

the grub of *Che/onus* may die even if it hatches early. HageP (1964) reported that aggressive action between larvae of their own species or of different species may be due to biting with mandibles or by secreting a cytolytic enzyme by the first larva which is destructive to the later appearing larvae. In majority of the egg-larva! parasites, larval development is very slow soon after hatching in the host and it is triggered only when it is-fuU grown. But in the egg parasites, larval feeding and development is very fast and the life cycle is completed in the egg itself. This advantage of fast development may eliminate the other parasites present in the egg. Further, it is desirable to

know the extent of parasitisation by these two parasites under field conditions and later a decision has to be made as to the species advantageous for undertaking field releases.

REFERENCES

- Hagen. K.S. 1964. Developmental stages of parasites. In : *Biological Control of Insect Pests and Weeds* (Paul DeBach ed). pp. 168-246.
- Pschorn-Walcher, H. 1971. Experiments on interspecific competition between three sp[^]ectes of T.[^]etunwis attack.r.o t-«* ?.<. a cintf moth boiei, D/jr/j[^]a jj,\-flt;i.'s O) *Entomophaga*, 16,125-131.
- Salt, G. 1961. Competition among insect parasitoids. *Symposia Soc. Exper. Biol.*, 15, 96-119.
- Smith, O.J. 1952. Biology and behaviour of *Microctonus vittatae* Muesbeck (Braconid ae). *Univ. California Publ. Ent.*, 9, 315-144.

J. flioj Control. 1(1), 3—6, 1987

Seasonal History and Biological Control of San Jose Scale *Quadraspidiotus perniciosus* (Comstock;) (Diaspidae : Homoptera) on Apple in Kashmir

MASOODI M. AMIN AND A. R. TRALI

Division of Entomology, Sher-e-Kashmir University of Agricultural
Sciences and Technology, Srinagar)91 121

ABSTRACT

The San Jose scale completed two generations with a partially incomplete third generation which over-wintered from November on apple trees in Kashmir. The population entered hibernation in all stages but nymphs of first instar survived. The overwintering nymphs became active in middle of March. The winged males emerged in late April. The females gave rise to first generation crawlers in the third week of May, about one month after the emergence of males. The second generation crawlers started emerging in the third week of July and development was completed in the first week of September. Nymphs of the third generation started appearing in the last week of September which stopped development in the end of November and entered hibernation.

Series of releases of laboratory multiplied parasites *Encarsia* (= *ProspalteHa*) *perniciosa* (Tower) and *Aphytis* sp. (*proclia*) were made in four abandoned apple orchards. The pretreatment count of apparent parasitism of San Jose scale® ranged between 4.97 and 15.60%. As many as 1,16,375 adults of *E. perniciosa* and 2,81,461 adults of *Aphytis* sp. (*proclia* group) were released during 1984. The recovery tests indicated an increase in apparent parasitism between 9.13 and 40.20%. During pre-treatment survey, besides *E. perniciosa* and *A. proclia*, *Marietta carnesi* Howard and *Azptus kas hmiri*-s/s Narayanan (Aphelinidae : Hymenoptera) were, also observed from the sample twigs.

Key words : San Jose scale, phenology, biological control, *Encarsia perniciosa* and *Aphytis proclia*.

;, More than 70-host plants are known to be susceptible to the San Jose scale *Quadraspidiotus perniciosus* Comstock. The control of the scale in Kashmir is achieved with diesel oil emulsion applied as dormant spray (Pruthi and Rao, 1951) or summer application of chemical pesticides against the crawlers. For successful control measure they have to be timed at the vulnerable stage of the pest's life cycle for which knowledge of the seasonal development of the scale is required. In addition, knowledge of biological characteristics of parasites and predators is indispensable for the development of integrated management of the pest. The present studies were aimed to observe the seasonal history and assess the interaction of entomophagous insects with San Jose scale.

MATERIALS AND METHODS

Biological studies were conducted during 1983 in an abandoned apple orchard of 2.5 ha at Dangerpora, Srinagar. The orchard contained about 350 trees of 10-12 years old, infested with San Jose scale. No control measure was used during the study period. Field

populations of San Jose scale were sampled at fortnightly intervals upto last week of July and at monthly interval upto December 8, 1983, to determine generations and quantitative estimation of its development. Scale infested twigs 20-30 cm long and 12-15 mm thick were sampled randomly from different trees as per methods of Morgan and Angle (1969) and examined in laboratory for recording the instars in the development of scale, degree of infestation and extent of parasitism. The scale density was measured as number of scales per cm of twigs. The timing of winged male flights was monitored through sticky traps. The traps were placed 2 m high on the trees and the number of adult males captured was recorded two times a week till no further catches were observed.

During 1984, four orchards at Dangerpora, Gallander, Chanapora and Awantipora were selected for release of parasites. The orchards did not receive any pesticide application for the previous three years. *E. perniciosa* and *Aphytis* sp. (*proclia* group) reared in the laboratory on San Jose scale (Flanders, 1949) developed on pumpkins were released in the orchards at

random after taking pre-release count of parasitism.

RESULTS AND DISCUSSION

San Jose scale on apple in Kashmir completed two generations with a partial third one which overwintered. The scale entered into hibernation in all stages but only first instars nymphs which secreted dark grey scales survived the low temperatures. The hibernation period extended from middle of November to first week of March depending upon the temperatures. The winged-males were observed appearing in the second week of April, and the peak emergence was between April 14 and April 28. Reproducing females were observed on May 12, and their number increased upto May 26, during which period crawlers of first generation were found in abundance (Table 1). The second generation crawlers were observed

from July 7 to August 18. An increase in the number of winged males was observed between June 9 and June 23.

The appearance of the third generation was signalled by the observation of trapped winged males on August 18 followed by increased number of crawlers from August 20 to September 15. The crawlers of second generation were found overlapping with the third generation. The third generation nymphs and few from second generation entered into hibernation from November 10. Pruthi and Rao (1951) also observed two complete and a partial third generation whereas Fotedar (1941) recorded as many as four generations of San Jose scale in Kashmir. The date of emergence of crawlers from overwintering recorded as last week of May by earlier workers (Pruthi and Rao, 1951; Fotedar, 1941 Anonymous, 1947) is in agreement with the results observed in the present

Table 1. Seasonal history of San Jose scale on apple trees during 1983 in Kashmir

Date	Mean per cent population of various stages		
	Crawlers	Male nymphs	Reproducing females
2—3—1983	0	0	0
16—3—1983	0	7.6	0
14—4—1983	0	22.9	0
28—4—1983	0 J	25.4	0
12—5—1983	47.9	0.5	15.5
26—5—1983	65.9	0	21.4
9—6—1983	27.5	2.8	17.6
23—6—1983	18.5	5.3	18.5
7—7—1983	52.7	0.8	25.6
21—7—1983	60.8	0.6	36.3
18—8—1983	39.5	4.7	16.3
15—9—1983	58.6	0.9	27.9
13—10—1983	17.5	0.2	19.7
12—11—1983	0	0	44.5
9—12—1983	0	0	0.1

December-March : Overwintering population.

Table 2. Field release of *Aphytis* sp. *proclia* and *Encarsia* (= *Prospaltella*) *perniciosa* on apple in Kashmir in 1984

Locati on	Pre-release % parasitism	Total No. of parasites released		Post release % parasitism
		<i>A. proclia</i>	<i>E. perniciosa</i>	
D angerpora	16.61	180768	64053	40.20
G al lender	5.97	168425	21022	18.75
Ch anapora	5.60	19648	15253	29.68
Awanti pora	5.24	15320	16047	9.13

studies. However, the observations of Rishi (1982) stating March as the period of emergence of crawlers is inconsistent with the present observations.

The apparent parasitism of San Jose scale in the study orchards ranged between 4.97 and 15.60%. At Dangerpora and Chanapora, the parasites were released from May to October whereas releases at Gallender and Awantipora were made from July to October. As many as 2,81,461 adults of *Aphytis* sp. (*proclia* group) and 1,16,375 adults of *E. perniciosa* were released in the four orchards from May to October and the recovery tests indicated an increase in apparent parasitism between 9.13 and 40.20 %. During pre-treatment survey, besides

E. perniciosa and *Aphytis* sp. (*proclia* group) *Marietta* *earnest* Howard and *Azptus kashmirensis* Narayanan (Aphelinidae : Hymenoptera) were also observed from the sample twigs.

REFERENCES

- Anonymous. 1947. Final report of San Jose scale and woolly aphis research scheme (Kashmir) from 1939-1947.
- Flanders, S. E. 1949. Culture of entomophagous insects. *Proc. 7th Pacific Congress*, 4, 259-277.
- Fotedar, M. R. 1941. San Jose scale and its control in Kashmir. *Indian Fmg.*, 5, 234-237.
- Morgan, C. V. G. and Angle, B. J. 1969. Distribution and development of San Jose scale (Homoptera: Diaspididae) on the leaves, bark and fruit of some orchards in British Columbia. *Can. Entomol.* 101, 983-989.
- Pruthi, H. S. and Rao, V. P. 1951. San Jose scale in India. ICAR Bull No. 71.
- Rishi, N. D. 1982. Ecological assessment of pest management in the Kashmir orchard ecosystem *Indian J. Entomol.*, 44, 344-350.