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HOST ACCEPTANCE TRIALS OF *KERRIA LACCA* (KERRIIDAE) PARASITOIDS FROM NORTHERN THAILAND ON THE PEST LOBATE LAC SCALE (*PARATACHARDINA LOBATA*) (KERRIIDAE)

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ABSTRACT

In an attempt to find potential biological control agents of the lobate lac scale (*Paratachardina lobata*), an important pest in southern Florida and the Bahamas, we made collections of the commercial lac scale (*Kerria lacca*) in northern Thailand. Four species of parasitoids and two species of predaceous moths were reared from *K. lacca* infestations on twigs imported into Florida quarantine. None of the parasitoids accepted *P. lobata* as a host. Parasitoids of *P. lobata* from India or Sri Lanka, the native home of this scale, probably have more promise as potential biological control agents of this pest.

Key Words: biological control, Aphelinidae, Blastobasidae, Encyrtidae, Eulophidae, Eupelmidae, Noctuidae

RESUMEN

En un intento de encontrar agentes de control biológico potenciales para la escama lobada de laca (*Paratachardina lobata*), una plaga importante en la Florida meridional y las Bahamas, se obtuvieron colecciones de la escama de laca comercial (*Kerria lacca*) en el norte de Tailandia. Cuatro especies de parasitoides y dos especies de polillas predadoras fueron criadas de *K. lacca* infestando ramas pequeñas importadas a la cuarentena en la Florida. Ninguno de los parasitoides aceptaron *P. lobata* como hospedero. Parasitoides de *P. lobata* de la India o Sri Lanka, la región nativa de la escama, probablemente tienen más promesa como agentes de control biológico potenciales de esta plaga.

Translation by authors.

The lobate lac scale insect, *Paratachardina lobata* (Chamberlin) (Hemiptera: Coccoidea: Kerriidae), native to India and Sri Lanka (Varshney 1976a), infests more than 300 economic and native plants in southern Florida and the Bahamas (Howard et al. 2002; Pemberton 2003a, b; Howard & Pemberton unpublished data). This recently introduced pest continues to spread in Florida, is present in the Bahamas, and could threaten cultivated and native vegetation in the West Indies and Mexico as well as subtropical regions such as Texas, California, and Hawaii should it make its way to these areas (Pemberton 2003a; Howard & Pemberton 2004).

Chemical control with imidacloprid and bifenthrin can successfully control this pest but is too expensive and/or inappropriate for large scale usage in natural areas (Howard & Steinberg 2005). Other control methods are needed and biological control is a good possibility. Biological control has a high success rate against scale insects (Kennett et al. 1999), and is thought to be suitable for the lobate lac scale because this insect is nonnative and taxonomically isolated from native scales and other Hemiptera in the region (Pemberton 2003a). Parasitoids and other enemies of this pest are absent or rare in Florida (Pemberton 2003a; Schauff 2005; Howard unpublished data). One of the approaches used in the program to develop biological control for *P. lobata* was to acquire and evaluate the parasitoids of the commercial lac scale, *Kerria lacca* (Kerr), which is also in the Kerriidae. This approach was considered because the lobate lac scale has been difficult to find and access in its native region. A two and a half week survey in the type locality of *P. lobata* in Sri Lanka during Mar 2003 failed to locate the insect, much less its enemies (Pemberton, unpublished

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data). Varshney, the Indian monographer of the Kerriidae, has not seen the lobate lac scale in the field in India, where it is assumed to be rare (Pemberton 2003a). In contrast, *K. lacca* and its relatively well-known parasitoids (Narayanan 1962; Bhattacharya 2002) were thought to be more accessible and some parasitoids of *K. lacca* also have been recorded from *P. lobata* (Varshney 1976b).

Materials and Methods

Field Collection

Parasitoids of *K. lacca* were first sought through the Indian Lac Scale Institute in Ranchi, Jarkhand, which has studied these pests of lac scale culture for many years and was willing to cooperate (Pemberton 2003a). However, this potential cooperation was stymied by the lack of enabling approvals from the Indian bureaucracy above the Institute. Lac scale culture was subsequently sought outside of India and found in northern Thailand. Preliminary surveys and a collection of *K. lacca* was made (by AW) in Ampur Mae Tha in Lampang Province on Sep 20, 2003. Two parasitoids emerged from the *K. lacca* brought to Bangkok and held. This indication of the presence of parasitoids prompted additional collections, which were made (by RWP and AW) at the following five sites in Lampang Province on Oct 13 and 14, 2003. Site 1, Oct 13, Moo 12, Baan Look, Nakrou, Mae Tha (N18°07' 69.1", E 99°33' 57") lac cultivated on rain trees, *Albizia saman* (Jacq.) F. Muell. (Fabaceae). Site 2, Oct 13, Moo 8, Baan, Mae Tha (N 18°07' 97.9", E 99°33' 90.2"), lac cultivated on rain trees. Site 3, 14 Oct, Wongklongsak farm near Ampur Jae Hom (N 18°45' 27", E 99°34' 11") lac cultivated on rain trees. Site 4, Oct14, Baan Sasobhok Tambon Bansa, Ampur Jae Hom (N 18° 39' 14.1", E 99° 32' 46.9") wild infestation of a longan tree (*Dimocarpus longan* Lour., Sapindaceae) in yard of house in town. Site 5, Oct 14, Ban Toongkla, Tambon Maesook, Ampur Jae Hom (N 18°48' 419", E 99°34' 40.8") lac scale was semiwild on large rain trees at edge of town. At all sites, infested twigs were cut from the trees and placed in cotton bags and hand-carried to the Florida State Biological Quarantine in Gainesville, and held for emergence. An additional collection was made again from the same sites in Ampur Mae Tha (by AW) Mar 10-11, 2004 and shipped to the Florida quarantine.

Quarantine Emergence and Tests

Infested twigs were held in plastic boxes ($35 \times 22.5 \times 15$ cm) with screen ventilation ports. Emerging parasitoids were sorted to species, held in vials for a few hours and fed with honey, then transferred to screen cages ($0.6 \times 0.6 \times 0.9$ m) containing 1- and 3-gal (3.8 and11.4 L) containers of wax myrtle (*Myrica cerifera* L., Myricaceae) or *Inga edulis* Mart. (Fabaceae) infested with *P. lobata*. These plants were infested with *P. lobata* (by FWH) by placing them beneath and among heavily infested trees at Secret Woods County Park in Broward County, FL, usually for one-month periods. Mixed stages, including crawlers, young and mature scales were present at the time of the tests. Honey and water were provided via cotton wicks in each cage, which were in a glasshouse with mean ambient temperatures about 27°C. Identification of parasitoids associated with the *K. lacca* collections were made by Greg Evans of the Florida Division of Plant Industry and Michael Gates of the USDA-ARS Systematic Entomology Laboratory in Beltsville, MD, both aided by specimens previously determined by the Indian Lac Research Institute (obtained by RWP).

Results

Four parasitoid species of *K. lacca* emerged from the collections (Table 1), including two primary parasitoids, *Tachardiaephagus tachardiae* Howard (Encyrtidae) and *Coccophagus tschirchii* Madhihassen (Aphelinidae) (Narayanan 1962; Varshney 1976b). Reasonably large enough numbers of *T. tachardiae* (119 from the Oct collections and 77 from the Mar collection) emerged, which enabled a good acceptance test against *P. lobata*. An adequate test probably did not occur with *C. tschirchii* because only 8 individuals emerged from the Oct collection and none from the Mar collection. The other two parasitoids emerging from *K. lacca* were *Aprostocetus purpureus* Cameron (Eulophidae) and *Eupelmus tachardiae* Howard (Eupelmidae), both of which can be either primary parasitoids of *K. lacca* or hyperparasitoids (Narayanan 1962; Varshney 1976b). *Aprostocetus purpureus* can be a secondary parasitoid of *T. tachardiae* or *C. tschichii,* while *Eupelmus tachardiae* can be a secondary parasitoid of braconid parasitoids of the predaceous lac moths. Large numbers of *A. purpureus* emerged from both collections (60 from the Oct collection and 866 from the Mar collection) to have allowed for a good acceptance test. This was not true for *E. tachardiae* because only 7 individuals were obtained from the Oct collection and none from the Mar collection. These species were tested after the first emergence before the identifications were obtained and their role as hyperparasitoids was recognized. *Aprostocetus purpureus* from the Mar collection was tested again to try to learn if it would accept *P. lobata* from which it has been recorded (as *Tetrastichus purpureus*) (Varshney 1976b).

None of the parasitoids showed any behavioral orientation (attraction, attenuation, host feeding, or oviposition) to exposed lobate lac scales and no parasitism occurred in the Florida quarantine. No

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emergence holes were detected in *P. lobata* and no wasp adults were found. Random dissections of more than 120 *P. lobata* scales exposed to *T. tachardiae* and *A. purpureus* were made in late May, after the second shipment and exposure period, but no evidence of parasitoid attack was found. Two predaceous moths of *K. lacca, Eublemma roseonivia* Walker (Noctuidae) and *Holcocera pulverea* Meyr. (Blastobasidae), and their associated parasitoids, *Brachymeria tachardiae* Cameron (Chalcididae) and *Elasmus claripennis* Cameron (Elasmidae), also emerged from the collected *K. lacca* colonies (Table 1). *Eupelmus tachardiae* may have been associated with the lac moths as hyperparasitoids of their braconid wasp parasitoids (Table 1).

Discussion

It is unclear why neither *T. tachardiae* nor *A. purpureus* would accept *P. lobata* in our tests. *Paratachardina lobata* (subfamily Tachardininae) and *K. lacca* (subfamily Tachardiinae) are actually not very closely related within the Kerriidae (Varshney 1976a) and may not be susceptible to the same parasitoids. The records of *T. tachardiae* and *A. purpureus* parasitizing *P. lobata* may be based on misidentifications of the parasitoids or the hosts. Perhaps the form of *P. lobata* adventive in Florida differs in acceptability compared to the forms of *P. lobata* in India, or our rearing conditions were in someway inadequate, such as the number of suitable stages present in all cages. The host plant species used by an herbivorous insect can influence the level of attack by its parasitoids (Werren et al. 1992). Perhaps the host plants used to culture *P. lobata* for the quarantine testing (*Myrica cerifera* and *Inga edulis*) may have been factors inhibiting parasitism.

The predaceous moths, *Eublemma roseonivia* and *Holcocera pulverea,* which are known to be among the most important mortality factors of *K. lacca* cultivation in India (Narayanan 1962), were considered and rejected for biological control for *P. lobata* (Pemberton 2003a). They lack specificity and during their predation of *K. lacca* destroy large numbers of immature parasitoids (Bhattacharya 2002). The 25 moths (21 *E. rosenivia* and 4 *H. pulverea*) reared from our Oct collections probably greatly reduced the number of emerging parasitoids. All members of this *K. lacca* enemy complex are known from India but apparently not previously recorded in Thailand where *K. lacca* is cultivated on a small scale and not previously

Table 1. Parasitoids and predators associated with the lac scale, *Kerria lacca,* in northern Thailand.

Families and species	Tropic roles[1]	Number emerged Total (Oct & Mar)
HYMENOPTERA		
Aphelinidae		
Coccophagus tschirchii Madhihassen	Primary parasitoid of *K. lacca*	8 (8 & 0)
Chalcididae		
Brachymeria tachardiae Cameron	Primary parasitoid of *Eublemma* and/or *Holcocera*	4 (4 & 0)
Elasmidae		
Elasmus claripennis (Cam.)	Primary parasitoid of *Eublemma* and *Holcocera*	21 (21 & 0)
Encyrtidae		
Tachardiaephagus tachardiae Howard	Primary parasitoid of *K. lacca*	196 (119 & 77)
Eulophidae		
Aprostocetus purpureus Cameron	Primary parasitoid of *K. lacca* Secondary parasitoid of *C. tschirchii* Secondary parasitoid of *T. tachardiae*	926 (60 & 866)
Eupelmidae		
Eupelmus tachardiae Howard	Primary parasitoid of *K. lacca* Secondary parasitoids of braconids of *Eublemma* and/or *Holcocera*	7 (7 & 0)
LEPIDOPTERA		
Blastobasidae		
Holcocera pulverea Meyr.	Predator of *K. lacca*	4 (4 & 0)
Noctuidae		
Eublemma rosenovia Walker	Predator of *K. lacca*	25 (21 & 4)

[1]Roles from literature (Narayanan 1962; Varshney 1976b; Battacharya 2002).

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studied. *Aprostocetus purpureus* and *T. tachardiae* were the most abundant of the parasitoids attacking *K. lacca* in our collections and are also known to be the most abundant parasitoids of *K. lacca* in India (Bhattacharya 2002).

Additional collection and screening of *K. lacca* parasitoids against *P. lobata* could be worthwhile. As mentioned above, the number of *C. tschirchii* obtained were not thought be high enough to allow for an adequate acceptance test. This parasitoid was also one of the hoped for natural enemies in the collections because it is also known only from lac scales and is not known to be hyperparasitic (Narayanan 1962; Varshney 1976b). Another primary parasitoid of *K. lacca*, *Tachardiaphagus somervilli* Madhihassen (Encyrtidae), that may have the ability to attack *P. lobata,* could also occur in Thailand. Perhaps these parasitoids could be obtained by collections at different times of the year and from different sites. Our Oct and Mar collections had large differences in parasitoid richness even at the same site (Ampur Mae Tha), although this may have been due to the very high populations of the hyperparasitoid *A. purpureus* during Mar (866 emerged from the collection). Acquiring and evaluating the parasitoids of *P. lobata* itself will probably bring more success.

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