

Life and fertility tables of *Achaea janata* Linnaeus on castor

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Abstract. The life fecundity tables were constructed when *Achaea janata* Linnaeus reared on castor leaves in the laboratory. The net reproductive rate (R_0) was 467.57 females/female/generation in a generation time of 37.99 days. The intrinsic rate of natural increase (r_m) was 0.1618 female/female/day. In the stable age-distribution, 99% contribution was made by immature stages.

Keywords. Life and fertility tables; *Achaea janata*.

1. Introduction

The castor semilooper, *Achaea janata* Linnaeus is one of the important pests of castor crop in many states of India. The intrinsic rate of increase is a basic parameter which an ecologist may wish to establish for an insect population. Birch (1948) defined it as actual rate of increase of population under specified constant environmental conditions in which space and food are unlimited when there are no mortality factors other than physiological ones. According to Howe (1953), a life-table can be constructed by following the life history of a group of insects from their birth (egg laying) to emergence of adults and recording all deaths as they occur together with sex of those which die in as adult. Therefore, an attempt was made to study life fecundity tables for *A. janata* when reared on castor leaves.

2. Materials and methods

The method used in the present study was similar to those used for *Heliothis armigera* (Hubner) when reared on pigeonpea (Bilapate *et al* 1983). To construct the life fecundity tables, 200 eggs were placed in 10 plastic boxes in batches of 20 each. After hatching, all the larvae were reared individually on castor leaves. Fresh food was supplied daily. Observations on hatching, larval and pupal development, successful adult emergence, fecundity and age specific mortality in eggs, larvae, pupae and adults were made daily. For determining the specific fecundity, all the adults emerged on a particular day were transferred to a separate cage for egg laying. The healthy castor twig was kept in the cages as oviposition site. Considering the sex ratio 1:1 (Southwood 1968), the number of eggs laid per female were divided by two to get the number of female births (m_x).

The following column headings proposed by Birch (1948), elaborated by Howe (1953) and Atwal and Bains (1974) were used for the construction of life-fecundity tables under laboratory conditions: x —pivotal age in days; l_x —survival of females at age x ; m_x —age schedule for female births at age x .

The values of x , l_x and m_x were calculated from the data on life tables. The sum of

the products $l_x m_x$ is the net reproductive rate (R_0). R_0 is the rate of multiplication of the population in each generation measured in terms of females produced per generation. The number of times a population would multiply per generation was calculated by the formula,

$$R_0 = \Sigma l_x m_x.$$

3. Results and discussion

The results in table 1 indicate that survival of *A. janata* was 184, 177 and 170 eggs, larvae and pupae in a cohort of 200 eggs. A cohort of 200 eggs resulted in the emergence of 89 females and 81 males.

The life-table and age specific-fecundity for *A. janata* indicated that the survival of immature stages was 0.85 (based on one individual) individual within a pivotal age of 32 days (table 2). The pre-oviposition period was 3 days i.e. from 33–35 days of pivotal age. The number of eggs laid per female were divided by two to get the number of female births (m_x). The female births was highest (129.75 female offspring) on the first day of oviposition of the female (36th day of pivotal age) and decreased slowly thereafter. The first female mortality occurred on 7th day ($l_x = 0.80$) after emergence of adult when the culture was in the 41st day of pivotal age. The mortality rate of female slowly declined thereafter. Thus, the females oviposited for 9 days. The net reproductive rate (R_0) of female was 467.57 female/female/generation. The results on the mean length of generation, intrinsic rate of increase in numbers and finite rate of increase in numbers of *A. janata* are presented in table 3. The approximate generation time (T_c) was found to be 38.38 days. The arbitrary value for intrinsic rate of natural increase (r_c) was 0.1602 female/female/day. The precise generation time was 37.99 days while the finite rate of increase in numbers was 1.18 female/female/day. The corrected innate capacity for increase in numbers (r_m) was calculated by using the formula, $\Sigma e^{7-r_m \times l_x m_x} = 1096.6$.

The two trial values of 1157.12 and 792.96 were plotted on horizontal axis against their respective arbitrary r_c values, 0.16 and 0.17 on vertical axis and the corrected r_m was calculated as 0.1618 female/female/day by interpolation method. The stable age-

Table 1. The survival of life stages of *A. janata* on castor leaves.

	Surviving No.			Sex	
	Egg stage (0–3 days)	Larval stage (4–20 days)	Pupal stage (21–32 days)		
				Female	Male
	18	17	16	10	6
	17	17	17	10	7
	19	19	18	8	10
	20	18	17	7	10
	18	18	18	10	8
	17	17	17	10	7
	18	17	17	11	6
	19	17	15	7	8
	19	19	18	8	10
	19	18	17	8	9
Total	184	177	170	89	81

Table 2. Life-tables (for females) are age specific fecundity for *A. janata* on castor leaves.

Pivotal age (days) (x)	Life table for female births (L _x)	(m _x)	Age schedule for female births	
			(L _x m _x)	(L _x m _x x)
0-32	0.85		Immature stages	
33-35	0.85		pre-oviposition period	
36	0.85	129.75	110.28	3970.35
37	0.85	88.70	75.39	3789.61
38	0.85	89.75	76.28	2898.92
39	0.85	78.90	67.06	2615.53
40	0.85	66.40	56.44	2257.60
41	0.80	53.05	42.44	1740.04
42	0.72	40.93	29.46	1237.72
43	0.56	18.25	10.22	349.46
44	0.42	0.0	0.00	0.0

$$\Sigma L_x m_x = \Sigma L_x m_x x$$

$$R_0 = 467.57 = 17,949.23$$

Table 3. Mean length of generation, innate capacity and finite rate of increase in numbers of *A. janata* on castor leaves.

Population growth statistics	
Mean length of generation	
$T_c = \frac{\Sigma L_x m_x x}{R_0} = \frac{17949.23}{467.57}$	38.38 days
Innate capacity for increase in numbers	
$r = \frac{\log_e R_0}{T_c} = \frac{6.147491}{38.38}$	0.1602 ♀/♀/day
Arbitrary $r_c = 0.16$ and 0.17 corrected $r_m \Sigma e^{7-r} r m_x L_x m_x = 1096.6$	
	0.1618 ♀/♀/day
Corrected generation time	
$T = \frac{\log_e R_0}{r_m} = \frac{6.1475491}{0.1618}$	37.99 days
Finite rate of increase in numbers $\gamma = \text{anti } \log_e r_m$	
Weekly multiplication $(1.18)^7$	3.18
Doubling time $\log_e \frac{0.6931471}{0.1618}$	4.28/day
Hypothetical F_2 females	218621

distribution of *A. janata* was worked out when reared on castor leaves (table 4). On reaching stable age-distribution, the population in its various stages viz the egg, larva, pupa and adult contributed to the tune of 49.06, 48.06, 2.50 and 0.34%

Table 4. Calculated stable age distribution of *A. janata* on castor ($r_m = 0.1618$).

Pivotal age (x)	L_x	$e^{-r_m x}(x+1)$	$L_x e^{-r_m(x+1)}$	Percentage distribution	Percentage contribution
0	1	0.8506	0.8506	15.38	
1	1	0.7235	0.7235	13.08	
2	1	0.6154	0.6154	11.13	49.06 eggs
3	1	0.5235	0.5235	9.47	
4	1.00	0.4453	0.4453	8.05	
5	0.98	0.3787	0.3712	6.72	
6	0.96	0.3222	0.3093	5.59	
7	0.96	0.2741	0.2631	4.76	
8	0.95	0.2331	0.2215	4.00	
9	0.94	0.1983	0.1864	3.37	
10	0.94	0.1687	0.1585	2.87	
11	0.94	0.1435	0.1349	2.44	
12	0.93	0.1220	0.1135	2.05	48.06 larvae
13	0.92	0.1038	0.0955	1.73	
14	0.91	0.0883	0.0803	1.45	
15	0.90	0.0751	0.0675	1.22	
16	0.90	0.0639	0.0575	1.04	
17	0.10	0.0543	0.0490	0.89	
18	0.89	0.0462	0.0411	0.74	
19	0.88	0.0393	0.0346	0.62	
20	0.87	0.0334	0.0291	0.53	
21	0.87	0.0284	0.0244	0.44	
22	0.85	0.0244	0.0205	0.37	
23	0.85	0.0205	0.0175	0.32	
24	0.85	0.0175	0.0149	0.27	
25	0.85	0.0149	0.0127	0.23	
26	0.85	0.0127	0.0108	0.19	
27	0.85	0.0108	0.0091	0.16	2.50 Pupae
28	0.85	0.0092	0.0078	0.14	
29	0.85	0.0078	0.0066	0.12	
30	0.85	0.0066	0.0056	0.10	
31	0.85	0.0056	0.0048	0.09	
32	0.85	0.0048	0.0041	0.07	
33	0.85	0.0041	0.0035	0.0633	
34	0.85	0.0035	0.0029	0.0524	
35	0.85	0.0029	0.0025	0.0452	
36	0.85	0.0025	0.0021	0.0379	
37	0.85	0.0021	0.0018	0.0325	
38	0.85	0.0018	0.0015	0.0271	0.34 Adult
39	0.85	0.0015	0.0014	0.0253	
40	0.82	0.0013	0.0011	0.0198	
41	0.76	0.0011	0.0008	0.0144	
42	0.64	0.0009	0.0006	0.0108	
43	0.49	0.0008	0.0004	0.0072	
44	0.42	0.0007	0.0003	0.0054	

respectively. The type of life-tables developed by Birch (1948) can be used to obtain growth statistics that can be used for both qualitative evaluation of rearing procedures and to estimate the projected potential increase of insects reared on different food commodities. The innate capacity of increase has not been quantified for many insects (Wellik and Pedigo 1978).

According to Bilapate (1987), the net reproductive rate of *A. janata* on castor leaves was 524.78, 382.52 and 242.70 female/female during I, II and III generation under laboratory conditions. The innate capacity for increase in numbers and mean generation time was 0.1692 and 37.01 days during first generation. The growth parameters namely survival of immature stages, contribution towards the female births and net reproductive rate yielded lower value in the present investigations during the rearing of *A. janata* on castor leaves. This might have attributed to the effect of temperature during the period of investigations.

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