LU·BI·LO·SA 3

The Newsletter of Phase 3 of the LUBILOSA Programme

LUBILOSA - **Lu**tte **Bi**ologique contre les **Lo**custes et **Sa**uteriaux

The Biological Control of Locusts & Grasshoppers

Issue No. 6 August 1998

WELCOME

Welcome to Issue 6 of the LUBILOSA newsletter. In this edition, we take a look at some of the ecological and behavioural issues associated with the control of locusts and grasshoppers using *Metarhizium*. Although LUBILOSA has concentrated on developing a high-performance fungal product, this practical work has always been strongly supported by more fundamental ecological studies that provide insight and understanding into how the *Metarhizium* interacts with its host. In carrying out this work, which is led by Dr Matt Thomas (see his profile on the back page), a number of unexpected benefits have been identified which add significantly to the value of the mycoinsecticide as a control agent. These achievements are reviewed by Simon Blanford in his article entitled "Stomach Ache for Locusts." In addition, the information gained from the ecological research plays an important role in defining proper use strategies for this fungal product, one of the issues that was raised in discussions at the Green Muscle workshop held in South Africa at the end of March.

The workshop was well attended and generated a great deal of interest in Green Muscle which was well presented by the media in South Africa. This meeting provided the springboard for raising awareness of the potential of Green Muscle for locust control and has been followed up with the submission of a dossier for registration and further collaborative work with the Plant Protection Research Institute (PPRI) and the company who will produce Green Muscle for southern Africa, Biological Control Products.

The work of LUBILOSA is of course not just confined to southern Africa. Our partners in West Africa, the International Institute for Tropical Agriculture and GTZ, continue to work with national partners and on collaborative programmes involving mycoinsecticide use throughout the region. A short report on activities that are being promoted by our West African partners is also included in this issue.

LUBILOSA moves steadily through the final year of Phase 3 and inevitably we have started looking to the future and the possibility of a Phase 4. Having taken the project to the stage where the product will be registered and available in two regions by the end of Phase 3, we are now looking at how best to ensure the success of the product during the first few crucial years of its availability. We will report more on these developments in the next issue.

LUBILOSA is funded by the Governments of Canada (CIDA; Canadian International Development Agency), Switzerland (SDC; Swiss Development Cooperation), the Netherlands (DGIS; Directorate General for International Cooperation) and the UK (DfID; Department for International Development).

LUBILOSA
Contact Names and Address

CABI Bioscience
Silwood Park, Buckhurst Road, Ascot, SL5 7TA, UK.
Fax: 44 1491 829123
Tel: 44 1491 829119
E-mail: D.Dent@cabi.org
Contact: Dr. David Dent, Programme Manager

International Institute of Tropical Agriculture
Plant Health Management Division,
B.P. 08-0932, Cotonou, Benin.
Fax: 229 350556
Tel: 229 350553 / 350188
E-mail: IITA-BENIN@CGNET.COM
Contact: Dr. Chris Lomer, Programme Leader

CILSS-INSAH
BP 1530, Bamako, Mali.
Fax: 223 225980
Tel: 223 224681
Contact: Dr. M.S. Sompo-Ceesay

CILSS-AGRHYMET
BP 12625, Niamey, Niger.
Fax: 227 732237
Tel: 227 732181
E-mail: AGRHYMET.CENTER@HIS.COM
Contact: Dr. J. S. Oliveira

GTZ
Postfach 5180
65726 Eschborn, Germany
Fax: 49 6196 79 7413
Tel: 49 6196 79 3289
E-mail: Stephan.Krall@gtz.de
Contact: Dr. Stephan Krall

design by Origami Graphics

GREEN MUSCLE WORKSHOP

***From left to right*: Dr Meshack Molope, Ms Njabulo Nduli, Mr Thys Botha and Ms Njobe Mbuli at the Green Muscle Workshop, Midrand.**

The workshop held in South Africa on 24 March 1998 was successful in attracting an excellent turn-out of 51 participants interested in the problems of locust control and the potential of Green Muscle as a biological control agent. There was also great interest shown by the South African media as Di Neethling (Biological Control Products) and David Dent (LUBILOSA Programme Manager) gave interviews to two radio stations and Elizabeth Müller (Plant Protection Research Institute) gave an interview in Afrikaans. The workshop was filmed for an environmental issues programme on brown locust control using Green Muscle that was shown on national television.

The workshop took place at the Midrand Conference Centre, halfway between Johannesburg and Pretoria, and participants included: Dr Brian Grimwood (Senior Natural Resources Advisor, DfID SA); representatives of the Department of Agriculture including the Chief Director, Dr Meshack Molope and the Registrar, Ms Annette Nel; representatives of PPRI, including the Director, Dr Mike Walters; and locust control officers and representatives from farmer and conservation organisations.

Presentations were given by Ms Nomvula Mokonyane (MEC Gauteng), Ms Njobe Mbuli (Agriculture Director-General), Thys Botha (Deputy Director, Dept. of Agriculture), David Dent, Roy Bateman and Christiaan Kooyman (LUBILOSA) followed by Roger Price (PPRI), Hennie Erasmus (Deputy Director, Northern Cape Nature Conservation Service) and Di Neethling. The workshop was managed by Brian Gibson (public relations consultant for BCP) and the final discussion chaired by Ms Njabulo Nduli (Director, Dept. of Agriculture). During this final discussion, the questions put to the LUBILOSA and BCP panel were about cost, storage and distribution indicating that the product was viable and acceptable to those present as a replacement for chemical insecticides.

Even if you are on the right track, you'll get run over if you just sit there - Will Rogers

The test of our progress is not whether we add more to the abundance of those who have much; it is whether we provide enough for those who have too little - F D Roosevelt

STOMACH ACHE FOR LOCUSTS

Mortality is the key evidence for effective control based on previous chemical pesticide models. One of the perceived disadvantages of the mycopesticide is the length of time it takes for the target insect to die after the initial application. Speed of kill is considered to be one of the major factors limiting the utility of mycoinsecticides for control of many pests including grasshoppers and locusts. However, effective control need not be determined by mortality rate alone. If, as a consequence of infection, the insect's behaviour is changed such that its impact as a pest is reduced, then this may constitute effective control.

The Leverhulme Unit for Population Biology and Biological Control has been working on a number of aspects of the interaction between *Metarhizium* and its locust and grasshopper hosts. In particular, interest has centred on the effect that the pathogen has on key behaviours during the infection process. One of these key interactions is the effect that the pathogen has on feeding rates once it breaches the cuticle and enters the haemocoel. A number of behavioural studies have now been completed on a variety of locusts and grasshoppers targeted by the LUBILOSA Programme.

Early studies during the first two phases of the project showed significant feeding reductions by *Schistocerca gregaria* at constant temperatures in the laboratory. Latterly, studies conducted on field sprayed locusts and grasshoppers have shown reductions when insects have been maintained in cages in field laboratories. Perhaps most encouraging was a large and rapid reduction found for *Zonocerus variegatus*. At three different doses, with insects maintained in large field cages and thus exposed to environmental conditions, this grasshopper almost halved the amount consumed in just two days following application of Green Muscle (See Figure 1). In a study with *Hieroglyphus daganensis*, the observed reduction in per capita feeding (also significant by day 2) appeared to continue even when the mortality rate slowed to a level equivalent to that of the controls. Laboratory studies on *S. gregaria* hoppers that are allowed to thermoregulate, and thus have the ability to limit pathogen growth, have also been encouraging.

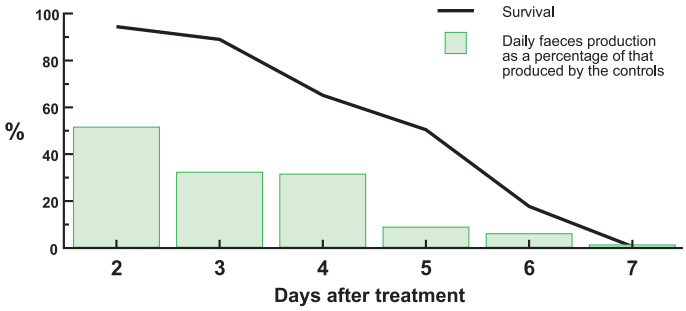

Figure 1: Overall control effect of *Metarhizium* on *Z. Variegatus* (medium dose of 10^5 spores/insect). Faeces production is used as an indirect measure of feeding.

The mechanisms behind such reductions are unclear. In the latter stages of the infection process, it can be attributed to mechanical damage of host tissue. However, the very early reductions exemplified by the *Z. variegatus* study and others suggest that there is competition for host nutrients and feedback mechanisms involved in stimulating feeding may also be inhibited. In addition, for the hosts that thermoregulate, the onset of "behavioural fever", seen as a drawback to infection, could in fact provide some contribution to control as well.

In the 1996 field trials in Niger, *Oedaleus senegalensis* was

found to adopt a behavioural fever response to infection by raising its preferred body temperature from 39°C to 42°C. At this higher temperature, fungal growth is inhibited although this temperature can only be maintained during the day; during the evening, night and morning, body temperatures of the grasshoppers are close to ambient (22-32°C), producing a window for pathogen growth. The effect of this behaviour on a field sprayed population is to lengthen the disease incubation time but it does not appear to result in declining total mortality at the application doses commonly used.

Locusts and grasshoppers feed optimally (rate and amount consumed) at the same temperature which many species maintain via thermoregulation. Behavioural fever shifts this "ideal" temperature to a range where feeding and development are also significantly reduced. Thus, while thermoregulation and fever may exacerbate mortality delay in field treated populations, behavioural fever could be seen as a positive control effect in terms of a more rapid reduction in feeding as the behavioural change has been shown to commence two days after treatment in field sprayed populations.

Such reductions (in conjunction with other pre-lethal effects such as moulting inhibition and loss of reproductive potential) are an obvious benefit to the overall picture of sub- and pre-lethal control effects of *Metarhizium.* Conveying an image of control that combines such effects with mortality is an important factor when explaining the mode of action and the other more obvious environmental benefits of employing Green Muscle as a mycopesticide.

LOCUST GOURMET!

As an interesting aside, we found this tasty recipe in a farmer information leaflet on "Biology, Behaviour and Control Methods for Locusts" written by the Peruvian National Plant & Animal Health Service SENASA (Inka region):

If you have lots of locusts which have not been killed by a chemical insecticide, you can use them as livestock feed for animals since they are a rich source of protein (67% by content). Locusts can also be used as an organic fertiliser thanks to their high nitrogen content.

How do you make Locust Flour? Collect locusts in a sack and put them into boiling water to kill them, or leave them submerged in a stream for 24-48 hours. Once dead, spread the locusts out on rocks or a sheet of roofing zinc to dry for 4 days. Crush and grind up the dried bodies in a mill or use a grinding stone to make a flour.

How much Locust Flour do you feed to animals? Mix one plate of locust flour with three plates of other cereals such as maize flour, barley, etc. You can also mix in alfalfa and a little salt. If you want to feed whole locusts to livestock, make sure to remove the legs which have sharp saw-like edges that can cause bleeding and haemorrhaging in the animal's throat or bird's crop.

For further information, contact:
FMI Gladys Yanque Prieto, Plant Health Specialist, SENASA, Ministry of Agriculture - Cusco Office, Av. Micaela Bastidas 310-314 Wanchaq, Cusco, PERU, tel/fax +51 (0)84 233 191.

NEWS IN BRIEF

Green Muscle is accepted as a viable replacement for chemical insecticides at the workshop held in South Africa in March.

LUBILOSA presentations by Matt Thomas and Simon Blanford and a poster by Elizabeth Müller of PPRI, South Africa, were well received at the VII International Congress of Ecology in Florence, Italy in July.

PARTNERS IN WEST AFRICA

The Crop Protection Training Department (DFPV) of CILSS/AGRHYMET is organising a seminar on "Gender Issues in Crop Protection" to be held on 28 September to 2 October 1998 at the CILSS/AGRHYMET regional centre in Niamey, Niger. The seminar is aimed at all those working in crop protection and on issues of gender and development and will analyse the role of Sahelian women in crop protection in order to produce recommendations for improvement.

The DFPV is also offering a new service called "One Dollar Per Insect" which offers a wide variety of insect collections from the Sahelian region to institutions or individual researchers at a much lower cost than if they were to organise their own collecting trips. For further details on both the seminar and the insect collection service, please contact the DFPV by either sending an e-mail to dfpv@sahel.agrhymet.ne or contacting them at the CILSS/AGRHYMET regional centre (address and contact numbers are on the front cover).

The Benin Crop Protection Service (SPV) and IITA have jointly produced an information leaflet on the "Use of the fungus, *Metarhizium flavoviride*, for the control of locusts and grasshoppers" for distribution to farmers and extension agencies. The leaflet is written in French and copies of this and other leaflets in the same series can be obtained from Dr Chris Lomer at IITA.

Dr Hugo De Groote of IITA (third from right) and Zakaria Ouambama of DFPV (in yellow shirt) discuss Green Muscle with farmers from the village of Gel adwaji in the east of Niger, three weeks after applying the mycoinsecticide to their millet fields to control the Senegalese Grasshopper, *Oedaleus senegalensis*. These farmers were pleased with the mycoinsecticide and clearly expressed their interest in using it. According to the farmers, Green Muscle was better than an organophosphate chemical pesticide used by another village.

LUBILOSA PROFILES

Matt Thomas is co-ordinator of ecological research for the LUBILOSA Programme and holds a joint position between the NERC Centre for Population Biology at Imperial College and CABI Bioscience. He leads a research group called the Leverhulme Unit for Population Biology and Biological Control which has the aim of combining real-world biological control problems with appropriate ecological studies to both further develop our understanding of the population dynamics of enemy-victim interactions and to improve the safety and effectiveness of biological pest control and IPM.

This approach is typified by the Unit's work with LUBILOSA in which a range of empirical and theoretical techniques from population biology have been applied to help interpret the overall impact of the mycopesticide on locust and grasshopper populations. This has revealed the importance of different routes of infection (i.e. direct hit from the spray, contact with the spray residue and secondary cycling of the pathogen) under different conditions as well as the role of behavioural changes and sub-lethal effects (such as reduced feeding reported earlier) following infection. In addition, these applied ecological studies have had clear reciprocal benefits, providing important insights for our understanding of the dynamics of natural host-pathogen interactions.

Jürgen Langewald collaborated with LUBILOSA as a PhD student at the beginning of the project in 1990 at IITA in Cotonou, Benin. After writing up his thesis on the use of neem products for the control of grasshoppers and locusts at the University of Giessen, Germany, he joined the LUBILOSA programme at the end of 1993. At IITA, he rationalised mass production, was responsible for field trials and for the collaboration with the national programmes. Since the beginning of Phase III, Jürgen has supervised the field research teams at IITA in Cotonou and at DFPV in Niamey and is responsible for the field trials in West Africa. At the beginning of 1998, he became the LUBILOSA team leader in Cotonou.

Stephan Krall is the co-ordinator for the GTZ contribution to LUBILOSA (ecotoxicology, field trials, ecological observation). He is also team leader of a German funded locust research project and other German and Swiss funded locust related projects. He joined the GTZ plant protection group in 1981 as junior expert in a post harvest project in Togo. From 1984 to 1988 he worked as a team leader of a plant protection project in Benin and since 1989, in the GTZ headquarters in Eschborn, Germany as team leader and co-ordinator of locust projects. His special concern lies in the development of IPM for migrating locusts. He studied Biology in Hamburg and obtained his PhD at Humboldt University, Berlin on the development and application of a crop loss assessment method on pearl millet in Niger.

Dave Moore is a member of the exclusive group to have worked on LUBILOSA since its inception in 1989. A biology degree from Portsmouth Polytechnic was followed by a two year stint as a volunteer teacher in The Gambia, and a PhD from Reading University while based at the Grassland Research Institute, Hurley. Dave joined CAB International as an entomologist, beginning his time with two years in St Lucia. Subsequently he was involved in the very successful control of *Rastrococcus invadens*, a serious pest of fruit trees in West Africa.

His LUBILOSA work focused on aspects of storage and persistence in relation to ultra-violet irradiation, but his publications reflect a range of inputs. Now the intention is to apply the lessons of LUBILOSA to other programmes; after locusts in the Sahara, no pest is safe from mycoinsecticides.

Recent LUBILOSA Publications

Bateman, R.P., Douro-Kpindou, O.-K., Kooyman, C., Lomer, C. and Ouambama, Z. (1998) Some observations on the dose transfer of mycoinsecticide sprays to desert locusts. *Crop Protection*, **17**,151 - 158.

Bateman, R.P. (1997) The development of a mycoinsecticide for the control of locusts and grasshoppers. *Outlook on Agriculture* **26**, 13 - 18.

Blanford, S., Thomas, M.B. & Langewald, J. (1998) Behavioural fever in a population of the Senegalese grasshopper, *Oedaleus senegalensis*, and its implications for biological control using pathogens. *Ecological Entomology* **23**, 9 - 14.

Hong, T.D., Jenkins, N.E., Ellis, R.H. and Moore, D. (1998) Limits to the negative logarithmic relationship between moisture content and longevity in conidia of *Metarhizium flavoviride*. *Annals of Botany* **81**, 628 - 630.

Jenkins, N.E., Heviefo, G., Langewald, J., Cherry, A.J., and Lomer, C.J. (1998) Development of mass production technology for aerial conidia of mitosporic fungi for use as mycopesticides. *Biocontrol News and Information* **19**, 21 - 31.

Thomas, M.B., Blanford, S., and Lomer, C. J. (1997) Reduction of feeding by the variegated grasshopper, *Zonocerus variegatus*, following infection by the fungal pathogen, *Metarhizium flavoviride. Biocontrol Science and Technology* **7**, 327 - 334.

Thomas, M.B., Blanford, S., Gbongboui, C. and Lomer, C. J. (1998) Experimental studies to evaluate spray applications of a mycoinsecticide against the rice grasshopper, *Hieroglyphus daganensis*, in northern Benin. *Entomologia Experimentalis et Applicata* **87**, 93 - 102.