BIOLOGICAL CONTROL WITH THE WEAVER ANT *OECOPHYLLA LONGINODA* IN AFRICA: A REVIEW OF RESEARCH AND DEVELOPMENT EFFORTS TO LINK FARMERS TO ORGANIC MARKETS

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Introduction

Classical biological control has achieved some tremendous successes over the past century, yet scientists recognize that the opportunities are limited and that greater attention is needed to increase the impact of native natural enemies (Greathead, 1991). A review of manipulative field studies showed that in 75% of cases, generalist predators, whether single species or species assemblages, reduced pest numbers significantly (Symondson *et al*., 2002).

The tree-inhabiting weaver ant *Oecophylla* effectively protects tropical tree crops as it actively patrols canopies and preys upon or deters a wide range of potential pests. According to taxonomists, nowadays only two species of the weaver ant *Oecophylla* exist: *O. longinoda* (Latreille) (Hymenoptera: Formicidae) in Africa and *O. smaragdina* (Fabricius) in Asia and northern Australia (see Figure 1). Reviews on the role of *Oecophylla* in pest management in the tropics were written by Way & Khoo (1992) and more recently by Van Mele (2008a). This paper draws on the last review paper and focuses on *O. longinoda* in crop protection in Africa.

Figure 1 . **Weaver ants construct their nests in trees by weaving living leaves together.**

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Oecophylla as biocontrol agent in multiple tree crops

In the next section, I will present commodity-based case studies that will help to shed light on the historical contexts, as well as the challenges and opportunities for research on *Oecophylla*. Recent efforts to integrate *Oecophylla* in programmes supporting organic and Fair Trade markets are equally presented.

Coconut: Before World War II, British scientists working in the Solomon Islands reported: "Planters, managers and investigators alike have noticed that where *Oecophylla* is present, the trees almost invariably bear well" (Phillips, 1940). This observation was taken seriously by the young scientist, Michael Way, working in Zanzibar, who found that the 'coconut gumming disease' was actually caused by bugs sucking the nuts. Because the coreid bug *Pseudotheraptus* is a low-density pest (10 bugs per hectare can cause significant damage) this had never been observed before, nor had this 'disease' ever been successfully controlled. Way demonstrated experimentally that coreid bugs could be controlled by weaver ants (Way, 1953). It took another 40 years, however, before an acceptable method of weaver ant establishment and management was developed.

As part of the weaver ant colony establishment, the control of non-beneficial predatory ants was also considered a key research challenge. A few farmers and scientists had come up with the idea of killing the competing ant *Pheidole megacephala* (Fabricius), in order to allow *Oecophylla* to establish or thrive, but without success. Way (1953) had noticed that a good ground cover provided seed and Homopterans for *Pheidole*, thus reducing its foraging high in the trees where it raids *Oecophylla* nests. Later on, one of his PhD students proved that regularly slashing, rather than spraying with herbicides or clean weeding, was both effective to establish weaver ant colonies and acceptable to farmers (Seguni, 1997). However, to suppress *Pheidole* more was needed.

Drawing from Stefan Oswald's PhD research, Löhr & Oswald (1989) found that colonization of palms by *O. longinoda* increased nut yield significantly, and that insecticide use could be significantly reduced. Ana Varela (1992) tried to exclude *P. megacephala* from coconut palms by sticky barriers on the tree trunks. Tests failed because the barriers did not last, but promising results were obtained by borrowing an innovation developed for a different crop in a different continent. Experiments with the fire ant bait Amdro (hydramethylnon), developed in the late 1970s by scientists

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in Hawaii to control fire ants in pineapple, proved highly effective in controlling *Pheidole* (Zerhusen & Rashid, 1992, Varela, 1992). Triggered by these research findings, the Tanzanian government registered hydramethylnon in the 1990s, yet until today the product is not available on the market. Researchers who used hydramethylnon in on-farm experiments (bought in small quantities in neighbouring Kenya) saw their efforts wither after the project ended. Farmers who were not involved in the research did not know about the existence and importance of the hydramethylnon bait, and private businesses were not tempted to establish a market as long as there was no national demand. Collaborative learning with farmers about ecological dynamics in their plantations may lead to the development of alternative *Pheidole* control methods. Mass media campaigns, on the other hand, may help to create demand for technical innovations such as the hydramethylnon bait.

Cocoa: With a focus on export-oriented plantation crops and its success in coconut plantations, research on *Oecophylla* was also initiated in cocoa plantations (Majer, 1976). The ants drive off a range of pests, including weevils *Pantorhytes*, coreid bugs *Amblypelta* and *Pseudotheraptus* (Lodos, 1967), capsids and mirids (Leston, 1970). However, the complex ant mosaic created particular challenges, especially with regard to managing the undesirable co-dominant ant *Pheidole* (Taylor & Adedoyin, 1978), as well as ants of the genus *Crematogaster* (Majer, 1978) and *Camponotus* (Fataye & Taffin, 1989). The ant mosaic is also affected by the shade regime, with *Oecophylla* being reduced by shade thinning (Leston, 1970). Depending on the cropping system, having sufficient food and good nesting sites all year round may also affect *Oecophylla* populations. On top of the complexity of managing the ecological system in cocoa plantations, plantation workers considered weaver ant aggression a hindrance, and therefore *Oecophylla* was often classified a pest. Apart from these ecological and perceptual factors, also political and market forces have determined the extent to which weaver ants have been incorporated into a cocoa IPM system.

The recommendation to avoid spraying cocoa trees where weaver ants are abundant was formulated about 30 years ago (Julia & Mariau, 1978, Majer, 1978), but was never given much attention. Recent efforts by Conservation International and the Sustainable Tree Crops Program to get IPM established in cocoa through farmer field schools take place under harsh conditions: the Ghanaian government decided to hire so-called spray gangs, to blanket spray cocoa farms against capsids. By upsetting the competitive balance, blanket-spraying encouraged the less desirable ant *Crematogaster* and reduced the distribution and abundance of *O. longinoda*, as already illustrated by Majer (1978).

Emerging niche markets for organic cocoa has renewed interest in research on *Oecophylla*. Although researchers initially objected to the idea, farmers of the local agricultural research committees insisted to investigate the potential of *Oecophylla* as a solution to their pest problems (Ayenor *et al*., 2004). As control against capsids is mainly effective at high weaver ant abundancy levels, botanical insecticides such as neem extracts (*Azadirachta indica*) were successfully tested to complement biological control (van Kessel & van Wijngaarden, 2006).

Citrus: Although weaver ant husbandry is a centuries-old tradition in China and Vietnam (see Figure 2), the use of weaver ants in citrus orchards decreased during the 1990s under pressure from the pesticide industry (Van Mele & Cuc, 2000). However, small-scale financial injections since the mid 1990s, media coverage, and involvement of farmer associations reversed this trend. Discovery learning exercises were developed for farmer field schools (see also http://www.eco-innovation.net/weaver-ants). Vietnamese farmer Associations currently support their members to comply with the Global Partnership for Safe and Sustainable Agriculture (EUREPGAP) and aim for organic export markets.

Figure 2. **The weaver ant *Oecophylla* effectively controls a wide range of pests in tree crops. To increase their efficiency, ropes can be attached between trees containing ant nests of the same colony.**

Research on citrus in Africa, apart from South Africa, has not received as much attention as in Asia. Recently, the Market-Oriented Agriculture Programme, supported by the Ministry of Food and Agriculture (MoFA) and the German Technical Co-operation (GTZ), works with the Coastal Out-growers Association to produce and market organic oranges in the Central Region in Ghana. They are developing Good Agricultural Practices (GAPs) for organic citrus production, including the use of *Oecophylla* as biological control agent.

Cashew: Research on the potential of weaver ants in cashew took off in Australia at about the same time as the work on citrus in Vietnam. Although weaver ants can effectively control most cashew and mango pests, fierce boundary fights between weaver ant colonies can limit their populations and control efficiency. Through the support of the Conservation, Food and Health Foundation (CFH), in 2006 weaver ant husbandry was also introduced in West Africa for cashew and mango. Discovery learning exercises were developed in Africa for use in farmer field schools, potentially contributing to more sustainable production and better quality fruits and nuts. More recently, research interest is increasing to explore the use of *Oecophylla* in cashew in Ghana (Dwomoh *et al*., 2008).

Mango: The same research team in Australia started research on weaver ants for pest management in mango with profits increasing by over 50% compared to conventionally-managed orchards, but management proved more complicated than in cashew. Promoting weaver ants in mango in less developed countries poses new challenges. Trees in traditional mango orchards are often up to 15 m high, influencing farmers' observation power and their subsequent knowledge and practices. In 1998, only two out of 93 farmers interviewed in Vietnam mentioned the weaver ant as predator in mango, despite its well-known role in citrus (Van Mele *et al*., 2001). The size of the trees also influences the harvesting practices. Long picking poles may be used, but in many cases harvesters still have to climb the trees. Local people in Asia and Africa have developed a range of solutions to reduce nuisance of ants during harvest, by adjusting their cultural and harvesting practices, reducing the ant population or repelling the ants (Van Mele & Cuc, 2003, Van Mele *et al*., 2008).

Despite a common negative perception, some African farmers have witnessed the ants' benefits and encourage them in their orchards. In Guinea, women told me that the quality and production was more elevated when weaver ants were present in mango, citrus and cola. In the latter, people think that ants improve flowering. In various African countries, including Benin, Burkina Faso, Mali and Guinea, ants were also considered to protect mangos from being stolen.

Fruit loss caused by fruit flies was significantly less in cultivars and orchards accommodating high abundance of weaver ants (Van Mele *et al*., 2007). IITA-CIRAD currently manages a regional fruit fly project in West Africa funded by the World Bank. In this project, weaver ants are considered as a key component to control fruit flies, with a special fact sheet being devoted to optimising the use of weaver ants in orchards.

Recent trends in exporting organic mangos from West Africa to European markets have created a demand for farmer training in weaver ant husbandry. In early 2007, the Food and Agriculture Organization of the United Nations (FAO) initiated South-South exchange of local innovations and the development of discovery learning tools for their farmer field schools. Striking the right balance between constructivist and behaviorist approaches in farmer education needs to be tested.

Recognizing the importance of *Oecophylla* in protecting tree crops, we translated the book 'Ants as Friends' (see Figure 3), written by Van Mele and Cuc (2003) into French for African farmers and extension workers (Van Mele & Cuc, 2008). These small developments, and the raised interest of private sector and international research centres in the subject, may trigger new initiatives to study the use of *Oecophylla* as an effective endemic biological control agent.

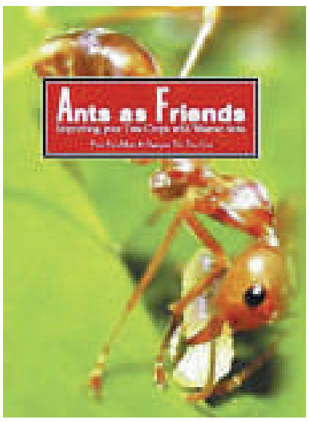

Figure 3. **The manual 'Ants as Friends' is written for extension workers and farmers. It aims to help farmers manage their tree crops without pesticides and is available in English, French, Vietnamese and Bahasa Indonesia.**

Conclusion

Although IPM has been successfully applied in some food crops in Asia, the low potential of cost-savings in Africa indicates that here IPM is more likely to be successful if it focuses on host-plant resistance, biological control and high-value commodities rather than on subsistence crops (Orr, 2003). This review shows the significant role and potential of *Oecophylla* as a predator in tree crops, either used alone or integrated with other pest management strategies, and indicates the role farmers can play in research and development.

Continuous efforts are needed to incorporate proven weaver ant husbandry technologies in the curriculum of the national extension and education systems fully. More efforts are also needed to build ecological literacy across the broader society, both in Africa and in Europe (Van Mele, 2008b). Emerging markets for organic and sustainably-managed fruit, nut and timber products is likely to boost investment in weaver ants. Well-targeted research interventions to optimize *Oecophylla* should be linked to innovative strategies of collaborative learning, communication and marketing if it is to benefit the millions of smallholder farmers in tropical countries.

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