demonstrating the importance of the former in maintaining overall diversity in agroecosystems. Both this and the surveys of pristine systems indicate that longer-term studies give a better picture of hymenopteran diversity at both specific and higher taxon levels. (*See also Section C below on Agrobiodiversity*)

We expanded the Hymenoptera study into a unique 'tri-trophic' study of RBA, funded by The British Ecological Society and led by Lawrie S. Springate of the Royal Botanic Garden Edinburgh. Concentrating on forest fragments in the Nairobi and Machakos regions, simultaneous surveys were made of producers (Angiospermae) and primary (moths - Lepidoptera) and secondary (Hymenoptera) consumers on a spot-sampling basis. Opportunity was taken to train two Kenyan students in the basics of RBA during this programme.

8.1.1 *Environmental impact assessment of ICIPE's tsetse and fruit fly control*

In collaboration with ICIPE's Lethal Insect Technique (LIT) project for tsetse and the African Fruit Fly Initiative (AFFI) Programme, Hymenoptera were used to study the non-target effects of the application of control agents in the Nguruman region. Two 10-week studies of Hymenoptera diversity were made before the application of *Metarhizium anisopliae* and baited traps to control Glossinidae (tsetse fly) and Tephritidae (fruit fly) and catches analysed. Follow-up studies have been made (LIT) or are in progress (AFFI).

Identification and analysis of material from all three studies is in progress.

8.2 INSECT COMMUNITIES IN EAST AFRICAN FORESTS STUDIED BY CANOPY FOGGING

Participating scientists: T. Wagner (Museum Koenig and University of Bonn) (*Visiting scientist)*

Students: Nadine Spitz (Bachelors student); Carsten Kneip (Masters student); and Eva-Maria Levermann (PhD student), all University of Bonn, Germany

Donor: German Science Foundation

Collaborators: • National Museums of Kenya • Kenya Wildlife Service • Museum Koenig • University of Bonn

Forest canopy arthropods were sampled in January and February 1999 at various sites in Kenya, as an extension of earlier studies elsewhere in eastern Africa. Study sites included the Aberdare National Park, Mount Kenya National Park, Kikuyu Escarpment (Gatamayu), Kakamega Forest, and forest fragments near Nairobi.

Analysis of the material is in progress, but some preliminary observations are possible: The Gatamayu and Aberdare sites belong to a (more or less) closed block of forests, but the faunal overlap of beetles between these two sites is much lower than between the two disjunct sites, Aberdare and Mount Kenya. The weevils (Curculionidae) show a very high overlap between the 'true' montane forest sites, because they may be much better adapted to low temperatures. Many of these Curculionidae have closely related species in Europe. At Gatamayu, where another forest type occurs (about 300 m lower altitude), the diversity is higher and shows more overlap to the typical tropical sites, such as Kakamega Forest.

Dependant on funding, it is hoped to continue with these studies in Kenya, including comparison of (more or less) primary forest stands, adjacent secondary forests and forest fragments, in order to get data on biodiversity reduction under habitat fragmentation. These data should be of interest in understanding sustainable use of forest resources.

9. BIODIVERSITY STUDIES AT MPALA RESEARCH CENTRE

Background, approach and objectives

Mpala Research Centre is a field station situated in the Laikipia District of central Kenya near Mount Kenya, a region characterised by semi-arid savanna habitat. The Centre is a collaborative project of the Kenya Wildlife Service, National Museums of Kenya, Princeton University, and the Smithsonian Institution. The Centre is well situated in one of the most biologically interesting regions within Kenya, but almost no entomological study has been undertaken there. In addition to the specific project outputs, these projects are also solidifying collaboration between ICIPE and Mpala. ICIPE maintains a network of field stations in Kenya, and there are considerable potential benefits in the collaboration for both institutions, such as maximising use of facilities by both staff and visiting scientists.

9.1 INVENTORY OF MOTHS (LEPIDOPTERA)

Participating scientist: *S.E. Miller*

Assistants: *N. Onyimbo and others*

Donor: *Smithsonian Institution*

Collaborators: *• Mpala Research Centre • National Museums of Kenya • Natural History Museum (London) • Smithsonian Institution*

The inventory of the species of larger moths (Sphingoidea, Bombycoidea, Noctuoidea, Geometroidea, Zygaenoidea, and Pyraloidea) present at Mpala together with data on seasonality, will provide a baseline for further faunistic and ecological work at Mpala. It will also provide data for larger ICIPE projects and collaborators, mapping the distribution of selected species in Africa. The initial plan was to undertake a 1-year survey of moths at Mpala Research Centre. The sampling continued over 20 months because of the on-going drought, and was completed in December 1999. Specimen preparation

is largely completed, but because of this extension, sampling, identification and analysis have only begun.

Blacklight sampling was undertaken on 24 nights in 11 sets from May 1998 to December 1999. Approximately 300 morphospecies of larger moths (Macrolepidoptera and Pyraloidea) have been segregated and tentative species identifications have been assigned to over half, using the National Museums of Kenya collection. Further identifications will be made at the Smithsonian and the Natural History Museum, London and an annotated checklist will be prepared; voucher collections will also be distributed. This survey of moths will have the direct impact of documenting a significant portion of the insect fauna at Mpala. The study has also had indirect impacts by promoting other research at Mpala and providing material for studies.

9.2 INVENTORY OF ANTS (HYMENOPTERA: FORMICIDAE)

Participating scientist: *R.R. Snelling (Visiting Scientist)*

Donor: *Smithsonian Institution*

Collaborators: • *Mpala Research Centre* • *National Museums of Kenya* • *Natural History Museum of Los Angeles County (USA)*

During September and October 1999, in the first of three visits that will allow seasonal coverage, 70 species of ants in the immediate vicinity of Mpala Research Centre, despite the dry conditions. Detailed identification of the species and preparation of taxonomic keys for their identification are in progress. The taxonomic information will be of immediate use to several projects already underway dealing with ant ecology at Mpala. This is one of the few detailed inventories of ants at a given site in East Africa (in contrast to West Africa, where there have been many more site-based studies). A reconnaissance visit was also made to Kakamega Forest, to assess the potential for further studies there.

9.3 IMPACT OF ANTS ON GROWTH AND REPRODUCTION OF *ACACIA DREPANOLOBIUM*

Participating scientist: *E.E. Lyons (Visiting scientist)*

Collaborators: • *Mpala Research Centre* • *National Museums of Kenya*

This project explores the impact of resident ant species on the growth and reproduction of *Acacia drepanolobium*, a small tree that covers millions of hectares in East Africa, particularly on black cotton soils. On any given tree, one of four ant species can live in the large swollen thorns (*Crematogaster mimosae*, *C. nigriceps*, and *Tetraponera penzigi*) or in the hollowed out, dead or dying parts of the stems (*C. sjostedti*). Trees with different resident ant species display different branch architecture and rates of flowering and fruiting. Trees with *C. nigriceps* residents tend to be more branched and to have few if any flowers. To determine whether the ants cause such changes, or whether they colonise trees with different attributes, an experimental plot was established at Mpala Research Centre in which ants of each species were permanently removed from some trees and not others. Bimonthly measures were initiated to document the number of leaves, flower buds, flowers and fruits on paired trees with and without ants.

Heavy browsing by an elephant herd several months into the project provided the first evidence that the presence of ants can influence elephant herbivory on *A. drepanolobium*. Trees from which ants had been removed suffered both a significantly greater likelihood of being browsed and branch lengths removed by the elephants.

Field observations and analysis are still underway.

10. IMPACT OF FRAGMENTATION IN THE COASTAL FOREST: CASE STUDY ON TERMITES (INSECTA: ISOPTERA)

Background, approach and objectives

The forest on the East African coast has existed for millions of years and has provided a refuge both for faunal and floral species that have evolved within it and for those that evolved outside. The resultant effect is a high level of endemism.

In the past, the forest covered an extensive area along the coast, but in the course of time, it has been destroyed to supply wood for fuel, building and carving. A large portion of the forest has been cleared to give way for farming and tourist development. As a result, the coastal forest remaining today exists as a series of small fragments, isolated from each other by expanding agricultural land, degraded scrubland and in some areas, savanna woodland. The remaining forest is of great conservation interest, since it is surrounded by an ever increasing human population that seeks to convert it to farmland.

Five forest fragments of different sizes were selected for the termite study. These are Arabuko Sokoke (size 41,716 ha), Marenje (size 1641 ha), Gongoni (900 ha), Muhaka (<200 ha) and Longo Mwagandi in Shimba Hills (<100 ha).

Termites are important indicators of human-induced changes since their species composition changes with alteration in landuse. When forests are cleared for agriculture or other forms of human development, termite species dependent on wood or woody litter decrease, while those with deep subterranean nests and ability to live on crops and crop residues increase. The key objective of this study is to establish and monitor the taxa of termites that habituate the fragmented forest. The taxa selected will be used for monitoring biotic response to anthropogenic environmental change associated with habitat fragmentation and modification.

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Cover photographs, clockwise from upper right:
Woman and child suffering with malaria, Coast Province, Kenya;
packaging processed honey in ICIPE's Apiculture Quality Control Laboratory;
woman farmer from Suba District, Kenya with new calf fed on *Desmodium* forage;
Iolaus icipe Çollins & Larsen;
Original photograph of katydid by Antony Bannister of Gallo Images, SA.

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