

The Biology and Natural Control of the Scale *Drepanococcus chiton* (Green) (Homoptera : Coccidae), a Minor Pest of Carambola in Malaysia

A. GHANI IBRAHIM,
Department of Plant Protection
Universiti Pertanian Malaysia
43400 UPM, Serdang, Selangor Darul Ehsan, Malaysia

Keywords: *Drepanococcus chiton*, nymphal development, field, parasitisation, *Eunotus* sp., carambola orchard

ABSTRAK

Teritip, *Drepanococcus chiton* (Green) (Homoptera : Coccidae) mempunyai potensi sebagai perosak pada tanaman belimbing besi, varieti B10 Averrhoa carambola. Serangga ini menyebabkan kematian pada pucuk dan dahan bunga. Semburan racun secara jadual ke atas lalat buah *Bactrocera dorsalis* kemungkinan menyebabkan pertambahan populasi teritip di ladang carambola di Sungai Long Ulu Langat, Selangor. Perkembangan telur ke peringkat teritip dewasa pada suhu $28^{\circ}\text{C} \pm 1.5^{\circ}\text{C}$ ialah 49.9 ± 1.06 hari. Seekor teritip betina boleh menghasilkan purata 1081.9 ± 256.0 telur dengan 97.9% penetasan. Walau bagaimanapun, cuma 2.5% daripada telur ini yang sampai ke peringkat dewasa di ladang.

Pemerhatian di ladang menunjukkan teritip diparasitkan oleh *Eunotus* sp. (Hymenoptera : Pteromalidae). Larva parasitoid ini memusnahkan telur teritip. Purata bulanan dari Ogos 1992 sehingga February 1993 peratus parasitisasi oleh *Eunotus* sp. ialah 40.6. Seekor larva parasitoid berupaya memusnahkan 93.2% telur teritip semasa perkembangannya. Kadar jantina parasitoid jantan dengan betina ialah 1 : 1.

ABSTRACT

The scale, *Drepanococcus chiton* (Green) (Homoptera: Coccidae) is a potential pest of carambola, variety B10 Averrhoa carambola. The insects caused drying of shoots and flower stalks. The regimental spraying of insecticides against the fruit flies, *Bactrocera dorsalis*, possibly gave rise to a build-up of the scale populations in a carambola orchard at Sungai Long, Ulu Langat, Selangor. The development of eggs to adult maturity at $28 \pm 1.5^{\circ}\text{C}$ was 49.9 ± 1.06 days. A female scale could produce an average of 1081.9 ± 256.0 eggs with 97.9% viability. However, only 2.5% of these eggs reached adult maturity in the field.

Field observation showed that the scales are being parasitised by an egg-parasitoid, *Eunotus* sp. (Hymenoptera: Pteromalidae). The average monthly parasitisation by *Eunotus* sp. from August 1992 to February 1993 was 40.6%. The parasitic larva was capable of destroying 93.2% of the scale's eggs during its larval development. The sex ratio of male to female parasitoid was 1 : 1.

INTRODUCTION

The scale, *Drepanococcus chiton* (Green) is a polyphagous insect (Williams and Watson 1990). It was first reported in Sri Lanka by Green in 1909 and has since been recorded in Papua New Guinea and the Solomon Islands. The insect has a waxy secretion to protect itself in the course of feeding (Ebeling 1959). This waxy layer adheres the scale to the plant tissues (Metcalf and Flint 1962). In addition to its feeding action, the scale also encourages the growth of sooty-moulds which adversely affect the growth of the plants (Peairs and Davidson 1966).

Although the scales have been reported on cocoa and several ornamental plants, in Malaysia the scales infest the carambola, *Averrhoa carambola*. The use of pesticides to control the major pests of carambola particularly the fruit-flies, *Bactrocera dorsalis* complex (Hendel), was suspected in the build-up of the scale population in the orchard. This was particularly so during the dry season. This work investigates the biology of the scale, with the aim of identifying an effective way of controlling the scale in the carambola orchard.

MATERIALS AND METHODS

The biological studies were conducted under laboratory conditions of $28^{\circ}\text{C} \pm 1.5^{\circ}\text{C}$ and 75% R.H. at the Department of Plant Protection, Universiti Pertanian Malaysia. The field trial was carried out in a carambola orchard of 100 ha at Sungai Long, District of Hulu Langat, Selangor.

(A) Laboratory Study

For the life-cycle study, 500 freshly laid eggs of *D. chiton* were incubated in 10 separate petri dishes lined with moist filter-paper. The length of 50 eggs and their development were recorded. For nymphal development, 3000 crawlers were transferred using a fine brush onto five separate carambola seedlings which were individually placed inside a cylindrical cage measuring 60 cm high and 27 cm in diameter. Every day 20 nymphs were sampled at random from the seedlings for determining the nymphal development. Nymphs and adults for morphological examination were fixed overnight in KAAD alcohol and then prepared by the method used by Peterson (1943).

Another 40 gravid females from the field were sampled at random for determining the relationship between body length and the total numbers of eggs. Eggs from selected specimens were evenly scattered over a petri dish and counted using a graph paper grid fastened underneath the dish.

Selected specimens such as eggs, nymphs and adult scales were then measured optically using a binocular microscope at X15 magnification. The use of transmitted light greatly facilitated the measurement of the specimens.

(B) Field Study

For studying the development of *D. chiton*, 25 flower stalks each accommodating a gravid scale were selected. Immature scales were removed from the selected stalks. Each stalk was individually labelled on 21st December 1992. The presence of a trace of what appeared to be a waxy secretion around the base of the scale served as a useful indication of a gravid female. When this secretion, which seemed to act as a seal or cement was broken or discontinuous, crawlers were suspected as having emerged.

For studying the parasitisation of the scale, four samples were taken at two-monthly intervals commencing in the first week of August 1992

until February 1993. During the sampling period, young shoots accommodating 1000 matured scales were kept in 100 aerated test-tubes of three cm diameter. The scales were incubated at room temperature of $28^{\circ}\text{C} \pm 1.5^{\circ}\text{C}$. The number of parasitoids and their sexes were recorded.

RESULTS AND DISCUSSION

(A) Laboratory Study

Table 1 gives the average developmental time of different stages in *D. chiton*. The total duration from egg to adult emergence was 49.9 ± 1.06 days.

(i) Eggs:

The egg is oval in shape with a broader anterior. Initially, it was pale white but later changed to a reddish colour. When hatching was about to occur, the eyes of the embryo appeared as a red-brown stage on both sides of the anterior portion of the egg. A similar condition occurs in the hemispherical scales, *Saissetia* spp. (Argyrio 1963; Barber 1980). The incubation period of the egg was 6.30 ± 0.58 days (Table 1).

(ii) Nymphal Development

There were three nymphal instars as indicated by the width of the head capsule and body length. The first stage i.e. the crawler is an active stage measuring 0.36 ± 0.02 mm. It lasted for one week before the nymphs settled on the softer tissues of the plant (Peairs and Davidson 1966). The subsequent instars were sessile, adhering closely to the plant tissues (Ebeling 1959; Metcalf and Flint 1962). The nymph significantly increased in size during the third instar. The waxy substance surrounding the scale became obvious and by now the nymph measured 2.30 ± 0.17 mm. The total duration of the 3rd nymphal stage was 22.30 ± 1.15 days.

Attempts were made to obtain the growth ratio of different instars by measuring the body-length and the width of the head capsule. The average ratio of body-length and head capsule width of the different instars were 2.5 and 1.9 respectively. Neither ratio agreed with Dyars Law of 1.4 (Wigglesworth 1965). The size of the nymph could possibly be influenced by the surface of plant tissues. It was observed that nymphs on flower stalk were more oblong than rounded. The scale became an adult female after 49.90 ± 1.06 days. The dorsum was usually membranous

TABLE I
The developmental period and growth ratios
of the scale, *D. chiton* from carambola orchard

Stage	N	duration (in days) X ± S.E.	body-length (mm) X ± S.E.	growth ratio	width of head- capsule(mm) X ± S.E.	growth ratio
Eggs	50	6.30 + 0.58	0.30 + 0.01			
Nymph I	20	6.00 + 1.00	0.36 + 0.02		0.09 + 0.002	
				2.70		2.00
Nymph II	20	15.30 + 1.53	0.98 + 0.26		0.19 + 0.004	
				2.30		1.80
Nymph III	20	22.30 + 1.15	2.30 + 0.17		0.32 + 0.004	
Adult	40		3.78 + 0.48		0.62 + 0.061	

with irregular rows of minute pores and cornical seta. The body-length and width of head capsule were 3.78 ± 0.48 mm and 0.62 ± 0.061 mm respectively. A gravid female could produce an average of 1081.9 ± 256 eggs. This egg number is comparable to that of *S. coffeae* in the glasshouses (Barber 1980). The percentage of egg viability was 97.9. The body length of gravid scale on average measured 3.78 ± 0.48 mm. There was a weak relationship ($r^2 = 0.44$) between the body-length of adult females and the number of eggs.

(B) Field Study

The field observation showed that a gravid scale could produce an average of 25 ± 5.0 matured scales during the period of seven weeks from December 1992. Although a gravid scale can produce an average of 1081.9 ± 256 eggs with 97.9% viability only 2.5% of these eggs reached maturity. Crawler mortality could be due to both abiotic and biotic factors with natural activity of enemies being expected to contribute significantly to this (Miller and Kosztarab 1979).

Although, reproduction of *D. chiton* is by parthenogenesis, occasionally the males appeared in the field. During the sampling period males of the scale were only found in February 1993. This

suggests that males are only present at specific periods. The males are very delicate insects measuring 2.30 ± 0.03 mm in length. The body is brownish with one pair of wings. The posterior of the abdomen is equipped with genital seta and style. The role of the male is for periodic sexual reproduction (Mckenzie 1967).

Sampling of adult scales from August 1992 to February 1993 showed that the scales were parasitised by *Eunotus* sp. (Hymenoptera: Pteromalidae). The female parasitoid oviposits in gravid scales and the parasitic larva prey on the eggs within the scales (Kirkpatrick 1962; Graham 1992). Normally one parasitic larva was found in a single scale and over 93.2% of the eggs were consumed by the larva. A small proportion of eggs gave rise to crawlers which settled on the younger parts of the plants.

The degree of parasitisation varied with the time of the year. There was a significant difference ($p < 0.05$) between the percentage of parasitisation in October 1992 compared with other sampling months (Fig. 1). The dry weather in October 1992 when the total rainfall was only 72 mm most likely brought about the build-up of scales on the flower stalks and shoots, which in turn, resulted in a higher percentage of

parasitisation. On the other hand, in December 1992, the amount of rainfall rose to 338 mm. This resulted in a significant reduction of scales population which correspondingly brought about a drop in percentage of parasitisation. Schultz (1984) observed a similar fluctuation of levels of parasitisation of scales in relation to weather.

The sole emergence of *Eunotus* sp. suggests that they were the dominant parasitoids of the scales in the field. This genus, *Eunotus*, has been successfully used in the biological control of the scales, *Eriopeltis signoret*, in the United Kingdom (Manawadu 1984). Another related species, *Eunotus lividus* has been used in the biological control of oak lecanium (Schultz 1990). Hence there is a potential for the use *Eunotus* sp in the biological control of the scale *Drepanococcus chiton* in carambola orchards in Malaysia.

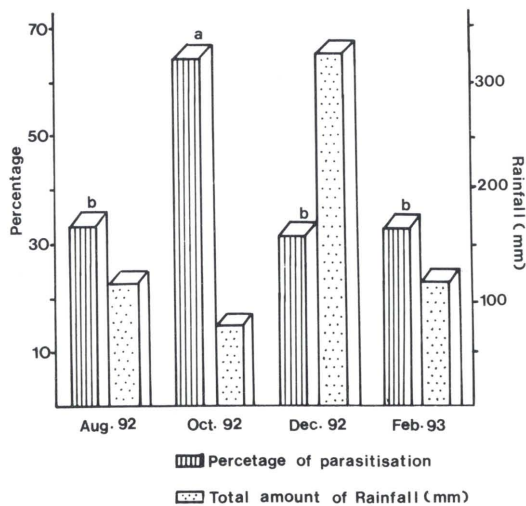


Fig. 1 : Percentage of parasitisation of *D. chiton* by *Eunotus* sp. in a carambola orchard. Columns with the same letters are not significantly different at the 5% level

ACKNOWLEDGEMENT

The author is thankful to En. Abdul Rahman Mohamad and En. Mohamad Tamsil of the Department of Plant Protection, Universiti Pertanian Malaysia for their assistance and Puan Hapsah Baharom for typing the manuscript.

REFERENCES

ARGYRIO, L.C. 1963. Studies on the morphology and biology of the black scale, *Saissetia oleae* (Bernard) in Greece. *Ann. Inst. Phytopath.* 5: 353 - 377.

BARBER, P. 1980. Studies on fecundity, longevity and settlement of hemispherical scales, *Saissetia coffeae* (Walker) (Homoptera: Coccidae). M.Sc. thesis. Wye College, University of London. 49 pp.

EBELING, W. 1959. *Subtropical Fruit Pests*. Division of Agricultural Science. University of California.

GRAHAM, M.W.R. DeV. 1992. Two new species of European Pteromalidae (Hym: Chalcidoidea). *Entomologist's Monthly Magazine* 115 - 117.

KIRKPATRICK, D. 1962. *Insect Life in the Tropics*. London: Longman, 311 pp.

MANAWADU, D. 1984. A new species of *Eriopeltis signoret* (Homoptera : Coccidae) from Britain. *Systematic Entomology* 11: 317 - 326.

MCKENZIE, H. 1967. *Mealybugs of California*. Berkeley and Los Angeles: University of California Press.

METCALF, C.L. and W.P. FLINT. 1962. *Destructive and Useful Insects, Their Habits and Control*. 4th. edn. McGraw-Hill Book Company.

MILLER, D.R. and M. KOSZTARAB. 1979. Recent advances in the study of scale insects. *Ann. Res. Entomol.* 24: 1-27.

PEAIRS, L.M. and R.H. DAVIDSON. 1966. *Insect Pests of Farm Garden and Orchards*. 6th. edn. New York: John Wiley and Sons.

PETERSON, A. 1943. Some new killing fluids for larvae of insects. *J. Econ. Entomol.* 36: 115.

SCHULTZ, P.B. 1984. Natural enemies of oak lecanium. (Homoptera : Coccidae) in Western Virginia. *Environmental Entomology*. 13: 1515 - 1518.

SCHULTZ, P.B. 1990. Forecasting flight activity of native parasitoids of oak lecanium (Homoptera: Coccidae). *J. Entomol. Sci.* 25(4): 622 - 627.

WIGGLESWORTH, V.B. 1965. *The Principles of Insect Physiology*. 7th edn. London: Chapman and Hall.

WILLIAMS, D.J. and WATSON, G.W. 1990. *The Scale Insects of the Tropical South Pacific Region. Part 3: The Soft Scales (Coccidae) and Other Families*. CAB International Institute of Entomology, Wallingford: Oxford. 267 pp.

(Received 24 November 1993)