Note: this document forms Appendix 6.3 of the Australian Centre for International Agricultural Research publication *Spiny lobster aquaculture development in Indonesia, Vietnam and Australia.* The main report can be downloaded from: http://aciar.gov.au/publication/pr145.

ACIAR Project SMAR2008/021

AUDIT OF DISEASES OF FARMED SPINY LOBSTERS IN VIETNAM

Conducted by

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and

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with coordination by

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6 - 11 September 2009

Audit Report

Activities are summarized in the table below. For a full description of places visited, people interviewed, background and related issues, findings and discussions see R. Callinan's trip report (trip report final.doc). In addition to the information presented in the trip report and summarized below, a large body of information, most of it in electronic form and largely in Vietnamese language, was collected prior to and during the visit; this information is supplied separately on the memory stick herewith.

	Activities	**Participants**
Sunday, Sep. 6	• Drs. Callinan and Corsin arrive Nha Trang • Drs Callinan, Corsin and Thuy ('the team') meet with Dr Dung (NTU)	
Monday, Sep. 7	• Travel to Tuy Hoa city • Meet with DARD staff, Phu Yen	Team
Tuesday, Sep.8	• Travel to Song Cau district • Meet with District staff • Visit lobster farms in Song Cau district, Phu Yen, meet with lobster farmers • Return to Nha Trang	Team
Wednesday, Sep.9	• Meet with DARD staff, Khanh Hoa • Visit lobster farm in northern Khanh Hoa, meet with key lobster farmer • Return to Nha Trang	Team and Dr Dung
Thursday, Sep. 10	• Meet with RIA3 lobster disease researchers; prioritise diseases; identify gaps; outline workshop • Drs Callinan and Corsin travel to Hanoi	Team and Dr Dung
Friday, Sep. 11	• Meet with Dr Dan, DDG/DAH/MARD and staff; confirm priority issues • Meet with Mr Geoff Morris, Ms An (ACIAR) • Meet with Dr. Tuan, Dept Science & Technology/MARD; discuss workshop options	Drs Callinan and Corsin
Saturday, Sep. 12	• Dr Callinan departs Hanoi	

Key audit findings are presented against each TOR below.

TOR 1
Through consultation with aquatic animal health counterparts and farmers, identify the important farmed lobster diseases and associated health issues (eg reduced growth rates, poor survival, poor condition, poor coloration etc) in Vietnam.

Current and available knowledge on farmed lobster diseases in Vietnam is summarised in the Disease Status table below. Key criteria for prioritisation were

frequency and magnitude of lobster losses (usually as mortality). Based on this evidence, we grouped the diseases/syndromes according to our perception of their importance as follows.

High priority diseases

- Milky haemolymph disease – spiny lobsters (MHD-SL)
- Red body
- Black gill

Disease whose importance needs clarifying

- Incomplete moult

Low priority diseases

- Tail rot
- Loose head
- Soft shell

Audit findings suggest that each of the 3 high priority diseases now causes comparable levels of production loss, but amongst different age/size classes, cage types and management regimes. However, evidence suggests research is most urgently needed on MHD-SL, for the following reasons:

- Even though MHD-SL in Vietnam currently occurs at levels which do not threaten the industry's survival, it is the only known farmed lobster disease in the region with the potential, on current understanding, to re-emerge at epidemic levels, particularly if antibiotic-resistant strains of the causal rickettsia-like bacterium (RLB) become widespread.
- Better understanding of pathogenesis and epidemiology of MHD-SL is urgently needed so that cost-effective, practical and sustainable control and prevention measures, acceptable to most farmers, can be developed.
- MHD-SL may become pandemic, given expansion of lobster farming in other regional countries, experimental evidence for horizontal spread of infection, and, at least currently, unregulated movement of seed between these countries.

Disease Status Table

Disease	Causal pathogen	Diagnostic test	Risk factors	Current control	Current prevention	Species affected (severity)
MHD-SL	RLB	Clinical signs Haemolymph smear Histopathology PCR	Tentatively identified, need more work[1]; see reports. Cage placement and density need to be examined	Oxytet i/m (officially recommended); others, e.g. quinolones, effective but not recommended. Optimal oral treatment needed.	Shorter cropping period, prophylactic antibiotics in feed, vitamins, immunostimulant, probiotics all used. Develop BMPs based on risk factor identification	*P.ornatus, P.homarus, P. stimsoni, P polyphagus* all affected ~ equally; *P.longipes* not known to be affected;
Red body	Vibrio spp., often *V. alginolyticus*, reported	Clinical signs Histopathology? Bacteriology	No formal study; farmer observation suggests: small lobster size, cage type related	Doxycycline 10% (3-7 g/kg feed) for 5-7 days; cage depth?	Tentative: maintain good hygiene; cage placement, depth.	*P.ornatus, P.homarus, P. stimsoni*, affected ~ equally; Not seen in *P. polyphagus, P. longipes* because small sizes not examined.
Black gill	Fungi, consistent with *Fusarium* spp	Clinical signs Wet mount Histopathology	No formal study; farmer observation suggests large size most susceptible, cage type.	Formalin (100-200 ppm) dip for 10-15 min. over 2 -4 consecutive days	Clean cage; move to clean site	No information, but probably all, esp *P.ornatus* since held to large size, longer growout.

1. Further analysis needed re 2007 survey work; further risk factor studies may be needed to address endemic situation rather than epidemic.

Disease	Causal pathogen	Diagnostic test	Risk factors	Control	Prevention	Species affected (severity)
Tail rot	Non-specific	Clinical signs Wet mount Histopathology	No formal study; no farmer observations recorded	As for black gill	Low stocking density, maintain cage hygeine	No information, but probably all, esp *P.ornatus* since held to large size, longer growout
Loose head	Not involved	Clinical signs	No formal study; possibly low salinity; no farmer observations recorded	Move cage to stable salinity (>28 ppt)??	Maintain cages in salinity >28 ppt??	All affected. Always seen in large size. Signif economic impact because mortalities.
Soft shell	Not involved	Clinical signs	No formal study		High quality feed (increased proportion of crustacean component in feed)	Can occur at any stage but most common at <100g. Can sell at lower price; not economic impt.
Incomplete moult	Not involved	Clinical signs	No formal study; observations indicate small size, possibly nutritional factor		Improve nutrition, vitamins, etc tried.	*P. ornatus, P. homarus, P. polyphagus* up to 100g; usually <1% mortality (Dr Thuy ~50% in some cases ??); provisional value is US$20 each.

TOR 2
Establish what is known about each disease (pathology, microbiology, epidemiology, economic impact) and collate all documentation for this knowledge.

Current knowledge is summarized in the Disease Status table above. Detailed information is available in the sources listed below.

MHD-SL
At the peak of the MHD-SL outbreak in 06/07, annual mortalities were >50% and up to 100% in some areas. At the time of the 2007 MARD investigation more than 90% of the farms had been affected by the disease and 88% had an ongoing outbreak. Now, annual mortalities are estimated at 20-40% from all diseases, with about half of these due to MHD-SL, usually in larger lobsters.

Much of the large body of information on MHD-SL is in Vietnamese language and will need to be translated prior to, or at, the proposed workshop if all issues are to be fully considered.

Key English language sources are:

a) OIE (2007) Milky haemolymph Disease of Spiny Lobsters (*Panulirus* spp.). OIE Aquatic Animal Disease Cards, 2007 (see memory stick file: milky haemolymph disease of lobsters card 9-04-08.pdf).
b) A presentation 'Study on milky syndrome in farmed lobster in Vietnam – preliminary results'given by Dr Dung (NTU) at a SEAFDEC meeting in Bangkok in December 2007 (see memory stick file: Lobster Milky Syndrome BKK Workshop.pdf)
c) A preliminary analysis of data obtained under the epidemiology component of the large MARD investigation into MHD-SL conducted in 2007 (see memory stick file: Flavio's input to Milky Disease report.doc).
d) Status report from Phu Yen province obtained during the audit visit; translation arranged by Dr Thuy stored on memory stick (Phu Yen province.doc).

Key Vietnamese language sources are:

a) Reports from the 2007 survey. Directories, containing individual files (with apparent content in each case shown below) are grouped on the memory stick as follows:
    i) Dr Do Thi Hua
        - Bao cao ket qua 1.doc (laboratory-based investigations)
        - Bao cao ket qua 2.doc (laboratory-based investigations)
        - Bao cao ket qua tom hum 2.ppt (laboratory-based investigations)
    ii) Dr Nguyen Huu Dung
        - Bao Cao Dac Diem Dich Te Benh Sua Tom Hum – Phan 2.doc (epidemiological investigations)
        - Bao Cao Dac Diem Dich Te Benh Sua Tom Hum – Phan 1.doc (epidemiological investigations)
        - Bao Cao Dac Diem Dich Te Benh Sua Tom Hum.ppt (epidemiological investigations)
    iii) NGUYEN TU CUONG va ctv – Nhom Dieu tra hien trang

- BAO CAO TGOAN QUOC 3.12.07.ppt (background survey design and findings)
- BC TOAN QUOC 7.12.doc (background survey design and findings)

b) Additional Vietnamese language information on 2 CDs from Dr Dung (NTU) grouped on the memory stick as follows:
   i) Dr Dung CD1
      - Lecture on Milky Syndrome_Preliminary Findings, Treatment a.ppt
      - Milky Syndrome Treatment Method.doc
   ii) Dr Dung CD2
      - Epigroup Movies
         - Lobster Injection 2.wmv
         - Lobster Injection.wmv
         - Net Cleaning.wmv
         - Net Washing.wmv
      - EpiGroup Pictures
         - North Khanh Hoa Group Pictures
         - Various untitled

c) MHD-SL section in booklet 'Mot So Bien Phap Phong Tri Benh O TOM HUM' by Mr Vo Van Nha (2008). Scanned copy of title page stored on memory stick (Nha 2008.jpg).

Red body and black gill

Information collected during the audit visit is presented in the Disease Status table above. A key source of information, largely unavailable to us during the audit, is the Vietnamese language booklet (which covers all significant diseases of farmed lobsters) 'Mot So Bien Phap Phong Tri Benh O TOM HUM' by Mr Vo Van Nha (2008). As noted in the trip report, Mr Nha was ill and unavailable for questioning re pathogenesis, epidemiology etc of these diseases during the visit.

TOR 3

Determine the extent to which risk factors for each important disease have been formally identified and whether or not programs to reduce losses have been devised and implemented.

MHD-SL

Risk factors under epidemic (2006/7) conditions have not yet been fully identified. Dr Corsin's preliminary analysis of data collected under the epidemiology component of the 2007 MARD investigation into MHD-SL is available (see memory stick file: Flavio's input to Milky Disease report.doc). Preliminary findings include:

- Cages held on the seabed present higher risk of disease. There are 3 types of cages – fixed, floating and submerged on seabed. Typical cage dimensions are 4m x 4m x 6m (depth). There are usually ~100 lobsters per cage
- Outbreaks in a single cage are usually protracted, with 2-5 animals dying per day, so that it can take up to 2 months for the entire cage population to be lost.
- Poor hygiene appears to increase risk of disease. Farmers who clean nets regularly and who dispose of waste away from the site report lower losses. This suggests the RLB is an opportunist pathogen but its sources in the environment are unknown

Under the 2007 MARD survey, the pathogenesis group established that the agent could be transmitted horizontally via water and intramuscularly via injection of unfiltered tissue extract. They did not do feeding trials.

Currently recommended control and prevention interventions are based on the above and include:

1. **Environmental protection (minimize pollution in the locality);**
2. **Maintain good cage conditions, including regular net cleaning;**
3. **Maintain good lobster health. Suggested interventions include supplementary feeding of vitamins, immunostimulants, probiotics, minerals;**
4. **Encourage community-based sustainable development in the locality;**
5. **At the first sign of a MHD outbreak in a cage, inject oxytetracycline intramuscularly into all animals in the cage.** Note that this antibiotic is generally accepted by regulators, provided withholding periods are observed. The group had no information about residue requirements re the major market, China, from where lobsters are reportedly forwarded to arguably stricter markets (e.g. Japan).

Some of the above evidence-based (some from first principles) prevention and control measures appear to have been loosely adopted and adapted to varying degrees only by individual farmers, probably in part because the package is operationally complex. In particular, we found little evidence that farmers complied with Intervention 5, seemingly because of (unwarranted) concerns about long term physical damage to lobsters, and hence lower price, arising from the injection. Instead, in an attempt to prevent losses, most farmers mix various antibiotics with feed, some maintain clean nets and some harvest early.

No formal work has been done on risk factors under current, endemic conditions and, importantly, the reasons for the decline in mortalities from 50-100% in 2006/7 are not clear.

Red body, black gill

We found no English language information on risk factors or control/prevention programs for these diseases. However, there is considerable Vietnamese language information in the booklet ‘Mot So Bien Phap Phong Tri Benh O TOM HUM’ by Mr Vo Van Nha (2008). As noted above, Mr Nha was ill and unavailable for questioning re pathogenesis, epidemiology etc of these diseases during the visit.

TOR 4

Determine the effectiveness of these programs and the constraints, if any, to broad program adoption.

As noted above, annual mortalities in farmed lobsters are currently estimated at 20-40% from all diseases, with about half of these due to MHD-SL, usually in larger lobsters. Audit findings suggest losses due to red body and black gill have remained relatively constant over the past 5 years. However, reasons for the decline in MHD-SL losses are not clear, but probably include the widespread practice of feeding antibiotics (not officially endorsed), regular net cleaning and, because larger sizes are more susceptible, early harvest, with farmers accepting lower returns.

Lack of basic knowledge about pathogenesis and epidemiology of the 3 main diseases under current conditions appears to be the major constraint to health-related BMP program formulation and adoption. For example, Phu Yen Provincial staff report that their lack of knowledge re cost-effective interventions re these diseases, combined with a lack of knowledge at farmer level is a major constraint to developing and implementing effective health management programs for farmed lobsters. Similarly, Song Cau District staff reported that they lack reliable information about lobster disease, i.e, they don't know the source(s) of infection, don't know when/how infection is first initiated and don't know how to prevent outbreaks.

These constraints notwithstanding, it appears a functional extension service is in place and able to disseminate programs. Dr Dan, DDG/DAH/MARD noted that Vietnam has a very effective extension system, as demonstrated under shrimp BMP programs, especially in coastal areas, so scale out of BMP programs for lobsters should not be a problem.

TOR 5
Identify key social, economic or political factors influencing the occurrence and control of important diseases

We noted the selection by Dr Dung (NTU) of a key farmer in Khanh Hoa province to disseminate control and prevention measures re MHD-SL within the locality.

Dr Dung also mentioned the importance of using national and local TV programs aimed at farmers to disseminate information.

TOR 6
Based on the above, determine the current status of each disease – distribution, trends re impacts on productivity and profitability.

As detailed above, annual mortalities in farmed lobsters generally are currently estimated at 20-40% from all diseases, with about half of these due to MHD-SL, usually in larger lobsters. Information is summarized in Disease Status table above.

Audit findings suggest losses due to red body and black gill have remained relatively constant over the past 5 years. Early harvest of small sized *P. ornatus* reduces returns to farmer.

Using information from one farmer in Phu Yen, profits can be made in spite of disease, although these are very limited. Using only information on cost of seed and feed (i.e. without taking into account additional operating/capital costs), a farmer with 10 cages (average in Phu Yen) would make a profit of about USD 1,000/year.

Item	N	Cost/unit	Total (mil VND)
Stocking (animals)	50	136	6,800
Feed (kg)	360	13	4,680
Partial operating cost			11,480

Harvest – size 600g (kg)	24	550	13,200
Profit/cage			1,720
N cages	10		
Profit/farm			17,200
Survival	80%		
FCR	15		

In this calculation several factors needs to be taken into account:

- Survival was sometimes reported to be significantly < 80% (about 40%)
- RIA3 studies reveal that the FCR is more often 20, rather than 15
- The cost of seed varies significantly and, on the previous year, it reached USD20/animal (approximately VND340-350,000/animal)
- Because some lobster farmers are also involved in capture fisheries, they can procure most of the feed which in reality would be considered as lost income from fishery.

Discussion with DARD Khanh Hoa revealed that if survival over a period of 14-16 months of culture is >75%, profits are considered acceptable by farmers. This shows the limited expectations and the huge potential for improvement. It is worth highlighting that farmers in Khanh Hoa province appeared to better managers and more prosperous than those in Phu Yen.

TOR 7
Identify what (if anything) Vietnamese agencies would be seeking in relation to follow-up ACIAR support.

Dr Dan, DDG/DAH/MARD proposed the following as important, immediate areas of need, with a particular focus on MHD-SL.

1. Improve understanding of pathogenesis and epidemiology of major diseases; in particular, identify sources of RLB infection, with focus on trash fish, seed.
2. Develop practical, evidence-based, cost-effective control and prevention methods.
3. Identify ways of eradicating MHD-SL and maintaining freedom in farming areas

Note that the above would also be highly relevant re development of a farmed lobster industry in Indonesia under SMAR/2008/021.

Elaborating on these items, the audit team identified the following needs.

Needs specific to MHD-SL:

1. To better understand the pathogenesis of MHD-SL, and to support formal refutation/confirmation of involvement of other pathogens, we need full descriptions of pathology at various stages of disease in typically affected individual lobsters;

2. We need to better understand the epidemiology of MHD-SL, including:

- source(s) of RLB infection for individual lobsters, especially horizontal infection pathways via (a) trash fish (components include finfish, molluscs, crustaceans) and (b) other infected lobsters;
- main transmission pathways between cages, farms and districts;
- main risk factors for emergence of MHD-SL (important re protecting the new industry in Indonesia: need to complete the analysis of 2007 epi survey findings);
- main risk factors for MHD-SL occurrence under endemic conditions (relevant to Vietnam; new study required);

3. We need accurate test(s) to detect and localize early RLB infection in individual lobsters and identify possible sources of infection in feed, environment etc,

4. Applying the above information, selected farmers, extensionists and technical people need to work together to develop and implement cost-effective treatment and control programs;

5. Understanding patterns of spread etc requires accurate, complete and systematically collected data re health status of farmed lobster populations - need to improve and harmonise province-based surveillance programs;

6. Need to better understand dissemination risks, if any, associated with unregulated movement of seed

7. There is some, possibly contradictory (depending on whether informant is provider or recipient), evidence of limited effectiveness of the government extension system re lobster health management programs – wide adoption of cost-effective control and prevention measures will require an effective, well informed service.

8. Relatively poor surveillance and reporting mechanisms limit notification of lobster health problems, thereby risking propagation to epidemic levels. Examination of the current system and identification of cost-effective, incentive-led notification mechanisms are needed.

9. There is currently no market-led mechanism to promote implementation of health management practices (e.g. responding to demand for product via responsible use of chemicals, etc), although markets worldwide increasingly require safer products cultured under environmentally and socially sustainable conditions. Such mechanisms do exist for other aquaculture products (e.g. shrimp, salmonids, etc.)

Some of the above needs may also be relevant to red body and black gill, depending on what is known re pathogenesis, epidemiology and management for each condition – will need to translate Mr Nha's booklet (or interview him further) to determine this.

TOR 8

Assuming a request for support appears strongly justified, identify key Vietnamese participants for the proposed workshop, at which a funding proposal could be framed up.

Dr Tuan (MARD, Hanoi) outlined plans for a MARD workshop proposed for December 2009:

- to review the findings of Dr Thuan's study and other current research;
- to review previous research;
- to identify future research needs

Dr Tuan agreed that the proposed MARD and ACIAR workshops could be combined under the following arrangements.

- A (probably 2-day) workshop will be held in Nha Trang in December 2009.
- The program will address causes, control and prevention of important diseases - current knowledge and future needs.
- Approximately 30-40 Vietnamese will attend, mainly drawn from key MARD departments (e.g. Dept of Science and Technology, DAH, Fisheries General Office) the 4 lobster-farming provinces and including provincial-level staff, researchers and, possibly, key farmers. Their attendance will be funded by GoV. The audit team suggests participants should include: Dr Thuy, Mr Dung, Mr Nha (all RIA3); Dr Hoa, Ms Thuy (both DARD, Khanh Hoa); Dr Dung and Mr Hich (NTU, fish pathology), Dr Duy (NTU, microbiologist), Dr Tuan (NTU, feed, management).
- Several foreign experts are suggested, including Dr Clive Jones (linkage with SMAR/2008/021); Dr Richard Callinan (aquatic animal health management, linkage with USyd farm health group); Dr Flavio Corsin (epidemiologist, linkage with Vietnamese agencies and programs); Dr Jenny-Ann Toribio (epidemiologist, USyd); Dr Brian Jones (lobster disease, WA Fisheries); Prof Leigh Owens (molecular biotechnology, JCU). These attendees, plus selected Vietnamese attendees (notably Dr Dung, NTU acting as facilitator and key participant) likely to be involved in any follow-on ACIAR work, could be funded by ACIAR.
- Presentations and discussion will be primarily in English.

TOR 9

Prepare a draft proposal for the lobster disease workshop including list of participants, venue, date, program and funding required

Not yet done. Will require further post-audit discussions re program, participants, funding, etc involving Dr C Jones, Dr Tuan, Dr Dung, Dr Corsin, Dr Callinan.