Curation and development of invertebrate collections within the Australian National Insect Collection

Summary
Invertebrate pests cause major losses to the Australian grains industry. GRDC invests many resources to combat such pests, through plant breeding, biotechnology, and management options. In all strategies, accurate information on identification, biology and distribution of the pest is crucial. Cryptic species, geographic races, pathotypes and resistance breaking races greatly impact on measures to counter pest losses. Previously unrecognised, newly emerging and misidentified pest species cause problems in crop protection programs. This proposal sought support for development, maintenance, and information management of collections of two major groups of cereal pests: insects and nematodes.

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Conclusions
High quality, enduring collections with reliable identification, associated data and easy accessibility are the basis of a substantial body of research, a situation likely to continue for some time. The collections are the basis for the recognition of species, pathotypes, biotypes, races and genetic variants which are the source of many areas of research and other activities. Some of the activities that rely on the collections are current and predictable, such as plant breeding and export certification. Other future uses are not currently predictable, just as the growth of molecular techniques was not predictable 20 years ago. No matter what the particular methodologies, the reliance on collections will continue.

The collections will also continue to expand to cover a larger proportion of the vast diversity of insects and nematodes in Australia, particularly as more valuable material is deposited from other studies. New studies continue to reveal that there is still a considerable amount to learn about insect and nematode pests and their biology and distribution. This is particularly so for nematodes. Specimens from many areas and species are still to be added to the collections, and continued expansion will remain important. New pests will probably emerge in both these groups with changes in crops, farming systems and climate, and the collections will be needed to track these phenomena. Specimens of significance for quarantine, import and export certification may also become increasingly important with greater movement of goods and people.

With a continuing need for the collections, monitoring and maintenance will remain necessary, despite improvements in curation, to preserve the expanded collections for future use. CSIRO is committed to maintaining and developing the collections, but with government policy requiring beneficiaries to contribute to costs, support from GRDC to ensure the future availability of this important resource is recommended.

Outcomes
Enhanced research capability, based on a higher quality resource to support a variety of basic enquiries into the systematics, biology and management of insects. Improvements to the Australian National Insect Collection (ANIC) will include a wider range of properly curated material and increased accessibility of information of relevance to crop protection in the areas of pest management, biosecurity, and making contingency plans for invasive pests.

Achievements/Benefits
Insects and nematodes cause an estimated 300 to 400 million dollars of crop losses to the Australian grains industry, and therefore are a current major research topic. Most of this research depends critically on the correct identification of the organisms involved, which, in turn, depends on the national collections.

In 1992, a review of plant nematology in Australia commissioned by Rural Industries Research and Development Corporation (RIRDC) reported that there was a lack of taxonomic expertise on plant-parasitic nematodes in Australia, and that several
collections were in a state of disrepair. The report concluded that the need to accurately identify nematodes remained essential for internal and external quarantine, for breeding of resistant varieties, and for efficient use of crop rotations as a management option, so that support for the consolidation and maintenance of nematode collections was essential. The need to develop and maintain a national reference collection was recognised by the Standing Committee on Agriculture and Resource Management (SCARM), with a recommendation to support a dispersed national reference collection.

A similar situation was noted for insect collections, with the emphasis on the need for monitoring and maintenance of the extensive existing collections, as well as preventing the loss of small collections which are no longer actively maintained.

Both reports recognised that biological collections were an essential part of the national research effort, but many were being neglected and even discarded. In response, GRDC and other beneficiaries were asked to support CSIRO’s national collections for insects and nematodes. CSIRO applied to GRDC for support for those parts of the collection relevant to GRDC’s interests, i.e. pests and beneficials, based on the expertise available in collection management and in most of the important groups of insects or nematodes.

The aim of the GRDC project was for general support for the collection. In the case of nematodes, development of the collection was a large component, whereas the collection of insects was already substantial, so monitoring and maintenance were emphasised. As the number of nematodes has grown, maintenance has become a larger part of the activities. The scope of activities has been broadened progressively to enhance the accessibility of information from the collection in the form of a growing specimen database. This GRDC grant has supported part of the maintenance of the basic resource, in the same manner as the molecular sequence databases or libraries, rather than the research into the areas.

The insect and nematode collections are the largest in Australia and the largest collections of Australian material in the world, with over 12 million and 25,000 specimens, respectively, and an annual budget of over $3 million. Pests of direct relevance to GRDC make up about 10% of this material, and a further proportion are beneficials also of interest (predators of pests, pollinators, nutrient recyclers). During the project, systematic audits of the collections have been completed, and a prioritised plan for monitoring and maintenance has been implemented to ensure continued availability. Specific tasks arising from this audit have included replacing pins (over 10,000), replacing specimen bottle caps and refilling preservative (over 20,000), replacing deterrent chemicals and reprinting labels (over 20,000). The grant has supported a proportion of these activities.

Ensuring that the collections and their associated data are accessible and used has also been a priority. Over the course of the project, over 200,000 specimens were databased, over 250,000 specimens loaned, and 10,000 labels from historical specimens replaced. The entire database is available on-line to further enhance accessibility.

The research and other activities that have used the collections and associated data have been varied, and to a certain extent unpredictable. Many years ago when some specimens were being collected, one could not have predicted using the material for studies of molecular diversity.

Some of the uses of most relevance to GRDC are listed below.
- Feasibility studies for tracking development of resistance in historical DNA from preserved specimens.
- Identification and distribution of pest species in the past to track emergence of new pests and changes in known pest populations resulting from climate change or new farming practices.
- Molecular studies of population and species boundaries for diagnosis and management of nematode pests.
- Distribution of mite species vectors of Wheat Streak Mosaic Virus (WSMV).
- Research on relationships between invertebrate biodiversity and ecosystem function in cropping systems.
- Studies of relationships between soil health and disease or pest suppression.
- Identification of exotic invasive species (e.g. the Coccinellid beetle *Hippodamia variegata*, first observed in Queensland in 2000, which competes with native species feeding on scale insects and is spreading, the rice nematode *Meloidogyne graminiphila* which is a quarantine pest, and weevil pests of stored grains).
- Feasibility studies for developing a molecular probe for root lesion nematodes (RLN) from grains in Western Australia.
- Validation of insect and nematode specimens for Australian Pest and Pathogen Database.
- Studies of distribution of different species of root lesion nematodes.
- Taxonomic monographs of Australian weevils.
- A morphological and molecular revision of *Heliothis* to clearly identify which are pest species and provide identification tools.
- Additions to the on-line electronic interactive key to beneficial nematodes.
- A total of three training courses and researcher workshops.
The growth of the collections is also evidence of their importance. Over the two years of the project, more than 5,000 insects and 300 nematodes of direct relevance to GRDC were added to the collection, out of about 50,000 total acquisitions. Acquisitions of particular significance to GRDC have included:
- the Balderson collection from a retired researcher from CSIRO
- the Zimmerman collection of weevils
- nematodes from the reference collection of the Victorian Department of Primary Industries (DPI).

Additional information
Further information can be found at http://www.csiro.au/Organisation-Structure/National-Facilities/Australian-National-Insect-Collection.aspx