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Intrinsic rate of natural increase of an isochnoceran louse *Goniocotes jirufti* (Ansari, 1947) (Insecta: Phthiraptera)

Aftab Ahmad

Estuarine Biology Regional Centre, ZSI, Gopalpur-On-Sea, Ganjam 761002, Odisha, India.
Email: draftab.lifescience@rediffmail.com

ABSTRACT: The ischnoceran lice, *Goniocotes jirufti* (Ansari, 1947) infesting the black partridge, *Francolinus francolinus* were reared *in vitro* condition (35 ± 1°C, 75-82% RH, at feather diet), to record the incubation period, adult longevity and daily egg rate. The data obtained from *in vitro* experimentation were used to construct the life table and to determine the intrinsic rate of natural increase (rm). The value of rm of aforesaid species was computed as 0.042. At this rate the doubling time of its population appeared to be 16.50 days. In comparison to the other species studied so far, *G. jirufti* seems to breed moderately.

KEY WORDS: *In vitro,* biotic potential, ischnocera lice, black partridge

INTRODUCTION

The intrinsic rate of natural increase is referred as the rate of increase per head of a population under specific physical conditions. Different authors have given, different names to intrinsic rate of natural increase i.e. Chapman (1931) referred it is a biotic potential; Stanley (1946) called it as environmental index. The intrinsic rate of natural increase of twelve avian ischnocera e.g., *Brueelia amandava* Rekasi, 2005 parasitizing red munia, *Amandva amandva* L. (Gupta *et al.* 2007); *Brueellia cyclothorax* Burmeister 1838 from house sparrow, *Passer domesticus* L; *Sternoedoecus bannoo* Ansari 1955 from common myna, *Acridotheres tristis* L; *Neopsittaconirmus elbeli* Guimaraes 1974 parasitizing Indian parakeet, *Psittacula eupatria* L; *Columbicola columbae* Linnaeus, 1758 from rock pigeon, *Columba livia* G.; *Anaticola crassicornis* (Scopoli, 1763) from Mallard duck, *Anas platyrhynchos* L (Saxena *et al*., 2009); *Brueelia plocea* Lakhsminarayana 1968 from common baya, *Ploceus philippinus* L. (Arya *et al*., 2009); (*Goniocotes gallinae* De Geer 1778 parasitizing domestic fowl, *Gallus gallus domesticus* L. (Saxena *et al.,* 2007); *Upupicola upupae* Shrank from common hoopae, *Upupa epops* (Agarwal *et al.,* 2011); *Columbicola bacillus* Giebel 1866 parasitizing Eurasian collared dove, *Streptopelia decaocta* F. 1838 (Singh *et al.,* 2012), *Lipeurus caponis* Linneus 1758 parasitizing Domestic fowl, *Gallus gallus domesticus* (Kumar and Hasan, 2016) have been noted on the basis of data obtained through *in vitro* experimentation. The value of intrinsic rate of natural increase of three mammalian lice (sheep louse, *Bovicola ovis* Schrank 1781, rodent louse, *Geomydoecus oregonus* Price & Emerson 1971 Goat biting louse, *Bovicola caprae* Gunlt 1843) have also been indicated by the workers (Murray and Gordon,

* Author for correspondence

1969; Rust ,1974; Rashmi *et al.,* 2010). Since, the values of 'rm' of the species studies so far, varied considerably. Hence, it was found worthwhile to work out the life table statistics of one more ischnoceran louse. In the present paper, an attempt has been made to compute the intrinsic rate of natural increase of *Goniocotes jirufti* Ansari 1947 infesting black partridges, *Francolinus francolinus,* on the basis of data obtained through *in vitro* experimentations.

MATERIALS AND METHODS

Some feathers bearing fresh eggs were gently cut from black partridges, *Francolinus francolinus* the host body and incubated in culture vials (at 35±1°C, 75-82% RH), to record the incubation period. The humidity was maintained in culture vials by placing 50-100 m.l. of saturated solution of salts (Witson and Bates, 1960). Freshly emerged nymphal instars were reared on the host feather diet, to determine the duration of three nymphal instars. Likewise, the colonies of apparently freshly moulted healthier adult lice were reared *in vitro* condition (in batches) to determine the adult longevity. Culture vials were examined daily.

The data obtained from *in vitro* experimentation were used to construct the life table and compute the intrinsic rate of natural increase, rm ($e^{-rmx}lxmx=1$; where e=base of natural logarithms; x = age of individuals in days; lx = number of individuals alive at age x as a proportion of one; mx = number of female offspring produced/ female in the age interval x), net reproductive rate (Ro= lxmx), the innate capacity of increase (rc= logeRo/ Tc), the precise generation time (T= loge Ro/ rm), the finite rate of increase (=erm) and the doubling time of population (DT= log2/ log Σ) on the lines suggested by Evans and Smith (1952), Howe (1953) and also followed by Saxena *et al*. (2007, 2009), Gupta *et al.* (2007) and Arya *et al*. (2009).

RESULTS AND DISCUSSION

The mean incubation period of the eggs appeared to be 5.70 ± 0.95 days (range, 4-8 days, n=118). The average duration of first, second and third instar nymphs ranged from 5.61 ± 0.77 days (range, 4-days, n=106), 5.67 ± 0.88 days (range, 4-7 days, n=93), 5.41 ± 0.82 days (range, 4-7 days, n=46) respectively (Fig. 1). The average adult life span of males and females was found to be (15.52 ± 6.66 days (range, 2-26 days, n=150, 16.64 ± 7.66 days (range, 2-30 days, n=150) (Fig. 2, 3).

The life table was constructed on the basis of lines suggested by the aforesaid workers. Studies on population structure of *G. girufti* indicated that male, female ratio in natural population is 1:1.35. Thus, maternal frequency (mx = average number of female egg produced) was determined by multiplying the daily average egg rate by a factor of 0.57. While preparing the survivorship table, it was assumed that all the eggs laid were fertile and the nymphal mortality (larval mortality) would be negligible on the body of host (Table 1).

The gross reproductive rate of *G. jirufti* (mx - average number of daughter eggs expected to be produced by a female living through entire reproductive period) seems to be 13.892 (Table 2). Likewise, the net reproductive rate (Ro) appeared to be 4.606. The mean length of generation (∑xlxmx/Ro) was determined as 37.09 days. The value of intrinsic rate of natural increase was computed by using trial values of r to find the figure which satisfied the equation $\sum e^{-rmx}lxmx= 1$. In table 1, put the values rm = 0.042 for each age, the summation of $\sum e^{-rmx}lxmx$ proved to be 1.008. By this value of rm (0.042) the precise corrected generation time (T=logeRo/rm) appeared to be 36.33. Likewise, at this value of rm (0.042) the doubling time (DT = loge2/log∑) of *G. jirufti* appeared to be 16.5 days.

Evans and Smith (1952) constructed the life table of human head louse *Pediculus humanas* after making several assumptions as done in present case also. A review of literature indicates that the intrinsic rate of natural increase of twelve ischnoceran species have been recorded, so far (Gupta *et al.,* 2007; Saxena *et al.,* 2007, 2009; Arya *et al*., 2009, Agarwal *et al.,* 2011; Singh *et al.,* 2012; Kumar and Hasan, 2016). The value of gross reproductive rate of the species studies by aforesaid workers varied from 4.7-29.2 days. The net reproductive rate varies from 2.9-14.4. The values of rm of the

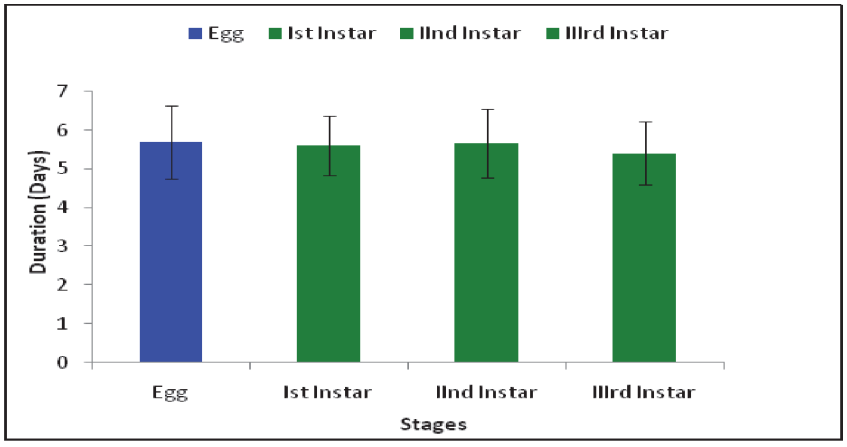

Fig. 1 Duration of different life stages of *G. jirufti* (Ansari, 1947).

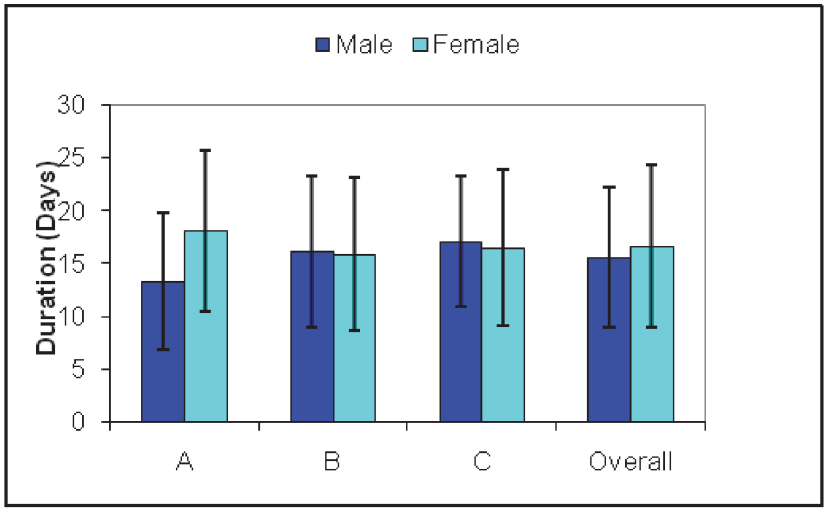

Fig. 2 Adult longevity of males and females of *G. jirufti* (Ansari, 1947).

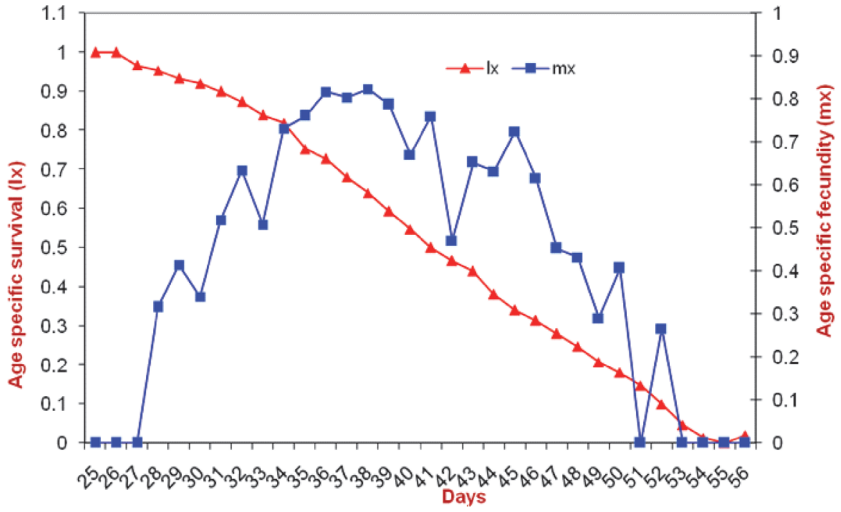

Fig. 3 Age specific survival and fecundity of *G. jirufti* (Ansari, 1947) in *in vitro* condition (35+1C, 75-82% RH, at feather diet).

Table 1. Life table and intrinsic rate of natural increase of *Goniocotes jirufti*

X	lx	mx	lxmx	X1xmx	rmx	e-rmx	e-rmx1xmx
0-23	Immature stage of *Goniocotes jirufti*						
24-25	Pre- oviposition period						
25	1.000	0.000	0.000	0.000	1.050	0.350	0.000
26	1.000	0.000	0.000	0.000	1.092	0.336	0.000
27	0.967	0.000	0.000	0.000	1.134	0.322	0.000
28	0.953	0.315	0.171	4.788	1.176	0.309	0.053
29	0.933	0.414	0.220	6.392	1.218	0.296	0.065
30	0.920	0.341	0.179	5.358	1.260	0.284	0.051
31	0.900	0.519	0.266	8.246	1.302	0.272	0.072
32	0.873	0.634	0.315	10.093	1.344	0.261	0.082
33	0.840	0.508	0.243	8.026	1.386	0.250	0.061
34	0.820	0.732	0.342	11.628	1.428	0.240	0.082
35	0.753	0.761	0.327	11.438	1.470	0.230	0.075
36	0.727	0.817	0.338	12.175	1.512	0.220	0.075
37	0.680	0.804	0.312	11.529	1.554	0.211	0.066
38	0.640	0.823	0.300	11.408	1.596	0.203	0.061
39	0.593	0.787	0.266	10.374	1.638	0.194	0.052
40	0.547	0.671	0.209	8.360	1.680	0.186	0.039
41	0.500	0.760	0.217	8.881	1.722	0.179	0.039
42	0.467	0.471	0.125	5.267	1.764	0.171	0.021
43	0.440	0.652	0.163	7.026	1.806	0.164	0.027
44	0.380	0.632	0.137	6.019	1.848	0.158	0.022
45	0.340	0.725	0.141	6.327	1.890	0.151	0.021
46	0.313	0.617	0.110	5.069	1.932	0.145	0.016
47	0.280	0.452	0.072	3.393	1.974	0.139	0.010
48	0.247	0.432	0.061	2.918	2.016	0.133	0.008
49	0.207	0.290	0.034	1.676	2.058	0.128	0.004
50	0.180	0.407	0.042	2.090	2.100	0.122	0.005
51	0.147	0.000	0.000	0.000	2.142	0.117	0.000
52	0.100	0.267	0.015	0.790	2.184	0.113	0.002
53	0.047	0.000	0.000	0.000	2.226	0.108	0.000
54	0.013	0.000	0.000	0.000	2.268	0.104	0.000
55	0.000	0.000	0.000	0.000	2.310	0.099	0.000
							1.008

Table 2. Intrinsic rate of natural increase of different ischnoceran lice.

Species	Gross reproductive rate	Net reproductive rate (females egg per female)	Mean length of generation	r	D	References
Brueelia amandava (*Amandava amandava*)	4.98	3.31	35.4	0.031	23.45	Gupta *et al*. 2007
Brueelia cyclothorax (*Passer domesticus*)	4.7	2.9	34.2	0.032	21.35	Saxena *et al*. 2009
Sturnidoecus bannoo (*Acridotheres tristis*)	9.3	5.0	33.1	0.049	14.21	Saxena *et al*. 2009
Neopsittaconirmus elbeli (*Psittacula eupatra*)	7.9	5.2	33.5	0.050	13.93	Saxena *et al*. 2009
Columbicola columbae (*Columba livia*)	9.9	8.0	39.4	0.053	14.2	Saxena *et al*. 2009
Anaticola crassicornis *(Anas platyrhynchos)*	29.2	14.4	36.6	0.074	9.01	Saxena *et al*. 2009
Brueelia plocea (*Ploceus phillipinus*)	7.74	3.74	28.19	0.045	15.41	Arya *et.al*. 2009
Goniocotes gallinae (*Gallus g. domesticus*)	12.49	8.3	36.9	0.059	11.73	Saxena *et al*. 2007
Upupicola upupae *(Upupa epops)*	6.08	3.67	37.15	0.035	19.1	Agarwal *et al*. 2011
Columbicola bacillus *(Streptopelia decaocta)*	12.37	6.20	35.93	0.054	12.95	Singh *et al* 2012
Bovicola caprae *(Copra hircus)*	11.62	6.73	35.27	0.055	12.6	Rashmi *et al* 2010
Lipeurus caponis *(Gallus gallus domesticus)*	12.53	3.9	29.64	0.046	16.1	Kumar and Hasan 2016
Goniocotes jirufti *(Francolinus francolinus)*	13.89	4.606	37.09	0.042	16.50	Present study

different species varied from 0.031-0.074. Finally, the value of doubling time of different species has been recorded as 9.0 -23.5 days (Table 2). In comparison to earlier studies species, the black partridge louse, *G. jirufti* appears to be moderate breeder as its rm equaled 0.042 and the doubling time remained 16.50 days.

As far as the mammalian lice are concerned, the value of rm 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 rm for rodent louse, *Geomydoecus oregonus* remained too low (0.006 per day indicating doubling after every 112 days) (Rust, 1974). The data clearly shows that the reproductive potentials of different phthirapterans exhibit considerable diversity.

Presumably, the fast breeding species may build their population at faster rate (than moderate and slow breeders) and consequently may cause extensive damage to feathers of the host. On the other hand, slow breeders may exhibit low prevalence and intensity of infestation and thus causing minimal effect on host plumage. The moderate breeders like *G. jirufti* presumably are

supposed to exhibit intermediate condition in this regard.

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REFERENCES

Agarwal G.P., Ahmad A., Rashmi A., Arya G., Bansal N. and Saxena A.K. (2011) Bio- ecology of the louse, *Upupicola upupae*, infesting the Common Hoopoe, *Upupa epops*. Journal of Insect Science 11: 26.

Arya G., Ahmad A., Bansal N., Rashmi A. and Saxena A.K. (2009) Population expansion of the Common baya louse, *Brueelia plocea* (Lakhsminarayana, 1968) (Phthiraptera: Ischnocera). Ibero-Latinamerican Journal of Parasitology 68(2): 192-195.

Chapmaan R.N. (1931) Animal ecology with especial reference to insects. *Ecology* (New York) 27: 303-14.

Evans F.C. and Smith FE. (1952) The intrinsic rate of natural increase for the human louse, *Pediculus humanus. L.* American Naturalist 86 (830): 299-310.

Gupta N., Kumar S. and Saxena A.K. (2007) Intrinsic rate of natural increase of *Brueelia amandavae* (Ischnocera, Phthiraptera) infesting Indian Red Avadavat. Biologia 62(4): 458-461.

Howe R.W. (1953) The rapid determination of the intrinsic rate of increase of an insect population. Annals of Applied Biology 40 (1): 134-151.

Kumar V. and Hasan S.S. (2016) *In vitro* bionomics of an ischnoceran louse, *Lipeurus caponis* (Phthiraptera: insecta). Journal of Parasitic Diseases 4: 374–376

Murray M.D. and Gordon G. (1969) Ecology of lice on sheep. VII: Population dynamics of *Damalinia ovis* (Schrank). Australian Journal of Zoology 17: 179-186.

Rashmi A., Ahmad A., Bansal N. and Saxena A.K. (2010) Rate of population expansion of goat biting louse *Bovicola caprae* (Phthiraptera: Ischnocera). Annals of Entomology 28(1):21-25.

Rust R. W. (1974) The population dynamics and host utilization of *Geomydoecus oreogonus,* a parasite of *Thomomys bottae*. Oecologia 15: 287-304.

Saxena A.K., Gupta N., Kumar S., Khan V., Arya G. and Saxena S. (2009) Intrinsic rate of natural increase of five ischnoceran lice (Phthiraptera: Insecta). Entomological News 120 (4): 385-391.

Saxena A.K., Kumar S., Gupta N. and Singh R. (2007) Intrinsic rate of natural increase of poultry fluff louse *Goniocotes gallinae* (De Geer, 1778) (Isochnocera, Phthiraptera, Insecta). Zoological Science 24: 327-330.

Singh P., Arya G., Ahmad A. and Saxena A.K. (2012) *In vitro* biology of *Columbicola bacillus* (Phthiraptera: Ischnocera). Journal of Applied and Natural Science 4(2): 234-236.

Stanley J. (1946) The environmental index, some new parameters as applied to *Tribolium.* Ecology 27 (1946), pp. 303-314.

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