PARASITOIDS AND PREDATORS OF INSECTS ASSOCIATED WITH OIL PALM (*Elaeis guineensis* Jacq.) IN INDIA

Keywords: Predators, parasitoids, natural enemies, oil palm, *Elaeis guineensis* Jacq. survey, biocontrol, India

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Oil palm nurseries and plantations in India were surveyed from April 1985 to February 1992 and 57 species of natural enemies of insects associated with the oil palm were recorded. These included 24 species of parasitoids, 17 species of predatory insects and 16 species of spiders. In the majority of the insects infesting the oil palm in India, native natural enemies could be found and the highest number of such natural enemies were reported on the diaspids encrusting fruits and leaves and the psychids causing defoliation. The role of these parasitoids and predators in naturally suppressing populations of limacodids, psychids and diaspids was highlighted. Infestations of the defoliating psychids and limacodids in Little Andaman Island were attributed to a lower incidence of parasitism by their natural enemies, thus augmenting these parasitoids from the main land in Little Andaman Island is suggested.

INTRODUCTION

The oil palm, *Elaeis guineensis* Jacq., is a newly-introduced crop to India and its large scale commercial cultivation began only from the mid-Seventies. The first commercial cultivation of the oil palm (around 3700 ha) was initiated in the state of Kerala where the coconut (*Cocos nucifera* Linn.) and the areca palms (*Areca catechu* Linn.) are the major crops. Subsequently, in the early Eighties, a large scale plantation (1500 ha) was established in a forest area in Little Andaman Island. Since 1989, oil palm plantations have been established in new areas in other states like Andhra Pradesh, Karnataka and

Maharashtra. In India, around 60 species of insects infesting oil palm have been reported (Dhileepan 1988, 1991a, 1991b, 1992). The pest scenario in the oil palm vary greatly, depending on the local crops as well as on the intercrops. In Kerala, the majority of the insects infesting the oil palm are known pests of the coconut and the areca palms, while in the other states, the nature of pest incidence in the oil palm, depends on the intercrops and the local crops. With the introduction of the oil palm in new areas with diverse cropping patterns, newer insects are emerging as potential pests. However in Little Andaman Island, the majority of the insects recorded in the oil palm were not known to be pests of any crops and are believed to be of forest origin. Among the various insects infesting the oil palm in India, the rhinoceros beetle *Oryctes rhinoceros* (Linn.) and the red palm weevil *Rhynchophorus ferrugineus* (Oliver) are the major pests, while the psychids (caseworms), the limacodids (nettle caterpillars) causing defoliation and the diaspids encrusting leaves and fruits are classified as potential pests.

In recent years, the role of an integrated approach for the management of insect pests in oil palm plantations is gaining importance (Mariau 1993, Wood 1971). Further, with the introduction of the pollinating weevil *Elaeidobius kamerunicus* Faust in most of the oil palm growing countries, the use of insecticides for the control of insect pests is being rationalised. In such a situation, the need for utilising natural enemies for the biological control of the insect pests appears important. In order to develop a viable biological control strategy, it is essential to catalogue the various natural enemies of insects infesting the oil palm. Information pertaining to the natural enemies of insects infesting the oil palm in South East Asia is well documented (Cock *et al.* 1987, Mariau *et al.* 1993, Sankaran and Syed 1972, Wood 1968). In India, except for reports on *Aspergillus candidus* Link and *Baculovirus oryctes* as entomopathogens of spindle bug *Carvalhoia areca* M&C and rhinoceros beetle *O. rhinoceros* respectively (Dhileepan *et al.* 1990, Dhileepan 1994), no information is available on the natural enemies of insects infesting the oil palm. The present study therefore deals with a survey and the cataloguing of various parasitoids and predators of insects associated with the oil palm in India with a view of using the information for future biological control programs.

SURVEY METHODS

Nurseries

The oil palm nurseries in the states of Kerala, Karnataka, Andhra Pradesh and Maharashtra (*Figure 1*) were surveyed during 1985-1992. In all nurseries, the seedlings were maintained in polythene bags and no insecticide application was carried out during the entire study period. Oil palm seedlings at Palode were examined at monthly intervals from March 1985 to February 1992. Oil palm nurseries at Shimoga, Bhadra, Konnali and Sidhipura (Karnataka State) were surveyed during 1989 and 1990, while the nurseries at Eluru, Kantaru and Lalshimipuram (Andhra Pradesh) were surveyed from 1989 to 1991. Oil palm nurseries at Sawantwadi (Maharashtra State) and HutBay (Little

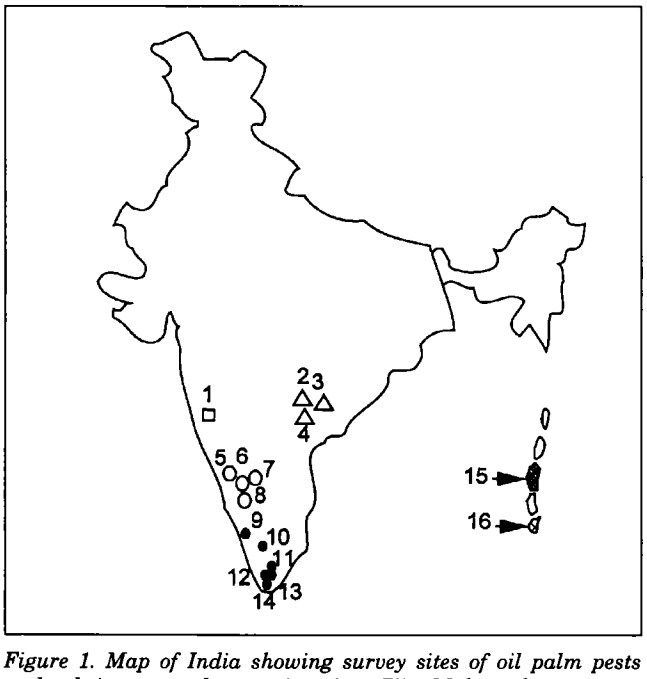

Figure 1. Map of India showing survey sites of oil palm pests and their natural enemies in (□) Maharashtra (1 = Sawantwadi), (Δ) Andhra Pradesh (2 = Eluru, 3 = Kantaru, 4 = Lakshimipuram), (O) Karnataka (5 = Shimoga, 6 = Bhadra, 7 = Konnali, 8 = Sidhipura), (●) Kerala (9 = Cannanore, 10 = Thodupuzha, 11, Yeroor, 12 = Chithara, 13 = Kulathupuzha, 14 = Palode) States and (➔) Andaman (15 = Port Blair) and Little Andaman (16 = Hut Bay) Islands.

Andaman Island) were surveyed once during March 1989 and February 1991 respectively. In all nurseries, randomly selected seedlings were sampled for insect pests and their natural enemies.

Field palms

All the mature and established plantations in India (*Figure 1*) were surveyed during 1985-1992. They included plantations at Palode (50 ha), Thodupuzha (40 ha), Chithara (1,018 ha), Yeroor (1,753 ha), Kulathupuzha (1,000 ha), Cannanore (10 ha) (all in Kerala State) and Little Andaman Island (in Andaman & Nicobar Islands). The plantation at Palode (1979-85 planting) was surveyed at monthly intervals from April 1985 to February 1992. The plantations at Yeroor (1971-84 planting), Chithara (1982-84 planting), and Kulathupuzha (1981-83 planting) were surveyed at quarterly intervals during 1985-1991. Plantations at Thodupuzha (1968 planting) and Cannanore (1987 planting) were surveyed once during August 1986 and March 1989, respectively. In the plantation at Hut Bay, Little Andaman Island (1981-84 planting) randomly selected palms were surveyed once during February 1991. In the newly emerging oil palm plantations (1988-1990 planting) in Karnataka (1,020 ha) and Andhra Pradesh (1,050 ha) (*Figure 1*), palms randomly selected were surveyed during 1989-91.

Collection of natural enemies

Oil palm nurseries and field plantations were surveyed and the various insects infesting the oil palm were brought to the laboratory at Palode and maintained for parasitoid emergence. To catalogue the parasitoids of coccoids infesting oil palm fruit bunches, randomly selected fruit bunches infested with coccoids (n=10 bunches) were brought to the laboratory at quarterly intervals and maintained in cages covered with muslin cloth for parasitoid emergence. Psychids, limacodids and other defoliating insects collected from the various plantations were brought to Palode and were fed with oil palm leaf until adult/parasitoid emergence. Predators noticed in the field were also brought to the laboratory and their predator status was ascertained. Initial sampling of 40 mature and 25 young palms revealed that spiders were present only in the outer whorl of fronds. Hence, the prevalence of spider fauna in the oil palm was studied by sampling all the outer whorl of fronds in 1800 mature palms (1976 planting) and 400 young palms (1982 planting). Various predators and parasites collected during the survey were identified by the International Institute of Entomology, the British Natural History Museum and the Entomology Department, Calicut University, India.

RESULTS

Parasitoids

Twenty four species of parasitoids were recorded on 16 species of insects associated with the oil palm (*Table 1*). Among them, 21 species of parasitoids were recorded on insects infesting oil palm, while others were either parasitoids of predators like *Chilocorus nigritus* F. and *Ankylopteryx octopunctata* (Fab.), or hyper-parasitoids through primary parasitoids. Group specific parasitoids were recorded on 12 species of lepidopteran insect, which mainly include potential pests like limacodids and psychids (*Table 1*). Psychids (*Metisa plana* Walker, *Kophena minor* Haylaerts, *Manatha albipes* Moore, *Kotochalia doubledayi* Westwood and *Manatha scolopepla* Hampson) and limacodids (*Darna jasea* Swinhoe and *Thosea aperiens* Walker) cause occasional defoliation in the oil palm plantations in the mainland (Kerala, Karnataka and Andhra Pradesh States) and are naturally suppressed by the higher incidence of parasitism, ranging from 59.5% to 88.5% (*Table 1*). In Little Andaman Island, both psychids (*Metisa* sp. and *Eumeta* sp.) and limacodid (*Thosea andamanica* Holloway) cause severe defoliation and attained major pest status. However, the sample larvae collected from the oil palm plantation in Little Andaman Island during an outbreak in 1990 (n=182) indicated a very low incidence of parasitism (1.4%-3.2%), mostly by tachinids (*Table 1*). In many of the nurseries, especially in Palode and Karnataka, the tussock caterpillar *Dasychira mendosa* Hb. is emerging as a major pest. Three species of

TABLE 1. PARASITOIDS OF INSECT PESTS AND OTHER INSECTS ASSOCIATED WITH OIL PALM IN INDIA.

Parasitoid species	Family	Host insects	Location*	% Parasitism# (No of samples)
Hymenoptera				
Telenomus (Ahokus) adenyus Nixon	Scelionidae	Egg parasitoid of *Spodoptera litura* and Chrysopid predator *Ankylopteryx octopunctata* F.	P	+
Enicospilus dasychirae Cameron	Ichneumonidae	Larval-pupal parasitoid of *Dasychra mendosa* Hb.	P Kr	14% (70) 17.2% (180)
Goryphus sp.	-do-	-do-	P	71.2% (184)
Tetrastichus howardi (Olliff)	Eulophidae	Larval parasitoid of psychid *Acanthopsyche cana* Hampson	P	13.04% (184)
Tetrastichus sp.	-do-	Larval parasitoid of coccinellid *Chilocorus nigritus*	P	++
Aroplectrus sp.	-do-	External larval parasitoid of limacodid *Darna jasea* and *C. nigritus.*	P C	71.6% (67) 69.1% (265)
Aulosaphes psychidivorus Muesebeck	Roganidae	Larval parasitoid of psychid *Manatha albipes* Moore	Y	88.5% (87)
Rhynchochalcis sp.	Chalcididae	Larval parasitoid of psychid *Kophena minor* Heylaerts	P Kr Y	40.5% (37) 58.5% (135) 75.9% (54)
Brachymeria megaspila Cameroun	-do-	Larval parasitoid of *K. minor.*	P Kr	21.6% (37) 19.6% (135)
		Larval parasitoid of *D. mensosa.*	Y	38.0% (130)
Brachymeria carinata Joseph et al.,	-do-	Larval parasitoid of *K. minor.*	Kr	8.9% (135)
Antrocephalus dividens Wlk.	-do-	Larval parasitoid of psychids *Manatha scolopepla*	Kr	67.8% (28)

TABLE 1 (CONT.) . PARASITOIDS OF INSECT PESTS AND OTHER INSECTS ASSOCIATED WITH OIL PALM IN INDIA.

Parasitoid species	Family	Host insects	Location*	% Parasitism# (No of samples)
Bothriophyrne sp.	Encyrtidae	Parasitoid of coccid *Ceroplastes* sp.	Kr	+
Homalotylus eytelweini (Ratzeburg)	-do-	Primary larval parasitoid of *C. nigritus*	P	+++
Prochiloneurus comperi Viggiani	-do-	-do-	P	+++
Arrhenophagus chinaspidis Aurivillus	-do-	Parasitoid of diaspid *Pinnapsis aspidistrae* (Signoret)	C,K	++
Aphytis sp.	Aphelinidae	Primary ectoparasitoid of diaspids *P. aspidistrae* and *Aspidiotus destructor* Signoret	C,LA,AN	++
Aphanogmus sp.	Ceraphronidae	Parasitoid or hyper-parasitoid through a primary braconid, on limacodid *Thosea andamanica.*	LA	1.45% (87)
Cryptochetum sp.	-do-	Parasitoid of margarodid *Icerya formicarum* Newstead	P,Kr	+
Goniozus sp.	Bethylidae	Primary ectoparasitoid of psychid *Acanthopsyche cana.*	P	71.2% (184)
Diptera				
Carcelia (Carcelia) sp.	Tachinidae	Larval-pupal parasitoid of *D. mendosa.*	P,Kr	5.5% (200)
Eozenillia equitorialis Townsend	-do-	Larval parasitoid of psychid *Eumeta* sp.	LA	3.12% (32)
		Larval parasitoid of psychid *Metisa* sp.	LA	3.17% (63)

* P = Palode; C = Chithara; K = Kulathupuzha; Y = Yeroor; T = Thodupuzha; Kr = Karnataka state; LA = Little Andaman Island; AN = Andaman Island (PortBlair).
# For parasitoids with no quantitative information on % incidence, abundance quantified as: +++ = common; ++ = occasional; + = rare

larval parasitoids were recorded on this pest and the incidence of parasitism ranged from 17% to 38% (*Table 1*).

Among the coccoids encrusting oil palm fruit bunches and leaves, the highest number of natural enemies were recorded on the diaspids, which included two species of parasitoids and eight species of predators (*Figure 2*). Among the diaspids, parasitoids were recorded on *Pinnapsis aspidistrae* (Signoret) encrusting oil palm fruit bunches at Chithara and Kulathupuzha plantations and *Aspidiotus destructor* (Signoret) encrusting mature leaves at Little Andaman Island (*Table 1*). *Bothriophyrne* sp. was recorded as a parasitoid of coccid *Ceroplastes* sp. infesting mature fronds in Karnataka State. However, no parasitoids were recorded on other diaspids (*Chrysamphalus aonidum* (Linn.), *Hemiberlesia palmae* (Cockerell) and *H. lataniae* (Signoret), pseudococcids (*Dysmicoccus brevipes* (Cockerell), *Pseudococcus citriculus* Green and *Palmicultor* sp.), margarodids (*Icerya aegyptiaca* (Douglas), *I. formicarum* Newstead, *I. menoni* Rao, *I. seychellarum* (Westwood) and *Icerya* sp.) and coccids (*Coccus accutissimus* (Green), C. *hesperidum* Linn., *Eucalymnatus tessellatus* (Signoret) and *Ceroplastes* spp. infesting oil palms in India.

Predatory Insects

Among the 17 species of predatory insects recorded (*Table 2*), seven species were group specific (oligophagous) which included mainly the aphidophagous and diaspidophagous coccinellids. Among the six species of diaspidophagous coccinellids, *Chilocorus nigritus* was the most efficient predator, naturally suppressing diaspids like *C. aonidum, H. palmae* and *Ischnaspis longirostris* (Signoret) encrusting oil palm leaves at Palode and oil palm fruit bunches at Yeroor plantations. In the oil palm plantation at Palode, *C. nigritus* was noticed during most of the months, except from June to August and

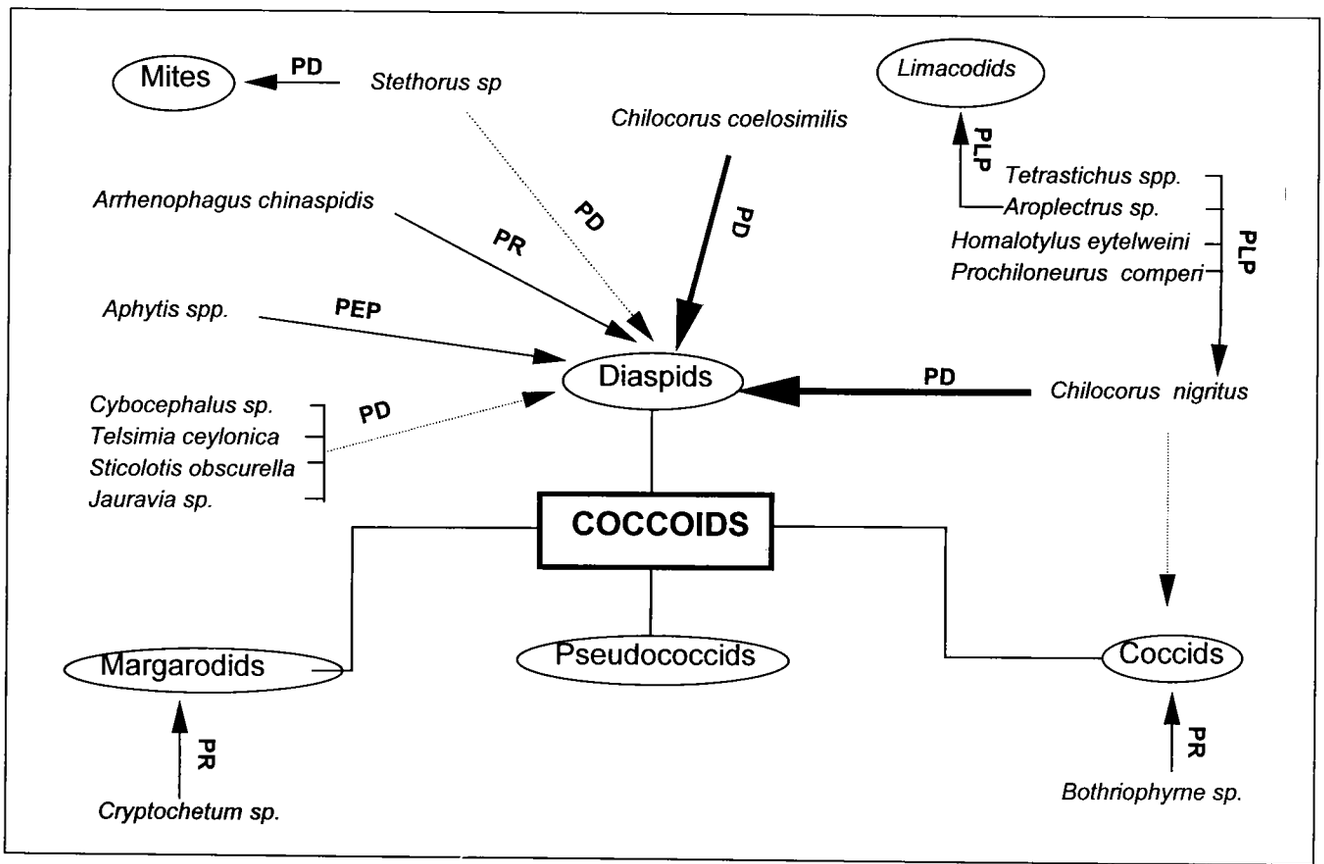

Figure 2. Natural enemy complex of coccoids infesting the oil palm in India. PD = *Predators;* PEP = *Primary ectoparasitoids;* PLP = *Primary larval parasitoids;* PR = *Predators*

TABLE 2. PREDATORS OF INSECT PESTS AND OTHER INSECTS ASSOCIATED WITH OIL PALM IN INDIA.

Parasitoid species	Family	Prey insects	Location*	Category#
Coleoptera				
Cybocephalus sp.	Nitidulidae	Predator of diaspid *Aspiditotus destructor* Signoret.	*LA*	+
Chilocorus coelosemilis Kapur	Coccinellidae	-do-	LA, AN	+++
Chilocorus nigritus F.	-do	-Predator of diaspids *Chrysomphalus aonidum* Linn. and *Ischnaspis longirostris* (Signoret).	P,Y	+++
Telsimia ceylonica Weise	-do-	Predator of diaspids infesting oil palm leaves.	P,C,T	+
Jauravia sp.	-do-	-do-	P,C,T	+
Sticolotis obscurella Weise	-do-	-do-	P	+
Stethorus sp.	-do-	Predator of plant mites.	Kr	+
Chilomenes sexmaculatus (F.)	-do-	Predator of aphids *Schzaphis rotundiventris* and *Hysteroneura setaria* infesting oil palm seedlings.	Kr	+
Hemiptera				
Eocanthecona furcellata (Wolff)	Pentatomidae	Predator of limacodid and other lepidopteran larvae.	P	+
Hymenoptera				
Oecophylla smaragdina Fab.	Formicidae	Predator of eggs, larvae, pupae and adults of *Elaeidobius kamerunicus* Faust.	P,C,Y,K	+++
Pheidologenton affinis Jordon	-do-	-do-	P,C,K	++
Diachamma rugosum (Le Guillou)	-do-	-do-	C	++

TABLE 2. PREDATORS OF INSECT PESTS AND OTHER INSECTS ASSOCIATED WITH OIL PALM IN INDIA. (CONT.)

Parasitoid species	Family	Prey insects	Location*	Category#
Orthoptera				
Haplopeza nilgirica Wood-Masom	Mantidae	General predator, preferably on derbid *Proutista moesta* Westwood.	T	+
Neuroptera				
Ankylopteryx octopunctata (Fab.)	Chrysopidae	General predator.	P,C,K,Y	++
Mantispa sp.	Mantispidae	-do-	P,C,T	+
Micromus sp.	Hemirobiidae	Predator of aphid *Astegopteryx rhapidis* (Van der Goot).	LA	++
Trichoptera				
Oecetis ceylonica (Ulmer)	Leptoceridae	General predator.	P	+

* P = Palode; C = Chithara; Y = Yeroor; K = Kulathupuzha; T = Thodupuzha; Kr = Karnataka state; LA = Little Andaman Island.
# +++ = common; ++ = occasional; + = rare

completed at least two generations in a year. It is assumed that the predator completes two more generations in a year outside the oil palm plantation. Peak predator population was noticed during April (5-6 beetles/infested frond) and November (5-8 beetles/infested frond), coinciding with the increased diaspid population (9.76 ± 6.57 SD scales/cm^2). However, no parasitoids or predators were noticed on diaspids *C. aonidum* and *H. lataniae* encrusting oil palm fruit bunches at Chithara and Kulathupuzha plantations. Coccinellid, *Chilocorus coelosimilis* Kapur which is endemic only to the Andaman & Nicobar Islands was noticed as an efficient predator of *Aspidiotus destructor* encrusting oil palm (1-3 beetles/infested frond) and coconut leaves in Little Andaman (Hut Bay) and Andaman (Port Blair) Islands. Other predators of minor importance include *Chilomenes sexmaculatus* (F.) predating on aphids *(Schzaphis rotundiventris* (Signoret) and *Hysteroneura setaria* (Thomas)) infesting oil palm seedlings in Karnataka and neuropteran *Micromus* sp. predating on aphid (*Astegioteryx rhapidis* Van der Goot) infesting oil palm and coconut leaves in Andaman & Nicobar Islands. The pentatomid *Eocanthecona furcellata* (Wolff.) predating on leaf-eating caterpillars was recorded only occasionally. Two species of neuropterans, one species of trichopteran and three species of ants were recorded as general predators in the majority of the oil palm plantations (*Table 2*). In the oil palm plantations at Palode, Chithara, Kulathupuzha and Yeroor, three species of ants were recorded as predators of the pollinating weevil *E. kamerunicus*. These ants fed on the adult weevils congregating on the anthesising male inflorescences as well as the immature (eggs, larvae and pupae) stages of the weevil in the post-anthesising male inflorescences. The red ant, *Oecophylla smargdina* Fab. was the most common and serious predator noticed throughout the year. These ants colonised only in the outer whorl of fronds and in many cases the colonies were extended to several adjacent palms due to the overlapping canopy. Incidence of other species of ants (*Pheidologenton affinis* Jordon and *Diachamma rugosum* Le Guilloue) predating on the pollinating weevil was noticed only during the rainy season. These ants feed also on smaller sap feeding insects like *Proutista moesta* (Westwood) and *Ricania speculum* (Wlk.).

Spider fauna

A total of 16 species of spiders associated with the oil palm were recorded (*Table 3*). In a survey conducted at Palode during Feb 1990, spiders were noticed on 91.7% (n=1800) of adult palms (1976 planting) and 81.8% (n=400) of young palms (1982 planting). However, the number of spiders found on each palm varied (4-12) depending upon the number of older fronds in each palm. Spiders were noticed only on the outer whorl of fronds, and usually one spider was noticed in each frond. In only 8% of the fronds surveyed were two spiders in a single frond noticed. The presence of spiders only in the older fronds was possibly due to the presence of preying insects, more specifically the derbid *P. moesta* on older and yellowing fronds. No spiders were noticed in the younger fronds and spear cluster. In other plantations, spiders were also noticed in the majority of the palms, predating mostly on sap feeding *P. moesta*, which is suspected to be a vector of mycoplasma-like organisms (MLO) causing spear-rot in oil palm.

DISCUSSION

The present survey revealed that for the majority of the insects infesting the oil palm in India, native natural enemies exist. For the rhinoceros beetle *O. rhinoceros* which is the major pest of oil palm in India, no specific parasitoids or predators were noticed in the oil palm plantations. However an indigenous baculovirus disease (*Baculovirus oryctes*) was noticed among the *O. rhinoceros* population in the oil palm plantations in Kerala (Dhileepan 1994). Similar incidence of baculovirus disease have been recorded among the rhinoceros beetle and its larval populations in Karnataka, Andhra Pradesh and Maharashtra States. For the red palm

TABLE 3. SPIDER FAUNA ASSOCIATED WITH OIL PALM IN INDIA.

Spider fauna	Location
Araneidae	
Gastracantha geminata (Fab.)	P
Neoscona spp.	P,C,K
Araneus sp.	P,C
Argiope sp.	P
Araneus laglaizai (Simon)	P,C,K,T
Salticidae	
Thiania bhameensis Threell	P
Hyllus sp.	P
Icius sp.	P,C
Rhintella suavis (Simon)	P
Thyene sp.	T
Plexopus petersi (Karsch)	P,C
Carrhotus sp.	P,Y
Brettus cingulatus Therell	P,Y
Epeus glorius Zabka	P,K,C
Gnaphosidae	
Aphantaulax sp.	P
Theridiidae	
Argyrodes sp.	P

P = Palode; C = Chithara; K = Kulathupuzha; T = Thodupuzha; Y = Yeroor

weevil *R. ferrugineus* which is also a major pest of the oil palm in India, no natural enemies were recorded. The highest number of natural enemies were recorded for diaspids and psychids infesting oil palm. In view of the absence of any parasitoids or predators for diaspids like *C. aonidum* and *H. lataniae* encrusting oil palm fruit bunches at Chithara and Kulathupuzha plantations, possibilities for introducing the more efficient *C. nigritus* to these plantations from Palode appear promising. In addition, *C. coelosimilis* which is endemic only to the Andaman and Nicobar Islands can also be introduced into the oil palm plantations in the mainland for bio-suppressing the diaspids infesting oil palms. Even though several species of psychids and limacodids infest oil palms in the mainland area, none of them caused any serious problem. This was presumably due to the higher incidence of parasitism. However in the Little Andaman Island, a lower incidence of parasitism among psychids (3.13-3.17%; n=55) and limacodids (1.45%; n=87) appeared to be due to the frequent use of pesticides (monocrotophos stem injection: 5-8 ml/palm) resulting in frequent outbreaks of infestations by limacodids and psychids. Monocrotophos have an adverse effect on the natural enemies of bagworms, which could last between two to three months (Basri *et al.* 1989). Wan and Hoh (1992) also suggested that outbreaks of leaf-eating caterpillars do occur due to the breakdown of the natural balance. Hence possibilities for augmenting parasitoids from the mainland to Little Andaman Island should be explored. In recent years, the tussock caterpillar *D. mendosa* is emerging as a major pest of the oil palm in several states (Dhileepan 1992). Many of the parasitoids recorded on *D. mendosa* are highly polyphagous, and hence the variations in the efficiency of these parasitoids in suppressing the pest species.

Even though *C. nigritus* is an efficient predator, the potential of the predator in suppressing the diaspids appears to be influenced by the prevalence of parasitism by larval parasitoids of the predator. Interestingly, the parasitoids attacking the *C. nigritus* also attack other insects like limacodids and psychids. Even with a very high parasitoid incidence among the *C. nigritus* larvae during October-November, the predator could successfully suppress the diaspids. Among other predators, ants, pentatomids, neuropterans and spiders play an important role in regulating the pest population in the plantation. Even though the pentatomid *E. furcellata* was not noticed as a common predator, it is worthwhile to breed the predator in the laboratory for their subsequent field release for controlling limacodids, as suggested by Wan and Hoh (1992). The spiders are the most common and

abundant natural enemies recorded in the oil palm plantations. Although the role of spiders in bio-suppressing the insect pests appears important, the utilisation of spiders for biological control is yet to be studied.

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