Pacific Horticultural and Agricultural Market Access Program (PHAMA)

Technical Report 28: Determination of the Quarantine Status of Nematodes on Samoan Taro Exports (SAMOA02)

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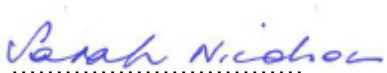

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Abbreviations

Abbreviation	Description
ACIAR	Australian Centre for International Agricultural Research
BORIC	Biosecurity Organisms Register for Imported Commodities
CABI	Centre for Agricultural Bioscience International
EU	European Union
FAO	The Food and Agriculture Organization of the United Nations
NZ MAF	New Zealand Ministry of Agriculture and Forestry
PHAMA	Pacific Horticultural and Agricultural Market Access Program
MAWG	Market Access Working Group
SPC	Secretariat of the Pacific Community
SPEC	South Pacific Bureau for Economic Cooperation
SROS	Scientific Research Organisation of Samoa
TLB	Taro leaf blight
UNDP	United Nations Development Programme
URS	URS Australia Pty Ltd
USP	University of the South Pacific
WST	Samoan Tala

Executive Summary

Samoa was the dominant supplier of taro to the New Zealand market until late 1993 when taro leaf blight (TLB) devastated the Samoan taro industry. Local production for export markets declined dramatically and it is only in recent times, through the Taro Improvement Programme led by the University of the South Pacific (USP) at Alafua, that the development of TLB-resistant varieties has given rise to the possibility of re-establishing exports of taro to New Zealand. Nevertheless, the export market in New Zealand continues to be dominated by taro from Fiji.

The discovery of nematodes determined to be 'regulated pests' by New Zealand biosecurity inspectors in taro imports requires the consignment be fumigated. Since 2006 interceptions of nematodes in taro consignments have not been routinely sent for laboratory diagnosis; importers have the option to fumigate any infested consignment directly, avoiding the cost of identification and facilitating more rapid clearance of the consignment to the market. Unfortunately, fumigation reduces shelf life and incurs treatment costs to the importer. Furthermore, treatment would not be necessary if the nematodes were 'non-regulated'.

Submission of detailed information of the species occurring in association with taro in Samoa may enable a re-assessment by New Zealand officials of the quarantine status of intercepted nematodes. Removal of, or reduction in the need for fumigation of Samoan taro, due to the presence of non-regulated nematodes on arrival in New Zealand, would represent a significant improvement in market access conditions for the Samoan taro export industry. The primary objective of the current work is to compile a list of nematodes associated with taro in Samoa drawing upon results of pest surveys and relevant research undertaken in Samoa, and provide comment on the likely quarantine status as determined by New Zealand authorities.

Although the focus on increasing exports of taro to New Zealand has been delayed due to supply chain issues, the Samoa Market Access Working Group (MAWG) has requested that the compilation of the nematode list for taro in Samoa be pursued in anticipation that exports to New Zealand will be re-established in the future. This work comprises:

- Documenting the species of nematodes associated with taro corms in Samoa;
- Obtaining details of nematode interceptions by the New Zealand Ministry of Agriculture and Forestry (NZ MAF) from Samoan taro; and
- Comparing New Zealand's nematode fauna with species found in association with Samoan taro and accessing relevant New Zealand databases to determine the current quarantine status of those species assessed to be associated with the taro export pathway.

Based on results of pest surveys undertaken in the late 1970s and early 1980s, a list of nematodes associated with taro has been compiled. The list includes nematodes of the genera *Aphelenchoides*, *Helicotylenchus*, *Meloidogyne*, *Pratylenchus*, *Radopholus*, *Rotylenchulus* and *Xiphinema*. The majority of these nematodes are categorised by NZ MAF as 'regulated pests' for New Zealand. Unfortunately, a good proportion of the nematodes collected during the aforementioned surveys were identified to genus level only. For quarantine purposes, including pest risk analyses and market access submissions, it is preferable for organisms associated with a particular commodity to be listed to species level. Nevertheless, information on the feeding habits of different nematode genera can assist in any analysis of the risk associated with particular nematodes. The publication by Yeates *et al.*

(1993) and reference to the recent comprehensive *Review of import conditions for fresh taro corms* undertaken by Biosecurity Australia (2011) are key documents.

Given the feeding habits and "potential to be on corms" as well as the apparent economic significance of these nematodes, NZ MAF's 'regulated pest' categorisation of species of *Helicotylenchus*, *Meloidogyne*, *Pratylenchus* and *Radopholus* not already present in New Zealand appears appropriate, as does the response to interceptions of such nematodes in the trial shipments of taro to New Zealand. However, the quarantine status of nematodes in the genera *Aphelenchoides*, *Aphelenchus*, *Ditylenchus*, *Paraphelenchus* and *Tylenchus* – hyphal, algal or lichen feeding nematodes – cannot be justified if applying the International Plant Protection Convention definition of 'quarantine pest' (as "a pest of potential economic importance to the area endangered thereby and not yet present there, or present but not widely distributed and being officially controlled"). In addition, the 'regulated' status of those ectoparasitic (Yeates *et al.* (1993) category 1d) nematodes is questionable.

Nevertheless, clarification of the occurrence and prevalence of nematode species in TLB-resistant taro varieties planted for export production, also identification of any nematodes intercepted on-arrival in New Zealand in future trial shipments may provide information to assist NZ MAF in any requested revision of the quarantine status of nematodes associated with taro.

In this regard, there are two Australian Centre for International Agricultural Research (ACIAR) projects – the *Cleaner Pathways* (PC/2007/118) and *Soil Health* (PC/2009/003) projects – that are now underway. Components of both projects will involve soil and taro root sampling, extraction of nematodes from the samples and subsequent identification of the nematodes. Discussion with some project researchers indicates that identifications undertaken will be to genus level only. Furthermore, existing capacity (taking account of the planned purchase of a new compound microscope) allows for reliable identification to only genus level. However, it is understood that for some genera morphological keys may be available for subsequent species identification and there is the capacity to prepare specimens for molecular diagnosis.

In conclusion, the following recommendations are made:

- *Ensure* that species-level identifications are pursued for intercepted nematodes from future trial consignments of Samoan taro, and if necessary, ensure that the costs of identification conducted by approved New Zealand diagnosticians are met;
- *Arrange* for species-level identification (if appropriate from international experts), when technically possible, of those nematodes extracted from samples collected in the course of the ACIAR-funded *Cleaner Pathways* and *Soil Health* projects;
- Where possible, *coordinate* and/or *combine* soil and taro root sampling planned as part of the two ACIAR-funded projects in order to ensure adequate sample numbers from representative sites and valid comparative analyses of the results subsequently;
- *Update* the list of nematodes associated with taro from Samoa (as presented in this report) as species information is clarified from current sampling; and
- *Request* NZ MAF (now the Ministry for Primary Industries) to review the quarantine status of nematodes in the genera *Aphelenchoides*, *Aphelenchus*, *Ditylenchus*, *Paraphelenchus*, *Tylenchus* and those 'regulated' ectoparasitic nematodes appearing on Samoa's list of nematodes associated with taro.

1 Introduction

1.1 Background

Taro was traditionally grown for local consumption in Samoa (Ministry of Agriculture and Fisheries Agriculture Sector Plan 2011–2015). Even though Fiji was the first Pacific Island country to start exporting taro to New Zealand, it was Samoa that really developed this market for export (McGregor et al. 2011). Taro became a major export earner for Samoa in the 1980s and early 1990s with exports estimated to be worth WST 16 million in 1989 (Ministry of Agriculture and Fisheries *Agriculture Sector Plan 2011–2015*) when around 7,800 tonnes were shipped (McGregor *et al.* 2011). Samoa was the dominant supplier of taro to the New Zealand market until late 1993 when taro leaf blight (TLB) devastated the Samoan taro industry (McGregor *et al.* 2011). Local production for export markets declined dramatically and it is only in recent times, through the *Taro Improvement Programme* led by the University of the South Pacific (USP) at Alafua, that the development of TLB-resistant varieties has given rise to the possibility of re-establishing exports of taro to New Zealand. Nevertheless, the export market in New Zealand continues to be dominated by taro from Fiji.

According to the Ministry of Agriculture and Fisheries (*Agriculture Sector Plan 2011–2012*), exports of taro from Samoa (mostly to American Samoa) have started to slowly recover and were estimated to be worth between WST 2–4 million annually from 2000 to 2009. Generally however, over the last decade the contribution of the export sector to Samoa's economy has deteriorated which is cause for concern. Facilitating trade and improving exports therefore remains a key priority for Samoa.

During 2010 and early 2011, a number of trial consignments of taro were shipped to New Zealand. As with Fijian exports over the past few years, the discovery of nematodes in some of these taro consignments highlights current issues with exporting fresh taro to New Zealand, and is indicative of problems likely to arise in the future as export taro production increases in Samoa.

The discovery of nematodes determined to be 'regulated pests' by New Zealand biosecurity inspectors in taro consignments requires the consignment be fumigated. Since 2006 interceptions of nematodes in taro consignments have not been routinely sent for laboratory diagnosis; importers have the option to fumigate any infested consignment directly, avoiding the cost of identification and facilitating more rapid clearance of the consignment to the market. Unfortunately, fumigation reduces shelf life and incurs treatment costs to the importer. Furthermore, treatment would not be necessary if the nematodes were 'non-regulated'.

Submission of detailed information of the species occurring in association with taro in Samoa may enable a re-assessment by New Zealand officials of the quarantine status of intercepted nematodes. Removal of, or reduction in the need for fumigation of Samoan taro, due to the presence of non-regulated nematodes on arrival in New Zealand, would represent a significant improvement in market access conditions for the Samoan taro export industry. The primary objective of the current work is to compile a list of nematodes associated with taro in Samoa drawing upon results of pest surveys and relevant research undertaken in Samoa, and provide comment on the likely quarantine status as determined by New Zealand authorities.

1.2 Required Investigations

Although the focus on increasing exports of taro to New Zealand has been delayed due to supply chain issues, the Samoa Market Access Working Group (MAWG) has requested that the compilation

of the nematode list for taro in Samoa be pursued in anticipation that exports to New Zealand will be re-established in the future. This work comprises:

- Documenting the species of nematodes associated with taro corms in Samoa;
- Obtaining details of nematode interceptions by the New Zealand Ministry of Agriculture and Forestry (NZ MAF) from Samoan taro; and
- Comparing New Zealand's nematode fauna with species found in association with Samoan taro and accessing relevant New Zealand databases to determine the current quarantine status of those species assessed to be associated with the taro export pathway.

This report addresses each of the aforementioned components.

2 Nematodes Recorded in Samoa

2.1 Nematode Surveys in Samoa

There are just two substantive works on nematodes in Samoa: Orton-Williams (1980) and Fliege and Sikora (1981). However, other relevant references include Orton-Williams (1982) and Orton-Williams (1985), both of which provide descriptions or clarification of the taxonomic status of nematodes collected in the survey reported in Orton-Williams (1980).

In addition, the thesis of Asiata (1984) contains results of research undertaken on the occurrence of nematodes in selected aroids in Samoa, including taro (*Colocasia esculenta*). Notably, all the published works relating to nematodes in Samoa date back to the late 1970s and early 1980s.

2.2 Recent Relevant Research in Samoa

As described in the Australian Centre for International Agricultural Research (ACIAR) publication, *Papua New Guinea and Pacific Nuis* (April 2011), two current ACIAR projects – the *Cleaner Pathways* (PC/2007/118) and *Soil Health* (PC/2009/003) projects – being undertaken in Fiji and Samoa include nematode research. Discussions with some of the project researchers, Angelika Matafeo (Plant Pathologist, Crop Division – Nu'u, Ministry of Agriculture and Fisheries) and Sanjay Anand (PhD Student, University of the South Pacific – Alafua), as well as Dr Seuseu Tauati (Principal Research Scientist, Scientific Research Organisation of Samoa (SROS)) indicate that nematode identifications will be made under components of both ACIAR projects. At this stage, however, it appears it is the intention to identify representative nematodes extracted from soil, taro root and/or corm samples to genus level only. Furthermore, existing capacity allows for reliable identification to only genus level. For some genera, morphological keys may be available for subsequent species identification.

A full list of those consulted in the preparation of this report is given in Appendix A.

2.3 List of Nematodes Recorded on Taro, *Colocasia esculenta*, in Samoa

Table 2-1, a list of nematodes recorded on taro, *Colocasia esculenta*, in Samoa has been compiled with reference to the available published literature (refer section 2.1), primarily Orton-Williams (1980), Fliege and Sikora (1981), and Asiata (1984). The nematodes appearing in Table 2-1 largely correspond with those listed in the Pacific Islands Pest List Database (Secretariat of the Pacific Community (accessed 19 September 2011)). With some of the nematodes, the level of identification specified is to genus level. In time, however, the ACIAR projects, PC/2007/118 and PC/2009/003, may contribute more detailed results providing clarification of most, if not all, the plant-feeding and hyphal-feeding species potentially associated with taro corms in Samoa. Nevertheless, some of the species are still likely to lack formal taxonomic description.

Table 2-1 Nematodes recorded on taro, *Colocasia esculenta*, in Samoa

Species of Nematode	Order and Family	Reference(s)
Aphelenchoides sp.	Aphelenchida: Aphelenchoididae	Asiata 1984*
Aphelenchoides spp.	Aphelenchida: Aphelenchoididae	Note: Fliege and Sikora 1981 reported *Aphelenchoides* spp. in a number of samples in their survey for nematodes attacking crops of economic importance (including taro).
Aphelenchus spp.	Aphelenchida: Aphelenchoididae	Note: Fliege and Sikora 1981 reported *Aphelenchus* spp. in a large number of samples in their survey for nematodes attacking crops of economic importance (including taro).
Criconema polynesianum	Tylenchida: Criconematidae	Orton-Williams 1980 (as *Nothocriconema* species 1) Orton-Williams 1982 (as *Nothocriconema polynesianum*)
Discocriconemella limitanea	Tylenchida: Criconematidae	Orton-Williams 1980
Ditylenchus sp.	Tylenchida: Anguinidae	Orton-Williams 1980
Gracilacus aonli	Tylenchida: Paratylenchidae	Orton-Williams 1985
Helicotylenchus dihystera	Tylenchida: Hoplolaimidae	Orton-Williams 1980
Helicotylenchus mucronatus	Tylenchida: Hoplolaimidae	Orton-Williams 1980
Helicotylenchus multicinctus	Tylenchida: Hoplolaimidae	Orton-Williams 1980
Helicotylenchus sp.	Tylenchida: Hoplolaimidae	Orton-Williams 1980
Meloidogyne spp. (*M. arenaria*, *M. incognita*, *M. javanica* (Orton-Williams 1980 and Bridge 1988))	Tylenchida: Heteroderidae	Orton-Williams 1980 Asiata 1984*
Meloidogyne incognita	Tylenchida: Heteroderidae	Fliege and Sikora 1981
Ogma melanesicum (syn. *Syro melanesicus* and *Seriespinula melanesica*)	Tylenchida: Criconematidae	Orton-Williams 1980 (as *Seriespinula melanesica*) Orton-Williams 1985 (as *Syro melanesicus*)
Ogma sp.	Tylenchida: Criconematidae	Orton-Williams 1980 (as *Ogma* species 1)
Paralongidorus sp.	Dorylaimida: Longidoridae	Asiata 1984*
Paraphelenchus sp.	Aphelenchida: Paraphelenchidae	Asiata 1984*
Pratylenchus brachyurus	Tylenchida: Pratylenchidae	Orton-Williams 1980
Radopholus similis	Tylenchida: Pratylenchidae	Orton-Williams 1980 Asiata 1984
Rotylenchulus reniformis	Tylenchida: Hoplolaimidae	Orton-Williams 1980 Fliege and Sikora 1981 Asiata 1984
Scutellonema sp. (certainly *S. brachyurus* (Bridge 1988))	Tylenchida: Hoplolaimidae	Asiata 1984*
Tetylenchus sp. Note: *Genus dubium* (Maggenti *et al.* 1987)	Tylenchida: Belonolaimidae	Asiata 1984*

Species of Nematode	Order and Family	Reference(s)
Tylenchorhynchus sp.	Tylenchida: Belonolaimidae	Asiata 1984*
Tylenchulus sp. (certainly *T. semipenetrans* (Orton-Williams 1980, Fliege and Sikora 1981, and Bridge 1988))	Tylenchida: Tylenchulidae	Orton-Williams 1980
Tylenchus sp.	Tylenchida: Tylenchidae	Asiata 1984* Note: Fliege and Sikora 1981 reported *Tylenchus* spp. in a large number of samples in their survey for nematodes attacking crops of economic importance.
Xiphinema brevicollum (previously *X. brevicolle*; one of the *X. americanum* group)	Dorylaimida: Longidoridae	Orton-Williams 1980 (as *Xiphinema brevicolle*)
Xiphinema ensiculiferum	Dorylaimida: Longidoridae	Orton-Williams 1980

*The research reported in this thesis focussed on nematode genera. Genera considered to be of economic importance in Samoa were: *Meloidogyne*, *Radopholus*, *Helicotylenchus*, *Aphelenchoides*, *Pratylenchus* and *Rotylenchulus*. Other nematodes found were "considered to be of lesser importance in taro production" (Asiata 1984).

3 Quarantine Status of Nematodes Associated with Taro in Samoa

3.1 New Zealand and Australia

NZ MAF does not yet hold a specific list of regulated and non-regulated organisms associated with taro from Samoa as part of its import health standard for taro. However, it does maintain what is referred to as the Biosecurity Organisms Register for Imported Commodities (BORIC). From BORIC, a publicly accessible and searchable database, it is possible to obtain the quarantine status (i.e. whether an organism has been categorised as regulated or non-regulated) of many organisms. Records in this database have been compiled from identifications to species level of organisms intercepted on imported consignments, as well as data gathered in the preparation of pest lists for inclusion in New Zealand's country/commodity import health standards. BORIC was therefore accessed to obtain information on the quarantine status in New Zealand of nematode species found in association with taro in Samoa (Table 3-1). However, BORIC may not record the complete list of organisms for which New Zealand has specified their quarantine status over the past.

Reference to McLeod et al. (1994), together with information contained in the *Review of import conditions for fresh taro corms* released recently by Biosecurity Australia (Biosecurity Australia 2011), enabled similar information to be compiled for Australia (Table 3-1). Of the 26 nematodes listed on the list of nematodes recorded in association with taro in Samoa, just one (namely, *Helicotylenchus mucronatus*) has been categorised by Biosecurity Australia as a quarantine pest (Table 3-1).

Table 3-1 Status in Australia and New Zealand of nematodes recorded from taro in Samoa

Species of Nematode from Taro in Samoa	**Present in Australia (McLeod *et al.* 1994)**	**Quarantine Status in New Zealand (MAF BORIC[3])**
Aphelenchoides spp.	*Aphelenchoides besseyi* (NT, Q); *Aphelenchoides bicaudatus* (N, Q, V, WA)	–
Aphelenchus spp.	*Aphelenchus avenae* (N, NT, Q, S, V, W)	–
Criconema polynesianum	No record	Regulated (as *Nothocriconema polynesianum*)
Discocriconemella limitanea	Yes (N, Q)	Regulated
Ditylenchus sp.	–[1]	–
Gracilacus aonli	No record	Regulated
Helicotylenchus dihystera	Yes (N, NT, Q, S, V, W)	Non-regulated (Knight *et al.* 1997; Knight 2001)
Helicotylenchus mucronatus	No record; **Quarantine (Biosecurity Australia 2011)**	Regulated
Helicotylenchus multicinctus	Yes (N, NT, Q, S, W)	Regulated
Helicotylenchus sp.	–[1]	–

Species of Nematode from Taro in Samoa	Present in Australia (McLeod *et al.* 1994)	Quarantine Status in New Zealand (MAF BORIC[3])
Meloidogyne spp.:		
M. arenaria	Yes (N, Q, S, T, V, W)	Regulated (as *M. thamesi*) (Knight *et al.* 1997)
M. incognita	Yes (N, NT, Q, S, T, V, W)	Non-regulated (Knight *et al.* 1997; Mercer and Miller 1997)
M. javanica	Yes (A, N, NT, Q, S, T, V, W)	Non-regulated (Knight *et al.* 1997; Mercer and Miller 1997)
Ogma melanesicum (syn. *Syro melanesicus* and *Seriespinula melanesica*)	Yes (W)	Not specified in BORIC
Ogma sp. (as *Ogma* species 1)	–[1]	Regulated
Paralongidorus sp.	–[1]	–
Paraphelenchus sp.	–[1]	–
Pratylenchus brachyurus	Yes (N, NT, Q, W)	Regulated
Radopholus similis	Yes (N, NT, Q, S, W)	Regulated
Rotylenchulus reniformis	Yes (NT, W) [Sauer 1981]	Regulated
Scutellonema brachyurus	Yes [Sauer 1981][1]	Not specified in BORIC (Knight 2001)
Tylenchorhynchus sp.	–[1]	–
Tylenchulus semipenetrans	Yes (N, NT, Q, S, V, W)	Non-regulated (Knight *et al.* 1997; Knight 2001)
Tylenchus spp.	–[1]	–
Xiphinema brevicolle	Yes (N, Q, V, W)	Non-regulated
Xiphinema ensiculiferum	Yes (N, Q)	Regulated

[1] Not listed in Biosecurity Australia (2011) although species belonging to this genus are present in Australia

[2] A=Australian Capital Territory; N=New South Wales; NT=Northern Territory; Q=Queensland; S=South Australia; T=Tasmania; V=Victoria; W=Western Australia

[3] BORIC (MAF Biosecurity Organisms Register for Imported Commodities, updated 20 February 2012), accessed 21 and 29 February 2012

Eleven of the 26 nematodes on the list of nematodes recorded from taro in Samoa have been specifically categorised as regulated pests by NZ MAF; two named species (*Ogma melanesicum* and *Scutellonema brachyurus*) do not appear in BORIC, while a further eight are listed to genus level only and cannot be categorised effectively in the absence of species identification. Some of these genera do contain species known to be damaging to plant health and not known to be present in New Zealand.

Not unexpectedly, there are no reliable records of those nematodes categorised as “regulated” (and appearing in BORIC) occurring in New Zealand (Knight *et al.* 1997; Knight 2001; Mercer and Miller 1997). However, there are validated records of *Scutellonema brachyurus*, one of the species for which its quarantine status is not specified in BORIC, occurring in New Zealand (Knight 2001). A determination on its quarantine status could be requested from NZ MAF.

At first glance then it would appear that the discovery by New Zealand inspectors of nematodes in fresh taro consignments from Samoa will warrant treatment, in this case fumigation, of affected

consignments before final clearance. In the absence of more detailed pest risk assessments of the "regulated" species having been undertaken by NZ MAF, the opportunity is taken to examine more closely NZ MAF nematode interception records (refer section 4) as well as compile relevant biological information on each species (refer section 5). Assessment of such records and/or information may assist in any discussions with NZ MAF on concerns about nematodes on taro from Samoa raised by either party.

4 Interceptions of Nematodes

4.1 Nematode Interceptions on Samoan Taro

As mentioned above (refer section 1.1), when TLB devastated Samoan taro production in late 1993 local production for export markets declined dramatically. From 2002–2009 small quantities of taro were exported to American Samoa but as a result of limited exports, in effect there is no dataset of interception records available for Samoan taro from New Zealand or Australian quarantine authorities.

Although nematodes were apparently intercepted in some of the six recent trial shipments of fresh taro corms to New Zealand, identification details are not available (Ms Talei Fidow-Moors, *pers. comm.*). There are, however, interception records for Fijian taro. Examination of these, bearing in mind the list of nematodes associated with taro in Samoa (Table 2-1), may provide some insights into problems potentially occurring in the future with exports of taro to New Zealand.

4.2 Nematode Interceptions on Fijian Taro

NZ MAF Border Interception Records for the period 1 January 2004 – 31 December 2005 had been previously obtained by the author for the purposes of another project. Permission was sought from, and granted by, Dr V. Herrera, NZ MAF (via emails of 12 and 13 September 2011), to use the subset of this large dataset (over 15,000 records) that related to interceptions from imported consignments of taro. These records constitute the most detailed New Zealand nematode interception dataset available. Over 96% of the taro interceptions analysed were from imports of taro from Fiji, and almost half of these involved the submission of samples to “Nematology” for identification – the resulting nematode identification records total 1,306. The identification of well over half of these nematode samples (n=849; 65%) could not be determined. A summary of the remaining 35% of identifications (n=457) is shown in Table 4-1. Notably, since 31 March 2006 identification of nematode interceptions from taro imports at New Zealand’s border have been rarely pursued.

On the assumption that the nematode genera intercepted from Samoan taro are similar to those intercepted on Fijian taro, also that those genera are found in similar proportions, 440 of the 457 identified nematodes (96.2%) belong to genera (and/or species) appearing in Table 2-1. Just one of the identified nematode interceptions was clearly a non-regulated species – specifically *Meloidogyne incognita* – as categorised by NZ MAF (Table 3-1). This represents 0.22% of the identified interceptions, and if unidentifiable ones are taken into account, just 0.08% of the nematode interceptions would require no regulatory action. Based on the lack of detailed information currently available on nematodes associated with taro from Samoa, taro exported to New Zealand is likely to experience problems with nematodes. NZ MAF inspectors are experienced with taro imports and fumigation of nematode-infested consignments can be expected.

If the assumption, that the nematode genera intercepted from Samoan taro are similar to those intercepted on Fijian taro and that those genera are found in similar proportions, is correct then it must be noted that nematodes of two genera, *Aphelenchoides* and *Aphelenchus*, make up a significant proportion of the identified interceptions (n=362; 79%). Better definition of the species involved, even if not formally described, and clarification of their feeding habits (plant parasites or fungivores) could assist NZ MAF revise its assessment of the quarantine status of the intercepted nematodes. An approach similar to Biosecurity Australia’s (Biosecurity Australia 2011) could be suggested/requested if information was available (refer text box below).

Table 4-1 Types of nematodes intercepted in New Zealand on taro imported from Fiji during 2004–2005

Nematode Class and Order	Nematode Family	Nematode Species	Number
Adenophorea, Dorylaimida	Mononchidae	*Mylonchulus* sp.	1
Adenophorea, Dorylaimida	Undetermined	–	5
Secernentea, Aphelenchida	Aphelenchidae	*Aphelenchus* sp.	67
Secernentea, Aphelenchida	Aphelenchoididae	*Aphelenchoides* sp.	295
Secernentea, Rhabditida	Undetermined	–	2
Secernentea, Rhabditida	Cephalobidae	–	1
Secernentea, Tylenchida	Anguinidae	*Ditylenchus* sp.	3
Secernentea, Tylenchida	Heteroderidae	*Heterodera* sp.	1
Secernentea, Tylenchida	Heteroderidae	*Meloidogyne incognita*	1
Secernentea, Tylenchida	Heteroderidae	*Meloidogyne* sp.	8
Secernentea, Tylenchida	Hoplolaimidae	*Helicotylenchus californicus*	2
Secernentea, Tylenchida	Hoplolaimidae	*Helicotylenchus egyptiensis*	2
Secernentea, Tylenchida	Hoplolaimidae	*Helicotylenchus microcephalus*	1
Secernentea, Tylenchida	Hoplolaimidae	*Helicotylenchus mucronatus*	1
Secernentea, Tylenchida	Hoplolaimidae	*Helicotylenchus pseudorobustus*	1
Secernentea, Tylenchida	Hoplolaimidae	*Helicotylenchus* sp.	18
Secernentea, Tylenchida	Hoplolaimidae	*Rotylenchulus reniformis*	3
Secernentea, Tylenchida	Pratylenchidae	*Pratylenchus coffeae*	37
Secernentea, Tylenchida	Pratylenchidae	*Pratylenchus* sp.	2
Secernentea, Tylenchida	Tylenchidae	*Tylenchus* sp.	3
Secernentea, Tylenchida	Tylenchulidae	*Gracilacus* sp.	3
		Total	**457**

The *Review of import conditions for fresh taro corms* documented Biosecurity Australia's (2011) analysis of the quarantine risks associated with the importation of fresh taro (*Colocasia esculenta*) from all countries. The analysis was undertaken in three consecutive stages:

1. Stage 1 – Initiation, which identifies the pest(s) and pathway(s) that are of quarantine concern and should be considered for risk analysis in relation to the identified area. **41 nematode species were identified, 14 of which there was no record of their presence in Australia. Six of the 14 were recorded as NOT having "potential to be on taro corms".**
2. Stage 2 – Pest categorisation, which identifies which of the pests with the potential to be on the commodity are quarantine pests for Australia and require pest risk assessment. **Of the eight nematodes NOT present in Australia AND with potential to be on taro corms, four did NOT require detailed pest risk assessment** [one of which was assessed as having NO "potential for establishment and spread" with the remaining three assessed as having NO "potential for economic consequences"]. **Four nematodes were identified as quarantine pests** [one of which is in Samoa].
3. Stage 3 – Pest risk assessment. **The resulting unrestricted risk estimates were VERY LOW for three quarantine nematode species and NEGLIGIBLE for the fourth.**

5 Feeding Habits of Nematodes Associated with Taro in Samoa

5.1 Feeding-habit Categories

In examining the feeding habits of soil nematode families and genera, Yeates *et al.* (1993) proposed seven broad categories of nematodes for ecological purposes, two of which are particularly relevant to the present study:

1. Plant feeding (involving soil nematodes feeding on vascular plants)
    a) Sedentary parasites (e.g. females of *Meloidogyne*, *Globodera*, *Sphaeronema*)
    b) Migratory endoparasites (e.g. Pratylenchidae, some Anguinidae)
    c) Semi-endoparasites (e.g. Hoplolaimidae, *Telotylenchus*)
    d) Ectoparasites (e.g. Dolichodoridae, Criconematidae, Paratylenchidae, Longidoridae)
    e) Epidermal cell and root hair feeders (e.g. Tylenchidae)
    f) Algal or lichen feeders
2. Hyphal feeding.

From a crop production perspective, those nematodes of greatest concern tend to be referred to as "plant parasitic nematodes". In a publication on plant parasitic nematodes of New Zealand, Knight *et al.* (1997) clarified their use of the term "plant-parasitic nematode" to mean nematodes in categories 1a–1d of Yeates *et al.* (1993).

5.2 Biological Status of Nematodes Associated with Taro in Samoa

Table 5-1 provides the list of nematodes found in association with taro in Samoa and the categories of Yeates *et al.* in which they fall. Notably, the nematode species listed in Table 5-1 (from Table 2-1) all fall, or potentially fall, in the "plant-parasitic nematode" categories applied in New Zealand. However, these categories do not necessarily equate to the probability of the listed nematodes being on or in taro corms, the commodity to be exported. Biosecurity Australia's (2011) recent assessment of these nematodes for their "potential to be on corms" is, therefore, also provided in Table 5-1.

The species in **bold** text in Table 5-1 are those that NZ MAF classifies as non-regulated, while those highlighted rows/species are those considered to be economically important on taro by Asiata (1984); all were extracted from taro roots, soil and weed roots in at least one of the two surveys conducted by Asiata which encompassed sampling from Upolu and Savai'i taro monocrops as well as subsistence areas where taro was intercropped with bananas, coconut and/or ta'amua (*Alocasia macrorrhiza*). Asiata (1984) considered *Helicotylenchus* to be the commonest genus of plant pathogenic nematode in Samoa but suggested that *Meloidogyne incognita* was of greater economic importance. In this regard, Asiata's results appear to mirror the earlier survey results of Orton-Williams (1980). In addition, Orton-Williams (1980) noted a high level of recovery of *Rotylenchulus reniformis*. Fliege and Sikora (1981) also reported very similar findings.

Given the feeding habits and "potential to be on corms" as well as the apparent economic significance of these nematodes, NZ MAF's 'regulated pest' categorisation of species of *Helicotylenchus*, *Meloidogyne*, *Pratylenchus* and *Radopholus* not already present in New Zealand appears appropriate, as does the response to interceptions of such nematodes in the trial shipments of taro to New Zealand. However, the quarantine status of nematodes in the genera *Aphelenchoides*, *Aphelenchus*, *Ditylenchus*, *Paraphelenchus* and *Tylenchus* – hyphal, algal or lichen feeding nematodes – cannot be

justified if applying the International Plant Protection Convention definition of 'quarantine pest' (as "a pest of potential economic importance to the area endangered thereby and not yet present there, or present but not widely distributed and being officially controlled"). In addition, the 'regulated' status of those ectoparasitic (Yeates *et al.* (1993) category 1d) nematodes is questionable.

Nevertheless, clarification of the occurrence and prevalence of nematode species in TLB-resistant taro varieties planted for export production, also identification of any nematodes intercepted on-arrival in New Zealand in future trial shipments may provide information to assist NZ MAF in any requested revision of the quarantine status of nematodes associated with taro.

Table 5-1 Biological status of nematodes recorded from taro in Samoa

Species of Nematode from Taro in Samoa	**Common Name**	**Biological Status (Yeates *et al.* 1993)**	**Potential to be on taro corms (Appendix 1, Biosecurity Australia (2011))**
Aphelenchoides spp.	–	Hyphal feeding [2], 1b, 1e or 1f	No (*A. besseyi* and *A. bicaudatus*)
Aphelenchus spp.	–	Hyphal feeding [2], or 1f	No (*A. avenae*)
Criconema polynesianum	Ring nematode	Ectoparasite [1d]	No
Discocriconemella limitanea	Ring nematode	Ectoparasite [1d]	No
Ditylenchus sp.	Stem and bulb nematodes	Hyphal feeding [2], or migratory endoparasites [1b] (mainly in shoots)	–
Gracilacus aonli	No common name	Ectoparasite [1d]	No
Helicotylenchus dihystera	Common spiral nematode	Semi-endoparasite[1] [1c]	Yes
Helicotylenchus mucronatus	Spiral nematode	Semi-endoparasite[1] [1c]	Yes
Helicotylenchus multicinctus	Spiral nematode	Semi-endoparasite[1] [1c]	Yes
Helicotylenchus sp.	Spiral nematode	Semi-endoparasite[1] [1c]	Yes
Meloidogyne arenaria	Peanut root-knot nematode	Sedentary endoparasite [1a]	No
Meloidogyne incognita	Root-knot nematode	Sedentary endoparasite [1a]	No
Meloidogyne javanica	Sugarcane eelworm	Sedentary endoparasite [1a]	No
Ogma melanesicum (syn. *Syro melanesicus* and *Seriespinula melanesica*)	No common name	Ectoparasite [1d]	No
Ogma sp.	–	Ectoparasite [1d]	–
Paralongidorus sp.	–	Ectoparasite [1d]	–
Paraphelenchus sp.	–	Hyphal feeding [2]	–
Pratylenchus brachyurus	Root-lesion nematode	Migratory endoparasite [1b]	Yes
Radopholus similis	Burrowing nematode	Migratory endoparasite [1b]	Yes
Rotylenchulus reniformis	Reniform nematode	Sedentary semi-endoparasite [1a]	No
Scutellonema brachyurus		Semi-endoparasite [1c]	Yes (*S. bradys*)
Tylenchorhynchus sp.	–	Ectoparasite [1d]	–

Species of Nematode from Taro in Samoa	**Common Name**	**Biological Status (Yeates *et al.* 1993)**	**Potential to be on taro corms (Appendix 1, Biosecurity Australia (2011))**
Tylenchulus semipenetrans	Citrus root nematode	Sedentary endoparasite [1a]	No
Tylenchus spp.	–	Algal or lichen feeders [1f]	–
Xiphinema brevicolle	Dagger nematode	Ectoparasite [1d]	No
Xiphinema ensiculiferum	Dagger nematode	Ectoparasite [1d]	No

[1] Usually *Helicotylenchus* spp. are ectoparasitic feeders on roots, but they can sometimes feed inside the roots (Luc et al. 1990, as cited in Biosecurity Australia 2011)

6 Summary

Table 6-1 summarises information contained in Table 2-1 – Table 5-1 and provides a detailed list of nematodes recorded on taro, *Colocasia esculenta*, in Samoa. It contains data that may be relevant to any New Zealand review of the quarantine status of nematodes appearing on Samoa's list of nematodes associated with taro.

Table 6-1 List of nematodes recorded on taro, *Colocasia esculenta*, in Samoa showing their quarantine status in New Zealand

Species	Common name	Order:Family	Feeding habit (according to Yeates *et al.* 1993)	Presence in Samoa	Presence in New Zealand	Quarantine status in New Zealand (BORIC)	Comments
Aphelenchoides spp.	–	Aphelenchida: Aphelenchoididae	Hyphal feeding [2], 1b, 1e or 1f	Asiata (1984) recorded *Aphelenchoides* sp. Fliege and Sikora (1981) reported *Aphelenchoides* spp. in a number of samples in their survey for nematodes attacking crops of economic importance (including taro).	–	– Note: In the absence of named species information Regulated.	*Aphelenchoides* sp. frequent interception on Fiji taro. *A. besseyi* and *A. bicaudatus* for which there are records on taro, considered by Biosecurity Australia (2011) to have no potential to be on corms processed for export. Hyphal feeders have no potential for economic consequences and should therefore be non-regulated. A few species of *Aphelenchoides*, including *A. fragariae* and *A. ritzemabosi*, are foliar feeders. Both these species are well established in New Zealand (Knight et al. 1997).

Species	Common name	Order:Family	Feeding habit (according to Yeates *et al.* 1993)	Presence in Samoa	Presence in New Zealand	Quarantine status in New Zealand (BORIC)	Comments
Aphelenchus spp.	–	Aphelenchida: Aphelenchoididae	Hyphal feeding [2], or 1f	Fliege and Sikora (1981) reported *Aphelenchus* spp. in a large number of samples in their survey for nematodes attacking crops of economic importance (including taro).	–	– Note: In the absence of named species information Regulated.	*Aphelenchus* sp. frequent interception on Fiji taro. *A. avenae* for which there are records on taro, considered by Biosecurity Australia (2011) to have no potential to be on corms processed for export. Hyphal feeders have no potential for economic consequences and should therefore be non-regulated.
Criconema polynesianum	Ring nematode	Tylenchida: Criconematidae	Ectoparasite [1d]	Orton-Williams 1980 (as *Nothocriconema* species 1) Orton-Williams 1982 (as *Nothocriconema polynesianum*)	No (Knight et al. 1997; Knight 2001)	Regulated (as *Nothocriconema polynesianum*)	Considered by Biosecurity Australia (2011) to have no potential to be on corms. As a root feeding ectoparasite is unlikely to be on corms and should therefore be non-regulated.
Discocriconemella limitanea	Ring nematode	Tylenchida: Criconematidae	Ectoparasite [1d]	Orton-Williams 1980	No (Knight et al. 1997; Knight 2001)	Regulated	Considered by Biosecurity Australia (2011) to have no potential to be on corms. As a root feeding ectoparasite is unlikely to be on corms and should therefore be non-regulated.

Species	Common name	Order:Family	Feeding habit (according to Yeates *et al.* 1993)	Presence in Samoa	Presence in New Zealand	Quarantine status in New Zealand (BORIC)	Comments
Ditylenchus sp.	Stem and bulb nematodes	Tylenchida: Anguinidae	Hyphal feeding [2], or migratory endoparasites [1b] (mainly in shoots)	Orton-Williams 1980	–	– Note: In the absence of named species information Regulated.	*Ditylenchus* sp. rarely intercepted on Fiji taro. Is unlikely to be on corms; *Ditylenchus* species are hyphal feeders or parasites of plant stems and leaves, and should therefore be non-regulated. *D. dipsaci*, a wellknown nematode pest in temperate climates is well established in New Zealand (Knight et al. 1997).
Gracilacus aonli	No common name	Tylenchida: Paratylenchidae	Ectoparasite [1d]	Orton-Williams 1985	No (Knight et al. 1997; Knight 2001)	Regulated	*Gracilacus* sp. rarely intercepted on Fiji taro. Considered by Biosecurity Australia (2011) to have no potential to be on corms. As a root feeding ectoparasite is unlikely to be on corms and should therefore be non-regulated.
Helicotylenchus dihystera	Common spiral nematode	Tylenchida: Hoplolaimidae	Semi-endoparasite [1c]	Orton-Williams 1980	Yes (Knight et al. 1997; Knight 2001)	Non-regulated	*Helicotylenchus* spp. intercepted on Fiji taro.
Helicotylenchus mucronatus	Spiral nematode	Tylenchida: Hoplolaimidae	Semi-endoparasite [1c]	Orton-Williams 1980	No (Knight et al. 1997; Knight 2001)	Regulated	*Helicotylenchus* spp. intercepted on Fiji taro.
Helicotylenchus multicinctus	Spiral nematode	Tylenchida: Hoplolaimidae	Semi-endoparasite [1c]	Orton-Williams 1980	No (Knight et al. 1997; Knight 2001)	Regulated	*Helicotylenchus* spp. intercepted on Fiji taro.

Species	Common name	Order:Family	Feeding habit (according to Yeates *et al.* 1993)	Presence in Samoa	Presence in New Zealand	Quarantine status in New Zealand (BORIC)	Comments
Helicotylenchus sp.	Spiral nematode	Tylenchida: Hoplolaimidae	Semi-endoparasite [1c]	Orton-Williams 1980	–	– Note: In the absence of named species information Regulated.	*Helicotylenchus* spp. intercepted on Fiji taro.
Meloidogyne spp., specifically:		Tylenchida: Heteroderidae		Orton-Williams 1980			*Meloidogyne* spp. rarely intercepted on Fiji taro.
M. arenaria	Peanut root-knot nematode		Sedentary endoparasite [1a]	Asiata 1984 Bridge 1988	Yes (Knight et al. 1997)	Regulated (as *M. thamesi*)	Considered by Biosecurity Australia (2011) to have no potential to be on corms.
M. incognita	Root-knot nematode		Sedentary endoparasite [1a]		Yes (Knight et al. 1997; Mercer and Miller 1997)	Non-regulated	Records of *M. arenaria* in New Zealand suggests its status as Regulated should be reviewed.
M. javanica	Sugarcane eelworm		Sedentary endoparasite [1a]	Fliege and Sikora 1981	Yes (Knight et al. 1997; Mercer and Miller 1997)	Non-regulated	
Ogma melanesicum (syn. *Syro melanesicus* and *Seriespinula melanesica*)	No common name	Tylenchida: Criconematidae	Ectoparasite [1d]	Orton-Williams 1980 (as *Seriespinula melanesica*) Orton-Williams 1985 (as *Syro melanesicus*)	No (Knight et al. 1997; Knight 2001)	Not specified in BORIC	Considered by Biosecurity Australia (2011) to have no potential to be on corms. As a root feeding ectoparasite is unlikely to be on corms and should therefore be non-regulated.
Ogma sp.	–	Tylenchida: Criconematidae	Ectoparasite [1d]	Orton-Williams 1980 (as *Ogma* species 1)	No (Knight et al. 1997; Knight 2001)	Regulated (as *Ogma* species 1)	As an ectoparasite is unlikely to be on corms and should therefore be non-regulated.

Species	Common name	Order:Family	Feeding habit (according to Yeates *et al.* 1993)	Presence in Samoa	Presence in New Zealand	Quarantine status in New Zealand (BORIC)	Comments
Paralongidorus sp.	–	Dorylaimida: Longidoridae	Ectoparasite [1d]	Asiata 1984	–	– Note: In the absence of named species information Regulated.	As an ectoparasite is unlikely to be on corms and should therefore be non-regulated.
Paraphelenchus sp.	–	Aphelenchida: Paraphelenchidae	Hyphal feeding [2]	Asiata 1984	–	– Note: In the absence of named species information Regulated.	Hyphal feeders have no potential for economic consequences and should therefore be non-regulated.
Pratylenchus brachyurus	Root-lesion nematode	Tylenchida: Pratylenchidae	Migratory endoparasite [1b]	Orton-Williams 1980	No (Knight et al. 1997; Knight 2001)	Regulated	*Pratylenchus* spp. intercepted on Fiji taro.
Radopholus similis	Burrowing nematode	Tylenchida: Pratylenchidae	Migratory endoparasite [1b]	Orton-Williams 1980 Asiata 1984	No (Knight et al. 1997; Knight 2001)	Regulated	
Rotylenchulus reniformis	Reniform nematode	Tylenchida: Hoplolaimidae	Sedentary semi-endoparasite [1a]	Orton-Williams 1980 Fliege and Sikora 1981 Asiata 1984	No (Knight et al. 1997; Knight 2001)	Regulated	*Rotylenchulus reniformis* rarely intercepted on Fiji taro. Considered by Biosecurity Australia (2011) to have no potential to be on corms. As a sedentary root feeding nematode is unlikely to be on corms and should therefore be non-regulated.

Species	Common name	Order:Family	Feeding habit (according to Yeates *et al.* 1993)	Presence in Samoa	Presence in New Zealand	Quarantine status in New Zealand (BORIC)	Comments
Scutellonema sp. (almost certainly *S. brachyurus* (Bridge 1988))	–	Tylenchida: Hoplolaimidae	Semi-endoparasite[1] [1c]	Asiata 1984 CABI 2012	Yes (*Scutellonema brachyurus* (Knight 2001; CABI 2012))	*S. brachyurus* not specified in BORIC (Knight 2001)	Present in New Zealand, therefore should be non-regulated.
Tetylenchus sp. Note: *Genus dubium* (Maggenti *et al.* 1987)	–	Tylenchida: Belonolaimidae	–	Asiata 1984	–	– Note: In the absence of named species information Regulated.	*Genus dubium* (Maggenti et al. 1987)
Tylenchorhynchus sp.	–	Tylenchida: Belonolaimidae	Ectoparasite [1d]	Asiata 1984	–	– Note: In the absence of named species information Regulated.	As an ectoparasite is unlikely to be on corms and should therefore be non-regulated.
Tylenchulus sp. (almost certainly *T. semipenetrans* (Orton-Williams 1980, Fliege and Sikora 1981, and Bridge 1988))	Citrus root nematode	Tylenchida: Tylenchulidae	Sedentary endoparasite [1a]	Orton-Williams 1980	Yes (Knight et al. 1997; Knight 2001)	*T.semipenetrans* Non-regulated	Considered by Biosecurity Australia (2011) to have no potential to be on corms. As a sedentary root feeding nematode is unlikely to be on corms and should therefore be non-regulated.

Species	Common name	Order:Family	Feeding habit (according to Yeates *et al.* 1993)	Presence in Samoa	Presence in New Zealand	Quarantine status in New Zealand (BORIC)	Comments
Tylenchus sp.	–	Tylenchida: Tylenchidae	Algal or lichen feeders [1f]	Asiata 1984 Fliege and Sikora (1981) reported *Tylenchus* spp. in a large number of samples in their survey for nematodes attacking crops of economic importance.	–	– Note: In the absence of named species information Regulated.	*Tylenchus* sp. rarely intercepted on Fiji taro. Algal or lichen feeders have no potential for economic consequences and should therefore be non-regulated.
Xiphinema brevicollum (previously X. *brevicolle*; one of the X. *americanum* group)	Dagger nematode	Dorylaimida: Longidoridae	Ectoparasite [1d]	Orton-Williams 1980 (as *Xiphinema brevicolle*)	Yes (Knight et al. 1997, as *X. americanum* (sensu lato); Knight 2001, as *X. americanum*)	Non-regulated	Considered by Biosecurity Australia (2011) to have no potential to be on corms. As a root feeding ectoparasite is unlikely to be on corms and should therefore be non-regulated.
Xiphinema ensiculiferum	Dagger nematode	Dorylaimida: Longidoridae	Ectoparasite [1d]	Orton-Williams 1980	No (Knight et al. 1997; Knight 2001)	Regulated	Considered by Biosecurity Australia (2011) to have no potential to be on corms. As a root feeding ectoparasite is unlikely to be on corms and should therefore be non-regulated.

7 Conclusions and Recommendations

The development of TLB-resistant varieties has given rise to the possibility of re-establishing exports of fresh taro to New Zealand. Nevertheless, the export market in New Zealand continues to be dominated by taro from Fiji. Clearance of consignments of Fijian taro on-arrival in New Zealand has not necessarily been straightforward; nematode interceptions have resulted in the need to treat/fumigate consignments. Similar problems should be anticipated with Samoan taro, especially given the recent experience with several trial shipments to New Zealand in 2010 and early 2011. Although nematodes were intercepted on some of these shipments, detailed identifications were not pursued. Such information, if obtained in the future may assist in more accurate assessment of the risk associated with nematodes found on Samoan taro.

Based on the results of pest surveys undertaken in the late 1970s and early 1980s, a list of nematodes associated with taro has been compiled. The list includes nematodes of the genera *Aphelenchoides*, *Helicotylenchus*, *Meloidogyne*, *Pratylenchus*, *Radopholus*, *Rotylenchulus* and *Xiphinema*. All the nematodes fall, or potentially fall, into groups described as 'plant parasitic', and most are categorised by NZ MAF as 'regulated pests' for New Zealand. Unfortunately, a good proportion of the nematodes collected during the aforementioned surveys of Orton-Williams (1980), Fliege and Sikora (1981) and Asiata (1984) were identified (and recorded) to genus level only. For quarantine purposes, including pest risk analyses and market access submissions, it is preferable for organisms associated with a particular commodity to be listed to species level. Nevertheless, information on the feeding habits of different nematode genera can assist in any analysis of the risk associated with particular nematodes. The publication by Yeates *et al.* (1993) and reference to the recent comprehensive *Review of import conditions for fresh taro corms* undertaken by Biosecurity Australia (2011) are key documents.

Given the feeding habits and "potential to be on corms" as well as the apparent economic significance of these nematodes, NZ MAF's 'regulated pest' categorisation of species of *Helicotylenchus*, *Meloidogyne*, *Pratylenchus* and *Radopholus* not already present in New Zealand appears appropriate, as does the response to interceptions of such nematodes in the trial shipments of taro to New Zealand. However, the quarantine status of nematodes in the genera *Aphelenchoides*, *Aphelenchus*, *Ditylenchus*, *Paraphelenchus* and *Tylenchus* – hyphal, algal or lichen feeding nematodes – cannot be justified if applying the International Plant Protection Convention definition of 'quarantine pest' (as "a pest of potential economic importance to the area endangered thereby and not yet present there, or present but not widely distributed and being officially controlled"). In addition, the 'regulated' status of those ectoparasitic (Yeates *et al.* (1993) category 1d) nematodes is questionable.

Nevertheless, clarification of the occurrence and prevalence of nematode species in TLB-resistant taro varieties planted for export production, also identification of any nematodes intercepted on-arrival in New Zealand in future trial shipments may provide information to assist NZ MAF in any requested revision of the quarantine status of nematodes associated with taro.

In this regard, there are two ACIAR projects – the *Cleaner Pathways* (PC/2007/118) and *Soil Health* (PC/2009/003) projects – that are now underway. Components of both projects will involve soil and taro root sampling, extraction of nematodes from the samples and subsequent identification of the nematodes. Discussion with some project researchers indicates that identifications undertaken will be to genus level only. Furthermore, existing capacity (taking account of the planned purchase of a new compound microscope) allows for reliable identification to only genus level. However, it is understood

that for some genera morphological keys may be available for subsequent species identification and there is the capacity to prepare specimens for molecular diagnosis.

In conclusion, the following recommendations are made:

- *Ensure* that species-level identifications are pursued for intercepted nematodes from future trial consignments of Samoan taro, and if necessary, ensure that the costs of identification conducted by approved New Zealand diagnosticians are met;
- *Arrange* for species-level identification (if appropriate from international experts), when technically possible, of those nematodes extracted from samples collected in the course of the ACIAR-funded *Cleaner Pathways* and *Soil Health* projects;
- Where possible, *coordinate* and/or *combine* soil and taro root sampling planned as part of the two ACIAR-funded projects in order to ensure adequate sample numbers from representative sites and valid comparative analyses of the results subsequently;
- *Update* the list of nematodes associated with taro from Samoa (as presented in this report) as species information is clarified from current sampling; and
- *Request* NZ MAF (now the Ministry for Primary Industries) to review the quarantine status of nematodes in the genera *Aphelenchoides*, *Aphelenchus*, *Ditylenchus*, *Paraphelenchus*, *Tylenchus* and those 'regulated' ectoparasitic nematodes appearing on Samoa's list of nematodes associated with taro.

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9 Limitations

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Appendix A

Appendix A List of People Consulted

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