluss des Hühnerläuslings *Gallacanthus cornutus* (Insecta, Phthiraptera, Amblycera, Menoponidae s. l.) auf die Fleischproduktion beim Haushuhn *Gallus gallus* forma domestica

Auf praktisch allen Arten der vom Menschen gehaltenen Nutztieren leben natürlicherweise Tierläuse (Phthiraptera). Unter den Bedingungen der konzentrierten Tierproduktion bewirken sie in Geflügel-, Leder- und Milchwirtschaft Schäden in Millionenhöhe. Der Einfluss von Haarlingen und Federlingen auf ihre als Haus- und Nutztiere gehaltenen Wirte wird in der Fachliteratur von Spezialisten unterschiedlich bis widersprüchlich bewertet. In der vorliegenden Arbeit ist der Einfluss von *Gallacanthus cornutus* (SCHÖMMER 1913) (Menoponidae s. l.) auf die Fleischproduktion über die Veränderung der Körpermasse bei Haushühnern in Purola (Bezirk Uttarkashi) in Indien untersucht worden. 100 gleichaltrige Hühner einer Herkunft wurden im Alter von zwei Monaten chemisch von Ektoparasitenbefall befreit. Jeweils 50 wurden in zwei separaten Verschlügen gehalten. Die eine Gruppe wurde mit jeweils 20 Individuen von *Gallacanthus cornutus* pro Wirtsindividuum infiziert, die andere blieb davon verschont. Die Massezunahme der Hühner vom Küken- bis zum Erwachsenenstadium verlief von Juli bis Dezember in beiden Gruppen unterschiedlich. Sie war bei den nicht mit *G. cornutus* infizierten Hühnern größer als bei den infizierten. Der Zweistichproben-t-Test für abhängige Stichproben ergab einen signifikanten Unterschied ($t(4) = 4,702, p = 0,005$). Daraus ist der Schluss zu ziehen, dass *Gallacanthus cornutus*-Befall bei industriemäßig gehaltenen Haushühnern einen klar negativen Einfluss auf ihre Massezunahme ausübt und damit zu ökonomischen Verlusten führt.

Keywords: Phthiraptera, Amblycera, *Gallacanthus cornutus*, weight-gain, meat production, *Gallus gallus* forma domestica.

* Dr. Adesh Kumar (corresponding author), Parasitology Laboratory, Department of Zoology, Government Post Graduate College, Ranikhet (Almora), India. Fax no. +9105966220372, Mob. +919411122341.

Email: dr.adeshkumar@hotmail.com dr.adeshkumar@gmail.com

** Rakesh Kumar, Department of Veterinary Physiology & Biochemistry, College of Veterinary and Animal Sciences, CSK Himachal Pradesh Krishi Vishvavidyalaya, Palampur-176062 (H.P.). Email: rkchauhan440@gmail.com

Introduction

The members of Phthiraptera are small and much irritating to host bird. The feather feeding and haematophagous habits considerably reduces the host fitness, productivity and vitality directly or indirectly (CLAYTON 1990, BOOTH *et al.* 1993). Most of the parasite affects its host (bird or mammal) is the major problem in host-parasite biology (TOFT *et al.* 1991). Lice infest a wide range of domestic livestock including poultry, pigs, cattle, goat, sheep and cause chronic dermatitis (pediculosis) characterised by constant itching, rubbing, tagging and biting of hair or fleece. These macroparasites have reported to incur heavy loss to dairy and poultry industry by causing severest irritation, sucking blood (haematophagous) and through spreading noxious pathogenic agents (e.g. bacteria, viruses, fungus and protozoans etc.) among birds and mammals (WATERSTON 1926, KALAMARZ 1963 a, b, SEAGER *et al.* 1976, KIM *et al.* 1973, SAXENA *et al.* 1985, BARTLETT 1993, DURDEN 2001, 2002).

The very heavy infestation of phthirapteran ectoparasites can decline feeding efficiency, body weight and egg production (NELSON *et al.* 1975, 1977, ARENDS 1997). The severest irritation incurs extensive negative impact of lice on their host (SOULSBY 1982). The very heavy infestation of *Cuclotogaster heterographa* (NITZSCH in GIEBEL) causes restlessness, reduction in vitality and seldom kills chicken (KIM *et al.* 1973, LOOMIS 1978). The cumbersome mallophagan lice load reported to cause hyperchronic anaemia and lameness also associated with heavy lice infestation in three species of birds (*Numidia meleagris galeata*, *Gallus gallus* f. dom., *Pavo muticus*) (JUNGMANN *et al.* 1970, OKAEME 1989). The diseases like diarrhoea and prostration has reduced body mass and declined laying capability in hens infested by *Eomenacanthus stramineus* (NITZSCH) (CHENG 1964). Lice have caused 711 gms/bird weight loss in Poultry of sharikia Governorate (EL-KIFL *et al.* 1973). Domestic fowls and turkey

with mallophagosis have documented stunted growth rate and sluggishness (FABIYI 1986). Few workers have noted 25 % higher mortality in chickens having mallophagosis than to controlled group (PRELEZOV *et al.* 2006). The substantial increases in preening scores have been recorded with increase in population of *Gallacanthus cornutus* (SCHÖMMER) in summer which causes skin lesion and haemorrhage (KUMAR & KUMAR 2010).

Mammals have also been severely affected by the lice and limit milk production in dairy cattle. 10 % cattle in Northern U.S. have had heavy infestation of *Bovicola bovis* (L.), which inflicts losses of many million dollars (KUNZ *et al.* 1991). The estimated losses including the control cost in United State due to lice have been cited between US \$ 126.3 million to US \$ 130 million (DRUMMOND *et al.* 1981, CHALMERS & CHARLESTON 1981, MEYER & KOOP 1987). In New Zealand, the cost of the legally required annual dipping has been estimated to cost approximately NZ \$ 7.5 million/annum for labour and material only for sheep lice (KETTLE 1985).

The phthirapteran ectoparasites incur heavy cost on host birds in form of time and energy. Recently, few workers have described that infested birds/mammals have increased B.M.R. (Basal Metabolic Rate) due to increase in thermal conductance (SCHMIDT-NELSON 1987, de VANEY *et al.* 1988, CLAYTON *et al.* 1995). The parasitized birds invest their maximum time and energy available for foraging to check the population of ectoparasites via preening (BROWN 1974, COTGREAVE & CLAYTON 1994, REDPATH 1988). Increased preening and grooming also enhance risk of being killed by predators due to reason that bird becomes less vigilant during grooming. These economically important ectoparasites exert natural selection pressure on host birds (REDPATH 1988).

The lice can indirectly harm the birds and mammals by acting as a vectors or intermediate host of pathogenic strains. For instance, *Menopon gallinae* (L.) and *Eomenacanthus stramineus*

infesting domestic fowls are serving as a vector of eastern equine encephalomyelitis and reservoiring as well as transmitting bacterial strains like *Pasteurella multocida* (LEHMANN & NEUMANN), *Escherichia coli* (MIGULA) and *Streptococcus* sp. among poultry birds (OLITSKY & CASAL 1959, DERYLO 1972, 1974 a, b, DERYLO & JAROSZ 1972, HOWITT *et al.* 1948). Dog louse, *Tricodectes canis* is also act as an intermediate host of tapeworm that parasitized canids (KIM *et al.* 1973). The severe infestation of lice can impart pathological problems as recorded by some workers (DURDEN 2001, NELSON *et al.* 1975, 1977).

Few workers have excellently reviewed the impact of lice on poultry birds, domestic mammals and wild animals (DURDEN 2001, ARENDS 1997, PRICE & GRAHAM 1997). A review of literature revealed that most of the workers have selected only *Eomenacanthus stramineus* for their experimentation while they have studied the impact on productivity of host. However, another haematophagous species, *Gallacanthus cornutus* remained unstudied from this point of view. Therefore, keeping in view the haematophagous nature of amblyceran lice, an attempt has been made to access the impact of *Gallacanthus cornutus* on meat production in *Gallus gallus* f. dom.

Materials and Methods

The birds used in experiment were indigenous fowl, *Gallus gallus* f. dom. of similar age and breed. 100 chickens of age two month were bought from poultry farm. The birds were deparasitized by repeated dusting with pyrethrum powder and deworming by veterinary deworming drug. The birds were kept in two separate flocks with similar male and female ratio (1 : 4). They were kept in two separate house side by side and same size. Each bird of first flock was parasitized with 20 *Gallacanthus cornutus* and second flock kept control (regularly deparasitized). Both the groups were provided

with similar food, hygiene and environmental condition (i.e. temperature, moisture, light etc.). Weight of all the birds (infested and uninfested) were taken weekly with the electronic balance.

Observations

Experiments were beginning in the month of July 2008. The starting average weights of each bird in two groups were more or less similar (0.256 kg in uninfested and 0.254 kg in infested groups). The uninfested group gain weight very rapidly. The average monthly weight of each bird in uninfested groups were 0.256, 0.374, 0.882, 1.379, 1.566 and 1.979 kg in July, August, September, October, November and December respectively (Fig. 1). Similarly, the average monthly weight gain per bird in infested group were 0.254, 0.215, 0.362, 0.479, 0.755 and 1.301 kg in July, August, September, October, November and December respectively. The weight gains in infested categories were much slower than uninfested categories (Fig. 1).

The difference in average weight gain per bird between uninfested and infested group were found 0.02, 0.159, 0.520, 0.900, 0.811 and 0.678 kg in July, August, September, October, November and December respectively (Fig. 1). The data were not taken after December because the *Gallacanthus cornutus* population drastically decline in the winter months (due to low environmental temperature) at Purola (Uttarkashi) (altitude 1500 meters from sea level). An examination of Figure 1 demonstrated that weight gain differences were increased up to the month of October followed by decline in two succeeding months. Obviously, the *G. cornutus* affect more in young chicken as compared to older ones. Furthermore, an attempt was also made to analyze the data statistically. Two tailed paired t-test was found significant between weight gain in uninfested and infested birds ($t(4) = 4.702$, $p = 0.005$).

Discussion

Poultry or chicken are reared for the purpose of human welfare as a rich source of protein in the shortest possible time. Egg, meat and feathers are the main products which are very important for human beings. Workers of the field have studied the effect of ectoparasites on the productivity of the birds. Most of the workers have investigated the effect of *Eomenacanthus stramineus* on chicken weight gain and egg production. The poultry of Uttarkashi (India) has found infested with *Gallacanthus cornutus*. This species is very fast runner over host body, haematophagous in nature intragenus to *Eomenacanthus stramineus* (KUMAR & KUMAR 2010). The sharp mandibles and other mouthparts of *Gallacanthus cornutus* are well equipped for piercing and sucking the blood of host birds (TRIVEDI *et al.* 1990). So this parasite might cause severe nuisance in chicken. Thus, in the present study author has made an attempt to investigate the effect of *G. cornutus* on chicken productivity. An examination of data indicates that *G. cornutus* able to reduce as much as 900 gm body weight decrease per bird (Fig. 1). Young chicken were more affected than the older ones. Young chicken does not have skilful in lice checking behaviour (e.g. preening, grooming and dusting etc.) and they have soft skin and feathers for feeding and hiding to parasites.

There are some conflicting reports published on economic importance of chicken body louse, *Eomenacanthus stramineus*. Some workers like have found no significant difference between two groups of laying hens TRIVEDI *et al.* 1990, STOCKDALE & RAUN 1960). While majority of workers have reported significant difference between uninfested and infested birds (EDGAR & KING 1950, GLEES & RAUN 1959, DE VANEY 1976, PANDA & AHLUWALIA 1983). However, in the present studies, authors have made first attempt to study the effect of *Gallacanthus cornutus* on the meat production. An analysis of data obtained through experimentation indicates that *G. cornutus* significantly decreases

the meat production (Fig. 1). The two tailed t-test between the uninfested and infested birds in relation to productivity of birds were found significant at 5 % level.

The combined population of Ischnoceran species *Columbicola columbae* (L.) and *Campanulotes bidentatus compar* (BURMEISTER) infesting rock pigeon have not shown significant loss in host fitness (CLAYTON & TOMPKINS 1995). However, *Gallacanthus cornutus* cause severe weight loss in poultry birds. Mortality has been recorded in juvenile American white pelican by hemorrhagic ulcerative stomatitis which is infested with menoponid louse, *Piagetrella peralis* (LEIDY) (SAMUEL *et al.* 1982). Macroscopically multiple wounds and haemorrhages on skin surface and histologically in all cutaneous layers of muscles, liver, lungs and kidneys have also recorded in infested host body (PRELEZOV *et al.* 2006). Furthermore, tissue hyperaemia, haemorrhages, pseudoeosinophilic and lytiocytic infiltration in the hens have also been recorded having mix infestation of biting lice *Gallacanthus cornutus*, *Eomenacanthus stramineus*, *Menopon gallinae* and *Goniocotes gallinae* (DE GEER). During the present experimentation, death of chicken has also been recorded but there is no manifestation of hemorrhagic condition appeared. Heavy and very heavily infested bird has been found lethargic in condition and finally such bird might die within 15 days due to anaemia. The present investigation has shown that *Gallacanthus cornutus* cause significant decrease in body weight. It means it decrease the meat production. Obviously, it causes great loss to the poultry industry as well as the economy of any country. So, poultrymen need to be careful about the infestation of *G. cornutus* and their proper control.

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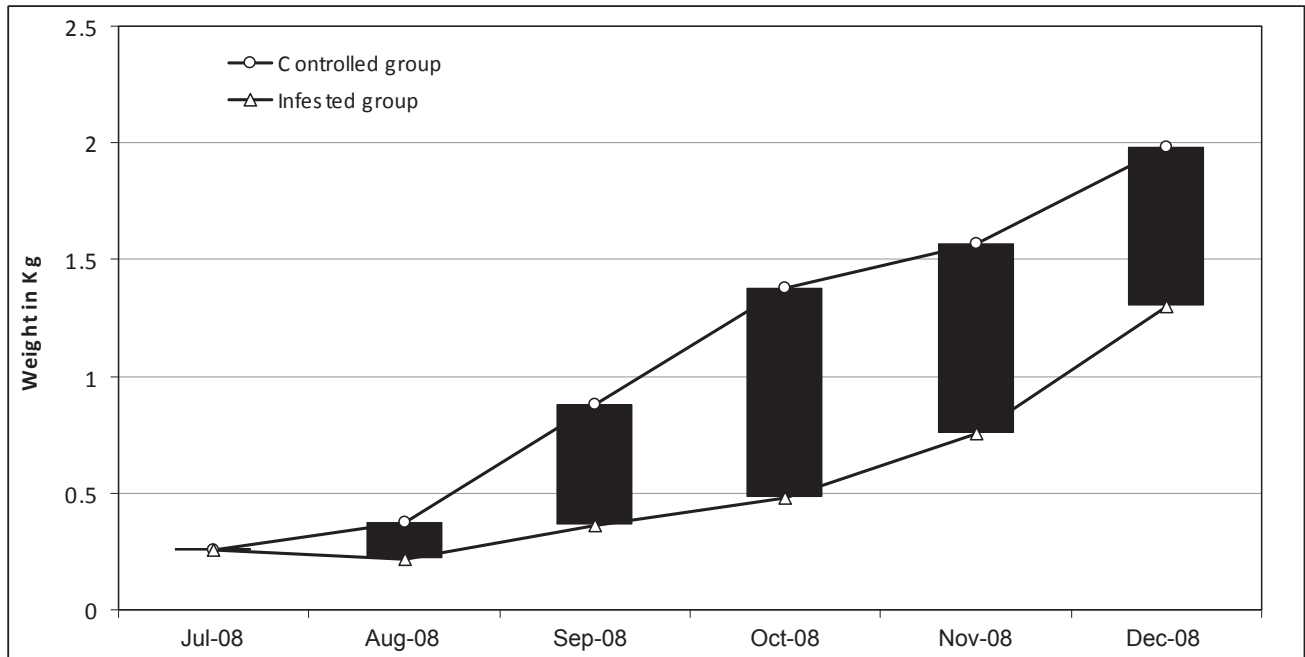


Fig. 1. Illustrating the effect of *Gallacanthus cornutus* (SCHÖMMER) on the average weight gain in infested and uninfested chicken.

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Literature

- ARENDS, J. J. (1997): External parasites and poultry pest. Pp. 785–813. – In: CALNEK, B. W. (ed.): Disease of poultry. – Iowa State University Press, America.
- BARTLETT, C. M. (1993): Lice (Amblycera and Ischnocera) as vectors of *Eulimdana* sp. (Nematoda: Filaroidea) in charadiiform birds and the necessity of short reproductive periods of adult worms. – *Journal of Parasitology* **79**, 85–91.
- BOOTH, D. T., D. H. CLAYTON & B. A. BLOCK (1993): Experimental demonstration of the energetic cost of parasitism in free range hosts. – *Proceeding of the Royal Society of London* **253**, 125–129.
- BROWN, N. S. (1974): The effect of louse infestation wet feather and relative humidity on grooming behaviour of the domestic chicken. – *Poultry Science* **51**, 162–164.
- CHALMERS, K. & W. A. G. CHARLESTON (1981): Lice do they affect live weight? – *New Zealand Journal of Agriculture Research* **142**(4), 27–28.
- CHENG, T. C. (1964): *The Biology of Animal Parasites*. Pp. 573–578. In: – London (W. B. Saunders Company, Philadelphia)
- CLAYTON, D. H. (1990): Mate Choice in experimentally parasitized rock doves: Lousy males lose. – *American Zoologist* **30**, 251–262.
- & D. M. TOMPKINS (1995): Comparative effects of mites and lice on the reproductive success of rock doves (*Columba livia*). – *Parasitology* **110**, 195–206.
- COTGREAVE, P. & D. H. CLAYTON (1994): Comparative analysis of time spent grooming by birds in relation to parasite load. – *Behaviour* **131**, 171–187.
- DE VANEY, J. A. (1976): Effects of the chicken body louse, *Menacanthus stramineus* on caged layers. – *Poultry Science* **55**, 430–435.
- , L. D. ROWE & T. M. CRAIG (1988): Density and distribution of three species of lice on calves in central Texas. – *Southwestern Entomology* **3**, 125–130.
- DERYLO, A. (1972): Aktualnu stan, badania and rola epizootiologiczna Wszolow (Mallophaga). – *Wiadomości parazytologiczne* **18**, 531–533.
- (1974 a): Studies on the economic harmfulness of the Mallophaga. II. The influence of Mallophagian invasion on the health in state of hens and turkeys. – *Medycyna Veterinary* **30** (6), 353–357.
- (1974 b): Studies on the economic harmfulness of the Mallophaga. I. The influence of lice infestation on egg laying and hatching in hens. – *Medycyna Veterinary* **30** (6), 406–410.
- & J. JAROSZ (1972): Mikroflora jelitowa niektórych wszolow haematofagicznych. – *Wiadomości parazytologiczne* **18**, 113–119.

- DRUMMOND, R. O., G. LAMBERT, H. E. SMALLEY JR. & C. E. TERRILL (1981): Estimated losses of livestock to pests. Pp. 111–127. – In: CRC Handbook of pest management. – Boca Raton, Florida (CRC Press Inc 1).
- DURDEN, L. A. (2001): Lice (Phthiraptera). Pp. 3–17. – In: SAMUEL, W. M., M. J. PYBUS & A. A. KOCAN (eds.): Parasitic diseases of wild mammals. – Iowa State University Press, America.
- (2002): Lice (Phthiraptera). Pp. 45–65. – In: MULLEN, G. R. & L. A. DURDEN (eds.): Medical and Veterinary Entomology. – San Diego (Academic press).
- EDGAR, S. A. & D. F. KING (1950): Effect of the louse, *Eomenacanthus stramineus* on mature chicken. – Poultry Science **29**, 214–219.
- EL-KIFL, A. H., A. WAHAB, M. K. KAMEL & W. A. E. ABDEL (1973): Poultry ectoparasites in sharikia Governorate. – Agriculture Review **51**, 113–120.
- FABIYI, J. P. (1986): Exclusion in Nigeria of chickens and guinea-fowls from the host range of *Menacanthus stramineus* (Mallophaga: Insecta). – Revue D' Elevage et de Medicine Veterinaire des Pays Tropicaux **39**, 377–379.
- GLEES, E. E. & E. S. RAUN (1959): Effects of chicken body louse infestation on egg production. – Journal of Economic Entomology **52** (2), 358–359.
- HOWITT, B. F., H. R. DODGE, L. K. BISHOP & R. H. GORRIE (1948): Virus of Eastern equine encephalomyelitis isolated from chicken mites (*Dermanyssus gallinae*) and chicken lice (*Eomenacanthus stramineus*). – Proceedings of the Society for Experimental Biology and Medicine **68**, 622–625.
- JUNGMANN, R., R. RIBBECK, S. EISENBLÄTTER & H. SCHEMATUS (1970): Zur Schadwirkung und Bekämpfung des *Dermanyssus-gallinae*- und Federlingsbefalls bei Legehennen. – Monatshefte für Veterinärmedizin **25**, 28–32.
- KALAMARZ, E. (1963 a): Badania nad biologią Mallophaga I. Zastosowanie izotopu żelaza (Fe^{59}) w badaniach nad składem pokarmu piórojadów (Mallophaga), bytujących na kurach (*Gallus domesticus* L.). – Zeszyty Naukowe Wyzsz. Szkoły Roln. w Olsztynie (Olsztyn) **15**, 247–251.
- (1963 b): Badania nad biologią Mallophaga II. Krew jako pokarm larw piórojadów *Menopon gallinae* (L.) i *Menacanthus stramineus* (Nitzsch), oraz niektóre inne obserwacje nad biologią tych gatunków larvae and some other observation on the biology of these species. – Zeszyty Naukowe Wyzsz. Szkoły Roln. w Olsztynie (Olsztyn) **15**, 253–260.
- KETTLE, P. R. (1985): Lice and keds. Pp. 9–13. – In: CHARLSTON, W. A. G. (ed.): Ectoparasites of sheep in New Zealand and their control. – New Zealand Veterinary Association and Beef Cattle Society.
- KIM, K. C., K. C. EMERSON & R. D. PRICE (1973): Lice. Pp. 376–397. – In: FLYNN, R. J. (ed.): Parasites of laboratory animals. – Iowa State University Press, America.
- KUMAR, A. & R. KUMAR (2010): Effect of chicken body louse *Gallacanthus cornutus* (SCHÖMMER) (Insecta, Phthiraptera, Amblycera) on the preening behaviour of Domestic fowl *Gallus gallus* forma domestica. – Rudolstädter naturhistorische Schriften **16**, 93–97.
- KUNZ, S. E., K. D. MURRELL & G. LAMBERT (1991): Estimated loss of livestock to pests. Pp. 69–98. – In: PIMENTEL, D. (ed.): CRC Handbook of Pest Management on Agriculture **2**(1).
- LOOMIS, E. C. (1978): External parasites. Pp. 667–704. – In: HOFATAD, M. S. *et al.* (eds.). Disease of poultry. – Iowa state University Press, America.
- MEYER, H. J. & D. D. KOOP (1987): Biting and sucking lice on North Dakota cattle. – Grand Forks ND: Cooperative Extension Service, North Dakota University.
- NELSON, W. A., J. F. BELL, C. M. CLIFFORD & J. E. KEIRANS (1977): Interaction of ectoparasites and their hosts. – Journal of Medical Entomology **13**, 389–428.
- , J. E. KEIRANS, J. E. BELL & C. M. CLIFFORD (1975): Host Ectoparasite Relationship. – Journal of Medical Entomology **12** (2), 143–166.
- OKAEME, A. N. (1989): Lameness associated with ectoparasitic infestation in *Numidia meleagris galeata*, *Gallus domestica*, *Pavo multicus* [sic]. – Bulletin Animal Health Production **37**, 189–190.
- OLITSKY, P. K. & J. CASAL (1959): Arthropod born group: A virus infection of man. Pp. 286–304 – In: RIVERS, T. M. & F. L. HORSEFALL (eds): Viral and rickettsial infections of man, 3rd edition. – Philadelphia, Lippincott.
- PANDA, D. N. & S. S. AHLUWALIA (1983): Effect of *Menacanthus stramineus* and *Lipeurus tropicalis* infestation on weight gain in broiler birds. – Indian Veterinary Journal **60** (2), 85–87.
- PRELEZOV, P.N., N. I. GROSEVA & D. I. GOUNDASHEVA (2006): Pathomorphological changes in the tissues of chicken, experimentally infected with biting lice (Insecta: Phthiraptera). – Veterinarski Archiv **76**, 207–215.
- PRICE, M. A. & O. H. GRAHAM (1997): Chewing and sucking lice as parasites of mammals and birds. – USPA, Agricultural research service, Technical Bulletin No. 1849.
- REDPATH, S. (1988): Vigilance level in preening Dunlin *Calidris alpina*. – Ibis **130**, 555–557.
- SAMUEL, W. M., E. S. WILLIAMS & A. B. RIPPIN (1982): Infestation of *Piagetialla peralis* (Mallophaga: Menoponidae) of juvenile white pelicans. – Canadian Journal Zoology **60**, 951–953.
- SAXENA, A. K., G. P. AGARWAL, S. CHANDRA & O. P. SINGH (1985): Pathogenic involvement of Mallophaga. – Zeitschrift für Angewandte Entomologie **99**, 294 – 301.
- SCHMIDT-NELSON, K. (1987): Animal physiology: adaptation and environment. – Cambridge, University Press.
- SEAGER, S. W., E. L. SCHILLER, W. J. L. SLADEN & M. TRIPS (1976): A Mallophaga, *Trinoton anserium*, as a cyclodevelopmental vector for a Heartworm parasite of a waterfowl. – Science **194**, 739–741.
- SOULSBY, E. J. L. (1982): Helminths, Arthropods and Protozoa of Domesticated Animals. 7th Edition. – London (Baillere Tindall and Cassell Ltd.). [Pp. 366–387].

- STOCKDALE, H. J. & E. S. RAUN (1960): Economic importance of the chicken body louse. – *Journal of Medical Entomology* **53**(3), 421–423.
- TOFT, C. A., A. AESCHLIMANN & L. BOLIS (1991): Parasite-host associations: coexistence or conflict. – Oxford (University Press).
- TRIVEDI, M. C., S. SHARMA, B. S. RAWAT & A. K. SAXENA (1990): Haematophagous nature of an amblyceran phthirapteran *Menacanthus cornutus* Schommer infesting poultry bird *Gallus gallus domesticus* L. in India. – *Journal of Applied Entomology* **110**, 107–111.
- WARREN, D. C., R. EATON & H. SMITH (1948): Influence of infestation of body lice on egg production in the hen. – *Poultry Science* **27**, 641–642.
- WATERSTON, J. (1926): On the crop contents of certain Mallophaga. – *Proceeding of the Royal Society of London* **96**, 1017–1020.