biennial report highlights

2008-2009

icipe

African Insect Science for Food and Health

biennial report highlights

2008-2009

icipe

African Insect Science for Food and Health

P. O. Box 30772-00100 Nairobi, Kenya; Tel: +254 (20) 8632000, Fax: +254 (20) 8632001/2; *icipe@icipe.org*, www.*icipe*.org

icipe biennial report highlights 2008–2009

ISBN: 92 9064 213 X

Published by

icipe Science Press
P. O. Box 72913-00200
Nairobi, Kenya
Tel: +254 (20) 8632000
Fax: +254 (20) 8632001/2
E-mail: isp@*icipe*.org
www.*icipe*.org

Compiled and edited by: Liz Ng'ang'a and Christian Borgemeister
Editorial assistance: Dolorosa Osogo
DTP, graphics and cover design: Irene Ogendo
Printing: KulGraphics Ltd.

The following provided additional input:
Eliud Muli, Daisy Salifu, Hellen Gatakaa, Sunday Ekesi, Suresh Raina, Sospeter Makau, Esther Kioko, Donald Kachigamba, Susan Sande, Johnson Nyasanikia, Baldwyn Torto and Simon Muriu

Cover photos courtesy of Santiago Escobar and Fred Makhulo (*icipe*)

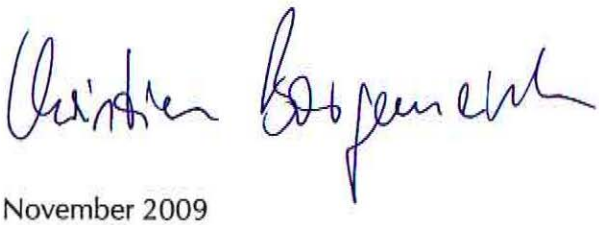
CONTENTS

MESSAGE FROM THE DIRECTOR GENERAL

Prof. Christian Borgemeister, Director General, *icipe*

Fruit flies, statistics, honey and silk in North Africa and malaria control – these are the main stories in this biennial report from *icipe*. No doubt, these topics are highly diverse. But this diversity reflects the wide scope of activities in our Centre. Moreover, varied as they are, these articles also share a number of common denominators. One is the rigorous and uncompromising approach to science, which *icipe*, in tandem with the global scientific community, ascribes to. This thoroughness necessitates sharp, accurate and often highly sophisticated quantitative analyses of data. Indeed, in many cases, it is this 'number-crunching' that distinguishes the good from the not-so-good research. Therefore, *icipe*'s two statisticians, Hellen Gatakaa and Daisy Salifu are fundamentally important in ensuring that our research outputs are correct and at par with the best in the respective fields on an international scale. This kind of support and guidance is especially important for all the young African scholars that populate our labs, offices and experimental sites across the continent. This brings me to the second common denominator between the stories in this report: building scientific capacity in Africa for Africa. Simon Muriu experienced first-hand the burden of malaria during his upbringing in rural Kenya, which influenced his later decision to learn more about the disease and its ever present vectors. We at *icipe* are proud to have contributed to the forming of this young, promising African health specialist. But we recognise that many more Simon Murius are needed to address the glaring shortfall of well-trained professionals like him. *icipe*'s philosophy of capacity building combines academic exactitude with hands-on training, frequently in field projects like the one in the Mwea Rice Irrigation Scheme where Simon learned to fight mosquitoes. This enables young scholars to 'know' the problems that truly affect communities in Africa, and what can be done to overcome them. Which leads me to the third common denominator of the four articles, and in general of the work we are doing at *icipe*: development. Often, rural Africa is stuck in a subsistence rut, without real opportunities to engage with the rest of the economy. The few commercial ventures in these regions are often unsustainable and environmentally disastrous, like the 'charcoalisation' of many parts of the continent. For more than a decade *icipe*'s Commercial Insects Programme has been developing practical strategies for African farmers to utilise their surrounding biodiversity to produce honey or silk. These two commodities can lift whole communities, and especially women, out of poverty. Eliud Muli speaks about his experiences with rural honey and silk producers in The Sudan, Egypt and Yemen, and how many of them are turning around their economic fortunes. The fourth common denominator is international collaboration. Fruit flies and other pests know no borders. Hence, any attempt to control them that stops at a national boundary will be futile. Only an international

and collaborative approach will effectively address the ever-increasing cross-boundary threats to African agriculture, especially those caused by alien invasive species. *icipe*, with its well developed network of collaborators in Africa and beyond, its internationally renowned quarantine facilities and its close to 40 years experience of 'working in Africa-for-Africa' is well positioned to help overcome many of these challenges. I hope that these four features will entice you to learn more about *icipe*'s work, and I invite everybody to visit us, either virtually at www.icipe.org, or at our various sites across Africa.



November 2009

PLANT HEALTH DIVISION

Contributing knowledge on *Bactrocera invadens*

***In March 2003, the invasive fruit fly* Bactrocera invadens *was reported to have invaded Africa from the Indian sub-continent. This news caused great concern to stakeholders in the fruit industry, as this highly invasive and polyphagous species was anticipated to cause even more damage than the native African fruit flies that were already crippling the continent's fruit production. icipe scientists swung into action, to research ways to understand and control the insect, described at the time as "a pest completely new to science". In the article below, icipe scientist Dr Sunday Ekesi describes how the centre has contributed towards the scientific understanding of* B. invadens.**

Photo caption: In many parts of Africa, small-scale farmers depend on the production of mangoes as a source of nutrition and income. Through its integrated pest management and post-harvest strategies *icipe* is helping farmers across the continent to produce healthy mangoes, thereby improving their livelihood – *PHOTO: icipe*

Reputed to be the most commonly eaten fresh fruit worldwide, the mango is particularly special in Africa, where it is a source of income and nutrition for many smallholder families. In many parts of the continent, the cultivation of mangoes has become popular, as the crop requires little labour, water or farm inputs. Mangoes also contribute to the export earnings of many African countries, as well as employment for a wide spectrum of people.

However, as is the case with other fruits, Africa's production and export of mangoes is way below potential. This is mainly due to fruit flies, which not only increase production costs but also seriously reduce the quality and quantity of marketable mangoes.

"Fruit flies attack fruits by laying their eggs into them. These eggs then hatch into maggots that feed on the decaying flesh. Infested fruits quickly become rotten and inedible, eventually dropping to the ground, and are thus completely lost to the growers," explains *icipe* scientist Dr Sunday Ekesi.

Dr Ekesi explains that for many years, the main constraint to the production of mangoes has been a plethora of indigenous African fruit flies, the most notorious being the mango fruit fly *Ceratitis cosyra*. Since 1994, *icipe* had been working with mango growers in several parts of Kenya to tackle this pest using environmentally friendly, affordable and accessible integrated pest management (IPM) strategies. Indeed, by 2001, the researchers had succeeded in developing a control package for *C. cosyra*, that included baiting and trapping techniques, use of insect killing fungus, and the sanitation of orchards to rid them of fallen fruits. The researchers were applying this package, in Kenya's Rift Valley, while continuing to monitor populations of the pest in Nguruman area. It was indeed during their routine seasonal population studies that the *icipe* scientists recorded for the first time in Africa *B. invadens* in October 2003.

"Because several *Bactrocera* species are well documented as notorious pests, which are ranked high on quarantine lists worldwide, we knew that the arrival of *B. invadens* spelt trouble for all stakeholders in the fruit industry in Africa. Moreover, although *B. invadens* has many host plants, such as citrus, cashew, papaya, guava, avocado, tomato and pepper, and several wild plants as well, the mango is its preferred fruit. At the very least, we estimated that the pest would reinforce the already devastating native African species," says Dr Ekesi.

Through the Centre's extensive research on fruit flies, icipe researchers have identified fallen fruits, either as windfalls or harvest rejects, as a contributory factor to the breeding of fruit flies. Therefore, the icipe IPM package for fruit flies includes orchard sanitation, by removing fallen fruits and depositing them in an augmentorium (a tent-like structure that retains adult fruit flies but allows parasitoids to escape) – PHOTO: icipe

As in all its research, icipe considers as critical the participation of stakeholders in developing knowledge on Bactrocera invadens. *In this picture Dr Sunday Ekesi is pictured in discussion with officials of the Kenyan Ministry of Agriculture and Malindi mango growers, during a field visit to the district – PHOTO: icipe*

Another point of concern for stakeholders, Dr Ekesi explains, was the fast speed at which the pest was spreading across the continent. Within a span of one year of it being reported in Kenya, *B. invadens* had moved to 10 other countries within the continent, spreading first to Tanzania and Uganda, and then to several Central and West African countries. Today, the pest has been reported in 28 African countries, including the Comoros Islands and the Republic of Cape Verde.

The *icipe* researchers therefore incorporated *B. invadens* into the ongoing fruit fly management project, expanding their studies beyond Kenya, to Uganda, Tanzania and Benin. Among the first steps was the assessment of the abundance, distribution, pest status, seasonality and host plants, and the identification of areas where additional information on the pest was required.

Dr Ekesi explains that the introduction of an alien invasive species in an area can alter various relationships and distribution patterns with indigenous species. "In general, the opportunity to study interactions between the invasive and native species in ecological studies on insects is missed because of how swiftly they occur, and the fact that most studies are focused on controlling the pest," notes Dr Ekesi.

"We speculated that with the arrival of *B. invadens*, competitive displacement of native fruit flies appeared to be in progress. However, despite this emerging trend, the dynamics between the invasive pest and the indigenous ones had not been studied in Kenya," he further explains.

For three years, from October 2005 to October 2008, the *icipe* researchers monitored seasonal and annual adult fruit fly populations in the Nguruman area, during and off the main mango seasons. "Throughout the entire study it was clear that *B. invadens* was becoming the predominant species, and within four years, the invasive pest had displaced the native *C. cosyra,* constituting 80% of fruit fly population in the traps," says Dr Ekesi. When the *icipe* scientists assessed the level of damage caused by the fruit flies on the mangoes, they noticed unusually high densities of *B. invadens* over the native *C. cosyra*.

To further understand the population dynamics of both species, the scientists assessed the role of fallen fruits (either as 'windfalls' or harvest rejects) as a possible breeding

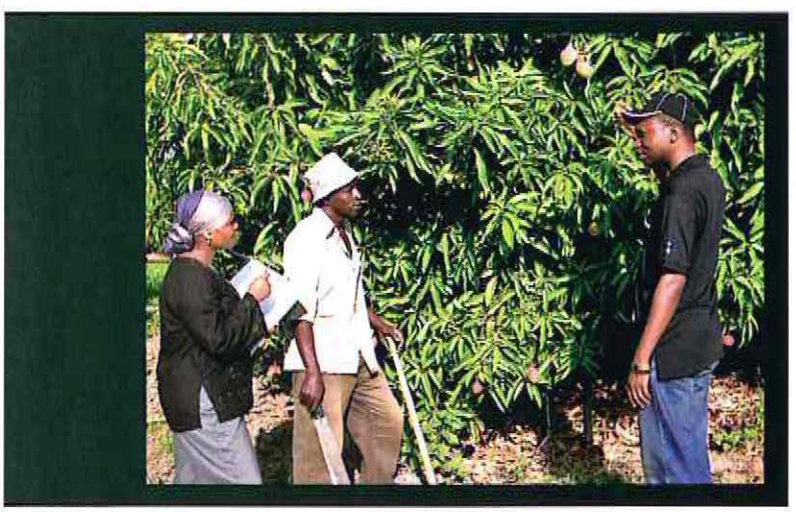
reservoir for the flies. "The test showed high levels of infestation in fruit samples collected from the ground, which means that orchard sanitation should be an integral part of integrated pest management (IPM) against *B. invadens* in mango orchards," says Dr Ekesi.

The results obtained from this study not only confirmed that *B. invadens* was displacing the native fruit fly species, but also explained why it was able to do so. One reason was because the invasive pest has a higher reproductive capacity than the indigenous species. In addition, *B. invadens* is a very mobile insect, which means that it tends to arrive first at host resources, giving it competitive superiority to *C. cosyra*. Importantly, in its new environment, *B. invadens* also stands a chance to thrive better as it is no longer under threat from its co-evolved natural enemies.

The *icipe* study also contributed further knowledge on the bioecology of *B. invadens*. For instance, the speed at which the pest displaced *C. cosyra* suggests that *B. invadens* has adapted to using the mango as host fruit over a long period. The research also provided baseline information necessary for a successful fruit fly suppression programme, through IPM and classical biological control. "The trend of the three-year annual population dynamics distinctly showed peak abundance of both fruit flies to be between the months of October to December, which indicates when management based on baiting technique and application of entomopathogens should commence," says Dr Ekesi.

He adds that the results of this study also showed that *B. invadens* was capable of year-round breeding, indicating that alternative host plants around a mango orchard were playing a part in the survival and thriving of *B. invadens*. Based on this inkling, between June 2006 to January 2009, the *icipe* researchers conducted a host plant survey for *B. invadens* in Kenya, Benin and Tanzania, which suggested further that the pest may be emerging as a polyphagous species.

To obtain more knowledge on the insect, the *icipe* scientists also conducted complementary laboratory based experiments. It was necessary, for instance, to have quality flies to use for evaluating the effectiveness of various fruit fly control packages, for instance some attractants and entomopathogens that had been applied successfully



icipe's pest management strategies are designed to be easily accessible and affordable to small-scale and resource poor farmers. In this picture, Dr Sunday Ekesi and Fikira Kimbokota, a PhD scholar at icipe, give advice to Mr Njoroge Mwangi, a farmer from eastern Kenya, who is distraught about the poor performance of his mango trees due to the B. invadens problem – PHOTO: icipe

icipe's research on Bactrocera invadens *has involved many components, both in the field and in the laboratory. In this picture, Mr Peterson Nderitu a research assistant in the Centre's African Fruit Fly Programme is collecting the eggs of* B. invadens, *for an experiment on the cold treatment methods to rid citrus fruits of the pest – PHOTO: icipe*

in *icipe's* work on *C. cosyra*. The flies were also needed for basic biological studies in the laboratory and screenhouse, as well as post-harvest treatment. Therefore, in April 2007, the scientists started rearing *B. invadens* colonies on artificial diet, using adult flies from rotten mangoes collected at local markets in Nairobi. This project led the *icipe* scientists into areas of fruit flies research that had so far received little attention, for instance the effect of environmental variables such as temperature and relative humidity on fruit fly species. Such information, Dr Ekesi explains, is important for understanding the insect, from various aspects including the temporal and geographic patterns of *B. invadens* and how the pest can be suppressed. The knowledge is also valuable in guiding the release of natural enemies, as well as the relationship between the pest and other native fruit flies.

In the meantime, the researchers were also investigating the native natural enemies in Kenya, Tanzania and Benin, to see if there were any that could attack *B. invadens*. "Although we had collected information regarding the parasitoid complex in the mango regions in Kenya in previous studies, we needed to further characterise them, to assess the rate of parasitism, and find out if any of the parasitoids would make new associations with the invasive species," Dr Ekesi explains.

The team also needed baseline information to predict potential competitive or complementary interaction between the indigenous and exotic parasitoid species. After carrying out tests on two indigenous parasitoid species, *Psyttalia* and *Tetrastichus*, the scientists concluded that none of them could be used for classical biological control of the pest because the immune system of *B. invadens* was stronger than that of the parasitoids, and the parasitoid eggs were encapsulated by the fruit fly. "Importantly, through the results of this study, we learned that in addition to the very destructive nature of *B. invadens*, it also has the potential to act as an ecological sink for some of the indigenous generalist parasitoids, and may even cause their extinction," Dr Ekesi notes.

As such, using some financial support from IITA, *icipe* took the search for natural enemies for *B. invadens* to the pest's putative aboriginal home, Sri Lanka, with the assistance of the country's Department of Agriculture, Horticultural Crops Research and Development Institute (HORDI). The activity required the posting of an *icipe*

scientist, Dr Samira Mohammed to Sri Lanka for six months. Although three natural enemy species were detected, their parasitisim rates on *B. invadens* were low in all the fruits collected and in the laboratory suitability and acceptability test.

This meant that a second trip was necessary, which commenced in July 2007, this time by Dr Maxwell Billah, another scientist from *icipe*'s African Fruit Fly Programme. The exploration work was more intense and incorporated a wide range of activities on the pest as had been done in Kenya, Uganda, Tanzania and Benin. "From the population studies, although *B. invadens* was found in all agroecological zones of Sri Lanka, the pest seemed to prefer the low and intermediate areas, which reaffirmed our results from Kenya that it is a lowland resident pest," Dr Ekesi notes.

He adds that from the range of natural enemies that were collected, it became clear that a large diversity of natural enemies of the *Bactrocera* species exist in Sri Lanka.

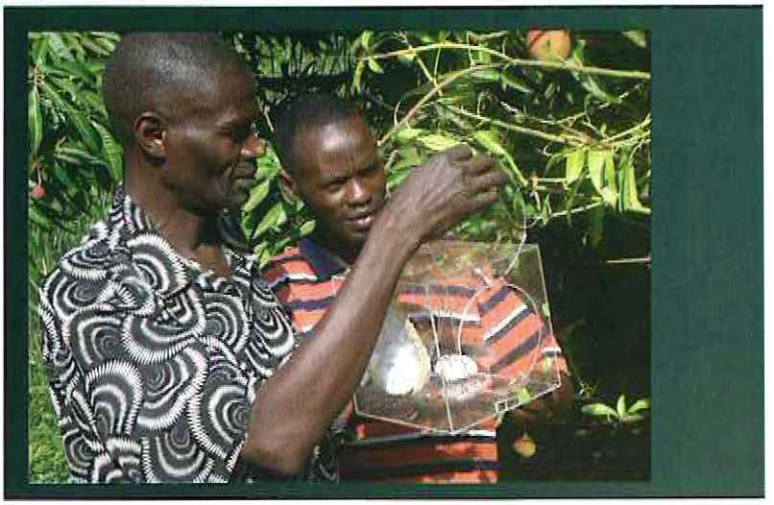
The scientists also obtained clear evidence that colonies of *B. invadens, B. zonata* and *B. kandiensis,* which are the dominant fruit fly species in Sri Lanka, could easily be established. They also succeeded in establishing colonies of the major parasitoid species, and identified the most attractive for future studies as *Fopius arisanus* and *Diachasmimorpha longicaudata*. In addition, they encountered some major alternative host plants such as *Terminalia catappa* (tropical almond), *Syzygium jambos* (rose apple) and *Solanum mauritianum* (bugweed). These plants are major reservoir hosts that could be good sources of natural enemies in future explorations.

Unfortunately, the *icipe* scientists were unable to import the promising parasitoid species from Sri Lanka to Africa to suppress *B. invadens*, as the restrictions of the Convention on Biological Diversity (CBD) related to movement of biological control agents made it difficult to obtain the necessary permits.

However, in parallel to the exploratory activities in Sri Lanka, the *icipe* researchers sought parasitoids from other established laboratories worldwide. They succeeded in obtaining *F. arisanus* and *D. longicaudata* from the USDA-ARS laboratory in Hawaii for introduction and testing against *B. invadens* in Africa. After encouraging laboratory results on the effectiveness of *F. arisanus* against *B. invadens*, the scientists submitted

Fruit flies are attracted to ripening fruits such as mangoes. The flies lay their eggs beneath the skin of a fruit, and upon emerging, their larvae continue their feeding damage into the fruit, completely ruining it. Close to this big fly is a fruit fly parasitoid (Fopius arisanus) exploring the fruit surface to lay its eggs in the fruit fly eggs – PHOTO: icipe

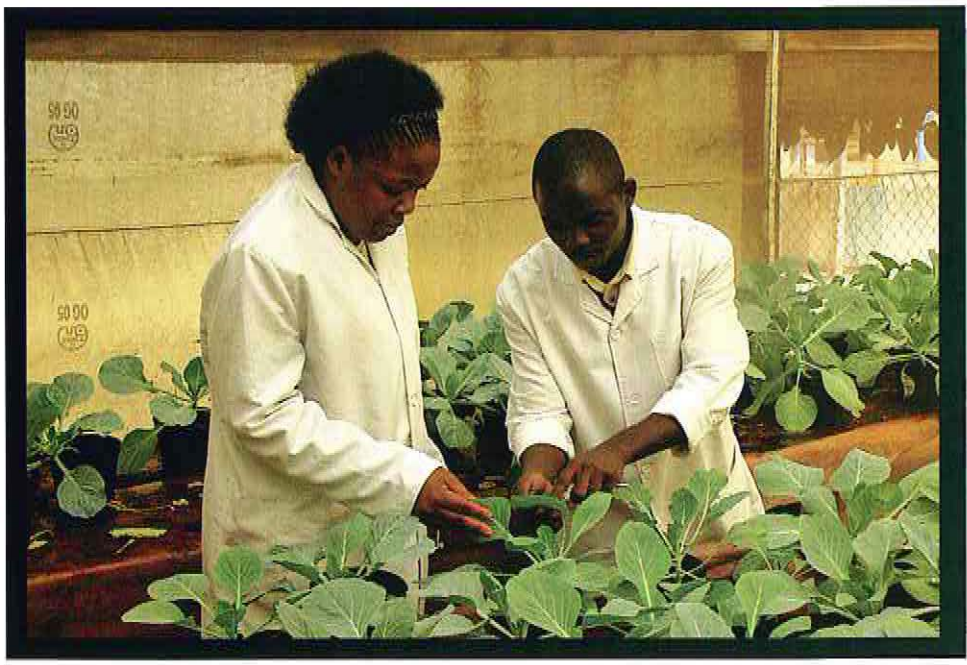
Mr Binito Atonya (left), a Divisional Agricultural Officer in Nguruman, Kenya's Rift Valley area, assists Mr Martin Wanyonyi, technical staff at icipe to release the fruit fly egg parasitoid Fopius arisanus, *a natural enemy of the invasive fruit fly* B. invadens *in a fruit orchard. icipe is currently conducting pilot field releases of the parasitoid in Kenya, Benin and Tanzania – PHOTO: icipe*



applications for import permits to the Kenya Plant Health Inspectorate Service (KEPHIS), Tanzania Ministry of Agriculture and Cooperatives, and Service de Protection des Végétaux, Ministry of Agriculture of Benin, to conduct experimental field biological control. This enabled them to commence pilot releases at the beginning of the 2008/2009 mango fruiting season in both Kenya and Tanzania and in March 2009 in Benin. Already, the scientists have recovered the parasitoid *F. arisanus* from field populations of *B. invadens*, which indicates success although it is too early to declare establishment of *F. arisanus*.

He adds that this classical biological approach with *F. arisanus,* if complemented with IPM packages such as baiting technique, soil inoculation with entomopathogenic fungus, male annihilation (removal of a large number of males using male attractant and a killing agent) and orchard sanitation using a tentlike structure called 'augmentorium' (it keeps fruit flies inside but allows beneficial parasitoids to escape), can result in over 80% suppression of *B. invadens* leading to production of quality fruits for domestic and export markets.

To further help exporters from Africa access lucrative overseas markets, in view of their strict quarantine regulations, the *icipe* scientists are working on post-harvest treatments parameters, such as hot water treatment of mangoes or cold treatment of citrus and avocadoes, which kills all immature stages of the fruit flies that may be in the fruits.



Research Support Units

Telling a story through numbers

Of late, biostatistical science – the application of statistics, mathematics and computing to a wide range of topics in biology and the life sciences – has gained increasing prominence across the globe. icipe recently recruited two biostatisticians, Hellen Gatakaa and Daisy Salifu. In the article below, these two young and dynamic African women, one from Kenya and the other from Malawi, narrate the diverse and interesting routes they have taken into the world of biostatistics. They also take stock of their accomplishments at icipe so far and discuss the critical role that biostatistics can play in aligning scientific research more closely to Africa's developmental needs.

Photo caption: Daisy Salifu, one of the two recently recruited biostatisticians at *icipe* discussing with Peter Malusi, a laboratory technician, ongoing research on kales, one of the most important vegetables in East Africa. *icipe* recognises the importance of biostatistics towards realising its mandate of contributing food security and better health to communities across Africa – PHOTO: *icipe*

Unlike many students, especially girls, who 'fear' mathematics, Hellen Gatakaa developed a love for the subject at an early age. Hellen, who was born in 1976 in Meru, but grew up in Malindi where her parents relocated when she was just three years old, says: "I think one's perception of mathematics is shaped by the attitude and atmosphere that they grow up in. My own liking of the subject was greatly motivated by my secondary school mathematics teacher, who was a woman."

However, Hellen is the first to admit that as a young student, she had a problem relating the applicability of mathematics in real life. Therefore, on completion of her 'O' level studies, she applied to the Catholic University of Eastern Africa to study accounting, a course through which she envisioned a clearer career path. But as chance would have it, the University admitted her to undertake a BSc degree in mathematics.

Hellen accepted the offer, but with mixed feelings. "I kept on wondering where I would apply what I was learning, other than pursuing a career in teaching or lecturing," she recalls.

Even well into her second year at university, Hellen was hell-bent on changing her course to accounting. But fate intervened through one of her lecturers, Prof. John Owino, who convinced Hellen, not only to stay on the mathematics course, but that she would not regret the decision. Today, Hellen recalls with gratitude how Prof. Owino mentored her, to the extent of giving her the opportunity to work with him during the holidays. "He would take me through the projects he was working on, giving me a chance to experience various aspects, from designing questionnaires, to data collection, entry and analyses," she recalls.

By the end of her first degree in 2002, Hellen was sold onto the possibilities of mathematics. Therefore, straight after, in 2003, she enrolled for a Masters course in Biometry at the University of Nairobi. During this course, Hellen had the chance to apply her skills to the world of development, through an attachment with the Poverty Reduction and Economic Recovery (PRER) programme of the UNDP-Somalia Office. Two years later, the organisation called her back to work as a data entry and processing assistant for the poverty mapping survey. But it was a six-month internship at the Kenya Medical Research Institute (KEMRI) Biostatistics Department in Kilifi, in late 2005, that launched her into the world of scientific research.

Hellen Gatakaa believes that when properly applied, biostatistics provides the vital link between scientific research and the statistical significance of its data. The beauty of this discipline, she says, lies in its ability to use numbers to tell a story – PHOTO: icipe

"In the ever changing environment of scientific research, biostatistics is becoming more and more critical, especially in developing countries in Africa and elsewhere, where communities face multiple problems such as poverty, food insecurity and poor health," says Daisy Salifu – PHOTO: icipe

The journey into the world of statistics has been even more convoluted for Daisy Salifu, who grew up in southern Malawi, where she was born in 1970. She recalls that as a young girl her utmost desire was to be a nurse, for no other reason than to wear the white cap that nurses adorned on their heads in those days. But a 'random' university course choice dramatically altered Daisy's career path. "I casually selected agriculture as one of the options for my university studies, based on which I was accepted to the Bunda College of Agriculture, a constituent College of the University of Malawi," she explains. She joined the University in 1989, completing the five-year degree with a bias in Crop Science, based on her final year project titled: "Screening bean genotypes for drought tolerance".

The degree earned Daisy a ground breaking appointment at ICRISAT-Malawi, as a Research Associate in the Plant Breeding Section, becoming the first woman researcher to be employed in the organisation. She was working on groundnuts, conducting crosses for desirable characteristics of the crop, such as disease resistance, high yields and drought tolerance, as well as trials for lines coming out of the breeding programmes. Importantly, Daisy was also responsible for the data analysis processes, for her own section, as well as for other sections.

In 1996, Daisy found herself back at her old school, Bunda College. "It so happened that the College had two openings; one for a Statistician and the other for a Plant Breeder. I applied and interviewed for the plant breeding position, but the college decided to offer me the statistics position, which was a priority as there was no statistician on the staff," she explains.

She took up the position, as a staff associate, housed in the Crop Science Department. Although, she was charged with assisting students in tutorials and research projects, in many cases she would fill in for lecturers, expanding her responsibilities in the position.

A year later, Daisy was on the move again. A British Council Chevening Scholarship enabled her to travel to the UK, to pursue an MSc in Biometry at the University of Reading. Once there, she found that she had to do a one-year Postgraduate Diploma in Statistics before proceeding to the MSc. "Although this sounds simple, I found the

mathematics quite challenging, considering that my background was in agriculture. But it helped me get to grips with the statistical knowledge I needed for the MSc," she says.

Armed with her MSc Degree in Biometry, Daisy returned to Malawi in 1999 and went back to Bunda College, where she worked for the next four years. But another move was just around the corner. In 2003, Daisy left Malawi, to accompany her husband who was taking up an appointment with UNEP's headquarters in Nairobi.

Initially, I thought this move would be a professional loss for me as I would have to put my career on hold. But it turned out not to be. Thanks to a Memorandum of Understanding between Bunda College and Jomo Kenyatta University of Agriculture and Technology (JKUAT), I got a contract as a visiting lecturer in Biometry in the university's Faculty of Agriculture. I worked at JKUAT for five years, from 2003 to 2008, before joining *icipe* in January 2009," she says.

Although Hellen and Daisy have followed different routes to form their careers in biostatistics – and even to *icipe* – today they share one conviction: The critical role that biostatistics can play in making scientific research more impactful on the development of Africa.

"Globally, biostatistics, the application of statistics in the biological sciences, is becoming unquestionably an essential tool in scientific research. Scientific research is all about looking for solutions to problems facing the society in a structured way. This is where biostatistics comes in, as a useful tool for researchers in the planning, analysing and interpreting the results of an investigation", explains Daisy.

She adds that biostatistics is even more critical in this era when the ways in which scientific research is being conducted are rapidly evolving. Such changes, she says, include the shifting focus of research for development, to generate more impact on old and emerging problems, the need for cross-disciplinary work, multi-scale approaches that look beyond small experimental units to farms, landscapes and regions and the involvement of various stakeholders, such as farmers, in research processes.

Hellen agrees, noting that although scientific research is undeniably critical for developing countries, in many developing countries in Africa and elsewhere, it is

Through its 4-H research paradigm and focus on building African scientific capacity, icipe offers an exciting variety of experiences for biostatisticians. In this photo, Hellen Gatakaa in discussion with icipe students (clockwise) Saliou Niassy, from Cameroon who is researching on the control of Frankliniella occidentalis, a pest of vegetables, Benjamin Muli from Kenya, is working on biological control of maize cob- and stemborers and Nigat Bekele Abebe from Ethiopia, who is conducting a socioeconomic study of smallholder horticultural production in Kenya – PHOTO: icipe

One of icipe's goals is to enable Africa's poor and marginalised communities to improve their livelihoods through the exploitation of beneficial insects, in an environmentally sustainable way. In this picture, Daisy Salifu offers biostatistical advice to icipe ARPPIS scholar, Ayuka Teboh Fombong (Cameroon), for his research aimed at improving the health of bees, and in the long run the quantity and quality of the honey produced – PHOTO: icipe

lagging behind. She argues that in Africa, the incorporation of biostatistics in research processes can help circumvent some of the constraints to scientific capacity and outputs, for instance the issue of limited resources. "Biostatistics has the potential to improve the quality of the research being done, as it allows researchers to pay more attention to the essential components of research such as the design of studies/experiments, data and its analysis," she explains.

Within the short period of time that Hellen and Daisy have been at *icipe*, the impact of their skills is being felt. Hellen, for instance has helped with a crucial assessment of a project of *icipe's* Commercial Insects Programme in the arid and semi-arid Mwingi District in eastern Kenya. Started 10 years ago, this pioneer project is helping people in this fragile ecosystem to make a living while protecting the environment, through silk farming and beekeeping. *icipe's* activities in the programme include providing training to registered community groups on modern sericulture and apiculture technologies, processing and marketing. This year, the scientists conducted a socioeconomic survey, to assess the difference in the impact of the programme between the community groups that have received training and those that have not. Using the survey questionnaires, Hellen was able to assist in creating a database and in interpreting the results. The knowledge obtained helped the scientists to understand the impact that the training activities have had on the income of the communities. Moreover, the researchers are now able to make clear links on how the programme is helping to improve the overall welfare of the communities, which is the utmost goal of *icipe*.

"Having a biostatistician on the case was useful because it made the process more efficient. Hellen has a better grip on the statistics, which means she can work at a faster pace. But more importantly she was able to guide us through the 'grey' areas and to make more meaningful interpretations to the data," says Dr Esther Kioko, who is in charge of the project.

A more gruelling task for the biostatisticians involves helping to review manuscripts for publication, in view of the exacting requirements of peer-reviewed journals. For instance, earlier this year, *icipe* PhD scholar, Susan Sande, submitted a manuscript on how proximity to forests can affect the quality and quantity of honey to a high impact journal. Susan had written the article using data that she had painstakingly collected over a period of one and a half years in the Arabuko-Sokoke Forest (one of the last of the

remnant indigenous forests in Kenya, and the largest and most intact coastal forest in East Africa). Faced with an intense critique from one of the reviewers, Susan sought Daisy's help. "It took the accomplished eye of a statistician to dispel the concerns raised by the reviewer by identifying counter-explanations in my data for the specific questions. Daisy was also able to guide me towards additional literature to support my responses. After that the paper was immediately accepted for publication," Susan notes.

When it comes to the centre's young scholars, the biostatisticians take a more hands-on approach. "I usually hold one-to-one discussion with the students on several aspects that are critical to proposal development. We review the objectives, making sure they are sound and clear. We then re-examine the hypothesis, to ensure that it is testable. After that we discuss the design of the study, the sample size, the data/variables to be collected and the methods to be used for analysis," explains Daisy.

For instance, Johnson Ounya Nyasanikia, a Kenyan PhD student at *icipe*, is working on the ecology and management of *Frankliniella occidentalis*, a pest that constrains the production of French beans in Kenya. "My challenge is to make sure that I have the right sample size of farmers to make the right conclusions. Daisy's assistance has been useful in selecting a sample size. She has also been helpful in the designing of the experiments in the field, to make sure that I avoid issues such as inadequate data replication. She also helped with preliminary data analysis, which enabled me to do an abstract for an international conference", he explains.

On their part, the interaction with scientists and students is giving Hellen and Daisy an insight on the biostatistics requirements of *icipe*. To respond to these needs they are conducting an annual biostatistics course at the Centre. "We held the inaugural course this year with great success. We intend to use a needs assessment and the experience gained from the annual forum to run other module-based statistical courses. We also plan to diversify the students' statistical computing skills by introducing them to more packages and especially R, a free-of-charge web-based statistical software package," explains Hellen.

Looking at the wider picture of biostatistics in Africa, the two professionals note that there is a relatively small number of applied biostatisticians in the region compared to the intensity at which scientific research is progressing.

icipe PhD researcher, Susan Sande (Kenya) (extreme right), pictured on the edges of the Arabuko-Sokoke Forest, with a group of children whose families live adjacent to it. Using biostatistical assistance, she was able to share the findings of her research, supporting the conservation of this important natural resource, with the international community – PHOTO: icipe

"When I was developing my research project proposal, I found the statistical guidance very useful. I am now implementing my project, and I continue to consult Hellen and Daisy to ensure the statistical credibility of my work," says icipe PhD student, Donald Kachigamba (Malawi), pictured here preparing Petri dish substrates for his experiments on fruit fly oviposition – PHOTO: icipe

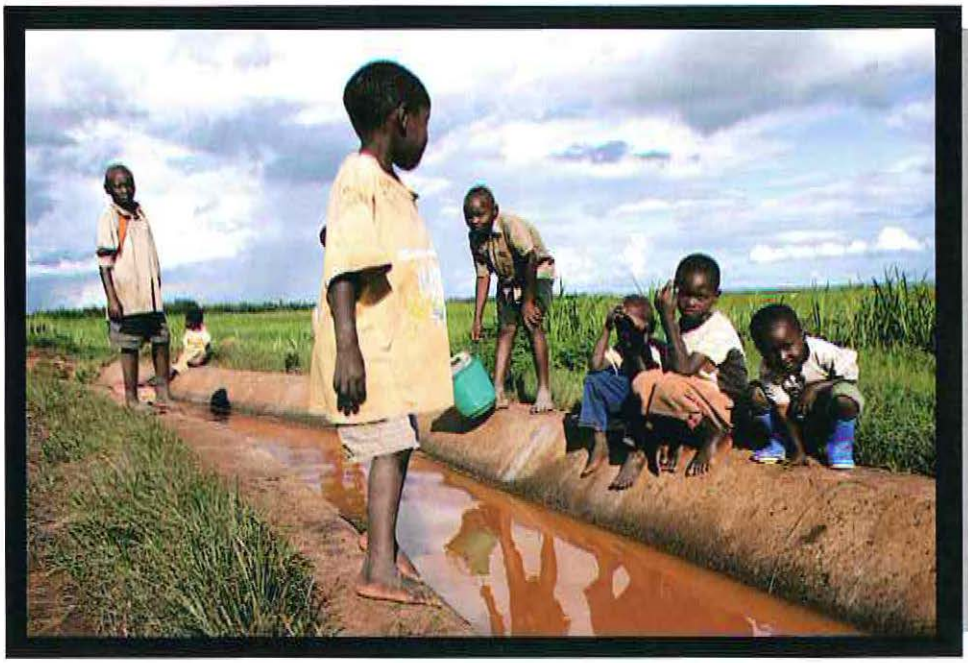
"There are many trained biostatisticians but few get the opportunity to work in a scientific environment. Some institutions also do not have the facilities, for instance computers and access to the Internet or to the relevant literature etc., for biostatisticians to develop their skills," says Hellen.

Daisy feels that the continent's human resource capacity is limited, both in terms of numbers and competence. She believes that the situation is critical in universities, where, in many cases, the training that the students undergo is too theoretical to relate to real research practice. She also feels that there are not enough universities offering degree programmes in biostatistics or biometry.

Hellen agrees, adding that while theory is critical, it should be backed by practical sessions and that courses should be made interactive from an early stage. She also feels that students should also be exposed to scientific writing and critique so that they can appreciate the application of what they learn.

In the meantime, Daisy and Hellen are finding their work at *icipe* exciting for the sheer variety offered by the Centre's range of activities, which means diverse biostatistical assignments.

As Hellen sums up: "Biostatistics offers a very interesting career, as one encounters new challenges on a day-to-day basis. It is also a fast growing discipline that puts one on their toes. The beauty of it is that you are able to use numbers to tell a story! In the one year that I have been at *icipe*, I have observed students getting more and more critical with their data and carrying out appropriate statistical methods. This will no doubt have an impact on the quality of their research and subsequent publications."



Capacity Building and Institutional Development Programme

Nurturing young African scientific talent

One of icipe's missions is to develop integrated vector management (IVM) approaches, that are specifically tailored for different communities and regions. Closely linked to this, is the Centre's focus on training young African scholars to take regional and international leadership in insect science, to meet the needs of the continent as well as the challenges of a rapidly changing global environment. In recognition of this dual vision, every year, the Governing Council of icipe presents an award to one outstanding student at the Centre, based on a scientific paper published in an international peer-reviewed journal. Below, Simon Muriu who won the prize last year, shares his story, and what the special recognition by this group of eminent global professionals means to him and the communities that he works with.

Photo caption: Children playing along the canals in the Mwea Rice Irrigation Scheme of central Kenya. Simon Muriu's work played a critical role in advancing knowledge on the connection between rice cultivation and the way in which *Anopheles* mosquitoes select their hosts – PHOTO: Santiago Escobar

In December 2008, Simon Muriu received the coveted *icipe* Governing Council Award for his paper, which was published in the internationally renowned *Malaria Journal* in February of the same year.

The article, which was based on his PhD research on the population dynamics of malaria-carrying *Anopheles* mosquitoes in the Mwea Rice Irrigation Scheme in central Kenya, highlighted two key findings of Muriu's study.

First, it made a connection between rice cultivation and the way in which *Anopheles* mosquitoes select their blood meal hosts. Second, it suggested that the multiple blood-feeding behaviour of these malaria-transmitting insects makes domestic animals 'dead-end' hosts. In turn, this finding proposes the possibility that cattle, goats, chickens and so on, could be incorporated into malaria control programmes.

So critical are these findings to global malaria research that Muriu's paper achieved the 'highly-accessed' status, by the BioMed Central Statistical Office, which is based on the number of downloads for an article within the first month of publication. As a result, the article is now permanently flagged on the *Malaria Journal* website so that other scientists may make reference to it.

But for the young researcher, it has been a long journey to this international recognition. Born in 1976 in Mukangu village in Murang'a district of central Kenya, Muriu learnt early enough that no matter the odds, the world still offered limitless possibilities.

He describes his early life as a struggle, which saw him miss the opportunity to join the district secondary school he had been admitted to, based on his good performance in the primary school examination. His parents, a junior civil servant and a housewife, couldn't afford the fees. Instead, Muriu joined Gikandu Secondary, a local 'harambee' school. But this did not kill his spirit to do well.

"The school lacked adequate facilities, such as laboratory equipment. But looking at my parents and the struggle they were going through to raise my six siblings, I said to myself: 'I can't condemn myself to fate by giving up. What is that special thing I could have done if I had gone to a better school?'" he recalls.

Simon Muriu (pictured) at the icipe laboratories conducting analysis on Anopheles mosquitoes collected from the Mwea Rice Irrigation Scheme. The young researcher has risen above his humble background to carve a niche for himself in malaria research – PHOTO: icipe

Simon Muriu sampling Anopheles mosquitoes in the Mwea Rice Irrigation Scheme. The icipe PhD research programme enabled him to work on-site on one of Africa's biggest problems – the deadly malaria disease and how it is transmitted – PHOTO: icipe

The answer was hard work and focus, which paid off, and Muriu secured himself a place at the University of Nairobi, which he joined in October 1996 to study for a Bachelor of Science in Botany and Zoology.

Joining the university from an 'unprestigious' institution can be daunting, but Muriu found solace in the words of one of his lecturers and recently appointed member of *icipe*'s Governing Council, Prof. Canute Khamala. "He would often say to us: It doesn't matter which school you come from; you are now on the same platform as everyone else, and there is no reason not to be the best."

Alongside other lecturers, the don provided Muriu the impetus he needed, and he graduated with a first class honours degree. Apart from helping him earn this distinction, his fourth year project on medical entomology imbued in Muriu a lasting love for this discipline, which focuses on the impact that insects and arthropods have on human health.

"Having grown up in a rural area where people suffer from a myriad of tropical diseases such as malaria, I was intrigued by ways that could lead to solutions for them," Muriu explains.

So, a year later he went back to the University of Nairobi to undertake a Masters Degree in Applied Parasitology – the study of disease-causing parasites, under a German Academic Exchange Service (DAAD) scholarship. On completion of his coursework, one of Muriu's supervisors, Prof. Lucy Irungu, recommended him to undertake a project with the Centres for Disease Control (CDC) at the Kenya Medical Research Institute (KEMRI).

"I conducted my research at the KEMRI field station in Kisumu, where I learnt more about malaria vectors, how to do research projects, analyse, participate and contribute to the knowledge on malaria control interventions," Muriu explains.

Importantly, while there, the KEMRI station director informed him of PhD positions at *icipe*, under the African Regional Postgraduate Programme in Insect Science (ARPPIS). Muriu submitted an application, and was accepted on a DAAD-funded ARPPIS scholarship to join *icipe's* Human Health Division, headed by Dr John Githure. His

PhD research was based on a project being done in collaboration with *icipe* and Illinois State University (USA) to pilot the use of environmentally-friendly microbial larvicides in the Mwea Irrigation Scheme rice fields.

Irrigated rice fields, Muriu explains, are important hotspots for mosquito-borne diseases because of the numerous mosquito species present. Worldwide, more than 89 species of *Anopheles* are associated with rice cultivation and at least 23 species occur in a variety of aquatic habitats present in African rice agroecosystems.

At the same time, the degree of human–vector contact is an important component of disease transmission, and is used in planning and evaluating the risk of vector-borne diseases and the impact of vector control strategies.

"In order for a mosquito to transmit an infection to people, it must have at least two blood meals, by feeding on a human being to facilitate the uptake of malaria parasites. The blood meal also assists egg-laying in female *Anopheles* mosquitoes," he explains.

Significantly, Muriu further notes, in Africa, the risk of human exposure to disease transmission by the majority of the mosquito species found in rice irrigation schemes is not fully understood. This, he says, is because most studies are restricted to the main vectors of malaria and Bancroftian filariasis.

"With this background in mind, my study was designed to evaluate the choice of blood meal hosts by *Anopheles* mosquitoes in the irrigation scheme and the potential impact on the control of malaria," he explains.

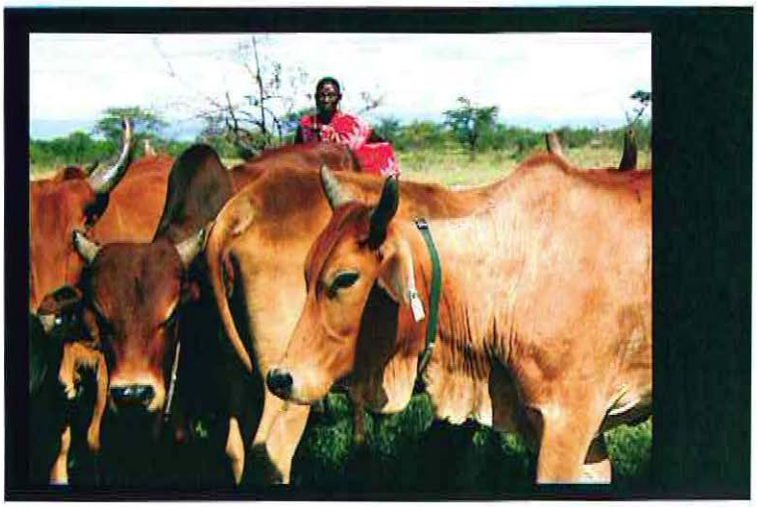
By February 2006, Muriu and his team conducted studies in eight sites in the scheme, including six villages where 75% of the land is under irrigated rice cultivation, and two villages outside the rice scheme.

In total, the team collected and successfully tested 3333 blood-fed female mosquitoes for host bloodmeal. This comprised eight different species of *Anopheles* mosquitoes occurring both inside people's houses and outdoors.

"Overall, we found that 69.9% of the blood meal was from bovines (cattle), followed by 8.1% from humans while the remaining was from goats and mixed blood meals. This

Young researchers at icipe benefit from working with both local communities as well as international collaborators. In this picture, Simon Muriu is pictured with Dr Benjamin Jacobs, then of Illinois State University, using a satellite map to explain to residents of a village in the Mwea Rice Irrigation Scheme of Central Kenya strategies for controlling mosquito larvae – PHOTO: icipe

Muriu's research showed that the multiple feeding behaviour of anophelines makes domestic animals, for instance cattle, 'dead-end' hosts of these blood-sucking insects because the animals do not get infected with malaria – PHOTO: Santiago Escobar



was the case in many of the species when analysed individually, including *Anopheles arabiensis*, the dominant malaria-transmitting species present in the study area," Muriu explains.

In contrast, the proportion of samples containing mixed blood meals was higher among mosquitoes collected outdoors, compared to those captured indoors.

"Because of the high mosquito densities, communities in the irrigation scheme use bednets to protect themselves against mosquito bites. As a result, to obtain their blood meal, the mosquitoes turn to domestic animals, which live in close proximity to the people. But the animals do not get infected with the malaria parasites, and they therefore become 'dead-end' hosts," Muriu explains.

Indeed, Muriu further expounds, when the patterns were separated by village, the human blood index for the malaria-transmitting mosquitoes was higher in the villages outside the irrigation scheme than those within it.

"These results show that integrated vector control strategies for malaria, incorporating the use of insecticide treated bednets (ITNs), and the management of larval and adult mosquitoes and so on, which *icipe* advocates, are possible. But their success lies in the scientific understanding of the population dynamics of the vectors and their susceptibility to specific interventions," he explains.

"These findings suggest that rice cultivation has an effect on host choice by *Anopheles* mosquitoes. Our data showed that mosquitoes feed less on people within the rice scheme, where irrigated cultivation is dominant, with trends being moderate in the unplanned rice agro-ecosystem, and highest in the non-irrigated agro-ecosystems, where there is minimal rice cultivation if any."

The research also indicates that zooprophylaxis – the use of animals to protect human health – may be a potential strategy for malaria control. However, Muriu cautions that before such a strategy can be adopted, it is necessary to assess how domestic animals may influence the transmission of other mosquito-borne diseases (e.g. arboviruses)."

Aside from these scientific achievements, the study showed that solutions for malaria control needed to be evaluated and implemented within local settings to ensure the best results. Indeed, building the capacity of communities in the fight against mosquitoes and malaria was one of the impressive outcomes of Muriu's study.

"Because of the intensity of the research, I had to reside in the Mwea irrigation scheme for almost four years. For instance, we needed to conduct mosquito collection once or twice every week. Moreover, we collected mosquitoes from people's homes, in their compounds and inside their houses and at times we had to do it at night. Of course we had to get their permission to do this. When you work and live in a community for a couple of years, you become part of it, and they become part of the research team as well," he comments.

With time, the Mwea locals started helping in the collection exercise. For the outdoor collection, Muriu used CDC light traps, which he would set up twice a week at six in the evening and collect at six the following morning. Village security personnel faithfully ensured that the lights were not stolen or damaged.

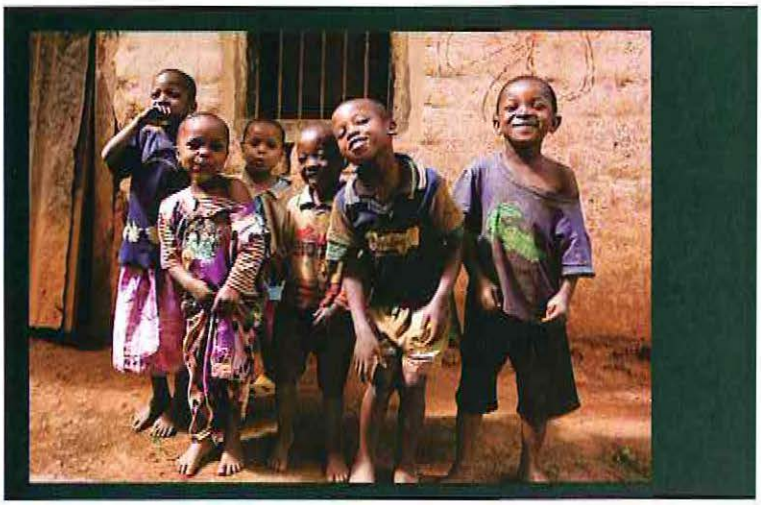
"Within no time, people were keen to understand more about our work. We would explain to them why we were collecting the mosquitoes and what we were going to do with them. The communities were always eager to hear the findings after the analysis. In this way, they got a better perspective of malaria, which depletes their earnings from rice cultivation, as most of the money is used to buy medicine. They understood the purpose, and some of the science involved in our work and how it affected their lives. So now when we go back with the recommendations based on the results, they are keen and excited to be involved in implementing them," Muriu notes.

The National Irrigation Board is also a critical partner in the process, and has leased the *icipe* team space for a field station where part of the analysis of the samples was done.

Never one to forget his background, this integration between science and community is an aspect that Muriu wants to be involved in more.

A woman in the Mwea Rice Irrigation Scheme (Central Kenya) works in a rice paddy planted with soya crop to mop up excess water thereby eliminating mosquito breeding sites. Simon Muriu says he found the communities and extension workers in the region critical partners in his data collection and analysis – PHOTO: Santiago Escobar

In sub-Saharan Africa, children under five years are a high risk group for malaria. As a young African researcher, Simon Muriu considers himself advantaged to contribute to Icipe's vision to ensure that Africa's children not only survive this deadly disease, but also enjoy a healthy and vibrant childhood – PHOTO: Santiago Escobar



"As a scientist trained in malaria vector control on the ground, I have the experience, the energy and the drive to work with institutions where communities present their problems and get involved in the process towards finding solutions for them," he says.

But this does not in any way mean that the young scientist is parochial. He is conscious of the fact that his study and the recognition it has brought him came as a result of collaborations between local and international organisations, including the University of Nairobi's School of Biological Sciences, the Centre of Geographic Medicine at the University of Alabama, the Department of Zoology of Jomo Kenyatta University of Agriculture and Technology and KEMRI's Centre for Geographic Medicine Research.

And, having successfully defended his PhD thesis in early 2009, Muriu sums his career plans this way: "No matter what achievements I make in life, I am constantly aware of my own humble background and upbringing, and the help I have received along the way. For this reason, I have a personal commitment to being part of the African and global research society that is addressing the challenges of poor communities, so as to improve their health and secure their livelihoods".

Environmental Health Division

A life among bees

Having joined icipe in 2000, as a PhD researcher, Dr Eliud Muli is today one of the Centre's commercial insects experts. In the interview below, he talks about his long association with bees; as a young boy growing up in eastern Kenya, and as a scientist helping poor and marginalised communities improve their livelihoods with his knowledge of the insects. In particular, he speaks candidly about the motivation, challenges and momentous occasions of implementing icipe's commercial insects programme in the Sudan, Yemen and Egypt, amidst diverse topography and communities still reeling from civil strife.

Photo caption: Dr Eliud Muli helps a farmer in Yemen harvest honey from a honeycomb. The *icipe* scientist has come a long way from his days as a young boy, enjoying the thrill of a bee-chase. Today, he traverses the remotest and marginalised regions of sub-Saharan Africa and the NENA region helping communities to employ modern day beekeeping techniques – PHOTO: *icipe*

Q. What is your background?

A. I grew up in eastern Kenya, and in my community beekeeping was a way of life for most people. As children, we used to throw stones at beehives while herding goats, just for a thrill. We would get a good chase from the bees and at times we would get stung! The harvesting of honey was usually done at night, which was fun. However, we had no protective gear to use for this activity, and if one of the children got stung badly then he or she would have to miss school the following day.

On the other hand, my grandmother used to grow *njahi* (white-eyed black beans), and when the crop was flowering it was a spectacle to see all the pollinators – all kinds of bees, as well as butterflies, on the plants. We, the children, would always try to catch the insects. So, I can say that I quite literally grew up among bees.

Q. Was this your motivation for studying entomology?

A. When I was in high school, my best subjects were biology and chemistry and I actually wanted to study medicine. However, I did not attain the required points for admission to that degree. Instead, I proceeded to Kenyatta University for a BSc in zoology and botany, which I undertook between 1991 and 1995. I ended up being the best zoology student and got a university scholarship to undertake a Masters degree. At this point, I had the chance to revert towards the direction of my first love, medicine, by studying immunology or parasitology. But by then I had realised that I did not like the hospital environment very much, so I opted for agricultural entomology. I continued to do well in my studies, scoring six straight 'A's in my MSc course work. It was also at this point that I got familiar with *icipe* through my Masters project which was on the control of the black bean aphids with neem-based pesticides. I conducted this study under the supervision of Dr Anna Milena Varela who was at that time, between 1997 and 1998, based at the *icipe* campus.

Q. How did you join the *icipe* Commercial Insects Programme?

A. After my MSc, I joined the Teachers Service Commission (TSC) as a high school biology teacher. That was when I heard about the *icipe* Commercial Insects Programme. I booked an appointment with the project leader, Prof. Suresh Raina. During our meeting, I told him about my desire to conduct PhD research on bees. He agreed, but on one condition: I had to undertake a 'test' which involved collecting information on beekeeping in Kitui district, a semi-arid region in eastern Kenya. This task required me to visit the remotest parts of Kitui, which was tough. I would, for instance, spend

A little girl pictured in the irrigated sections of Al-Dhala, Yemen, on the edge of an onion field, a great food source for pollinators. Local authorities and development partners are increasingly engaging communities in designing and implementing programmes that simultaneously improve livelihoods and protect the country's diverse ecosystems, for the security of future generations – PHOTO: icipe

Left to right: icipe scientist, Prof. Suresh Raina, Mr Babikir, a silk farmer, and Mr Mohammed SirElkhatim of IFAD are pictured amongst towering mulberry plants in a farm in Kassala state, the Sudan. This region is endowed with soils that are rich in minerals, which enable mulberry plants to grow very fast and reach a height of 3–5.5 m, within eight to10 months – PHOTO: icipe

the night on the floor in beekeepers' homes, because that was all they could afford to offer me. But all in all, I managed to gather impressive data, earning myself entry into CIP in mid 2000. My PhD thesis was on bee breeding and royal jelly production.

Q. Since joining the programme, how have you seen the CIP progress?

A. The CIP project has been going on for close to two decades, and I am proud to have been part of this journey. We have taken our know-how to poor and marginalised communities across sub-Saharan Africa (SSA), including in my own region of eastern Kenya. And I have seen first hand how commercial insects can be exploited, while protecting the often fragile ecosystems that these communities live in. Because of my own background, I know first hand of the close linkage between rural poverty and environmental degradation. In developing regions, many communities over-rely on natural resources, simply because they have no other means of earning a living. At the same time, as I mentioned earlier, I have been aware of the wealth of arthropods lying in these areas from my early childhood. The CIP programme is strategically designed to include basic laboratory-based research, the actual implementation of projects in the field, as well as the business aspects of beekeeping and silk farming. In this way, we help communities add value to their traditional knowledge on the production of bee and silk products. We have recently entered an exciting phase in our work, by spreading our activities to the Near East and North Africa (NENA) region.

Q. How did *icipe* start its commercial insects programmes in the NENA region?

A. *icipe* started working in the NENA region in 2000, with programmes in Libya, Morocco, Tunisia and Algeria, which wound up in 2002. We trained beekeepers in these four countries on how to rear queens, so as to mass multiply their bee colonies and to replace those that were diseased with healthy stocks. At the time, many bee colonies were suffering from attacks by the Varroa mite and American and European foulbrood diseases. We tested fumigation methods, using neem, to see their effectiveness in controlling this pest as well as the diseases. In addition, we established four quality control laboratories in these countries, to ensure that the honey and hive products met the requirements of the export market. In 2007, *icipe* received a grant from OPEC Fund for International Development (OFID) to support ongoing IFAD loan projects in the poverty-stricken, semi-arid spiny woodlands of the Sudan and Yemen, and the reclaimed desert land in Egypt. The broad objective is to reduce poverty by improving food security as well as the income levels of communities – especially women and the youth – by promoting better use of natural resources.

Q. What is the situation regarding the management of the natural resources in these three countries?

A. As in many countries in the Arab region, the Sudan, Yemen and Egypt have for long had policies guiding the conservation and management of natural resources. However, although some accomplishments have been made through these policies, in view of the magnitude of the problem, a lot more still requires to be done. One of the key constraints has been the inadequate involvement, and at times the complete absence, of local people in natural resource management programmes. Fortunately, local authorities and development partners are increasingly recognising that the protection of the environment requires a strategic mix of law enforcement and the right incentives for communities to participate in the programmes. In turn, there is renewed will by political leaders and donors alike to invest in the relevant institutions as well as the strengthening of local capacity in the management of natural resources.

Q. How is your work in the Sudan progressing?

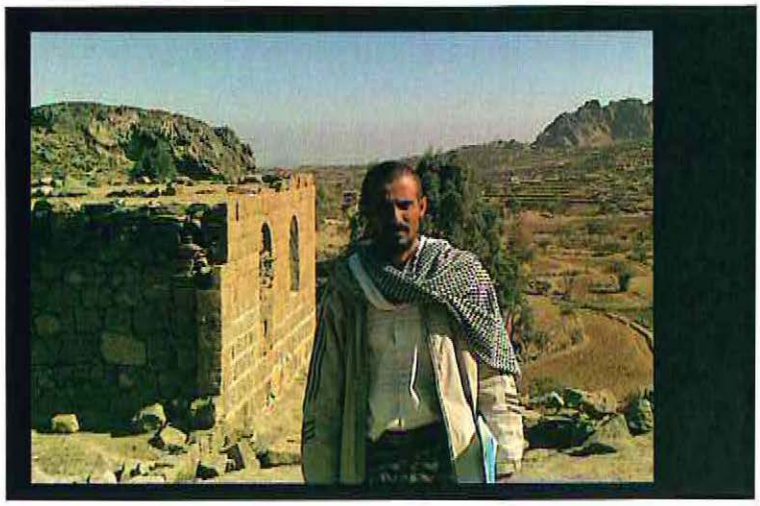
A. We have two project areas, in Southern Kordofan and in the Gash River Basin. Southern Kordofan has been the scene of major civil unrest in the past decades. As a result, the lives of the communities in this area have been considerably disrupted, while the agricultural activities and the infrastructure have been severely affected. In addition, the Southern Kordofan region is an arid area, with minimal, erratic and unreliable rainfall. On the other hand, the Gash Delta, which is in the eastern part of the Sudan, is an important water resource area. As a result, large numbers of people displaced by the civil war and by drought have migrated there. In recent years, the region has witnessed a rise in population, placing immense pressure on the resource base. We are working hand in hand with the IFAD South Kordofan Rural Development Programme and the Gash Sustainable Regenerating Livelihood Project, which support the peace process through post-crisis rehabilitation and development.

So far, we have trained over 24 trainers of trainers in modern beekeeping. We have also set up four apiaries each comprising 40 hives, including a central one for training purposes. We have also been exploring market outlets to ensure that the beekeepers have a ready sale point for their products.

The sericulture industry is very new in the Sudan, and we have therefore had to start our work from scratch. In our favour, the soil in our pilot sites is rich in minerals and the mulberry plants grow very fast and reach a height of 3 to 5.5 metres within

icipe scientist, Dr Eliud Muli (left) visited a proposed development site for a marketplace to process, package and market honey and silk products, in the Kassala state of Sudan. With him are representatives of the Government of Sudan and IFAD – PHOTO: icipe

A farmer pictured near a ruined building in the Al-Dhala governorate of Yemen. The region has been one of the hotspots of the civil strife that has marked the country for seven years. icipe's Commercial Insects Programme activities have proved to be a good tool to help communities in the region reconstruct their livelihoods – PHOTO: icipe



eight to 10 months. So far, we have mulberry planted in over seven 'feddans' (acres) and we are targeting to reach 15 feddans by the end of 2009. For each feddan of mulberry, farmers receive four beehives. The project is quickly taking shape, as we have established a beekeeping and sericulture producers association. We have made major progress towards setting up of a marketplace, through the Director General of MAI-PCU, Kassala State, which will be contracted as per the government rules.

Q. What are your challenges in the Sudan?

A. We have several challenges, one of them being the high temperatures, coupled with a limited electricity supply, which in turn limits the capacity to irrigate the land. The region is also prone to drought spells. For instance, between March to June 2009, most mulberry plants were completely ruined by lack of rain. However, we are optimistic of the future. Our plans include conducting more on-site training on rearing silkworms and supplying silkmoth eggs to the farmers. We also hope to increase the beekeeping activities. Our other major aim is to continue strengthening the silk and bee farmers' association to empower it to coordinate the activities.

Q. How about your work in Yemen?

A. *icipe*'s initial work in Yemen was in the Al-Dhala governorate. This region has a very fragile and diversified climate, due to its elevation, which ranges between 1200 to 2400 metres above sea level, and average rainfall ranging between 150 to 450 millimetres. Traditionally, the communities in Al-Dhala have made attempts at beekeeping, using the different ecosystems in the area. But they have had several constraints, key among them being the farming of khat. This crop, which takes up most of the arid land, has health and social consequences. Part of our work, therefore, has been to create awareness regarding the benefits of modern beekeeping. We have worked with the communities to form associations, which then become forums for building people's capacity and skills in beekeeping. As an incentive, we have provided 5 to 10 Langstroth hives per household. Each hive produces 10 to 15 kilogrammes of honey a year, which can fetch up to US$ 1000. We are hoping this will encourage more farmers to take part in modern beekeeping.

One of our major achievements has been the construction of the Al-Dhala Honey Marketplace, with all the equipment for extracting, processing and packaging honey.

Other project sites in Yemen are Wadi Hadramout (Seiyun), Coastal Hadramout (Al-Mukalla) and Al-Mahara Governorates. In 2008, these areas were affected by severe flooding. The Yemeni Government approached the Islamic Development Bank (IDB) for funding to rehabilitate the beekeeping and date palm industries, which had been ruined by this disaster. *icipe* was chosen to provide technical support in beekeeping. In June 2009, we travelled to this region, and discussed with senior government officials as well as researchers and stakeholders in the beekeeping industry about the damage caused by the floods, which ruined property, and even worse caused loss of lives. The bee colonies suffered damages of upto 60% in some areas. Our challenge is to assist the beekeepers, taking into account the urgency of the matter. For instance, it is critical that the farmers do not miss the lucrative *Ziziphus* honey season, which runs between September and October. For a variety of reasons, including possible heart remedial properties, this honey, which is made from *Ziziphus spina-christi* plants, is among the most expensive brands in the world, selling at between US$ 60 to 100 per kilogramme at the farm gate. To restart the industry, beekeepers need hives and honey harvesting accessories such as wax sheet foundations and extractors. They also need quality bee colonies. *icipe*'s role is to provide hives and to train farmers in rearing of queens to multiply their colonies. We also worked with the Ministry of Agriculture, local authorities and beekeeper's associations to devise a way of providing hives to the beekeepers, and to ensure that the material they require gets to them in a fair condition and timely manner.

Q. And how about your work in Egypt?

A. In Egypt, we are working with small-scale farming households and unemployed youth who were dispossessed of their statutory tenancies in the old lands and compensated with one or two hectare holdings of reclaimed desert land.

I would say that in general, our work in Egypt is a lot easier, as the country has had a long tradition of silk farming. The farmers are quite conversant with the growing of mulberry and rearing of silkworms. Their major constraint is in post-harvest technology. We have been working closely with government ministries and departments, especially the Sericulture Research Department (SRD) and the ministries of Agriculture and Forests, Education and Environment to improve this. We are also creating community awareness, through lectures on the importance of sericulture; how it can improve people's livelihoods and its benefits to the environment. Moving this forward, we have worked with the communities to conserve the various

A farmer rearing young silkworms on mulberry leaves in Egypt. icipe is enhancing the country's long tradition of silk production by providing additional training, especially in the post-harvest stage of the product – PHOTO: icipe

Children pose beside a roadside sign of the western Noubaria Rural Development project, in which icipe is partnering with IFAD and Egyptian government ministries and departments. By creating awareness among them, such youngsters have now become custodians of mulberry planted on the roadside – PHOTO: icipe

ecosystems, through mulberry plantations, by planting saplings along the roadsides and canals. We supplied cuttings and applied manure to barren land. In addition to the conservation aspect, this approach is an advantage for the communities, given the limited land allocation per household under the Noubaria settlement plan. The mulberry plants provide supplementary leaves for silkworm rearing. In general, we have noted an increase in the quantity and quality of mulberry leaves, which has been very useful in the production of quality silk cocoons. Last year, the Noubaria and other silk groups supported by SRD produced over 8 tons of silk cocoons with a value of US$ 64,000.

Q. What challenges have you faced in your career as a commercial insects researcher?

A. I think the biggest challenge has been, and still remains, lack of sufficient funds. For instance, at one point, CIP was so short of funding that we had to use public transportation to go to the field. This made our work very difficult.

The implementation of community projects is also quite complex, first because people often have unrealistic expectations. In some instances, community members are not patient enough for the initiatives to take root and produce results. In other cases, people are not prepared for the hard work it takes to successfully get a project working sustainably. At times, we have to work quite hard to explain the concept of the projects as partnerships for the ultimate benefit of the communities themselves. And we always have to make sure that our activities are conducted ethically and in the most transparent manner possible.

Another major problem is that of poor infrastructure, since most beekeeping activities take part in the remote and marginalised regions. Aside from rough, off-road travelling, our work at times puts us in the face of insecurity, for instance in areas prone to cattle-rustling, and in the case of NENA, civil strife. I should add that in many of these places our activities are made easier and more effective by the support we receive from the government staff, and even the communities, on the ground.

I am also always motivated by the fact that beyond these challenges is the joy of seeing people's livelihoods transformed. Most communities also go to great lengths to show their appreciation of our efforts. For instance, I know two families – one in Rift Valley and the other in Northeastern Kenya – who have named children after me, which is the ultimate expression of honour in African custom.

Q. Having worked in different parts of Africa, how different is the NENA region?

A. One thing is the reality of civil strife and how deeply it affects people's lives. For instance, in Southern Kordofan, which borders the troubled Southern Sudan region, people's movement is restricted, especially at night. We therefore have to be sensitive to this fact in our activities.

In most parts of sub-Saharan Africa, you will find that even in the most marginalised regions, women take part in activities. I was quite surprised to find that this is not the case in a country like Yemen. Women are largely inconspicuous, and when we call meetings, only men attend. Initially, we felt a component was lacking in our work. But we respect this culture. We know that women are interested and benefiting from the project even though they are not as conspicuous as the men.

Q. Overall, what would you say have been your most momentous occasions when working in the NENA?

A. There have been many significant moments, but two stand in mind. One was when we first reared queen bees on site in a local farmers apiary in Seiyun (Yemen) and the beekeepers saw that it could actually be done. The whole process took around two weeks, starting with theoretical training. We then went into the practical aspects including preparing artificial queen cups from beeswax, identifying young larvae from worker cells and grafting them onto the queen cups. The beekeepers were involved in the whole process and saw everything happening step by step. And when the cups started elongating, meaning that the process was actually working, it was a moment of great celebration, that was captured on national television across Yemen. The knowledge on how to rear queens is very useful for beekeepers, because it means that one can stock, or improve their colonies any time of the year, without waiting for the natural process.

The second notable moment for me was when working in the flood-damaged areas of Yemen. We had proposed to provide the beekeepers with hives as well as bee colonies. But the beekeepers offered to take on the responsibility of stocking their hives, a decision that saved the project budget money. We used this surplus cash to buy more hives, and we were therefore able to assist more beekeepers than we would have, were it not for that decision by the stakeholders. It was a touching moment for us to see communities that had been through so much suffering having such presence of mind and thoughtfulness. Indeed, regardless of the challenges we encounter in our work in the NENA, the communities always make it worthwhile.

Ecological honey produced in Southern Kordofan region, in Sudan. This is one of the NENA regions that icipe is working in, to promote more effective use of natural resources, with particular focus on the production of top-scale insect-based products – PHOTO: icipe

Acronyms and Abbreviations

ARPPIS	African Regional Postgraduate Programme in Insect Science
CDC	Centers for Disease Control
DAAD	German Academic Exchange Service
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics
IDB	Islamic Development Bank
IFAD	International Fund for Agricultural Development
IITA	International Institute of Tropical Agriculture
IPM	integrated pest management
JKUAT	Jomo Kenyatta University of Agriculture and Technology
KEMRI	Kenya Medical Research Institute
MAI-PCU	Ministry of Agriculture, IFAD - Project Coordination Unit
NENA	Near East and North Africa Region
OPEC	Organisation of the Petroleum Exporting Countries
SRD	Sericulture Research Department
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
USDA-ARS	United States Department of Agriculture-Agricultural Research Station
PRER	Poverty Reduction and Economic Recovery Programme (of UNDP)
UNDP	United Nations Development Fund

icipe is a unique and advanced research and training organisation working to improve the lives and livelihoods of people in Africa. Because insects and other arthropods have a major impact in almost every area of their physical well-being and prosperity, ***icipe*** is making its contribution by continuing to improve the plant, animal, human and environmental health of, primarily, smallholder farmers and disadvantaged urban dwellers in Africa.

Cover photos:

Top left: Daisy Salifu, one of the two recently recruited biostatisticians at *icipe* discussing with Peter Malusi, a laboratory technician, ongoing research on kales, one of the most important vegetables in East Africa. *icipe* recognises the importance of biostatistics towards realising its mandate of contributing food security and better health to communities across Africa – *Courtesy of Fred Makhulo (icipe)*

Top right: Harvested silk moths cocoons. Insect derived products like silk and honey substantially improve the livelihoods of many communities in Africa. *icipe*'s Commercial Insects Programme recently started work in Northern Africa – *Courtesy of Santiago Escobar*

Bottom left: Agriculture and human health are often interlinked. For instance, in irrigated rice vector-borne diseases like malaria often flourish. *icipe* is working together with communities in the Mwea irrigation scheme of Central Kenya to develop an integrated malaria management programme – *Courtesy of Santiago Escobar*

Bottom right: *icipe* scientist Sunday Ekesi is carefully examining a fruit fly infested mango fruit. Fruit flies are threatening mango production throughout tropical Africa. Through its African Fruit Fly Programme, *icipe* is combating these notorious pests of high value crops – *Courtesy of Santiago Escobar*

ICIPE Science Press

ISBN: 92 9064 213 X