if treatment was repeated at regular intervals (2–4 weeks). He stated that too little emphasis has been placed on the distinction between the ability of an insecticide to control flies and its ability to kill them when the insecticide is applied sporadically against a heavy population.

Although no direct comparison of complete coverage and selective treatment in the same season is available, 1 of the dairies received both types of treatment with 5% Mobam in successive years. Although control was not obtained after week 8 in 1966, the fly indices thereafter were not excessively high. Since the period of control in 1966 was half that in 1965, the question remains as to the effect the application of a dosage of 4 g/m^2 to the selective resting site would have had. In 1965, complete coverage of dairy Ra with 30 gal of 5% Mobam gave 15 weeks of control. In 1966, selective treatment of the same dairy with 13 gal of the same material resulted in control for 8 weeks.

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Two Potential Parasites of the Mexican Bean Beetle[1] from India[2,3]

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ABSTRACT

Two parasites of *Henosepilachna sparsa* (Herbst) from India were tested against the Mexican bean beetle, *Epilachna varivestis* Mulsant, at the Insect Identification and Parasite Introduction Research Branch, Moorestown, N. J. *Tetrastichus ovulorum* Ferriere attacked *E. varivestis* and damaged the host eggs, but only a few parasites were able to complete their development. *Pediobius foveolatus* (Crawford) attacked and reproduced in larvae of *E. varivestis*. Neither species of parasites attacked or showed interest in several species of beneficial coccinellids native to India and the United States.

During a survey made to discover beneficial insects in India in 1956, one of us (G. W. A.) collected several egg masses of *Henosepilachna sparsa* (Herbst), a plant-feeding coccinellid, parasitized by *Tetrastichus ovulorum* Ferriere (Fig. 1), a solitary parasite. Also, several mummified larvae of *H. sparsa* that produced *Pediobius foveolatus* (Crawford) (Fig. 2, 3), a gregareous parasite, were collected. Later at the Indian Agricultural Research Institute in New Delhi, the percentage parasitization of *H. sparsa* on eggplant by *T. ovulorum* increased as the season advanced; in 1 plot, 84% of the egg masses were parasitized. The recovery of these parasites was of particular interest because of the possibility they might accept a new host, the Mexican bean beetle, *Epilachna varivestis* Mulsant, a destructive pest throughout the greater part of the United States. This beetle does not occur in India.

Krishnamurti (1932) first recorded *T. ovulorum* in India at Mysore and reported that the percentage parasitization of *H. sparsa* ranged from 1.5% on the monsoon potato crop to 2.45% on the summer crop. His attempts at large-scale production of the parasite for mass liberation failed because he could not find a suitable host other than *Henosepilachna* on which the parasite could be reared in the laboratory.

P. foveolatus was first recorded in India by Ayyar (1921). In 1946 Lal reported a maximum parasitization of larvae of *H. sparsa* by *P. foveolatus* of 16.9% in Bihar, but in 1948 Appana found an average 40 and a maximum 70% parasitization at Bangalore. Usman and Thontadarya (1957) reported 74.3% parasitization at Mysore.

T. ovulorum and *P. foveolatus* were imported into the United States in 1966 for laboratory study under quarantine conditions by the Insect Identification and Parasite Introduction Research Branch, Moorestown, N. J. The shipments were obtained through the courtesy of V. P. Rao, Commonwealth Institute of Biological Control, Indian Station, Bangalore, India. Before the parasites could be considered for release we needed to determine whether the parasites would attack the beneficial predaceous coccinellid species present in the United States.

METHODS AND RESULTS.—*Tests of* T. ovulorum.—Preliminary laboratory testing of *T. ovulorum* against

[1] Coleoptera: Coccinellidae.
[2] Accepted for publication February 21, 1968.
[3] The *Chilocorus renipustulatus* (Scriba) and *Exochomus 4-pustulatus* (L.) used in our studies were obtained through the courtesy of Dr. K. S. Hagen, Biological Control of Insects, University of California, Berkeley.

FIG. 1.—*Tetrastichus ovulorum* parasitizing eggs of Mexican bean beetle.

native beneficial coccinellids was conducted at New Delhi during the summer of 1957 after several hundred egg masses of *H. sparsa* and the eggs from 4 species of beneficial coccinellids (*Coccinella septempunctata* L., *Menochilus sexmaculata* (F.), *Adonia variegata* (Goeze), and *Brumus suturalis* (F.)) were obtained. The procedure was: fifty 1- to 2-day-old eggs of each species of coccinellid were placed in separate 6×3-in. glass dishes with 50 eggs of *H. sparsa*, then 24 mated females of *T. ovulorum* were released into the dish, and the dish was held at 22°C and 70% RH for 72 hr. Each test was replicated twice each month from June to September. None of the coccinellid eggs were attacked by *T. ovulorum*, but parasitization of *H. sparsa* eggs ranged from 72 to 100%, and the eggs were often destroyed by multiple stinging.

Later, in our studies at Moorestown, N. J., *T. ovulorum* was placed with lots of about 50 eggs of predaceous native coccinellids and *E. varivestis* in 1¼×4-in. glass cylinders closed with milk-bottle caps, ½-pint cylindrical cardboard cartons covered with halves of petri dishes, and 1-gal glass jars. Droplets of honey were provided as food. The containers were held in chambers maintained at a temperature of 25°C and 50% RH.

The native coccinellids tested included the convergent lady beetle, *Hippodamia convergens* Guérin-Méneville; *Coleomegilla maculata* (De Geer); *Coccinella novemnotata* Herbst; *Chilocorus renipustulatus* (Scriba); and *Coccinella septempunctata* (from Europe) obtained in the field on alfalfa foliage. Similar

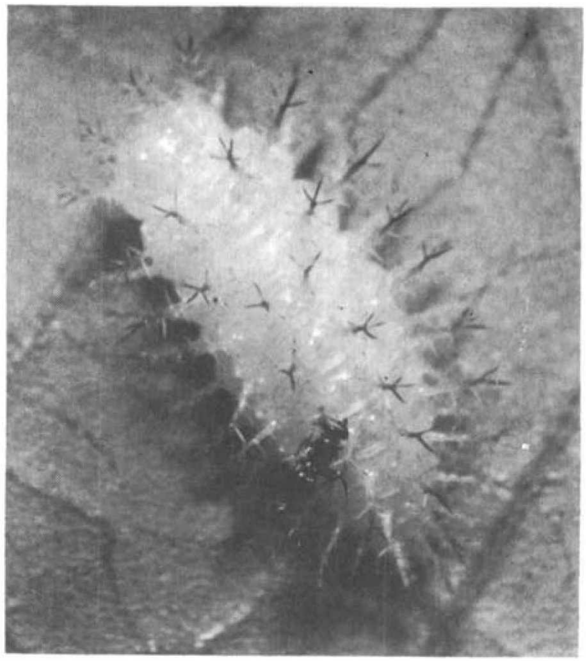

FIG. 2.—*Pediobius foveolatus* parasitizing a larva of Mexican bean beetle.

lots of *E. varivestis* were obtained in the field on bean leaves. Eggs of the beneficial coccinellids were not attacked by the parasite, but the eggs of *E. varivestis* were readily parasitized.

Thus methods used in our studies and the laboratory environment seemed favorable to the reproduction of *T. ovulorum* on *E. varivestis*. However, further observations showed that only a small percentage of the eggs that had been stung contained immature parasites, apparently because the eggs had been excessively damaged, that is, most eggs exuded a considerable quantity of fluid as a result of the oviposition puncture, consequently the eggs desiccated or decomposed. Apparently the egg chorion of *E. vari-*

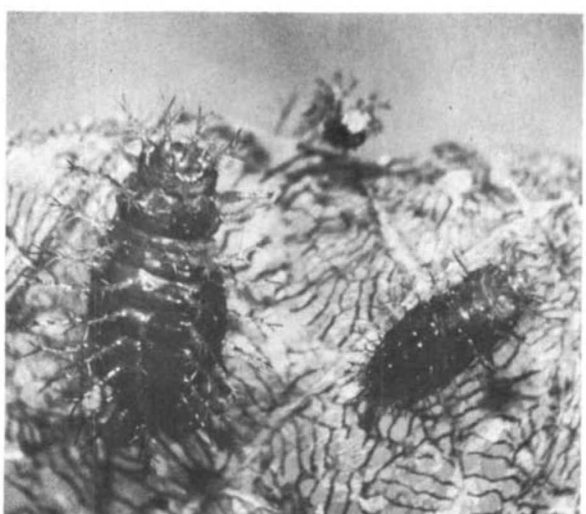

FIG. 3.—Mummies of Mexican bean beetle that contain larvae of *Pediobius foveolatus*.

vestis is too delicate to withstand parasitization by this parasite. When successful reproduction did occur, the life cycle of the parasite was completed in about 15 days. Females predominated in the F_1 generation. Newly emerged females mated soon after eclosion, and survival was satisfactory. Some parasites lived more than 3 weeks.

Tests of P. foveolatus.—*P. foveolatus* reproduced readily in 3rd- and 4th-instar larvae of *E. varivestis*, but earlier larval stages were occasionally attacked. The female worked her way in between the spines of the dorsoventral area of the host larvae to oviposit. Lall (1961) stated that the parasite deposited 3–6 eggs in the haemocele of the host. After parasitization, the host larvae eventually became grayish-brown and died before pupation. Adult parasites emerged from the host mummies about 30 days after parasitization when the mummies were held at 25°C.

Extensive replicated tests were made in the laboratory to determine whether *P. foveolatus* would attack different sizes and ages of the beneficial coccinellid larvae of *H. convergens, Coleomegilla maculata, Cycloneda munda* (Say), *Coccinella novemnotata, C. septempunctata, Chilocorus renipustulatus,* and *Exochomus 4-pustulatus* (L.). *P. foveolatus* did not attack or show interest in any; however, *P. foveolatus* readily parasitized the larvae of *E. varivestis* that were placed in each test cage after the parasites had been exposed for a day or more to larvae of the beneficial coccinellids.

Thus, *P. foveolatus* can be produced readily in the laboratory, and releases of this parasite were made in some eastern States in 1967.

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Oils for Summer Control of Pear Psylla and Their Effects on Pear Trees[1]

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ABSTRACT

Oils of various specifications, used alone and in combination with insecticides, were evaluated over a 3-year period as foliage sprays for control of *Psylla pyricola* Foerster. In 1 series of experiments a 140 S. S. U. oil gave better psylla nymph control than a lighter oil (60 S. S. U.) when the oils were used as dilute sprays. Pear trees sprayed with both oils exhibited noticeable lenticelular tissue proliferation on new and old wood and 1 application marked foliage, but no other persistent effects were apparent after 3 years.

Oils when used in combination with azinphosmethyl, ethion, and Perthane® (1,1-dichloro-2,2-bis(*p*-ethylphenyl) ethane and related reaction products) increased psylla control over these insecticides without oil. Psylla control with 2 oils or as oil–azinphosmethyl combinations was more effective with a heavier (134 S. S. U.) than a lighter (50 S. S. U.) oil.

Increasing resistance of the pear psylla, *Psylla pyricola* Foerster, to organic insecticides has resulted in efforts to improve control through the use of petroleum oils or oil–insecticide combinations during the foliage season. The history of psylla control in the Hood River, Oregon, area since its introduction in 1949 (Davis 1949), has followed a similar history of insecticide usage to that outlined by Harries and Burts (1965). They (1959, 1965) found that adult and nymphal psylla from different locations in the Wenatchee and Yakima, Wash., areas possess varying degrees of resistance to the cyclodiene compounds and azinphosmethyl in laboratory evaluations.

Oils and oil–insecticide combinations for psylla control have previously been investigated by numerous workers. Hartzell (1930, 1931) reported reduced costs and more effective control of psylla nymphs with white oils, but cautioned against possible undefined tree damage resulting from applications over several years. Hamilton (1948) noted nicotine + oil was more effective as a foliage spray than nicotine alone. Mundinger (1952) found oil to be only slightly toxic to eggs but more effective against newly hatched nymphs. Smith's (1965) tests with delayed dormant oils indicated poor ovicidal action but a toxic residual action to young nymphs crawling over oil deposits which was positively correlated with increasing viscosity. Madsen and Williams (1967a) reported increased effectiveness with azinphosmethyl + oil vs. the insecticide alone. They attributed better control of psylla during the foliage season with heavier oils to adult rather than to nymphal mortality. Carlson and Newcomer (1949) and Burts (1961) recommended oil + nicotine or rotenone for foliage-season control.

In evaluating oils and oil-insecticide combinations for psylla control during the foliage season, it was observed that increased effectiveness of several insecticides resulted from the addition of oils. The use of oil at 2–4 qt/100 gal water at this time is believed by many local orchardists to result in pear tree injury if applied over a span of several growing seasons. Accordingly, little information is available, either locally

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