An investigation into the life-cycle, biology and potential use in aquaculture of selected indigenous freshwater prawns in northern Mekong tributaries of the Lao P.D.R.

Inception Report

Prepared for

The Living Aquatic Resources and Research Center

(LARReC)

Vientiane, Lao P.D.R.

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BACKGROUND TO STUDY

A freshwater prawn fishery has been identified along certain stretches of the Ou, Xuang and Khan Rivers in Luang Prabang Province in northern Lao P.D.R. (see Map). This report summarizes the information currently available on the fishery, based on surveys carried out by Mr. Somboon (LARReC Research Officer), Mr. Oulaytham Lasasima (LARReC Research Officer), Mr. Xaipladeth Choulamany (LARReC Director) and an external advisor, Mr. Terry J. Warren. It's main purpose is to present a proposal to conduct basic research into the life-cycle, biology and potential use in aquaculture of the most important prawn species associated with the fishery.

Economic importance of the prawn fishery

Whilst relatively unimportant in terms of the national economy, the prawn fishery is of considerable economic
significance to the local communities where the prawns are found and caught. Information gathered during surveys suggests that individual fishers may catch between about 2 and 10 kg of prawn per night over approximately a 120 day fishing season. Prawn fishers are required to contribute 60,000K per person, per year to a "village fund". A trading system operates whereby prawns are bought from villagers by a village middle-person at around 30 to 35,000K/kg (approx. 3.8 to 4.4 $US). The first middle-person then holds the prawns alive in special cages and sells them to a second-level trader. The second-level trader is required to pay tax to the District authorities at around 7,000,000K/year.

Each year, bidding for the second-level trading takes place. The person who gets the bid then has the sole right to distribute the prawns in the Luang Prabang area and can sell them for around 38,000K/kg (approx. 4.8 $US). Prawns sell for around 40 to 50,000K/kg (approx. 5 to 6 $US) in local markets, and around 60,000K/kg (around 7.5 $US) if the prawns are pre-cooked. It has been estimated that approximately 1000 kg of prawn passes through a market in Luang Prabang during the June to September period. However, based on recent interviews, this figure seems somewhat conservative.

Species of prawn

It is not currently known how many prawn species or genera are involved with the fishery. The following initial descriptions provided over page suggest that there may be at least 4 or 5 species involved. Some of these have been identified as belonging to the *Macrobrachium* genus (Funge-Smith, pers. com.) of the Caridean prawn group.

- **Small Prawn (SP)** – a small common species widely distributed throughout the country and known throughout most of Lao PDR and Thailand as "Goong foi".

- **Mekong Prawn (MP)** – a much larger species of prawn than the one above, and males possess very long second walking legs (periopods) modified into chelae. Males attain a greater size than females and grow to at least 12 cm measured from the tip of the rostrum to the tip of the telson (tail). Adult males appear dark greenish-grey. Females are lighter coloured. Both sexes become darker just prior to moultting (Souksavat, pers. com.). When observed in tanks, males surround certain females with their chelae and use them to fend off other males. Cannibalism is reported to be a problem in tanks. The species is quite slender, and might be described as not very fleshy. According to local sources, MP does not appear to form an important component of the fishery in the Ou, Xiang and Khan River systems, and may not even be present in those rivers at all. The MP held at Na Luang Fishery Station (NLFS) were caught directly from the Mekong mainstream close to Luang Prabang.

- **Blue Prawn (BP)** – a species having a blue colour, short body and legs compared to the Yellow Prawn below. No specimens of this species / type were observed anywhere during a 5-day survey in the Luang Prabang area in mid September 2000.

- **Yellow Prawn (YP)** – a species having a yellow / orange colour but with a longer body and walking legs compared with the Blue Prawn above. Likewise, no specimens of this species / type were observed either during the survey mentioned above. Locals in villages along the Ou River refer to this animal as "Goong Si Leung".

- **Orange Prawn (OP)** – a species very similar to the one above, but with distinctly orange legs. No specimens have been observed, and it may become apparent that it is the same species as YP and / or related to sex. Locals in villages along the Ou River refer to this animal as "Goong Fai Mai".

- **Red Head Prawn (RH) and Green Head Prawn (GH)** – both these animals either represent separate species or, more likely, represent the sexes of the same species. RH appears to attain a greater size than GH and has longer second walking legs / chelae. With RH, the top part of the thorax appears reddish, dark red, or almost black in some individuals. With GH, the top of the thorax appears light green. Both RH and GH are important economic components of the fishery in the Ou and the Xuang Rivers at least. They were still being caught in late September 2000. If it established that they are in fact separate species, they appear to co-habit.

- **White Prawn (WP)** – Very little information available on this locally reported species / type. Known locally from the Ou River, it is described as less common than other species and is large. Villagers refer to it as "Goong Khao".

- **Don Prawn, or Si Don Prawn (DP)** – a comparatively uncommon species and reported from only one
village (Muang Ngoi). A long, delicate species (perhaps up to 15 cm in TL) that is considered by locals to live in holes. The local name is “Goong Don” or “Goong Si Don”.

At this initial stage of the investigation, the above are assumed to be separate species and not hybrids. However, it remains to be established if the some types actually represent the same species (possible sexual dichromatism / dimorphism), at different life-cycle stages or observed in different habitats and / or feeding on different dietary items (Funge-Smith, pers. com.).

According to New and Singholka (1985), over 100 species of the freshwater prawn genus *Macrobrachium* are known throughout the tropical and sub-tropical regions of the world. Most species require brackish water in the initial stages of their life-cycle although some complete their cycle in inland saline and freshwater lakes and rivers. Some species prefer clear-water rivers whilst others can tolerate highly turbid conditions.

The *Macrobrachium* species that spend their entire life cycle in freshwater DO NOT hatch as planktonic larvae, such as seen with *M. rosenbergii*. Instead, full development of the post larvae occurs within the egg, and the hatchling is already a post-larvae or juvenile immediately after hatching (Funge-Smith, pers. com.).

**Known prawn habits and the fishery**

The fishery begins around June each year and ends in late September. When the mainstream rivers become very turbid due to heavy rainfall, the prawns move up out of the river into “Bo”. “Bo” are cool, gin-clear streams that issue from caves at the base of riverside hills and mountains. In some instances, the prawns actually enter the caves themselves. These short migrations only take place at night. Local fishers intercept these movements by placing special traps (sai) along the sides and middle of the “Bo”. “Sai” are made from bamboo and are essentially cylinders with a cone entrance. They are set during the late afternoon and prawns are retrieved at dawn. Local villagers claim that prawns only enter "Bo" and do not move up into other streams that carry surface run-off from rainfall. As soon as the turbidity decreases in the mainstream, the prawns move back down out of the "Bo" again.

According to local people, prawns are never seen in reproductive condition (“berried”) during the main fishing season in the wet-season months. This suggests that either the "Bo" fishery targets pre-adult prawns and that spawning habitats have not yet been identified, or that spawning takes place during the dry-season / late wet-season months. In any event, it seems highly unlikely that spawning takes place in the "Bo" and probably takes place in the mainstream itself.

**Initial observations at the Luang Prabang Fishery Station (NLFS)**

Initial stocking trials and observations have been started at the NLFS in Luang Prabang. Yellow and Mekong Prawn have been held and grown in ponds. Yellow Prawn has become sexually mature and has reproduced under these conditions. There is some evidence that Mekong Prawn has reproduced also, but their grow-out size is smaller than wild specimens. Prawns have been raised together with fish using prepared feeds. Separate studies concentrating on prawn monocultures have not yet been carried out at NLFS.

**The September 18 to 22 2000 prawn survey**

From September 18 to 22 2000 a survey of the prawn fishery in Luang Prabang Province was carried out by Mr. Oulaytham Lasasima (Research Officer, LARReC), Mr Pa-Ney Souriyamat (Fishery Officer, Luang Prabang) and an external advisor, Mr. Terry J. Warren. The following account describes the itinerary and the main findings of the survey.

**September 18**

Arrival at Luang Prabang and meetings with Mr. Onidet Souksavat (Chief of Luang Prabang Fishery Station) and Mr. Pa-Ney Souriyamat. Travel by car to Ban Nong Kieo, approximately 140 km north of Luang Prabang and located on the banks of the Nam Ou. Meetings with Mr. Wunsai Pantiwilai (Chief of Nong Kieo Livestock-Fisheries). Overnight in Nong Kieo.
To the Nong Kieo Agricultural Office to collect Mr. Wunsai. Boat trip up river from Nong Kieo to visit villages where prawns are caught. First "Bo" (Tam rulium) is located approximately 500 m upstream from Nong Kieo. Water issues from a cave right next to the mainstream. Here, 6 "sai" are placed in about 4 or 5 m of water. "Sai" are attached to a lattice-work of bamboo poles. Local people report that approximately 300 to 500 kg of prawn are caught at the site annually. This "Bo" connects with another (Huay khan) where prawns are also caught.

Next "Bo" upstream is "Bo neang" close to Ban Viang Sai. Here, the water is occasionally dirty in the "Bo" and hence there are fewer prawns caught (estimated on average at between 50 and 60 kg per year). Also, the cave from which the "Bo" issues is some 200 to 300 m away from the mainstream. Villagers claim that more prawns are caught in "Bo" that are only a short distance from the mainstream. The Nai Ban, Mr. Siang Khampa explained that prawns have been caught at the site for generations. Mr. Wunsai mentioned that small eggs can be seen on the roots of trees in the mainstream in February and March and he considered these might be prawn eggs. Only small prawns are seen around the shoreline during the dry-season months, and these may possibly be recruits, or perhaps another species. This year, about 200 kg of prawn have been caught. The "Bo" is full of "sai" during the fishing season, with no restrictions on anyone fishing.

The complete list of "Bo" names upstream from Nong Kieo is as follows:

1. Bo tamrulium
2. Bo tamrulium connects with Huay khan
3. Bo neang
4. Bo huay tam hadt pba
5. Huay ngoi ngoi
6. Bo tam gang (connects with Huay ngoi ngoi)
7. Bo huay butt
8. Bo yang mong
9. Bo luang (second most important "Bo")
10. Bo pa sang
11. Bo pa nok kaw
12. Bo bouam hin
13. Bo pa houat (most important in terms of landings)
14. Bo pa man
15. Bo hay gem
16. Bo pa vee

At Muang ngoi, Mr. Bouangun (head of prawn fishing group) explained about the different types / species of prawn caught in the area. He claimed that "white prawn" is occasionally seen with eggs in August. He also mentioned another prawn "Goong don" which he described as long and delicate, but not many are caught. He estimated that people can catch approximately 7 kg per person per night. There were village rules in the past regarding the fishery, but no restrictions now. Return to and overnight in Nong Kieo

September 20

Visit to Ban Huay Goong, approximately one hour downstream from Nong Kieo by boat. Here, "Bo huay
goong" issues from a small cave about 100 m away from the Nam Ou mainstream. Approximately 300 kg of prawn were caught last year, but landings were higher this year at between 400 and 500 kg. Middle level traders come from Nong Kieo to purchase prawns every 2 or 3 days during the main fishing season in June, July and August. Fishers sell prawns at around 20 to 25,000 K/kg depending on market demand. All 46 families in the village fish for the prawns. Each month, the prawns move up into the "Bo" for a period of about 10 days when the mainstream becomes turbid. Prawn landings then decrease for 3 or 4 days before they start appearing again in large numbers. The Nai Ban, Mr. Tow Oun, thought that the Red Head and Green Head Prawn was the same species; RH are male, and GH are females. Another "Bo" ("Bo pba pun") is located just upstream from Huay goong.

Final visit was to "Houay gout" just outside Nong Kieo. Here, Huay gout issues from a cave approximately 50 m away from the Nam Houn, a tributary of the Nam Ou. Accounts of prawn behaviour and fishing practices were the same as in all other villages. Return to and overnight in Luang Prabang.

September 21

Visit to Ban Na Pho on the Nam Xuang, a Mekong tributary approximately 50 km north of Luang Prabang. Here, a series of waterfalls enter the Nam Xuang from a number of different caves. "Bo dtat goong" is one of the most important "Bo" for catching prawn at this site. Prawns actually climb up the rock face into the "Bo" current when conditions become turbid in the mainstream. Fishers intercept the movements by placing many "sai" traps in the areas at the base of the cliff. Fishers sell their prawns to a local middle person for approximately 30,000 K/kg. "Bo pboon sakang" is located approximately 20 minutes downstream from Ban Na Pho. Here, prawns enter a cave directly next to the mainstream. According to local people, the prawns begin moving up into the "Bo" in March, or as soon as the Nam Xuang starts to become muddy. Some landings take place all year round at this site, but fishing activities peak in June, July and August. Return to and overnight in Luang Prabang.

Two kilogrammes of live prawns were purchased at Ban Na Pho (Red Head Prawn and Green Head Prawn) and taken back to the Na Luang Fishery Station. One hundred and twenty RH and GH were released into a small pond at NLFS to await further research.

September 22

Meeting at the Na Luang Fishery Station to discuss research priorities and directions. A further 120 prawns (RH and GH) were placed in plastic bags and taken back to Vientiane. Approximately 60 Mekong prawn were also transported. These are now being held in two separate ponds at the Nong Teng Fishery Station to await further research.

PROPOSED RESEARCH ACTIVITIES AND TENTATIVE TIME SCHEDULE

Species identification

Several leading taxonomists have been contacted already with the objective of obtaining positive identifications for the most important prawn species associated with the Luang Prabang fishery. These include Dr. Tyson Roberts (Smithsonian affiliated researcher), Dr. Darrel Siebert (British Natural History Museum) and Dr. Fernando (Waterloo University, Canada). However, this has so far produced no leads regarding a prawn taxonomist capable of providing a positive ID. Mr. Wattana Leelapatra of the Thai DOF suggests that samples be sent to Dr. Chavalit, a leading Thai fish taxonomist. Tyson Roberts has also requested samples. Specimens will be sent shortly. However, we are currently in possession of only 2, or possibly 3, species at present and identification will be an on-going process over the life-time of the Project. Eventually, it should be possible to have good quality photographs, scientific names and preserved specimens. Dr. Funge-Smith suggested obtaining a copy of L. B. Holthuis's monograph on prawn identification. This may be present at the British Library, and I may be able to obtain information when I visit the UK in November 2000.

A self-sustaining fishery

Based on anecdotal reports and interviews with many local people during the September 18 to 22 survey, there does not appear to be any evidence to suggest that the prawn fishery in the Luang Prabang area is over-fished or in decline. Although landings are variable from year to year, most people did not consider that landings were less now compared to 10 or 15 years ago. One reason for its apparent sustainability may be
that the prawns are targeted outside their breeding season, and the spawning habitats are not subject to interference. The fishing season is also comparatively short, and fishing is naturally restricted to only those areas where "Bo" are found. Perhaps even, the distribution of prawns within the whole river system is restricted to those areas where "Bo" are found.

There remains the option to conduct a CPUE study at selected sites during the 2001 fishing season, and this can be discussed amongst all involved with the Project. However, the strict objectives of such a study would need to be agreed on beforehand. One objective might be to collect CPUE data over just one year to act as baseline data for comparison in 5 or 10 years time. However, given that landings are variable between years, this may not be a worthwhile approach. Alternatively, a time-series CPUE study over several years might reveal the variability in landings between years, but would have to take place over perhaps 5 or 10 years if the objective is to identify drastic declines or increases in the fishery. This would involve a considerable research effort and costs, and ultimately may not reveal much useful information. At this point, this report does not recommend a CPUE study. Anecdotal evidence from local people should be sufficient to identify if catastrophic declines are taking place within the fishery.

Natural spawning habitats

Currently, it is not known exactly where the various species of prawn breed. However, it is quite clear that the prawns do not spawn in the "Bo" as previously hypothesized. In addition, it is also quite clear that the prawns in the Nam Ou, Nam Khan and Nam Xuang do not breed during the main wet-season period from June to September. This leads to the inevitable conclusion that egg development and breeding takes place sometime between September and June, and almost certainly in the mainstream itself. In order to try and identify spawning periods and habitats in the wild, it is suggested that prawn traps be deployed at selected localities and in a variety of habitats with the cooperation of local fishers. A prawn trap will need to be designed (perhaps based on an existing model) and a sampling schedule drawn up. Traps should be deployed every 15 days (approximate moulting period) and any prawns caught should be examined for egg development. A percentage of "berried" females from samples should be able to identify when the main spawning periods are for each species. Simple forms can be used to record data in villages. This same technique can be used for the prawns held in ponds at NLFS (Luang Prabang) and NTFS (Vientiane) to cross-check if the prawns become sexually mature under captive conditions.

Prawn fecundity

One of the main constraints to the use of the prawns in aquaculture may be the level of fecundity (Funge-Smith, pers. com.). Therefore, every attempt should be made to record this from the prawns held in ponds and in the wild. There may be differences in fecundity between captive-held and wild prawns. Strictly speaking, fecundity is a measure of the number of live fertilized eggs produced by a female. This is often difficult to measure because fertilization is external in prawns and also fish. Therefore, it is usually necessary to measure the potential fecundity as the best estimate of absolute fecundity. Inevitably, potential fecundity will provide an over-estimate of fertility, but this is probably unavoidable. With certain fish species, the absolute number of eggs produced increases with the age of the fish. This may also be the case with the Luang Prabang prawns. Also, with some fish species, there is a relationship between the fecundity and the length of the fish. This can be described using the following equation; \( F = aL^b \) (where \( F \) = fecundity, \( L \) the length of the fish, and \( a \) and \( b \) are fitted constants). Therefore, an attempt should be made to relate fecundity to some morphometric character of the prawns using regression. Such a relationship may prove useful later on in the research program.

For "berried" prawns retrieved from ponds at NLFS and NTFS, fecundity can be measured in one of two ways. "Berried" prawns should be humanely killed by oxygen starvation, or immersion in iced water. Immediately after death, the prawn should be blot dried with tissue paper and weighed with eggs intact using a sensitive laboratory balance. Depending on the size of the eggs, they can either be gently removed using tweezers and counted, or batch-weighed to the nearest 0.001g. The counting method is preferable and is the usual method employed for measuring fecundity. The fecundity should be expressed as the numbers of eggs / body weight of female. Alternatively, it may be possible to estimate fecundity by weighing and counting a small sample of eggs, and then multiplying up the number by the total weight of the eggs. An attempt should be made to relate fecundity to an easily measurable morphometric character of the prawn. It is suggested that carapace length be the morphometric character measured using vernier calipers. To attempt to measure total length of the prawn will almost certainly lead to discrepancies and a poor regression relationship. The above data should also be able to identify approximately at what size each prawn species become sexually mature.

Semi-artificial propagation and larval-rearing of prawns
If the prawns are able to reach sexual maturation in ponds, an attempt will be made to spawn them under semi-artificial conditions in tanks and aquaria at NLFS and NTFS. Because there is presumably no previous literature published on breeding and raising the Luang Prabang prawn species, wherever possible, methods and techniques should be employed as for raising *M. rosenbergii* in the first instance. Such methods can be modified later in the light of experience gained in the first year. Perhaps the best approach will be to follow some of the methods and techniques provided in New and Singkhola’s 1985 "Freshwater prawn farming" FAO / UN manual. Rather than re-present large sections of the manual here in this report, only some of the main points taken from the report are given below:

- Suitable tanks should either be purchased or identified at both NLFS and NTFS. Rectangular concrete tanks may be suitable, or purchased round plastic tanks. Fiber-glass tanks are suitable if already available, but it is not recommended to purchase them, as plastic tanks are more suitable (Leelapatra, pers. com.). The post-larvae stage of the Luang Prabang prawns may prefer a flat-bottomed raceway type tank, which may be circular or rectangular (Funge-Smith, pers. com.).

- As the reproductive work in the first year will be mainly experimental, almost any volume of tank will be suitable (2 to 10m$^3$). Smooth sides and bases will be essential for a healthy environment and ease of cleaning. A turn-down drain protected by a filter sock is essential to prevent loss of post-larvae during water changes. Moderate aeration via a system of perforated PVC pipes is recommended over airstones. If the aeration is too vigorous, the PL may have some difficulty in catching hold of their food. This may result in excessive cannibalism (Funge-Smith, pers. com.). Tanks for holding post-larvae should also have similar characteristics to the tanks described above.

- It may prove useful to have some "hide" material in the tanks to reduce cannibalism at the PL stage. Blue nylon panels, small bits of PVC pipe or bamboo may be suitable, especially during the moultmg period (Funge-Smith, pers. com.).

- An oil free blower supplying high volume, low-pressure air supply is preferred over a compressor.

- If "berried" prawns are caught during regular 15 day sampling with castnets, a small number (depending on apparent fecundity) should immediately be placed in the spawning tank. Perhaps no more than 3 or 4 "berried" females should be used to begin with until experience is gained. No males should be required, as it is assumed fertilization will have taken place in the pond. It is essential to obtain "berried" females that are at the same stage of ripeness to prevent cannibalism amongst newly hatched post larvae. With *M. rosenbergii* this can usually be achieved by observing the colour of the eggs (grey or black are ripe and orange are immature). It is not yet known if egg development is accompanied by colour changes with the Luang Prabang prawns. With *M. rosenbergii*, hatching will take place within 2 or 3 days if females are selected with grey or black eggs. It is quite likely that the hatching period for the Luang Prabang prawns will be considerably longer, because complete egg development will have taken place within the egg membrane (Funge-Smith, pers. com.). However, the exact hatching period remains to be established through observation. "Berried" females should NOT be fed during the pre- and post spawning period. Egg hatching may take place at night, as with *M. rosenbergii*. Hatching can be detected by the presence of larvae in the tank and absence of eggs underneath the female. Females should be removed immediately after spawning has taken place.

- Many changes in water quality in the larval-rearing tank will take place and are not visible with the naked eye. These are mainly due to the metabolic wastes produced by the larvae (and live food organisms) and the degradation of excess food. The most serious potential toxins are non-ionized ammonia, which is especially evident at high pH, and nitrite. Water hardness can also be a problem with *M. rosenbergii* (Funge-Smith, pers. com.). *M. rosenbergii* prefers a water hardness of between 50 and 150 ppm as calcium carbonate. Funge-Smith (pers. com.) recommends regular checking of water hardness, pH, alkalinity, ammonia and nitrite levels in ponds at NLFS and NTFS and in larval-rearing tanks using TETRA-AQUARIUM water quality test kits.

- Because, in the first year at least, the prawns will be bred and post-larvae raised in water that has not been bio-filtered, it will be essential to make regular water changes in the larval-rearing tanks. Prior to water changes, the larval-rearing tanks should be siphon-cleaned each day. The air supply should be turned off to allow any solid particles to settle on the tank base. The time taken to complete this task should be kept to a minimum to allow the air to be turned back on again. Some larvae may be removed together with solid wastes, and this should be kept to a minimum by using some sort of filtering device. After siphoning, 50% of the water volume should be changed each day. This should begin 3 to 4 days after hatching. Over 50% of the water volume should be changed towards the end of the larval-rearing cycle.
Water hardness (if too low) can be boosted by re-circulating the water over limestone and chalk. The use of an in-tank re-circulation device that operates on an airlift can be very effective and reduces the need for water exchange. This also assists in the reduction of water turbidity, which is useful for visual observation. Sodium bicarbonate should always be on hand to boost alkalinity from time to time if it gets too low (this gets lost if a bio-filter is used through bacterial acidification). If hardness is too high, sodium bicarbonate can offset this as well (Funge-Smith, pers. com.).

A wide variety of feeds can be used to rear the larvae of *M. rosenbergii* including the nauplii of brine shrimp, *moina* spp., fish eggs, squid flesh, frozen *Artemia*, fish flesh, egg custard, worms and compound feeds. However, brine shrimp and other feeds that float in the water column may not be suitable, because the Luang Prabang prawns probably forage for their feed on the tank base rather than rely on chance encounters in the water column. Such benthic feeding habits would probably suit a sinking feed that could be foraged for (Funge-Smith, pers. com.) A sinking aquarium feed, or perhaps *Artemia* flake would be well worth trying at first (Funge-Smith, pers. com.). It is quite likely that the newly hatched PL are carnivorous, but it is recommended to add small amounts of chopped vegetables just in case (Funge-Smith, pers. com.). Watercress may be suitable in addition to ground catfish pellets or commercial prawn feeds. There may be other feeds locally available, and it is recommended to experiment with these over the course of the Project.

After hatching, the PL can be transferred to holding tanks (for a further 1 to 4 weeks) or released into specially prepared ponds. Other feeds such as fish offal or chicken feed can be experimented with. Stocking level in tanks is best at no more than 1000 PL/m² and stocking in ponds can be anywhere between 1000 and 2000 PL/m².

**Growth rate of prawns in ponds**

If breeding of prawns is possible, an attempt should be made to conduct grow-out trials at NLFS and NTFS in the first year (2001). Ponds will need to be selected, pumped dry and prepared, and designated only for prawn research. Samples of post-larvae (200 individuals) should be measured (carapace length) to the nearest millimeter to obtain a mean value, and mean weight estimated by batch weighing before being stocked in grow-out ponds. The stocking density should be 500 PL/m² for the first set of trials. Prawns will be fed commercial *M. rosenbergii* diets throughout the duration of the trials, starting with the pellet sizes recommended for post-larvae and finally for adult prawns. Feeding levels should be estimated based on 6% of total biomass. The prawns should be sampled every 15 days (200 individuals) and new mean lengths and weights estimated. If the prawns achieve reasonable growth, there will be an option to conduct further trials in the second year (2002) to identify 1) optimum feeding levels, and 2) other appropriate non-commercial diets.

**MAIN CONCLUDING REMARKS**

- A prawn fishery has been identified in Luang Prabang Province that is important for local rural and urban economies.
- It is not yet known how many species are involved in the fishery, but there may be 4 or 5 important commercial species.
- The fishery is restricted to the areas where "Bo" are found, and only takes place for some 3 or 4 months per year.
- The fishery does not appear to be under any particular threat and appears to be reasonably self-sustaining. One reason for this may be because the prawns appear to breed outside the main fishing season.
- There remains the possibility that they may have some potential for aquaculture, but nothing is yet known about their fecundity and experimental breeding and grow-out trials will need to be conducted to assess their potential.
- An attempt should be made to identify if "Bo" are found in other parts of the Lao PDR (and if a prawn fishery exists there also). Only then can an assessment be made of the potential for translocation of the Luang Prabang prawns.
List of items, materials and equipment required to conduct research at NLFS and NTFS

- Sensitive chemical balance capable of weighing to at least 0.001g
- Aquaria and air pumps
- Tetra-aquarium water quality test kits
- Various hatchery items such as nets, buckets, trays etc....
- Materials to construct 10 prawn traps
- Commercial prawn diets
- Aquarium feeds and Artemia flake diets

Project duration and research action plan

1. YEAR 2000

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<td>Construct, test and distribute prawn traps to selected villages in LP Province</td>
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<td>Purchase water quality test kits and test water quality in ponds at NLFS/NTFS every month</td>
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2. YEAR 2001
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<th>Main Activities.</th>
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<td>Continue sampling of prawns held in ponds at NLFS / NTFS every 15 days to</td>
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<td>Identify spawning tanks and larval-rearing tanks at NLFS / NTFS and make any</td>
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<td>Establish the most suitable ways to rear larval prawns</td>
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REFERENCES

An investigation into the life-cycle, biology and potential use in aquaculture of selected indigenous freshwater prawns in northern Mekong tributaries of the Lao P.D.R.
An investigation into the life-cycle, biology and potential use in aquaculture of selected indigenous freshwater prawns in northern Mekong tributaries of the Lao P.D.R.

Inception Report

Prepared for

The Living Aquatic Resources and Research Center (LARReC)
Vientiane, Lao P.D.R.

By

Mr. Onideth Souksavat
Mr. Oulaytham Lasasima
Mr. Pa Ney Souriyatmat
Mr. Terry J. Warren

October 2000

Published by the Data & Information Unit,
Living Aquatic Resources Research Center
PO Box 9108, Vientiane, Lao PDR
E-mail: larrec@laonet.net
Background to study

A freshwater prawn fishery has been identified along certain stretches of the Ou, Xuang and Khan Rivers in Luang Prabang Province in northern Lao P.D.R. (see Map). This report summarizes the information currently available on the fishery, based on surveys carried out by Mr. Somboon (LARReC Research Officer), Mr. Oulaytham Lasasima (LARReC Research Officer), Mr. Xaipladeth Choulamany (LARReC Director) and an external advisor, Mr. Terry J. Warren. It’s main purpose is to present a proposal to conduct basic research into the life-cycle, biology and potential use in aquaculture of the most important prawn species associated with the fishery.

Economic importance of the prawn fishery

Whilst relatively unimportant in terms of the national economy, the prawn fishery is of considerable economic significance to the local communities where the prawns are found and caught. Information gathered during surveys suggests that individual fishers may catch between about 2 and 10 kg of prawn per night over approximately a 120 day fishing season. Prawn fishers are required to contribute 60,000K per person, per year to a “village fund”. A trading system operates whereby prawns are bought from villagers by a village middle-person at around 30 to 35,000K/kg (approx. 3.8 to 4.4 $US). The first middle-person then holds the prawns alive in special cages and sells them to a second-level trader. The second-level trader is required to pay tax to the District authorities at around 7,000,000K/year.

Each year, bidding for the second-level trading takes place. The person who gets the bid then has the sole right to distribute the prawns in the Luang Prabang area and can sell them for around 38,000K/kg (approx. 4.8 $US). Prawns sell for around 40 to 50,000K/kg (approx. 5 to 6 $US) in local markets, and around 60,000K/kg (around 7.5 $US) if the prawns are pre-cooked. It has been estimated that approximately 1000 kg of prawn passes through a market in Luang Prabang during the June to September period. However, based on recent interviews, this figure seems somewhat conservative.

Species of prawn

It is not currently known how many prawn species or genera are involved with the fishery. The following initial descriptions provided over page suggest that there may be at least 4 or 5 species involved. Some of these have been identified as belonging to the *Macrobrachium* genus (Funge-Smith, pers. com.) of the Caridean prawn group.

- **Small Prawn (SP)** – a small common species widely distributed throughout the country and known throughout most of Lao PDR and Thailand as “Goong foi”.
- **Mekong Prawn (MP)** – a much larger species of prawn than the one above, and males possess very long second walking legs (periopods) modified into chelae. Males attain a greater size than females and grow to at least 12 cm measured from the tip of the rostrum to the tip of the telson (tail). Adult males appear dark
greenish-grey. Females are lighter coloured. Both sexes become darker just prior to moultng (Souksavat, pers. com.). When observed in tanks, males surround certain females with their chelae and use them to fend off other males. Cannabalism is reported to be a problem in tanks. The species is quite slender, and might be described as not very fleshy. According to local sources, MP does not appear to form an important component of the fishery in the Ou, Xuang and Khan River systems, and may not even be present in those rivers at all. The MP held at Na Luang Fishery Station (NLFS) were caught directly from the Mekong mainstream close to Luang Prabang.

**Blue Prawn (BP)** – a species having a blue colour, short body and legs compared to the Yellow Prawn below. No specimens of this species / type were observed anywhere during a 5-day survey in the Luang Prabang area in mid September 2000.

**Yellow Prawn (YP)** – a species having a yellow / orange colour but with a longer body and walking legs compared with the Blue Prawn above. Likewise, no specimens of this species / type were observed either during the survey mentioned above. Locals in villages along the Ou River refer to this animal as “Goong Si Leung”.

**Orange Prawn (OP)** – a species very similar to the one above, but with distinctly orange legs. No specimens have been observed, and it may become apparent that it is the same species as YP and / or related to sex. Locals in villages along the Ou River refer to this animal as “Goong Fai Mai”.

**Red Head Prawn (RH) and Green Head Prawn (GH)** – both these animals either represent separate species or, more likely, represent the sexes of the same species. RH appears to attain a greater size than GH and has longer second walking legs / chelae. With RH, the top part of the thorax appears reddish, dark red, or almost black in some individuals. With GH, the top of the thorax appears light green. Both RH and GH are important economic components of the fishery in the Ou and the Xuang Rivers at least. They were still being caught in late September 2000. If it established that they are in fact separate species, they appear to co-habit.

**White Prawn (WP)** – Very little information available on this locally reported species / type. Known locally from the Ou River, it is described as less common than other species and is large. Villagers refer to it as "Goong Khao".

**Don Prawn, or Si Don Prawn (DP)** – a comparatively uncommon species and reported from only one village (Muang Ngoi). A long, delicate species (perhaps up to 15 cm in TL) that is considered by locals to live in holes. The local name is “Goong Don” or “Goong Si Don”.

At this initial stage of the investigation, the above are assumed to be separate species and not hybrids. However, it remains to be established if the some types actually represent the same species (possible sexual dichromatism / dimorphism), at different life-cycle stages or observed in different habitats and / or feeding on different dietary items (Funge-Smith, pers. com.). According to New and Singholka (1985), over 100 species of the freshwater prawn genus *Macrobrachium* are known throughout the tropical and sub-tropical regions of the world. Most species require brackish water in the initial stages of their life-cycle although some complete their cycle in inland saline and freshwater lakes and rivers. Some species prefer clear-water rivers whilst others can tolerate highly turbid conditions.
The Macrobrachium species that spend their entire life cycle in freshwater DO NOT hatch as planktonic larvae, such as seen with *M. rosenbergii*. Instead, full development of the post larvae occurs within the egg, and the hatchling is already a post-larvae or juvenile immediately after hatching (Funge-Smith, pers. com.).

**Known prawn habits and the fishery**

The fishery begins around June each year and ends in late September. When the mainstream rivers become very turbid due to heavy rainfall, the prawns move up out of the river into “Bo”. “Bo” are cool, gin-clear streams that issue from caves at the base of riverside hills and mountains. In some instances, the prawns actually enter the caves themselves. These short migrations only take place at night. Local fishers intercept these movements by placing special traps (sai) along the sides and middle of the “Bo”. “Sai” are made from bamboo and are essentially cylinders with a cone entrance. They are set during the late afternoon and prawns are retrieved at dawn. Local villagers claim that prawns only enter “Bo” and do not move up into other streams that carry surface run-off from rainfall. As soon as the turbidity decreases in the mainstream, the prawns move back down out of the “Bo” again.

According to local people, prawns are never seen in reproductive condition (“berried”) during the main fishing season in the wet-season months. This suggests that either the “Bo” fishery targets pre-adult prawns and that spawning habitats have not yet been identified, or that spawning takes place during the dry-season / late wet-season months. In any event, it seems highly unlikely that spawning takes place in the “Bo” and probably takes place in the mainstream itself.

**Initial observations at the Luang Prabang Fishery Station (NLFS)**

Initial stocking trials and observations have been started at the NLFS in Luang Prabang. Yellow and Mekong Prawn have been held and grown in ponds. Yellow Prawn has become sexually mature and has reproduced under these conditions. There is some evidence that Mekong Prawn has reproduced also, but their grow-out size is smaller than wild specimens. Prawns have been raised together with fish using prepared feeds. Separate studies concentrating on prawn monocultures have not yet been carried out at NLFS.
Map of the main survey area in Luang Prabang showing relative positions of towns, villages and rivers.
The September 18 to 22 2000 prawn survey

From September 18 to 22 2000 a survey of the prawn fishery in Luang Prabang Province was carried out by Mr. Oulaytham Lasasima (Research Officer, LARRDeC), Mr Pa-Ney Souriyatmat (Fishery Officer, Laung Prabang) and an external advisor, Mr. Terry J. Warren. The following account describes the itinerary and the main findings of the survey.

September 18

Arrival at Luang Prabang and meetings with Mr. Onidet Souksavat (Chief of Luang Prabang Fishery Station) and Mr. Pa-Ney Souriyamat. Travel by car to Ban Nong Kieo, approximately 140 km north of Luang Prabang and located on the banks of the Nam Ou. Meetings with Mr. Wunsai Pantiwilai (Chief of Nong Kieo Livestock-Fisheries). Overnight in Nong Kieo.

September 19

To the Nong Kieo Agricultural Office to collect Mr. Wunsai. Boat trip up river from Nong Kieo to visit villages where prawns are caught. First “Bo” (Tam rulium) is located approximately 500 m upstream from Nong Kieo. Water issues from a cave right next to the mainstream. Here, 6 “sai” are placed in about 4 or 5 m of water. “Sai” are attached to a lattice-work of bamboo poles. Local people report that approximately 300 to 500 kg of prawn are caught at the site annually. This “Bo” connects with another (Huay khan) where prawns are also caught.

Next “Bo” upstream is “Bo neang” close to Ban Viang Sai. Here, the water is occasionally dirty in the “Bo” and hence there are fewer prawns caught (estimated on average at between 50 and 60 kg per year). Also, the cave from which the “Bo” issues is some 200 to 300 m away from the mainstream. Villagers claim that more prawns are caught in “Bo” that are only a short distance from the mainstream. The Nai Ban, Mr. Siang Khampa explained that prawns have been caught at the site for generations. Mr. Wunsai mentioned that small eggs can be seen on the roots of trees in the mainstream in February and March and he considered these might be prawn eggs. Only small prawns are seen around the shoreline during the dry-season months, and these may possibly be recruits, or perhaps another species. This year, about 200 kg of prawn have been caught. The “Bo” is full of “sai” during the fishing season, with no restrictions on anyone fishing.

The complete list of “Bo” names upstream from Nong Kieo is as follows:

1) Bo tamrulium
2) Bo tamrulium connects with Huay khan
3) Bo neang
4) Bo huay tam hadt pba
5) Huay ngoi ngoi
6) Bo tam gang (connects with Huay ngoi ngoi)
7) Bo huay butt
8) Bo yang mong
9) Bo luang (second most important “Bo”)
10) Bo pa sang
11) Bo pa nok kaw
12) Bo bouam hin
13) Bo pa houat (most important in terms of landings)
14) Bo pa man
15) Bo hay gem
16) Bo pa vee

At Muang ngoi, Mr. Boua ngun (head of prawn fishing group) explained about the different types/species of prawn caught in the area. He claimed that “white prawn” is occasionally seen with eggs in August. He also mentioned another prawn “Goong don” which he described as long and delicate, but not many are caught. He estimated that people can catch approximately 7 kg per person per night. There were village rules in the past regarding the fishery, but no restrictions now. Return to and overnight in Nong Kieo

September 20

Visit to Ban Huay Goong, approximately one hour downstream from Nong Kieo by boat. Here, “Bo huay goong” issues from a small cave about 100 m away from the Nam Ou mainstream. Approximately 300 kg of prawn were caught last year, but landings were higher this year at between 400 and 500 kg. Middle level traders come from Nong Kieo to purchase prawns every 2 or 3 days during the main fishing season in June, July and August. Fishers sell prawns at around 20 to 25,000 K/kg depending on market demand. All 46 families in the village fish for the prawns. Each month, the prawns move up into the “Bo” for a period of about 10 days when the mainstream becomes turbid. Prawn landings then decrease for 3 or 4 days before they start appearing again in large numbers. The Nai Ban, Mr. Tow Oun, thought that the Red Head and Green Head Prawn was the same species; RH are male, and GH are females. Another “Bo” (“Bo pba pun”) is located just upstream from Huay goong.

Final visit was to “Houay gout” just outside Nong Kieo. Here, Huay gout issues from a cave approximately 50 m away from the Nam Houn, a tributary of the Nam Ou. Accounts of prawn behaviour and fishing practices were the same as in all other villages. Return to and overnight in Luang Prabang.

September 21

Visit to Ban Na Pho on the Nam Xuang, a Mekong tributary approximately 50 km north of Luang Prabang. Here, a series of waterfalls enter the Nam Xuang from a number of different caves. “Bo dtat goong” is one of the most important “Bo” for catching prawn at this site. Prawns actually climb up the rock face into the “Bo” current when conditions become turbid in the mainstream. Fishers intercept the movements by placing many “sai” traps in the areas at the base of the cliff. Fishers sell their prawns to a local middle person for approximately 30,000 K/kg. “Bo p boon sakang” is located approximately 20 minutes downstream from Ban Na Pho. Here, prawns enter a cave directly next to the mainstream. According to local people, the prawns begin moving up into the “Bo” in March, or as soon as the Nam Xuang starts to become muddy. Some landings take place all year round at this site, but fishing activities peak in June, July and August. Return to and overnight in Luang Prabang.
Two kilogrammes of live prawns were purchased at Ban Na Pho (Red Head Prawn and Green Head Prawn) and taken back to the Na Luang Fishery Station. One hundred and twenty RH and GH were released into a small pond at NLFS to await further research.

September 22

Meeting at the Na Luang Fishery Station to discuss research priorities and directions. A further 120 prawns (RH and GH) were placed in plastic bags and taken back to Vientiane. Approximately 60 Mekong prawn were also transported. These are now being held in two separate ponds at the Nong Teng Fishery Station to await further research.

Proposed research activities and tentative time schedule

Species identification

Several leading taxonomists have been contacted already with the objective of obtaining positive identifications for the most important prawn species associated with the Luang Prabang fishery. These include Dr. Tyson Roberts (Smithsonian affiliated researcher), Dr. Darrel Siebert (British Natural History Museum) and Dr. Fernando (Waterloo University, Canada). However, this has so far produced no leads regarding a prawn taxonomist capable of providing a positive ID. Mr. Wattana Leelapatra of the Thai DOF suggests that samples be sent to Dr. Chavalit, a leading Thai fish taxonomist. Tyson Roberts has also requested samples. Specimens will be sent shortly. However, we are currently in possession of only 2, or possibly 3, species at present and identification will be an on-going process over the life-time of the Project. Eventually, it should be possible to have good quality photographs, scientific names and preserved specimens. Dr. Funge-Smith suggested obtaining a copy of L. B. Holthuis’s monograph on prawn identification. This may be present at the British Library, and I may be able to obtain information when I visit the UK in November 2000.

A self-sustaining fishery

Based on anecdotal reports and interviews with many local people during the September 18 to 22 survey, there does not appear to be any evidence to suggest that the prawn fishery in the Luang Prabang area is over-fished or in decline. Although landings are variable from year to year, most people did not consider that landings were less now compared to 10 or 15 years ago. One reason for its apparent sustainability may be that the prawns are targeted outside their breeding season, and the spawning habitats are not subject to interference. The fishing season is also comparatively short, and fishing is naturally restricted to only those areas where “Bo” are found. Perhaps even, the distribution of prawns within the whole river system is restricted to those areas where “Bo” are found.

There remains the option to conduct a CPUE study at selected sites during the 2001 fishing season, and this can be discussed amongst all involved with the Project. However, the strict objectives of such a study would need to be agreed on beforehand. One objective might be to collect CPUE data over just one year to act as baseline data for comparison in 5 or 10 years time. However, given that landings
are variable between years, this may not be a worthwhile approach. Alternatively, a
time-series CPUE study over several years might reveal the variability in landings
between years, but would have to take place over perhaps 5 or 10 years if the
objective is to identify drastic declines or increases in the fishery. This would involve
a considerable research effort and costs, and ultimately may not reveal much useful
information. At this point, this report does not recommend a CPUE study. Anecdotal
evidence from local people should be sufficient to identify if catastrophic declines are
taking place within the fishery.

**Natural spawning habitats**

Currently, it is not known exactly where the various species of prawn breed. However, it is quite clear that the prawns do not spawn in the “Bo” as previously hypothesized. In addition, it is also quite clear that the prawns in the Nam Ou, Nam Khan and Nam Xuang do not breed during the main wet-season period from June to September. This leads to the inevitable conclusion that egg development and breeding takes place sometime between September and June, and almost certainly in the mainstream itself. In order to try and identify spawning periods and habitats in the wild, it is suggested that prawn traps be deployed at selected localities and in a variety of habitats with the cooperation of local fishers. A prawn trap will need to be designed (perhaps based on an existing model) and a sampling schedule drawn up. Traps should be deployed every 15 days (approximate moulting period) and any prawns caught should be examined for egg development. A percentage of “berried” females from samples should be able to identify when the main spawning periods are for each species. Simple forms can be used to record data in villages. This same technique can be used for the prawns held in ponds at NLFS (Luang Prabang) and NTFS (Vientiane) to cross-check if the prawns become sexually mature under captive conditions.

**Prawn fecundity**

One of the main constraints to the use of the prawns in aquaculture may be the level of fecundity (Funge-Smith, pers. com.). Therefore, every attempt should be made to record this from the prawns held in ponds and in the wild. There may be differences in fecundity between captive-held and wild prawns. Strictly speaking, fecundity is a measure of the number of live fertilized eggs produced by a female. This is often difficult to measure because fertilization is external in prawns and also fish. Therefore, it is usually necessary to measure the potential fecundity as the best estimate of absolute fecundity. Inevitably, potential fecundity will provide an over-estimate of fertility, but this is probably unavoidable. With certain fish species, the absolute number of eggs produced increases with the age of the fish. This may also be the case with the Luang Prabang prawns. Also, with some fish species, there is a relationship between the fecundity and the length of the fish. This can be described using the following equation; \( F = aL^b \) (where \( F \) = fecundity, \( L \) the length of the fish, and \( a \) and \( b \) are fitted constants). Therefore, an attempt should be made to relate fecundity to some morphometric character of the prawns using regression. Such a relationship may prove useful later on in the research program.

For “berried” prawns retrieved from ponds at NLFS and NTFS, fecundity can be measured in one of two ways. “Berried” prawns should be humanely killed by oxygen starvation, or immersion in iced water. Immediately after death, the prawn should be
blot dried with tissue paper and weighed with eggs intact using a sensitive laboratory balance. Depending on the size of the eggs, they can either be gently removed using tweezers and counted, or batch-weighed to the nearest 0.001g. The counting method is preferable and is the usual method employed for measuring fecundity. The fecundity should be expressed as the numbers of eggs / body weight of female. Alternatively, it may be possible to estimate fecundity by weighing and counting a small sample of eggs, and then multiplying up the number by the total weight of the eggs. An attempt should be made to relate fecundity to an easily measurable morphometric character of the prawn. It is suggested that carapace length be the morphometric character measured using vernier calipers. To attempt to measure total length of the prawn will almost certainly lead to discrepancies and a poor regression relationship. The above data should also be able to identify approximately at what size each prawn species become sexually mature.

Semi-artificial propagation and larval-rearing of prawns

If the prawns are able to reach sexual maturation in ponds, an attempt will be made to spawn them under semi-artificial conditions in tanks and aquaria at NLFS and NTFS. Because there is presumably no previous literature published on breeding and raising the Luang Prabang prawn species, wherever possible, methods and techniques should be employed as for raising *M. rosenbergii* in the first instance. Such methods can be modified later in the light of experience gained in the first year. Perhaps the best approach will be to follow some of the methods and techniques provided in New and Singkhola’s 1985 “Freshwater prawn farming” FAO / UN manual. Rather than re-present large sections of the manual here in this report, only some of the main points taken from the report are given below:

- Suitable tanks should either be purchased or identified at both NLFS and NTFS. Rectangular concrete tanks may be suitable, or purchased round plastic tanks. Fiber-glass tanks are suitable if already available, but it is not recommended to purchase them, as plastic tanks are more suitable (Leelapatra, pers. com.). The post-larvae stage of the Luang Prabang prawns may prefer a flat-bottomed raceway type tank, which may be circular or rectangular (Funge-Smith, pers. com.).
- As the reproductive work in the first year will be mainly experimental, almost any volume of tank will be suitable (2 to 10m$^3$). Smooth sides and bases will be essential for a healthy environment and ease of cleaning. A turn-down drain protected by a filter sock is essential to prevent loss of post-larvae during water changes. Moderate aeration via a system of perforated PVC pipes is recommended over air-stones. If the aeration is too vigorous, the PL may have some difficulty in catching hold of their food. This may result in excessive cannibalism (Funge-Smith, pers. com.). Tanks for holding post-larvae should also have similar characteristics to the tanks described above.
- It may prove useful to have some “hide” material in the tanks to reduce cannibalism at the PL stage. Blue nylon panels, small bits of PVC pipe or bamboo may be suitable, especially during the moulting period (Funge-Smith, pers. com.).
- An oil free blower supplying high volume, low-pressure air supply is preferred over a compressor.
- If “berried” prawns are caught during regular 15 day sampling with castnets, a small number (depending on apparent fecundity) should immediately be placed in
the spawning tank. Perhaps no more than 3 or 4 “berried” females should be 
used to begin until experience is gained. No males should be required, as it 
is assumed fertilization will have taken place in the pond. It is essential to obtain 
“berried” females that are at the same stage of ripeness to prevent cannibalism 
amongst newly hatched post larvae. With *M. rosenbergii* this can usually be 
achieved by observing the colour of the eggs (grey or black are ripe and orange 
are immature). It is not yet known if egg development is accompanied by colour 
changes with the Luang Prabang prawns. With *M. rosenbergii*, hatching will take 
place within 2 or 3 days if females are selected with grey or black eggs. It is quite 
likely that the hatching period for the Luang Prabang prawns will be considerably 
longer, because complete egg development will have taken place within the egg 
membrane (Funge-Smith, pers. com.). However, the exact hatching period 
remains to be established through observation. “Berried” females should NOT be 
fed during the pre- and post spawning period. Egg hatching may take place at 
night, as with *M. rosenbergii*. Hatching can be detected by the presence of larvae 
in the tank and absence of eggs underneath the female. Females should be 
removed immediately after spawning has taken place.

- Many changes in water quality in the larval-rearing tank will take place and are 
  not visible with the naked eye. These are mainly due to the metabolic wastes 
  produced by the larvae (and live food organisms) and the degradation of excess 
  food. The most serious potential toxins are non-ionized ammonia, which is 
  especially evident at high pH, and nitrite. Water hardness can also be a problem 
  with *M. rosenbergii* (Funge-Smith, pers. com). *M. rosenbergii* prefers a water 
  hardness of between 50 and 150 ppm as calcium carbonate. Funge-Smith (pers. 
  com.) recommends regular checking of water hardness, pH, alkalinity, ammonia 
  and nitrite levels in ponds at NLFS and NTFS and also in larval-rearing tanks 
  using TETRA-AQUARIUM water quality test kits.

- Because, in the first year at least, the prawns will be bred and post-larvae raised 
  in water that has not been bio-filtered, it will be essential to make regular water 
  changes in the larval-rearing tanks. Prior to water changes, the larval-rearing 
  tanks should be siphon-cleaned each day. The air supply should be turned off to 
  allow any solid particles to settle on the tank base. The time taken to complete 
  this task should be kept to a minimum to allow the air to be turned back on again. 
  Some larvae may be removed together with solid wastes, and this should be kept 
  to a minimum by using some sort of filtering device. After siphoning, 50% of the 
  water volume should be changed each day. This should begin 3 to 4 days after 
  hatching. Over 50% of the water volume should be changed towards the end of 
  the larval-rearing cycle.

- Water hardness (if too low) can be boosted by re-circulating the water over 
  limestone and chalk. The use of an in-tank re-circulation device that operates on 
  an airlift can be very effective and reduces the need for water exchange. This 
  also assists in the reduction of water turbidity, which is useful for visual 
  observation. Sodium bicarbonate should always be on hand to boost alkalinity 
  from time to time if it gets too low (this gets lost if a bio-filter is used through 
  bacterial acidification). If hardness is too high, sodium bicarbonate can offset this 
  as well (Funge-Smith, pers. com.).

- A wide variety of feeds can be used to rear the larvae of *M. rosenbergii* including 
  the nauplii of brine shrimp, *moina* spp., fish eggs, squid flesh, frozen *Artemia*, fish 
  flesh, egg custard, worms and compound feeds. However, brine shrimp and other 
  feeds that float in the water column may not be suitable, because the Luang 
  Prabang prawns probably forage for their feed on the tank base rather than rely
on chance encounters in the water column. Such benthic feeding habits would probably suit a sinking feed that could be foraged for (Funge-Smith, pers. com.) A sinking aquarium feed, or perhaps Artemia flake would be well worth trying at first (Funge-Smith, pers. com.). It is quite likely that the newly hatched PL are carnivorous, but it is recommended to add small amounts of chopped vegetables just in case (Funge-Smith, pers. com.). Watercress may be suitable in addition to ground catfish pellets or commercial prawn feeds. There may be other feeds locally available, and it is recommended to experiment with these over the course of the Project.

- After hatching, the PL can be transferred to holding tanks (for a further 1 to 4 weeks) or released into specially prepared ponds. Other feeds such as fish offal or chicken feed can be experimented with. Stocking level in tanks is best at no more than 1000 PL / m² and stocking in ponds can be anywhere between 1000 and 2000 PL / m².

**Growth rate of prawns in ponds**

If breeding of prawns is possible, an attempt should be made to conduct grow-out trials at NLFS and NTFS in the first year (2001). Ponds will need to be selected, pumped dry and prepared, and designated only for prawn research. Samples of post-larvae (200 individuals) should be measured (carapace length) to the nearest millimeter to obtain a mean value, and mean weight estimated by batch weighing before being stocked in grow-out ponds. The stocking density should be 500 PL/m² for the first set of trials. Prawns will be fed commercial M. rosenbergii diets throughout the duration of the trials, starting with the pellet sizes recommended for post-larvae and finally for adult prawns. Feeding levels should be estimated based on 6% of total bio-mass. The prawns should be sampled every 15 days (200 individuals) and new mean lengths and weights estimated. If the prawns achieve reasonable growth, there will be an option to conduct further trials in the second year (2002) to identify 1) optimum feeding levels, and 2) other appropriate non-commercial diets.

**Main concluding remarks**

- A prawn fishery has been identified in Luang Prabang Province that is important for local rural and urban economies.
- It is not yet known how many species are involved in the fishery, but there may be 4 or 5 important commercial species.
- The fishery is restricted to the areas where “Bo” are found, and only takes place for some 3 or 4 months per year.
- The fishery does not appear to be under any particular threat and appears to be reasonably self-sustaining. One reason for this may be because the prawns appear to breed outside the main fishing season.
- There remains the possibility that they may have some potential for aquaculture, but nothing is yet known about their fecundity and experimental breeding and grow-out trials will need to be conducted to assess their potential.
- An attempt should be made to identify if “Bo” are found in other parts of the Lao PDR (and if a prawn fishery exists there also). Only then can an assessment be made of the potential for translocation of the Luang Prabang prawns.
List of items, materials and equipment required to conduct research at NLFS and NTFS

- Sensitive chemical balance capable of weighing to at least 0.001g
- Aquaria and air pumps
- Tetra-aquarium water quality test kits
- Various hatchery items such as nets, buckets, trays etc....
- Materials to construct 10 prawn traps
- Commercial prawn diets
- Aquarium feeds and Artemia flake diets

Project duration and research action plan

1. YEAR 2000

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<td>Obtain positive identification for prawn species currently held at NLFS / NTFS</td>
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<td>Begin sampling of prawns held in ponds at NLFS / NTFS every 15 days to identify spawning period</td>
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<td>Construct, test and distribute prawn traps to selected villages in LP Province</td>
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<td>Purchase water quality test kits and test water quality in ponds at NLFS / NTFS every month</td>
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2. YEAR 2001

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<tr>
<td>Continue sampling of prawns held in ponds at NLFS / NTFS every 15 days to identify period</td>
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<td>Continue to test water quality in ponds at NLFS / NTFS every month</td>
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<td>Visit Luang Prabang to assess results of the wild prawn sampling by villagers</td>
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<td>Revisit “prawn” villages in Luang Prabang and attempt to obtain all species of prawn caught. Photography / preserve specimens and produce a short illustrated guide to prawn ID</td>
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<td>Identify spawning tanks and larval-rearing tanks at NLFS / NTFS and make any modifications necessary</td>
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<td>If prawns are found in “berried” condition at NLFS / NTFS, attempt to breed the prawns</td>
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<td>Establish the most suitable ways to rear larval prawns</td>
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<tr>
<td>If breeding has been successful and post-larval prawns are available, begin grow-out trials at NLFS / NTFS</td>
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<td>Complete mid- Project report and with the aid of experience, provide direction for further research in year 2002</td>
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