Intrinsic Rate of Natural Increase of Five Species of Ischnoceran Lice (Insecta: Phthiraptera) from India

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INTRINSIC RATE OF NATURAL INCREASE OF FIVE SPECIES OF ISCHNOCERAN LICE (INSECTA: PHTHIRAPTERA) FROM INDIA[1]

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ABSTRACT: Five ischnoceran lice (*Brueelia cyclothorax, Sturnidoecus bannoo, Neopsittaconirmus elbeli, Columbicola columbae* and *Anaticola crassicornis*) infesting the house sparrow, common myna, Indian parakeet, domestic pigeon and mallard duck, were reared *in vitro* conditions (35 ± 1°C, 75-82% RH, at a feather diet), to record the incubation period, adult longevity and daily egg rate. The data obtained were used to construct the life table and to determine the intrinsic rate of natural increase (r). The values of r of aforesaid species were 0.032, 0.049, 0.050, 0.053 and 0.074 female per day, respectively. Likewise, the doubling time of the population differed, as follows, 21.35, 14.21, 13.93, 14.2 and 9.01 days, respectively. The results indicate that reproductive potentials of different phthirapteran species exhibit considerable variation.

KEY WORDS: Intrinsic rate of natural increase, r, Ischnocera, Phthiraptera, India, *Brueelia cyclothorax, Sturnidoecus bannoo, Neopsittaconirmus elbeli, Columbicola columbae* and *Anaticola crassicornis,* life table analysis

In vitro experimentations on avian lice (in order to record the bionomics) have been made from time to time (Saxena et al., 2007). However, the data obtained from *in vitro* experimentations were not utilized for estimation of intrinsic rate of natural increase (r) and for the construction of life tables. Such attempts have been made in the case of two avian lice e.g. poultry fluff louse, *Goniocotes gallinae* (Saxena et al*.,* 2007) and an Indian red avadavat louse, *Brueelia amandavae* (Gupta et al., 2007). The intrinsic rate of natural increase of two mammalian lice i.e. sheep louse, *Bovicola bovis* (Murray and Gordon, 1969) and a rodent louse, *Geomydoecus oregonus* (Rust, 1974) have been noted. The values of r of the aforesaid species differed significantly. Hence, it was found worthwhile to work out the life table statistics of a few more ischnoceran species, infesting different avian hosts. In the present report, an attempt has been made to compare the value of r of five ischnoceran lice: *Neopsittaconirmus elbeli* Guimaraes, 1974 from Indian Parakeet (*Psittacula eupatria* L), *Sturnidoecus bannoo* Ansari, 1955 from Common Myna (*Acridotheres tristis*, L), *Brueelia cyclothorax* (Burmeister, 1838) from House Sparrow (*Passer domesticus* L), *Anaticola crassicornis* (Scopoli, 1763) from Mallard Duck (*Anus platyrhynchos* L) and *Columbicola columbae* (Linnaeus, 1758) from Rock Pigeon (*Columba livia* Gmelian), on the basis of results obtained from *in vitro* rearing.

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METHODS

Feathers bearing fresh eggs of aforesaid lice were gently cut from host body and incubated in culture vials (at 35±1°C, 75-82% RH), to record the incubation period. The first nymphal instars so obtained were removed day wise and further reared till adulthood (on host feather diet), to derive information regarding the duration of three nymphal instars. Three colonies of apparently freshly moulted healthier adults (in each case) were reared to obtain information about the adult longevity (35 ± 1°C, 75-82% RH, on host feather diet). Culture vials were examined daily to record the number of survivors and the numbers of eggs laid. Detailed rearing technique has already been discussed elsewhere (Saxena et al., 2007 and Gupta et al., 2007). The intrinsic rates of natural increase of each louse was calculated by using the formula $\sum e^{-rm_x} l_x m_x = 1$, where e is the base of natural logarithm, x is the age of individual in days, l_x is the number of individuals alive at age x, as the proportion of 1, and m_x is the number of female offspring produced/female in the age intervals x (Howe, 1953). The net reproductive rate ($R_o = \sum l_x m_x$), the innate capacity of increase ($r_c = \log_e R_o / T_c$), the precise generation time ($T = \log_e R_o / r_m$), and the finite rate of increase ($\lambda = e^{rm}$) were also determined. The doubling time was calculated by using the equation, $DT = \log 2 / \log \lambda$.

RESULTS AND DISCUSSION

The mean incubation period of the eggs of five ischnocerans varied from 4.8 – 5.7 days (range, 4-8 days) (Table 1). The average duration of first, second and third instar nymphs ranged from 5.1 – 7.1 (range, 4-10 days), 5.5 – 6.1 (range, 4-7 days) and 5.4 – 6.7 days (range, 4-8 days), respectively. Five lice exhibited considerable variation with respect to adult longevity. The males survived for an average of 9.7 – 18.4 days. Maximum survival of any male avian lice was 29 days (*C. columbae*). The female lice also exhibited nearly similar trend (12.0 – 23.0 days). A female of pigeon louse, *C. columbae* survived up to 32 days.

Five avian lice exhibited differences with respect to egg rates (Table 1). Reproductive rates of *B. cyclothorax* remained lowest (5.1 eggs/female during lifespan, at a rate 0.37 egg/day) in contrast to *C. columbae* (7.8 eggs/female during lifespan, 0.36 egg/day), *S. bannoo* (8.7 eggs/female during lifespan, 0.71 egg/day) and *N. elbeli* (8.9 eggs/female during lifespan, at a rate of 0.55 egg/day). The reproductive potential of duck louse, *A. crassicornis* appeared to be quite high (22.4 eggs/female during lifespan, at a rate 1.76 eggs/female/day).

Table 1. *In vitro* bionomics of five ischnoceran lice (*Brueelia cyclothorax, Sturnidoecus bannoo, Neopsittaconirmus elbeli, Columbicola columbae*, and *Anaticola crassicornis*), reared at 35 ± 1°C, 75-82% RH, at a feather diet.

Host bird	Species	Incubation period (days)	Duration of nymphal instars (days)			Adult longevity (days)		Egg rate	
			Ist instar	IInd instar	IIIrd instar	Male	Female	/female during lifespan	/female per day
House sparrow (*Passer domesticus*)	*Brueelia cyclothorax*	5.73 ± 0.77 (range 5-7 days, n= 90)	6.85 ± 0.80 (range 6-8 days, n= 73)	5.49 ± 0.61 (range 5-7 days, n= 49)	5.41 ± 0.64 (range 5-7 days, n= 24)	9.7 ± 4.1 (range 2-17 days, n= 90)	12.8 ± 5.8 (range 2-20 days, n= 90)	5.1	0.37
Common myna (*Acridotheres tristis*)	*Sturnidoecus bannoo*	4.80 ± 0.8 (range 4-6 days, n= 77)	5.43 ± 0.94 (range 4-7 days, n= 53)	5.56 ± 1.44 (range 5-7 days, n= 32)	5.92 ± 0.73 (range 5-7 days, n= 13)	8.9 ± 4.6 (range 2-19 days, n= 90)	12.0 ± 6.2 (range 3-25 days, n= 90)	8.7	0.71
Indian parakeet (*Psittacula eupatria*)	*Neopsittaconirmus elbeli*	5.02 ± 0.63 (range 4-6 days, n= 53)	6.02 ± 0.69 (range 5-7 days, n= 43)	6.11 ± 0.74 (range 5-7 days, n= 27)	5.77 ± 0.90 (range 4-7 days, n= 10)	11.1 ± 9.3 (range 2-21 days, n= 100)	15.5 ± 6.5 (range 3-27 days, n= 100)	8.9	0.55
Domestic pigeon (*Columba livia*)	*Columbicola columbae*	5.60 ± 1.03 (range 4-8 days, n= 33)	7.10 ± 1.20 (range 5-10 days, n= 29)	6.0 ± 0.59 (range 5-7 days, n = 25)	6.5 ± 0.66 (range 5-7 days, n= 13)	18.4 ± 6.9 (range 3-29 days, n= 150)	23.0 ± 6.5 (range 4-32 days, n= 150)	7.8	0.36
Mallard duck (*Anas platyrhynchos*)	*Anaticola crassicornis*	5.18 ± 0.89 (range 4-7 days, n= 71)	5.07 ± 0.77 (range 4-6 days, n= 53)	5.96 ± 0.85 (range 4-7 days, n= 29)	6.67 ± 0.94 (range 5-8 days, n= 15)	10.4 ± 4.8 (range 2-23 days, n= 90)	14.9 ± 7.7 (range 2-27 days, n= 90)	22.4	1.76

Table 2. Intrinsic rates of natural increase of five ischnoceran lice (*Brueelia cyclothorax, Sturnidoecus bannoo, Neopsittaconirmus elbeli, Columbicola columbae* and *Anaticola crassicornis*).

Species	Gross reproductive rate ($\sum m_x$) female eggs/ (female)	Net reproductive rate ($\sum l_x m_x$) female egg/ (female)	Mean generation length (Tc)	Doubling time (DT)	Finite rate of increase	Intrinsic rate (r_m) (female/ day)
Brueelia cyclothorax	4.7	2.9	34.2	21.35	1.033	0.032
Sturnidoecus bannoo	9.3	5.0	33.1	14.21	1.050	0.049
Neopsittaconirmus elbeli	7.9	5.2	33.5	13.93	1.051	0.050
Columbicola columbae	9.9	8.0	39.4	14.20	1.054	0.053
Anaticola crassicornis	29.2	14.4	36.6	9.01	1.080	0.074

Analysis of the life table of five ischnocerans (Table 2) indicated variation in the gross reproductive rate ($\sum m_x$). It remained 4.7 in case of *B. cyclothorax*, 7.9 for *N. elbeli*, and 9.3 for *S. bannoo*, 9.9 for *C. columbae* and 29.2 for *A. crassicornis.* Net reproductive rate ($\sum l_x m_x$) also exhibited similar trend accordingly (2.9 for *B. cyclothorax*, 5.0 for *S. bannoo*, 5.2 for *N. elbeli*, 8.0 for *C. columbae* and 14.4 for *A. crassicornis).* However, the mean length of generation time exhibited lesser variation. It varied from 33 to 37 days for four species (*S. bannoo, N. elbeli, B. cyclothorax* and *A. crassicornis*) and 39.4 for *C. columbae*. The values of intrinsic rates of natural increase were computed as 0.032 per day for the sparrow louse (*B. cyclothorax*), 0.049 for myna louse (*S. bannoo*), 0.050 for parrot louse (*N. elbeli*) and 0.053 for pigeon louse (*C. columbae*). Value of r of the duck louse, *A. crassicornis* was comparatively higher (0.074 female/day). Using these figures, the doubling time of duck louse, *A. crassicornis* appears to be 9.01 days. In contrast, the doubling time of the population of parakeet louse, *N. elbeli*, pigeon louse, *C. columbae* and myna louse, *S. bannoo* were recorded as 13.93, 14.20 and 14.21 days, respectively. However, the doubling time of sparrow louse, *B. cyclothorax* was 21.35 days. Since all the five species were not reared at the same period of the year, the impact of seasons on "r" still deserves investigation. However, clues regarding the mortality of lice at different stages can be obtained from Table 1 (*in vitro* condition). The overall results indicate that aforesaid lice may produce 9 to 11 generations per year.

Marshall (1981) has clearly stated that adequate information for the construction of life table is rarely available. Evans and Smith (1952) prepared the life table of *Pediculus humanus* (Anoplura), after making several assumptions. Survey of literature indicates that few workers have reared the avian lice, especially the ischnocerans, under *in vitro* condition (Martin, 1934; Arora and Chopra, 1959; Singh et al., 2001), but the data obtained has not been utilized for the construction of life table. However, the long term *in vitro* culturing remained more successful in the case of mammalian Ischnocera (Hopkins and Chamberlain, 1972; Rodriguez et al., 1986; Cruz et al., 1987; Kumar et al., 1993). Attempts to furnish information about the intrinsic rates of natural increase have been made in case of two mammalian Ischnocera. The value of r for sheep louse, *B. bovis* has been estimated as 0.053 per day (thus, doubling in 13-14 days) (Murray and Gordon, 1969). The value of r for rodent louse, *Geomydoecus oregonus* remained too low (0.006 per day indicating doubling after every 112 days) (Rust, 1974). The data clearly show that the reproductive potentials of different phthirapterans exhibit considerable diversity. Such information regarding the amblyceran avian lice deserves investigation. However, some clues regarding growth rate of chicken body louse, *Menacanthus stramineus* can be derived from selected papers dealing with its economic effects of parasitism. For instance, Glees and Raun (1952) released ten chicken body lice on each of the poultry birds and found that the numbers increased to 23,063 per bird, during a span of 14 weeks. Likewise, Stockdale and Raun (1965) released three adult females of

same louse species and found that the number could increase to 12,305 per bird in 16 weeks (indicating the rate of increase similar to *P. humanus*). However, Brown (1970), while demonstrating the effect of debeaking, found that a population of 56 chicken body lice increased to 1584 in 31 days, on debeaked birds, but it could not increase beyond 56-lice/birds on normal poultry birds. Recently, the value of r of two avian lice (poultry fluff louse, *G. gallinae* and red avadavat louse, *B. amandavae*) has been recorded as 0.07 and 0.031 per day, respectively (Saxena et al., 2007, Gupta et al., 2007). Present studies on the intrinsic rates of natural increase indicate that its value ranged from 0.032 to 0.074/day for five ischnoceran lice occurring on different kinds of birds (Indian parakeet, common myna, house sparrow, mallard duck and blue rock pigeon), belonging to diverse habitat. Likewise, the doubling time of the population also exhibited considerable variations (ranging from 9.0 for duck louse, *A. crassicornis* to 21.35 for sparrow louse*, B. cyclothorax*). However, the value of r varies with several intrinsic as well as extrinsic factors. It may be noted that avian lice exhibit seasonal variation in population (population increases during summers and spring and declines during winters). Hence, the role of extrinsic factors is likely to be more decisive than intrinsic factors (since the phenomen of cannibalism and a interspecies competition have lesser importance).

Nevertheless, all the avian lice taken into consideration were reared in similar conditions. Hence, for comparative purposes, the data clearly indicates that avian lice exhibit differences with respect to reproductive potentials. The duck louse, *A. crassicornis*, appears to be a fast breeder and the sparrow louse, *B. cyclothorax*, may be regarded as a slow breeder.

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