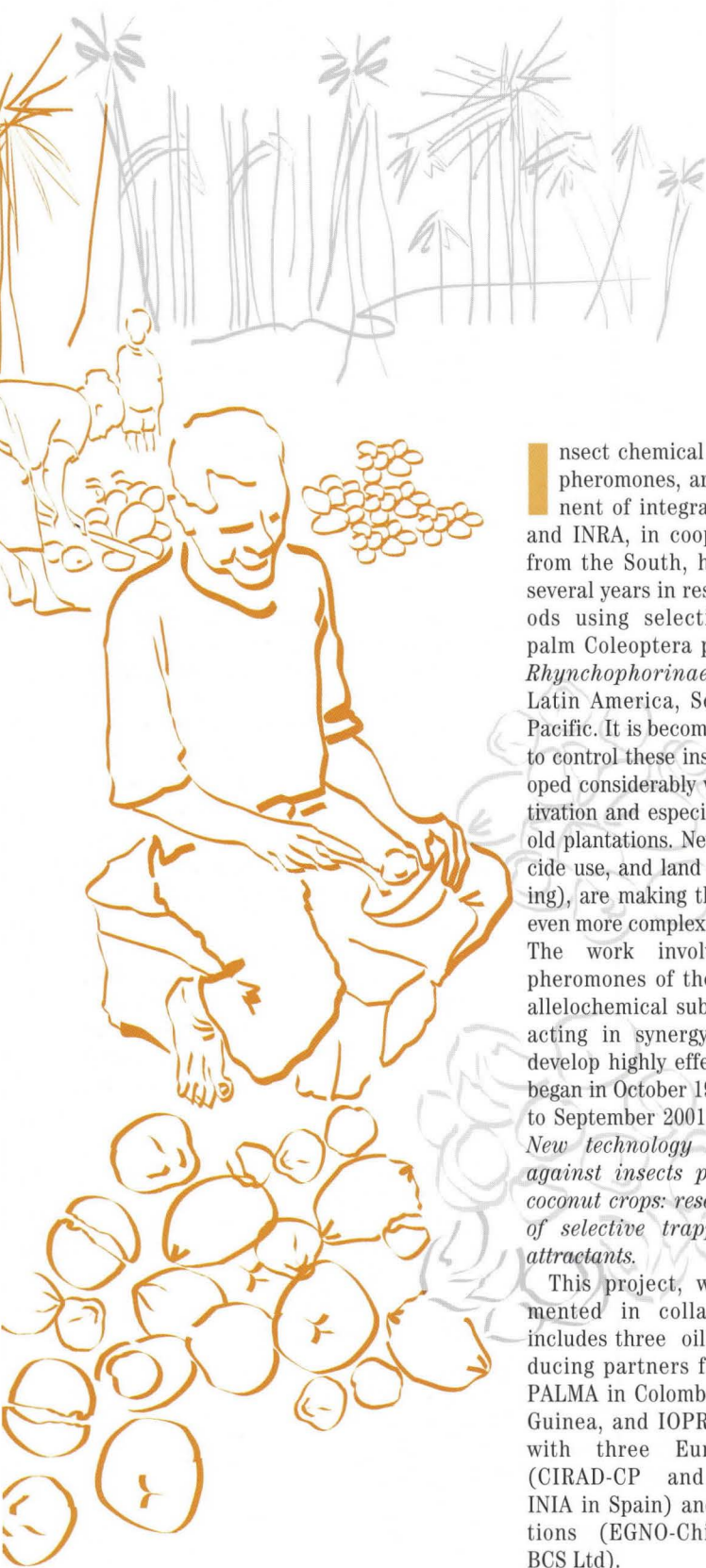


Controlling palm pests: olfactory trapping



Insect chemical mediators, particularly pheromones, are an important component of integrated protection. CIRAD and INRA, in cooperation with partners from the South, have been engaged for several years in research on control methods using selective mass trapping of palm Coleoptera pests (*Dynastinae* and *Rhynchophorinae*), which are rife in Latin America, Southeast Asia and the Pacific. It is becoming increasingly difficult to control these insects as they have developed considerably with more intensive cultivation and especially with the renewal of old plantations. New rules governing pesticide use, and land preparation (zero burning), are making the choice of treatments even more complex.

The work involves indentifying the pheromones of these insects, along with allelochemical substances (plant odours) acting in synergy with pheromones to develop highly effective attractants. Work began in October 1997 and will continue up to September 2001 under an INCO project *New technology of pest management against insects pests of oil palm and coconut crops: research and development of selective trapping using synthetic attractants*.

This project, which is being implemented in collaboration with INRA, includes three oil palm and coconut producing partners from the South (CENIPALMA in Colombia, CCRI in Papua New Guinea, and IOPRI in Indonesia), along with three European organizations (CIRAD-CP and INRA in France, INIA in Spain) and two private organizations (EGNO-Chimie and Agrisense-BCS Ltd).

Methods

Characterization of a pheromone and of allelochemical attractants was the culmination of a succession of observations, and research work involving biologists and chemists.

The attraction of one of the sexes under natural conditions was discovered through trapping with living insects, along with studies on behaviour and sexual activity, and on the role played by the host plant. This initial stage was essential, since it provided information about the conditions under which the insects came together and, consequently, the conditions under which the pheromone was produced. The physiological condition of the individuals had to be taken into account, along with the rhythm of activity and whether or not the host plant had to be present.

Pheromones and allelochemical substances were isolated by collecting the effluvia of the insect on specific absorbent material (Supelpak-2 made by Supelco). In some cases, when the compounds to be analysed were very volatile, the SPME method (Solid Phase Micro-Extraction) was used. It offered the advantage of sampling odours on an adsorbent fibre directly in a chromatograph, without solvent.

The biological activity of the extracts was studied by olfactometry or by electroantennography (EAG).

A physico-chemical analysis of the extracts was carried out by gas chromatography (GC), either alone or combined with mass spectrometry. Detection of pheromone compounds was sometimes facilitated by using combined GC-EAG.

The different molecules that probably made up the pheromone were synthesized,

and biological tests (EAG, olfactometry, trapping in the field), were carried out.

A formulation was developed and the effective doses were optimized in trapping trials in the field.

Results

Coleoptera Rhynchophorinae

Rhynchophorus are large weevils attracted by wounded palms in which their larvae develop, often after attacks by dynastid beetles. *Rhynchophorus palmarum* is the most dangerous since it is a vector of the nematode responsible for red ring disease. Synthetic pheromones are now available for these insects, but trapping is only possible with a piece of plant matter (co-attractant). Work is under way to develop a synthetic mixture that acts in synergy with the pheromone, to replace the plant.

Complex mixtures that compete well with the plant have been found for *R. palmarum*. They include a major ferment fraction, marking the existence of a wound, and a fraction more particularly linked to the palm. A comparative analysis testing sub-fractions was carried out with CENIPALMA, in Colombia, to determine simplified mixtures containing 5 to 6 constituents with synergistic effects. These mixtures are also being tested on the species found in Papua New Guinea (*R. bilineatus*).

Coleoptera Dynastinae

Damage is caused by adults. The larvae develop in leaf mould or old rotting wood.

Scapanes australis

Studies were carried out in collaboration with CCRI in Papua New Guinea on *S. australis*, a large Coleoptera measuring 6 cm, which attacks coconut palms on several islands in the Bismarck archipelago (Papua New Guinea, Solomon Islands). The adult mines galleries in the petiole bases of fronds, and penetrates the stem. Given the size of the insect, damage is severe in young 1 to 5-year-old coconut palms. Deep *Scapanes* galleries cause fermentation of the tissues, which then very often attracts *R. bilineatus*. The latter lays its eggs and the larvae cause destruction inside the plant, with foul smelling bacterial rot diseases. These combined *Scapanes* and *Rhynchophorus* attacks inevitably kill the coconut palm and prevent any coconut planting in some regions of the country.

Studies carried out in recent years, in connection with the INCO project, have led

to significant progress in our knowledge of the biology and behaviour of *Scapanes*: identification of larva sites, particular behaviour of males and flight periods. The last observation was decisive in discovering a signalling behaviour in males and in identifying the insect's pheromone.

During the day, males remain inside their galleries. At nightfall, they move to the entrance and take up a very original position, with the head in the gallery and the abdomen held erect outside the gallery; a droplet of liquid is secreted from the abdomen and spread by the hind legs (photo1). Field trials with caged insects showed that calling males were attracting both males and females of the species. The females did not show this behaviour. They were highly mobile and only remained for a short time, around one night, in the galleries.

Gas chromatography analyses, combined or not with mass spectrometry after sampling by the SPME technique (figures 1 and 2), led on to the identification of compounds in the secretion that corresponded to an aggregation pheromone. The two compounds required were 2-butanol and acetone (3-hydroxy-2-butanone) in a ratio of 90:5 (v/v). The third compound identified in the male secretion (2,3-butanediol) did not improve captures. The synthetic mixture attracted the pest into traps. It was contained in a plastic sachet and outwardly diffused through the walls of the bag. The trap developed by CCRI is a plastic bucket with two large holes in the side. The pheromone sachet is hung from an inner box which contains the plant used as a synergist with the pheromone (photo 2). This insecticide-free trap is covered with coconut fibres to provide easier access for the insects. The insects are kept inside with a little water containing detergent. Over the last two

years, experimental mass trapping with 14 traps has led to the capture of 3,000 adult insects, bringing the population down and reducing damage at the study site.

These results are very promising for the possible use of mass trapping to control *Scapanes*. Trapping trials have been set up to check the effective control of the pest in new coconut plantings with high-yielding hybrid material in zones where this crop had become impossible due to the high infestation rate.

Oryctes rhinoceros

Work undertaken with IOPRI in Indonesia showed that *O. rhinoceros* is one of the most serious pests in young oil palm and coconut plantings in Southeast Asia. The adults mine galleries at the base of young fronds. These attacks retard development and sometimes kill the palm.

The insect develops in rotting wood and in old stems left on the ground when the land is being prepared, or left standing after poisoning. Replantings carried out to replace old plantations encourage development of this pest. Protecting young palms with repeated applications of insecticide granules is expensive and involves environmental risks, notably pollution of the water table. Manual collection necessitates frequent rounds and is labour-intensive.

Identification of the aggregation pheromone ethyl 4-methyloctanoate (E 4-MO), in *O. monoceros* in 1995 and in *O. rhinoceros* in 1996 offered new prospects for controlling and reducing populations by mass trapping.

A "dose-captures" trial carried out over 163 ha near Marihat in Indonesia over a long period (15 weeks) revealed a dose effect: the greater the diffusion, the larger the size of the catches (table). The number of captures was high, at 11,482 insects, two



Photo 1.
Calling
Scapanes male.

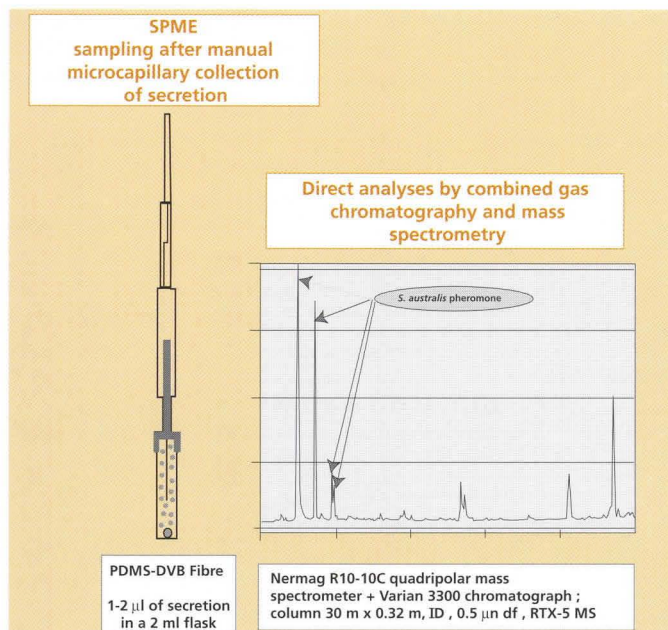


Figure 1. Sampling of the *Scapanes australis* male secretion by solid phase micro-extraction.

thirds of which were females, which enabled rapid action to be taken against the pest's multiplication potential. Given the cost of E 4-MO, it is not feasible to use the highest doses for the commercial production of dispensers. Research currently under way is attempting to find synergist compounds that will make it possible to reduce the pheromone dose, hence the cost price.

As it was not known how and when the pheromone was involved in the life of the insect, the biology and behaviour of *O. rhinoceros* were studied. A complementary study of antenna structure led to the identification of several specific sensilla, which responded to certain chemical compounds.

Photo 2 .
Scapanes trap developed by CCRI.



An examination of young attacked palms in the field showed that there was no aggregation at that level, and that the palms were colonized separately, as much by males as females. Insect grouping occurred in larva sites, such as old wood or rotting stems. Investigations carried out on those materials confirmed that insect arrivals corresponded to a stage in

stem decomposition that enabled mating and egg-laying. The pheromone emitted by the males would therefore seem to play a role at that level, promoting the colonization of that medium. This hypothesis was put to the test by carrying out trapping with pheromone and rotting wood or plant compost. The synergistic effect observed led to a substantial 2 to 4-fold increase in captures. Studies are continuing with IOPRI to identify synthetic compounds that are potential synergists with the pheromone.

Conclusion

Mass trapping of Coleoptera pests of palms using synthetic attractants is now possible, but further development of dispensers—determination of mixtures and doses—and traps is still required. Strategies for their use depending on cultivation conditions also need to be tested. The method will only be required in the first 4 or 5 years after planting, when palms are highly susceptible to attacks. It will offer the advantage of being

Table. *Oryctes rhinoceros* captures depending on the doses emitted by different dispensers. Trial over 163 ha of young palms at the Laras estate, North Sumatra, Indonesia.

Type of dispenser	Diffusion rate (mg/day)		Captures (males and females)	
	In the laboratory (INIA)	In the field	Total (60 traps for 15 periods of 4 days)	Mean/trap in 4 days
D4	54	61	3,099	22.1 a
D3	27	32	2,392	17.1 b
D2	16	17	1,962	14.0 c
D6	—	16	1,577	11.3 d
D5	—	13	1,459	10.4 d
D1	5	5	826	10.3 e
Total			11,482	

Means followed by the same letter are not different at $P < 0.05$ (Newman-Keuls test).

adjustable to pest population levels, and to a seasonal effect, whilst taking into account the degree of damage.

Trapping offers the advantage of having an immediate impact on damage by reducing populations of the pests responsible,

whilst being environment-friendly. It complements biological control, which acts slowly and in the long term. ■

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