Classical Biological Control of the Coconut Mite (*Aceria guerreronis*) in Sri Lanka

Presented by:

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***Neoseiulus californicus*, mite predator**

CIAT, 2005

Concept Note

Title of the Project: Classical Biological Control of the Coconut Mite (*Aceria guerreronis*)

Project Goal: Enhanced coconut production and increased incomes of coconut farmers in Sri Lanka and other regions.

Purpose Project: Control and management of the coconut mite in Sri Lanka and other countries, through the introduction of effective mite predators from the Neotropics.

Background and Justification

Coconut, *Cocos nucifera* L., is considered the most important crop of the humid wet tropics and one of the most important crops in the world (Vietmeyer, 1986). It is present in the everyday life of many communities and it is often referred to as the "tree of life". It is part of the daily diet of the inhabitants of production areas as a supply of food and drink. There are more than 100 products made directly or indirectly from coconut. The most important products in world trade are copra, coconut oil, copra meal, desiccated coconut, coir fiber, and an increasing amount of coconut milk. The major producing areas are in Asia, especially in the Philippines, Indonesia, India, Papua New Guinea, Sri Lanka and in the Pacific Islands, but it is also important in coastal areas in the Americas and in Africa (Persley, 1992). Together with rice, coconut is one of the main sources of carbohydrates for human consumption in most parts of these countries.

The coconut mite, *Aceria guerreronis* Keifer, develops on the meristematic area of coconut fruits. Feeding by the mite results in uneven growth, distortion and stunting of the attacked organ. Resulting losses include reduced fruit size (Julia & Mariau, 1979; Moore & Howard, 1996; Nair, 2002; Zuluaga & Sánchez, 1971), extensive premature dropping of coconuts (Doreste, 1968; Seguni, 2002) and reduction of coir fibre (Nair, 2002), all leading to highly significant reduced yield. Infestations as high as 100% have been reported in some infested regions (Fernando *et al.*, 2002). Damage by the coconut mite has also been reported on the growing tip of coconut trees in northeastern Brazil; affected plants often died by the attack of the mite (Aquino & Arruda, 1967).

Rapid spread and establishment of the coconut mite is possible due to its high breeding potential and short developmental time (Haq *et al.*, 2002). Initial colonization of a single young nut can rapidly lead to the formation of large colonies and subsequently continuous migration to neighboring fruits and trees (Moore & Alexander, 1987).

The coconut mite was first described in 1965 from specimens collected in the State of Guerrero, Mexico (Keifer, 1965). However, that species could already be rather disseminated in the American and African Continents before the original description of the species, as suggested by references to damages to coconuts similar to the ones caused by the coconut mite since 1948 in Colombia (Zuluaga & Sánchez, 1971); 1953 in Brazil (Arruda, personal communication), 1960 in Mexico (Ortega *et al.*, 1965), and the fact that the mite was reported from several countries in America and Africa soon after its original description.

In the Americas, the mite was found for the first time in 1964, in the State of Rio de Janeiro, southeast Brazil, as reported by Robbs & Peracchi (1965). In that same paper, the authors mention that they had previously observed symptoms of the attack by the mite in the State of Pernambuco, northeast Brazil. It was then reported from Venezuela (Doreste, 1968), Colombia (Zuluaga & Sánchez, 1971), Cuba (Estrada & Gonzalez, 1975); Trinidad (Griffith, 1984); Puerto Rico (Howard *et al.*, 1990), St Lucia (Moore *et al.*, 1989); Grenada, Dominican

Republic and St. Vincent (Moore, 1985) Florida (USA) (Howard *et al.*, 1990), Costa Rica (Schliesske, 1988) and California (USA) (Ansaloni & Perring, 2002).

The coconut mite was found in São Tomé & Príncipe Islands, off the west coast of Africa, in 1966, that is, soon after its original description from Mexico, (Cabral & Carmona, 1969). On the African Continent, it was first found widespread in Benin in 1967 (Mariau, 1969; Mariau, 1977). It was then reported from the neighboring Cameroon, Costa do Marfim, Nigeria and Togo (Mariau, 1977; Julia & Mariau, 1979). The mite is supposed to have first arrived on the east coast of Africa in the 1980's, where it was reported from mainland Tanzania as well as from the islands of Mafia, Pemba, Unguja and Zanzibar (Seguni, 2002).

In Asia, the mite was first reported from the Ernakulam District, in the central part of the State of Kerala, southern India (Sathiamma *et al.*, 1998). A survey conducted in 1999 indicated that the mite was established throughout the States of Kerala, Tamil Nadu and areas of Karnataka, as well as on the islands of Lakshadweep, Minicoy, Kalpeni and Kavaratti (Haq, 1999). In Sri Lanka *A. guerreronis* was first reported in late 1997. It first appeared in the Kalpitiya Peninsula, Puttalan District, Northweastearn Province. It then expanded into Wanathavillu, Puttalum, Madurankuliya and Rajakadaluwa areas of the same district and isolated places in Chilaw and Kuliyapitya, Kurunegala District (Fernando *et al.*, 2002).

The damage caused by the coconut mite continues to increase in Asia, with the continuous spread of the mite in Sri Lanka and India. There is still a permanent threat that the mite may move to other neighboring countries in the Continent, where coconut is similarly as important as in Sri Lanka and India. Considering that the coconut is much more widely cultivated and consumed in Asia then elsewhere, it is expected that the coconut mite may cause a much more serious problem in the whole Continent if major actions are not now undertaken effective control.

Coconut is widely produced by small holders in Asia who most commonly have no experience with pest control techniques. The major perspective to *A. guerreronis* management and control is on the utilization of biological control agents. Despite the fact that recent studies have indicated that some synthetic chemical pesticides have significant impact on the coconut mite, their actual use in the field is made very difficult and often undesirable for several reasons. In the first place, chemicals are expensive and may cause significant health problem to growers and consumers if not properly utilized. In addition, the use of chemicals is often harmful to the environment, not sustainable and can cause disturbances to the prevailing ecological balance often found in the coconut plantations in Asia. Another major limitation to the use of chemicals in coconut plantations refers to the difficulty in reaching the target, considering that the plants are quite often more than 10-15 m high.

Thus, one of the most desirable approaches to reduce the damage caused by the coconut mite in countries which it has already invaded, and to reduce the chances of new invasions into other countries, relies on the application of biological control.

Biological control of a given organism is exerted by action of its natural enemies, which may be classified as pathogens, predators or parasites. No true parasites are known to directly affect mite species harmful to plants, and thus they would not be used for the control of the coconut mite. A major effort to determine and use prospective species of pathogens for the control of the coconut mite has already been initiated in Sri Lanka and India. The present project proposes a major effort to introduce and establish the use of exotic predators for control of the coconut mite.

From a practical point of view, biological control of a pest organism can be accomplished through three different strategies: conservation, augmentation and classical biological control. While conservation and augmentation rely on the use of effective natural enemies already present in the area where the pest is to be controlled, classical biological control refers to the search for effective natural enemies in areas where the organism is maintained at acceptable levels, and their introduction and establishment in areas where the pest is to be controlled. A single species of predator has been found attacking the coconut mite in Sri Lanka until now. The species has been identified as *Neoseiulus* aff. *paspalivorus* (Fernando et al., 2002). Despite the fact the this predators seems to exert some degree of control, it has not, by itself, been able to maintain the coconut mite below economic injury levels in the country, and damage by that pest mite continues to increase. Thus, we feel that the discovery of new, more effective predators, in the area where the mite is present but causes little or no damage must be pursued, to effectively reduce the population of the coconut mite to non economically harmful levels (Moraes & Zacarias, 2002).

There are areas in the Americas where the coconut mite causes little or no significant damage. It is expected that effective natural enemies of the coconut mite exist in these areas. Ideally, effective natural enemies of the coconut mite should be searched for in the site of origin of the pest, for that is where the pest and its enemies have co-evolved, and where equilibrium between them should have been established (Van Driesche & Bellows, 1996). The history of the detection of this pest in different parts of the world suggests that it is native to the South American Continent, and that is where effective natural enemies are expected to be found.

Summary of Deliveries

1. Project Objectives

- Identify the predatory mites associated with the coconut mite in regions of the Neotropics where that pest species has already become established.
- Determine the most promising predators to be introduced into Africa and Sri Lanka.
- Develop methods to mass produce and ship the most promising predator species.
- Establish effective predators of the coconut mite in Sri Lanka.

Project Outputs and Activities (see Work Breakdown, page 9)

Achievements and Methodologies

Effective predators of the coconut mite will be searched for in the Neotropics (North, South and Central America and the Caribbean), where they are expected to be found. The search will be conducted by CIAT, UFRPE and ESALQ. Initially, priority areas for the search will be determined by a comparison of the prevailing climatic and ecological conditions in places in Sri Lanka where the coconut mite causes the heaviest damages with the prevailing conditions or homologues in different parts of the Americas.

It is expected that different species of natural enemies will be found in this region, and that a screening of their efficacy will be required to determine the most promising species to be sent to Sri Lanka for eventual field releases. The identification of the collected predatory mites will be done by CIAT and ESALQ. Such screening will be based on ecological data collected in the field and on laboratory evaluations.

The ecological data will correspond to a comparison of the fauna of predators found in areas with different levels of mite damage in the Americas. This reasoning indicates that predators occurring in areas with minor coconut mite damage can be expected to be more promising than predators occurring concurrently in areas with high and low damage.

Laboratory evaluations will correspond basically to the following types of analyses; a) determination of prey preference through studies comparing development, reproduction and food consumption of prospective species feeding on the coconut mite and other food sources; b) ability to reach and search the habitat most commonly occupied by the coconut mite (underneath the perianth) c) attraction to the coconut mite, determined by the use of olphactometers.

The most promising species will be maintained in the laboratory on the coconut mite, and techniques for mass production will be developed. These techniques will be used by Sri Lankan participants in this project to produce sufficient predators for field releases. Techniques currently used for the mass production of other predator species will be tested for the production of each predator species (Gerson et al., 2003)

The selected predators will be shipped to and quarantined at the University of Amsterdam, according to usual techniques employed in the case of the most common predators of phytophagous mites.

From Amsterdam, the selected predators will be shipped to CRI (Coconut Research Institute Lunuwila, Sri Lanka), where they will be mass produced for field releases. Mass production will be conducted according to the best methods developed at CIAT (Centro Internacional de Agricultura Tropical, Cali, Colombia), UFRPE (Universidade Federal Rural de Pernambuco, Recife, Brazil), IITA (International Institute of Tropical Agriculture, Benin) or ICIPE (International Centre of Insect Physiology and Ecology, Kenya).

Mass produced predators will be released by CRI personnel in selected fields, following the procedures used in the cassava green mite project. To ensure better chances of establishment, each species will be released in a number of fields representing an array of ecological conditions. An effort will be made to release a total of at least 5,000 predators in each release site, within a period of ca. 6 months. Starting a month after the initiation of the releases, samples will be periodically collected from the release fields to verify the presence of the introduced species.

As soon as establishment of a species is ascertained, individuals of that species will be taken to the laboratory where they will be mass produced in separate colonies, which will then be used for releases in other fields,

At the end of the project, an evaluation of the economic return of the project will be conducted.

Project Participants

1. CRI (Coconut Research Institute), Lunuwila, Sri Lanka
2. CIAT (Centro Internacional de Agricultura Tropical), Cali, Colombia
3. ESALQ (Escola Superior de Agricultura Luiz de Queiroz), Brazil
4. EFRPE (Universidade Federal Rural de Pernambuco), Brazil

Project Collaborators

1. IITA (International Institute of Tropical Agriculture, Ibadan, Nigeria
2. ICIPE (International Centre of Insect Physiology and Ecology, Nairobi, Kenya
3. University of Amsterdam, Netherlands

Project Schedule
Duration: 3 years

Budget: See Attached

Project Management
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Proposed Budget over three years

	Year												
	2006				2007				2008				
Item	CIAT	Sri Lanka	Brazil	Other	CIAT	Sri Lanka	Brazil	Other	CIAT	Sri Lanka	Brazil	Other	Total
Personnel													
Res. Assist.	18,000.00	800.00			20,000.00	1,700.00			22,000.00	1,700.00			64,200.00
Technician	9,500.00	600.00	10,000.00		10,500.00	4,800.00	10,000.00		11,500.00	4,800.00	10,000.00		71,700.00
Student Thesis	6,000.00	8,000.00	15,000.00		6,000.00	8,000.00	15,000.00		6,000.00	8,000.00	15,000.00		87,000.00
Total Personnel	**33,500.00**	**9,400.00**	**25,000.00**	-	**36,500.00**	**14,500.00**	**25,000.00**	-	**39,500.00**	**14,500.00**	**25,000.00**	-	**222,900.00**
Supplies/Operations													-
Vehicle Use	7,500.00	500.00	10,000.00		8,000.00	1,000.00	10,000.00		8,500.00	1,500.00	10,000.00		57,000.00
General Supplies	3,700.00	1,000.00	6,300.00		4,100.00	5,000.00	6,300.00		4,510.00	5,000.00	6,400.00		42,310.00
Services	1,650.00	1,200.00	300.00		1,700.00	7,000.00	300.00		1,750.00	7,000.00	400.00		21,300.00
Greenhouse and Lab. Space	500.00		300.00		550.00		300.00		650.00		400.00		2,700.00
Shipment/natural enemies	1,500.00		2,000.00		3,000.00		3,000.00		3,000.00		3,000.00		15,500.00
Total Operations	**14,850.00**	**2,700.00**	**18,900.00**	-	**17,350.00**	**13,000.00**	**19,900.00**	-	**18,410.00**	**13,500.00**	**20,200.00**	-	**138,810.00**
Equipment													-
Computer, software	2,200.00	2,500.00	4,000.00										8,700.00
Lab. Equipment	3,000.00	6,000.00	6,000.00		1,000.00	6,000.00	3,000.00		1,000.00		1,000.00		27,000.00
Total Equipment	**5,200.00**	**8,500.00**	**10,000.00**	-	**1,000.00**	**6,000.00**	**3,000.00**	-	**1,000.00**	-	**1,000.00**	-	**35,700.00**
Training/Capacity Building													-
Consultancy		20,000.00				30,000.00				30,000.00			80,000.00
Training and Workshop	1,000.00				1,000.00	1,000.00			500.00	4,000.00			7,500.00
Meetings	1,000.00		2,500.00				2,500.00				3,000.00		9,000.00
Farmer Participatory Research					1,000.00	1,000.00			1,000.00	1,500.00			4,500.00
Total Training	**2,000.00**	**20,000.00**	**2,500.00**	-	**2,000.00**	**32,000.00**	**2,500.00**	-	**1,500.00**	**35,500.00**	**3,000.00**	-	**101,000.00**
Publications													-
Pub. in Journals	500.00	1,000.00			1,000.00	1,000.00	1,000.00		1,000.00	1,000.00	2,000.00		8,500.00
Farmer/Extension Pub.						500.00				1,000.00			1,500.00
Total Publications	**500.00**	**1,000.00**	-	-	**1,000.00**	**1,500.00**	**1,000.00**	-	**1,000.00**	**2,000.00**	**2,000.00**	-	**10,000.00**
Travel													-
International	7,000.00		1,500.00		10,000.00	10,000.00	2,500.00		10,000.00	10,000.00	2,500.00		53,500.00
National	3,000.00	500.00	6,000.00		3,000.00	2,000.00	6,000.00		2,000.00	2,000.00	6,000.00		30,500.00
Total Travel	**10,000.00**	**500.00**	**7,500.00**	-	**13,000.00**	**12,000.00**	**8,500.00**	-	**12,000.00**	**12,000.00**	**8,500.00**	-	**84,000.00**

Proposed Budget over three years

	Year												
	2006				2007				2008				
Item	CIAT	Sri Lanka	Brazil	Other	CIAT	Sri Lanka	Brazil	Other	CIAT	Sri Lanka	Brazil	Other	Total
SUBTOTAL	66,050.00	42,100.00	63,900.00	-	70,850.00	79,000.00	59,900.00	-	73,410.00	77,500.00	59,700.00		592,410.00
Institutional Cost	13,210.00	4,210.00	6,390.00	-	14,170.00	7,900.00	5,990.00	-	14,682.00	7,750.00	5,970.00	-	80,272.00
GRAND TOTAL	79,260.00	46,310.00	70,290.00	-	85,020.00	86,900.00	65,890.00	-	88,092.00	85,250.00	65,670.00	-	672,682.00

Total for CIAT	252,372.00
Total for Sri Lanka	218,460.00
Total for Brazil	201,850.00
Total for 3 years	**672,682.00**

Budget Notes

1. **International Travel:** CIAT will be responsible for exploratory surveys to identify natural enemies of the coconut mite in northern South America, the Caribbean region and Central America and Mexico.
2. **National Travel:** ESAL/USP will be responsible for exploratory surveys for natural enemies of the coconut mite throughout Brazil, especially the northeaster region.
   CIAT will carry out these surveys throughout Colombia, especially the Atlantic Coast Region.
3. **Consultation:** Sri Lanka lacks expertise on mites, their natural enemies, and mite biological control systems. It is therefore envisioned that a specialist consultant be available for contracting during a 3 to 6 month period.
4. **Personnel:** Trained research assistants and technicians are required for carrying out exploratory surveys in the neotropics and for the mass rearing, evaluations, shipments and release of candidate natural enemies.
5. **Shipment of Natural Enemies:** Candidate natural enemies for introduction into Sri Lanka will be initiated in the neotropics, especially in Colombia and Brazil. Shipment will be by air and may require a third party intervention while in route.
6. **Computers/Software:** Relevant literature and information will be resourced and stored. An information database will be established and made available to all participants. Survey data on collections sites, climatic conditions, crop management, agrochemical use, prey specificity and natural enemy biology ecology and behavior will be collected and shared.

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▪ Develop GIS linkages and database to establish ecological homologues between Neotropics and Sri Lanka. ▪ Exploration of targeted areas carried out in collaboration with local scientists and specialists. ▪ Establish a database on demographic information related to collected species. ▪ Determine yield losses to coconut production caused by coconut mite in Sri Lanka. ▪ Survey farmers perception of coconut mite problem in Sri Lanka and collect data on yield loss, pesticide use and production costs.	▪ Conduct necessary research on biology, ecology and behavior of pest and predator species. ▪ Conduct comparative studies on predator/prey selection, consumption, development stage preference and population dynamics. ▪ Evaluate fecundity, development time and survival parameters of selected predator species. ▪ Determine prey preferences, including other arthropod species, pollen, honey, fungus, etc. ▪ Analyze climatological parameters affecting prey predator interactions.	▪ Develop techniques for shipping live predators over time and distance.	▪ Develop predator shipment and release techniques in country (Sri Lanka). ▪ Carry out biology, ecology, behavior research of introduced predators on local target coconut mite. ▪ Mass release selected predatory mites into targeted coconut agroecosystems in Sri Lanka. ▪ Develop techniques for evaluating effect of predatory mite on prey population dynamics in the field.	▪ Determine cost/benefit ratio.