PANIS, A.[1]; PINET, C.
INRA, Laboratoire de Biologie des Invertébrés, Antibes, France
[1]14 Avenue Schubert, 83440 Montauroux, France

A STUDY OF TWO *PLAGIOMERUS* SPECIES (HYMENOPTERA: ENCYRTIDAE) PARASITISING DIASPIDID SCALES (COCCOIDEA) IN GLASSHOUSES IN FRANCE.

ABSTRACT

A STUDY OF TWO *PLAGIOMERUS* SPECIES (HYMENOPTERA: ENCYRTIDAE) PARASITISING DIASPIDID SCALES (COCCOIDEA) IN GLASSHOUSES IN FRANCE.

Plagiomerus diaspidis Crawford was imported from Tenerife (Canary Islands, Spain) and released experimentally as a biological control agent against *Diaspis echinocacti* (Bouché) (Hemiptera, Diaspididae) within a cactus glasshouse in south-eastern France but it failed to provide control, apparently due to very weak powers of dispersal. A second undescribed *Plagiomerus* was found in a wet tropical greenhouse in the same region of France and was thought to be a potential biocontrol agent of Diaspididae. It was found to parasitise the three *Diaspis* species (*D. boisduvalii* Signoret, *D. coccois* (Lichtenstein) and *D. bromeliae* (Kerner)) present in the greenhouse, although it failed to control them. Both parasitoid species reproduced by thelytokous parthenogenesis.

Key words: development, Boisduval scale, preferred environments, USA, Mexico, Azerbaidjan, *Opuntia*, *Strelitzia*, *Calanthe*, palm.

INTRODUCTION

The biology of an undescribed species of *Plagiomerus* was observed in a tropical glasshouse of south-eastern France (Alpes-Maritimes department) in 1996 and 1997. Within the genus *Plagiomerus* as redefined by Noyes (1980), this species could be separated from the other six described species by the scutellar setae - this undescribed species had four setae which were long and slender, while the described species have either two or four setae which are thickened, with the anterior pair on the posterior third of the scutellum somewhat shorter than the posterior pair on the scutellum apex.

Four species of *Plagiomerus* are known to be internal parasitoids of armoured scale-insects. Of these, *P. diaspidis* Crawford, is known to be a parasitoid of the cactus scale, *Diaspis echinocacti* (Bouché), on cacti in the USA and Mexico (Gordh & Lacey, 1974) and in Azerbaidjan (Trjapitzin, 1968). *P. diaspidis* has also been recorded on an undetermined host in Italy (IOBC Secrétariat, 1960). In November 1997, an old branch of *Opuntia ferox* Salm.-Dyck was brought from Tenerife (Canary Islands, Spain) to Antibes (Alpes-

Maritimes department). It was infested with the *D. echinocacti* from which adult *P. diaspidis* emerged in February 1998. This was the second record of *P. diaspidis* from a hot temperate European country. Both sexes are known in Azerbaidjan and in California, but the frequency of males is very low, with less than 5 males per several hundred females in California and it is likely, therefore, that *P. diaspidis* has thelytokous parthenogenetic reproduction, as in France where no males have been found.

MATERIALS AND METHODS

The undescribed species of *Plagiomerus* was found in a 2.3 hectare, wet, tropical greenhouse within which the tallest vegetation was about 6m high and which had automated control of temperature and relative humidity (RH), with temperature gradients between 22 and 28°C and RH between 60 and 85% between the lowest layer of the vegetation and the sunny top of the canopy. All diaspidid species living indoors could be regarded as potential hosts. Very limited samples of plants were collected for observations on the behaviour and emergence of the parasitoid and hence quantitative data could not be obtained.

For the study of *P. diaspidis*, a 25cm tall branch of *Opuntia ferox* from Tenerife was firmly fixed in an upright position in soil in a pot and used as a host for rearing *Diaspis echinocacti*, in which the parasitoid could breed. The uncaged branch was in a very sunny position in a heated laboratory. Honeydew droplets were artificially deposited on the branch to provide food for the emerging parasitoid adults. These wasps never appeared to try to escape. Some flew a few centimetres away before landing but would then fly back to the scale-infested branch. Between mid-March and mid-May 1998, 300 cultured *P. diaspidis* were released once a week into a $10m^2$, hot temperate, cactus collector's glasshouse with about 200 plants in the Alpes-Maritimes department. Approximately two-thirds of the plants had low or medium infestations of *D. echinocacti*. In California, according to Gordh & Lacey (1976), gravid and ovipositing female scales were attractive to searching *P. diaspidis* but 2^{nd}-instar male and female scales were not. Larval development required between 13 and 21 days at 25-28°C.

Using these biological data, the efficiency of *P. diaspidis* was estimated in the cactus collector's glasshouse. It was found impossible to count all the scales on a plant and, therefore, the cactus pots were not removed from the bench but were regarded as having low infestations when less than 10 female scales were visible, and as having a medium infestation when more than 10

were visible. The number of living and dead female scales were counted in mid-March 1998 before the first parasitoid release, in mid-May after the last release and on the 30th June 1998 when the experiment was ended. On each occasion, 10 plants with a low scale infestation and 10 with a medium infestation were removed from the bench. Using a needle and a fine, wet brush, the scale covers were removed and the female bodies extracted and examined under a microscope. The bodies of healthy females were yellow and turbinate, those which had died naturally were shrivelled, whilst those which had been attacked by fungi were a dirty grey colour. Females that had been parasitised showed one to three tiny, brownish spots on the dorsum. These spots appeared 1-3 days after parasitisation, each spot indicating where the parasitoid had punctured the skin when ovipositing. In consequence, recently parasitised individuals would be counted as healthy. Once the parasitoid was well developed, the larvae or pupae were visible through the scale cuticle. If all scales were naturally dead or had been attacked by a fungus, additional plants were sampled. After discarding all naturally dead and diseased scales, sampling of each plant was stopped when either all scales on that plant had been studied or when up to 10 healthy and/or parasitised scales had been counted. Because each count was considered to be a biased estimate, additional observations were made on the 15th April, 29th May and 15th June. These observations involved marking plants on the margins of the bench on which recently emerged scales (crawlers and 1st-instar nymphs before the test-cover had been completely built) could be seen using a hand lens. A small, brightly-coloured plastic marker was fixed to each plant. When examined a second time, a second marker was fixed. The markers were intended to show whether the scales had been controlled by *P. diaspidis*.

RESULTS AND DISCUSSION

The hosts of the undescribed species of *Plagiomerus* in the tropical greenhouse were the Boisduval scale, *Diaspis boisduvalii* Signoret, which was widespread on many plant species, *Diaspis coccois* (Lichtenstein) (here regarded as a good species distinct from *D. boisduvalii* (Miller, 1996)) which occurred in mixed colonies with *D. boisduvalii* on coconut palm, and *Diaspis bromeliae* (Kerner) which was present in a small area of the greenhouse on three bromeliad species. *Plagiomerus* sp. was most abundant when (a) *D. boisduvalii* and *D. coccois* were crowded together on the dark base of the leaves of coconut palm, (b) when *D. boisduvalii* was overcrowded on the dark sheathing base of leaves of *Strelitzia alba* Skeels, and (c) in *D.*

boisduvalii scattered on the two-leafed orchid, *Calanthe furcata* Lindl. It was also found to parasitise *D. boisduvalii* on about 10 further plant species but did not parasitise all Boisduval scales in all situations. Its distribution appeared to be unrelated to such climatic conditions as light, RH and temperature. *Plagiomerus* sp. laid its eggs in non-ovipositing adult female *Diaspis* species, frequently with 2 or more rarely 3 eggs per host, all of which emerged.

On the other hand, *Plagiomerus diaspidis* cannot be regarded as a useful biocontrol agent of *D. echinocacti* in Mediterranean glasshouses, because the percentage parasitism was too low (Table 1) and because the level of scale infestation remained constant during the experimental period (Table 2), probably due to the very weak dispersal ability, with the parasitoid rarely leaving the source plant, as revealed by observing the scale populations on neighbouring plants.

Table 1. Percentage parasitism of adult female *D. echinocacti* by *P. diaspidis* released in a collector's glasshouse once a week. Data were collected on 15th March (just before first parasitoid release), on 15th May (just after the last release) and on 30th June (6.5 weeks later). On each occasion, up to 10 healthy and/or parasitised scales per plant were examined on 20 plants as described in the text. Naturally dead scales and those attacked by fungi were discarded.

Sampling date	15th March	15th May	30th June
Total healthy scales	142	98	169
Total parasitised scales		41	103
Percentage parasitism		29.5	37.9

Table 2. Number of plants with recently emerged crawlers of *D. echinocacti* in a cactus collectors glasshouse into which *P. diaspidis* had been released once a week between mid-March and mid-May. Where 1st and 2nd generations refer to generations subsequent to the release of the first parasitoids.

Date of observation	15th April	29th May	15th June
No. plants with:			
1st-generation crawlers	8	21	19
2nd-generation crawlers	-	2	10
Total number of plants	8	23	29

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