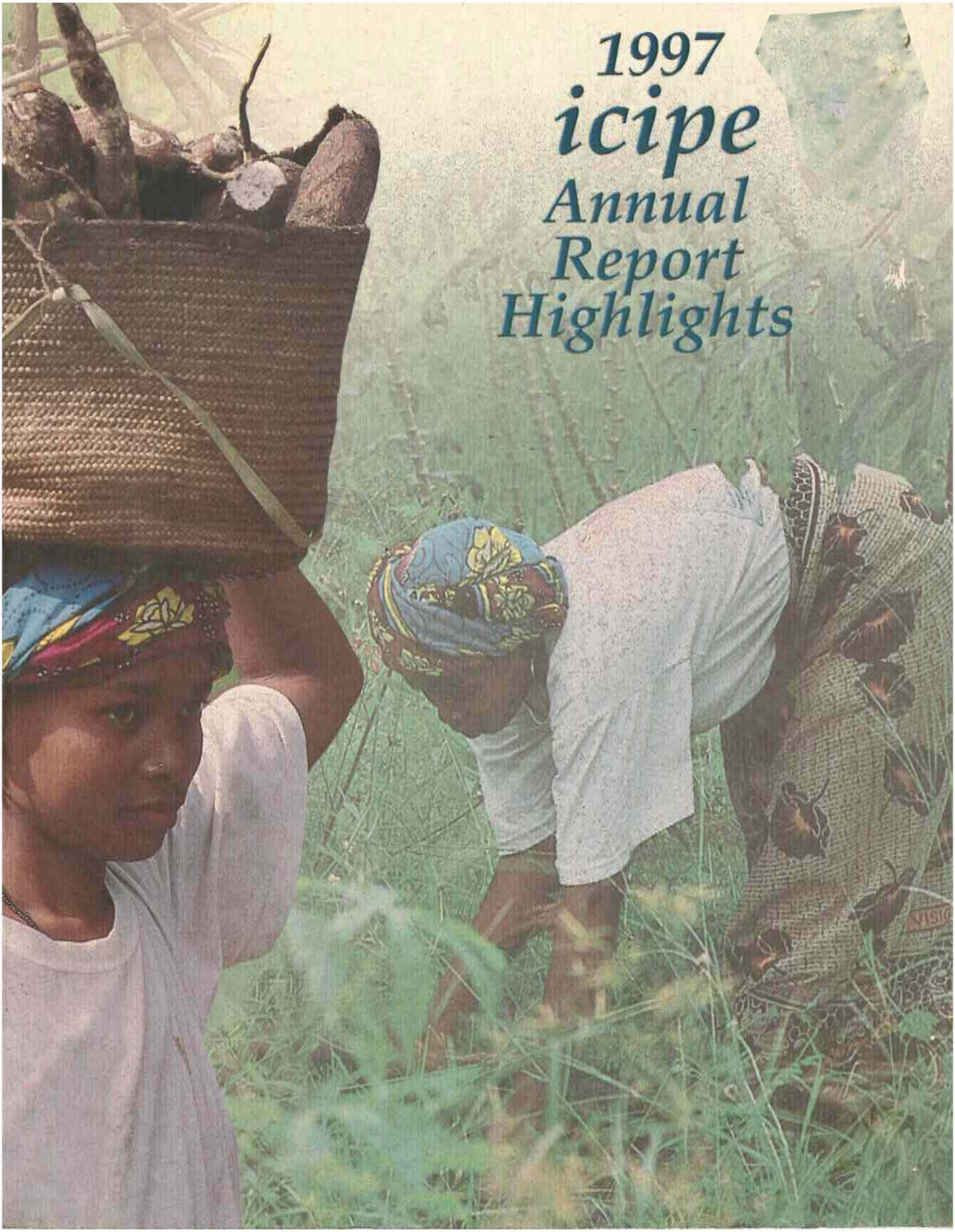
1997 *icipe* Annual Report Highlights



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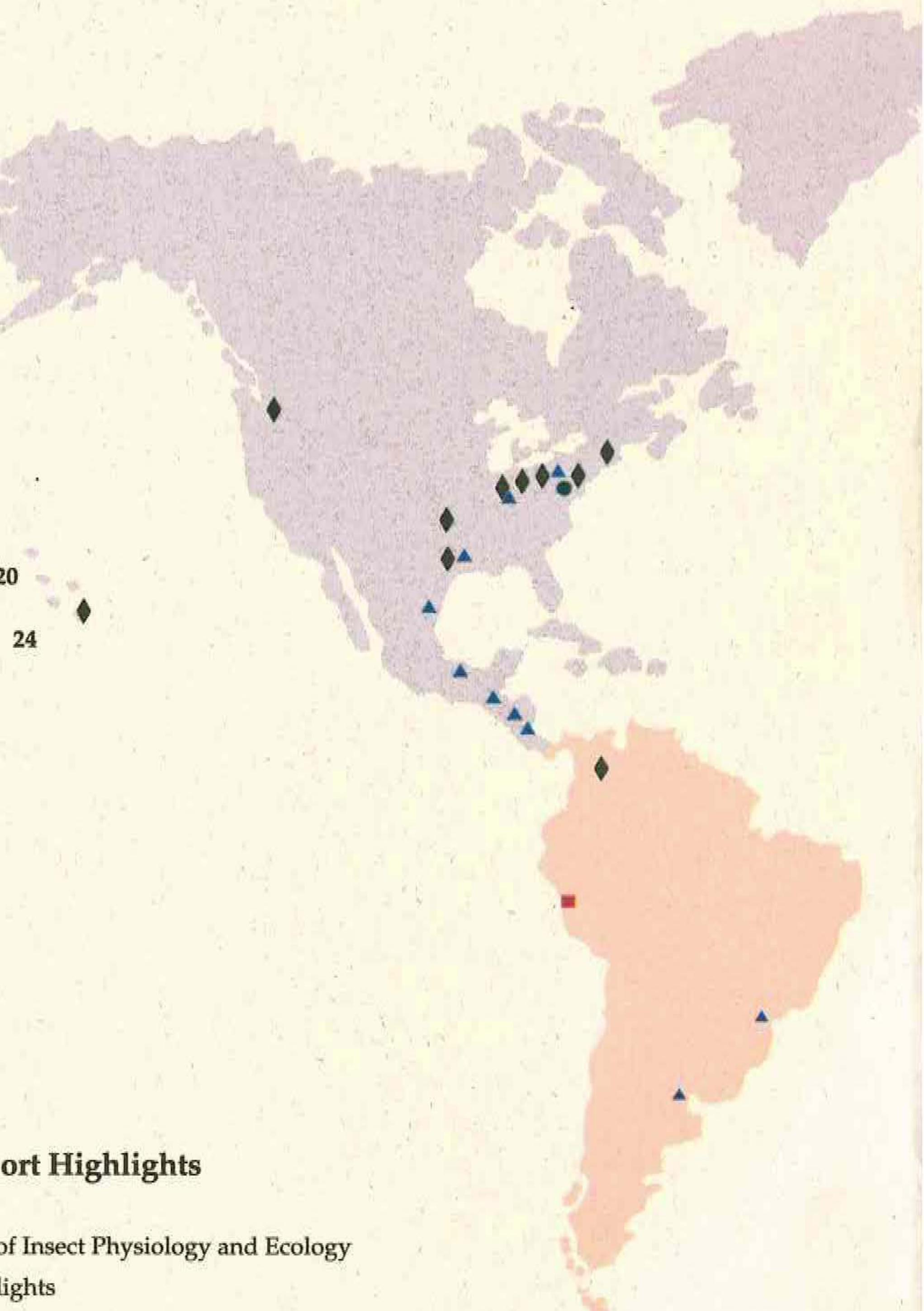

icipe 1997 Annual Report Highlights

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FOREWORD

The last year (1997/98) has seen considerable change at ICIPE, within the Governing Council (GC) and in the management structure and its staff as well as in the research staff and their projects. My election as Chairman of the GC of ICIPE to succeed Jacob L. Ngu in May 1997 coincided with the retirement of four stalwart Council members who had guided the Centre through some difficult times and had effected some important changes. While the dedication, expertise and ability of their successors is not in doubt, such a large exodus of key Council members at one time is undesirable and serves to highlight the need for Council to review the election/retirement process of its members. The preparation of a new set of Guidelines for the GC and its Committees has been completed and steps taken to arrange an annual assessment, both of Council and its Chairperson.

N. L. Innes

As new Members of the Governing Council, we have Niklaus A. Weiss from Switzerland and Gabrielle Persley from Australia. Positive steps are being taken to strengthen the African representation on Council and also to identify potential members with financial and private sector experience and know-how. The year 1997/98 saw the retirement of Benjamin Kipkorir, Kenya's former Ambassador to the USA, who served Council with distinction and was Chairman of the Audit Committee. Fortunately, the Council has been strengthened by two new Government of Kenya appointees, namely Paul K. arap Konuche and Walter N. Masiga.

Before its Annual Meeting in Nairobi in April 1997, the Council Chairman and Programme Committee members visited Ethiopia to see the work being undertaken by ICIPE in that country. Not only were Council members impressed by what they saw, but they also heard first hand from politicians, researchers, extension workers and farmers of the importance and appreciation of ICIPE's research and development efforts and of the value placed on them. It was obvious that greater financial support for ICIPE's efforts in Ethiopia would pay handsome dividends.

The UK-based Friends of ICIPE has taken steps to increase its membership and to widen it to include more members who are resident outside the UK. Efforts are also underway to create a USA-based Friends of ICIPE. At the 22nd Meeting of the Sponsoring Group of ICIPE (SGI) in Washington last October, Carl-Gustaf Thornström succeeded Michel Petit as Chairman of the SGI. The Governing Council and ICIPE's Senior Management are grateful for the support and guidance provided by Michel Petit and are confident that his successor will continue in like vein.

As part of an effort to reduce overheads and to concentrate Nairobi-based staff on one campus, buildings which were originally built by ICIPE and occupied by Centre staff on the Chiromo campus of the University of Nairobi have been vacated. A new agreement with the University aims to strengthen existing collaboration between the two institutions.

We trust that as you read these highlights of ICIPE's activities over the current reporting period (September 1997–March 1998), you will be encouraged by the innovative and worthwhile efforts being made by the Centre staff to address the most pressing development issues in the tropics in the areas of human, animal, plant and environmental health—the 4H's.

N. L. Innes
Chairman, ICIPE Governing Council

Director General's Message

Insects provide crucial pollination services for crops and wild plants running into the billions of dollars annually. Here, *Mylabris escherichi*, one of the millions of useful African insects, is shown pollinating a wild flower.

This year's *1997 Annual Report Highlights* summarises ICIPE's major activities since October 1997 when we published our regular Annual Report for the period January 1996–September 1997, and I would refer you to the latter publication for more in-depth coverage. We will also have available later this year a scientific report which will contain detailed results and analysis of our research activities. Note that all our reports are now available on our new homepage, http://www.icipe.org. In addition, our website will carry other information which you may wish to read or download on research, training and education, publications, staff, news items, workshops, meetings, facilities and services. We hope that this new facility will help bring you closer to us and also encourage you to comment on our reports and activities, in particular on our new project ideas.

Given our uniqueness, and our key role in the field of insect science research and capacity building in Africa and the tropics in general, ICIPE is and will continue to contribute tremendously to sustainable development. This is a goal of not only ICIPE, but of the donor community and the people of the developing countries alike.

Insects are key to agriculture, environment and health. In a recent article published in *Nature*, Vol. 387 of 15 May 1997, R. Costanza and colleagues put the value of the ecosystem service from pollinators in the order of US$ 232 per hectare per year in grass / rangeland alone, or a world total of US$ 117 billion, while biological control provides services amounting to US$ 417 billion. The value of the services rendered by the soil-borne arthropods and microorganisms in the nutrient cycling processes, which assure the sustainability of the agricultural production base, is estimated at a staggering US$ 17 trillion. These numbers, according to the authors, are conservative estimates of the potential value of the services performed by the earth's natural capital stock (which includes a large proportion of insects, spiders, ticks, centipedes and other arthropods) in various ecosystem functions. Their obvious economic importance should stimulate additional research and point to areas for further analysis.

My message here to scientists is that there is a tremendous need for more and better research. My message to policy makers and donors is that *insect science needs much more attention and investment. Unless more work is carried out towards a better understanding of the ecosystem functions of insects and their role as both pests and beneficial organisms, the optimistic predictions of increased food production will never materialise.*

In this vein, I would also like to emphasise the role of 'traditional' disciplines *vs* the now ubiquitous 'genetic engineering', the latter being advertised by industrialised countries as the solution to the world's food and health problems. Progress has certainly been made in both areas, but I doubt very much that the investments—made at the cost of the more solid and basic disciplines upon which even biotechnology and genetic engineering have been built and will depend for their deployment—will in the next 20 years deliver any products of value which are or will be affordable by the resource-poor farmers of the developing countries. Let me also cast a word of caution to the donor community, which is joining the bandwagon of private sector investors in supporting an ever increasing number of genetic engineering projects. These public funds are ill invested, and will only serve to increase the one-sided approach taken by industry. It may be necessary for the public sector to fund the 'traditional' research efforts which do not find a place in the private sector's high profit margin agendas. The World Bank admits that "biotechnology and genetic engineering will be crucial in expanding agricultural production, but that this will require many other things".

Ants such as these African safari ants are often thought of only as pests, but these highly organised social insects are vital in soil conditioning and nutrient recycling. The value of the environmental services rendered by soil-borne organisms is estimated in the trillions of dollars.

These "things" are some of what we at ICIPE are (or would like to be) working on. Our new research agenda, compiled in the *Vision and Strategy towards 2020* document and in the *Five-Year Plan(1996-2000)*, both of which have been endorsed by a donor-selected group of experts, is specifically addressing these 'classical' issues of insect ecology, behaviour, biology, taxonomy and diversity relative to their pest and vector status, as well as their potential for income generation and their invaluable ecosystem services.

The new solutions to insect problems being sought by ICIPE are in the realm of alternatives to the pesticides currently used at ever increasing rates, despite their now widely acknowledged direct and indirect deleterious effects on human health and the environment. Such new methods will also be sustainable and affordable, unlike the ones provided by chemical pesticides and the insufficiently tested transgenic plants currently being promoted. As regards the latter issue, ICIPE has been suggesting, and has now put into action under a collaborative agreement with ORSTOM, studies on gene flow and the role of insects in the transfer of genes from modified cultivated plants to their wild relatives. The ecological impact of such transfers will be assessed, in particular the development of resistance and potential threat to pollinators.

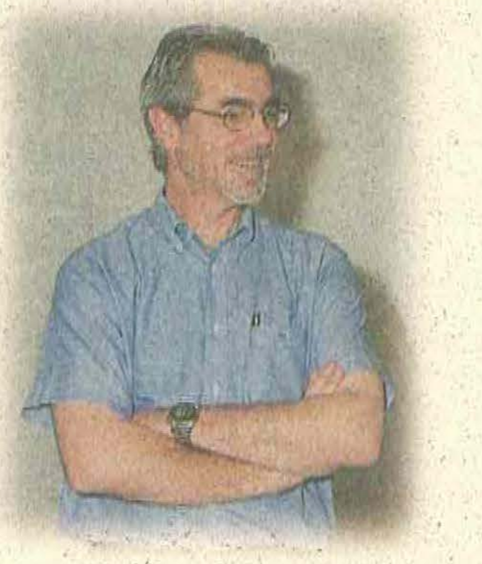
The general project funding of ICIPE showed a gradual improvement in 1995 and 1996, with a slight downward trend in 1997 and 1998. In the area of special projects, ICIPE scientists have done well, with a success rate of some 40% and for 1998, a total of US$ 8.5 million. This shows that our research agenda matches the donors' objectives. The situation with regards core funding for 1998 is, however, still a matter of concern, with only US$ 3.0 million committed as of March. This state of affairs is extremely unhealthy, given that we estimate an absolute minimum core requirement of double this amount. Most special project donors appear unwilling these days to contribute more than 9% on average toward general services and other support costs. As a result, we are fast approaching the anomalous situation of being able to finance special project research research but unable to operate the Centre!

At this point, I would like to extend a hand of appreciation to those donors who have been willing to specifically support the less visible, but vital core activities: the governments of Sweden, Denmark and Switzerland. I should also like to acknowledge the modest, yet significant contributions of a growing number of African countries (Kenya, Mozambique, Uganda) to the ICIPE budget for 1998 and beyond. This is a confirmation of their confidence that we are moving in the right direction in addressing the continent's important development issues.

There is another fundamental problem with the donor community's requests regarding fund generation by research institutions based in developing countries: It has been suggested that a good share of the funding requirements should be raised from the local private sector, as do the research institutes located in the industrialised countries. One major drawback has escaped the attention of the architects of this approach, however: The industrialised countries have a long-standing experience with investing in research and consequently place a high value on it. In the developing countries, there is on the one hand virtually no private sector capable of funding major research endeavours, and on the other, very minimal appreciation of the value of research, as most of the manufactured products are made under license. The time lag until there is genuine and substantial support of research by the private sector of the developing countries is at best 25 years away.

There is, therefore, no alternative to a continued strong support to research by the industrialised countries. This should be done in the spirit that this support will accelerate the true independence of the developing countries.

Give us the means and we will do the job.



Hans R. Herren

Why ICIPE?

The International Centre of Insect Physiology and Ecology (ICIPE) is a tropical organisation with a tropical agenda. But why study insects? Because in the tropics, insects are a fact of life to be reckoned with. Insects pose a greater risk to food production, often causing the loss of entire crops and destroying about half of all harvested food in storage. The 'old' tropical vector-borne diseases of malaria, dengue, kala-azar and the like are making a dramatic comeback and frightening new ones are emerging. Livestock succumb in their millions to insect- and tick-borne diseases, resulting in loss of milk, meat and traction power. Underlying all of these issues is the fundamental poverty of most tropical countries and inability to harness their natural resources for themselves.

Established in Kenya in 1970, ICIPE's founders recognised that the mainly Third World countries of the tropics had special problems that were not being adequately addressed by scientists and organisations in the North. Furthermore, there was a serious lack of indigenous expertise to resolve these problems. It should come as no surprise that ICIPE's objectives for the next millennium are essentially the same as they were three decades ago: to help ensure food security and better health for humankind and its livestock, to protect the environment and to conserve and make better use of natural resources.

A new paradigm

The agenda for achieving the above goals is based on the paradigm of ensuring the 4H's: human, animal, plant and environmental health. Carrying the health paradigm a step further, ICIPE stresses 'prevention over cure' when it comes to arthropod-related problems, preferring this to the 'fire-brigade' approach so often used these days. ICIPE's research activities are focused around 11 megaprojects which are highlighted in this report. Capacity building (see page 30) runs as a current through all of the Centre's activities and projects.

ICIPE's 360 staff hail from over 20 countries and work in multidisciplinary teams in the paradigm of the 4H's, as outlined below.

"The food supply in Africa is under constant pressure... African farmers are poor. They work small plots of land with little benefit of high technology. The scientific advances available to farmers in the industrialised world are mostly unaffordable to them. Dr Herren's [IPM] work speaks to these concerns. His effort to save the cassava crop was achieved with economic efficiency and with virtually no disruption to the everyday practices of the African farmer [and] moreover without disruption to the environment".

The Hon. Jimmy Carter (WFP Council of Advisors) on Hans R. Herren's receiving the 1995 World Food Prize

Plant health

As the millenium draws to a close, the euphoria of the Green Revolution has been tempered by the realities of the intractability of development problems and the need for more sustainable, long-term solutions. But what is the alternative? **Integrated pest management,** or IPM, is an approach to pest control that encourages natural solutions to agricultural and human and livestock health problems. The crops currently being protected by IPM worldwide include cotton, wheat, maize, sugarcane, rice, vegetables, legumes, coffee, fruits and flowers.

IPM is especially appropriate for resource-poor farmers whose know-how about appropriate application and safe use of pesticides is limited. Almost as important are the secondary benefits, of which N.A. van der Graaff, Chief of FAO's Plant Protection Service says, "*IPM enhances ecological awareness, decision-making, business skills and farmer confidence. IPM thus has long-lasting social and economic benefits far beyond the area of plant protection*". IPM is now the preferred method of pest management encouraged by other important agricultural research organisations including members of the CGIAR system and by donors such as the World Bank.

ICIPE works on pests of maize, sorghum, cowpea, banana, fruits, vegetables, horticulture, and storage and agroforestry (see pages 16–23) using improved farming practices such as intercropping, crop rotation, resistant seeds; biological control using natural enemies and pathogens; habitat modification and use of biodiversity; and use of botanicals such as neem. Many of these techniques are based on creating an unfavourable environment for pest feeding and reproduction.

Human health

ICIPE is one of the few organisations working to develop IPM strategies for use against tropical human disease vectors such as malaria mosquitoes, tsetse flies, sandflies and filth flies. Malaria and other mosquito-borne diseases take a heavy toll on Third World populations. Often overlooked is the loss of labour and productivity resulting from the recurrent general debilitation accompanying serious illness. In the new Malaria Vectors Megaproject (see page 8), ICIPE is looking towards an integrated approach to vector management, called IVM. IVM combines methods for reducing mosquito numbers that rely on preventing them from breeding, increasing their mortality through insect (entomo-) pathogens, traps and other non-chemical control methods. These long-lasting methods will be used in combination with other conventional preventive methods such as the use of impregnated bednets and prophylactics that have heretofore not proven sufficient in themselves to reduce the spread of virulent malaria. This same IVM approach is being used to develop methods of managing the tsetse vectors of the dreaded human sleeping sickness (see page 10).

Animal health

African livestock and wildlife live in a paradoxical situation: in the humid and sub-humid zones where there is plentiful grazing, the tsetse fly threatens them with animal trypanosomosis (nagana). Livestock production is therefore severely limited. Moreover, Africa could effectively cultivate 10–100 times more arable land if draught animals were available. The loss in potential livestock and crop production is estimated at US$ 4 billion in sub-Saharan Africa. Added to this are the losses due to tick-borne diseases. For instance, over a million cattle in Africa die every year from East Coast fever alone.

Total extermination of tsetse and ticks over the continent is an untenable prospect, so ICIPE is using the integrated pest and vector management (IPVM) approach to reduce fly numbers in crucial areas to levels where the threat of contracting these diseases is reduced to tolerable levels. Non-chemical methods such as the use of traps, pheromones to influence behaviour, pathogens and repellents are some of the preventive approaches described in this report on pages 10–14.

Environmental health

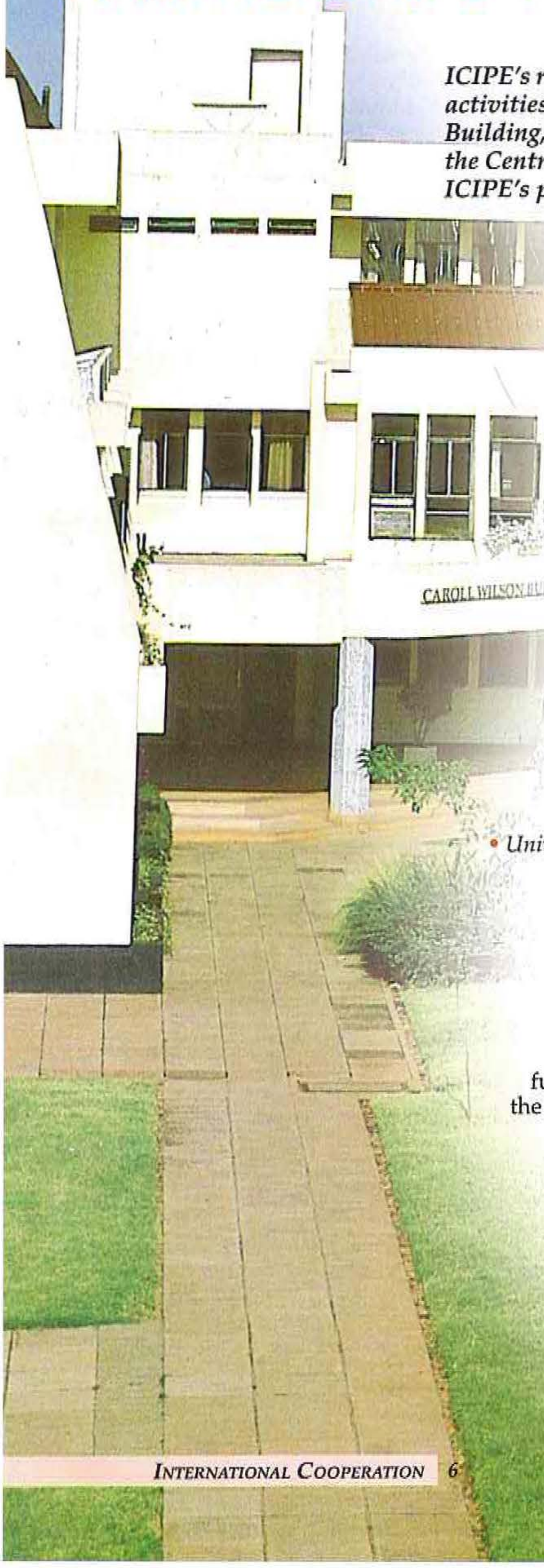
Underlying all other aspects of development is the now-imperative need to preserve the integrity of the environment. ICIPE's belief that human development and concern for the environment need not conflict with each other is reflected in all the Centre's projects, for instance in those that seek to make use of the wild habitat to control pests, and in those where surveys of pests' natural enemies can provide a rationale for conserving plant and animal species. Farmers are learning through the Commercial Insects projects (see page 26) on silkmoths and honey bees that insects can be a resource that brings direct cash benefits. The secondary benefits of maintaining arthropod diversity (see pages 24–28) have also been stressed in the DG's message on page 2.

Beyond IPM

At the crux of all development issues is the eventual end-user, in ICIPE's case the small- and medium-scale farmers and communities of the tropics who have little capital or access to credit to finance expensive solutions to their agricultural, health and environmental problems. ICIPE's social scientists help ensure that the new technologies being introduced incorporate as much as possible of farmers' traditional practices, while helping in the design, testing and evaluation of the improved methods. The Technopark initiative (see page 29) will help provide important products and services to ICIPE's end-users, while the Biovillage (see page 28) being planned in Ethiopia will integrate the 4H's into a holistic model for other regions.

Cleaning up after the Green Revolution is harder than was first imagined. The United Nations Environment Programme(UNEP), together with the UN Food and Agriculture Organisation(FAO), have recently announced an International Convention on Dangerous Chemicals and Pesticides. Ninety-five countries have agreed to the Convention. Most of the real 'baddies' are pesticides, some of the key weapons of the Green Revolution. FAO estimates that at least US$ 80 million is needed to clean up this surplus of unwanted, unused chemicals. Paradoxically, donors who could be supporting research into finding new solutions to the problem are now being requested to fund the clean-up exercise. Today's second-generation chemicals, which are more selective and less persistent, are often simply unaffordable by the world's majority of resource-poor farmers, most of whom earn less than $1 a day. As a result, many developing countries still continue to rely on the cheaper, more toxic or more persistent formulations. The Convention will regulate trade in over 22 hazardous pesticides and will "actively promote environmentally friendly IPM in agriculture".

Partnerships for Progress



ICIPE's relationship with its stakeholders is being strengthened by the activities of the Directorate of International Cooperation and Capacity Building, which also supervises resource mobilisation. As the needs of the Centre's clientele change, so must the cooperative agreements with ICIPE's partners in research.

ICIPE's comparative advantage in arthropod science and its application forms the basis of agreements with its partners. There are currently over 80 formal Memoranda of Understanding or Agreement (MoU/A) and many additional informal collaborative agreements which form the framework of cooperation. A few of those signed since January 1997 are highlighted below:

- *National organisations:* Kenya Medical Research Institute (KEMRI); Chinese Academy of Agricultural Sciences (CAAS); Indian Council for Agricultural Research; Plant Protection Research Institute (PPRI) and Onderstepoort Veterinary Institute (OVI), South Africa
- *International organisations:* ORSTOM, IITA, ICRISAT, WHO/ FAO/UNEP/Habitat, CAB International, AVRDC
- *Governments:* Oromia and Tigrai States(Ethiopia); Democratic Republic of Congo; Ministry of Research, Science and Technology of Senegal; Ministry of Agriculture of Mozambique; Papua New Guinea
- *NGOs:* Honey Care International, Winrock International
- *Private sector:* Research Corporation Technologies, John Innes Centre, PTA Bank
- *Universities:* of Zimbabwe, Malawi, Zambia, Ghana, Assiut and Gezira (Egypt), Chinese Agricultural University, Texas A&M.

In addition to the above, UNESCO and FAO are processing the upgrading of their relationship with ICIPE to 'A' category, and plans are underway to initiate formal collaboration with institutions in Latin America.

The Directorate also assumes overall responsibility for ICIPE's fund-raising, which is intended to raise resources for implementing the *Five-Year Plan (1996–2000).* Currently, about US$ 6 million is being sought to support the Centre's core activities. By enlarging the number of core donors and more careful inclusion of core costs in restricted project proposals, it is hoped that this shortfall will reduce in the next reporting period. Thus far, 12 countries have been visited in eastern and southern Africa, of which seven have indicated a willingness to contribute to the core budget from 1998. Other non-traditional sources of income not previously exploited are also being investigated, such as through developing closer links with national systems, by direct investments, and through commercialisation of R&D products. (see the Technopark report, page 29).

Writing a good project proposal is

critical to attracting research funds, and the Directorate has forwarded 38 proposals to donors since January 1997, of which 11 have already been funded. Outstanding among these are proposals for the Biovillage Initiative (see page 28), the African Fruitfly Initiative (see page 18) and the ICIPE Technopark Initiative (see page 29), for bringing returns that can be ploughed back into the Centre's R&D activities.

Public-relating

Visitors to the ICIPE Headquarters at Duduville are coordinated by the Public Relations office, and this year included the Hon. Marie-Louise Correa, Minister for Scientific Research and Technology, Senegal; Hon. Dr Seifu Ketema, Minister for Agriculture, Ethiopia; Hon. Prof. Hassan Omar Elnour, State Minister, Ministry of Agriculture and Forestry, Sudan; H.E. Ms Prudence Bushnell, American Ambassador to Kenya; Mr Kees Rade and Mr Frank Keurhorst of the Royal Netherlands Embassy; Dr Sam Olowude of IFAD; Dr Gary Toenniessen of the Rockefeller Foundation, NY; and Mr Pape M'Baye, Director General of Shelter Afrique. The headquarters was also a popular destination for farmers, women's groups and students. Another field day organised by the Gatsby-funded project at Mbita Point Field Station demonstrated the new techniques for management of cereal stemborers and striga weed. The farmers themselves, through their self-help organisation for tsetse control known as KISABE, organised a field day to demonstrate ICIPE's successful model of community management of tsetse and trypanosomosis in the Lambwe Valley which they have been undertaking for the last four years.

During the year, news of ICIPE's R&D activities were broadcast and published on a monthly basis throughout Africa via the respected AGFAX Radio and Press services run by the UK-based WREN-media. The broadcasts and publications were distributed to all major radio stations of Anglophone Africa and to international broadcasters including the BBC, RFI, Deutsche Welle and Swiss Radio. The articles were also distributed to daily newspapers in Africa and to international publications. ICIPE's tsetse and horticulture research activities were featured on ORF Austrian TV and RFI (Radio France International).

ICIPE staff kept abreast of the latest developments in insect science through over 40 seminars by invited speakers and Centre scientists. Staff, Governing Council members, donors and collaborators are informed of key developments and forthcoming events through the monthly newsletter "ICIPE UPDATE", and through workshops, seminars, training courses and conferences. In 1997 these included the First International Workshop on Conservation and Utilisation of Commercial Insects; Workshop on Global Change Impact Assessment Approaches for Vectors and Vector-Borne Diseases; Refresher Training Course on Improved Pest Management Technologies in Export Vegetables; Management of Banana Pests-Mobile Training Course; Flower Pest Management Meeting; and Seminar on Neem for Sustainable and Environmental Conservation.

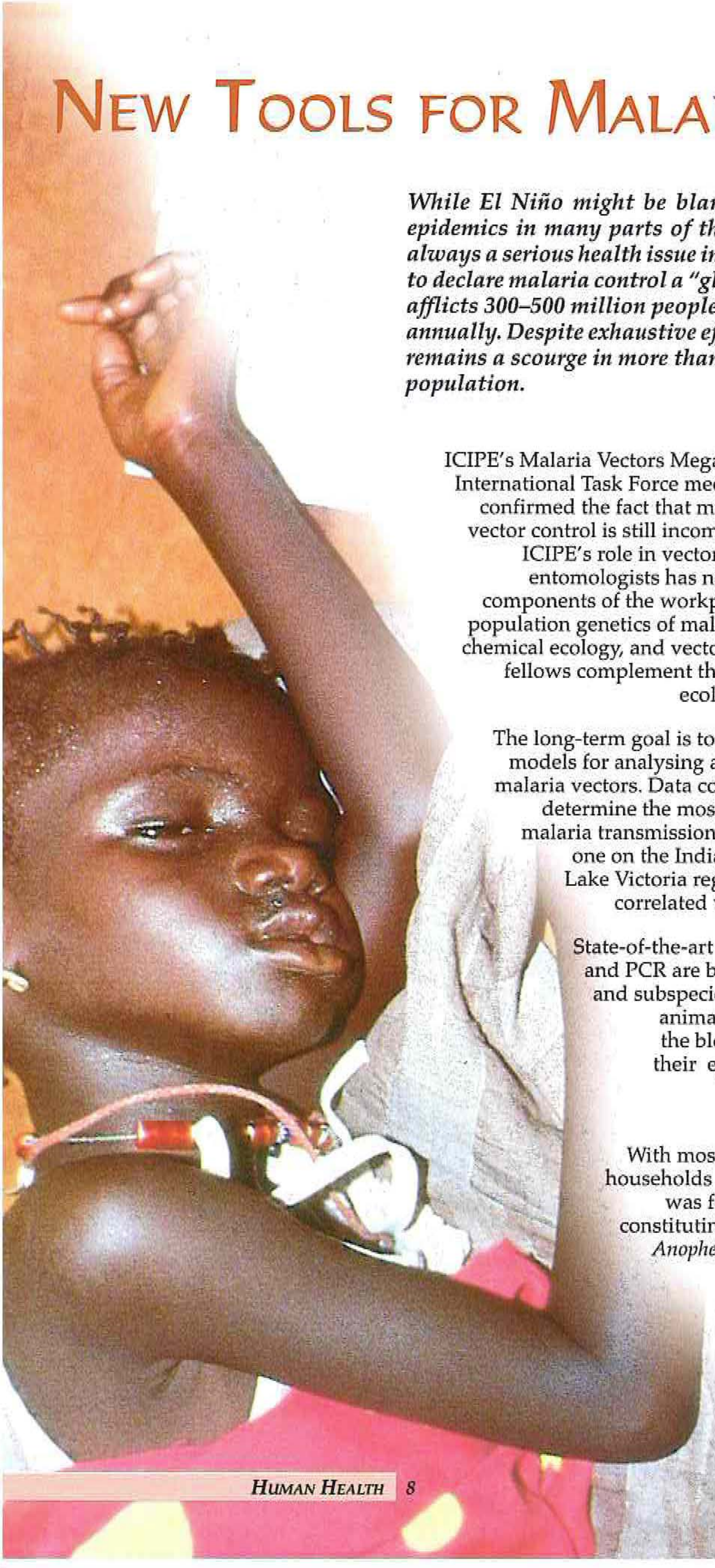
Eritrean Ambassador to Kenya, H.E. Mr Ghirmai Ghebremariam (2nd left) signs the ICIPE Charter. Participating in the ceremony are ICIPE's Director General, Dr Hans R. Herren (left), Kenya's Hon. Kalonzo Musyoka, Minister for Foreign Affairs (right) and Mr Sammy Kipngetich Kirui, Head of Legal Division (2nd right). Eritrea became the 11th country to sign the ICIPE Charter.

Farmers' groups from Uganda, Tanzania and Kenya joined ICIPE in celebrating the 50th Anniversary of IFAD in September. IFAD is funding the Centre's research and development of sericulture and improved apiculture for Africa. Here, farmers look at the reeling and twisting of the silk thread from home-grown cocoons.

The Ambassador of the United States to Kenya, H.E. Ms Prudence Bushnell visits ICIPE's research station at Mbita Point on Lake Victoria. *Desmodium*, a useful intercrop for striga control, can be seen on the left.

Left: ICIPE International Headquarters, Duduville

NEW TOOLS FOR MALARIA CONTROL



While El Niño might be blamed for the unusually severe malaria epidemics in many parts of the world over the past year, malaria is always a serious health issue in the tropics and reason enough for WHO to declare malaria control a "global priority". This debilitating disease afflicts 300–500 million people and reaps as many as 2 million deaths annually. Despite exhaustive efforts over the past five decades, malaria remains a scourge in more than 90 countries holding 40% of the global population.

ICIPE's Malaria Vectors Megaproject was launched in 1996 following an International Task Force meeting of mosquito and malaria experts who confirmed the fact that much of the information needed for effective vector control is still incomplete. The meeting unanimously endorsed ICIPE's role in vector research, and a core team of six PhD-level entomologists has now been assembled to work on the various components of the workplan: vector ecology and eco-epidemiology, population genetics of malaria-carrying mosquitoes, behavioural and chemical ecology, and vector–parasite relationships. Two postdoctoral fellows complement the team through studies on mosquito larval ecology and ethnobotany and phytochemistry.

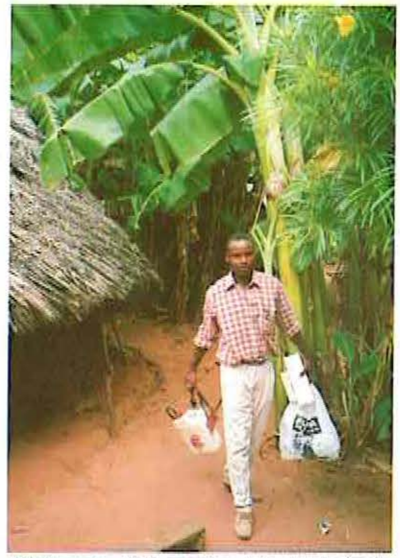
The long-term goal is to develop new tools for malaria control and models for analysing and predicting countrywide distribution of malaria vectors. Data collection began in June 1997 with studies to determine the mosquito species composition, abundance and malaria transmission intensity in two ecologically distinct sites, one on the Indian Ocean coastal plain and the other in the Lake Victoria region. Field catches of mosquitoes are being correlated with malaria prevalence in schoolchildren.

State-of-the-art techniques such as ELISA and cytogenetic and PCR are being used to identify the mosquito species and subspecies, the kind of parasites they carry and the animals on which the females have fed to obtain the bloodmeal necessary for the development of their eggs. The genetic structure of the mosquito population is also being studied using microsatellite markers.

With mosquito numbers of up to 190 found in some households around the Lake, not surprisingly malaria was found to be the leading cause of morbidity, constituting 42–48% of all illnesses in 1995 and 1996. *Anopheles gambiae* was determined to be the most common vector species, followed by *An. funestus*. The former species had about twice the sporozoite infection rate, however, at 13.5% (80/594), confirming that *Anopheles gambiae* is the most important vector in the region.

Where do these mosquitoes breed? Knowledge of breeding sites gained by studies of ecological factors necessary for larval growth and survival such as water chemistry, nutrient supply and natural predators will be used to target control operations. Instead of the notoriously persistent organochlorine pesticides like DDT and the ultra-expensive newer biodegradable chemicals, ICIPE will be using its Mbita Point Field Station on the Lake to test cheaper, more benign control agents such as *Bt* (*Bacillus thuringiensis*), insect growth regulators, and other biological control agents under development here and elsewhere. These will be used in a preventive approach to curtail vector breeding before it gets out of hand. Traditional methods of mosquito control, including the use of repellent plants and use of impregnated bednets will also be tested and promoted where applicable. ICIPE is looking for partners, collaborators and donors to participate in the fight against this most serious vector-borne disease.

Anopheles gambiae, a mosquito character in the play *Mosquito Mask* with a public health message.

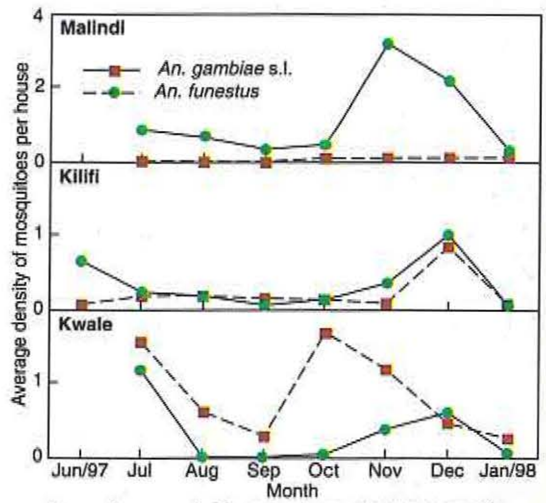


ICIPE scientist carries his trademark trapping devices for monitoring mosquito numbers, species and vector potential. Such information will be used to predict countrywide distribution of these disease vectors.

Public health awareness is being tackled at the school and community level, and a multi-media approach was launched in November when *Mosquito Mask*, a play emphasising the role mosquitoes play in disease transmission, was staged in rural secondary schools. Methods for both vector and disease control were stressed for the young audience. This educational drama is enjoying runs in several venues and has to date won four national awards at district and provincial levels.

ICIPE's Neem Awareness Project (see page 19) is promoting the use of this traditional Indian malaria remedy in western Kenya. Neem is being taken by an increasing number (36%) of the 175 households surveyed as an infusion of the bark, leaves or roots, by inhalation of the leaf smoke or as a concoction of neem seed powder. The communities in this malaria-endemic region are expressing the need for alternative approaches to malaria control.

Donors: DANIDA, OPEC



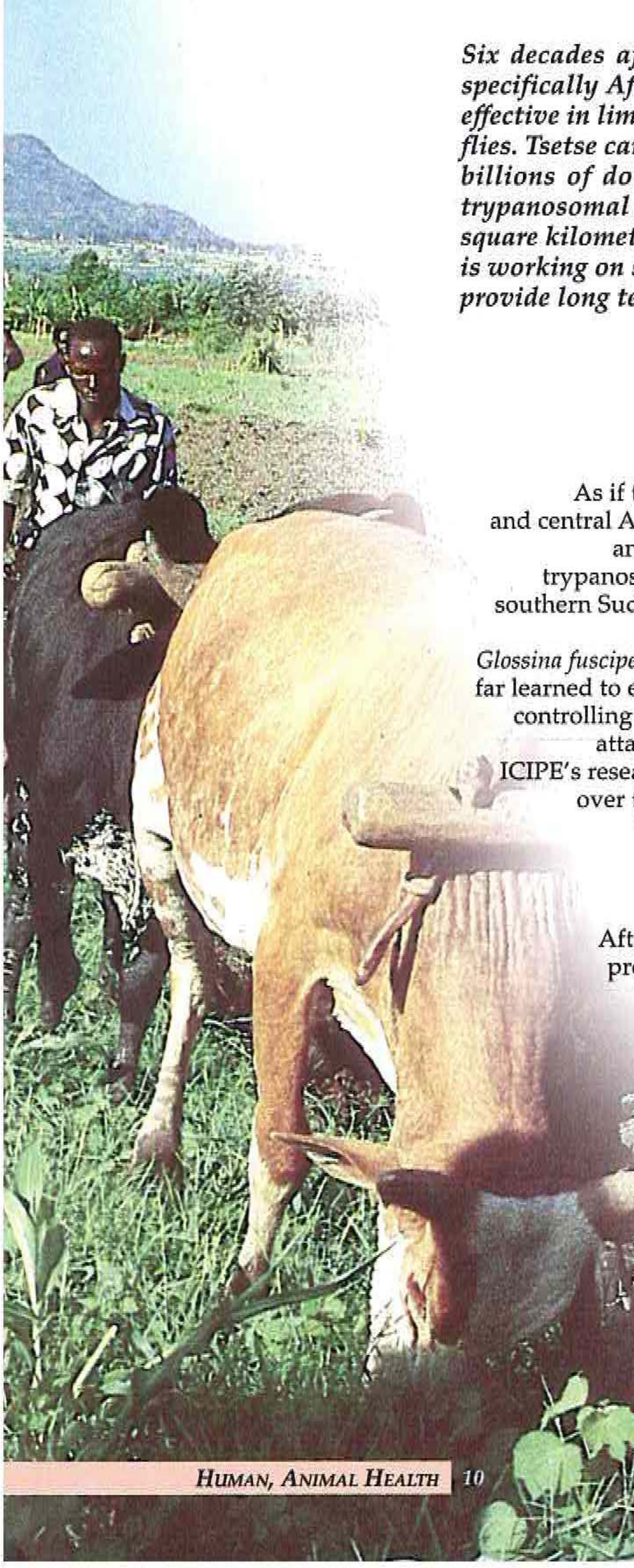
Mosquito populations in three districts on the Indian Ocean coast.

AND A REMEDY FOR THE COMMON FLY

Filth flies are among the most ubiquitous of disease vectors, but reach staggering numbers in areas where there is poor sanitation and refuse disposal. 'Dudustop' (*dudu* is the Kiswahili word for insect) was developed in collaboration with Oy GAC Ab, a private Finnish firm and is being produced on a small scale in the ICIPE laboratories with donor support. The UNHCR have been one of the most important consumers, purchasing it for use in pit latrines in refugee settlements in northern Kenya and Ethiopia. The preparation has also been successfully used in high-density living areas around Nairobi city. The *Bt* slurry is poured down pit latrines, and exerts a specific toxic effect on fly larvae (other ICIPE *Bt* formulations are mosquito- or stemborer-specific). This and other *Bt* biopesticides are slated for production in the ICIPE Technopark (see page 29).

Left: Global warming and other meteorological phenomena such as El Niño are expected to increase the risks of malaria and other vector-borne diseases. The effects are already evident in the tropics and may soon be felt in more northern climates.

TSETSE—NEW SOLUTIONS TO AN OLD AFRICAN PROBLEM



Six decades after researchers turned their attention to these most specifically African disease vectors, no single method has yet proved effective in limiting the devastation of this scissored-winged group of flies. Tsetse carry human sleeping sickness and cause annual losses of billions of dollars in livestock through the effects of nagana, the trypanosomal disease they carry. Chemical control over the 10 million square kilometres of the tsetse range is out of the question, but ICIPE is working on several innovative, non-chemical approaches that may provide long term, sustainable solutions.

HUMAN SLEEPING SICKNESS REARS ITS UGLY HEAD

As if their lot in life were not already difficult enough, the eastern and central African states, many of which are located amidst civil conflict and social disruption, are home to the tsetse vectors of human trypanosomosis (sleeping sickness). Recent outbreaks such as that in southern Sudan of this often-fatal disease indicate a worsening situation.

Glossina fuscipes fuscipes is one of the riverine species of tsetse that has thus far learned to evade most trapping devices that have proved successful for controlling the savanna group of flies (see following pages). This insect attacks humans and their domestic animals near watering sites. ICIPE's research in biological, behavioural and chemical ecology studies over the past several years is beginning to reap benefits. The fly's vulnerability centres around its predilection for the monitor lizard, *Varanus niloticus niloticus*, a large reptile found living in river banks.

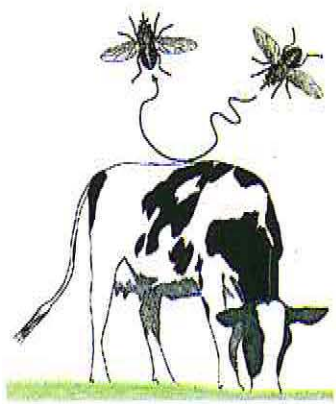
After identifying and characterising the kairomones (chemicals produced by one species that attract another) from the lizard's body and urine, detailed behavioural studies with the individual components and/or blends have continued this year, and the straight-chain aldehyde (C_{10}–C_{12}) active ingredients have been packaged in controlled-release containers for testing. These are being stabilised with commercial antioxidants. Preliminary field evaluations on Rusinga Island (on Lake Victoria) and in Ethiopia indicate that these aldehyde 'baits' increase the catches of *G. fuscipes fuscipes* 2- to 3-fold. The higher boiling constituents appear to have a role as short-range contact arrestant (i.e. repellent-acting) signals. This year, design of a purpose-built lizard house assisted in testing the feeding response of the flies. Work is continuing on improving the olfactory baits to be used in traps for this group of riverine flies which is also common throughout much of West Africa.

Repellents to keep the flies at bay

One new addition to ICIPE's tsetse control arsenal is a fly repellent (now under patent application) that can be used to protect cattle directly from *Glossina pallidipes*, the most important species in the African savanna. Alternatively, it could be used in barrier systems or in combination with a bait (attractant) to push and pull tsetse from specified areas, within a village setting, for instance. The repellent's efficacy is evident from the fact that it can bring about reductions in trap catches by more than 80%. The repellent is so strong that even when a visual (and odiferous) target such as a live cow is present, the catches are still lower by 70% than in controls where the repellent is missing. The substance also lowers tsetse feeding on cattle.

Odours from the monitor lizard, preferred host of one tsetse species that transmits human sleeping sickness and animal trypanosomosis, can be used to attract the flies to traps.

Waterbuck are another animal source of allomones. The animal's skin sebum (oil) and whole body volatiles show different levels of repellency to *Glossina pallidipes* and another fly, *G. morsitans morsitans*, showing once again how complex tsetse control is in the field. Thus far, over 13 GC-EAD-active compounds have been detected in the buck's secretions, of which eight have been chemically characterised.



Repellents applied onto cattle's skin can be used to deter biting tsetse flies. ICIPE are investigating several compounds for use in this way.

Nursery-natics

Most species of flies lay thousands of eggs, and this example of nature's 'wastefulness' can be used to advantage in fly control by locating and treating wellknown egg-laying (oviposition) sites with control agents. The tsetse, however, is a supremely specialised fly, each female tsetse giving birth to a single live larva only three times on average in her lifetime. Locating the nursery sites under rotting vegetation or in moist soil where the females lay their eggs would be a gargantuan task, but for the fact that ICIPE scientists have isolated a chemical pheromone secreted by the emerging larva that serves to attract other gravid females to the favourable nursery sites. Field tests on this substance against *G. morsitans morsitans* are still underway in Zimbabwe in collaboration with RTTCP. The larviposition pheromone, a 15-carbon hydrocarbon (*n*-pentadecane), could be used to lure the females to areas where an insect pathogen or other control method is employed. Larvae of *G. pallidipes* are also being screened for volatile chemicals that could serve as attractants for expectant females of this species, and thus far, three GC-EAD active compounds have been characterised.

Whole-body volatiles from this waterbuck are being collected with special collars for testing as repellents for tsetse. Wildlife constitute important hosts and non-hosts for these flies, but the waterbuck is less attractive than many species, a feature which is being investigated.

The necessity of testing such novel approaches to tsetse control in the field became particularly apparent this year, as the laboratory-reared flies appear to have lost their sensitivity to many natural odours. ICIPE is looking for support to continue in the search for a solution to Africa's massive tsetse problem.

Lethal insect technique— A new concept for tsetse control

The 'trap and kill' strategy is currently the most commonly employed method for non-chemical control of tsetse. ICIPE is working to improve on this basic technique by introducing a specific insect pathogen into the traps. Called the 'lethal insect technique (LIT)', the procedure entails exposing both male and female flies to a fungal pathogen such as *Metarhizium*

Left: Humans and animals live closely with nature in Africa, and both suffer from diseases carried by the bites of arthropods such as tsetse, biting flies and ticks.

Spread of a fungal pathogen among tsetse: Percentage of *Metarhizium anisopliae*-infected flies (*Glossina morsitans morsitans*) dying*

Matings	'Donor' mortality (%)	'Recipient' mortality (%) 1st mates	2nd mates	3rd mates	4th mates
Infected male 'donors' with uninfected female 'recipients'	100	70.0	65.0	60.0	20.0
Infected female 'donors' with uninfected male 'recipients'	100	80.0	72.5	57.5	45.0
Control: Male and females both uninfected	0	0.0	0.0	0.0	0.0

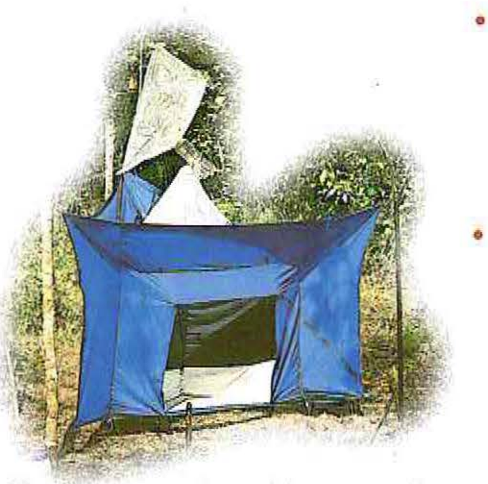
*Three replicates of 10 flies each. Each 'donor' fly was allowed to mate four times.

anisopliae or *Beauveria bassiana*. This can be done in a special contaminating device attached to a conventional tsetse trap in the wild or in mass-rearing facilities. Preliminary studies have shown that one contaminated insect can transfer the fungal conidia to four healthy mates during courtship or mating. The LIT has the advantage over the sterile insect technique (SIT) in being cheaper, less technically demanding (SIT requires nuclear irradiation facilities and aerial release of sterile males), sexually non-selective (SIT is used on male flies only), and applicable over a wider environment (SIT has thus far been used most successfully in the contained island situation of Zanzibar). ICIPE has made important advances in mass rearing of tsetse (*Glossina austeni* and *G. f. fuscipes*) this year, and this should allow the production of contaminated flies *in vitro* for eventual mass release into the wild for speedier spread of the pathogen. In preparation for large-scale field trials, populations of *G. f. fuscipes* (see page 10) are being monitored on two other tsetse-endemic islands, Mfangano and Rusinga, on Lake Victoria.

Substituting or alternating the fungus with an insect growth regulator (IGR) is another variation of the LIT being tested, and field tests show that flies exposed to triflumuron directly or indirectly suffer reproductive impairment even if the contaminating device has been in the field for a month.

Community-based trapping

Over the past decade, ICIPE has specialised in developing low-cost cloth traps that mimic animals shapes and attract the flies into chambers where they are killed by the heat of the sun. Odour baits are used to improve the efficiency and attract the flies from longer distances. One model, the NGU trap has now been tested in several ecozones and among different-structured communities:



The S3 trap, one of several traps currently being tested in Ethiopia for catching *Glossina morsitans submorsitans*. This species avoids most current trap designs.

- among the agrarian communities in the Lambwe Valley, on the eastern shores of Lake Victoria, a region notorious for the intractability of the tsetse problem. Trapping has effectively reduced the flies to only 0.1% of their former levels and has resulted in opening up large tracts of new land for agriculture and habitation. The community are now completely managing the trapping activity, including construction, placement, servicing and financing.
- among the agropastoral community in Nguruman, in Kenya's Rift Valley. The trapping technology was officially handed over to the local herdsmen in late 1996 and ICIPE are continuing with studies on the adoption and impact of the trapping technology. The semi-transitory nature of this society has made it more difficult to transfer the trapping technology than was originally anticipated.
  One encouraging recent observation is that 18 individuals in an area adjacent to the study site have followed their neighbours' example and have made 53 traps to place around their homesteads.
  The obvious need for continual trapping in this region was made evident by a major experiment conducted this year to test the components of a barrier system. During the one month when odour-

baited barrier traps were deployed around the study site, over a quarter of a million flies were captured.
- among the Ethiopian communities in the southern states of Oromia and Tigrai. 1997 saw the placement of over 500 additional traps to the existing 1000 or so in the 100-km^2 test site. The Gurage community are planning to install an additional 2000 traps with money raised from cultivating teff. These will be in addition to another 2000–3000 traps to be supplied by the regional agricultural bureau.

ICIPE is convinced that this important work in developing and refining the basic trapping systems should continue as an essential element in improving the nutrition and health of the people, their livestock and wildlife. The Centre is eager to respond to more communities' requests for assistance when funding permits.

Farmers in the Lambwe Valley learn to construct a tsetse trap during one of ICIPE's numerous training seminars.

Capacity building for tsetse and trypanosomosis professionals was very active over the past year, with four PhD students in training under the ARPPIS programme and 12 senior staff from Uganda, Tanzania, Kenya and Ethiopia trained, as well as a workshop for 100 Ethiopians earlier in the year at Axum.

Basic research provides technologies for testing

This past year, ICIPE continued with the basic research on tsetse biology and trapping behaviour vital for improving control programmes:

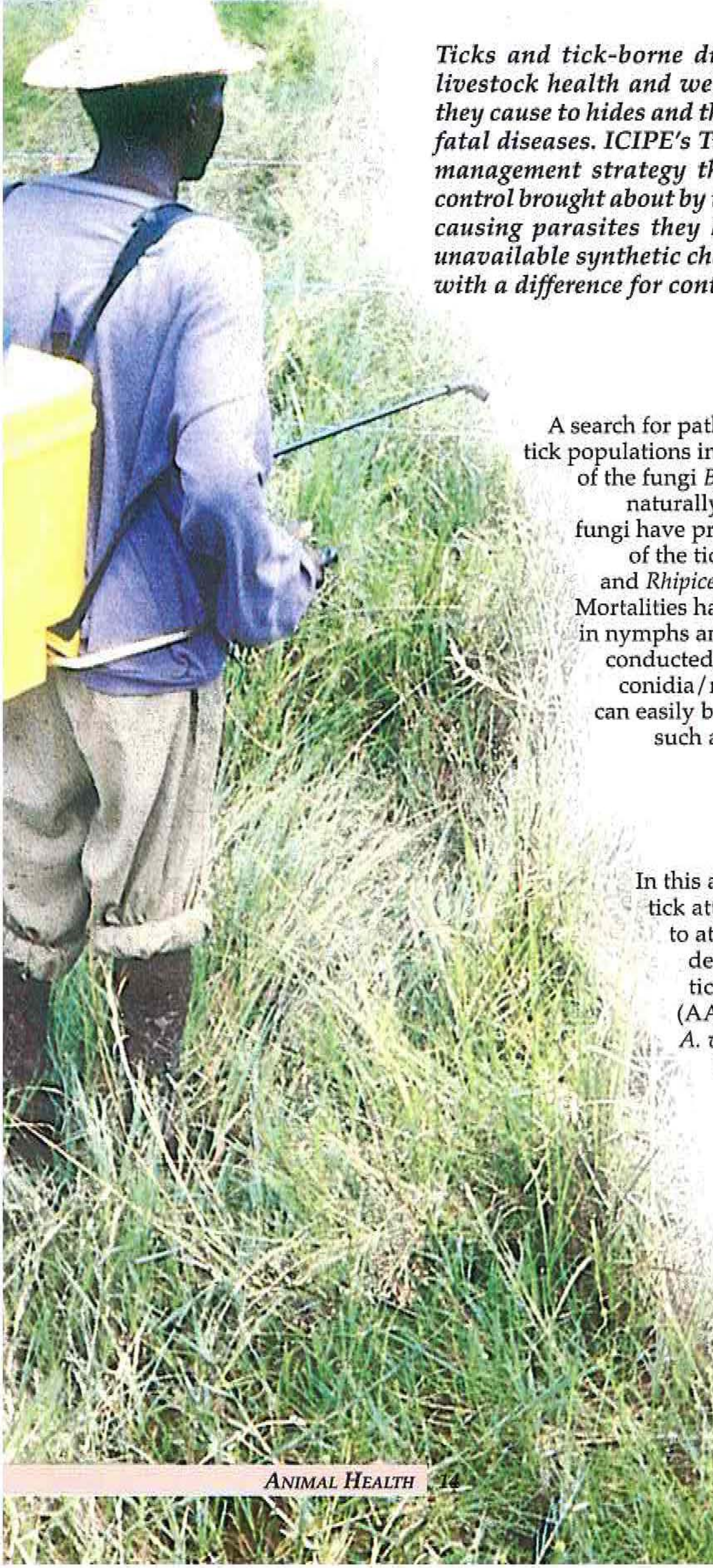
- Development of trap designs for *G. morsitans submorsitans* in Ethiopia. This fly is only one-tenth as responsive (3%) to the classic triangular blue and black trap designs as *G. pallidipes* (30%).
- Evaluation of stronger materials such as blue-dyed sisal in lieu of blue cotton for use in traps.
- Testing of barrier systems to prevent immigration of flies into areas cleared of tsetse, and use of repellents and odour baits.
- Assessing the economic cost–benefits of community-based programmes.
- Development of an ELISA system to identify blood meals from about 30 tsetse host species. This is ready for field use.
- Characterisation of the lectin–trypsin complex from the tsetse midgut. Characterisation was completed this year. This complex helps determine whether or not a given fly will become infected with the *Trypanosoma* parasites and therefore how good a disease vector the fly can be. A second molecule purified this year can cause the destruction of the bloodstream trypanosomes. The trypanolysin is a high molecular-weight protein (M_r~500,000).
- Improvements in the statistical analysis of tsetse data, e.g. for estimating trap efficiency, better experimental design and interpretation of results. Issues addressed include importance of space x time interactions, efficiency of the Latin square design and methods for accounting for flies that escape the traps.

The semi-pastoralist Nguruman community during the handing over ceremony of the tsetse trapping technology.

A section of the Lambwe Valley community participating in the trapping programme.

Donors: **European Union, Austrian Government, ICIPE Core Fund donors**

Turning Off the Tick Time Bomb



Ticks and tick-borne diseases pose one of the greatest threats to livestock health and well being. Apart from the mechanical damage they cause to hides and the pain to animal flesh, ticks transmit several fatal diseases. ICIPE's Ticks Megaproject is developing an integrated management strategy that will overcome the current crisis in tick control brought about by the growing resistance of ticks and the disease-causing parasites they harbour to the expensive and often locally unavailable synthetic chemicals. Below are described a few strategies with a difference for controlling this ticking time bomb!

Tick pathogens

A search for pathogenic microorganisms that can be used to keep tick populations in check has resulted in the isolation of two strains of the fungi *Beauveria bassiana* and *Metarhizium anisopliae* from naturally infected ticks. The oil-based formulations of the fungi have proved effective in controlling the immature stages of the ticks *Amblyomma variegatum* (vector of heartwater), and *Rhipicephalus appendiculatus* (vector of East Coast fever). Mortalities have been recorded of 100% in the larvae, 70–100% in nymphs and 63–97% in adults. In field tests currently being conducted, a water suspension containing the fungus at 10^8 conidia/ml is sprayed on the grass in a pasture. The fungi can easily be grown using cheap, locally available substrates such as rice, maize and other grains (see *1996/97 ICIPE Annual Report*).

Pathogens plus

In this approach, the pathogen is combined with natural tick attractants such as pheromones and CO_2 that serve to attract the ticks to the fungus-contaminated site. A device has been made which, when baited with the tick attractant-aggregation- attachment pheromone (AAAP), attracts unfed adults of the variegated tick, *A. variegatum* to a site containing a lethal cocktail of both the above fungi. About three-quarters of all the ticks released in field tests succumbed to the fungal infection.

Anti-tick vaccine

The dream of many entrepreneurial biology researchers is to develop a vaccine to combat a specific disease. ICIPE scientists have been following leads from the observation made some years ago that antigens from the guts of the brown ear tick, *R. appendiculatus* and *Boophilus microplus* protect rabbits and cattle against subsequent infestations of the respective tick. The protective substances appear to be glycoproteins, which to complicate matters differ in chemical nature depending on whether they are collected from laboratory-raised ticks or from those in the field. The method of preparation of the glycoprotein also results in differing degrees of protection. ICIPE molecular biologists are therefore looking at the best methods for preparing these protective substances. Once enough of the antigenic glycoprotein is available, it will be tested in immunisation trials.

Other aspects of ICIPE's tick research are highlighted below:

- **Natural enemies:** The seemingly impervious leathery sack of the tick body can be effectively penetrated by a tiny wasp, *Ixodiphagus hookeri*. As reported previously, this little parasitoid can bring about mortalities in *Amblyomma variegatum* of up to 80%. The limitation to this method of control has been the difficulty in raising enough of the wasps for an effective mass release operation. Progress has been made this year in raising the wasps on artificial media. Host tick haemolymph appears to be a vital ingredient in either the liquid media used for the pupal stages or in the moist agar found optimal for the later stages.
- **Tick ecology:** Most ticks have a complex life cycle, with some species finding it necessary to live part of their life stages in three different host animals. Ecological field studies on *R. appendiculatus* and *A. variegatum* were carried out in two sites, to validate the 3-host tick model developed by Australian scientists.Tick experts from six East African countries and two Australian modelling experts gathered at ICIPE to evaluate the model.
- **Tick population genetics:** Genetic differences in 11 different populations of *R. appendiculatus* in terms of its ability to transmit the East Coast fever parasite, *Theileria parva* are being studied. Genetic markers that can link the vectorial capacity to the specific tick population are being identified using the RAPD-PCR technique. This information might one day be useful in breeding out ability to carry the disease-carrying parasite.

A heavy infestation of *Boophilus microplus*, vector of redwater and gall sickness. Cattle sometimes endure a tick-load of several thousand of these pests, leading to severe blood loss and greater susceptibility to infection.

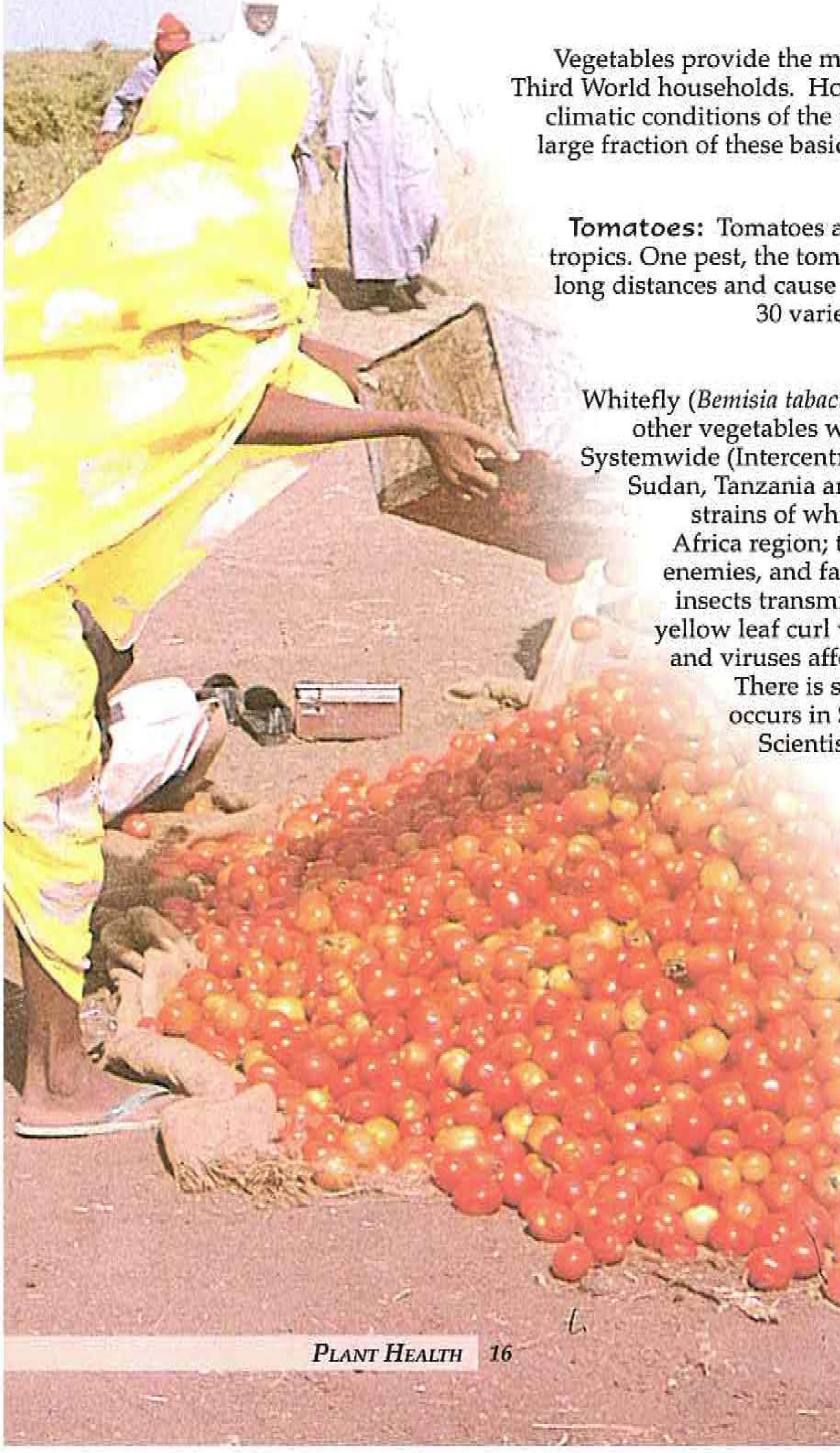
- **Neem for tick control:** Neem oil (25%) applied directly to the skin of animals serves to repel all stages of three species of ticks (*R. appendiculatus, A. variegatum* and *Boophilus decoloratus*) and also serves as an antifeedant. The deterrence of tick attachment could be especially important for the latter species, since it is a one-host tick and the larva is the only host-seeking stage. Other neem formulations will be tested in multilocational field trials.

Donors: ICIPE Core Fund donors, ACIAR, Toyota Foundation

Left: A simple knapsack sprayer can be used to apply a suspension of a fungal tick control agent. The fungus is cheap and can be easily grown using locally available raw materials.

Boosting Horticulture Health

Horticulture is one of the fastest growing industries in the tropics. However, production techniques are often rudimentary, with many important agricultural aids like improved seed, fertilisers, irrigation and farm machinery lacking. The warm tropical environment also gives rise to vast numbers and varieties of insect pests. ICIPE is looking at new IPM solutions to increase production of the valuable vegetable, fruit and flower crops for export and local consumption.



Vegetables provide the main source of proteins and micronutrients for Third World households. However, very few cultivars adapted to the wet climatic conditions of the tropics are available, and most farmers lose a large fraction of these basic staples to pests. Below are highlights of the new IPM approaches ICIPE is developing:

Tomatoes: Tomatoes are a popular, yet difficult crop to grow in the tropics. One pest, the tomato fruit borer, *Helicoverpa armigera* can move long distances and cause high losses. ICIPE researchers have screened 30 varieties for tolerance to this pest, of which three are promising: 93 K79-1, 93KT 10 and Heinz.

Whitefly (*Bemisia tabaci*) is an important pest of tomatoes and many other vegetables worldwide. ICIPE is coordinating the CGIAR-Systemwide (Intercentre) Global Whitefly IPM Initiative in Malawi, Sudan, Tanzania and Kenya to map the distribution of species/ strains of whiteflies occurring in the eastern and southern Africa region; the project also seeks to identify their natural enemies, and farmers' knowledge and control practices. The insects transmit several plant viruses, including the tomato yellow leaf curl virus (YLCV) (observed in all four countries) and viruses affecting okra (seen in Sudan) and watermelon. There is some evidence that the 'B' biotype of *B. tabaci* occurs in Sudan, and likely in Egypt and South Africa. Scientists in the region are being trained in whitefly taxonomy and use of molecular identification techniques.

Onions: Onions are a major vegetable crop in Africa, with over 2.25 million tonnes produced annually. Farmers routinely spray against pests, especially the onion thrips, *Thrips tabaci* without actually knowing if the pest level is high enough to cause economic 'injury' or serious yield loss. This year, the economic threshold level has been determined and such knowledge should help farmers in knowing exactly when to apply a control agent. The thrips are susceptible to a new fungal control agent, Metathripol (see page 19).

Cabbage and collards: The diamondback moth (DBM), *Plutella xylostella*, a notorious pest of cabbage and kale crops worldwide, has become resistant to all known insecticides. Yield losses in these brassicas from DBM in East Africa can reach as high as 40% in cabbage and over 50% in collards (kale). New IPM components being tested at ICIPE include the use of *Bt* and neem, both of which give acceptable levels of control (see below). Intercropping cabbage with onion is to be recommended for its high yield of both crops (land equivalence ratio of 1.7). Another kind of intercropping being promoted is that of cabbage (a 'European' vegetable), with indigenous vegetables. Intercropping *Gynandropsis gynandra*, an indigenous East African vegetable, with cabbage in row ratios of 1:1 effectively lowered the numbers of DBM larvae/pupae from 79 to 42, over 50%.

Whitefly on bean leaves. ICIPE is coordinating research on this pest in eastern and southern Africa as part of a global initiative.

Trials using neem to control DBM have shown that the pest can be controlled within 3 weeks using an ultra-low volume spray application of 20% neem seed extract. The neem is also proving effective against another cabbage pest, the aphid *Brevicoryne brassicae*. Neem cake powder (NCP) water extracts applied at the rate of 50 g aza/ha and neem oil (1,2%) had an aphicidal effect.

Donors: ICIPE Core Fund donors, GTZ

Export vegetables

French beans is a popular export vegetable that must meet the very high pesticide residue standards set by importing countries. Neem, a natural botanical harmless to humans, is being tested for control of the important bean pest *Aphis fabae*. Neem oil EC (3%) is as effective in reducing aphid numbers when applied as a foliar spray as is the insecticide Karate, and is significantly superior to seed dressing with another insecticide, Gaucho (see table).

Estimates from Kenya put yield losses from pests in okra, capsicum and eggplant at 40, 15 and 32%, respectively. Neem seed treatment is also being tested on okra and bittergourd (karela). ICIPE has identified one pest-tolerant okra cultivar out of seven tested, and other genotypes are currently being tested.

Left: Women in the Sudan harvest tomatoes. Sudan is successfully using IPM, particularly for vegetables, wheat and cotton.

In an effort to increase farmers' awareness of the need to find alternatives to pesticides on export produce, ICIPE is cooperating with extensionists in Kenya's Ministry of Agriculture in the Nguruman area, an emerging site for horticultural activities. The problems of the industry were reviewed in a national stakeholders meeting, which was attended by researchers, extension agents, farmers and exporters. The most promising components available for improved pest management were covered at this meeting and again at a training course organised by ICIPE and the Horticultural Crops Development Authority (HCDA) for 20 horticultural extensionists. The latter group identified the IPM options which they would like to see demonstrated and tested.

Donors: GTZ, USAID

Neem approaches pesticide performance for aphid control in French beans

Treatments	Mean number of pods/plant[1]	Total fresh pod weight (g)/plant
Karate (2 ml/l)	10.3 c	1044
Neem oil EC (3%)	9.3 c	959
NCP/WE[2] (50 g/l)	6.2 b	906
Gaucho (8 ml/kg)	5.0 b	578
Control	3.3 a	60

[1]30 plants per treatment. Plants were artificially infested with 20 aphids per plant in a screenhouse.
[2]NCP/WE = neem cake powder water extract.
Means followed by the same letter are not significantly different at the 5% level.

The African fruit fly initiative

Although travellers to Africa marvel at the variety and flavour of its fruits, production of this valuable export commodity remains largely an unexploited opportunity. The reason is twofold: excessive fruit fly damage and lack of

Farmers learn techniques for producing clean banana planting material.

expertise. ICIPE is responding to requests from East African fruit growers to address the first problem through the African Fruit Fly Initiative, an integrated programme for applied research, technology adaptation and capacity building. East Africa has been chosen as the first region for implementation because of its strong economic links, emerging entrepreneurship and rapidly growing domestic fruit market.

ICIPE has done much of the exploratory research on assessing the economic role and distribution of African fruit flies, and searching for their natural enemies. Preliminary samplings from Kenya and the fruit-rich islands of Pemba and Zanzibar of Tanzania show that there is a complex of fruit flies present. The mango fly, *Capititis cosyra* is the major pest of mango in most areas, causing losses of 30–40% on average, with the Natal fruit fly, *C. rosa* and the medfly, *C. capitata* also important.

Fruit flies are global pests, and ICIPE is collaborating with over 14 other organisations worldwide. One such effort seeks to discover natural enemies for use in biological control programmes. Shipments of infected fruit to Hawaii has yielded 527 parasitoids, from which one species has been cultured and sent to Guatemala for evaluation against the medfly in that country.

To address the second issue of lack of local expertise, ICIPE are beginning to train African scientists through the ARPPIS programme (see Capacity Building on page 30) in fruit fly studies. A PhD student from Sudan is studying the biology of parasitoids of these insects.

Donor: IFAD

Banana

Young banana farmer on her way to market.

This diverse crop is used as a sweet fruit, for brewing and as an important starchy staple for millions of people in the tropics. In East Africa, the banana weevil, *Cosmopolites sordidus* is a serious pest that can cause severe loss of crop. ICIPE's past work on banana is now yielding its own fruit. A method for producing clean planting material using a split corm and hot water cleaning procedure is being transferred to farmers in the region; thus far over 8000 pest-free planting materials have been supplied.

Neem is proving an effective method for controlling the weevil. Treating the pseudostems with neem oil (1–5%) inhibits the growth of weevil larvae up to 14 days. Neem repels the insects, and treated corms show less than 5% weevil damage. In preliminary trials, three neem treatments per year appear sufficient to adequately protect banana plants from attack by both *C. sordidus* and nematode pests.

To support the banana IPM activities, studies on the behaviour of the weevil continue. These long-lived insects feed exclusively on banana, and have few natural enemies. They are difficult to control with insecticides because of their secluded lifestyle. ICIPE's approach to control of this destructive pest is to lure the weevils to an artificial device for a sufficient time to infect them with a weevil-specific contagious pathogen. Studies this year have confirmed that a farm-based control operation rather than an area-wide approach may suffice.

Weevils from geographically different banana-growing regions are being studied for their genetic diversity using the RAPD-PCR method. Preliminary results show a high level of diversity between two Ugandan populations.

Donors: BMZ, Rockefeller Foundation, UNEP, Government of Finland

New pest control agents from nature

Metathripol: This new product under development at ICIPE takes its name from its fungal source (*Metarhizium anisopliae*) and its target, the thrips. Thrips are important pests of vegetables and flower crops worldwide, and also cause losses between 20–100% in flowering cowpeas and beans. Metathripol is a strain of the fungus which was selected because it is pathogenic to several species of thrips and is effective over a wide temperature range. Field tests on Metathripol applied as an aqueous suspension (at 1×10^{13} conidia/ha) from an ordinary knapsack sprayer show that it is as effective as chemical insecticides in controlling three species of thrips. Furthermore, the fungal agent does not kill the beneficial non-target organisms like insecticides do. Another strain of *M. anisopliae* has been shown to be effective against termites (see *1996/97 Annual Report*).

Donor: ICIPE Core Fund donors

Metathripol compares favourably with synthetic chemicals for thrips control

Treatment	Target crop: Cowpea		Onion		Chrysanthemum
	M. sjostedti[1]	Yield (kg/ha)	*T. tabaci*[2]	Yield (kg/ha)	*F. occidentalis*[3]
Control	472	384	2808.0	22,326	33.4
Metathripol	76	1730	13.8	26,498	11.3
Chemical	6	1826	20.5	25,748	11.6

[1]Mean no. insects/20 flowers; [2]Mean no. insects/100 plants; [3]Mean no. insects/20 cuttings.

The natural pest control agent, Metathripol, is environmentally safe to non-target organisms

Treatment	Number of organisms⁺: Coccinellid beetles	Earwigs	Ants	Spiders
Control	2.2	2.8	10.3	6.4
Metathripol	2.6	3.1	9.4	6.5
Chemical	0	0	1.3	1.2

Data collected following three applications of Metathripol and chemical insecticides in a cowpea agroecosystem.
⁺Mean of 3 samplings.

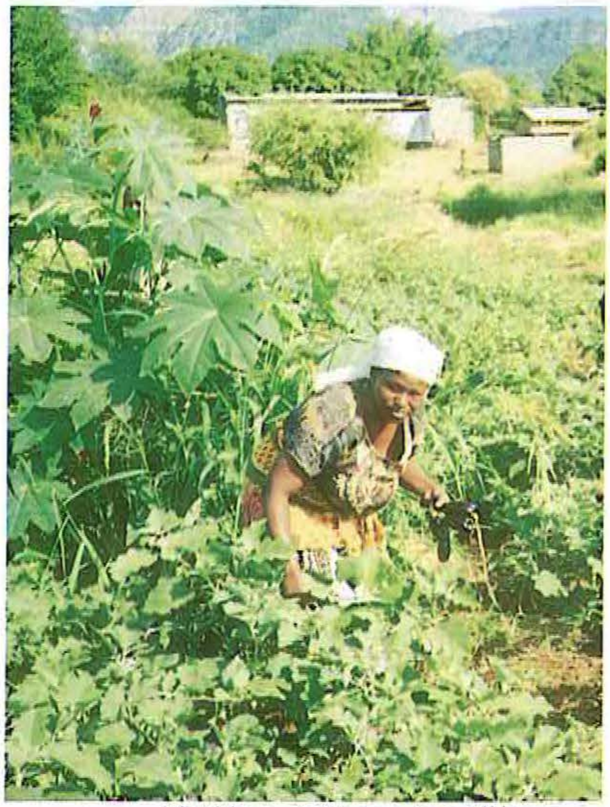
Neem

The usefulness of neem, *Azadirachta indica* has been exploited for centuries by farmers on the Indian sub-continent. Neem is non-toxic to higher animals and most beneficial insects. The technology required to produce products for smallscale farmers is simple and will be encouraged in the ICIPE Technopark (see page 29). The ability of this botanical cousin of mahogany to control stemborers, banana and vegetable pests, ticks and malaria mosquitoes has been outlined under the respective chapter headings of this report. Neem has also been shown by ICIPE and ICRAF scientists to control agroforestry pests such as root-knot nematodes (*Meloidogyne* spp.) in sesbania and termites in grevillea seedlings when applied to the soil.

Womens' and farmers' groups around ICIPE's Mbita Point Field Station are now raising neem in nurseries with seed provided by the Neem Awareness Project. At Kwimba Afforestation Project in Tanzania, neem is now being planted at the rate of half a million seedlings annually. About 600 neem workers from seven African countries have thus far been trained in intensive 2-week-long workshops, and another 200 trained in one-day seminars.

Demand for information about neem and its uses is now more than ICIPE can meet, and reflects the efforts of ICIPE's Neem Awareness Project to acquaint Africa's farmers with what Indian farmers already appreciate: neem is truly a wonder tree.

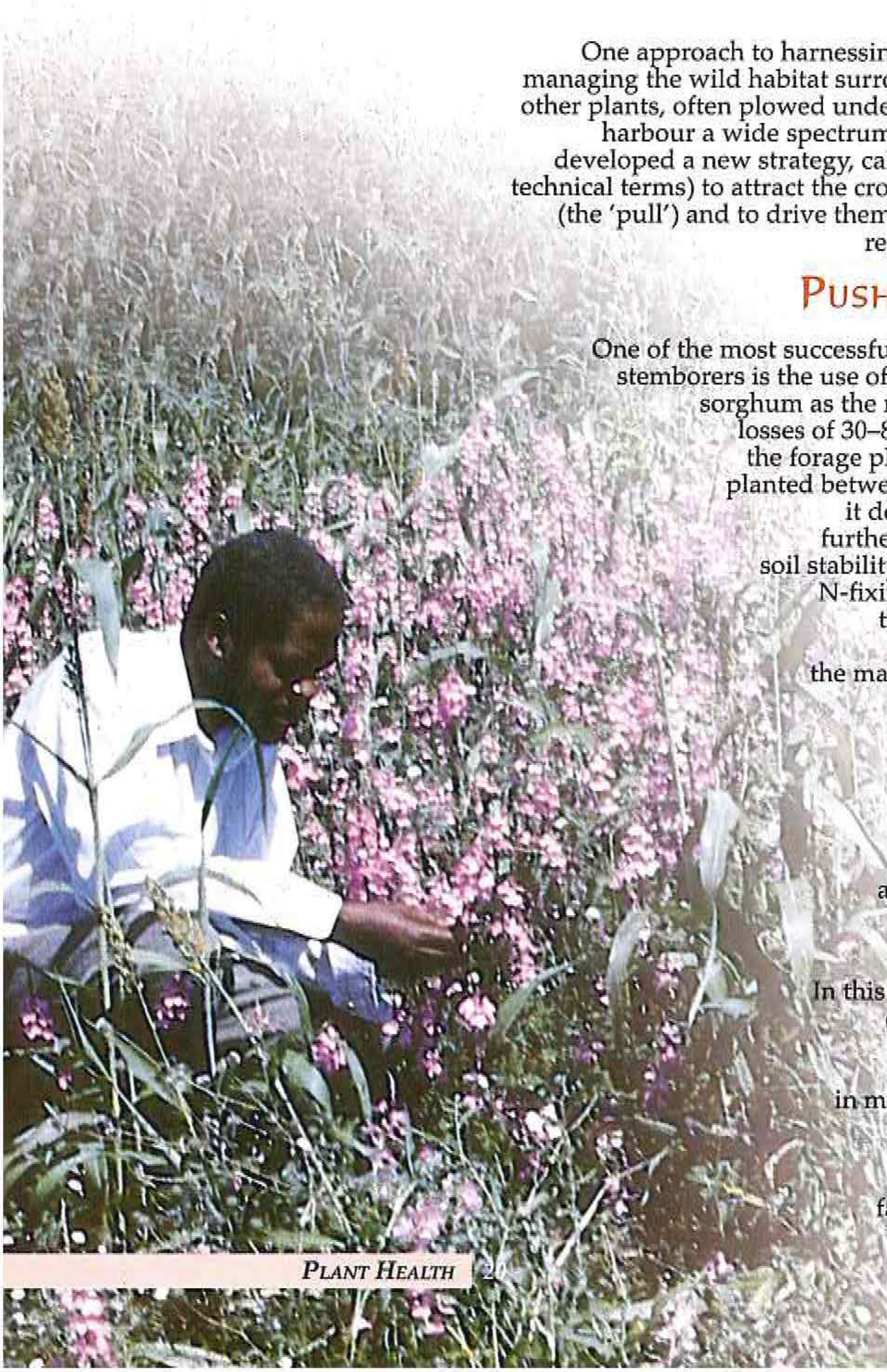
Donors: UNEP, Government of Finland



A healthy vegetable crop is possible without the use of polluting and expensive pesticides. ICIPE research is dedicated toward finding organic solutions such as use of neem and Metathripol.

Management Matters for Cereal Crop Pests

Almost no country escaped the influence of El Niño in 1997, whether it brought floods or famine. Once again, we are reminded of the power of nature to determine our well being and even to seal our fate. However, natural systems have enormous resilience and self-healing powers. ICIPE's Food and Perennial Crop Pests Megaproject is trying to use these to advantage to manage the crop pests that attack cereal crops and threaten food security, made all the more imperative in El Niño years.



One approach to harnessing nature for crop pest management is by managing the wild habitat surrounding farmland. The wild grasses and other plants, often plowed under in modern monocropping practice, can harbour a wide spectrum of the pests' natural enemies. ICIPE has developed a new strategy, called 'push-pull' (or 'stimulo-deterrent' in technical terms) to attract the crop pests to a highly susceptible trap plant (the 'pull') and to drive them away from the main crop using another repellent plant as an intercrop (the 'push').

Push-pull for borer control

One of the most successful models so far to limit the damage from stemborers is the use of two plants in conjunction with maize or sorghum as the main cereal crop. These pests cause crop losses of 30–80% in many countries. As the intercrop, the forage plant *Desmodium uncinatum* (silver leaf), is planted between maize rows. Being a low-lying plant, it does not interfere with maize growth, and furthermore has the advantage of maintaining soil stability and improving soil fertility through its N-fixing action. Silver leaf's real advantage in this new cropping system, however, is its property of repelling female stemborers, the major threat to cereals in East and southern Africa. As the trap crop, Napier grass (*Pennisetum purpureum*) or Sudan grass (*Sorghum vulgare sudanense*) borders planted around the field have both been shown to attract the stemborers away from the maize for laying their eggs. These same grasses, moreover, are also home to the borers' natural enemies, which foray out into the maize field in search of the pests.

In this more diverse agroecosystem, consisting of wild and cultivated plants interacting together in many complex checks and balances, there is a significant increase in maize yield (up to 20% greater), as well as a substantial harvest of the fodder crop for livestock. This strategy fits in well with small- and medium-scale farmers in Africa, who have traditionally practised mixed farming.

Other bonuses: This year, ICIPE scientists discovered that the system above offers a further unexpected bonus: *Desmodium* species (*D. uncinatum* and *D. intortum*) were found to reduce infestation by *Striga hermonthica*, a parasitic weed which is a serious pest of cereals in Africa. The root system of the *Desmodium* appears to inhibit striga in the soil, reducing the weed by a factor of 40. On-farm trials are now in progress in Kenya to test the efficacy of this trio of Napier grass–maize–*Desmodium* to reduce yield losses from both stemborers and striga. ICIPE's social scientists are evaluating the socioeconomic aspects of this new IPM approach, which has thus far met with overwhelming interest on the part of the participating farmers.

Donor: Gatsby Charitable Foundation

Desmodium uncinatum (silver leaf) is a leguminous forage plant likely introduced to Africa from South America. Its double-barrelled effect on stemborers and striga is being used to increase maize yield.

Wasp-weapons

Stemborers are widespread pests that feed deep within the stems in their damaging larval phase, making them difficult to control with 'conventional' methods such as application of pesticides. For instance the spotted stemborer, *Chilo partellus* has spread across Africa since its accidental introduction to the continent earlier this century and is now the most important maize pest in the eastern and southern regions. Losses from this pest alone range between 20–40%.

Many African farmers do not recognise the moth-like adult and its eggs and pupae as stages in the life cycle of the pest. Surveys of the prevalence of stemborers and their natural enemies, and of farmers' traditional knowledge about their management and the levels of damage they cause are in progress in Kenya. IPM may provide the only solution, as surveys this year have shown that only a small percentage of the resource-poor farmers in the coastal region use pesticides, presumably due to their high cost and/or unavailability. ICIPE's Biosystematics Unit and its collaborators now have the capability to identify the various borer species and a reference collection of the pests and their natural enemies has been established at Duduville.

The parasitic wasp *Cotesia flavipes* laying its eggs in a stemborer larva. The emerging wasp larvae consume the borer host deep within the plant stems. Thus far, *Cotesia* has been released in four countries in eastern and southern Africa.

A tiny parasitic wasp, *Cotesia flavipes*, was introduced into East Africa by ICIPE as one possible weapon to combat the borer. In this example of classical biological control, the wasp has now spread from its original release point on the Kenya coast five years ago and is moving inland, now being observed at Kibwezi, a distance of 200 km, all the time surviving on stemborers. The wasp has now been introduced into Uganda, Mozambique and Somalia, and plans are underway to release it in Malawi, Ethiopia, Eritrea, Zambia and the island of Zanzibar by 1999.

Donors: The Netherlands Government, Rockefeller Foundation

Leafhoppers and MSV

Host plant resistance to pests and plant diseases is an IPM component that is being studied in relation to another important pest of maize: leafhoppers (*Cicadulina* spp.). These small insects transmit the maize streak virus (MSV), which causes losses of 30% of this important crop in some regions. ICIPE is collaborating with institutions in South Africa, Kenya and abroad to study the mechanism of maize resistance to the virus, and why in a uniform field of maize, only some plants become diseased. Thus far, five species of *Cicadulina* have been identified in Kenya, of which *C. mbila* appears the most widespread. New facilities for rearing type cultures of five leafhoppers species for virus transmission studies have been established at ICIPE's Mbita Point Field Station. The role of alternate hosts in the epidemiology of MSV could be important, and one wild plant, *Setaria sphacelata* appears to be favoured by two of the leafhoppers.

Donor: Rockefeller Foundation

Left: A heavy infestation of the beautiful pink witchweed, *Striga hermonthica* in this field spells doom for the sorghum crop. This parasitic weed now infests over 40% of arable land in the African savanna, and could invade another 40% within the next 10 years if left unchecked.

Desert Locusts in an El Niño Year

After several years of basic ecological and behavioural research into this global pest, ICIPE scientists are now moving into the field to test new, environmentally benign approaches to controlling the locusts, which can invade a 29 million km²-belt extending from southern Europe into Africa and the Middle East.

The changing rain patterns in its recession area of the Red Sea served to trigger unusually high levels of the desert locust, *Schistocerca gregaria* Forskal in 1997. This provided ICIPE researchers with the opportunity of field testing a new method for locust control: The adult insects produce an aggregation pheromone which keeps them together in their gregarious state, thus maintaining the swarm. This chemical signal also serves to bring any immature adults in the vicinity into sexual maturity, allowing synchronised, mass-scale reproduction.

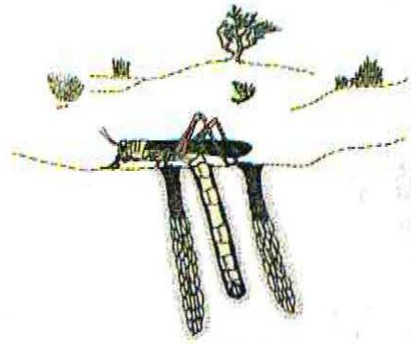
ICIPE scientists have discovered under controlled field conditions that this aggregation–maturation pheromone of the adults has a deleterious effect on the locust nymphal stages, however, and makes them especially susceptible to low doses of entomopathogens (insect pathogens) and insecticides. The treated nymphs disperse into small groups, which makes them more susceptible to predation. It is hoped that this effect should allow the emerging marching bands of nymphs, or 'hoppers', to be destroyed at costs far less than the millions of dollars it now takes to spray the vast areas involved in a locust plague.

A series of major field trials on large hopper bands in two locations near Port Sudan and Swakin in the Sudan this year confirmed the remarkable effect of the adult pheromone in causing the gregarious hoppers to revert into their solitarious mode. Similar trials will be conducted in Saudi Arabia, Eritrea, Morocco, Yemen and Oman in 1998, thanks to renewed funding for this project. In particular, the effect of pheromone in combination with biopesticides or conventional pesticides on the fate of solitarious insects will be investigated. The opposite approach will also be tested, i.e. to determine the effect of the nymphal aggregation pheromone on the susceptibility of the adult insects.

Egglaying can be a risky business!

During swarm development, female locusts lay their eggs in synchrony, thus giving rise to the hundreds of millions of insects in the swarm. Group egglaying (oviposition) has been shown to be stimulated by another group of pheromones associated with the egg pods that attract the pregnant gregarious females to sandy sites where eggs are being, or have been, laid. Observations on locust behaviour showed that the ovipositing females touch the sand with their antennae, palpi and mouthparts, and now three EAG-active compounds have been identified from this sand: (*Z*)-6-octene-2-one, (*E*,*E*)-3,5-octadien-2-one and (*E*,*Z*)-3,5-octadien-2-one. Once large enough quantities of these compounds are available, ICIPE scientists plan to test them as a lure to attract females to artificial sites contaminated with pathogens or insecticides.

One important finding this year is that females of solitarious-phase locusts (S-females)— who normally live several kilometres apart and pose no threat— are less interested in chemicals from their own egg pods, preferring instead to lay their eggs near desert plants like *Heliotropium* spp. and millet. (The former plant appears to be the key desert plant in the life cycle of this insect in the Red Sea area). However, when offered the chance to lay their eggs near the egg pods of gregarious females (G-females), the S-females choose to do so. The young nymphs that emerge show more signs of gregarisation than their parents, suggesting that this is another mechanism for recruiting solitarious insects into groups (see illustration).



Solitarious (S-) females oviposit near gregarious egg-pods when possible. The offspring show more signs of gregarisation than the S-parent.

Setting the sexual trap

Previous ICIPE research (see *1992/93 Annual Reports*) has shown that mature adult solitarious S-females attract S-males for mating. Once S-males begin to undergo the physiological changes that occur during gregarisation and turn into G-males (see *1995/96 ICIPE Annual Reports*), they become even more interested in the S-females.

Several components of the sex pheromone secreted by the S-females have already been isolated, and these will be tested for use in a pheromone trap for catching and monitoring the build-up of gregarious character in a population. Such a device could be an important component of an early warning system for plagues.

A gregarising male mating with an S-female. Note the difference in colour of the two phases.

Crowded neighbourhoods

The desert locust is not the only acridid species in the desert. Hoppers of the desert locust have been observed to march, roost and feed together with hoppers of the migratory locust (*Locusta migratoria*), evidently due to some survival advantage. This led ICIPE ecologists to compare the pheromone systems of both species. Results show such strong similarities that S-desert locusts could be stimulated to gregarise by G-migratory locusts and *vice versa*. This would explain why mutual outbreaks of different locust species often occur, such as that of red locusts and migratory locusts in the Caprivi district in Namibia.

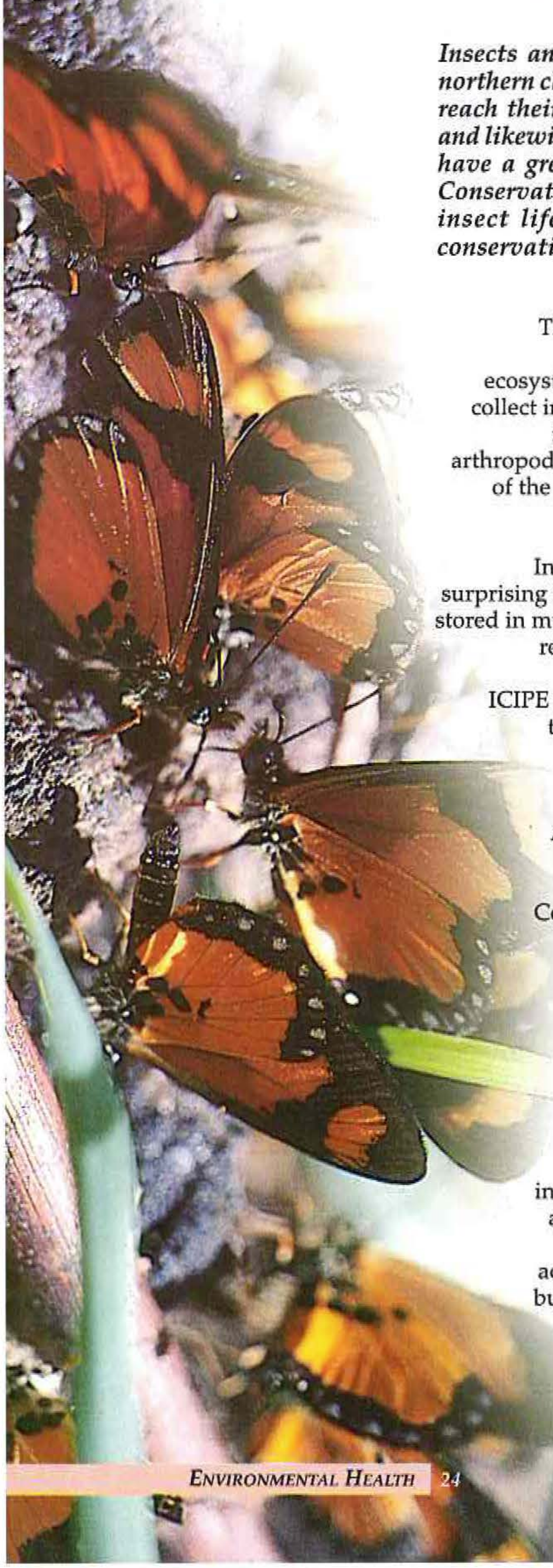
The above 1997 research helps in explaining further how the solitary locusts often living several kilometres apart are able to come together and reproduce to form the billions of insects in a large swarm: Following a clustering process that leads to the formation of nuclei of gregarising insects (see *1996/97 Annual Report*), the several sets of pheromones emitted by the nymphal and adult insects serve to rapidly recruit other individuals, such that the gregarious attributes quickly spread through the population.

The challenge now for the project is to draw from these ideas to develop models that relate the pace and extent of gregarisation to measurable habitat attributes and locust numbers. This could then be integrated with GIS technology and remote-sensing techniques for the development of a more refined and reliable early-warning system. If additional resources become available, these questions will be given priority. PhD students from Eritrea, Sudan and other locust-breeding countries are being trained to help discover the answers to the mystery of the desert locust.

Groups of pheromone-producing adults serve as 'nuclei' to actively recruit solitarious adults, thus leading to the spread of gregarisation through the population.

Donor: IFAD

Insect Riches



Insects and people live together more closely in the tropics than in northern climes. The arthropods (insects, spiders, ticks, millipedes, etc.) reach their maximum size and numbers in the warmer temperatures, and likewise their species diversity is greater. Consequently, arthropods have a greater impact on human society. ICIPE's Biodiversity and Conservation Megaproject is looking at the vast variety of African insect life to provide the framework for better utilisation and conservation of this vital resource.

The initial pages of this report have emphasised the importance of arthropod fauna to human life and the functioning of the earth's ecosystems. This new megaproject, now in the final proposal stage, will collect information about the kinds, numbers and distribution of Africa's insect life. Although there are an estimated 8–9 million species of arthropods, only 150,000 or so of African species have been described. One of the first activities of the project will be to assemble a complete list of insect species of Africa.

In spite of over 200 years of formal description of life on earth, it is surprising that this has never been done before. Much of this information is stored in museums and other institutions around the world, so the project is recruiting collaborators to assist in repatriating this data to Africa.

ICIPE will act as a focal point for data collection. Important partners in this massive exercise include the Xerces Society (for international invertebrate conservation) and the Entomological Information Services of Maryland (USA), a private company which has just completed a list of the 100,000 or so known species of North American insects. Once compiled, the African list will be a major contribution to the proposed Species 2000 of DIVERSITAS (a list of world species) and will assist countries signing the Convention on Biological Diversity (the so-called Rio Convention) in inventorying their biodiversity. The list will be issued in printed and CD versions and will be available on the Worldwide Web.

Butterfly flagships

The practical utility of collecting baseline information about arthropod species can be seen from one of the project's pilot activities to inventory butterflies from forest fragments. Many insects are good indicators of the overall state of the environment, and can be used to monitor changes in water, air and soil quality as well as giving an indication of habitat disturbance. In a pilot activity this year, the species diversity, richness and abundance of butterflies were measured in two small coastal forest fragments of different sizes; comparisons were then made with the butterfly data from larger protected forest reserves several hundred times their size (see table).

The results show that the two forest fragments retained about one-third of the butterfly species found in the larger forest reserves, and about the same proportion of termite species (6 species in Muhaka compared to 18 species in Shimba Hills). The butterflies therefore appear to be a good flagship group to indicate general insect biodiversity within a forest ecosystem. Any efforts to promote the conservation of these beautiful and highly visible insects would therefore be expected to have a beneficial trickle-down effect on other arthropod species. Although these results confirm the impression that the forest fragments lack a significant component of the insect biodiversity found in larger forests, nevertheless, a one-third fraction is still considered a respectable proportion and the small forest fragments should be conserved. Such information should be useful in formulating land use patterns to conserve biodiversity.

Forest fragments contain less butterfly diversity but are still important enough to conserve

Forest	Forest size (km^2)	No. of species
Muhaka	1.8	
Interior		47
Forest + support zone		67
Mrima	3.5	
Interior		46
Forest + support zone		66
Shimba Hills	140	304 [1, 3]
Arabuko Sokoke	400	
Interior		134 [2]

[1,2]Obtained from other studies.
[3]Not indicated whether the support zone is included.

A biodiversity hotspot

The Eastern Arc Mountains stretching across eastern Africa are covered with high-altitude (up to 2200 m) forest. Because of their geographical isolation from the savanna below, the hills harbour many rare and endemic species, making it one of the world's top 25 biodiversity hotspots and qualifying as a world heritage site. The ICIPE Biodiversity Megaproject intends to study the impact of population pressure and forest fragmentation and land use and management activities in the Taita Hills, the northernmost part of the Eastern Arc Mountains. ICIPE will look at several groups of insects (butterflies, termites, bees and beetles) with a view to selecting a group that is especially sensitive to disturbance. This will help in monitoring future ecological and environmental changes in these mountains and can provide a basis for improved management decision making and refining restoration or management plans.

The praying mantis also preys. This mantis is making a meal of a stemborer larva. ICIPE's IPM approach seeks to preserve these natural enemies by finding alternatives to chemical pesticides.

IPM relies on biodiversity

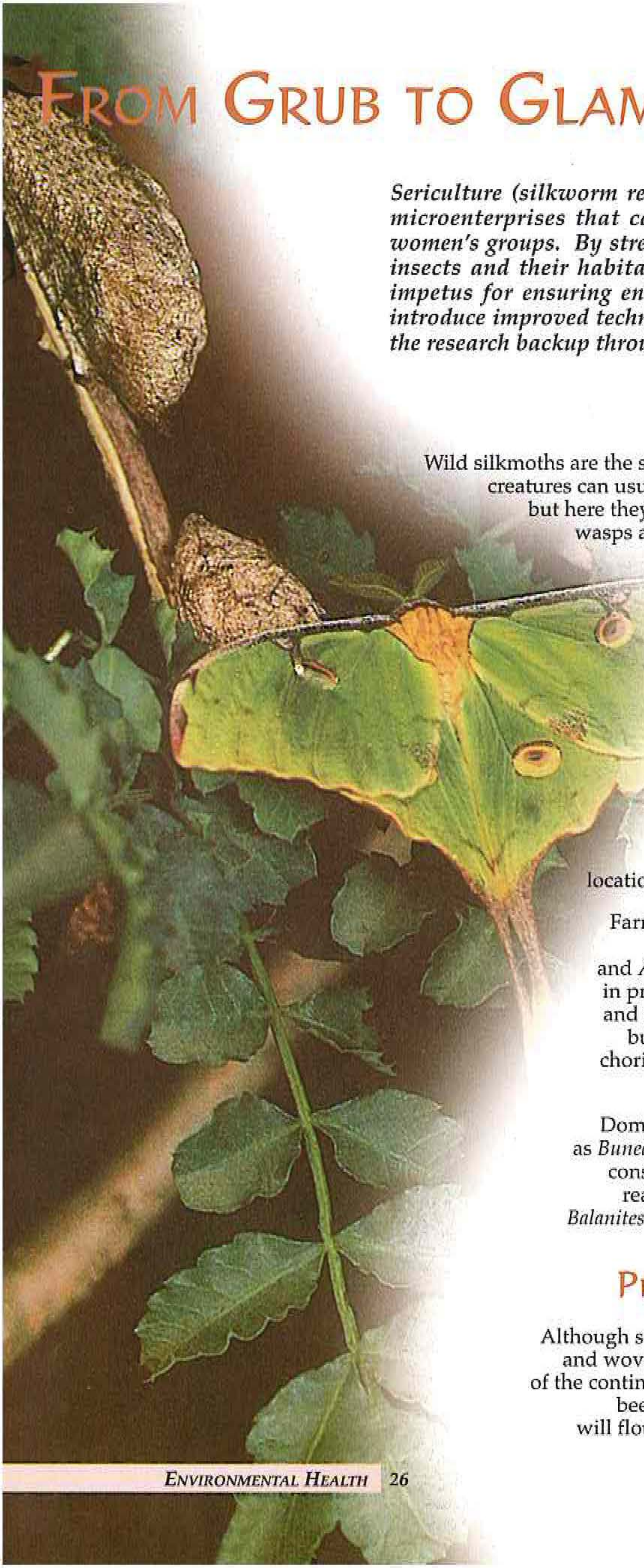
Most ICIPE projects have a biodiversity component, because the IPM approach relies on making use of pests' natural enemies and studying their ecosystem relationships. A few of these are highlighted below:

- Survey of stemborers and their natural enemies in Ethiopia, Somalia, Zanzibar and Kenya.
- Impact of predators on cereal stemborers at the Kenya coast: 34 beetles (Coleoptera) and 31 ant species have been identified so far.
- Survey of cabbage pests and their natural enemies in eastern and southern Africa.
- Exploration for indigenous natural enemies of African fruit flies and study of their biosystematics.
- Exploration for wild silkmoth species.
- Studies on honey bee genetics and diversity in eastern and southern Africa.

Donors: ICIPE Core Fund donors, Norwegian Government

Left: Butterflies can be useful indicators to monitor environmental health, such as signalling changes in habitat and loss of diversity. Here, a forest species feeds on monkey dung.

From Grub to Glamour



Sericulture (silkworm rearing) and apiculture (beekeeping) are two microenterprises that can be easily adopted by smallholders and women's groups. By stressing the benefits of conserving these useful insects and their habitats, economic development can provide the impetus for ensuring environmental health. ICIPE is working to introduce improved technologies in these ancient arts and to provide the research backup through its Commercial Insects Megaproject.

The wild silk of Africa

Wild silkmoths are the source of the valuable tussar silk. These beautiful creatures can usually be harvested only from their forest habitats, but here they are subject to attack by natural enemies such as wasps and flies and by man, as a source of protein food. ICIPE scientists are studying the life cycle of these potential silk producers (surveys indicate about 65 species) with the aim of breaking the egg diapause at a time of optimal host plant availability so as to allow continuous production. Methods are also being investigated to reduce the parasitism in the wild from the current level of 80%. Protective measures being developed for the young larvae in the forests include the use of very fine nets to keep the parasitoids at bay. However, the impact of El Niño this year could not be anticipated, and 65% of the cocoons in one test location in Kenya were washed away during flooding.

Farmers in two locations in eastern Kenya are being trained to produce cocoons from *Gonometa* sp. and *Argema mimosae*; the first field trials are currently in progress. Silk fibre from the former species is firm and of high grade, while *A. mimosae* silk can be spun but is not reelable. Electron microscopy of the egg chorion is being used as a taxonomic tool to identify the silkmoth species.

Domestic rearing of wild silk may be on the horizon, as *Bunea alcinoe*, a saturniid moth whose caterpillars are consumed in many parts of Africa, was successfully reared in the laboratory on leaves of its host plant, *Balanites aegyptiaca*. Attempts are being made to develop an artificial diet for rearing in the laboratory.

Promoting the culture of silk

Although several African countries have traditionally used and woven silk, sericulture is a new technology for most of the continent. The first two years of this new project have been spent in developing a domestic hybrid which will flourish in the African environment and produce a high quality of silk. Among the races selected for further testing are NB_{18} x NB_7, ICIPE I and II, Egyptian and Shanshi (the best silk producer). The mulberry cultivar Kanva 2 has proved the best of seven tested. Production figures in field trials by the Uganda Silk Secor Association using the Shanshi race has reached 2–3 tonnes per year, while Kenya is expected to produce about 1 tonne with Tanzania following suit in 1998. All necessary equipment for rearing the domestic silkworms has been made of local materials and using local labour.

The entire process of transforming the cocoons into the silk fabric of glamour is being addressed and this year saw the establishment of reeling and weaving facilities in the Sericulture Unit. It takes about 5000–6000 green cocoons to produce 1 kg of raw silk. The first cloth made from ICIPE's bivoltine silk was woven on the Unit's powerloom and handlooms especially constructed by an Indian company for African silk farmers. With further training, it is planned to transfer all aspects of textile engineering for manufacturing this beautiful fabric (see also Technopark, page 29). Thus, a full technology and training package is being developed.

Covering the young caterpillars of the lunar moth with a fine net sleeve has reduced parasitism rates more than 3-fold to 20%. Such tactics are necessary for successful commercialisation of wild species.

Better beekeeping to boost income

The African bee industry is in its infancy, and ICIPE's ambition is to help it come of age by providing farmers with improved hives and better bees. The modern Langstroth hive allows a 3–5-fold increase in honey production compared to the traditional log hive in common use. It also allows for the harvesting of valuable hive products such as royal jelly and propolis. ICIPE's Commercial Insects Megaproject has distributed over 1000 of these hives to farmers' groups in the East Africa region, and is helping to fill them with bees genetically selected for desirable traits such as gentleness (African honey bees are notoriously aggressive), fecundity and productivity.

The first silk cloth produced by the Commercial Insects Megaproject from African cocoons comes off a simple purpose-built powerloom.

Of the three races of *Apis mellifera* found in East Africa, *A.m. monticolla* is superior to *A. m. scutellata* and *Apis mellifera* for royal jelly production. The races are also being compared for their egg-laying rates and their brood dynamics. Bee diseases such as mites and brood diseases have not been observed so far, although colonies are affected by the wax moth, *Galleria mellonella*. Research this year on the use of *Bt (Bacillus thuringiensis) aiziwai* and other *Bt* isolates has shown that the egg and lst instar larvae of the moth are the most sensitive to *Bt*, and field trials are about ready to start in collaboration with a local NARS (National Bee Keeping Division of the Ministry of Agriculture of Kenya) for testing of this entomopathogen. Testing of the honey from sprayed hives is also being done to ensure wholesomeness.

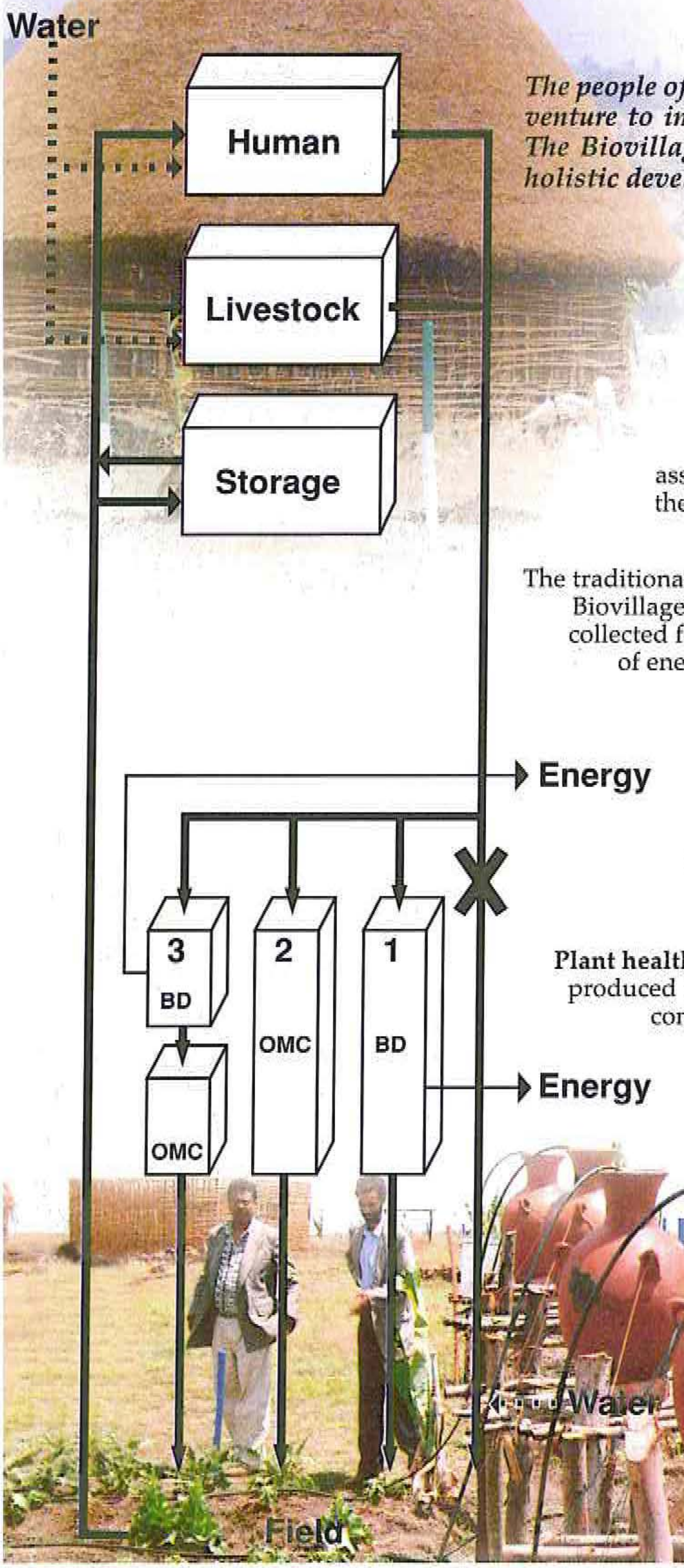
ICIPE technical staff inspect Langstroth hives in an apiary established in a farmer's beeyard. The improved technology has now been introduced to over 3500 farmers in the East Africa region.

To test the overall honey quality, a quality control laboratory has been established. This facility is also able to determine the floral quality and identify and classify the origin of the honey purchased from the project's participating beekeepers. National and international outlets for marketing of high-quality honey have been established. Over 3500 individual farmers from Uganda, Tanzania, Kenya, Ethiopia and Eritrea, as well as representatives from NGOs and government agencies have to date received training in commercial insects utilisation techniques. To assist farmers in the marketing of their commercial insect products, ICIPE is currently acting as an intermediary with traders. The income of participating farmers has increased by 40–60%. Based on the encouraging results of this two-year-old project, plans are to extend it to 11 other countries in eastern and southern Africa in Phase II.

Donor: IFAD

ICIPE: The African lunar moth, *Argema mimosae* on its indigenous host plant, *Sclerocarya birrea*. The silk cocoons, source of the valuable tussar silk, are also visible. The cocoons of this wild species can only be harvested from the forest. ICIPE surveys indicate there are about 65 potential wild silk producers in East Africa.

THE BIOVILLAGE INITIATIVE



The people of southern Ethiopia are embarking on an exciting new venture to improve their food security, health and environment. The Biovillage Initiative will integrate the 4H's in a model for holistic development.

Necessity was the mother of invention in this case. The tsetse fly, so prevalent in the Oromia, Amhara, Gambella, Benshangul-Gumuz and Southern Regional states of this region of Ethiopia, were devastating the livestock population. The success of ICIPE's tsetse trapping campaign, initiated in 1995, resulted in a reduction of tsetse numbers so dramatic that it prompted the local communities to request further assistance in improving their own health and welfare. Thus, the concept of a multifaceted integrated health and resource management system was conceived.

The traditional Ethiopian dwelling, the *tukul*, will be at the centre of the Biovillage. Animals will be kept in the animal tukul and their dung collected for a biogas digester (BD). By using this alternative source of energy, women's labour and trees will be conserved, thereby improving **environmental health**. The zero-grazing system will help limit livestock exposure to helminths (worms), ticks, tsetse and other biting insects, thus improving general **animal health**. The villages and the surrounding countryside will be protected from tsetse by a sustainable management approach, allowing safer cultivation of tsetse-infested areas. For instance, the LIT technique (see page 11) could be considered as an additional component in the tsetse control system.

Plant health will be improved by the application of organic fertiliser produced from farm wastes and biogas sludge in an organic matter converter (OMC) and by implementation of IPM techniques for crop pests such as those outlined in this report (see pages 16–23). **Human health** will be improved by the use of *Bt* for control of disease-carrying filth flies (see page 9). The modified design of tukul will incorporate mosquito netting to reduce the risk of malaria, a chronic public health problem in this region. ICIPE's integrated vector management (IVM) technologies (see pages 8–15) will eventually be incorporated into the plan.

To encourage better use of the region's natural resources, income-generating activities such as ICIPE's beekeeping and sericulture technologies (see page 26) will be introduced. Capacity building of villagers to assist them in managing the Biovillage and in training their neighbouring villagers is already underway.

The villagers' enthusiasm for the Biovillage is apparent and construction of about 10 demonstration tukuls is nearing completion. Agreements with the aforementioned state governments and with the Ethiopian Science and Technology Commission (ESTC) have cemented ICIPE's partnership with local officials in securing a better future for their people.

Donors: ICIPE Core Fund donors, Austrian Development Corporation

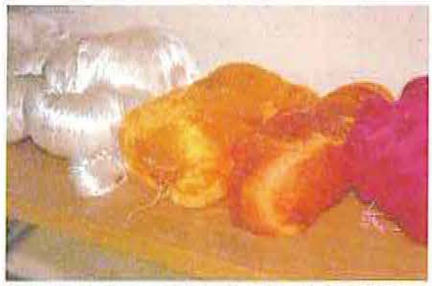
TECHNOPARK

This poster, prepared by the Gurage community reads, "We will fully participate in the effort to control tsetse and trypanosomosis".

After more than a quarter century of research and development (R&D) activities aimed at improving human health, agriculture and livestock development in Africa, ICIPE is now in a position to initiate pilot-scale production of a number of its R&D products. The pioneer ICIPE Technopark is set to develop as a high-tech biotechnology industry aiming to capture a number of niche markets by its wide range of products and services. Many of these are environmentally benign pest management products, as well as insect-derived commodities such as cosmetics, pharmaceuticals, fibres and food. When fully developed, the ICIPE Technopark will consist of an industrial incubation centre with six customised facilities able to provide 12 incubators, along with an ultra-modern multimedia information complex, accomodation and recreation facility, coordination offices and quality verification reference laboratories. Three Technopark activities are highlighted below.

Weaving silk on a simple, purpose-built handloom.

Development of **neem products** continued apace this year, in collaboration with a private Nairobi firm (SAROC Ltd.). Preliminary registration of two neem products (NCP, or neem cake powder and neem oil) with the Pest Control Products Board of Kenya will allow widescale testing against diamondback moth and aphids on cabbage, aphids and thrips on French beans, and root knot nematodes and leafminers on tomato. The aza content of the NCP is being standardised at 0.5% and 0.03% aza in the water-miscible oil. As a result of the Neem Awareness Project (see page 19), neem production has now increased to about 20 tonnes per season in Kenya and is providing a cash income to the people of several remote areas such as Wajir, Garissa and Lamu. In Tanzania, several women's groups have begun producing mosquito-repellent candles made from wax and neem oil. Aflatoxin-free neem oil and cake is being prepared at ICIPE's Mbita Point Field Station (MPFS) and a process for sterilising neem seed for both processing and propagation has been developed. Supplies of this seed are being sent to southern African countries and overseas to Jamaica and Panama.



Silk yarn from ICIPE-developed bivoltine hybrid silkmoths.

Post-cocoon technology in ICIPE's **sericulture** unit has now progressed from the reeling stage to winding, twisting, doubling and bleaching to produce the silk warp needed for weaving. Appropriate model machines have been constructed for Africa by an Indian firm, and weaving is now being demonstrated on a simple powerloom and easily constructed handloom. ICIPE is thus able to provide a complete technology package to African farmers from grainage (silkworm eggs) to equipment for producing the final woven fabric.

African honey is organically raised and of high quality. Development of a technology package for modern apiculture, from provision of improved queens to value-added honey processing, bee venom collection and royal jelly formulation into capsules is nearing completion.

A **Bt formulation** for controlling filth flies (Dudustop) is being produced in limited quantities under agreement with a Finnish company and with donor support (see page 9). A larger fermenter is required before the Technopark can meet the high demand for this product. Other opportunities for collaboration can be found in several areas of ICIPE's mandate: fungus-based biopesticides; trapping technology; pheromone and other attractants, repellents and behaviour modifiers; bioprospecting; informatics; analytical services; publications.

Donors: ***Neem:*** **GTZ, UNEP, Government of Finland;** ***Apiculture and sericulture:*** **IFAD;** ***Bt:*** **Government of Finland**

Left: A model Biovillage energy flow and resource utilisation system. The large pots are being used for drip irrigation. The traditional *tukul* (top) will be improved as a key element in this integrated system approach.

Building Indigenous Capacity

The shortage of trained personnel, especially in the sciences and technology, remains an important constraint to development in the tropics. Capacity building is a major responsibility of all of ICIPE's research projects and disciplinary departments, and consumes an average of 30% of the Centre's resources.

The main objective of ICIPE's education and training programme is to imbue citizens of tropical countries with the skills and personal resources for research and application of insect science, thus promoting the development and utilisation of sustainable methods of arthropod management. While the Centre uses the programme as a mechanism for science leadership development and dissemination of its research findings, the programme also makes a substantial contribution to ICIPE's research output through the scholarly activities of the trainees. ICIPE's strategy for capacity building reaches out to all cadres, from farmers to PhD level and beyond.

Postgraduate training programmes

Highly trained personnel are still in scarce supply in many developing countries. Until recently, some countries in Africa could not claim a single PhD entomologist to help solve arthropod-related problems. To help redress this sorry state of affairs, ICIPE's ARPPIS programme was conceived.

The African Regional Postgraduate Programme in Insect Science (ARPPIS) is a training programme in which ICIPE collaborates with African universities, national and international institutions, academies of science, the donor community and a network of alumni working in national institutions. First established in 1983, the ARPPIS programme runs a three-year doctoral fellowship scheme with an average enrollment of 30 research students at any one time. Scholarship in the programme is under the close supervision of the ARPPIS Academic Board, composed of renowned professors from the participating universities. By 1997, ARPPIS had enrolled 131 PhD students from 25 African countries; of these, 91 have graduated with PhDs from 18 African universities.

In 1997 the ARPPIS PhD programme had a bumper harvest of graduates: nine former students were awarded their doctoral degrees after defending their theses at the registering universities (Table 1), while seven new graduates from the 1994 class were released to the international network of ARPPIS scientists after completing their studies at ICIPE. Ten continuing students of the 1995 and 1996 classes made excellent progress during the year, while five new students were admitted in the 1997 class (Table 2). Cooperation with other international research centres was fruitful, as two of the new ARPPIS students took up their research projects at ICRAF.

Three sub-regional centres are already operating the ARPPIS training at Masters level. The ARPPIS sub-regional centre for southern Africa, hosted by the University of Zimbabwe, enrolled its third intake of students in March 1997 for the two-year MSc in tropical entomology. The sub-regional centre for West Africa admits students for a two-year MPh degree in insect science and was officially inaugurated during the 28th meeting of the ARPPIS Academic Board held at the University in December 1997; its second intake of students reported in September 1997. The sub-regional centre for eastern and northeastern Africa is hosted by Addis Ababa University and is due to be officially inaugurated at the next Academic Board meeting in October 1998. The Centre admitted its first intake of students late in the year for the two-year course leading to the MSc in entomology. A fourth centre is planned for francophone Africa.

The Dissertation Research Internship Programme (DRIP) is a highly flexible programme which effectively complements ARPPIS in providing postgraduate training opportunities at ICIPE. In 1997 alone, 12 new trainees (3 PhD and 9 MSc) were enrolled in the programme with sponsorship from three Kenyan and one German universities, while seven other trainees continued their research. Since 1992 when the programme was established, 11 PhD and 19 MSc students have been enrolled.

Table 1. List of ARPPIS scholars graduating with PhDs in 1997

Name of student	Country of nationality	Examining university
Dr F. Masaninga	Zambia	University of Zambia
Dr A. Ngi-Song	Cameroon	University of Ghana
Dr T. T. Epidi	Nigeria	Rivers State University
Dr K. Dossa	Benin	University of Ghana
Dr C. J. Mutinda	Kenya	University of Nairobi
Dr E. O. Omolo	Kenya	University of Nairobi
Dr E. K. Kinyua	Kenya	University of Nairobi
Dr A. I. Tawfic	Egypt	Assuit University
Dr S. F. Kutua+	D.R. of Congo	Kenyatta University

+Awarded posthumously

Table 2. Profile of new scholars admitted to the ARPPIS PhD programme in 1997

Name	Country of nationality	Employment status
Mr S. G. Weldesemayat	Ethiopia	Lecturer and Head of Biology Section, Alemaya University
Mr V. O. Oduol	Kenya	Tutorial Fellow, Dept. of Biochemistry, University of Nairobi
Mr A. T. Haile	Ethiopia	Senior Agricultural Expert, Ministry of Agriculture
Mr S. T. Kandji	Senegal	—
Ms S. A. Mohamed	Sudan	Research Officer, ARC, Ministry of Agriculture

Professional career development programmes

ICIPE recognises the potential contribution of young scientists graduating from centres of excellence as well as those of accomplished professors and international scientists. In this respect, the Centre encourages the appointment of **postdoctoral scientists** for medium-term assignment to on-going research projects and welcomes senior scientists to contribute to its research in the capacity of **visiting scientists** and **consultants** for research planning and evaluation activities. From 1995–1997, nine postdoctoral and four visiting scientists worked at ICIPE.

Training for research support and technology dissemination

These programmes aim to facilitate technology transfer to national programmes and institutions and to enhance their capacities to support technology generation and assimilation. In 1997, they included the following:

- for scientists and technologists, **research methodology courses** (11 trained)
- for IPVM practitioners, **group and individual training courses** (12)
- for technician trainees and university undergraduates, **practical training attachments** (78)
- for farmers and extension personnel, **awareness training and demonstrations** (100)

Donors: DAAD, Government of Netherlands, IFAD, Rockefeller Foundation, EU, GTZ, USAID, ODA, Gatsby Charitable Foundation and ICIPE Core Fund donors

Left: IPM practitioners from three countries learn how to set up a sticky trap for monitoring fly population levels in one of ICIPE's training courses. Over 6500 people have already benefited from the Centre's capacity building programme.

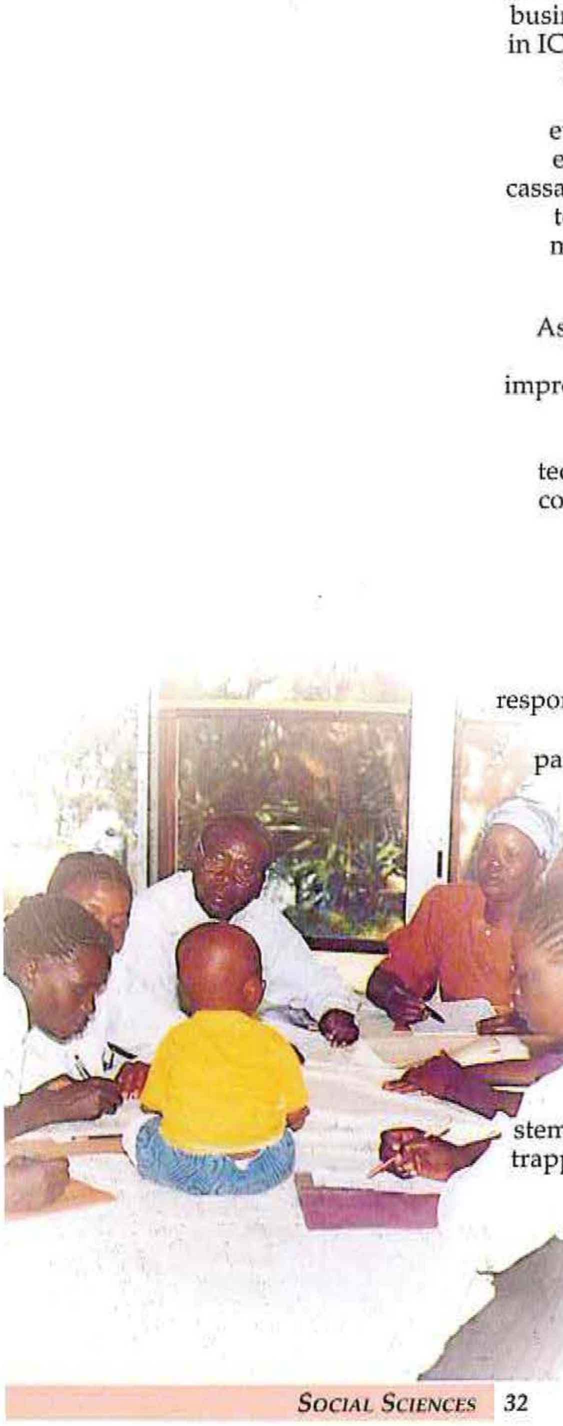
Social Sciences

ICIPE is a research institution with a social mission to improve human welfare in terms of food security, health and the environment. The Centre's Social Sciences Department (SSD) works hand in hand with biologists to help keep projects on track, from the planning stage through implementation and finally in assessment.

At the beginning of this report (see page 4) IPM was described as a pest management strategy that "enhances ecological awareness, decision-making, business skills and farmer confidence". Nowhere has this been as evident as in ICIPE's model project in coastal Kenya called 'Interactive Socio-Economic Research for Bio-Intensive Pest Management (ISERIPM)'. This five-year project involved 80 farmers from six villages in testing, adapting and evaluating several IPM components developed through ICIPE's research efforts. Improved pest-tolerant varieties of maize, sorghum, cowpea and cassava were provided as well as control agents such as *Bt* and neem. A new technique of strip relay intercropping was introduced and other cultural methods such as early planting were compared with farmers' traditional practices (see *1996/97 Annual Report*).

As an essential aspect of the project, farmers' self-help organisations were created. In 1997, these groups continued with the multiplication of the improved maize and sorghum seeds of their choice under the supervision of the Kenya NARS. Extensionists from the local Ministry of Agriculture (MOALDM) are planning and managing demonstration of the IPM technologies in 80 locations in the Kwale and Kilifi Districts. Such fruitful collaboration between ICIPE and the local NARS is expected to serve as a model for future projects elsewhere, and will help ensure widespread adoption of IPM.

The social scientists discovered that the variations in the patterns of adoption seem to reflect the differences in farmers' socioeconomic circumstances and agroecological factors. For instance, out of 112 respondents, 61% preferred ICIPE's ICZ5 maize cultivar while 39% preferred M5. About 78% applied *Bt* on their maize fields, and variations in the pattern of plant spacings and types of intercrops planted were also noted.

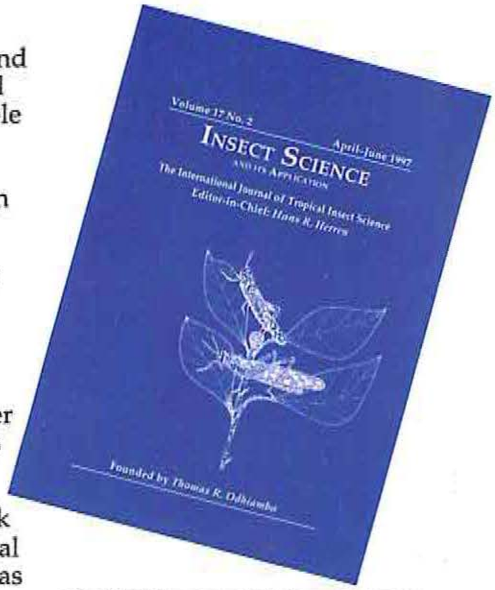


A SWOT (strength, weakness, opportunities and threats) analysis of the SSD conducted during the year recommended that technology impact assessment by the department should continue along with studies on policy issues and marketing in pest and vector management as priorities for research. Other areas in which the SSD is currently conducting research include • socioeconomic aspects of biological control of cereal stemborers in eastern and southern Kenya (in progress on the Kenya coast since 1991); • socioeconomic aspects of utilising wild host plants for stemborer management; • socioeconomic evaluation of use of fodder plants in an integrated strategy for control of maize stemborers and livestock management (pilot activities in progress); • tsetse trapping effectiveness and acceptability among three target communities in Kenya's Rift Valley and Lake Victoria basin and in Ethiopia's southern region; • impact of banana IPM in Uganda.

Donors: Rockefeller Foundation, IFAD, European Union, ICIPE Core Fund donors

Research Support

The **Biomathematics Unit** assists ICIPE staff and students in design of experiments, input of statistical ideas, data analysis, results verification and interpretation. The Unit also helps in manuscript/thesis review, statistical software installation and teaching, and also statistically exploring available databases. This year the Unit contributed to capacity building by conducting a four-week course in biostatistics for the ARPPIS students during the year, as well as training of students on industrial attachment in statistics.



The ICIPE-supported journal has a new design.

The activities of the **Biosystematics Support Unit** are described under the reports on stemborers, fruit flies and biodiversity, among others. The Unit assists with taxonomic identification of arthropods and plants, thus reducing reliance on external expertise and providing speedier identification. The Unit's curators are establishing collections of voucher specimens of stemborer and fruit fly parasitoids, vegetable pests and other insects of relevance to ICIPE's projects. Training of parataxonomists—this year from five countries—is another important activity.

Providing a steady supply of arthropods for research is a daunting task faced by the **Animal Rearing and Quarantine Unit**. The Unit raises several species of tsetse, ticks, stemborers, gregarious and solitary-phase locusts, as well as beneficial insects. A new facility for rearing mosquitoes at ICIPE's Mbita Point Field Station was established this year. The Unit also conducts its own research into rearing methodologies.

The objective in creating the new **Information Services (IS) Unit** was to coordinate and consolidate ICIPE's information activities, including editing, publishing, graphics and design, printing and photography. The international journal, ***Insect Science and Its Application*** attempted to redress its slow publication rate over the past two years since it lost its science editor in 1996, and published five issues in 1997. It is expected to make the journal current with Volume 18 (1998). Improvements in editorial content, quality of statistical treatments, design and presentation have been made. From Volume 17 (1), the journal is going to be put on-line *via* the Electronic Publishing Trust (UK) and Bioline, through a grant from CTA.

ISP (ICIPE Science Press) continues to serve as the printer for most ICIPE stationery, books, brochures, etc. It also has a healthy business in publishing and printing work for external clients, including other IARCs, Government of Kenya projects, NGOs, UN agencies, etc. Of note in 1997 was the publication of 4 out of 13 titles received in the UNU Institute for Natural Resources of Africa series of field surveys. This year, ISP also published and printed the maiden issues of two new journals, a book on IPM in the Sudan for FAO, several newsletters, manuals and other books. ISP is hoping to move toward full cost recovery in 1998, and is under considerable demand to publish tertiary level science and medical manuscripts whose authors lack subsidisation for publication.

ICIPE's **Information Resource Centre** (IRC) houses over 7000 books and 5000 periodicals. Through collaborative information exchange arrangements, the IRC has sustained its CD-ROM collection. For instance, the FAO-AGRIS database is received in exchange for ICIPE's PMDISS bibliography, a pest management database for the eastern and central Africa sub-region. The IRC provided service to over 7000 users and delivered over 400 literature requests and about a hundred computer searches in 1997, as well as facilitating e-mail and Internet connections. The latter two modes of communication have recently been streamlined by the establishment of the **Information Technology Unit.** The IT staff are currently installing a new computerised financial management system (Sunsystem), a campuswide Local Area Network (LAN) and have set up an Internet home page (www.icipe.org) and an Internet Research Laboratory with a 64K dedicated connection to the Internet.

Left: Farmers contribute their expertise and experience in all aspects of project planning, implementation and evaluation as in this group participating in tsetse control in western Kenya.

1997 Publications

A. Refereed papers

(Includes notifications up to March 1998. Does not include articles in press or those submitted)

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Assad Y. O. H., Hassanali A., Torto B., Mahamat H., Bashir N. H. H. and El Bashir S. (1997) Effects of fifth-instar volatiles on sexual maturation of adult desert locust *Schistocerca gregaria*. *Journal of Chemical Ecology* 23, 1373–1388. 97–1365

Assad Y. O. H., Torto B., Hassanali A., Njagi P. G. N., Bashir N. H. H. and Mahamat H. (1997) Seasonal variation in the essential oil composition of *Commiphora quadricincta* and its effect on the maturation of immature adults of the desert locust, *Schistocerca gregaria*. *Phytochemistry* 44, 833–841. 97–1350

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Denlinger D. L. and Zdarek J. (1997) A hormone from the uterus of the tsetse fly, *Glossina morsitans*, stimulates parturition and abortion. *Journal of Insect Physiology* 43, 135–142. 97–1339

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Hailemichael Y., Schulthess F., Smith J. W., Jr. and Overholt W. A. (1997) Suitability of West African gramineous stemborers for the development of *Cotesia* species. *Insect Science and Its Application* 17, 89–95. 97-1419

Kaaya G. P. (1996) Mortality and pathology in tsetse flies (*Glossina* spp.) treated with neem extracts. *Tanzania Veterinary Journal* 16, 58–65. (Publication released in 1997).

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Khan Z. R. and Saxena R. C. (1997) Use of a surrogate stem for eliciting ovipositional response of *Busseola fusca* (Lepidoptera: Noctuidae). *Journal of Economic Entomology* 90, 1426–1429. 97-1412

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Kimani-Njogu S. W. and Overholt W.A. (1997) Biosystematics of the *Cotesia flavipes* species complex (Hymenoptera : Braconidae) parasitoids of gramineous stemborers. *Insect Science and Its Application* 17, 119–130. 97-1422

Kimani-Njogu S. W., Overholt W. A., Woolley J. and Walker A. (1997) Biosystematics of the *Cotesia flavipes* species complex (Hymenoptera: Braconidae): Morphometrics of selected allopatric populations. *Bulletin of Entomological Research* 87, 61–66. 97-1346

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Mbapila J. C. and Overholt W. A. (1997) Oviposition, development and searching behaviour of *Cotesia flavipes* (Cameron) and *Cotesia sesamiae* (Cameron) (Hymenoptera: Braconidae) in relation to aestivating and non-aestivating *Chilo* spp. (Lepidoptera: Pyralidae) larvae in maize. *African Entomology* 5, 35–39. 97–1356

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Njagi P. G. N. and Torto B. (1996) Responses of nymphs of desert locust, *Schistocerca gregaria* to volatiles of plants used as rearing diet. *Chemoecology* 7, 172–178. (Publication released in Dec. 1997). 96-1400

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Odulaja A. (1996) Modifications to the evaluation of intercropping advantage. *Tropical Agriculture* 73, 231–233. (Publication released in 1997). 96-1391

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Odulaja A. and Madubunyi L. C. (1997) A sampling bias model for odour-baited traps in relation to tsetse hunger cycle and population suppression. *Ecological Modelling* 104, 165–173. 97-1413

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Omolo E. O., James M. D., Osir E. O. and Thomson J. A. (1997) Cloning and expression of a *Bacillus thuringiensis* (L1-2) gene encoding a crystal protein active against *Glossina morsitans morsitans* and *Chilo partellus*. *Current Microbiology* 34, 118–121. 97–1344

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Tawfik A. I., Vedrova A., Li W., Sehnal F. and Obeng-Ofori D. (1997) Haemolymph ecdysteroids and the prothoracic glands in the solitary and gregarious adults of *Schistocerca gregaria*. *Journal of Insect Physiology* 43, 485–493. 97–1347

Zdarek J. and Denlinger D. L. (1997) Species variation in the response of tsetse flies (*Glossina* spp., Diptera: Glossinidae) to parturition hormone. *European Journal of Entomology* 94, 381–383. 97–1362

Reprints of articles with a call number at the end of the citation can be ordered from the Documentalist, ICIPE.

B. Other Publications

(Includes papers in published conference proceedings and other papers by ICIPE staff)

Bob M. A., Sithanantham S. and Nono Womdim R. (1997) Whitefly problems in Africa: Known importance and research needs, pp. 859–866. In *Proceedings of ANPP-Fourth International Conference on Pests in Agriculture* 7–9 Jan. 1997, Montpellier, France, Volume 2/3. Association Nationale de Protection des Plantes, Paris. 97-1392

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Khan Z. R. (1997) A review of entomological techniques and methods used to determine mechanisms and bases of stem borer resistance in maize, pp. 62–67. In *Insect Resistant Maize: Recent Advances and Utilisation* (Edited by J. A. Mihm). Proceedings of an International Symposium held at the International Maize and Wheat Improvement Centre (CIMMYT), 27 November–3 December 1994, CIMMYT, Mexico, DF.

Mihok S. (1997) Tsetse and trypanosomiasis and wildlife/ livestock interactions, pp. 165–172. In *Proceedings of the East Africa Livestock Assessment Workshop*. University of California, Small Ruminant CRSP, Davis, California.

Mihok S., Kock R. and Masake R. (1996) Health implications of translocations of endangered species in Africa: Trypanosomiasis in rhinoceros, pp. 423–424. In *Proceedings of the Joint Conference of AAZV/WDA/AAWV*. Michigan, USA. (Publication released in 1997).

Ngi-Song A. J. and Overholt W. A. (1997) Host selection by *Cotesia flavipes* and *Cotesia sesamiae* (Hymenoptera: Braconidae): An example of a tritrophic relationship in a grass–stem borer parasitoid system, pp. 173–181. In *Integrating Biological Control and Host Plant Resistance*. Proceedings of a CTA/IAR/IIBC Seminar, Addis Ababa, Ethiopia. 9–14 October 1995. CTA Publication.

Odindo M. O., Nour A. M., Ajala S. O., Kiros F. G., Chitere P. O., Ampong-Nyarko K., Mohamed Ali M. A. and Ngalo Z. O. (1997) Integration of *Bacillus thuringiensis* with elite sorghum and maize genotypes to enhance productivity of small-scale farms in the coastal region of Kenya, pp. 144–153. In *Integrating Biological Control and Host Plant Resistance*. Proceedings of a CTA/IAR/IIBC Seminar, Addis Ababa, Ethiopia. 9–14 October 1995. CTA Publication. ISBN 92 9081 1625. 97-1351

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C. ICIPE Science Press

Publications

(See also page 33)

1996/97 Annual Report Highlights. ISBN 92 9064 112 6. 56 pp. September 1997.

Directory of Neem Workers in Eastern and Southern Africa. Edited by R. C. Saxena. ICIPE Science Press, Nairobi. ISBN 92 9064 107 X. 30 pp. April 1997.

Vision and Strategic Framework towards 2020. ISBN 92 9064 111 8. 74 pp. September 1997.

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Core Research Departments

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Dr William A. Overholt, *Principal Scientist (and Megaproject Leader, Food and Perennial Crop Pests)*
Dr Scott E. Miller, *Principal Scientist (and Megaproject Leader, Biodiversity)****
Dr Steven Mihok, *Senior Scientist (and Ag. Programme Leader, Disease Vectors Management Programme*)*
Dr Srinivasan Sithanantham, *Senior Scientist (and Ag. Programme Leader, Plant Pests Management Programme*)*
Dr Kundam V. Seshu Reddy, *Senior Scientist, Scientist-in-Charge (Mbita, Muhaka Field Stations)*
Dr Suresh K. Raina, *Senior Scientist (and Megaproject Leader, Commercial Insects)*
Dr Magzoub O. Bashir, *Senior Scientist, Scientist-in-Charge (Port-Sudan Field Station)*
Dr Maurice Odindo, *Senior Scientist (and Ag. Head, ARQU##)*
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Dr Charles M. Mbogo, *Scientist, on secondment from KEMRI***
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Dr Shifaw Ballo, *Postdoctoral Fellow*
Dr Zhou Guofar, *Postdoctoral Fellow*
Dr Shawgi M. Hassan, *Senior Research Assistant*
Mr Lucas Ngode, *Senior Research Assistant*

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Mr Christopher N. Olando, *Senior Research Assistant*
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Animal Rearing and Quarantine Unit
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Ms Daisy W. Ouya, *Science Editor, Insect Science and Its Application*

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Field Stations

Mbita Point Field Station/Muhaka Field Station
Dr Kundam V. Seshu Reddy, *Scientist-in-Charge*

Port-Sudan Field Station
Dr Magzoub O. Bashir, *Senior Scientist, Scientist-in-Charge*

Ethiopia Country Office
Dr Getachew Tikubet, *Country Coordinator*
Dr Shifaw Ballo, *Postdoctoral Fellow*
Mr Ato B. Ameya, *Protocol Officer*

≠As of 6 March, 1998 (Staff joining or leaving in 1997 or joining in 1998 are shown with asterisks).
*Until mid-1997.
**From mid-1997.
***Staff joining in 1998.
#On extension until December 1997.
Until February 1998.
From February 1998.

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Financial Statement

Audited Income and Expenditure Account for the Year Ended 31st December 1997

	US$ 000	
	1997	1996
Income		
Grants	9357.3	9,864.5
Currency translation gains	134.7	241.1
Miscellaneous	124.9	208.5
	9616.9	10,314.1
Expenditure		
Core Research	5840.9	4,724.2
Research Support Services	781.9	484.2
Training and International Cooperation	539.1	1,049.7
Information	142.4	145.0
Management and General Operations	1855.6	2,403.0
	9159.9	8,806.1
Land and Buildings	14.2	158.4
Scientific Equipment	138.3	506.1
Office Equipment and Furniture	292.1	415.8
Vehicles	141.8	428.8
	9746.3	10,315.2
Total (deficit) surplus for the year	(129.4)	(1.1)

Balance Sheet as at 31 December 1997

	US$ 000	
	1997	1996
Fixed Assets		
Nominal value	*	*
ICIPE Riverside House	251.2	260.2
Current Assets		
Consumable Stores	25.9	31.8
Grants Receivable	1329.9	1,565.3
Debtors and Pre-payments	401.4	851.3
Deposits—Buildings Maintenance Fund	37.6	127.4
Bank Balances and Cash	2423.9	2,192.5
	4218.7	4,768.3
Current Liabilities		
Bank Overdraft (secured)	1091.0	112.7
Loan (repayable within one year)	66.7	81.0
Creditors and Accruals	925.8	1,933.9
Unexpended Operating Grants	2687.1	2,804.1
	4770.6	4,931.7
Net Current Assets	(551.9)	(163.4)
Total Net Assets	(300.7)	96.8
Financed by:		
Reserve Funds (deficits)	(404.9)	(146.2)
Buildings Maintenance Fund	37.6	127.4
	(367.3)	(18.8)
Deferred Financing	50.3	60.4
Long-Term Loan (secured)	16.3	55.2
	(300.7)	96.8

*In accordance with ICIPE accounting policy, all fixed assets are written off to the Income and Expenditure Account in the year of purchase. However, the fixed assets held by ICIPE as at 31st December 1997 at cost amount to US$ 8,971,559 (1996—$ 8,386,066).

1997 Donors

Grants received and receivable	1997 (US$ 000)	1996 (US$ 000)
Arab Fund for Economic and Social Development (AFESD)	200.0	200.0
Australian Centre of International Agricultural Research (ACIAR)	51.3	55.8
Austrian Government	876.9	500.0
Danish International Development Agency (DANIDA), Danish Government	876.2	786.6
European Union, European Development Fund (EDF)	1,310.7	2,484.6
Finnish Government	202.7	150.0
Gatsby Charitable Foundation	298.6	349.7
German Academic Exchange Service (DAAD)	222.5	245.0
German Federal Ministry of Economic Cooperation	971.9	240.6
Hebrew University of Jerusalem	52.4	31.0
ICIPE/IFAD/ILRI Collaborative Project	179.7	–
International Bank for Reconstruction and Development (World Bank)	–	200.0
International Centre of Tropical Agriculture (CIAT)	136.5	–
International Committee of the Red Cross (ICRC)	11.8	–
International Crops Research Institute for Semi-Arid Tropics (ICRISAT)	5.0	–
International Development Research Centre (IDRC)	37.3	5.4
International Fund for Agricultural Development (IFAD)	671.0	1,429.6
International Institute of Tropical Agriculture (IITA)	15.0	16.0
Japan International Research Centre for Agricultural Sciences (JIRCAS)	15.5	27.5
Japan Society for the Promotion of Science (JSPS)	–	6.0
Johnson Wax	5.0	–
Kenya Government	109.8	115.9
Natural Resources Institute (NRI), UK	–	37.0
Netherlands Government, Directorate of NGO, International Education and Research Programme	1,645.4	1,229.1
Norwegian Government	444.0	309.1
OPEC Fund for International Development	30.0	40.0
Rockefeller Foundation	399.8	528.1
Swedish International Development Agency (SIDA)	973.5	1,200.1
Swiss Government	400.0	2,075.0
Toyota Foundation	27.0	18.4
United Nations Development Programme (UNDP)	–	249.7
United Nations Educational, Scientific and Cultural Organisation (UNESCO)	1.7	–
United Nations Environment Programme (UNEP)	–	1.0
United States Agency for International Development (USAID)	600.0	249.6
University of East Anglia, UK	4.5	5.6
University of Hawaii, USA	21.7	5.0
World Health Organisation (WHO)	8.2	–
Total Grants Received and Receivable	10,805.6	12,791.4
Add: Unexpended Grants—brought forward	2804.1	2,198.6
	13,609.7	14,990.0
Less: Unexpended Grants—carried forward	(2687.1)	(2,804.1)
	10,922.6	12,185.9
Less: Grants receivable—1·1·97	(1565.2)	(2,321.4)
Grants taken into income	9357.4	9,864.5

ACRONYMS AND ABBREVIATIONS

ACIAR	Australian Centre for International Agricultural Research
AGRIS	Agricultural Information Service (FAO)
ARPPIS	African Regional Postgraduate Programme in Insect Science (ICIPE programme)
AVRDC	Asian Vegetable Research and Development Centre (Taipei, Taiwan, China)
BMZ	Bundesministerium fur Wirtschaftliche und Entwicklung Zusammenarbeit (Bonn, Federal Republic of Germany)
Bt	*Bacillus thuringiensis*
CAAS	Chinese Academy of Agricultural Sciences
CGIAR	Consultative Group on International Agricultural Research (Washington DC, USA)
DANIDA	Danish International Development Agency (Copenhagen, Denmark)
DBM	diamondback moth
DRIP	Dissertation Research Internship Programme (ICIPE programme)
EAG	electroantennogram
FAO	Food and Agriculture Organisation of the United Nations (Rome, Italy)
G	gregarious phase (of migratory pests)
GIS	geographic information systems
GTZ	Gesellschaft für Technische Zusammenarbeit (Eschborn, Germany)
HCDA	Horticultural Crops Development Authority, Kenya
ICRAF	International Centre for Research in Agroforestry (Nairobi, Kenya)
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics (Hyderabad, India)
IFAD	International Fund for Agricultural Development (Rome, Italy)
IGR	insect growth regulator
IITA	International Institute of Tropical Agriculture (Ibadan, Nigeria and Cotonou, Benin)
ILRI	International Livestock Research Institute (Nairobi, Kenya and Addis Ababa, Ethiopia)
IPM	integrated pest management
IPVM	integrated pest and vector management
ISERIPM	Interactive Socio-Economic Research for Bio-Intensive Pest Management (ICIPE project)
IVM	integrated vector management
KEMRI	Kenya Medical Research Institute
LIT	lethal insect technique
MOALDM	Ministry of Agriculture, Livestock Development and Marketing (Kenya)
MPFS	Mbita Point Field Station (ICIPE)
MSV	maize streak virus
NARES	national agricultural research and extension systems
NGO	nongovernmental organisation
OPEC	Organisation of Petroleum Exporting Countries (Vienna, Austria)
ORSTOM	Office de la recherche scientifique et technique outre-mer (France)
OVI	Onderstepoort Veterinary Institute, South Africa
PPRI	Plant Protection Research Institute, South Africa
R&D	research and development
RTTCP	Regional Tsetse and Trypanosomiasis Control Programme (Zimbabwe)
S	solitarious phase (of migratory pests)
SIT	sterile insect technique
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organisation
UNHCR	United Nations High Commission for Refugees
USAID	United States Agency for International Development (Washington DC, USA)
WFP	World Food Prize
WHO	World Health Organisation
YLCV	yellow leaf curl virus

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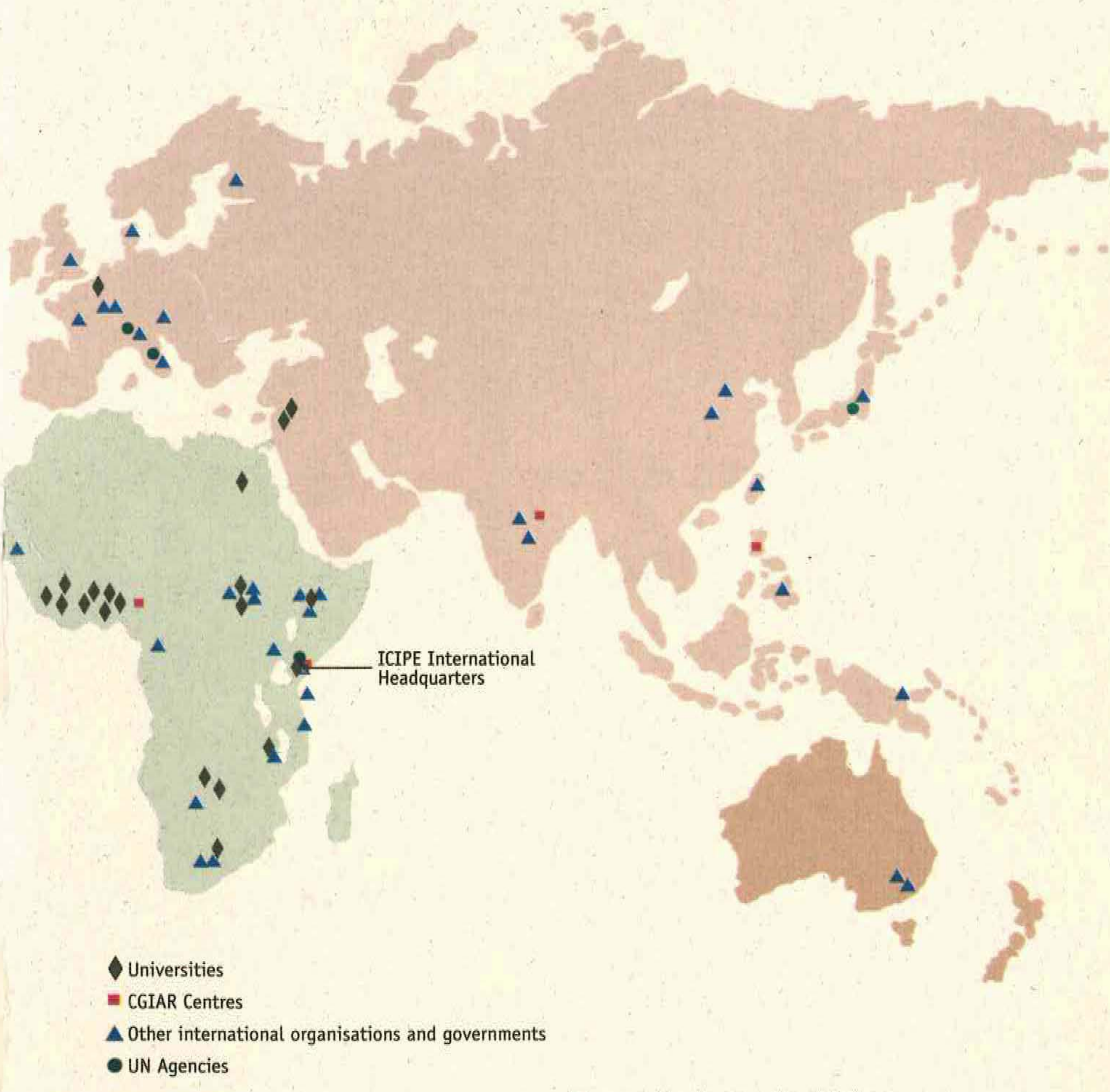

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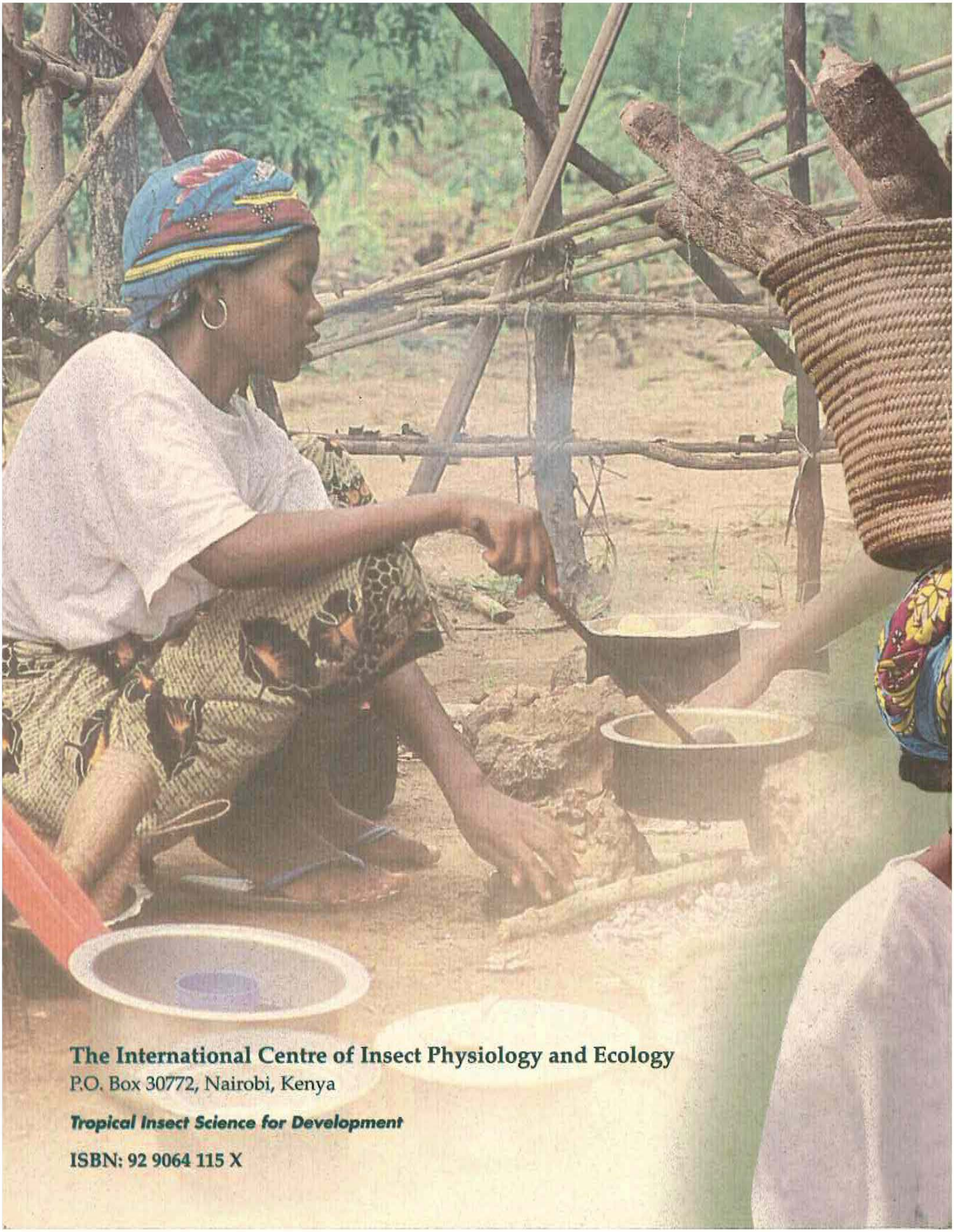

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