



Editorial

Given the current interest in preserving natural resources, reducing or avoiding the use of insecticides against insect pests in the tropics is one of CIRAD's main aims. The latest crop protection strategies hinge on increasingly detailed knowledge of insect biology and behaviour, and of the ecosystems with which they are associated. CIRAD and its partners have assigned researchers to the world regions most affected by entomological problems, with a view to establishing projects geared towards finding solutions that are both sustainable and appropriate to the current socioeconomic climate.

In conducting such projects, CIRAD relies in particular on technological resources such as remote sensing, radio tracking, molecular biology tools, and data analysis and simulation softwares.

CIRAD's researchers are working on both risk prevention and integrated pest management (IPM) techniques. This issue looks at various case studies.

There are already applicable results as regards prevention, a key part of CIRAD's studies of locusts. In terms of control, our entomologists work to validate techniques developed in the field, before transferring them to users via appropriate training courses.

The solutions we offer are designed to respect both the environment and biodiversity. Their cost and efficacy are similar to those of chemical control methods. CIRAD is keen to share its experience with you: do not hesitate to get in touch.

Bernard DUFOUR,
Controlling Pests and Diseases
in Tree Crops Research Unit

Véronique VISSAC-CHARLES,
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Controlling the locust risk in Madagascar

CIRAD has recently completed the development of a geographic information system intended to manage the migratory locust *Locusta migratoria* in Madagascar, one of the major threats to farming in the country, which saw a catastrophic invasion between 1997 and 1999. The software can be used as a decision support tool to identify zones with a high probability of a locust outbreak and thus organize surveillance and early intervention operations more efficiently. This is a major step towards a preventive strategy aimed at managing the locust risk in the country. The project was funded by the African Development Bank (ADB) on behalf of the Centre national antiacridien in Madagascar.

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Controlling oil palm leaf miners

The larvae of *Coelaenomenodera lameensis* (Coleoptera: Chrysomelidae) cause substantial damage in Africa by mining galleries in oil palm fronds. *Elaeis oleifera* is the palm species most resistant to attacks. CIRAD and INRAB (Benin) are studying the physicochemical factors involved in how the pest feeds and develops, and the differences in the polyphenol profiles of the various palm species that may account for certain types of resistance.

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Systematics research on beneficials, a key part of biological control projects

Hymenopteran parasitoids, whose larvae eat insect pests, are highly specific beneficials that are often used in biological control programmes. Describing the biodiversity of this group, which probably comprises several hundreds of thousands of species, is of vital importance for control operations. Researchers use both morphological and molecular characters to discriminate between species. This has been done for the hymenopteran *Eretmocerus cocois*, which is now being bred and reared for use against coconut whiteflies in the Comoros and the Seychelles.

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When a new fruit fly invades a region...

An invasive fruit fly of Asian origin, *Bactrocera invadens*, became established in Africa in 2004. It has since become a major pest on mango, and is now threatening exports. CIRAD is leading a project funded by the World Bank and the World Trade Organization (via the STDF¹) to study the fly. CIRAD and COLEACP have produced a bilingual e-newsletter to facilitate communication between the various players concerned (www.coleacp.org). The EU has ordered a global study with a view to proposing an international plan of action in 2010, aimed at ensuring better protection for products intended both for local consumption and for export.

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A palm pest from South America

Paysandisia archon is a South American lepidopteran that was accidentally introduced into Spain, Italy and then the South of France in 2001. It attacks more than 20 palm species. The insect is now threatening date palms, which are grown from North Africa to the Persian Gulf and are the characteristic vegetation in oases: the economic stakes are thus very high. CIRAD and the Languedoc Roussillon Regional Council are funding a thesis on the topic in the hope of learning more about the pest's biology, ecology and chemical communication mechanisms. The studies are intended to enable the development of prevention and control methods.

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¹ Standards and Trade Development Facility

Science

► DESERT LOCUSTS IN WEST AFRICA

The desert locust, *Schistocerca gregaria*, is a pest whose spectacular invasions concern a vast area covering more than 60 countries, from Mauritania to India, and from southern Europe to the Equator. It cost the international community almost a billion euros to control the last two invasions, in 1987-89 and 2003-05. CIRAD has been working for some considerable time to understand the origin of the phenomenon better and to perfect control strategies. Several projects are under way with a view to: 1) understanding—using molecular biology techniques—locust population dynamics prior to invasions, 2) enabling—through spatial remote sensing—earlier identification of the conditions propitious to locust reproduction and exponential growth in numbers, and 3) improving management of surveillance and control operations in the countries concerned using a specific database accessible in real time via the Internet. This work is being done in conjunction with the FAO, the Desert Locust Control Commission for the Western Region and the locust control centres for West Africa and the Maghreb, with funding from the French Ministry of Foreign Affairs Priority Solidarity Fund (PSF) and the Fonds français pour l'environnement mondial (FFEM). ■

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► CONTROLLING *ORYCTES RHINOCEROS* USING PHEROMONE TRAPS

Oryctes rhinoceros is a beetle that causes severe damage on coconut and oil palms. To control the insect, pheromone traps can be used to catch thousands of individuals and thus reduce attack levels. The question now is whether this technique really serves to reduce population levels (by capturing the insects) or in fact favours the persistence of the species within plantations (by attracting them). A trial has been set up in Southeast Asia to study pest population behaviour, produce a spatiotemporal map of infestations, determine the physiological state of the insects captured and estimate the efficacy of different trapping strategies. An analysis of the results should serve to determine the relevance of the method, fine-tune its use and assess its cost. ■

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► INSECT POPULATION DYNAMICS IN UNSTABLE CROPPING SYSTEMS

To study how grassland agrosystems are colonized by plant-eating insect populations, how those insects move opportunistically from plant to plant (cultivated or otherwise), and the impact they have on crops, it is essential to have tools capable of characterizing their evolution in time and space. The two model insects on which the Annual Cropping Systems Research Unit is working are the moth *Helicoverpa armigera* and the aphid *Aphis gossypii*. Two types of innovative tools have been developed in partnership with the public and private sectors. One type comprises markers—molecular (microsatellites), botanical (pollens), geochemical (carbon isotopes) and biochemical (gossypol)—that are used to identify the plants that successively host insect populations. The other, which is still being studied, involves hydrogen isotopes and bacterial flora composition, which should serve to provide information on the geographic origin of migrant individuals. It should subsequently be possible to reduce the impact of insect populations on a farming system by modifying the distribution and type of crops in space and time (habitat management). ■

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► OMEGA³ (OPTIMIZING ECOLOGICAL PEST MANAGEMENT METHODS TO ENSURE SUSTAINABLE IMPROVEMENTS IN FARMING SYSTEM PRODUCTIVITY)

This project, involving crop protection and systemic agronomy researchers from CIRAD and partners from Africa, Latin America and the French overseas islands, set out to determine the ecological processes by which pests are regulated and the conditions for reducing their adverse effects by introducing plant diversity into farming systems. It centres on a study of six tropical pathosystems covering a very broad range of pests, host plants, and modes and degrees of plant diversification (soil-plant, plot and landscape, in direct seeding, horticultural and agroforestry systems). The knowledge generated will be used for modelling, to develop innovative cropping systems that are "resistant" to pests thanks to their degree of plant diversification. ■

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Migratory locust swarm in flight over the Horombe Plateau, Madagascar, in 1999

Market

► ENTOMOLOGY TRAINING COURSES

Entomologists in developing countries often feel the need for refresher courses, to learn the latest knowledge and be able to use all the available concepts and tools.

Taxonomists with the Centre for Biology and Management of Populations (UMR CBGP) provide "à la carte" training courses tailored to individual and collective requirements. They can also organize training in systematics and in the recognition of insects from warm regions. Such courses are intended for professionals in particular, and include a large proportion of practical exercises: introduction to and further training in entomological techniques, determination sessions using teaching tools, bibliographical data searches, etc.

The Locust Ecology and Control Research Unit offers two training courses on request: Locust control techniques: how to control locust pests, and Application techniques for locust control and crop protection. <http://www.cirad.fr/ur/acridologie/formations> - http://formation.cirad.fr/formation_collective/catalogue/l_expertise_acridienne ■

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Technology

▶ RADIO TRACKING TO MONITOR INSECT PEST MOVEMENTS

Using radio transmitters to detect insect swarms has become increasingly common in recent years. The necessary equipment has been sufficiently miniaturized to allow its use on insects. Active electronic chips are attached to the thorax of insects and detected using a receiver, to monitor the insects' movements in space and map them using geographic information systems (GIS). A successful study of the movements of the coconut and oil palm Dynastinae beetle *Scapanes australis* has been conducted in Papua New Guinea, and is being continued in Southeast Asia. A project is under way in Australia to study the movements of the sugarcane grub *Dermolepida albohirtum*. ■

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▶ THE AUGMENTORIUM: AN ORIGINAL PREVENTIVE TECHNIQUE AGAINST INSECT PESTS

An augmentorium is a canvas tent with a piece of mosquito netting in the roof. Fruits infested with fruit and vegetable fly eggs or larvae are placed inside the tent. Such flies are major pests in horticultural systems. The adult flies that hatch from the fruits in the augmentorium are trapped in the tent and eventually die. However, their parasitoids, which are smaller, can escape after hatching, through the holes in the mosquito netting. Augmentoria are thus: 1) a means of prevention, by reducing fly population levels, 2) a biological control method, by increasing parasitoid population levels (hence the name), which is what makes them original, and 3) a means of producing compost: an appropriate mixture of rotting damaged fruits and organic matter. ■

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▶ MOSQUITO NETS TO PROTECT CABBAGES

Market garden crops, which are often attacked by insects, are generally protected by means of chemicals. Such treatments are costly, toxic for both man and the environment, and frequently poorly applied, and can usefully be replaced by physical control, in the form of mosquito nets. Covering cabbage crops with mosquito nets overnight prevents pests reaching the plants (particularly to lay their eggs). The mosquito nets are impregnated with insecticide, hence they also work against smaller insects that can pass through the holes in the nets. The technique protects cabbages against pests while avoiding any contact with the crop (hence improving food safety). ■

<http://www.cirad.fr/upload/fr/actualite/videos/moustiquaire/index.php>

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▶ BIOLOGICAL CONTROL AND CONSERVATION OF PREDATORS: A WORTHWHILE WAY OF REDUCING THE DAMAGE CAUSED BY SUGARCANE BORERS

For a decade or so, research has been under way in Réunion in partnership with INRA and a professional (FDGDON), with a view to controlling the sugarcane borer *Chilo sacchariphagus*, a lepidopteran. The aim is to develop biological control methods involving releasing trichogramma, which are egg parasites. When done just after planting, such releases give very good results, since this coincides with the borer's egg-laying peak. Predation by ants is subsequently sufficient to provide effective protection, and indeed becomes increasingly effective as the cane grows. It is thus a good idea to preserve ant species, notably *Pheidole megacephala*, and adapt trichogramma release strategies to the degree of predation. Biological control? OK, but using the ecological services rendered by predators, in a complementary approach! ■

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▶ DATA SHEETS ON LOCUSTS

Technical advice notes on the main locust pest species are available on request. An on-line encyclopaedia is available at: <http://locust.cirad.fr/>, along with many previously published articles: <http://ispi-lit.cirad.fr/> ■

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▶ A NEW WAY OF USING THE BROCAP® COFFEE BERRY BORER TRAP

The latest research aimed at controlling the coffee berry borer has led to a marked improvement in the efficacy of trapping, resulting in a reduction in infestations of more than 90% compared to the levels in control plots. In the trials, the BROCAP® trap was made the heart of an integrated pest management approach including two complementary operations: removing by hand any berries still on the coffee trees after harvesting, and applying the basic postharvest agronomic principles, such as pruning and plot cleaning. The traps are currently made in El Salvador, Mexico and Indonesia. ECOM distributes the traps and diffusers and handles quotes and export procedures, on behalf of CIRAD. ■

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The CLCPRO

The Desert Locust Control Commission for the Western Region (CLCPRO) was founded in 2002 under the aegis of the FAO. It promotes operations, research and training operations aimed at ensuring preventive control of desert locusts and coping with outbreaks. It covers ten countries in the western region (West and Northwest Africa): Algeria, Burkina Faso, Chad, Libya, Mali, Mauritania, Morocco, Niger, Senegal and Tunisia. Its HQ is in Algiers.



Interview with Dr Thami Ben Halima, Executive Secretary, CLCPRO, Algiers

○ What does the CLCPRO do?

Desert locust outbreaks have a huge impact on the economy of the countries concerned (60 countries, 29 million km²), food security, the fight against poverty and the environment. Preventing and controlling these phenomena calls for significant regional and international cooperation. The CLCPRO's main aim is to introduce a **sustainable preventive control strategy** against desert locusts in the western region. To this end, we need to build our countries' human, material and research capacity so as to enable them to fight the locust threat in two different ways: prevention, and better control of invasions. Setting up autonomous national locust control units was once a dream, but we have now begun doing just that. The FAO EMPRES programme, a multi-donor programme that we are coordinating, is providing us with significant support to develop and introduce such a strategy. This is an opportunity for us to thank all the donors who have contributed: France, the African Development Bank, the World Bank, USAID, IFAD and the FAO.

The CLCPRO at a glance

Nationality: International organization
 Status: FAO Desert Locust Control Commission for the Western Region
 Founded: February 2002
 Staff: 10
 Field: Desert locust control capacity coordination and building

○ How did you get to know CIRAD?

Our first joint operations with CIRAD date back to the 1987-89 desert locust invasion. Since then, and as soon as the EMPRES programme was extended to the western region in 1997, CIRAD has helped us with the feasibility study of the programme and supported us in convincing donors and planning our operations.

○ How can prevention be improved?

The keystones of prevention strategies are early warning systems, rapid intervention and operational research. This is why we are always working to gain a better understanding of how desert locust swarming sites (the zones that give rise to invasions) develop. We are working with CIRAD to develop the watch components of national locust control systems and set up a florule of locust biotopes in the western region, a vital tool for prospectors. Along with the FAO Desert Locust Information Service and CIRAD, we are working on tools that should enable us to monitor at-risk zones more closely so as to detect and destroy locust swarms in the initial stages. We use GIS and are developing communication systems and networks to pass on and analyse information on locusts as quickly as possible. In future, improvements in satellite image processing should allow us to improve monitoring and decision support operations even further.

○ Do you have any plans to work with CIRAD again in future?

A general cooperation agreement between CIRAD and the CLCPRO was signed in June at the 5th CLCPRO Meeting in Agadir. CIRAD is involved in a postgraduate course in locust control at the Institut agronomique et vétérinaire Hassan II in Agadir, Morocco. In future, it will be continuing to work with us on planning phase II of the EMPRES programme in the western region. We will be working together to define the research priorities for the future, at the Dakar workshop in October 2009. We will also be looking into the dynamics of solitary populations prior to invasions, to further improve prevention.

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The ENDURE network

The ENDURE network of excellence (European Network for the Durable Exploitation of Crop Protection Strategies) was set up to develop environmentally friendly crop protection strategies that satisfy consumer expectations and are compatible with profitable agriculture. ENDURE is coordinated by INRA, has a budget of 11.2 million euros, was set up in 2007 for a four-year period, and involves more than 300 researchers from 18 European organizations. Several CIRAD internal or joint research units are members of the network: 1) Banana, Plantain and Pineapple Cropping Systems, and Agroecological Functioning and Performances of Horticultural Cropping Systems (Hortsys) internal research units, in Guadeloupe and Martinique; 2) Plant Communities and Biological Invaders in Tropical Environments Joint Research Unit, in Réunion; and 3) Biology and Genetics of Plant-Pathogen Interactions for Integrated Protection Joint Research Unit, in Montpellier. Moreover, CIRAD is charge of coordinating the network's relations with extra-European countries, particularly its partners in the South. It also coordinates external communication and runs the ENDURE website, which since January 2009 has included a bi-monthly e-newsletter. The proceedings of the international conference organized in Montpellier in October 2008 are available on the site: <http://www.endure-network.eu/>.

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R-System network: supporting insect identification

A systematics network led by UMR CBGP (see above) is currently working to associate a dozen or so research teams with a view to the molecular and morphological characterization of organisms of interest (pests and diseases, beneficials, tropical trees, etc). The aim is to compile a dictionary on genotypic and phenotypic variability, and thus enable better characterization of these organisms, by combining taxonomy, barcoding and phylogeny. Moreover, a computer tool is being developed to make the relevant data available on line. It should: 1) make it possible to link each specimen studied to taxonomic, geographic, phenological, phenotypic and genotypic attributes; 2) allow the extraction and crossing of these data on different levels, so as to analyse the variability of these characters and above all the co-variability between different attributes (ie phenotypic and genotypic), and thus define the entities studied better; and 3) enable molecular and/or phenotypic identification by users of the base (external function) and at the same time better compatibility between the perimeters of taxonomic units (internal function).

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