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

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Abstract: The isochnoceran lice, *Goniocotes jirufiti* (Ansari, 1947) infesting the black partridge, *Francolinus francolinus* (Linnaeus, 1766) 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. Obtained data from in vitro experimentation were used to construct the life table and was used 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. jirufiti* (Ansari, 1947) seems to be a moderate breeder.

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Key words: In vitro, intrinsic rate, Ischnocera, Lice, Phthiraptera

1. Introduction


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 jirufiti* (Ansari, 1947) infesting black partridges, *Francolinus francolinus* (Linnaeus, 1766) on the basis of data obtained through in vitro experimentation.

2. Materials and methods

Black partridges, *Francolinus francolinus* (Linnaeus, 1766) were trapped alive during (2016-17) in district Rampur U.P. and subjected to deloused (manually). Few feathers were gently taken out and deloused bird released in the wild. Some feathers bearing fresh eggs were gently cut from 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 according to the guidelines of the worker 11. 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)=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 ) on the lines suggested by. Evans and Smith, Howe and also followed by (4, 2, 1, 3).

3. Result

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, 4-7 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 (Table 1) was constructed on the basis of lines suggested by the aforesaid workers. Studies on population structure of G. jirufti (Ansari, 1947) 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.

The gross reproductive rate of G. jirufti (Ansari, 1947) (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 (∑lxmx/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 ∑e^rmx lxmx= 1. In Table1, put the values rm = 0.042 for each age, the summation of ∑e^rmx lxmx proved to be 1.008. By this value of rm (0.042) the precise corrected generation time (T=logeR0/rm) appeared to be 36.33. Likewise, at this value of rm (0.042) the doubling time (DT = loge2/log∑) of G. jirufti (Ansari, 1947) appeared to be 16.5 days.

4. Discussion

Marshall has indicated that adequate information for construction of life table is rarely available. Evans and Smith constructed the life table of human head louse Pediculus humanus 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 (1, 4, 2, 3, 5, 6, 7) (Table 2). The value of gross reproductive rate of the species studies by aforesaid workers varied from 4.7-29.2 days (Table 2). The net reproductive rate varies from 2.9-14.4. The values of rm of the 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, Goniocotes jirufti (Ansari, 1947) appears to be moderate breeder as its rm equaled 0.042 and the doubling time remained 15.6 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)9. 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 (Ansari, 1947) presumably are supposed to exhibit intermediate condition in this regard.

5. Acknowledgements

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### Table 1: Life table and intrinsic rate of natural increase of Goniocotes jirufti

<table>
<thead>
<tr>
<th>X</th>
<th>lx</th>
<th>mx</th>
<th>lxmx</th>
<th>Xlxmx</th>
<th>rmx</th>
<th>e-rmx</th>
<th>e-rmxlxmx</th>
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<tbody>
<tr>
<td>0-23</td>
<td>Immature stage of Goniocotes jirufti</td>
<td>Pre-oviposition period</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>25</td>
<td>1.000</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
<td>1.092</td>
<td>0.336</td>
<td>0.000</td>
</tr>
<tr>
<td>26</td>
<td>1.000</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
<td>1.092</td>
<td>0.336</td>
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<tr>
<td>27</td>
<td>0.967</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
<td>1.134</td>
<td>0.322</td>
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<tr>
<td>28</td>
<td>0.953</td>
<td>0.315</td>
<td>0.171</td>
<td>4.788</td>
<td>1.176</td>
<td>0.309</td>
<td>0.055</td>
</tr>
<tr>
<td>29</td>
<td>0.933</td>
<td>0.414</td>
<td>0.220</td>
<td>6.392</td>
<td>1.218</td>
<td>0.296</td>
<td>0.065</td>
</tr>
</tbody>
</table>
Table 2: Intrinsic rate of natural increase of different ischnoceran lice.

<table>
<thead>
<tr>
<th>Species</th>
<th>Gross reproductive rate</th>
<th>Net reproductive rate (females egg per female)</th>
<th>Mean length of generation</th>
<th>r</th>
<th>D</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brucella amandava (Amandava amandava)</td>
<td>4.98</td>
<td>3.31</td>
<td>35.4</td>
<td>0.031</td>
<td>23.45</td>
<td>Gupta et al. 2007</td>
</tr>
<tr>
<td>Brucella cyclobothrus (Passer domesticus)</td>
<td>4.7</td>
<td>2.9</td>
<td>34.2</td>
<td>0.032</td>
<td>21.35</td>
<td>Saxena et al. 2009</td>
</tr>
<tr>
<td>Sternopterus bannoi (Acrothorax tristis)</td>
<td>9.3</td>
<td>5.0</td>
<td>33.1</td>
<td>0.049</td>
<td>14.21</td>
<td>Saxena et al. 2009</td>
</tr>
<tr>
<td>Neosiptuncirus elbelli (Pittaicae eupatra)</td>
<td>7.9</td>
<td>5.2</td>
<td>33.5</td>
<td>0.050</td>
<td>13.93</td>
<td>Saxena et al. 2009</td>
</tr>
<tr>
<td>Columbicola columbae (Columba livia)</td>
<td>9.9</td>
<td>8.0</td>
<td>39.4</td>
<td>0.053</td>
<td>14.2</td>
<td>Saxena et al. 2009</td>
</tr>
<tr>
<td>Anaticola crassicornis (Anas platyrhyphchos)</td>
<td>29.2</td>
<td>14.4</td>
<td>36.6</td>
<td>0.074</td>
<td>9.01</td>
<td>Saxena et al. 2009</td>
</tr>
<tr>
<td>Brucella pioinae (Pioecus philipinus)</td>
<td>7.74</td>
<td>3.74</td>
<td>28.19</td>
<td>0.045</td>
<td>15.41</td>
<td>Arya et al. 2009</td>
</tr>
<tr>
<td>Goniocotes gallinae (Gallus g. domesticus)</td>
<td>12.49</td>
<td>8.3</td>
<td>36.9</td>
<td>0.059</td>
<td>11.73</td>
<td>Saxena et al. 2007</td>
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<td>Upupica apauae (Upupa epops)</td>
<td>6.08</td>
<td>3.67</td>
<td>37.15</td>
<td>0.035</td>
<td>19.1</td>
<td>Agarwal et al. 2011</td>
</tr>
<tr>
<td>Columbicola bacillus (Strytopelia decaocto)</td>
<td>12.37</td>
<td>6.20</td>
<td>35.93</td>
<td>0.054</td>
<td>12.95</td>
<td>Singh et al 2012</td>
</tr>
<tr>
<td>Bovicola caprae</td>
<td>11.62</td>
<td>6.73</td>
<td>35.27</td>
<td>0.055</td>
<td>12.6</td>
<td>Rashmi et al 2010</td>
</tr>
<tr>
<td>Lipeurus caponis (Gallus gallus domesticus)</td>
<td>12.53</td>
<td>3.9</td>
<td>29.64</td>
<td>0.046</td>
<td>16.1</td>
<td>Kumar and Hasan 2016</td>
</tr>
<tr>
<td>Goniocotes jirufii (Francolinus francolinus)</td>
<td>13.89</td>
<td>4.606</td>
<td>37.09</td>
<td>0.042</td>
<td>16.50</td>
<td>Present study</td>
</tr>
</tbody>
</table>

References:
- Gupta et al. 2007
- Saxena et al. 2009
- Saxena et al. 2009
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- Saxena et al. 2009
- Saxena et al. 2009
- Saxena et al. 2009
- Agarwal et al. 2011
- Singh et al 2012
- Rashmi et al 2010
- Kumar and Hasan 2016
- Present study
Fig. 1: Duration of different life stages of *G. jirufii* (Ansari, 1947).

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

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

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