INCO-DEV contract number ICA4-CT2002-10056

Third Annual Report, January to December 2005.

RatZooMan, Prevention of sanitary risks linked to rodents at the rural/peri-urban interface

http://www.nri.org/ratzooman

Keywords: zoonosis, infectious disease, rodent, peri-urban, epidemiology

Table of Contents

Scientific report

Summary of content

WP1 Retrospective and prospective investigation of human sera for zoonotics
The collection of human sera has been successfully carried out in all four African countries with significant sample sizes, showing a few seropositive cases for leptospirosis (in all countries), plague (only in Mozambique and Tanzania) and toxoplasmosis (quite high in Mozambique but relatively lower in other countries). Leptospira have been isolated only in three cases from Tanzania. Further details can be found in the partners reports of KIT and SPMC.

WP2 Taxonomic identification of rodent species found in rural and peri-urban habitats
A small number of taxa are unknown or poorly documented in literature and need in-depth taxonomic research. These samples cannot be finalised completely within the Ratzooman project timeframe, and some research activity will continue beyond the project end date. The majority of specimens have been analysed, and a brief summary of results can be found in the RUCA partner report.

WP3 Isolation and identification of zoonotics from rodents and domestic animals
A large number of samples have been collected from rodents, shrews, pigs, dogs, cats, goats and sheep. The data are nearly fully analysed and incorporated into the GIS database so that the data can be cross-correlated. This analysis is expected to be complete in time for the final workshop in May showing seropositive cases and how they may be linked to human cases and/or environmental issues.

WP4 Rodent ecology in rural/peri-urban Africa
Research activities in this workpackage are complete. Preliminary analyses of CMR data from Tanzania, South Africa, Zimbabwe and Mozambique indicate similar seasonal population dynamics patterns and reproductive patterns in peri-urban populations as in agricultural areas. A manuscript was submitted on foraging movements of rodents in an African city as follows:

Mohr, K., H. Leirs, A. Katakweba & R. Machang'u. Movements of rodents around introduction and feeding foci in an urban environment in Tanzania. *Mammalia*.(submitted).

Further details can be found in the DPIL partner report

WP5 Impact of environmental factors, water management and land use strategies upon zoonotics
Complete analysis is pending the arrival of two more satellite images. Land use change results so far indicate that all sites have seen significant changes through increased urbanisation (including rural towns, villages and suburban areas), deforestation and agricultural expansion. Links between these changes and risk of rodent disease transmission will be presented at the final project workshop in May.

WP6 Socio-economic impact and livelihood constraints of disease
This workpackage is complete. The final document, Socio-economic factors influencing the transmission of rodent-borne diseases in southern Africa, amalgamates the data collected from studies in South Africa, Zimbabwe, Mozambique and Tanzania.

WP7 Measuring factors of anthropogenic change upon rodent ecology, epidemiology and natural capital
In addition to the final report for anthropological studies in the following sites: Cato Crest, Mapate, Lushoto, there has been further progress in producing a report for Mozambique. A final report will be completed before the project ends. Due to the government destruction of settlements in Zimbabwe that were being used for project research activities, it will not be possible to produce an anthropological report for Zimbabwe.

WP8 Geographic Information System
The database has been completed and distributed to all partners. Separate files of updated data, particularly with regard to human samples, are currently being uploaded. Pivot tables to analyse

relationships between rodent species, disease in animals and humans is currently under way and will comprise one of the main results presented at the final workshop.

WP9 Predictive modelling tools for assessing zoonotic transmission risks
Good progress has been made in developing a mathematical model that explains the transmission of leptospirosis through different pathways (environmental, sexual, maternal) within a rodent population over time. The general approach has been to devise a model combining a rodent population model with an epidemiological model of leptospira infection in the rodents. The latter is entirely novel as no previous attempt to model the dynamics of the disease has been found in the literature. Validation is planned by comparison of model output with rodent population data, and to the extent that it is available, leptospira prevalence data in the rodents. The model will then be used to investigate the potential effects of management interventions affecting rodent populations. This work is complete and has been recently submitted for peer review as follows.
Davis, S., R. Makundi & H. Leirs. Demographic and spatio-temporal variation in human plague at a persistent focus in Tanzania. *Acta Tropica*. (submitted)
Holt, J., S. Davis & H. Leirs. A model of Leptospirosis infection in an African rodent. *Acta Tropica* (submitted)

WP10 Development of sustainable control strategies for the management of rodent-borne disease
This workpackage is based on data collected in other workpackages. Not all data collected in other workpackages have been available mainly because they have not been fully analysed. Therefore the amount of data available varies from country to country. Data on rodent species trapped and data from serological surveys regarding the three diseases together with the reports from Social Anthropological Studies were most complete for the urban settlement Cato Crest and the two rural areas Mapate and Lushoto. As rodents are involved in transmission of the three diseases, integrated pest management is to be incorporated into the strategies along with other elements. Sustainable control strategies involve three different levels of activities, i.e. 1) Individual level, 2) Settlement / community level, and 3) Government level. Further details can be found in the DPIL partner report

WP11 Analysis of policy issues
Diseases caused by rodents, particularly leptospirosis, toxoplasmosis and plague, appear to be a grey area in the SADC region and do not register with government plans or priorities. There is a great need to create awareness and develop tools to capacitate the region on the epidemiology of rodent borne diseases at the community level. Under reporting of the above-mentioned diseases is apparent and derived from poor capacity to carry out surveillance, monitoring and clinical diagnosis. Similar tools and guidelines as those used on diseases such as HIV, TB and malaria need to be developed to see the effectiveness of managing these diseases. A policy document will be produced and included in the workshop packs of attendees. This will be used to highlight policy issues and lead discussion at the final workshop.

WP12 Stakeholder workshop
The workshop is scheduled for the 4th and 5th May taking place at the Pestana Kruger Lodge near Nelspruit, South Africa. The organisation of the workshop is proceeding smoothly in the hands of South African partners and we are expecting a good turnout and lively discussion. Details can be found under the provisional programme, as well as within the minutes of the coordination meeting that took place in Pretoria. The final announcement flyer also gives further detail about the workshop.

WP13 Output dissemination and project co-ordination
We have had good success in advertising the project, particularly in the city of Durban, where the local government and media have really embraced the project activities. Local health authorities have largely used the project as a means of publicising that they are doing something about the rat problems faced by people, particularly residents in squatter camps. Dissemination actions are discussed further under plans for publications.

Problems

The delays with financial payments from the EC have recently been resolved. However, there have been knock-on effects caused by payment delays in ensuring that samples are analysed in time. We do believe that nearly all research activities will be analysed in time for incorporation into final

presentations given at the final workshop, Rats and Human Health in Africa, taking place over the 4th and 5th May in South Africa.

Publications

Article appearing in The Mercury

Article appearing in SABC News

Davis, S., E. Calvet & H. Leirs. 2005. Fluctuating rodent populations and risk to humans from rodent-borne zoonoses. *Vector-Borne and Zoonotic Diseases*, 5(4):305-314.

Mgode, G.F, Mhamphi, G., Katakweba, A., Paemelaere, E., Willekens, N., Leirs, H, Machang'u, R.S., Hartskeerl, R.A. 2005. PCR detection of Leptospira DNA in rodents and insectivores in Morogoro Tanzania. *Belgian Journal of Zoology*, 135 (suppl).

Davis, S., R. Makundi & H. Leirs. Demographic and spatio-temporal variation in human plague at a persistent focus in Tanzania. Acta Tropica. (submitted)

Holt, J., S. Davis & H. Leirs. A model of Leptospirosis infection in an African rodent. Acta Tropica (submitted)

lecture at the International Meeting "Plague: bacteriology, evolution, ecology, epidemiology and its impact on human history". Oslo, Norway, 9-13 November 2005: Laudisoit, A., H. Leirs, R.H. Makundi. Plague in the Western Usambara mountains. Ecological study on hosts and vectors of plague in Lushoto district (Tanzania).

lecture at the International Meeting "Plague: bacteriology, evolution, ecology, epidemiology and its impact on human history". Oslo, Norway, 9-13 November 2005: Makundi, R.H., H. Leirs, A. Massawe, L. Mulungu, B.S. Kilonzo & R.M. Machang'u. Plague in Lushoto, NE Tanzania.

lecture at the International Meeting "Plague: bacteriology, evolution, ecology, epidemiology and its impact on human history". Oslo, Norway, 9-13 November 2005: Belmain, S.R.. The Socio-economics of Plague in Africa: A growing ecological problem or a mere indicator of increasing deprivation?

Outline plans for next year

Preparations are under way for the Final Workshop taking place over the 4th to 5th May 2006 in South Africa. Details of these preparation are mentioned under the provisional programme, as well as within the minutes of the coordination meeting that took place in Pretoria.

As nearly all research activities are now complete, partners will be busy analysing data and making preparations for various presentations at the final workshop.

Management report

Organisation

No problems encountered.

Meetings

A consortium partner meeting took place at the Royal Tropical Institute, the Netherlands, 27-29 April 2005, the minutes can be found in this report. A second meeting scheduled to take place in November had to be cancelled due to no payments having been received by the EC for the first or second cost statements. Partners simply had no money to pay for their attendance, and it was decided that whatever money they did have access to was better spent on research activities. However, as described below the EC payments did eventually arrive, and the meeting was rescheduled for February 2006, the minutes found in this report.

Exchanges

Staff from Mozambique visited South Africa on two occasions to learn diagnostic techniques and assist in sample analysis.

Problems

Financial problems that plagued project actions over the first two years of the project were resolved when the EC finally processed the 1st and 2nd cost statements in October 2005. Despite this, the project has carried on, albeit with delays to activities which inevitably will affect the ability to fully analyse the results in time for the final project report.

Annexes

Meeting reports

Minutes of RATZOOMAN meeting held at the Royal Tropical Institute, the Netherlands, 27-29 April 2005

The following people were in attendance:-
Lorraine Arntzen, National Health Laboratory Service, South Africa
Steven Belmain, Natural Resources Institute, UK
Nan Chalmers, Syngenta, Zimbabwe
Godfrey Chikwenhere, Plant Protection Research Institute, Zimbabwe
Mirjam Engleberts, Royal Tropical Institute, the Netherlands
Rudy Hartskeerl, Royal Tropical Institute, the Netherlands
Ann-Charlotte Heiberg, Danish Pest Infestation Laboratory, Denmark
Monica Janowski, Natural Resources Institute, UK
Frikkie Kirsten, Plant Protection Research Institute, South Africa
Herwig Leirs, Danish Pest Infestation Laboratory, Denmark and University of Antwerp, Belgium
Jens Lodal, Danish Pest Infestation Laboratory, Denmark
Robert Machang'u, Sokoine University of Agriculture, Tanzania
Anabela Manhica, National Veterinary Research Institute, Mozambique
Martha Mpisaunga, Syngenta, Zimbabwe
Rassul Nala, National Institute of Health, Mozambique
Judith Pender, Natural Resources Institute, UK
Linda Ritchie, Natural Resources Institute, UK
Peter Taylor, Durban Natural History Museum, South Africa

WP1 Retrospective and prospective investigation of human sera for zoonotics.
Representatives from each DC partner reported on progress since the last meeting in Denmark. Human samples have been collected in Mozambique, Tanzania and Zimbabwe, with the results summarised in their respective reports. Although no samples have yet to be collected from South Africa, the ethical clearance procedures have now been approved, and sample collection is due to commence within a few weeks. It was expected that human samples from Mapate and Cato Crest would take about three weeks to complete collection from local clinics and community volunteers. Although nurses will be paid to collect samples, it was agreed that blood donors must volunteer and will not be paid for ethical reasons. The only analysed human samples we have are from Tanzania as summarised in Robert's report. In Tanzania, human samples have been coming from hospitals. Samples from Morogoro have only been screened for leptospirosis. Samples from the south of Tanzania have been screened for toxoplasmosis only. No samples have been collected from Lushoto; however extensive plague data already exists for Lushoto. In Mozambique, human samples have been collected during two separate visits, collecting about 250 samples the first time and 1000 samples the second time in Zambezia province. No samples have been collected from Maputo yet but should be collected by end of May. In Zimbabwe, about 150 samples have been collected from Nkai from blood bank programmes. Efforts to collect from Harare will be emphasised to aid quick collection of larger sample sizes.
Action: It was agreed that samples collected in Zimbabwe would be sent to South Africa for analysis, as the information is needed for the project now.
Action: Outstanding samples from Mozambique to be sent to South Africa by end of May, now that border clearance problems are sorted out.
Action: It was agreed that staff from Mozambique and Zimbabwe will visit South Africa to assist in the analysis of samples in time for the results to be presented at our next meeting.
Action: Martha to contact blood banks to collect large sample sizes and send to South Africa for analysis.
Action: Samples to be collected from Maputo, Mapate and Cato Crest to happen in the next few weeks, targeting households involved in other parts of the project as well as the general population and nearby clinics

WP2 Taxonomic Identification of rodent species found in rural and peri-urban habitats.
Field work is continuing. Summary of outstanding information and data collection requirements is summarised in Herwig's presentation.

WP3 Isolation and identification of zoonotics from rodents and domestic animals.
Samples from Zimbabwe and Mozambique are being analysed in South Africa along with their own samples. Port Elizabeth is now collecting samples after staff have received training, and results will be fed into WP2 as well. For leptospirosis, the only test for which we have results is using the human dridot test which will be used to compared against MAT results which are still outstanding. Isolation and MAT results are outstanding for these three countries all going through the same system. Samples from Tanzania are being serologically tested and isolated, where progress continues as described in the Tanzania report. Progress on collecting samples from domestic animals has been slow and difficult, analysis of samples that have been collected is still outstanding for all sites.
Action: Lorraine to chase up the MAT results.
Action: Domestic animal samples (pigs, goats, cattle, sheep, dogs, cats) are still required from the sites. Those samples that have been collected must be analysed asap.
Action: A more complete set of results is desperately needed if we plan to invite WHO staff to our next meeting.

WP4 Rodent Ecology in rural/peri-urban Africa
Analysis of CMR data generally shows that seasonality is less pronounced in urban areas than in more fallow/rural areas. There is good correlation among the grids in the same area, emphasising the data is robust. Breeding rates do appear to change between different localities, e.g. breeding in Mapate is over a longer period than breeding in Morogoro.
Action: Herwig emphasised that various problems still exist in the collection of CMR data in different localities. Please refer to his presentation to remind yourself of what information is still required and needs further attention.
Action: CMR sites are all due to complete by end of December, the exception being sites in Zimbabwe which will continue until the end of February 2006.

WP5 Impact of environmental factors, water management and land use strategies upon zoonotics.
Judith gave a presentation about the analysis that has been conducted on land use changes for the sites. A large number of land use categories were established using the more recent SPOT images for each site. She emphasised that the resolution of the older images implies few land use categories can be established, but that general changes in urbanisation and agricultural intensification/deforestation will be possible. This has not been done yet. There are still a few images which are missing. These have been ordered. Judith will be able to send high resolution maps of the sites to everyone very soon.
Action: Judith to send everyone maps showing how the sites have changed over time.

WP6 Socio-economic impact and livelihood constraints of disease
Summaries have been produced for Cato Crest, Mapate and Lushoto and the report of this can be found within the second annual report. Data files from the Mozambique survey were collected at the meeting and will be analysed over the next month by Malcolm Iles. A report from the survey in Harare was handed over at the meeting, and data files that produced this report need to be sent Malcolm so he is able to incorporate the analysis into the summary report.
Action: Martha to send data to Malcolm
Action: Robert to quickly sort out what needs to be done to collect socio-economic data in Morogoro
Action: Malcolm to incorporate data from Mozambique and Zimbabwe into final report.

WP7 Measuring factors of anthropogenic change upon rodent ecology
Final reports for Cato Crest, Mapate and Lushoto are available on the project website. Data from Morrumbala must be sent to Monica so that a report for this site can be drafted. Negotiations with the anthropologist in Zimbabwe are still ongoing and it is not certain that this work will go ahead as the anthropologist is asking for too much money.
Action: Martha and Monica to liaise with Rudo and try to come to arrangement for at least one site to be done within the next month.

WP8 Geographic Information System
Judith gave a demonstration of what GIS information is currently available. Data sheets for the results of human sample analysis were sorted out by Rudy, Linda and Lorraine to facilitate their importation into the GIS.
Action: Linda/Judith to send round an updated version of the ratzooman database to everyone.
Action: Monica and Linda to discuss how the anthropological data can be incorporated
Action: Everyone to tell Judith what sorts of queries they would like the database to make
Action: Judith, Rassul and Ricardo to sort out a time for Ricardo to visit the UK. As Linda, Judith and Alan all need to hand over and train Ricardo, Ricardo will have to be the one to make the trip. This must happen well before the next project meeting so that Ricardo will be able to demonstrate the database to invited WHO staff.

WP9 Predictive Modelling for assessing zoonotic transmission risks.
Stephen Davis and John Holt are in the process of drafting up a publication on the leptospirosis model which should be submitted soon.

WP10 Development of Sustainable Control Strategies
Jens presented an overall summary of the relevant issues which was followed by Anne-Charlotte who gave a more detailed presentation specific to Cato Crest. Peter Taylor then gave a presentation that discussed activities and results in Cato Crest.
Action: It was agreed that DPIL will deliver a draft report by the 1st June which will give a generalised summary and case examples for those sites where all the data have been collected so far, i.e. Mapate, Cato Crest and Lushoto. Skeleton reports will be drafted for the other sites, with the detail added in once it has been collected and reported.

WP11 Analysis of Policy Issues
Martha gave a presentation summarising her discussions with WHO staff and Health Ministers from the various SADC member countries. Generally, SADC countries have no or few policies and strategies related to rodent borne diseases. There is generally little awareness about rodent-transmitted diseases, except when bubonic plague is a known problem. Leptospirosis and toxoplasmosis are not monitored or even recognised to be a problem in any of the SADC countries.
Action: Invite WHO and FAO to our next meeting. Everyone must send Steve contact details of WHO and FAO people that should be contacted. Steve will then update everyone on whether anyone would be able to attend and whether the dates of our meeting need to be changed in order to accommodate WHO staff.
Action: There is no point inviting WHO staff to our meeting unless we can give them an excellent presentation of our project results. Without clear human prevalence data on the three diseases, there is little point in inviting them to the meeting. We will therefore have to pull out all the stops to ensure that we get human blood analysed in time for a meeting in September.

WP12 Stakeholder Workshop
Lorraine discussed having the workshop at a game lodge, Pestana Lodge, just outside Kruger Park. Everyone agreed we should pursue having the meeting there.
Action: Steve to develop draft of 1st announcement flyer that will be posted to potential attendees. This will be circulated within a couple weeks for everyone to comment on before it is printed and posted.
Action: Steve to draft up proposals to CTA and SSA for further funding. SSA proposal is submitted in September, CTA proposal is submitted asap.
Action: Lorraine to draft up workshop programme and circulate.
Action: Everyone to send list of attendees to Lorraine by the end of May.

WP13 Output Dissemination
Monica gave a presentation of the BBC World Service series RATS! which draws heavily on ratzooman activities and researchers. Drafts of the two programmes were listened to and a presentation of the material and photographs which will appear on the BBC website was shown. The programmes are likely to be broadcast in June.
Action: times of broadcast and website address to be circulated once the details are known.

Administration / Financial Issues

There is a slight conflict of dates with our next meeting in September as it is shortly before the deadline for proposals to the EC on neglected communicable diseases. We may therefore want to delay the meeting. This also depends on whether WHO staff will attend our next meeting and what dates would be best for them as well as uncertainty over whether we will have managed to get enough human and animal samples properly analysed by then. Steve Belmain will communicate with everyone to sort out the timing of the next meeting. Problems with money continue with no relief in sight. The Director of NRI plans to go to Brussels to find out what is going on and hopefully put pressure on decision makers to release our advance funds.
Action: Everyone to send contact details of WHO staff who should be invited to our next meeting in Harare. Steve Belmain will then contact them to see whether they are interested to attend and could make a meeting in September/October.

Dates of next meetings:
Harare meeting current stands at 7-9 September 2005. However, this is likely to change in response to EC proposal deadline conflict, WHO staff invitations, and our ability to deliver analysed results in time. Steve will inform asap
Final workshop scheduled for 4-5th May. Pre-meeting of ratzooman partners to take place over 2-3rd May, therefore everyone arriving on in South Africa on 1st of May.

Minutes of RATZOOMAN meeting held in Pretoria, South Africa, 6-8 February 2006

The following people were in attendance:-
Lorraine Arntzen, National Institute for Communicable Diseases, Health Laboratory Service, South Africa
Steven Belmain, Natural Resources Institute, UK
Godfrey Chikwenhere, Plant Protection Research Institute, Zimbabwe
John Frean, National Institute for Communicable Diseases, Health Laboratory Service, South Africa
Rudy Hartskeerl, Royal Tropical Institute, the Netherlands
Frikkie Kirsten, Plant Protection Research Institute, ARC, South Africa
Herwig Leirs, Danish Pest Infestation Laboratory, Denmark and University of Antwerp, Belgium
Jens Lodal, Danish Pest Infestation Laboratory, Denmark
Robert Machang'u, Sokoine University of Agriculture, Tanzania
Anabela Manhica, National Veterinary Research Institute, Mozambique
Emil von Maltitz, Plant Protection Research Institute, ARC, South Africa
Martha Mpisaunga, Syngenta, Zimbabwe
Rassul Nala, National Institute of Health, Mozambique
Peter Taylor, Durban Natural Science Museum, South Africa
Ricardo Thompson, National Institute of Health, Mozambique
Moses Zimba, Harare City Health, Zimbabwe

Links to following sections of this document

Summary of meeting

Finances
Steve asked all countries to ensure that they submitted corrected claims for old claims that had been rejected. In many cases this was simply a case of re-submitting sub-contract invoices in an acceptable form or in other cases ensuring that the overhead rates charged were clearly indicated on the submission forms. Steve reminded that in some cases the NRI had paid for funding out of their own budgets and that these funds would have to be recovered by NRI. Third cost statements must have been sent by now. Any that had not been sent or that needed correction MUST be sent immediately. Corrections from old submissions MUST be submitted with third cost statements. Steve asked all countries to review the reasons why some claims had been rejected. The amounts rejected and the reasons why the rejections have been made are identified on the forms returned by the EU. These corrections must be made as soon as possible. Both first and second cost statements must be corrected as soon as possible.

Target Date
Submissions of 3rd Cost Statement by end February.
Submit Corrections of 1st and 2nd Cost Statements with 3rd Cost Statement

Technical Reports
To be submitted by Wednesday 8th February. Steve to circulate annual report for comment by 24 February and submit to EC by 28 February.

Final Workshop
Lorraine spoke for some time about organisation progress. Registration is necessary as soon as possible and payment for those who have already registered must be made by the 15th February.

Final registration MUST be undertaken by 1st March 2006. Game Drives must be paid personally and can be paid on the day of the Drive.

Steve has obtained ten thousand euros from the CTA for payment of delegates to come to the workshop. These funds must can only be used for delegates from Africa. Nominations for this fund should be made to Steve as soon as possible.

Steve reminded everyone that if any collaborators had spare funds within their budgets they could use this money for payment of delegates to attend. These funds could be used for payment of delegates outside the countries concerned, even outside Africa.

Sponsorship deals are currently under discussion which may pay for additional attendees, as well as drinks, conference packs, game drives, etc. Lorraine asked everyone to ensure that when they booked flights they let the organisers know so that transport arrangements can be made to collect them from the airport and bring to the lodge .

A press release should be generated prior to the Workshop – Steve will produce and circulate a draft asap.

Steve is expecting everyone involved with the project to arrive on Monday 1st May. The costs of the extra days are not covered by the registration fees and will have to be paid additionally when sending the money through.

The desirability of producing a video that illustrates rodent behaviour was discussed. It was agreed that it would be useful to have the Bangladesh video running in the foyer or other area where delegates might congregate. The objective of the video would be simply to draw delegates attention to the rodent issue by using the work in Bangladesh. There is no equivalent material for African rodent issues.

The provisional programme was discussed at great length to establish agenda and speakers. See **Agenda and timetable for May workshop, indicating roles and responsibilities.**

Presentations
Agreement was made on who is presenting what and the individuals should start drafting their Powerpoint talks up now. Presentations should be standardised and we will do this by circulating drafts and finalising content during the first working days at the lodge before the with workshop. It was agreed that each country will present its work related to the disease results in rodents and humans. This four presentations will need to be standardised as much as possible giving the following.

a. Overview of past country knowledge for plague, leptospira and toxoplasmosis
b. Descriptions of sites
c. Tables and graphs summarising results. Important to differentiate between rodent species where applicable and linking the rodent and human results were possible. If help with analysis is required contact Steve as soon as possible.
d. Conclusions and summary

NB. All sampling in **Mozambique** is completed and results from Loraine awaited.
NB. **Zimbabwe**. A further 150 rodent samples still have to be sent to Lorraine although all trapping is now complete. Also 159 human samples from blood banks due to be sent. Still need to obtain information about the individuals who contributed the samples so that they match Peter's data. Dog samples also need to be analysed.
NB. **Tanzania & South Africa.** Ensure that Mapate data presented in a similar way to Cato Crest as far as possible. Tanzania data should focus on where rodents and human samples have been collected from same areas.

Posters
If anybody wishes to produce a poster they may do so. The details and content of the posters should be emailed to both Steve and Frikkie, including text, graphs, photos, figures, etc. Frikkie agreed to try and have the posters laid out by an ARC colleague. Frikkie will need the final details by 1st April.

Logo
John Frean is making one for use on conference materials and posters and will circulate an electronic version. **Note this is now complete and pasted here in black and green versions**.

To do list

Financial

- Sort out third cost statement and send to Jane Shirley and Philip Davies
- Sort out rejected costs from 1st and 2nd cost statements and resubmit along with 3rd cost statement – mainly issue of certified copies of subcontractor invoices (with VAT and company registration numbers). Cost statement should have a covering note explaining what is being resubmitted for previous cost statements.
- Cost statements and resubmissions must be sent by end of February
- Figure out whether you will fully spend the total money allocated to you in your part of the ratzooman budget so that leftover money can be used to pay for workshop attendees. We don't want unspent funds remaining.

Technical reports in my hand before you leave today.

Workshop

- Get yourself and ratzooman colleagues registered and send payment by 15 February
- Payment amount is more than that mentioned in the registration form as ratzooman people are expected to arrive on the Monday. Work it out based on daily rates mentioned in flyer.
- Send flight details through to Lorraine and Sue McGuiness so that collection from Nelspruit airport can be arranged
- Remind people about the workshop and that they must register soon or it will be too late.
- Steve will draft up a 2nd announcement and will send to everyone to circulate to colleagues and potential candidates.
- Steve will draft up press release and circulate
- Steve will draft up policy document and circulate
- Everyone to send Steve the full contact details of people nominated for CTA funding. He must have name and email address so that he is able to contact them directly and get them to look into flight costs to the meeting.
- Take note of your responsibilities mentioned in the workshop agenda. Start preparing powerpoint presentations you are meant to present. Circulate draft of presentation to Steve by 31 March.
- Mediators to investigate subheadings to key constraints and circulate to Steve by 31 March.
- If you want to make a poster for display at the workshop, all the text, photos, figures, etc must be sent to Frikkie and Steve by the 1st April.

- Everyone should gather together any corporate material from your own institution you wish to include in workshop bags.
- Lorraine, Sue dealing with sponsorship, conference bags, name tags, logo – as per John's design. Sponsorship amounts and what they are to be directed to need to be sorted soon. Would be good if commercial sponsors would not only support conference activities such as drinks, entertainment, but attendance of young scientists.

Data

- Outstanding samples in Zimbabwe to be sent to Lorraine ASAP. Lorraine to try to complete analysis in time for data to be incorporated into presentation.
- Lorraine to send results of sample analysis and revised spreadsheets to partners to Judith, Linda and Steve
- Judith to make pivot tables on rodent and human samples and send to relevant partners
- Herwig to work out age classes for rodent species with abundant samples and send to partners and send by 17th February
- Presenters of country reports of rodent and human disease to pick out the most important correlations found from pivot tables generated by Judith to incorporate into their presentations. These presentations should try to be standardised giving overview of issues in country, summary of results related to locations, conclusions – particularly highlighting difficulties and capacity constraints and how they were resolved.
- Anthropology report for Mozambique – Steve and Rassul to discuss, Monica to finalise and send to Jens to assist in his presentation.

Invoice example

TAX INVOICE

TO:
Syngenta, Zimbabwe - address
NICD, South Africa - address
INS, Mozambique - address
Sokoine, Tanzania – address

Date:
Invoice number:
Invoice date:
Reference: ratzooman ICA 4 CT 2002 10056

Expenses related to ratzooman research project
(VAT inclusive) ……. Amount (state the amount in local currency)

Total payable ……$£

Signature: Date:

Name: Anabela, Godfrey, Moses, Pfarelo, etc.
Position:

_____
Name and address of subcontractor

e.g.
Dr Steven Belmain
Natural Resources Institute
University of Greenwich
Central Avenue
Chatham Maritime
Kent ME4 4TB

Phone:
Fax:

VAT registration number: …….

Company registration number: ……..

Sponsorship list – particularly CTA, but also through spare funds available through ratzooman partner budgets.

CTA funding – notify Steve with full contact details by 24 February.

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Victoria Ngowo, National Rodent Control Centre, Tanzania
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Mr. S.M. Msingwa, District Medical Office, Lushoto, Tanzania
Mgemasam@yahoo.co.uk

Dr Mutambu Ministry of Health Communicable diseases, Zimbabwe

Lukwa Nzira, Blair Research. National Institute for Research, Zimbabwe (rodenticides)

Loth Mulungu, SUA, Tanzania

Apia Massawe, SUA, Tanzania

Rhodes Makundi, SUA, Tanzania

Chris Chimimba, South Africa – accommodation and subsistence costs only?

Mozambicans will not need flight costs as can drive there. They only need registration, accommodation subsistence at workshop. Provincial Directors of Zambezia and Tete can be funded by Mozambique budget.

Elizabeth Calvet to be funded by Belgian budget
Elizabeth Carniel?
Alan Buckle?

Grant Singleton to be funded through IRRI

Aubrey Silinyana funded by South African budget

Financial breakdown explanation

Partner	Total budget	Amount received from EC (advance + 1st + 2nd)	Additional amount received from NRI	Total sent to partner	Outstanding funds (TB - TS)	Percent remaining
United Kingdom	394,355.00	351,374.75	0.00	351,374.75	42,980.25	10.90%
Denmark	103,543.00	71,634.10	0.00	71,634.10	31,908.90	30.82%
Netherlands	236,268.00	161,582.44	0.00	161,582.44	74,685.56	31.61%
Belgium	200,106.00	87,804.51	0.00	87,804.51	112,301.49	56.12%
Tanzania	121,922.00	94,114.45	4,908.55	99,023.00	22,899.00	18.78%
Mozambique	133,761.00	71,504.00	37,000.00	108,504.00	25,257.00	18.88%
South Africa	178,748.00	137,467.33	0.00	137,467.33	41,280.67	23.09%
Zimbabwe	81,297.00	44,479.01	34,726.04	79,205.05	2,091.95	2.57%

Partner	1st submitted	1st accepted	1st rejected	2nd submitted	2nd accepted	2nd rejected
United Kingdom	123,024.19	122,974.16	50.03	149,519.00	150,224.96	-705.96
Denmark	16,944.00	8,448.20	8,495.80	42,344.00	42,325.66	18.34
Netherlands	72,794.81	60,463.61	12,331.20	53,803.12	53,798.11	5.01
Belgium	30,183.00	30,193.21	-10.21	57,612.02	57,611.30	0.72
Tanzania	45,911.00	39,754.90	6,156.10	33,851.00	29,854.59	3,996.41
Mozambique	30,576.47	26,368.13	4,208.34	41,143.21	19,030.82	22,112.39
South Africa	60,491.53	56,073.77	4,417.76	69,470.15	45,781.21	23,688.94
Zimbabwe	38,902.44	29,731.51	9,170.93	32,168.85	14,747.50	17,421.35

Partner	Total rejected	Unclaimed funds (TB - TS)	Partners must still claim for (TR+UF)	Percent to claim	Difference between % remaining and % to claim
United Kingdom	-655.93	121,811.81	121,155.88	30.72%	19.82%
Denmark	8,514.13	44,255.00	52,769.13	50.96%	20.15%
Netherlands	12,336.21	109,670.07	122,006.28	51.64%	20.03%
Belgium	-9.49	112,310.98	112,301.49	56.12%	0.00%
Tanzania	10,152.51	42,160.00	52,312.51	42.91%	24.12%
Mozambique	26,320.72	62,041.32	88,362.04	66.06%	47.18%
South Africa	28,106.71	48,786.32	76,893.03	43.02%	19.92%
Zimbabwe	26,592.28	10,225.71	36,817.99	45.29%	42.72%

List of potential research papers

Durban Museum Novitates paper to be prepared by Peter Taylor on Durban actions
Authors Peter, Lorraine, John

South African Journal of Science to be prepared by
authors Peter, Lorraine, John, Frikkie, and Emil, Steve

African Zoology, Koedoe, Annals of the Transvaal Museum for paper on new genus in South Africa
Authors Peter, Frikkie, Emil, Herwig

Regional paper with entire team listed as joint authors to be submitted to *Acta Tropica*.
Author list Rudy, Herwig, Anabela, Rassul, Ricardo, Robert, Godfrey, Martha, Moses, Frikkie, Jens, Peter, Abdul, Malcolm, Monica, Solveig, Anne-Charlotte, Judith, Linda, Alan, John H, Stephen, Emil, John F, Adrian, Lorraine, Steve to be corresponding author

Paper on Leptospirosis serovars in Tanzania. *International Journal of Systematic and Evolutionary Microbiology*
Robert, Rudy, Abdul, Ahmed

Regional paper on leptospirosis submitted to Journal of Emerging Diseases
Authors, Rudy, Robert, Ricardo, Anabela, Rassul, Martha, Moses, John, Lorraine, Andrew Potts

Belgian Journal of Zoology. PCR detection of leptospires in rodents and insectivores. IF 0.7
Herwig, Rudy, Robert, Georgie, Mhamaphi, Abdul, Paemelatre, Willekens,

Model of Leptospirosis submitted to *Acta Tropica* authors of UK and Belgium
Herwig, John H, Stephen

Plague paper to resubmit to *Acta Tropica* authors of Belgium and Tanzania
Stephen, Robert, Herwig, Rhodes

Paper to *Mammalia* on Movements of rodents …. Denmark, Tanzania
Herwig, Solveig plus either Georgie or Abdul

R. tanezumi paper to be submitted by Amanda Bastos et al. to *Molecular Phylogeny and Evolution*.
Peter, Frikkie, Steve, Emil, Amanda, Chris, Herwig, plus a couple others

Paper on anthropology and socioeconomics to be submitted as an entire team joint authorship
Monica, Malcolm, Nemarundwe, Rassul, Anabela, Colaco, Damas, Mshote, Takalani, Peter, Susanne, Pharelo, Frikkie, Emil,

Mark recapture studies to be submitted to *Oikos* or *Journal of Tropical Ecology* as an entire team authorship
Herwig, Frikkie, Emil, Solveig, Anabela, Rassul, Martha, Godfrey, Moses, Robert, plus number of students involved

Rodent species compositions and link to biotypes. Small mammals in urban peri-urban Africa. *Journal Tropical Ecology*
Herwig, Frikkie, Emil, Solveig, Anabela, Rassul, Peter, Martha, Godfrey, Moses, Robert,

Lepto and toxo results together and plague results separately to be submitted to Mozambican Medical Journal after an English international paper as been published
Rassul, Anabela, Lorraine, John, Ricardo, Rudy, Mirjam

Rodent paper specific on Mozambican results in Portuguese after English version has been published
Rassul, Anabela, Aida, Quiba, Gawana, Milagre, Susana, Alberto, Ricardo, Herwig, Solveig

Journal of Medical Geography for GIS as a tool for disease and disease risks.
Judith, Ricardo, Linda, Alan

Paper on management actions related to rodent diseases. Pest Management Science IF 1.17
Author list Rudy, Herwig, Anabela, Rassul, Ricardo, Robert, Godfrey, Martha, Moses, Frikkie, Jens, Peter, Abdul, Malcolm, Monica, Solveig, Anne-Charlotte, Judith, Linda, Alan, John H, Stephen, Emil, John F, Adrian, Lorraine, Steve to be corresponding author

Chris Appleton to submit parasitology papers

Vector borne zoonotic diseases?
Emerging Infectious Diseases?

Remember to acknowledge EC and mention contract number ICA4 CT2002 10056

Agenda and timetable for May workshop, indicating roles and responsibilities

Programme for Ratzooman workshop in May 2006

Before May	Content of talks drafted up by presenters. Content of pack information drafted up including: • Workshop schedule – best if this can be finalised and printed at Lodge on 2nd May along with group id cards so that people know what group they will be in on 5th May • Policy paper • Copies of publicity material (Rats! CD, video of Aubrey?, copies of papers, institutional promotional material) • Commercial sponsorship material and advertising
1st May	Ratzooman team to arrive at Pestana Kruger Lodge Europeans likely to arrive before lunch, everyone should arrive before nightfall. Organise an evening game drive before dinner for those who arrive in time – 3pm departure
2nd May	Finalise talks (which should be mostly drafted before arrival) by working in teams to improve content of presentations where possible, adding in pictures, etc. Grouping of attendees for session on 5th May. This is likely to be a long hard day with minimal break times
3rd May	Practice run through of talks by presenters Workshop attendees start to arrive in afternoon Registration desk – name tags, packs handed out
18:00	Bar open – on own account or sponsored?
19:30	Opening dinner – SA buffet, welcome speech by Steve
4th May	
07:00	Breakfast
08:00	Welcome by Steve, introduce guest of honour
08:10	Welcome by guest of honour – SA Head of Communicable Disease Control in Dept of Health
08:25	Overview of workshop, objectives, introduce session chair – Steve Session chaired by Lorraine
08:35	Overview of ratzooman – Steve
08:55	Overview of rats and disease – Herwig
09:15	Overview of leptospirosis – Rudy
09:30	Overview of toxoplasmosis – Ricardo
09:45	Overview of plague – John
10:00	Discussion Session chaired by Frikkie
10:10	Lassa Fever - Elizabeth Calvet
10:30	Enteric diseases, salmonella, and food borne pathogens - Rolf Uys AIB
10:50	Coffee
11:20	Parasites, worms - Chris Appleton UKZN
11:40	Plague globally - Russell Enscore CDC
12:00	The agriculture/health divide rodents - Grant Singleton IRRI
12:20	Discussion
12:30	Lunch Session chaired by Rudy
13:20	Human behaviour and socio-economics combined into one - Monica
13:40	GIS – Ricardo
14:00	Cato Crest part one – Peter
14:20	Rodent ecology results – Herwig
14:40	Mozambique disease results in rodents and humans - Rassul
14:55	Zimbabwe disease results in rodents and humans - Godfrey
15:10	Tanzania disease results in rodents and humans - Robert
15:25	South Africa disease results in rodents and humans – Lorraine
15:40	Discussion

15:50 Tea – can carry on for those who do not go on game drive
16:00 Game drive for two hours only
18:00 Bar open – alcohol on own account or sponsored?
19:30 Dinner – performance by Aubrey

5th May
07:00 Breakfast
Session chaired by Martha
08:00 Cato Crest part two – Guy Redman, Mel Hayter
08:20 Modelling plague and leptospirosis – John and Stephen
08:40 Rodent control – Adrian Meyer
09:00 Disease management recommendations – Jens
09:20 Practicalities of management / Introduction to policy paper discussion – Adrian/Steve/Martha
09:40 Discussion
10:00 Formulation of key constraints – Mediator will be Malcolm who will explain procedures. Groups will be uniform status level, e.g. scientists, ministry of health, pest control operators, environmental health, etc. Each group will be given two constraints to discuss from the below list. Each question will be discussed in the group for 30 minutes, and the mediator for each group will direct the conversation. Groups will nominate a reporter who will write down the information and report back to workshop.

- How should we improve surveillance and monitoring of diseases and diagnostic capacities within African countries? Moses to investigate subheadings to be addressed
- How can improve clinical treatment, prevention and interventions against rodent diseases? John to investigate subheadings to be addressed
- How do get Departments of Agriculture, Health and Environment working together to develop national rodent management strategies? Robert to investigate subheadings to be addressed
- How can we influence national and international research priorities and funding opportunities to improve knowledge about rodent transmitted diseases? Rudy to investigate subheadings to be addressed
- How do we raise awareness about the risk of rodents transmitting diseases with the general public, service providers and the international community? Peter to investigate subheadings to be addressed

10:10 Group discussion – Mediator for each group, groups should elect spokesperson. We will need between 4 and 6 mediators – John, Robert, Moses, Peter, Herwig, Rudy
11:10 Coffee
11:40 Group reports – 15 minutes per group by elected spokespersons
13:00 Lunch
14:00 Discussion about reports made in mixed groups or with the whole workshop depending on number of attendees
14:45 Synthesis, development of common statement, reports from groups – Steve
15:15 Where do we go from here? – Steve
15:30 Closing Discussion – Steve
15:45 Tea – can carry on for those who do not go on game drive
16:00 Game drive for two hours only
18:00 Bar open – alcohol on own account or sponsored?
19:30 Dinner – Swazi dancers?

6th May
07:00 Breakfast, departure

Below is proposed Ratzooman team arriving on 1st May. The costs of these people should come directly from the ratzooman budgets for each country. Problems in meeting these costs must be determined now! I am hoping that any project underspend by particular countries can be used to fund further people's attendance.

Steve Belmain
Monica Janowski
Malcolm Iles
John Holt
Adrian Meyer
Rudy Hartskeerl
Herwig Leirs
Stephen Davis
Jens Lodal
Robert Machang'u
Rassul Nala
Ricardo Thompson
Anabela Manhica
Lorraine Arntzen
John Frean
Peter Taylor
Frikkie Kirsten
Emil von Maltitz
Phanie Malebana
Martha Mpisaunga
Godfrey Chikwenhere
Moses Zimba
Anne Laudisoit
Malodi Setshedi
Guy Redman

Those from our institutions that we know will come on Wednesday

Abdul Katakweba
Mel Hayter
Sagren Moodley
Aubrey Silinyana
Mirjam Engleberts

Any budget underspend from ratzooman budgets can be used to pay for as many people to attend as possible. We may want to target this at people from consortium partner countries. However, we do have permission from the EC to use any project underspend to fund anyone from anywhere in the world with preference given to African countries. We all must, therefore, carefully assess whether partners will fully utilise their budgets. Any partner thinking they won't use all the money allocated to them in the contract should get in touch with me.

We have 10,000 euros granted through the CTA which should fund approximately 10 people from African nations to attend.

Commercial sponsorship of attendees – may find some Agrochemical sponsors willing to do this as well as perhaps some of the larger South African pest control companies

Analysis questions for rodent and human disease data

Rat species relationship with disease positives – number of tested animals and number of positives
In relation to disease found in rodents, where have the rodents been trapped (house, field, etc.)
Make a contingency table with habitat, disease status and rodent species
Make a contingency table with locality (focal area) and disease status and rodent species
Age and sex status of rodents with relation to disease – contingency table with age, sex, disease status
In order to determine age, you will need to break down status using two different methods. One contingency table should be made using weight categories and other table should be done using maturity status (i.e. immature vs. mature).
Time series of sample collection vs disease prevalence.

Judith to run the above once data input to database.
Herwig to supply age categories for main rodent species to be assessed.

For human disease
Relationship between human positives and rodent positives for Zimbabwe, Cato Crest, Morrumbala, Morogoro, Masasi, but should probably leave out samples collected from clinics outside of rodent areas.
Table correlating age, sex and disease prevalence
Spatial relationship among human positives and against disease prevalence in rodents
Temporal relationship in human sample collection in Tanzania

Publications

Article appearing in The Mercury

Article appearing in SABC News

Davis, S., E. Calvet & H. Leirs. 2005. Fluctuating rodent populations and risk to humans from rodent-borne zoonoses. *Vector-Borne and Zoonotic Diseases*, 5(4):305-314.

Mgode, G.F, Mhamphi, G., Katakweba, A., Paemelaere, E., Willekens, N., Leirs, H, Machang'u, R.S., Hartskeerl, R.A. 2005. PCR detection of Leptospira DNA in rodents and insectivores in Morogoro Tanzania. *Belgian Journal of Zoology*, 135 (suppl).

Davis, S., R. Makundi & H. Leirs. Demographic and spatio-temporal variation in human plague at a persistent focus in Tanzania. Acta Tropica. (submitted)

Holt, J., S. Davis & H. Leirs. A model of Leptospirosis infection in an African rodent. Acta Tropica (submitted)

lecture at the International Meeting "Plague: bacteriology, evolution, ecology, epidemiology and its impact on human history". Oslo, Norway, 9-13 November 2005: Laudisoit, A., H. Leirs, R.H. Makundi. Plague in the Western Usambara mountains. Ecological study on hosts and vectors of plague in Lushoto district (Tanzania).

lecture at the International Meeting "Plague: bacteriology, evolution, ecology, epidemiology and its impact on human history". Oslo, Norway, 9-13 November 2005: Makundi, R.H., H. Leirs, A. Massawe, L. Mulungu, B.S. Kilonzo & R.M. Machang'u. Plague in Lushoto, NE Tanzania.

lecture at the International Meeting "Plague: bacteriology, evolution, ecology, epidemiology and its impact on human history". Oslo, Norway, 9-13 November 2005: Belmain, S.R.. The Socio-economics of Plague in Africa: A growing ecological problem or a mere indicator of increasing deprivation?

Consortium partner reports

NRI

RATZOOMAN Prevention of sanitary risks linked to rodents at the rural/peri-urban interface
INCO-DEV contract number ICA4-2002-10056
ANNUAL SCIENTIFIC REPORT

Participant:	NRI
Period:	Jan to Dec 2005

Scientific achievements

WP5 Impact of environmental factors, water management and land use strategies upon zoonotics - Complete analysis is pending the arrival of two more satellite images. Land use change results so far indicate that all sites have seen significant changes through increased urbanisation (including rural towns, villages and suburban areas), deforestation and agricultural expansion. Links between these changes and risk of rodent disease transmission will be presented at the final project workshop in May.

WP6 Socio-economic impact and livelihood constraints of disease - This workpackage is complete. The final document, Socio-economic factors influencing the transmission of rodent-borne diseases in southern Africa, amalgamates the data collected from studies in South Africa, Zimbabwe, Mozambique and Tanzania.

WP7 Measuring factors of anthropogenic change upon rodent ecology, epidemiology and natural capital - In addition to the final report for anthropological studies in the following sites: Cato Crest, Mapate, Lushoto, there has been further progress in producing a report for Mozambique. A final report will be completed before the project ends. Due to the government destruction of settlements in Zimbabwe that were being used for project research activities, it will not be possible to produce an anthropological report for Zimbabwe.

WP8 Geographic Information System - The database has been completed and distributed to all partners. Separate files of updated data, particularly with regard to human samples, are currently being uploaded. Pivot tables to analyse relationships between rodent species, disease in animals and humans is currently under way and will comprise one of the main results presented at the final workshop.

WP9 Predictive modelling tools for assessing zoonotic transmission risks - Good progress has been made in developing a mathematical model that explains the transmission of leptospirosis through different pathways (environmental, sexual, maternal) within a rodent population over time. The general approach has been to devise a model combining a rodent population model with an epidemiological model of leptospira infection in the rodents. The latter is entirely novel as no previous attempt to model the dynamics of the disease has been found in the literature. Validation is planned by comparison of model output with rodent population data, and to the extent that it is available, leptospira prevalence data in the rodents. The model will then be used to investigate the potential effects of management interventions affecting rodent populations. This work is complete and has been recently submitted for peer review as follows.
Holt, J., S. Davis & H. Leirs. A model of Leptospirosis infection in an African rodent. *Acta Tropica* (submitted)

Scientific problems encountered
None

Publications or presentations
Holt, J., S. Davis & H. Leirs. A model of Leptospirosis infection in an African rodent. Acta Tropica (submitted)

lecture at the International Meeting "Plague: bacteriology, evolution, ecology, epidemiology and its impact on human history". Oslo, Norway, 9-13 November 2005: Belmain, S.R.. The Socio-economics of Plague in Africa: A growing ecological problem or a mere indicator of increasing deprivation?

RUCA

RATZOOMAN Prevention of sanitary risks linked to rodents at the rural/peri-urban interface

INCO-DC contract number ICA4-2001-10125

ANNUAL SCIENTIFIC REPORT

Participant:	RUCA
Period:	Jan 2005-Dec 2005

Scientific achievements

The analysis of 1986-2004 human plague data from Lushoto, Tanzania, was completed and a manuscript submitted. It showed a strong geographical concentration of plague cases and an disproportionately high incidence in children and adult women.

A preliminary and exploratory analysis of rodent and flea data collected in villages with and without plague in Lushoto District, Tanzania, suggested the abundance of human fleas as one of the major differences between those villages.

A basic mathematical model for the spread of leptospirosis among rodents has been improved and a manuscript submitted.

A large majority of the rodent specimens collected and sent to Antwerp have been identified at species level, part of them just at genus level and require still more taxonomic attention.

Scientific problems encountered

The problem remained to obtain basic parameter values for leptospirosis infection from the literature; no estimates of leptospirosis prevalence rates in rodents have been made available.

A small number of taxa are unknown or poorly documented in literature and need in-depth taxonomic research (which cannot be finalised completely within the Ratzooman project timeframe).

Publications or presentations

Davis, S., E. Calvet & H. Leirs. 2005. Fluctuating rodent populations and risk to humans from rodent-borne zoonoses. *Vector-Borne and Zoonotic Diseases*, 5(4):305-314.

Mgode, G.F, Mhamphi, G., Katakweba, A., Paemelaere, E., Willekens, N., Leirs, H, Machang'u, R.S., Hartskeerl, R.A. 2005. PCR detection of Leptospira DNA in rodents and insectivores in Morogoro Tanzania. Belgian Journal of Zoology, 135 (suppl).

Davis, S., R. Makundi & H.Leirs. Demographic and spatio-temporal variation in human plague at a persistent focus in Tanzania. Acta Tropica. (submitted)

Holt, J., S. Davis & H. Leirs. A model of Leptospirosis infection in an African rodent. Acta Tropica (submitted)

lecture at the International Meeting "Plague: bacteriology, evolution, ecology, epidemiology and its impact on human history". Oslo, Norway, 9-13 November 2005: Laudisoit, A., H. Leirs, R.H. Makundi. Plague in the Western Usambara mountains. Ecological study on hosts and vectors of plague in Lushoto district (Tanzania).

lecture at the International Meeting "Plague: bacteriology, evolution, ecology, epidemiology and its impact on human history". Oslo, Norway, 9-13 November 2005: Makundi, R.H., H. Leirs, A. Massawe, L. Mulungu, B.S. Kilonzo & R.M. Machang'u. Plague in Lushoto, NE Tanzania.

Work Package 3: Taxonomic identification of rodent species found in rural and peri-urban habitats

Objectives

- To ascertain the rodent and insectivore species found among different habitats in SADC communities

Activities and preliminary results

The large majority of specimens arriving in Antwerp had the skull removed and cleaned for taxonomic investigation. For large series of specimens of the same species from a locality (typically in the genera *Rattus, Mus, Mastomys*) only a subsample of the specimens was dissected, the rest were kept for later reference. Removed skulls were measured, and this work is ongoing. On each skull, 19 skull measurements are taken for later multivariate analysis, and if needed comparison with type material. More than 15,000 rodent issue samples have arrived in Antwerp and have been stored after classification. These samples are used for molecular identification of specimens that cannot be reliably identified morphologically. For such molecular identification, DNA is extracted from the samples, and the cytochrome B gene of the mitochondrial DNA is sequenced and compared with known DNA sequences.

The tables below gives a preliminary overview of the different species identified for all four countries. It should be noted however, that not all these identifications have been confirmed, and that within some genera, more than one species is represented in the collections.

species	Mozambique	S Africa	Tanzania	Zimbabwe	Total
Acomys	2				2
Aethomys	4	45			49
Arvicanthis			115		115
Cricetomys			151		151
Crocidura	3		412	1	416
Dasymys		4	6		10
Dendromus			3		3
Grammomys			162		162
Hylomyscus			10		10
Lemniscomys	13	13	17	2	45
Lophuromys			125		125
Malacomys		1			1
Mastomys	44	479	2204	80	2807
Mus	198	25	406		629
Mus (Leggada, Nannomys)		1	29		30
Nannomys	5				5
Otomys		3	2		5
otomys ango.		1			1
Praomys			128		128
Rattus	122	8		5	135
Rattus				16	16
Rattus norvegicus		236	36		272
Rattus rattus		21	608	2	631
Rattus sp.		6			6
Rhabdomys		27		1	28
Saccostomys		1		1	2
Sciurida sp.			3		3
Shrew			24		24
Squiral			1		1
Steatomys		1	1		2
Tatera	19		52		71
Thallomys				1	1
UNKNOWN			25		25
Total	410	872	4520	109	5911

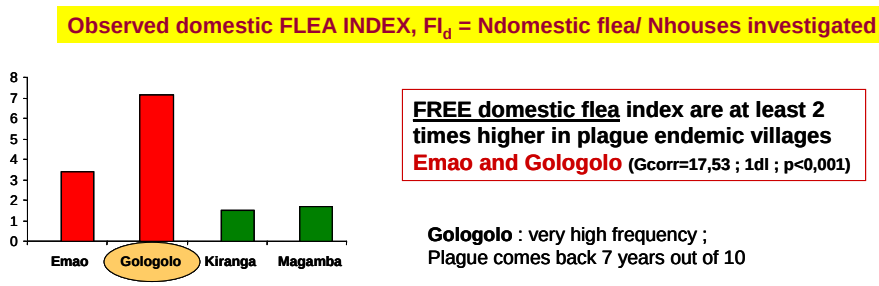
Within the focal sites, rodent collections were made in various habitats, and as illustrated by the tabulated data for Morogoro, Tanzania, below, there is a considerable variation in species composition between habitats:

Species (Field-Id)	Crop Field	Fallow Land	House	Market	Mill	Slaughterhouse	Store	Swamp area
Arvicanthis								1
Cricetomys			75			2		1
Crocidura	2	9	100			6	7	177
Dasymys								6
Grammomys			2					19
Lemniscomys		6	1					3
Mastomys	8	308	98			4	10	1203
Mus		1	130	4	2	1	2	1
Mus (Leggada, Nannomys)		1	1				2	12
Praomys		1						1
Rattus norvegicus			20		1		1	
Rattus rattus	12	2	276	2	2		10	12
Shrew		1						
Squiral			1					
Steatomys								1
Tatera		32						7
Total	22	361	704	6	5	13	32	1444

These data will now be linked to results from the pathogen surveys in order to indicate the most risky combinations of habitat and rodent species.

Rodent-flea fauna comparisons in Lushoto

Since the wild reservoir and ecology of plague in Lushoto, NE Tanzania are still not understood and since analysis of human plague records indicated a very strict geographical concentration of plague, a study was set up to compare the rodent and flea fauna of two villages with a reported high incidence and frequency of plague cases (Emao, Gologolo), and two nearby villages where plague was very rare (Kiranga, Magamba). A large variety of parameters was compared since there is at present no sound a priori hypothesis about which factors would be important to explain the local distribution of plague. So far there seems to be no major difference between the village groups in rodent abundance, rodent species, rodent flea index. However *Lophuromys* sp. was more often and *Praomys* sp. less often trapped in plague-positive villages. The most significant difference however was that many more human fleas (*Pulex irritans*) were trapped in the plague positive villages:



The work is now being repeated in another season. Human fleas will be compared with more than two villages in each group. All rodent and flea samples will also be checked for presence of the plague bacterium.

Work Package 9: Predictive and simulatory modelling

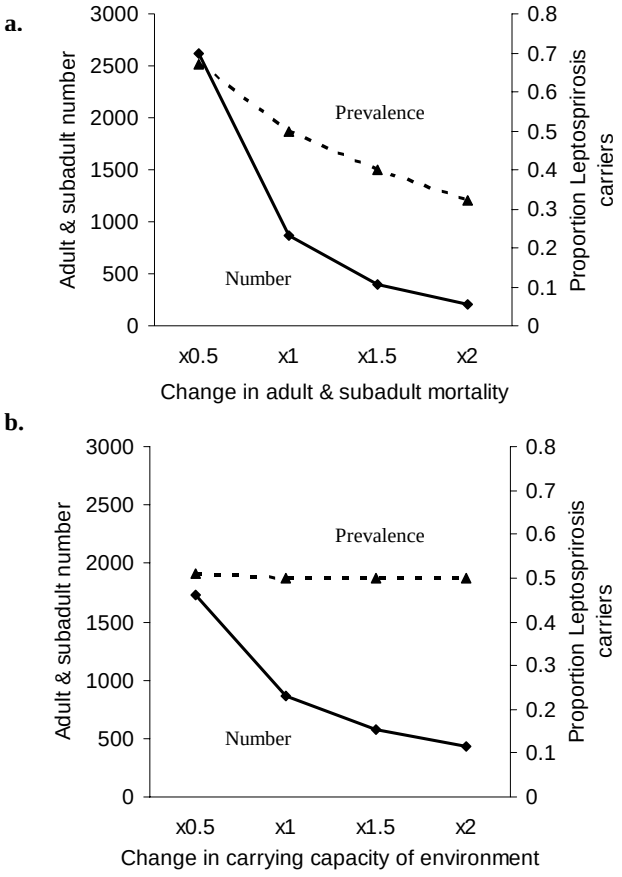
Objectives

- To develop modelling tools that are capable of providing accurate simulations and predictions of when zoonotic diseases may outbreak and to determine particular areas that are or will become increasingly susceptible to zoonosis.

Model of rodent population with leptospire infection

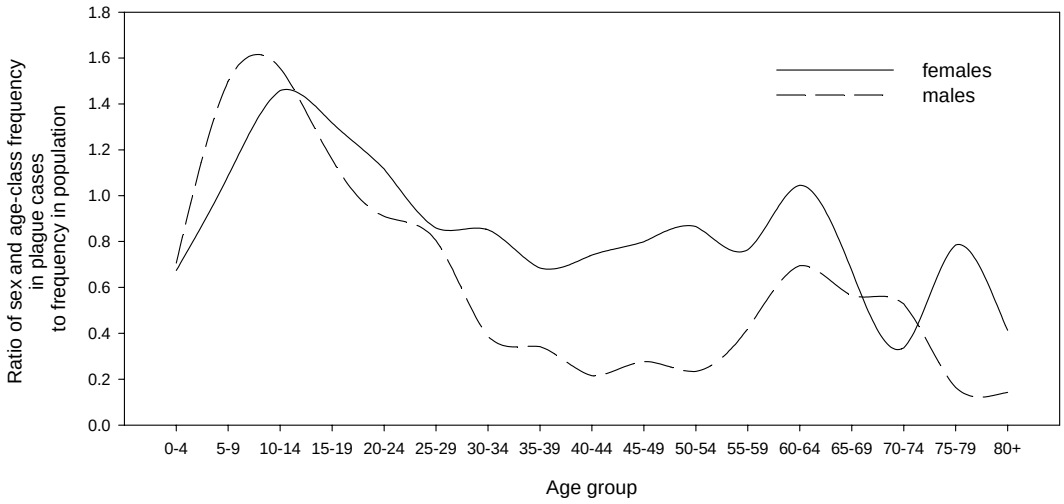
Human leptospirosis (Leptospira spp. infection) is a worldwide public health problem that is of greatest concern for humid tropical and subtropical regions. The magnitude of the problem in these areas is larger because of the climatic and environmental conditions the bacterium face outside their hosts but also because of the frequency of contacts between people and sources of infection. Rodents are thought to play the most important role in human leptospirosis. We modelled the dynamics of infection in *Mastomys natalensis*, a species that is thought to be the principal source of infection in parts of Tanzania. Our model, representing the climatic conditions in central Tanzania, suggests a strong seasonality in the force of infection on humans with a peak in the abundance of infectious mice between November and February in agricultural environments. In urban areas the dynamics are predicted to be more stable and the period of high numbers of infectious animals runs from November to June. Our results indicate that removal of animals by trapping rather than reducing the habitat available to rodents will have the greater impact on reducing human cases of leptospirosis.

Fig. The effects of a) rodent trapping, and b) reduced rodent habitat, on adult and sub-adult number and on leptospira infection rate in the rodents.



Analysis of hospital data on plague

Human plague in the Western Usambara mountains in Tanzania has been a public health problem since the first outbreak in 1980. The wildlife reservoir is unknown and eradication measures that have proved effective elsewhere in Tanzania appear to fail in this region. We collated hospital records on plague patients kept since 1986 and use them to describe the temporal, spatial and demographic variation in human plague in Lushoto. A seasonal peak in cases occurs from December to February and between years the numbers of cases over these three months varies between 0 and 1150. Plague risk depends on age and sex; incidence among children is higher than for adults and higher among adult women than men. These demographic patterns are most obvious in the villages having highest incidence where risk among children aged 10-14 is 2.4 times higher than for adults aged 30-34, and within this adult age-class incidence among women is 2.2 times higher than among men. The mean incidence at three neighbouring villages in the ward Shume is particularly high; cases per thousand inhabitants per year are 5.8, 8.0 and 9.2. The annual incidence across these three villages is correlated with the spatial extent of human plague in the Lushoto district measured by the numbers of villages with cases that year.



Incidence profiles for male and female residents of Shume Ward (western Malalo where the majority of plague cases occur). Shume includes the villages Viti, Gologolo, Nywelo, Manolo, Madala, and Mkunki.

DPIL

RATZOOMAN Prevention of sanitary risks linked to rodents at the rural/peri-urban interface

INCO-DC contract number ICA4-2001-10125

ANNUAL SCIENTIFIC REPORT

Participant:	DPIL
Period:	Jan 2005-Dec 2005

Scientific achievements

Preliminary analyses of CMR data from Tanzania, South Africa, Zimbabwe and Mozambique indicate similar seasonal population dynamics patterns and reproductive patterns in peri-urban populations as in agricultural areas. A manuscript was submitted on foraging movements of rodents in an African city

Scientific problems encountered

none

Publications or presentations

Davis, S., E. Calvet & H. Leirs. 2005. Fluctuating rodent populations and risk to humans from rodent-borne zoonoses. *Vector-Borne and Zoonotic Diseases*, 5(4):305-314.

Mohr, K., H. Leirs, A. Katakweba & R. Machang'u. Movements of rodents around introduction and feeding foci in an urban environment in Tanzania. *Mammalia*.(submitted)

lecture at the International Meeting "Plague: bacteriology, evolution, ecology, epidemiology and its impact on human history". Oslo, Norway, 9-13 November 2005: Laudisoit, A., H. Leirs, R.H. Makundi. Plague in the Western Usambara mountains. Ecological study on hosts and vectors of plague in Lushoto district (Tanzania).

lecture at the International Meeting "Plague: bacteriology, evolution, ecology, epidemiology and its impact on human history". Oslo, Norway, 9-13 November 2005: Makundi, R.H., H. Leirs, A. Massawe, L. Mulungu, B.S. Kilonzo & R.M. Machang'u. Plague in Lushoto, NE Tanzania.

Work Package 4: Rodent ecology in rural/peri-urban Africa

Objectives
To establish rodent population dynamics for the major rodent and small mammal species identified in targeted areas of the SADC
To understand the interactions among different small mammal communities in these areas
To analyse the roles of the different species identified in WP 2 in relation to human populations and zoonosis
To discover potential factors influencing small mammal species prevalence

Activities and Preliminary results

Capture-Mark-Recapture study
Briefly, in Tanzania, South Africa and Zimbabwe a replicated CMR-study was set up in two fields at the peri-urban/rural interface in the main focal site. In Mozambique the CMR-study was only set up in one field.

Monthly CMR trapping sessions were carried out for two years, during which animals were marked and released (see the appendix in the first annual report for a full detail of the WP protocol). In S Africa, the CMR studies were already completed in 2004, in the other localities they continued until late 2005 or even early 2006. Thus, final analyses are currently still ongoing. Monthly rainfall data were obtained from weather stations near the study sites in each of the African countries.

CMR-data files were closely examined for identification and typing errors before closed-model population estimates for the monthly capture-mark-recapture sessions on rodents were calculated with the software program CAPTURE (White *et al*. 1982) using the jack-knife model for heterogeneous capture probability (M_h). Numbers of reproducing females were calculated at each trapping session by an add-on software program developed for the purpose. Subsequently the proportions of reproducing females (i.e. females that either had perforated vagina, were lactating or were pregnant or had a combination of those stages) were calculated at each trapping session as the number of reproducing females divided by the total number of females (adults as subadults).

Since the CMR-study in South Africa has been finalised completely, we only present the main conclusions for that study here. For the other sites, similar analysis is in progress. Two CMR-grids (CMR2 and CMR3) were set up in a rural/peri-urban setting in Mapate, Limpopo Province, in September 2003. Data were collected until September 2005. Captured species involved are *Mastomys natalensis*, *Rhabdomys* sp., *Aethomys* sp., *Otomys* sp., *Mus* sp., *Tatera* sp., *Lemniscomys rosalia* and *Saccostomys campestris*. Of these, *M. natalensis* was the most common group.
The populations of *M. natalensis* fluctuate seasonally (see Fig. below). In both years, population density increases from March to July-August and after reaching that peak slowly decrease again until the next April. There is a clear difference between the two years of the study, with much lower peak densities reached in the second year. This coincided with a much drier rainy season in this second year of the study. Breeding started few months before populations begin to rise (i.e. in February) and continued through the population rise, peak and decline period.

A second species, *Rhabdomys pumilio*, was only present in CMR2, and at much lower densities. It showed a similar but less outspoken seasonality as *M. natalensis*, but there was not all the same clear difference between years, as observed in the latter species.

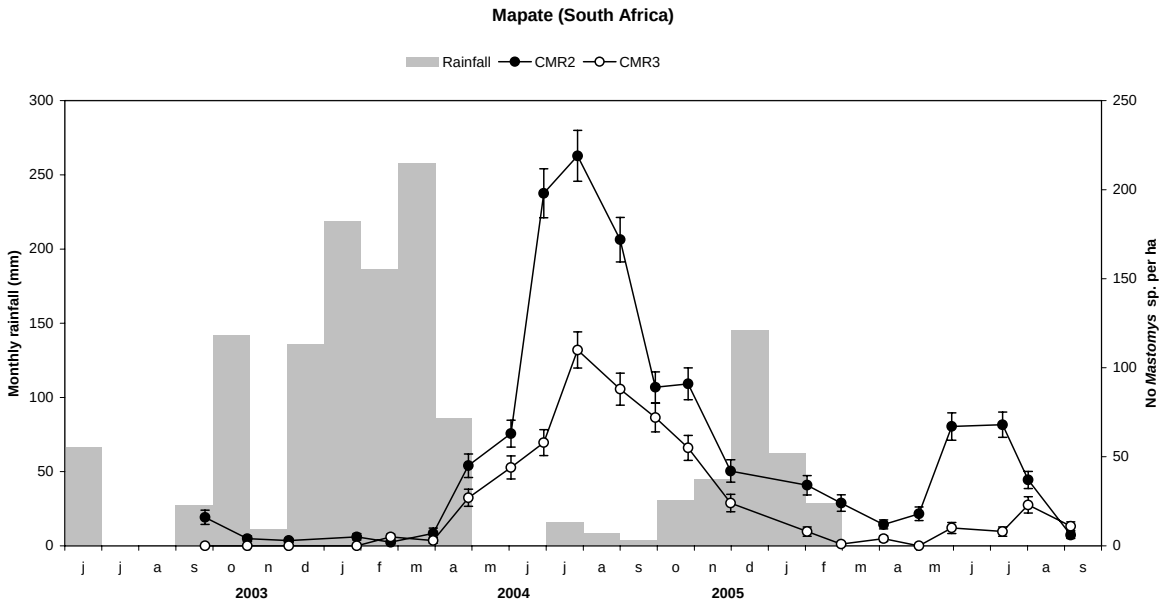


Fig. Population dynamics of *Mastomys natalensis*. in CMR2 and CMR3 grids in Mapate, South Africa.

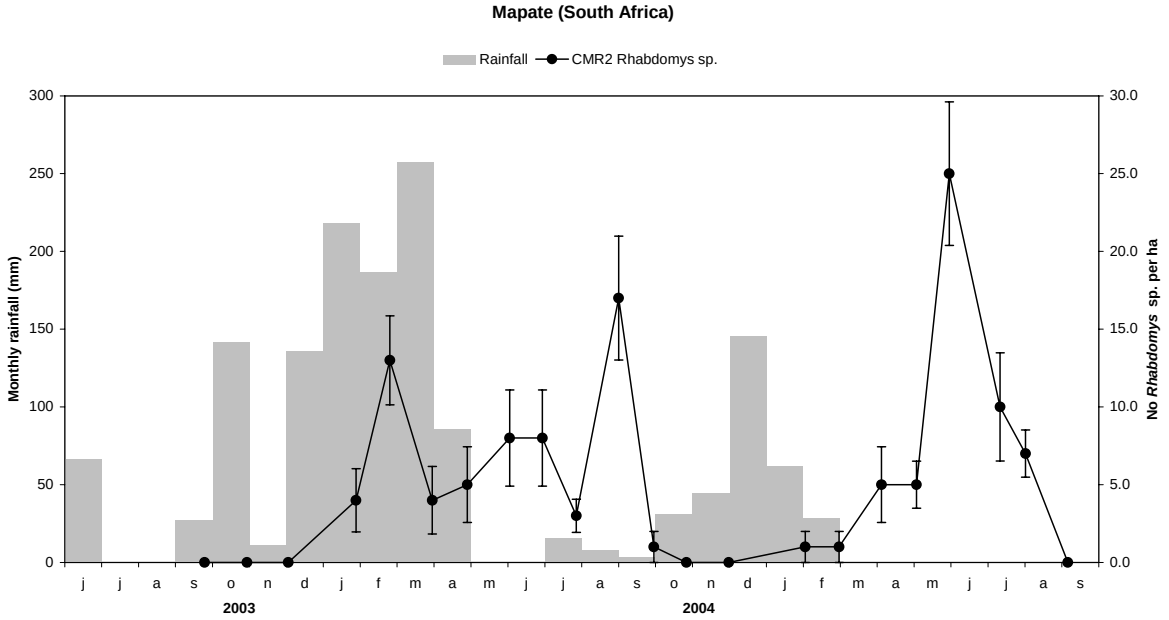


Figure 1. Population dynamics of Rhabdomys sp. in CMR2 site

Work Package 10: Development of Sustainable Control Strategies

Objectives
To develop sustainable control strategies for the management of rodent-borne diseases.

Activities

This workpackage is based on data collected in other workpackages. Not all data collected in other workpackages have been available mainly because they have not been fully analysed. Therefore the amount of data available varies from country to country.

Data on rodent species trapped and data from serological surveys regarding the three diseases together with the reports from Social Anthropological Studies were most complete for the urban settlement Cato Crest and the two rural areas Mapate and Lushoto.

There are some important characteristics about the three zoonoses plague, leptospirosis and toxoplasmosis that have to be considered when strategies are being developed:

Plague
Some of the rodent species occurring act as carriers and vectors
Flea transmits bacteria from rat to human
Bacteria able to survive in the environment
Humans may acquire infection from infected meat
Leptospirosis
A number of pathogenic species of the genus *Leptospira.* Varying pathogenicity and virulens but these differences not taken into account here.
Bacteria excreted in the urine
Humid or wet environment necessary for bacteria to survive and remain infectious
Toxoplasmosis
Any rodent species and all mammals may act as intermediate host with cysts in their tissues
Cat is final host (sexual reproduction), shedding oocysts in faeces
Transmitted to humans through encapsulated cysts in undercooked meat (from a variety of mammals and birds) or via oocysts shed in cat faeces

As rodents are involved in transmission of the three diseases, integrated pest management is to be incorporated into the strategies along with other elements:

Sustainable and very simple
Rodent control related
Reduce risk of disease transmission
Specific rodent species involved in a specific disease
Other animals of importance for a specific disease
Handling and storage of food and water
Hygiene / sanitation

Sustainable control strategies involve three different levels of activities, i.e. 1) Individual level, 2) Settlement / community level, and 3) Government level.

Important factors identified at the different levels are:

1) Individual level
improved personal hygiene (esp. hand washing), handling of food, avoid contaminated water for food preparation, boiling of water for human beings, handling of animals, especially pets and hunted animals, improve house rodent-proofing
2) Settlement / community level
information (given by local authorities) on connection between rodents and disease transmission, water supply, waste water handling, sewer systems, handling of waste and rubbish
3) Government level
education and information to make people aware of the connection between rodents and disease transmission and how to reduce the risk of getting infected

Chemical control of rodents is not considered a sustainable method but it may turn out to be a valuable element when possible, especially in urban settlements. In such cases control carried out by professional control operators is considered the best solution based on the experience expressed by inhabitants of the project areas. Mechanical control with traps can be carried out bye the households themselves. Biological control of rodents may to some degree be possible with cats and dogs.

When plague occurs and imposes a risk to the human population, close contact between rodents and human beings is to be avoided at least with the key species. Therefore, storing of grain and other foodstuff attractive to rodents should be avoided in rooms where people sleep, waste of food should not be left uncovered close to huts and houses, and vegetation that can be used by rodents as protection when they move around close to huts and houses should be avoided or removed.

When data from other project areas are available the analyses will be continued and refined.

KIT

Department of Biomedical Research, KIT (Koninklijk Instituut v.d. Tropen/Royal Tropical Institute

Report for January to December 2005

Work package 1: Retrospective and prospective investigation of human sera for the presence of antibodies against Leptospira, Toxoplasma, and Yersinia antigens

For this work package, a plan was formulated at the inception meeting in UK in March 2003. The availability of sera, the analysis techniques to be used, and the collection of samples and data were discussed: (1) For the retrospective analyses, DC partners should identify all sources of sera that could be used for testing and find ways to facilitate their analysis for leptospirosis, toxoplasmosis and plague. (2) DC partners should select one major and two minor focal towns for project activities in each country, also to be used for all other work package activities. DC partners need to contact local hospitals in focal areas for involvement in prospective serological analysis. (3) Tests: DriDot will be used as screening tests for acute human leptospirosis. MAT will be used for leptospirosis in rodents and other animals and for confirmation of human samples. Toxoplasmosis will be established through serology and by thick blood smear. The toxoplasmosis kit will be adapted for use in (other) animals. PCR could serve as an alternative. For plague, ELISA is available for humans and can be adapted for rodents and other animals. Culturing of leptospires will be done where possible.

Care should be taken to deliver the promised outputs in time. Till 2005, sample sizes collected were small and unlikely to provide representative prevalence data. In 2005 large numbers of human samples have been collected in Tanzania and in South Africa. Although many samples from Tanzania have been analysed for leptospirosis by MAT, many still remain to be done. To my knowledge, all samples still have to be tested for the other diseases and epidemiological/demographic data are not complete. For Cato Crest, Durban, about 200 human samples have been collected and analysed for leptospirosis (DriDot only) and toxoplasmosis and analysed together with demographic and geographic data. Testing for plague and MAT testing to confirm leptospirosis is still pending on these samples. So far (to my knowledge) no isolates have been obtained in the project from humans and from domestic animals. A huge amount of work has to be done towards the end of the project and it is anticipated that it will be virtually impossible to collect and fully analyse all samples in time. Choices and selections of samples will have to be made.

Work package 3: Analysis of rodents, insectivores and domestic animals for the presence of leptospirosis, toxoplasmosis and plague

Leptospira should be routinely cultured (see WP1). Considering the low success rate of isolations from rodents done in Tanzania and the meanwhile amazingly high numbers of rodents that have been sampled it has been recommended at several occasions to fully focus for isolation, PCR and serology on a selected number of rodents and doing them well rather than spreading attention to large numbers.

KIT received 215 rodent kidneys from Mozambique. DNA for PCR has been extracted from all these samples. In 2005, PCR has been performed on 10 samples only. One sample was clearly positive. One is weak positive/doubtful. The remaining samples will be tested in 2006 by a newly developed (but not yet fully evaluated) real-time PCR. Early 2006, KIT received over 2000 kidney samples from Tanzania, with 2000 more present at Sokoine University. As stated above, a selection has to be made. There is a practical and financial impossibility to test all these samples in PCR. In addition, there is no direct need for it. We only need to assess infection/carrier rates which can be done by investigating a representative selection of samples.

Nineteen *Leptospira* isolates were received from Tanzania (eight more in January 2006, heavily contaminated and possibly lost). Due to problems at KIT with good quality BSA required for the EMJH culture medium, typing could only be started at the end of September. As at least 10 in vitro passages (taking 3 months) are required before the actual serotyping can be started, results are as yet not available.

In 2005 excel files to collect all data obtained from the investigation of domestic animals and humans have been completed and distributed to the partners.

Work package 4 : Rodent ecology in rural/peri-urban Africa
Participation in the discussions only.

Work package 5: Impact of water management and land use strategies upon rodent zoonotics
No practical input in 2005.

Work package 11: Analysis of policy issues
No practical input in 2005.

Work package 13: Output dissemination and project co-ordination
KIT organised the project coordination meeting in Amsterdam, The Netherlands on 26 – 29 April 2005.

In summary, large numbers of samples are becoming available only towards the end on the project. There are strong concerns about the practical and financial feasibility to process all these samples (in time). For KIT, I envisage that not all travel funds will be spent. I suggest to transfer the maximum allowed amount (I believe this is 20% of the travel budget) to the consumables-budget and ask EU to grant even a larger amount.

Rudy Hartskeerl, January 2006

SPMC

PROJECT ANNUAL PROGRESS REPORT (Jan-Dec. 2005)
Project title: **Prevention of Sanitary Risks linked Rodents at the Rural/Periurban Interface (RATZOOMAN).**

Contract No. ICA4-2001-10125.
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1.0 REPORT SUMMARY

The project activities continued into 2005 amidst uncertainty of advancement of funds by the EU as it was in 2003/2004. Thanks to continued advance of funds from the Natural Resources Institute activities planned for this year were to a great extent accomplished although with some unavoidable delays. Activities carried out continued to address the work packages (WPs) charted out at the project's semi annual progress report held in Morogoro in July 2003.
The project study areas were Morogoro urban/periurban, (the major study area) and Lushoto rural/periurban and Masasi/Mtwara, (second and third minor study areas respectively). The work packages addressed in 2005 included:

WP1: Retrospective and prospective investigation of human and domestic animals sera for zoonotics
WP2: Taxonomic identification of rodent species in the study areas
WP3: Isolation of zoonotics from rodents, domestic animals and humans from the study areas.
WP6: Socio-economic impact of rodent transmitted disease (leptospirosis)

Generally speaking the activities carried out in 2005 were a continuation of activities of the previous years (2003/2004), and most of these were in their final stages.
There activities included:
Further analysis of the sera (human, domestic animals, rodents) obtained through WP1 in 2003/2004.
Further characterization of isolated pathogens and their rodent vectors (WP2, WP3).
Socio-economic studies associated with leptospirosis in Morogoro (WP6).

2.0 DETAILED REPORT ON PROJECT ACTIVITES

2.1 Retrospective and prospective investigation of human sera for zoonotics (WP1)

Human sera were obtained (starting 2003) from ongoing epidemiological research, elsewhere, or from routine diagnostic procedures (e.g. HIV, schistosomiasis, malaria and PUOs). Sera were also kindly provided from serum banks of two major referral hospitals. Additional sera were obtained in 2004 from three hospitals from Masasi and Mtwara, in the southern Tanzania Region of Mtwara. **For the year 2005 additional sera were also obtained from Mikumi Health Centre and Matumaini Medical Laboratory Morogoro.** Wherever possible the clinical-epidemiological information related to the donor of the serum was recorded, however, without disclosing the identity of the donors. The amounts and origin of the serum samples collected (2003-2005) were as shown in Table 1. Representative samples of these sera were screened for antibodies *to Leptospira spp* and *Toxoplasma spp*. using the micro agglutination test (MAT), and the Bio-Rad Pastorex Toxo® latex agglutination kit respectively. The results are shown in Tables 2a,b, & c and in Table 3.

Table 1: - Human serum collections by locality from 2003 to 2005

Period	Region	Source	No of Samples
May-June (2003)	Morogoro	Aga Khan Hospital	336
May (2003)	Morogoro	Upendo Medical Laboratory	325
May-July (2003)	Morogoro	Mikumi Health Centre	290
July-Sept. (2003)	Dar-Es-Salaam	MUCHS – Referral Hospital	399
May-July (2003)	Kilimanjaro	KCMC - Referral Hospital	352
Oct – Nov (2004)	Mtwara	Masasi District Hospital	200
Oct – Nov (2004)	Mtwara	Ndanda Mission Hospital	100
Oct – Nov (2004)	Mtwara	Mtwara Regional Hospital	100
May – June (2005)	Morogoro	Mikumi Health Hospital	50
May – June (2005)	Morogoro	Matumaini Medical Laboratory	30
TOTAL			**2182**

Table 2a. Human sera (n = 150) tested for leptospira antibodies by MAT (Source; Aga Khan Hospital, Morogoro)

Titres	Serovars tested					
	Grippo.	Ictero.	Hardjo	Pomona	Canicola	Ballum
1:20		1	1	1		1
1:40		1		1		
1:80			2			
1:160		1				1
1:320						
1:640		1				
1:1280		1	1			
Total (%)	**0**	**5 (3.33)**	**4 (2.67)**	**2 (1.33)**	**0**	**2 (1.33)**

Table 2b. Human sera (n = 150) tested for leptospira antibodies by MAT (source; Upendo Medical Laboratory, Morogoro)

Titres	**Serovars tested**					
	Grippo.	Ictero.	Hardjo	Pomona	Canicola	Ballum
1:20		7				
1:40	1	4	2			
1:80		2				
1:160	1	2				
1:320			1			
1:640						
Total (%)	**2(1.3)**	**15 (10)**	**3 (2)**	**0**	**0**	**0**

Table 2c. Human sera (n = 100) tested for leptospira antibodies by MAT (Source; Mikumi Health Centre, Morogoro)

Titres	**Serovars tested**					
	Grippo.	Ictero.	Hardjo	Pomona	Canicola	Ballum
1:20		4	2	2	1	
1:40		5			1	
1:80		9	1		4	
1:160		3			1	
1:320		2				
1:640			1			
1:2560			1			
Total (%)	**0**	**23 (23)**	**5 (5)**	**2 (2)**	**7 (7)**	**0**

Table 3. Human sera from southern Tanzania tested for antibodies to Toxoplasma spp

Source of sample	**Sera collected**	**Sera tested**	**Positive sera**	**% Positive**
Masasi District Hospital	200	60	13	**21.7**
Ndanda Mission Hospital	100*	30	3	**10**
Mtwara Region Hospital	100	30	7	**23.3**
TOTAL	**400**	**120**	**23**	**19.2**

*Most sera were haemolysed and this could have interfered with the reading of the agglutination titres

2.2 Identification of predominant rodent and shrew species in study areas (WP2)

Rodent and shrews were trapped between February and December 2003 using procedures described by Leirs and others. During the Month of February, March, July and August 2003 trapping was done weekly, while for the remaining months trapping was done once per month. Areas sampled were primarily in Morogoro district and they included human residences, peridomestic sites, home gardens and fallow lands in the vicinity of human settlements. A limited number of rodents from other areas were kindly provided by colleague-researchers during their trapping expeditions outside Morogoro. In 2004, additional trapping was carried out in few houses and swamps in Morogoro to complement trappings done in 2003. Also captures made in Masasi and Mtwara districts (once) in the month of November 2004, have been included in the inventory. For 2005 additional rats and shrews were captured from Morogoro, and Lushoto districts in ongoing research activities on a) prevalence of *Mycobacterium spp* in rodents and b) rodent flea ectoparasites. In total 4358 rodents and shrews were captured over the period of three years (2003-2005) of time (Tables 4a,b, c & d). Identification of the captured rodents was preliminarily done to the genus/species levels at SUA. In-depth identification shall be done where necessary by Partner 3 (RUCA) and reported accordingly.

Table 4a. Rodent and shrews captured in urban and peri-urban Morogoro, Lower Moshi, Dodoma and Chunya districts (February-December 2003)

Rodents	Period of collection											
	Feb	Mar	Apr	May	Jun	July	Aug	Sept	Oct	Nov	Dec	**Total**
M. natalensis	213	32	0	0	0	183	328	177	40	10	46	**1029**
Crocidura spp.	59	17	4	0	4	13	16	22	0	4	5	**144**
R.rattus	104	14	37	38	22	29	21	7	30	10	1	**313**
R. norvegicus	10	4	5	0	2	6	2	4	0	0	0	**33**
Mus spp.	154	111	20	15	17	24	21	4	2	0	0	**368**
C. gambianus	1	20	23	9	18	21	5	9	14	1	0	**121**
Tatera spp.	5	3	0	0	0	11	17	0	0	0	0	**36**
Lemniscomys spp.	5	3	0	0	0	0	3	0	0	0	0	**11**
Grammomys spp.	0	0	0	0	0	0	5	1	1	2	1	**10**
Leggada spp.	0	0	0	0	0	3	1	1	1	1	2	**9**
Dasymis spp.	0	0	0	0	0	0	2	2	0	0	0	**4**
Praomys spp.	2	0	0	0	0	0	0	0	0	0	0	**2**
Steatomys spp.	1	0	0	0	0	0	0	0	0	0	0	**1**
Arvicanthis spp.	0	0	0	0	0	0	1	0	0	0	0	**1**
Total	**554**	**204**	**89**	**62**	**63**	**290**	**422**	**227**	**88**	**28**	**55**	**2082**

Lower Moshi : *Mastomys natalensis* (30)
Kongwa: *Arvicanthis spp* (110)
Chunya : *Rattus rattus* (1), *Mastomys natalensis* (5)

Table 4b. Rodents and shrews captured in urban and peri-urban Morogoro and Masasi (January – December 2004)

Rodents	Period of collection												
	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sept	Oct	Nov	Dec	**Total**
M. natalensis	39	0	45	NT	48	30	214	187	105	NT	154	131	**953**
Crocidura spp.	4	0	15	NT	24	13	18	37	6	NT	6	27	**150**
R. rattus	23	0	0	NT	8	47	2	0	2	NT	10	0	**92**
R. norvegicus	0	0	0	NT	0	2	0	0	0	NT	0	0	**2**
Mus spp.	2	0	0	NT	0	36	0	0	0	NT	0	0	**38**
C. gambianus	2	4	0	NT	0	9	2	0	0	NT	0	0	**17**
Tatera spp.	5	0	1	NT	0	0	1	1	0	NT	3	0	**11**
Lemniscomys spp.	2	0	0	NT	0	0	0	0	0	NT	1	0	**3**
Grammomys spp.	0	0	0	NT	0	0	1	2	8	NT	0	0	**11**
Leggada spp.	0	0	0	NT	1	0	0	1	1	NT	1	1	**5**
Dasymis spp.	0	0	0	NT	0	0	0	2	0	NT	0	0	**2**
Total	**77**	**4**	**61**	NT	**81**	**137**	**238**	**230**	**122**	NT	**175**	**159**	**1284**

NT = No trapping
From Masasi, 175 animals were captured; *M. natalensis* (153) *Tatera spp* (3) *Crocidura spp* (7) *R. rattus* (10) and *Leggada spp* (1)

Table 4c. Rodents and shrews captured in urban and peri-urban Morogoro* in 2005

Rodent	Period of collection												
	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sept	Oct	Nov	Dec	**Total**
M. natalensis	-	-	-	3	1	4	-	-	23	20	35	-	**86**
Crocidura spp	-	-	-	6	18	22	-	-	4	27	0	-	**77**
R. rattus	-	-	-	8	37	13	-	-	26	21	7	-	**112**
R. norvegicus	-	-	-	0	0	0	-	-	0	0	0	-	**0**
Mus spp.	-	-	-	10	0	0	-	-	2	0	0	-	**12**
C. gambianus	-	-	-	7	0	0	-	-	4	0	0	-	**11**
Tatera spp.	-	-	-	0	0	0	-	-	0	0	0	-	**0**
Lemniscomis spp	-	-	-	0	0	0	-	-	0	0	0	-	**0**
Grammomys spp	-	-	-	0	1	0	-	-	1	0	0	-	**2**
Leggada spp.	-	-	-	0	0	0	-	-	3	0	0	-	**3**
Dasymis spp.	-	-	-	0	0	0	-	-	0	0	0	-	**0**
TOTAL	**-**	**-**	**-**	**34**	**57**	**39**	**-**	**-**	**63**	**68**	**42**	**-**	**303**

* Captures made during Mycobacterium research

Table 4d. Rodents and shrews captured in Lushoto* in 2005

Rodent	Period of collection												
	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sept	Oct	Nov	Dec	**Total**
M. natalensis	-	-	-	-	91	9	6	7	-	-	-	-	**113**
Crocidura spp	-	-	-	-	11	10	9	10	-	-	-	-	**40**
R. rattus	-	-	-	-	16	34	12	13	-	-	-	-	**75**
Mus spp.	-	-	-	-	1	0	0	0	-	-	-	-	**1**
C. gambianus	-	-	-	-	0	1	0	0	-	-	-	-	**1**
Tatera spp.	-	-	-	-	5	0	0	0	-	-	-	-	**5**
Leggada spp.	-	-	-	-	3	2	2	4	-	-	-	-	**11**
Lemniscomis spp	-	-	-	-	0	4	0	0	-	-	-	-	**4**
Grammomys spp	-	-	-	-	18	46	23	56	-	-	-	-	**143**
Lophuromys spp.	-	-	-	-	27	15	44	39	-	-	-	-	**125**
Otomys spp.	-	-	-	-	1	1	0	0	-	-	-	-	**2**
Praomys spp	-	-	-	-	6	80	21	19	-	-	-	-	**126**
Sciurida spp.	-	-	-	-	1	1	1	0	-	-	-	-	**3**
Dendromus spp.	-	-	-	-	3	0	0	0	-	-	-	-	**3**
Hylomyscus spp	-	-	-	-	0	0	8	3	-	-	-	-	**11**
Arvicanthis spp	-	-	-	-	0	0	0	4	-	-	-	-	**4**
Unidentified	-	-	-	-	15	0	4	3	-	-	-	-	**22**
Total	-	-	-	-	**198**	**203**	**130**	**158**	-	-	-	-	**689**

* Captures made during rodent/flea ectoparasite research

2.3 Collections of rodent and shrew sera for zoonotic screening (WP3)

Subsequent to trapping (WP2). sera from the captured rodents and shrews were analysed for antibody to zoonotics. The total amounts of sera collected in the Morogoro and in other areas for the period 2003-2005 were 2219. Out of these 500 randomly selected sera were tested by MAT against six serovars of the *Leptospira interrogans* namely, Icterohaemorrhagiae, Grippotyphosa, Ballum, Canicola, Hardjo and Pomona (Table 5).

For serovars Icterohaemorrhagiae and Grippotyphosa local isolates (RM1 and RM4) respectively, were used. The highest MAT titre was obtained with serovar Icterohaemorrhagiae (> 1:20480). The results were as shown in Table 5. Analysis for antibody to *Toxoplasma spp* was carried on 110 out of 170 sera collected in Masasi and Mtwara districts. All these sera were negative by the latex agglutination Bio-Rad Pastorex® Toxo kit.

Table 5. Rodent and shrew sera (n = 500) tested for antibodies to *Leptospira spp* by MAT in 2005

Titres	Ictero.	Hardjo	Pomona	Canicola	Ballum	Grippo.
1:20	9			4		5
1:40	2		1	1		3
1:80	1			4		1
1:160	1			1		1
1:320	2					
1:640	3			3		
1:1280	3			1		
1:2560	2					
>1:20480	2					
Total %)	**25 (5)**	**0**	**1 (0.2)**	**14 (2.8)**	**0**	**10 (2)**

2.4 Studies of sera from domestic animals for analysis of zoonotics (WP1, WP3)

A total of 964 serum samples, were collected in Morogoro from dogs, pigs (each 300 samples), cats (64 samples) and small ruminants (goats and sheep-total 300) from urban and periurban Morogoro in 2003. No further collections were made in 2004 and 2005. A total of 364 sera samples from dogs, pigs, cat, sheep and goats were analysed for Leptospira antibodies in 2005 (Tables 6a, b, c, & d). Serovar Icterohaemorrhagiae appears to be the predominant serovar in all species.

Table 6a. Goat and Sheep sera (n = 100) tested for antibody to *Leptospira spp* by MAT in 2005

Titres	Serovars tested					
	Grippo.	Ictero.	Hardjo	Pomona	Canicola	Ballum
1:20	7	15	6	3	1	15
1:40	3	9	11	3	4	12
1:80	4	4	6	1	3	5
1:160		9	1	1	1	
1:320		1				2
1:640				1		
1:2560						
Total (%)	**14 (14)**	**38 (38)**	**24 (24)**	**9 (9)**	**9 (9)**	**34 (34)**

Table 6b. Pig sera (n = 100) tested for antibody to *Leptospira spp* by MAT in 2005

Titres	Serovars tested					
	Grippo.	Ictero.	Hardjo	Pomona	Canicola	Ballum
1:20	7	10	5	2		2
1:40	7	8	19		3	8
1:80	5	13	2	1	3	9
1:160	3	8		1		6
1:320		2		1		1
1:640				1		1
1:2560						
Total (%)	**22 (22)**	**41 (41)**	**26 (26)**	**6 (6)**	**6 (6)**	**27 (27)**

Table 6. Dog sera (n = 100) tested for antibody to *Leptospira spp* by MAT in 2005

Titres	Serovars tested					
	Grippo.	Ictero.	Hardjo	Pomona	Canicola	Ballum
1:20	3	11	4	1		5
1:40	3	11	3	3	2	5
1:80	2	12	2	2	1	11
1:160	2	2		2	2	5
1:320		1		1		
1:640		1				
1:1280		1				
Total (%)	**10 (10)**	**39 (39)**	**9 (9)**	**9 (9)**	**5 (5)**	**26 (26)**

Table 6d. Cat sera (n = 64) tested for antibody to *Leptospira spp* by MAT in 2005

Titres	**Serovars tested**					
	Grippo.	Ictero.	Hardjo	Pomona	Canicola	Ballum
1:20	4	3	6	1		2
1:40	1	3			1	2
1:80						1
1:160		3				2
1:320						
1:640						
1:1280						
Total (%)	**5 (7.8)**	**9 (14.1)**	**6 (9.4)**	**1 (1.6)**	**1 (1.6)**	**7 (10.9)**

2.5 Isolation of zoonotic agents from rodents shrews and humans (WP 3)

Primary isolation of *leptospira spp* was carried out from urine and kidney tissues of the rodents and shrews obtained in WP2; isolations were also attempted from freshly obtained human blood and urine. Specimens were inoculated in Fletcher's medium and incubated at room temperature (24-28^{0}C) over a period of 4 months and under a regular weekly screening for bacterial growth. Secondary cultures were grown in EMJH medium. Spirochetal isolates were obtained from kidney tissues and urine of *Cricetomys gambianus, Mastomys natalensis,* and *Crocidura spp.* (Table 7)

Table 7: - Leptospira isolates from rodents and shrews captured in Morogoro and Masasi (in brackets)

Rodent and shrew species	**Total cultures**	**Positive**	**% Positive**
M. natalensis	1382 (97)	8	**0.58**
Crocidura spp.	298 (1)	16	**5.37**
C. gambianus	202 (0)	11	**5.45**
TOTAL	**1882**	**35**	**1.86**

Specimen from other species of rodent yielded no isolates. These include: Arvicanthis spp(n=22) *Nannomys spp* (11*) Tatera spp* (11), *Lemniscomis spp* (5), *Grammomys spp* (15), *Daymsys spp* (96) *Steateomys spp* (1), *Rattus spp* (390) *and Muss pp* (149)*.*

For 2005, additional 8 isolates were obtained from rodents and shrews (Fletcher's and EMJH kidney and urine cultures), making the number of isolates from small mammals obtained so far to be 35.

For humans, samples of fresh blood (n = 318) and urine (n = 589) were cultured in the same manner as for rodents. Three suspected spirochetal isolates were obtained from the human urine samples; one isolate was from an apparently hepatitic patient at Mikumi Heath Centre and the remaining two were from slaughter men at the Morogoro abattoir. A total of 201 kidney samples from rodents and shrews and 83 urine samples from slaughter men are still in incubation and all positive isolates are from Morogoro.

2.5.1 Characterization of isolates

Preliminary characterization of these isolates except for the human urine isolates has been done by MAT using hyperimmune sera to reference strains raised in rabbits. Duplicates of the isolates (rodent/shrew = 26; humans = 3) have been submitted for further identification by KIT and shall be reported accordingly upon completion of the analysis.

2.6 Socio-economic and socio-anthropogenic studies in Lushoto districts (WP6 &7)

These studies focused on selected villages in plague endemic areas of Lushoto District in Tanga Regional, effective 2003. The final report on the socio-anthropogenic component of the study has been received. Further report, if any, shall be presented by the NRI team. Likewise reports on socio – economic studies on impact of rodent transmitted disease, carried out in Morogoro (in 2005), shall be presented by the NRI team.

3.0 GENERAL COMMENTS

For 2005 most activities went on smoothly or to completion, thanks to NRI willingness to advance USOKA PMC with funds pending the release of the same by EU.

It was initially suggested that the component involving identification of rodent species in Lushoto (WP2) and studies on zoonotics in this district refer to existing materials/ data obtained from previous studies, and available at SPMC or at Lushoto District Hospital. This is mainly due to public health reasons and the general feeling that extensive expeditions in Lushoto have already been carried out in the past. Nonetheless it is anticipated that the studies on rodents and their (potential) plague vector - fleas, which started in May 2005, shall add to new information to existing knowledge on the two important elements of plague epidemiology (rats and fleas) in Lushoto District.

A manuscript titled “Rodent and shrews as carriers of potentially zoonotic spirochetes in rural and periurban Tanzania” shall be finalized upon completion of the isolation and their characterization of pathogens, and shall be published in a relevant journal, such as the East Africa Journal of Public Health.

4.0 FUTURE ACTIVITES

Future activities shall aim at completing the few remaining activities.

Serological analyses of rodent sera for toxoplasmosis

Further identification of the rodents/shrews predominant in the study areas – to be done in collaboration with RUCA

Characterization of the leptospira isolates obtained from rodents and humans –to be done in collaboration with KIT.

NHLS

Prevention of sanitary risks linked to rodents at the rural / peri-urban interface – RATZOOMAN PROGRESS REPORT, YEAR 3 (2005)

PRIME CONTRACTOR:
SA, National Health Laboratory Service
(John Frean, Lorraine Arntzen, Malodi Setshedi, Chantel le Roux)

INSTITUTIONAL SUBCONTRACTORS:
PPRI / ARC, Pretoria
(Frikkie Kirsten, Emil von Maltitz, Fanie Phanuel S Malebana)

Natural Science Museum, Durban
(Dr Peter Taylor)

INDIVIDUAL SUBCONTRACTORS:
Pfarelo Matshidze, Takalani Thakani {Thohoyando } and Suzanne Leclerc-Madlala {KwaZulu-Natal }

2. Prevention of sanitary risks linked to rodents at the rural / peri-urban interface – RATZOOMAN

Measurement of disease prevalence for the three major diseases, plague, Leptospirosis and toxoplasmosis. Host ranges will be investigated, and the infection dynamics within the host populations and from the hosts to humans will be studied.

SAMPLING AREAS: Mapate Limpopo, Durban & Port Elizabeth.

Mapate, Limpopo.
This is the main trapping area in South Africa.
All trapping has been completed in this area. The CMR studies have also been completed. Weather data, soil and water pH have been taken during the study period. A portion of the tests on samples taken from the rodents obtained during the trapping sessions in this area are still to be completed. Rodents carcasses were either sent to Prof Herwig Leirs or Dr Peter Taylor for further identification. Toe clippings and data from the CMR study was sent to Prof Herwig Leirs for processing.

Durban.
This is a minor trapping site in South Africa
All trapping has been completed in this area. Weather data, soil and water pH have been taken during the study period. A portion of the tests on samples taken from the rodents obtained during the trapping sessions in this area are still to be completed. Rodent carcasses were identified by Dr Peter Taylor.
Human blood samples where obtained from this area. This was the only area in South Africa that was successful in obtaining human samples. Testing against the three different zoonotics has been completed with some interesting results.

Port Elizabeth
This is a minor trapping site in South Africa
Training was given to the Environment Officers from the Nelson Mandela Metro in 2005. The Port Elizabeth site was very slow to start trapping and to take samples from rodents. The training improved the situation in this region and we are now receiving samples on a regular basis from this site. We will continue to process samples from this site for as long as possible so that we can obtain a representative number of complete samples. Before the training we only received rodent blood and no other samples. A portion of the tests on samples taken from the rodents obtained during the trapping sessions in this are still being processed. Rodent carcasses were sent to Prof Herwig Leirs and then later in the year sent to Dr Peter Taylor for further identification.

3. RESULTS

Rodent sample results:

AREA	MAPATE, LIMPOPO			DURBAN *********			PORT ELIZABETH		
TESTS	**Plague**	**Lepto**	**Toxo**	**Plague**	**Lepto**	**Toxo**	**Plague**	**Lepto**	**Toxo**
Number	**202**	**202**	**202**	**232**	**232**	**232**	**1219**	**1219**	**1219**
Negative	**202**	**129**	**162**	**232**	**196**	**214**	**1219**	**937**	**1176**
Positive	**0**	**37**	**37**	**0**	**36**	**9**	**0**	**282**	**170**

Human sample results:

AREA	DURBAN		
TESTS	**Plague**	**Lepto**	**Toxo**
Number	**217**	**217**	**217**
Negative	**217**	**174**	**141**
Positive	**0**	**43**	**76**

SUMMARY OF RESEARCH TO DATE:

The interesting results obtained early on in the testing of the rodent sera for the three zoonotics are again demonstrated in the human samples. All of the serological tests for Plague , Leptospirosis and Toxoplasmosis have been completed, except of the incoming samples from the Port Elizabeth area. We will continue to test from this site until April 2006. This is because this site only started sending in full samples at the beginning of 2005.

Serum samples from both rodent and humans have been sent to Onderstepoort Veterinary Institute (OVI) for MAT testing and we are awaiting results. They have stated that they are almost completed with this testing.

Culture of rodent kidney for *Leptospirosis* , was not successful, due to heavy contamination of the samples and media. These cultures where sent to OVI for testing.

PCR is being carried out on the rodent kidney's and will be compared with the MAT test results and also the DriDot screening test. The DriDot test is designed to test human sera. In this project we have used it as a screening test with rodent sera, to see if we could evaluate the test for rodent testing in the future. PCR has been preformed on all the rodent spleens received from the three sites in South Africa and they are all negative for *Yersinia pestis.* Culture on heart and lung tissue from these rodents was negative for *Yersinia pestis.*

All the fleas collected from rodents from the three study sites, have been identified and tested with PCR for the presence of *Yersinia pestis.* All fleas tested from these sites are negative for *Yersinia pestis.*

All *Toxoplasmosis* tests have been completed from the Mapate and Durban sites. Testing is continuing from the Port Elizabeth site until April 2006.

All test results and other data is being collated and a final report will be presented at the final workshop which will be held in May 2006.

Testing was preformed for Mozambique, rodent and human samples. Mozambique will present their results. Testing was preformed for Zimbabwe, very few samples where received. Zimbabwe will present their results.

Prepared by:
Lorraine Arntzen

SZ

Ratzooman
Zimbabwe

February 2006 WP1 - Retrospective and prospective investigation of human sera for zoonotics
Collection of human sera was done by National Blood Transfusion Services. A total of 159 sera were received and have been hand -carried to South Africa by the team NBTS are currently collecting human sera in Nkayi and nearby areas, the human sera are expected to be dispatched end of February 2006.

WP2 – Taxonomic identification of rodent species found in rural and peri urban habitants
Majors species trapped at Hatcliffe and Mbare were *Rattus rattus* and *Mastomys natalensis* (MN). The most predominant species at Mbare and Hatcliffe was (MN) while *Tatera* spp were mainly found in Nkayi

WP3- Isolation and identification of zoonotics from rodents and domestic animals
Leptospirosis and Toxoplasmosis related organisms were found in the 200 blood samples send to SA in March 2005. Additional 65 rodents were captured thereafter in Mbare and Hatcliffe, however the sera from these animals were spoiled due to persistent power cuts. The carcasses and internal organs were shipped to Belgium in January 2006

Low rodent captures indicated above could have been attributed to
The national cleanup operations which took place in June 2005 that changed the picture of Rodent trapping and at the same time the human population composition also changed, with a lot of them displaced from the selected study areas. Many rodents were observed, but they were difficult to trap and that resulted in low catches. Stray cats were becoming more visible at Mbare, and these are rodents predators. Young rodents were likely to have been killed or starved to death during the cleanup operations campaigns.

WP4- Rodent ecology in rural and peri-urban agriculture
Most rodents were re-captured during the dry and warm season, this could have been triggered by lack or food. There was a sudden increase in the rodent recapture from October through to December 2005 that could have been attributed to availability of refuge for shelter from early grass shoots promoted by the first rains.

WP 11- Policy Issues
Diseases caused by Leptospirosis, Toxoplasmosis and Plague (*Yersinia pestis*) appear to be a grey area in the SADC region. There is need to develop tools to capacitate the region on the epidemiology of the diseases at community level. There has been under reporting of the above-mentioned diseases in Botswana, Malawi, Zambia and Zimbabwe. There is need to develop similar tools as those used on diseases such as HIV TB and Malaria. Guidelines are a requirement so as to see the effectiveness of a follow up on these diseases.

Reports related to bubonic plague (*Yersinia pestis*) for some SADC countries since 2001.

Country	Cases
Malawi	7
Zambia	27
Botswana	11
Zimbabwe	19

INS

RATZOOMAN PROJECT MOZAMBIQUE ANNUAL REPORT, 2005

INTRODUCTION

Main activities implemented between April and /December, 2005:
- rodents and small mammals collection and processing
- capture and recapture of rodents and small mammals
- socio economic study in Maputo Tsalala

WP 1

During 2005: 788 human serum sample collected in Morrumbala and Mutarara were processed in South Africa.
Samples positive for *Toxoplasma gondii*: 44.5%.
Results for plague and leptospirosis are yet to be received from NHL in Johannesburg.

WP 2

From April to December 2005, 122 rodents were captured and processed in Maputo.
Outstanding results of 347 rats sample (South Africa) and 107 (Netherlands).
238 rodents captured and recaptured.
Identified species: *R. rattus, Mus spp, Mastomys, Tatera, Crocidura, Acomys, Lemniscomys, Aethomys* and *Nannomys*.

	Maputo	Morrumbala	Mutarara
R. rattus	78	44	13
Mus spp	186	5	-
Mastomys	27	14	3
Tatera	3	13	3
Crocidura		1	2
Lemniscomys	13	-	-
Acomys	-	1	1
Aethomys	2	-	2
Nannomys	4	-	1

WP 4

289 rodents captured and toe clipped at Tsalala field.
110 recaptured
24 dead due to the weather, ants and during processing

WP 6

Questionnaires were carried out in Maputo-Tsalala.
A total of 30 household families were involved.

WP 7

Study done in Morrumbala district and report produced.
In-depth interviews with community groups were conducted, to find out their attitudes, knowledge and their behavior with rodents.
Mutarara was not covered by this study due to the similarity in living habits of both populations.
Study done in Maputo province, Tsalala. Row data sent to Malcolm for analyses

WP 8

Spot scenes and TM images for the main site in each country were purchased from the Satellite Applications Centre, South Africa. The images have already been processed at the NRI. The images were analyzed in order to evaluate land use changes.

Land use patterns have been analyzed in connection with rodent and disease data.

A Geographic Information System (GIS) using Arc View has been developed and additional data is continuously being incorporated.