

COST

Domain Committee Food and Agriculture

COST Action 872

Exploiting genomics to understand plant-nematode interactions

MONITORING PROGRESS REPORT

Period: *From 1st January 2007
To 31st December 2007*

This report is presented to the relevant Domain Committee and contains two parts:

- I. **Management Report** prepared by the COST Office*
- II. **Scientific Report** prepared by the Chair of the Management Committee of the Action*

I. *Management Report prepared by the COST Office*

I.A. *COST Action Fact Sheet*

Action 872 Fact Sheet

Title

Exploiting genomics to understand plant–nematode interactions

Contacts

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Details

MoU: 265/06	Start of Action: 04/12/2006
CSO approval date: 27/06/2006	Entry into force: 21/09/2006
End of Action: 03/12/2010	

Objectives

The main objective of the Action is to develop a coordinated approach to exploitation of genomics information that is appearing for plant parasitic nematodes and host crops.

Signatures

Country	Date	Status	Country	Date	Status	Country	Date	Status
Austria	04/10/2006	Confirmed	Belgium	03/10/2006	Confirmed	France	02/03/2007	Confirmed
Germany	20/09/2006	Confirmed	Greece	20/06/2007	Confirmed	Ireland	20/09/2006	Confirmed
Israel	06/10/2006	Confirmed	Italy	17/10/2006	Confirmed	Netherlands	20/09/2006	Confirmed
Norway	25/09/2006	Confirmed	Poland	04/10/2006	Confirmed	Portugal	05/12/2006	Confirmed
Slovenia	13/10/2006	Confirmed	Spain	21/09/2006	Confirmed	Sweden	04/06/2007	Confirmed
Switzerland	12/12/2006	Confirmed	Turkey	11/01/2007	Confirmed	United Kingdom	20/09/2006	Confirmed
Total:	18							

Intentions to sign

Country	Date	Status	Country	Date	Status	Country	Date	Status
Total:	0							

Participating Institutions from non-COST countries

Institute of Plant Protection (UAAS) (UA)

Murdoch University WA State Agricultural Biotechnology Centre (SABC) (AU)

Wollongong University, Centre for Biomedical Science School of Biological Sciences (AU)

Working Groups

WG1: Functional genomics of plant parasitic nematodes

WG2: Comparative genomics of plant parasitic nematodes

WG3: Functional genomics of the plant response

Website

<http://cost872.scri.ac.uk/>

I.B. Management Committee member list

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I.C. Overview activities and expenditures

Budget Overview - Report N°4

Action 872

14/02/2008

Meetings

Meeting Type	Date	Place	Paid part	Cost	Total
Management Committee	4/12/2006	Brussels (BE)	14	8368.91	
Joint Management Committee	9/05/2007	La Colle sur Loup (FR)	78	52958.65	
Working Group	7/02/2008	Vienna (AT)		10880.00	
					72,208

STSM

Beneficiary	Date	From	To	Cost	Total
Ms Sylwia Fudali	12/08/2007	Warsaw (PL)	GB	2500.00	
Dr Krzysztof Wieczorek	10/10/2007	1190 (AT)	PL	2500.00	
Mr Jose Lozano	23/09/2007	Wageningen (NL)	GB	1790.00	
Mr Markus Oggenfuss	14/05/2007	CH-8820 Waedenswil (CH)	GB	1650.00	
Mr Paulo Cezanne Reis Vieira	6/03/2007	Evora (PT)	FR	1200.00	
Dr Barbara Geric Stare	20/05/2007	1000 Ljubljana (SI)	FR	1320.00	
Mr Saša Širca	21/05/2007	1000 (SI)	FR	630.00	
					11,590

Workshops

Title	Date	Place	Cost	Total
Joint Management Committee	9/05/2007	La Colle sur Loup (FR)	2770.00	
				2,770

General Support Grants

Title	Date	Cost	Total
General	1/01/2007	2000.00	
General	4/12/2006	2000.00	
			4,000

Schools

Title	Date	Place	Cost	Total

90,568

II. Scientific Report prepared by the Chair of the Management Committee of the Action

II.A. Results achieved during the period 1st January 2007 to 31st December 2007

Working group 1: Functional Genomics of Plant Parasitic Nematodes

In the year 2007 most progress in the areas covered by WG1 has been achieved in the application of RNA interference to knock-down gene transcription in plant-parasitic nematodes. Several groups have tested and further refined the methodology of RNA interference by soaking the nematodes in highly concentrated solutions of double stranded RNA. Most of the genes targeted in these studies were chosen based on an expectation that they have a role in the initial stages of parasitism, such as host invasion. One group has successfully targeted a neuronal peptide with RNAi in plant-parasites; a remarkable finding as the neuronal tissue seems to be refractory to RNAi in *Caenorhabditis elegans*. Another noteworthy finding was the delivery of RNAi from the host to a plant-parasitic nematode (by an Australian group) who targeted a transcription factor in the root-knot nematode *Meloidogyne javanica*. In this project a strong reduction of transcript levels was found in nematodes feeding on transgenic plants overexpressing dsRNA, although no lethal phenotype was observed. The group was able to show the presence of small interfering RNAs originating from the dsRNA construct suggesting that at least part of the dsRNA is digested in the plant prior to delivery into the parasite. So far all reports on host delivered RNAi in plant-parasitic nematodes involved root knot nematodes, while the method has not proven of value for cyst nematodes as yet. RNAi continues to be used with animal parasitic nematodes. In order to develop links with people working in this area a researcher (Peter Geldhof) who has recently co-authored a review on RNAi in animal parasitic nematodes has been invited to attend the 2008 inter-WG workshop.

Work in other areas highlighted in WG1 is in progress but not yet completed. Several groups are using cell biological techniques and assays for suppression of plant defences in order to examine function of selected nematode proteins. This work is drawing heavily on the experience of researchers using other pathosystems (bacteria, fungi and oomycetes). Microarrays carrying nematode genes are being developed by several groups and it is likely that data will emerge from these studies in the coming year.

Working group 2: Comparative genomics of plant parasitic nematodes

Sequencing of two root-knot nematode genomes (*Meloidogyne hapla* and *M. incognita*), and the first detailed annotation of these sequences, has been completed in 2007. Tools for automated annotation, including gene finding software optimised for *Meloidogyne*, have been developed. Manual annotation of one of these genomes (*M. incognita*) has been performed by a consortium of researchers, including participants in COST 872. A project to sequence the genome of the potato cyst nematode *Globodera pallida* has been approved and is now underway. This project is run by a consortium of UK based partners but

exploitation of the sequence will involve groups across the EU and will be facilitated by activities within COST 872. In addition, Expressed Sequence Tags have been generated from plant nematode groups that have not previously been analysed including *Bursaphelenchus*, *Aphelenchus* and *Radopholus*.

A significant advance within the area of WG2 is the continued development, and associated reduction in costs, of new DNA sequencing technologies. As a result of these changes obtaining genome scale sequence data is likely to become easier. Far more sequence data is likely to become available than could have imagined just a few years ago. Major opportunities for comparative genomics are therefore likely to emerge and there will be a greatly increased requirement for bioinformatics expertise. The MC of COST 872 will examine how COST funding can assist plant nematologists in this area.

Researchers working with plant parasitic nematodes continue to use comparative studies with animal parasites and *C. elegans* as a way of driving their work forward. For example, studies on mechanisms of innate immunity in plant parasitic nematodes as compared to *C. elegans* have been published during 2007. In addition, sequence information that is developed for plant parasitic nematodes is being exploited in comparative studies that aim to develop diagnostic tools for specific nematode groups or pathotypes.

Working group 3: Functional Genomics of the plant response

In WG3 most efforts are currently directed towards transcriptome analyses of host plants in order to dissect specific metabolic pathways that are altered upon nematode infection. Several groups in France, Spain, UK Germany and Austria are working in this area with different species of cyst nematodes and root-knot nematodes. The first results have been published but many more are in the pipeline. A recent WG3 workshop held in Vienna revealed an urgent need for a common platform for dissemination of microarray data. Means of supporting this area through COST 872 are currently being investigated.

Detailed gene expression, biochemical, microscopical and functional analyses have been performed on sugar transport and metabolism in syncytia, indicating a complex interplay of apoplasmic and symplasmic sugar transport pathways and starch synthesis and storage. The essential role of specific expansin and endo-1,4-beta-glucanases in the development of syncytia has been confirmed in *Arabidopsis* and tomato.

A research area that is currently very promising is the study of the effect of nematode proteins on plant defense and hormone signaling pathways. The plant response in the compatible interaction appears to be strongly modulated by secreted proteins from the nematodes. Clearly this work overlaps extensively with areas covered under WG1.

Outputs and overall progress towards goals – the role of COST 872

For all areas, a comparison of progress to date with the plans submitted in the original proposal show that the activities are proceeding as anticipated. Participants in COST 872 have published extensively during 2007 (Appendix 1) and have also submitted numerous grant proposals (Appendix 2). Interactions

funded or stimulated by COST 872 have been instrumental in many of these outputs. For example, several STSMs have led to preliminary data that has been used to prime joint grant applications. Other groups have used STSMs as a means of developing collaborative links in new and emerging areas. Early career stage scientists have often been the direct beneficiaries of these projects. Meetings funded through COST 872 have also led to several new collaborations or have helped scientists interpret their results. Early career stage scientists have been funded to attend COST 872 meetings and encouraged to present their work in order to help with their training. The MC of COST 872 considers this an important role for COST 872.

Results achieved during the period 4th December 2006 to 31st December 2006

The main objective of the Action is to develop a co-ordinated approach to exploitation of genomics information that is appearing for plant parasitic nematodes and host crops. Since this action was only running for three weeks at the end of 2006 there will clearly be little to report for this period. However, several significant steps forward have been reported in the areas covered by this Action since the original proposal was formulated, and these are noted below.

Scientific developments

The identification of parasitism genes is no longer a bottleneck for our understanding of plant-nematode interactions. Consequently, the focus of many researchers is beginning to shift towards the design of novel functional assays to study genes involved plant-nematode interactions. Several groups have reported the use of RNAi to study gene function in plant parasitic nematodes, confirming that this technique will be an important tool for functional studies on plant parasitic nematodes. In addition, three independent publications have reported the generation of transgenic plants expressing dsRNA targeting (different) nematode genes followed by an assessment of the effects on parasitism.

Studies on genes important in parasitism have previously been focused on the economically important root knot and cyst forming nematodes. However, in 2006 further publications on genes important in the parasitic process of another nematode – the pine wood nematode *Bursaphelenchus xylophilus* were reported. These studies demonstrated that multiple independent horizontal gene transfer events from bacteria and fungi have played an important role in the evolution of nematode parasitism of plants in several nematode taxa.

Genome projects for two major nematode species continued in 2006. Work is in progress in the USA on a sequence for *Meloidogyne hapla* and one invited speaker for the 2007 COST 872 meeting will provide further details of the *M. hapla* project. Within the EU, work has begun on the sequence of the *M. incognita* genome; at the time of writing 5X coverage has been achieved and gene-finding software is being used to analyse the sequence. An application for funds to sequence the genome of a cyst nematode *Globodera pallida* is under review at the time of writing.

Progress was made in several aspects of the plant response to nematode infection. The role of a range of enzymes in metabolism of free radicals produced response to nematode infection has been studied and it has been shown that reactive oxygen species are produced in the early stages of an incompatible interaction between cyst nematodes and plants. The roles of various phenylpropanoids in basal resistance of banana against nematode infection have also been analysed. Meanwhile, in other plant-pathogen interactions, a range of avirulence proteins have been identified including Avr3a from late blight and dspE from *Pectobacterium*. These studies have shown that avirulence proteins frequently have an important role in manipulation of plant defence signalling pathways. The prospect that nematodes may produce proteins with similar functional roles will be investigated by several groups within COST 872.

For the compatible interaction, the role of host expansins in development of the feeding site has been studied using microarrays. Several studies have also examined the molecular mechanisms underlying sugar translocation into nematode feeding sites. Studies published in 2006 have

shown that expression of genes encoding sucrose transporters is activated in syncytia and that functional plasmodesmata are formed between the phloem and syncytia during the later stages of syncytium formation.

COST 872 Activities in 2006

The first MC meeting for COST 872 was held in Brussels on December 4th 2006 at which the working structures of the Action were agreed and the Chair, vice-chair and WG coordinators were elected. As outlined in the original MOU, three WGs were established in the areas of “Functional genomics of plant parasitic nematodes”, “Comparative genomics of nematodes” and “Functional genomics of plant responses”. It was agreed that the aims of the Action would be best served by holding a relatively large inter-WG workshop in 2007 in order to encourage communication between scientists working on various aspects of molecular host-parasite interactions. A gathering of this type has not taken place in the community for some years.

In order to encourage participation of younger scientists in COST 872 plans were made to set aside a substantial sum of money for STSMs from the 2007 budget. An STSM committee composed of the Action chair, Action vice-chair and the WG Coordinators has been set up to evaluate applications for funds under this scheme.

II.B. Dissemination of results

Action related publications and reports

A report of the first combined MC meeting and inter-WG workshop was produced and is appended to this report (Appendix 3). In addition, a full booklet of abstracts was distributed to delegates attending the meeting and is available on the Action website. This abstract booklet is appended to this report (Appendix 4). STSM reports (7 in total) have been produced to date and are available on the Action website.

During the 2007 meeting, the MC of COST 872 decided to investigate the possibility of producing a book on “Molecular and cellular aspects of plant-nematode interactions”. A book of this nature was published in 1997 following a CAP programme but is now considered outdated. Various publishers are being contacted to assess the appetite for a publication in this area.

A leaflet publicising the aims and activities of the Action has been produced with input from a professional design company. A pdf of this leaflet is appended to this report (Appendix 5). Copies of this leaflet have been sent to COST Office for use in their activities and are available to all Action participants.

Conferences and workshops

One meeting was held under the auspices of COST 872 during 2007. This was a combined MC meeting and inter-WG workshop held at La-Colle-sur-Loupe (France) from 9th-11th may 2007. The meeting attracted over 115 delegates, including 36 that did not receive funding from COST 872. A meeting report and proceedings are appended to this report (Appendices 3 and 4). At least two events (one WG3 event and a combined MC meeting and inter-WG workshop) are planned for 2008.

Web site

A website has been created with input from a professional designer. The site (<http://cost872.scri.ac.uk/>) is hosted at the institute of the Action Chair and features a simple-to-use content management system that allows the Action Chair or Vice-Chair to update the site without the need for IT support. Information on upcoming and past activities is available on the site, with registration documents and programmes available for download. STSM reports are also available on the site. The site also provides instructions on how to access STSM funding through COST 872.

Scientific and Technical Cooperation

Three additional countries (France, Greece and Sweden) have become signatories to COST 872 during 2007 and three outside institutions, (Wollongong University (Australia), Murdoch University (Australia) and The Institute of Plant Protection (Ukraine) have become external participants in the action. The Action Chair has been in contact with the proposer of a new COST Action (Multiscale

Analysis of the Response of Key Food Web Organisms to Environmental Change - MARKER), which will include work on ecological aspects of plant nematodes, in order to explore potential synergy between the two programmes.

Participants in COST 872 have generated grant proposals to a variety of sources (Appendix 2) and COST 872 has been an important factor for several of these. For example, collaborative grant proposals have been generated by institutes in Slovenia (KIS) and France (INRA Rennes) to various awarding bodies (including ERA) and these have arisen from STSMs between the two institutions. Participation in COST 872 has also been a factor in the success of other National grant applications including one on "Comparative genomic studies on root-knot nematodes (*Meloidogyne* spp.) in Switzerland and Europe" to the State Secretariat for Education and Research (SER), Switzerland by Dr. S. Kiewnick and Dr. J. Frey and a genome sequencing project for *G. pallida* by a consortium of UK researchers. COST 872 is therefore acting as a stimulus that is enabling participants to attract additional funds to the field.

Transfer of results

This Action has been running for a relatively short time and links with industry and other end-users are likely to be established later in the course of the Action. However, a number of the delegates at the 2007 combined MC meeting and inter WG workshop were from various industrial companies, and two of the MC members for COST 872 are from industry. Individual participants in the Action have links with a range of industry representatives.

Dissemination plan with regard to end users

All participants in the Action publish scientific papers in refereed journals and a full list of these is appended to this report (Appendix 1). Such publications, and presentations at scientific meetings, are the primary means of disseminating information to scientific end users. During compilation of the list of papers for this report the participants were asked to assess whether COST related activities had any impact on each publication; over half of the publications were assessed by the authors as having benefited from the activities of this Action, demonstrating the impact of COST funding to this field.

Contacts in the ERA

This Action has been running for a relatively short time and these links are likely to be established later in the course of the Action. Calls under FW7 to which research on plant nematodes is applicable have been scarce. It is planned to address this through COST 872. However, a proposal has been submitted to SEE ERA-NET by participants in the Action and several partners have projects funded through ESF. A new MSc in plant nematology (EUMAINE) has been funded through the ERASMUS-MUNDUS scheme and several participants in COST 872 will be part of this multi-site scheme.

From the 2006 report:

Given the short time frame that the Action has been running in 2006 little progress has been made in this area. However, the Chair is building a website for COST Action 872 that will incorporate a SharePoint site to facilitate reporting.

We have aimed to include representatives from industry at all stages of the planning of this Action in order to encourage uptake of knowledge that is generated by the Action. In this regard it is encouraging to note that MC representatives for two countries are from the commercial rather than the academic sector.

II.C. Self evaluation

COST Action 872 has started well. The MC is delighted to have funded 7 STSMs in 2007 (with a further two funded for 2008 at the time of writing). The combined MC meeting and inter WG workshop was well attended and delegates were extremely enthusiastic about holding similar events in future years. The meeting stimulated interactions between different groups and at least four STSMs resulted from discussions that took place during the meeting.

Proposals for WG specific activities were made by participants and at least one such event (WG3 – microarrays in plant nematode interactions) will be held in 2008. The MC is pleased to note that the community has participated enthusiastically in the activities of the Action.

Scientific progress in the areas covered by COST 872 has been rapid, as illustrated in the scientific report. The MC aims to target COST funding in areas that require co-ordination or in areas where training is important, where COST funding can have greatest impact. For example, the decision to hold a WG3 workshop on microarrays arose from participants at the 2007 combined MC meeting and inter WG workshop noting a need for coordination in this area.

There have been no major difficulties in running COST 872. However, the number of scientists wishing to participate in the activities of the Action continues to increase and this may put pressure on the budget in the coming years. In particular, the MC are keen to be able to support STSMs as these frequently benefit early career stage scientists and this will require careful financial planning.