PERKOW, W., 1976: Wirksubstanzen der Pflanzenschutz- und Schädlingsbekämpfungsmittel. Loseblatt-Sammlung, Stand: Feb. 1976, Berlin und Hamburg: Paul Parey.
SCOPES, N. E. A.; LICHTENSTEIN, E. P., 1967: The use of *Folsomia fimetaria* and *Drosophila melanogaster* as test insects for the detection of insecticide residues. J. econ. Entomol. *60*, 1539–1541.
SKATULLA, U., 1975: Über die Wirkung des Entwicklungshemmers Dimilin auf Forstinsekten. Anz. Schädlingskde., Pflanzenschutz, Umweltschutz *48*, 145–147.
THOMPSON, A. R., 1973: Persistence of biological activity of seven insecticides in soil assayed with *Folsomia candida*. J. econ. Entomol. *66*, 855–857.
THOMPSON, A. R.; GORE, F. L., 1972: Toxicity of twenty-nine insecticides to *Folsomia candida*: laboratory studies. J. econ. Entomol. *65*, 1255–1260.
TOMLIN, A. D., 1975: Toxicity of soil applications of insecticides to three species of springtails (Collembola) under laboratory conditions. Can. Ent. *107*, 769–774.
TURNER, W. V.; KHALIFA, S.; CASIDA, J. E., 1975: Toxaphene toxicant A. Mixture of 2, 2, 5-endo, 6-exo, 8, 8, 9, 10-octachlorobornane and 2, 2, 5-endo, 6-exo, 8, 9, 9, 10-octa-chlorobornane. J. Agric. Fd.Chem. *23*, 991–994.
WEBER, E., 1967: Grundriß der Biologischen Statistik. Anwendungen der mathematischen Statistik in Naturwissenschaft und Technik. Stuttgart: G. Fischer.
WELLINGA, K.; MULDER, R.; DAALEN, J. J. VAN, 1973: Synthesis and laboratory evaluation of 1-(2,6-disubstituted benzoyl)-3-phenylureas a new class of insecticides. II. Influence of the acyl moiety on insecticidal activity. J. Agric. Fd. Chem. *21*, 993–998.
YU, S. J.; TERRIERE, L. C., 1977: Ecdysone metabolism by soluble enzymes from three species of Diptera and its inhibition by the Insect Growth Regulatur TH-6040. Pesticide Biochem. and Physiol. *7*, 48–55.
ZACHARIAE, G.; EBERT, K. H., 1970: Gefährdet chemische Schädlingsbekämpfung im Forst die Regenwürmer? Pedobiologia *10*, 407–433.

Anschrift des Verfassers: Dr. H. DOPPELREITER, Institut für Holzbiologie und Holzschutz, Leuschnerstr. 91d, D-2050 Hamburg 80

Department of Zoology, Banaras Hindu University, Varanasi, India

Studies on seasonal dynamics of Lipeurus lawrensis tropicalis Peters (Phthiraptera: Ischnocera) infesting poultry birds

By G. P. AGARWAL and A. K. SAXENA

Abstract

The population indices show constant relation with the rise or fall in temperature, during summer and winter months. Lice index (monthly mean/bird) increased from February–March corresponding the gradual increase in temperature. The peak index is obtained in May–June when there is a sharp increase in temperature. The lower index is seen from September–February, corresponding with the decline in temperature and increase in relative humidity.

1 Introduction

Seasonal changes in nature are very clearly reflected in organic life. It is, therefore, natural to expect that parasites, particularly the ectoparasites, also

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respond to the annual cycles of climatic changes. Among phthirapterans, specially the Mallophaga, inspite of the fact, that they live in relatively constant environment of their host feather's or hairs, even though they are not able to remain unaffected by the climaxes of seasonal changes (VON KELER 1969). Some of the mammalian as well as avian lice species have been studied from this point of view. DERYLO (1975) has briefly reviewed the effect of ecological factors on the intensity of avian Mallophaga. It is noticed that studies on the seasonal fluctuations in the population of mammalian lice have been made by CRAUFURD–BENSON (1941) and MATTHYSSE (1944) in *Bovicola bovis* (Linn.) infesting cattles; by SCOTT (1952) and MURRAY (1963a, 1968a and b) in *Damalinia ovis* (Schrank) infesting sheeps; by COWAN (1944) in some species of *Tricholipeurus* (Bedford) infesting black-tailed deer; by BENNET (in ANDERSON 1962), SAMUEL and TRAINER (1971) and WATSON and ANDERSON (1975) infesting white-tailed deer; by MURRAY (1963b) in *Damalinia equi* (Denny) infesting horses and by AMIN (1973) in *Heterodoxus spiniger* (Enderlain) infesting dogs, whereas little information on similar work on avian Mallophaga is also available from the work of WOODMAN and DICKE (1954) on *Bruelia vulgata* (Kellogg) infesting sparrow; by TOULESHKOV (1965) on some species of Mallophaga infesting *Sturnus vulgaris;* by BAUM (1968) on six species of mallophaga infesting black bird *Turdus m. merula;* and by EVELEIGH and THRELFALL (1976) on twelve species of Mallophaga infesting auks.

But to date no detailed study has been undertaken on the seasonal dynamics of avian Mallophaga. Therefore, the present study on one of the avian species has been undertaken.

2 Material and method

During the last two months of the year in 1976 and entire year 1977, 50 birds were banded (ringed) and examined from this point of view. These birds were kept under ideal conditions in Banaras Hindu University Agricultural Poultry Farm. A record of daily maximum-minimum temperature and relative humidity was maintained and mean monthly values were determined (table I).

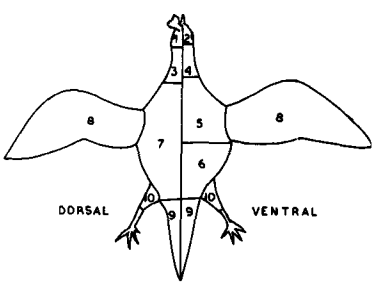

Fig. 1. Body regions of host examined. – 1. crown, 2. gular, 3. nape, 4. neck, 5. breast, 6. abdomen, 7. back, 8. wing, 9. tail, 10. leg

To find out the changes in the population and distribution of lice on the host, each bird was examined at weekly intervals. Experimental birds were handled with great care so that no damage is done to them, as well as to the lice population present on them. Each bird was thoroughly searched for the presence of lice by deflecting feathers. The use of a magnifying lens was quite helpful to locate the lice on the feathers. Like this the number of lice present on each feather (in situ) is assessed and an approximate total population of lice on the bird is determined. As this species is a sluggish one and does not move fastly from one part of the body to the other part, there

was no difficulty in locating them. Eventhough some birds were sedated with the help of ether and the count of the entire population of lice in different regions of body was made to confirm the data obtained by previous method. For accounting the distribution of lice on different parts of the body, the entire body of host is arbitrarily divided into ten regions viz. crown, gular, nape, neck, breast, abdomen, back, wing, tail and legs (fig. 1).

3 Results

As far as fourteen species of Mallophaga are reported to occur on poultry bird *Gallus domesticus* (L.) but only one species *Lipeurus lawrensis tropicalis* Peters, is found infesting the domesticated poultry birds of Banaras Hindu University Agricultural Poultry Farm. The frequency and intensity of infestation of *L. lawrensis tropicalis* during different months of the year is given in table 1, and figs. 2, 3. The relative abundance of the lice on different parts of the body of theo host is shown in table 2. During the winter months (late October–early February) when the atmospheric temperature is low and relative humidity is

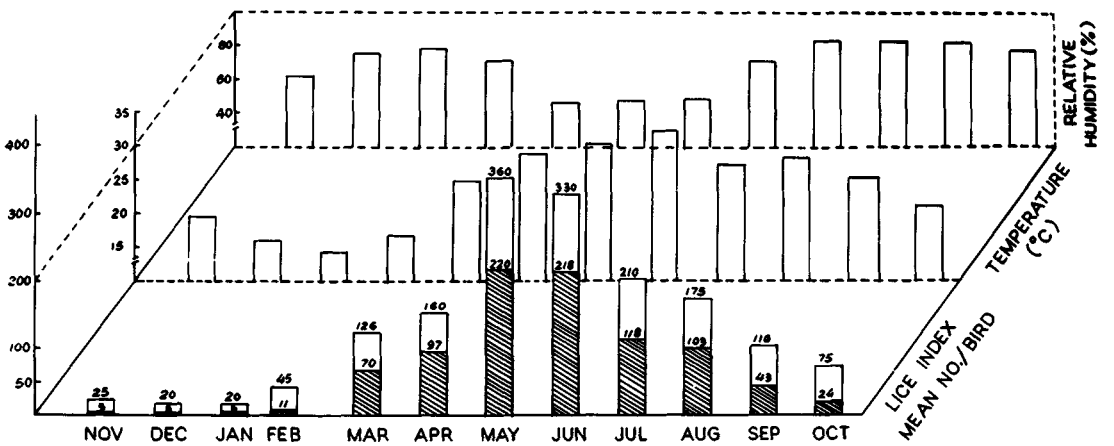

Fig. 2. Seasonal dynamics of *Lipeurus lawrensis tropicalis* compared with mean monthly temperature (°C) and mean monthly relative humidity (%) □ adults ▨ nymphs

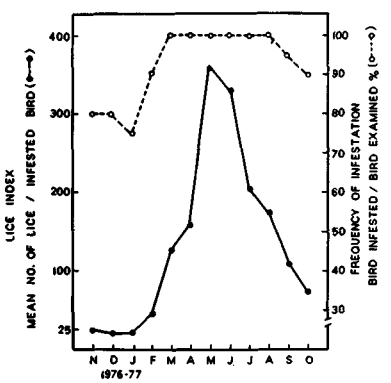

Fig. 3. Seasonal dynamics of *Lipeurus lawrensis tropicalis*

Table 1. Showing the frequency and intensity of infestation of *Lipeurus lawrensis tropicalis* Peters during different months of a year. The temperature and relative humidity for each month is also shown

Month	No. of birds examined	No. of birds infested (% in parenthesis)	Number of lice/Infesting bird adults (% in parenthesis)	nymphs (% in parenthesis)	mean no. of lice	Min./max. of lice/bird	Temperature °C max.	min.	mean	Relative humidity % max.	min.	mean
Nov 1976	50	40 (80)	20 (80)	5 (20)	25	12–46	25.5	13.6	19.55	69.7	54.2	61.95
Dec	50	40 (80)	15 (75)	5 (25)	20	7–42	23.0	8.0	15.95	84.3	68.1	76.20
Jan 1977	50	37 (74)	15 (75)	5 (25)	20	10–36	21.0	8.4	14.7	87.3	70.5	78.9
Feb	50	45 (90)	34 (76.5)	11 (24.5)	45	20–56	24.1	10.1	17.1	81.4	60.1	70.75
March	49	49 (100)	56 (44.5)	70 (55.5)	126	56–150	33.4	16.1	24.75	59.7	30.0	46.35
April	49	49 (100)	63 (39.5)	97 (60.5)	160	110–190	36.9	21.8	29.35	64.1	29.8	46.95
May	46	46 (100)	140 (39)	220 (61)	360	150–490	37.5	25.1	31.5	61.4	37.2	49.30
June	43	43 (100)	112 (33.9)	218 (66.0)	330	136–430	36.8	28.2	32.5	78.5	64.4	71.45
July	43	43 (100)	92 (44)	118 (56)	210	140–310	28.6	25.9	27.55	89.8	76.7	33.25
August	41	41 (100)	72 (41.2)	103 (58.8)	175	80–200	31.6	26.1	26.5	89.9	76.0	82.95
Sept	40	38 (95)	67 (60.9)	43 (39.0)	110	56–170	27.7	22.8	25.25	89.0	75.2	82.1
Oct	40	36 (90)	51 (68.0)	24 (32.0)	75	48–110	26.3	16.2	21.25	84.0	69.7	76.6

Table 2. Relative abundance of *Lipeurus lawrensis tropicalis* Peters on different parts of the body of poultry bird *Gallus domesticus* (L.) during different months of the year (Nov 1976 to Oct 1977)

Months of the year	Regions of the body crown	gular	nape	neck	breast	abdomen	back	wing	tail	leg
Nov 1976	+ +	+	+ +	+	+	−	−	+ +	− −	− −
Dec	+ +	+	+ +	+	+	−	−	+ +	− −	− −
Jan 1977	+ +	+	+	+	+ +	−	−	+ +	− −	− −
Feb	+ +	+	+ +	+	+ +	−	+	+ +	− −	− −
March	+ +	+	+ +	+ +	+ +	+	+ +	+ +	+	− −
April	+ +	+	+ +	+ +	+ +	+ +	+ +	+ +	+ +	− −
May	+ +	+	+ +	+ +	+ +	+ +	+ +	+ +	+ +	+
June	+ +	+	+ +	+ +	+ +	+ +	+ +	+ +	+ +	+
July	+ +	+	+ +	+ +	+ +	+ +	+ +	+ +	+ +	+
August	+ +	+	+ +	+ +	+ +	+ +	+ +	+ +	+ +	+
Sept	+ +	+	+ +	+ +	+ +	+	+ +	+ +	+	−
Oct	+ +	+	+ +	+	+	−	+	+ +	+	− −

+ + high, + moderate, − slight, − − nil

sufficiently high, the population density of lice on each bird is extremely low while the percentage of adult population is higher than the nymphal population (ratio varies from 4:1 to 3:1). As atmospheric temperature rises the relative humidity decreases during spring season (late February to early March) there is a rise in the population density of lice and the adult nymph ratio also changes from 3:1 to 2:2. The further rise in temperature and decrease in relative humidity during the summer season (March to early July) causes the population of lice to reach its climax but the ratio of adult becomes low (1:2). During rainy season (late July–early October) the population of lice shows a decline trend which gradually goes on decreasing in the autumn months (late July to early October) whereas the adult nymph ratio shows a change from 1:2 to 2:2.5 in July and reaches 3:1 in September and October.

Since the poultry birds are domesticated birds and live in close association to each other, the frequency of infestation cannot be of so importance. Even though there is a decrease in infestation (75–80 %) during winter months (late November, December and early February) (table 1) but 100 % infestation was noticed from the month of March to September and it decreases up to 90 % in the month of February and October.

4 Discussion

This study shows that there is a direct correlation between the prevalence of infestation and environmental factors i. e. temperature and relative humidity. Lice index remained at low level during the winter months (November–mid February) when atmospheric temperature is low and humidity is considerably high. The lice index increases in February–March corresponding the gradual increase in atmospheric temperature and decrease in relative humidity. The peak index is obtained during May–June which is caused by a sharp increase in atmospheric temperature and decrease in relative humidity (figs. 2, 3). More or less similar findings are reported for *Bruelia vulgata* infesting sparrows (WOODMAN and DICKE 1954); in some species of Mallophaga infesting *Sturnus vulgaris* (TOULESHKOV 1965) and in several species of *Saemundssonia, Cummingsiella* and *Austromenopon* infesting auks (EVELEIGH and THRELFALL 1976). However, BAUM (1968) has pointed out that there is no basic difference in annual fluctuation of population of amblyceran and ischnoceran mallophaga, but VON KELER (1969) has clearly mentioned the occurrence of seasonal variations in the density of mallophagan populations by having maxima in winter and summer and minima in spring and autumn. Furthermore during the period of increasing infestation, it is noticed that nymphal population dominated over the adult population. Whereas in mammalian species of lice the population rises during the winter months instead of summer months as in *Bovicola bovis* infesting cattles (CRAUFURD-BENSON 1941 and MATTHYSSE 1944); in *Damalinia ovis* infesting sheeps (SCOTT 1952; MURRAY 1963a, 1968a and b); in some species of *Tricholipeurus* infesting black and white-tailed deer (COWAN 1944; BENNETT in: ANDERSON 1962; SAMUEL and TRAINER 1971; WATSON and ANDERSON 1975); in *Damalinia equi* infesting horses (MURRAY 1963b). But the population of *Heterodoxus spiniger* is higher during the spring (May) instead in winter months (November–December) (AMIN 1973).

Therefore, it is concluded that the infestation of *L. lawrensis tropicalis*

depends upon the external environmental factors and on the seasonal variations.

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Zusammenfassung

Untersuchungen zur Saisondynamik des Federlings Lipeurus lawrensis tropicalis Pet. (Phthiraptera, Ischnocera) bei Geflügel

Die Populations-Indices von *L. lawrensis tropicalis* zeigten während der Sommer- und Wintermonate konstante Relationen zwischen dem Auftreten des Mallophagen am Geflügel und der Außentemperatur. Der Spitzenindex wurde – nach starkem Temperaturanstieg – im Mai/Juni erreicht. Der Minimalindex wurde zwischen September und Februar bei niedriger Temperatur aber relativ hoher Luftfeuchtigkeit beobachtet.

References

AMIN, O. M., 1973: Distribution and seasonal dynamics of a tick, a louse fly, and a louse infesting dogs in the Nile Valley and Delta of Egypt. J. Med. Ent. *10*, 295–298.

DERYLO, A., 1975: Investigations on economic disadvantage of Mallophaga. VI. An Influence of Ecological and Physiological factors on the intensity of Mallophaga infestation. Prz. Zool. *19*, 181–187.

ANDERSON, R. C., 1962: The helminth and arthropod parasites of white tailed deer *(Odocoileus virginianus)*: a general review. Trans. Roy. Can. Inst. *34*, 57–92.

ASH, J. S., 1960: A study of Mallophaga of birds with particular reference to their ecology. Ibis *102*, 93–110.

BAUM, H., 1968: Biologie und Ökologie der Amsel-Federläuse. Angew. Parasitol. *9*, 129–175.

COWAN, I. Mct., 1946: Parasites, diseases, injuries and anamolies of Columbia black-tailed deer (*Odocoileus hemionus columbianus* [Richardson]) in British Columbia. Can. J. Res. *24*, 71–103.

CRAUFURD-BENSON, H. J., 1941: The cattle lice of great Britain. Parasitology *33*, 331–358.

EVELEIGH, E. S.; W. THRELFALL, 1976: Population dynamics of lice (Mallophaga) on auks (Alcidae) from Newfoundland. Can. J. Zool. *54*, 1694–1711.

KELER, S. VON (1969). 17. Ordnung Mallophaga (Federlinge und Haarlinge). In: HELMCKE, J. G., STARCK, D.; WERMUTH, H. (eds.), Handbuch der Zoologie *4* (2) Lfg. 10, 1–72.

MATTHYSSE, J. G. 1944. Biology of the cattle biting louse and notes on the cattle sucking lice. J. Econ. Ent. *37*, 436–442.

— 1946. Cattle lice, their biology and control. N. Y. Agric. Exp. Stn. Bull. *832*, 1–67.

MURRAY, M. D., 1963a: The ecology of lice on sheep V. The influence of heavy rains on population of *Damalinia ovis* (L.). Aust. J. Zool. *11*, 173–82.

— 1963b: Influence of temperature on the reproduction of *Damalinia equi* (Denny). Aust. J. Zool. *11*, 183–189.

— 1968: Ecology of lice on sheep VI. The influence of shearing and solar radiation on populations and transmission of *Damalinia ovis*. Aust. J. Zool. *16*, 725–738.

MURRAY, M. D.; GORDON, G., 1968: Ecology of lice on sheep VII. Population dynamics of *Damalinia ovis* (Schrank). Aust. J. Zool. *16*, 179–186.

SAMUEL, W. M.; TRAINER, D. O., 1971: Seasonal fluctuations of *Tricholipeurus parallelus* (Osborn 1896) (Mallophaga: Trichodectidae) on white-tailed deer (*Odocoileus virginianus* Zimmermann) 1780 from South Texas. Amer. Mid. Nat. *85*, 507–13.

SCOTT, M. T. 1952: Observations on the bionomics of the sheep body louse *(Damalinia ovis)*. Aust. J. Agric. Res. *3*, 60–70.

TOULESHKOV, K., 1965: Mallophaga (Insecta) – Ectoparasites on the starling (*Sturnus vulgaris* L.). Izv. Zool. Inst. (Sofija) *19*, 175–187.

WATSON, T. G.; ANDERSON, R. C., 1975: Seasonal changes in louse population on white-tailed deer *(Odocoileus virginianus)*. Can. J. Zool. *53*, 1047–1054.
WOODMAN, W. J.; DICKE, R. J., 1954: Population fluctuations of mallophagan parasite *Bruelia vulgata* (Kellogg) upon the sparrow. Trans. Wisconsin Acad. Sci. *43*, 133–35.

Authors' address: Dept. of Zoology, Banaras Hindu University, Varanasi – 221005, India

A study on the phenology and ecology of the green stink bug Nezara viridula L. (Heteroptera: Pentatomidae)

By M. A. ALI, A. M. AWADALLAH, and A. A. EL-RAHMAN

Abstract

The population of the green stink bug *Nezara viridula* L. was estimated by conducting periodic survey during the years 1975 and 1976. It was expressed as number per 100 double strokes. Overwintering adults resumed activity by mid of March, and the population attained its maximum by mid of April. The number of adults in either spring or late summer correlated closely with population size of nymphs. All nymphs developing in August produced adults that entered hibernal diapause. The insect had 4 generations in 1975, while only 3 generations were recorded in 1976. The overall sex ratio among field collected bugs was aproximately ♀ : ♂, 1 : 1.

The effect of daily mean temperature, daily mean rel. humidity and day-length on the population density of the green stink bug was investigated. A positive relationship was found between insect population density and each of daily mean temperature and day lenght, while rel. humidity showed different relations depending on season and year. The partial regression values and the percentages of the explained variance showed that the effect of the three climatic factors was high only in spring. These values also denote that there are other environmental and biological factors that play a great role in the variability of the population dynamic of the green stink bug population particularly during summer.

1 Introduction

The green stink bug *Nezara viridula* L. is a polyvoltine species. It covers temperature and tropic areas, including southeastern Asia and Africa (MITCHEL and MAU 1969). In Egypt, it was recorded by WILLCOCKS (1924) on okra, later it became a serious pest on cotton (KAMAL 1937), on vegetable crops and recently on citrus trees (ATTIAH et al. 1974). One generation is produced in the spring and one to three generations during summer and autumn (KAMAL 1937; CUMBER and EVERET 1950; KIRITANI et al. 1967; RIZZO et al. 1968). The adults of fall generations undergo a hibernal diapause and last almost 4 months from mid September to mid January (PESCOTT 1940; KIRITANI and HOKYO 1970). Survival rate of winter population is greatly influenced by the environmental conditions, especially low temperature. Males usually severe great mortality throughout winter due to their heterogametic composition (WIGGLESWORTH 1953; ANDERESEN 1961; KIRITANI et al. 1962).

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