J. Biol. Control, 20(2): 159-164, 2006

Age-specific fecundity and intrinsic rate of natural increase of *Aphytis* sp.? *hispanicus* (Mercet), the proclia- group, an ecto-parasitoid of the San Jose scale, *Quadraspidiotus perniciosus* (Comstock) (Homoptera: Diaspididae)

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ABSTRACT: **Age specific fecundity and intrinsic rate of increase of *Aphytis* sp.? *hispanicus*, an important ecto-parasitoid of the San Jose scale, *Quadraspidiotus perniciosus* (Comstock) was studied in the mid - hill region of Himachal Pradesh which revealed that the net reproductive rate (R_0) of the species was 17.47 female eggs/ female. The true intrinsic rate of increase (r_m) was 0.116. The population multiplied 1.123 times per day during the generation time of 24.66 days. The doubling time of the species was 5.98 days.**

KEY WORDS: Age specific fecundity, *Aphytis* sp., ecto-parasitoid, intrinsic rate of increase, San Jose scale

INTRODUCTION

The San Jose scale (SJS), *Quadraspidiotus perniciosus* (Comstock) is a polyphagous pest reported on diverse group of plant species. Initially a quarantine pest (Hyot and Burts, 1974) has now become an ubiquitous pest of fruit trees. This pest has spread everywhere in the country and is reported in hill districts of fruit growing regions and also in Karnataka and Tamil Nadu (Singh, 1963). Endowed with colossal potential of reproduction, waxy scaly shield and sedentary nature, it has become difficult to control this pest with insecticides. Parasitoids in general play a pivotal role in reducing the severity of this pest and *Aphytis* Howard (Hymenoptera: Chalcidoidea: Aphelinidae) in particular outclasses the others as natural enemies of the scale insects (Rosen and DeBach, 1979). Fertility studies of a parasitoid provide a valuable picture of the fecundity and growth potential. The present study, therefore, was planned to find out fecundity and intrinsic rate of natural increase of this parasitoid on the San Jose scale.

MATERIALS AND METHODS

A stock culture of this *Aphytis* sp. *hispanicus* (Mercet) was maintained under laboratory

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conditions. Life fertility studies were carried out under laboratory condition in BOD incubator at 25 ± 1°C. Newly emerged adult parasitoids were shifted to a homoeopathic glass vials (53 X 13 mm) having a fine streak of Protinex mixed honey (1:1 ratio). Vial was then plugged with cotton bung. After four hours, female parasitoid was confined under a micro plastic cage (small plastic thimble, 13 X 9 mm with fine holes on its top) affixed with the help of sticky material to the surface of factitious host containing 5-10 mixed population of scales. The aphelinid wasp was shifted to a new site after every 24 hours, which was continued till its death. After shifting the female to new site, the scaly armature of exposed scales to the parasitoid was gently lifted with the help of fine tipped needle and each scale was examined under microscope to count eggs laid. Observations were recorded to get the information on pre-oviposition, oviposition, and post-oviposition periods and the number of eggs laid each day.

Life fertility table was constructed by making use of the data collected on the developmental and reproductive biology of the species as per formulae provided by Birch (1948) and further elaborated by Watson (1964). The true intrinsic rate of increase (r_m) which is actual rate of increase of a population under specified constant environmental conditions in which space and time was calculated through graphical method by taking two arbitrary values of r_c up to two decimal place substituted in a formula $\Sigma e^{7-rm} \times l_x m_x$ until the two values of the equation ($e^{7-rm} \times l_x m_x$) were found which lie immediately one above and the other below 1096.6. These were plotted on the horizontal axis against the trial values of r_m on the vertical axis. A vertical line drawn from 1096.6, value on x- axis and intersecting the line joining theses two trial values of r_m gave the r_m accurate to three decimal places at the point of intersection.

RESULTS AND DISCUSSION

The species on which studies were made is uni-parental. Data presented in Table 1 reveal that the oviposition began on 22nd day and mean progeny produced was 0.03 female eggs/ female. The first female mortality occurred on 25th day. Peak egg laying was observed on the 6th day of oviposition (5.25 female eggs/ female) and decreased thereafter. The egg laying ceased on the 8th day of ovi-position. Reproductive growth rate statistics of the parasitoid presented in Table 2 reveal that the gross reproductive rate (GRR) was 27.44 female eggs/ female and the net reproductive rate that takes in consideration the age specific survivorship of the parasitoid was 17.47 female eggs/ female. The difference in GRR and R_0 was due to the death of females earlier than the maximum reproductive period of 7 days. True generation time (T) was 24.66 days against 24.73 days as the approximate generation time (T_c). Statistics indicate that species was capable to multiply 17.47 times in a single generation of 24.7 days. Parasitoid innate capacity for natural increase (r_c) was in no way different from the true intrinsic rate of multiplication (r_m), which was 0.116. The r_m values calculated by Singh and Gupta (1994) for SJS reared on pumpkin and apple plant were 0.072 and 0.069, respectively, which is about 1.7 times higher for the parasitoid than that for its host. The high value of r_m may be attributed to short duration of true generation time (24.7 days) for the parasitoid as compared with that for the SJS on pumpkin (49.9 days) and apple (49.9 days). The finite rate of increase (λ) for the species was 1.123 thereby suggesting that the species under rearing set of conditions would multiply at the rate of 1.123 times per day and its population would double in 5.98 days.

While Gerson (1968) observed *A. hispanicus* ovipositing soon after emergence on *Parlatoria pergandii*, some uni-parental species like *Aphytis maculicornis* (Ahmad and Ghani, 1971) and *Aphytis chrysomphali* (Bartlett and Fisher, 1950; Das, 1988) commenced egg laying within 24 hours of emergence. However, in none of the present cases, egg laying by this parasitoid was noticed within 24 hours of the emergence. Majority of females commenced laying between 48 and 72 hours. Since these females were fed on Proteinex mixed honey (1:1), it may be possible that the Protenix might not be as good source of protein as the host body haemolymph. Ovi-position period was spread over a duration of 7 days, during which adult laid 1-32 eggs per female and egg laying per day per

Table1. Fertility table of *A. hispanicus* on the San Jose scale at 25 ±1° C

Pivotal age in days (x)	Age specific survivorship (l_x)	Female progeny per female (m_x)	$l_x m_x$	$x l_x m_x$	Trial r_m	
					0.11	0.12
0-21	Development and pre-ovipositon periods				$e^{7-rm} \times l_x m_x$	$e^{7-rm} \times l_x m_x$
22	1.000	0.03	0.03	0.66	2.925	2.348
23	1.000	3.50	3.50	80.50	305.749	242.927
24	1.000	4.77	4.77	114.48	373.287	293.638
25	0.900	4.44	4.00	100.00	280.422	218.393
26	0.700	4.95	3.47	90.22	217.926	168.032
27	0.267	5.25	1.40	37.80	78.765	60.128
29	0.067	4.50	0.30	8.40	15.120	11.428
29	0.000	0.00	0.00	0.00	0.000	0.000
Total		27.44	17.47	432.06	1274.194	996.894

Table 2. Reproductive growth of *A. hispanicus* on the San Jose scale

Sl. No	Parameters	Values	
1	Gross reproductive rate (GRR)	27.44	female eggs /female
2	Net reproductive rate (R_o)	17.47	female eggs /female
3	Approximate generation time (T_c)	24.73	days
4	Capacity to natural increase (r_c)	0.116	
5	True intrinsic rate (r_m)	0.116	
6	True generation time (T)	24.66	days
7	Finite rate of increase (λ)	1.123	
8	Doubling time (DT)	5.98	days

surviving female (3.47- 4.77 eggs/ day) was high on 3rd to 6th day of adult age. These studies differ slightly from those of Gerson (1968) and Titayavan and Davis (1988) who observed peak ovi-position on second and third day of ovi-position. Gerson (1968) also found *A. hispanicus* surviving for 11 days and its fecundity was 8-33 eggs. According to Titayavan and Davis (1988), *Aphytis vandenboschi* parasitizing the SJS laid for a period of 1-6 days, Gulmahamad and DeBach (1978) observed very high fecundity rate (85daughters/ female) in *Aphytis aonidiae* on the SJS but all this may be due to long survival (25 days) for the female. Variation in fecundity rate may also be because of kind of host on which scale insect is reared as observed by DeBach and White (1960). Post-oviposition period though not well marked in this parasitoid, yet it was of short duration (0-1 day). Gulmahamad and DeBach (1978) observed this period as 2-4 days for *A. aonidiae*, which survived

relatively for a longer period (24 days). Though this species on which present studies were made its longevity was of shorter duration but as long as this species survived it continued laying.

On the basis of fertility analysis this species can be rated as a potential parasitoid of the SJS, much better than its predator *Chilocorus bijugus* Mulsant that has r_m of 0.068, finite rate of increase as 1.07 and the doubling time of 10.19 days (Gupta and Singh, 1996). The only study carried out on innate capacity for increase in any *Aphytis* species on armoured scale appears to be that of Abdelrahman (1974), who studied the growth, development and innate capacity for the increase of *Aphytis chrysomphali* and *Aphytis melinus* on California red scale, who found the r_m value to be 3.1 - 5.0 times that of its host depending upon the species and the temperature. Titayavan and Davis (1988) constructed partial field life table for *A. vandenboschi* parasitizing the SJS in northern Utah, which indicates that high field mortality of *Aphytis* might have occured due to various mortality factors in field. Such study needs to be carried out to determine effectiveness of *Aphytis* under field conditions.

ACKNOWLEDGEMENTS

The senior author is grateful to the Plant Protection Adviser, to the Government of India, Directorate of Plant Protection, Quarantine & Storage- Faridabad, Department of Agriculture & Co-operation, Ministry of Agriculture, New Delhi for sanctioning leave for pursuing Ph. D programme. Thanks are also due to Dr. M. Hayat, Department of Zoology, Aligarh Muslim University, Aligarh for identifying the parasitoid specimens.

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