THE BIOLOGY OF *SPILOCONIS PICTICORNIS* BANKS
(NEUROPTERA: CONIOPTERYGIDAE)

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The dustywing *Spiloconis picticornis* Banks was introduced into California from Taipo, Hong Kong, in 1953 by S. E. Flanders. As it is predaceous on plant feeding mites and scale insects, attempts are now being made to establish it in citrus and avocado groves in southern California. For this reason *S. picticornis* is being reared in large numbers by the Department of Biological Control, University of California Citrus Experiment Station at Riverside. Thousands of individuals of *S. picticornis* have already been released in southern California citrus and avocado groves and many thousands more will be released during the coming season. The following information on the life history and feeding habits of *S. picticornis* was obtained during the process of developing a mass production program for this predator.

Procedure.—These studies were made in a darkened insectary room having a temperature of 80°F. with the relative humidity between 50 and 60 per cent. Adults were kept in 8 dram vials. Each vial was placed over a detached leaf of *Pittosporum Tobira* Ait., the petiole of which was inserted in a ¼ dram vial filled with water and held in place with cotton. The leaves were infested with crawlers of the soft (brown) scale, *Coccus hesperidum* Linn. one to two days before they were to be used. Red scale crawlers, *Aonidiella aurantii* (Mask), were placed on the leaf just prior to insertion into the vial containing the dustywings. Each vial was supplied with a fresh leaf daily.

Egg.—The eggs are irregularly ellipsoidal in outline, approximately 0.53 mm. long and 0.34 mm. wide. They

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are flat and scale-like. The chorion is strongly reticulate. The reticulations are often stretched and even obliterated during deposition if the egg is not supported. In many instances the eggs follow the contour of the surface upon which they are laid, and are thus distorted from the usual shape. The color of the eggs varies from straw-yellow to pink or pale purple. The straw-yellow colored eggs usually turn pinkish between 12 and 14 days after deposition. The pink or light purple eggs show no change except for the appearance of the eye spots which begin to show up 10 to 12 days after deposition. The length of the egg stage is rather consistent at 16 days.

Larvae.—As in most Neuroptera the larvae emerge from the egg by means of an egg burster. In this species the egg burster is attached to the hatching membrane which is shed immediately after the egg is broken. While still in the egg the larva is lying on its back with the head curved forward and down between the legs. The egg burster is located on the top of the head and projects upward over the mouthparts. Hatching is facilitated by the movement of the head, which manipulates the egg burster, thus breaking the chorion. The hatching membrane remains attached to the inside of the egg.

The larvae are shortly fusiform, the widest part being the thorax. In color they vary from creamy white to pink. The darker characteristic color pattern is confined to the lateral margins of the body (see fig. 1). The mature larvae are generally more uniformly pinkish-purple with small white markings as well as the dark lateral areas. The gut contents are clearly visible as a central, reddish-brown stripe. The integument of the dorsum of the body and head is very minutely muricate, the points being four and five sided. The venter is nearly smooth. Each abdominal segment bears eight pairs of minute squamiform setae (fig. 2) in addition to two pairs of simple setae;

EXPLANATION OF PLATE 8

Figure 1. Mature fourth instar larva of *S. picticornis*. Figure 2. Enlarged drawing of a dorsal squamiform setae. Figure 3. Exarate pupa of *S. picticornis* showing the attached last larval molt skin.

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laterally there are two pairs of squamiform setae; ventrally there are four pairs of simple setae on each segment.

The thoracic segment bears eight to ten pairs of dorsal squamiform setae. The head bears six pairs of squamiform setae and four pairs of serrated setae. The antennae are three-segmented and sparsely covered with setae of unequal length; three or four of the basal setae are serrated, the others comparatively smooth. The labial palpi are two-segmented, the second segment being much longer than the first and rather fleshy and swollen. The mandibles and maxillae together form a hollow tube through which the food is ingested. When not feeding, the mouth parts are held in a forward projecting position with the two mandibles and maxillae appearing as a single unit.

S. picticornis larvae pass through four instars. This is in contradiction to the findings of Killington (1936) concerning British Neuroptera. Killington found that all British Neuroptera underwent only three larval molts. The first larval molt of *S. picticornis* occurs one to three days after hatching; the second molt four to seven days later; the third molt takes place five to seven days after the second; and the last or fourth molt occurs within five to eight days. The last instar larva moves about freely for from one to seven days. At the end of its feeding period it seeks a place in which to spin a cocoon. From five to eight days are spent in this fourth instar as a prepupa before the final molt to the pupal stage. The larval skin remains attached to the pupa, usually on the back towards the posterior end (fig. 3). In these studies the total elapsed time in the larval state varied from 16 to 32 days.

The larvae have been observed to feed only upon the scale insects of the diaspine and lecanine groups. The preferred stage of the scale appears to be the younger settled scale, although all stages have been attacked from the crawlers to the second instar. The lecanine scales are more easily consumed than the diaspine scales. In the former group the dustywing larva may make only one feeding puncture, this is through the dorsum of the scale; while in the latter group the larva very often is un-

able to pierce the scale cover and after several attempts will move to the edge of the scale and insert the mandibles between the cover and the substrate.

When ready to pupate the fourth instar larva selects a crevice or crack in which to spin the cocoon. Contrary to the usual occurrence of two envelopes, it has been found that there are three distinct layers which make up the cocoon. The first or outer layer is loose and lace-like and is mostly the framework by which the cocoon is held in place. The second layer is also lace-like but it has a more definite vertical wall-like construction. The third or innermost layer is thick and closely woven. This last layer is the toughest of the three and is appressed to the pupa contained therein. The whole cocoon is irregularly circular, 2.5 mm. to 3 mm. in diameter, and flattened, approximately 0.5 mm. high.

After the cocoon is spun the larva turns on its side and becomes quiescent. This quiescent prepupal period lasts from five to eight days. At the end of this period the larval skin is shed and the exarate pupa is exposed (fig. 3). The pupal stage lasts from eleven to twenty days. When the adult is ready to emerge the pupa cuts an irregular opening in the cocoon and crawls out, leaving the posterior abdominal segments in the cocoon to act as an anchor. Occasionally the pupa will crawl completely out of the cocoon. In this case emergence of the adult is completed with a great deal of difficulty.

Adult.—Upon completion of emergence the adults are grayish in appearance, they remain in this state until the secretion of the wax-like coating completely covers the body and wings. It has been observed that a period as long as 48 hours may elapse before the adult begins to secrete the wax-like covering.

Mating has not been observed to take place prior to three or four days after emergence. This period is presumed to be the length of time required for the ovaries to mature. The pre-oviposition period varies from four to ten days. Oviposition rarely occurs before mating and when it does the eggs are nonviable. An occasional female has been observed to mate more than once after

oviposition has commenced but the necessity for repeated impregnation has not been determined. Within one day after mating the female begins depositing eggs. As many as 20 eggs have been obtained from a single female within a twenty-four hour period, but this is an extreme; the average number of eggs laid during this period has been approximately ten.

The females prefer a rough surface, with many depressions or crevices, for oviposition. In many cases the females will not oviposit if they are not provided with a suitable ovipositional substrate. The eggs are laid singly, but quite often large numbers will be found in a favorable location. Most of the oviposition takes place at night, there being little or no activity during the day.

The length of life of the adults provided with an adequate diet varied from 49 to 63 days. The length of life from the time of egg deposition until death of the adult varied from 92 to 131 days; the average being approximately 110 days under insectary conditions.

Hosts.—While the results obtained and the list of species tested as hosts are not complete, they do indicate the type of food required for development and egg production. As mentioned above the larvae were observed to feed only upon the young scale of the diaspine and lecanine groups. The adults have been observed to feed upon the citrus red mite, *Metatetranychus citri* (McG.) and the citrus rust mite, *Phyllocoptruta oleivora* (Ashm.) in addition to the scale insects. In order to promote egg production and also lengthen the life of the adults, honey and water are necessary. As shown in table 1 the diet which proved to be the most sufficient as to length of life consisted of water, honey and scale crawlers. The length of life of dusty-wing adults which fed on citrus red mites or citrus rust mites, with honey and water added in each case, was similar to that obtained with a diet of scale crawlers, honey and water.

Table 1 shows that when adults of *Spiloconis picticornis* were fed only citrus red mites or scale crawlers the maximum length of life was four days. When fed only honey, water, or citrus rust mites the maximum length of life

was six days. When fed rust mites and water the maximum life period was seven days. When water was added to the scale crawler diet the maximum life period was 18 days. When honey was added to the scale crawler diet the maximum life period was thirty-five days. When both honey and water were added to the scale crawler diet the maximum life period was extended to sixty-three days. When both honey and water were added to the mite diet similar results were obtained.

TABLE 1

Number of Days Adults of *Spiloconis picticornis* Lived When Fed Various Foods or Combinations of Foods.

FOOD	Number of Adults Tested	No. of Days for 50% Mortality	No. of Days for 100% Mortality
Scale Crawlers ¹	26	2	4
Red Mites ²	10	2	4
Honey	10	5	6
Water	36	3	6
Rust Mites ³	40	2	6
Rust Mites, Water	30	4	7
Scale Crawlers, Water	6	16	18
Scale Crawlers, Honey	30	18	35
Scale Crawlers, Honey, Water	30	45	63

¹*Aspidiotus hederae* (Vallot)

²*Metatetranychus citri* (McG.)

³*Phyllocoptruta oleivora* (Ashm.)

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