Summary

This thesis provides new information on various aspects of *Artemia* biomass production in solar salt ponds in the Mekong Delta, Vietnam, more specifically on culture techniques, drying methods and its applications for target aquaculture species.

With the aim to optimize *Artemia* biomass production in the salt ponds (chapter 3), firstly we evaluated different harvesting strategies on *Artemia* biomass production; the results showed that the highest biomass yield was achieved when using a 3-days harvesting interval, i.e. 17%, 31% and 39% higher compared to the 1-day, 6-days and 9-days harvesting frequencies, respectively. Hence, partial harvest of *Artemia* biomass done every 3 days seems to be an appropriate strategy to enhance biomass productivity in the Mekong delta salt ponds (Section I). Secondly, the effect of different supplemental feeds on the production and quality of *Artemia* biomass was assessed. The results illustrated that different supplemental feeds had a significant effect on growth and total yield, but did not affect the proximate composition of the *Artemia* biomass. *Artemia* ponds supplied with pig manure alone or in combination with rice bran or soybean meal as supplemental feeds gave significantly higher biomass yields compared to the control, only receiving green water as natural food. Our results show that the co-supplementation of pig manure and rice bran or soybean meal can be applied for culture of *Artemia* in salt ponds (Section II). Furthermore, we investigated the effect of different ratios of N:P on primary productivity, combined with feeding strategies for *Artemia* biomass production in salt ponds. The results revealed that when applying ratios of N:P=5 and 10 in the fertilization pond, the chlorophyll a concentration and algal composition was similar. Bacillariophyta (diatoms) were the dominant group over the sampling period. When using this green water combined with rice bran or pig manure for rearing *Artemia*, the result illustrated that total biomass yields in the N:P=5 treatment were better than in the N:P=10 treatment but not statistically different at P=0.05. An economic analysis showed that higher profits could be obtained by using the N:P=5 ratio to produce green water as natural food and pig manure as feed supplement for production of *Artemia* biomass in salt ponds (Section III).

Investigation of drying methods for *Artemia* biomass was performed to find out an appropriate drying method in terms of economic aspects and product quality (chapter 4). A thin layer of *Artemia* biomass dried by outdoor sun drying was compared with three indoor drying techniques namely convective hot air drying (HA), intermittent microwave
combined with convective hot air drying (MWHA) and oven drying at temperatures of 50, 60 and 70°C. The results showed that among the three indoor drying techniques, the shortest drying times were observed in MWHA followed by HA and oven drying, respectively, while sun drying showed the longest dehydration times compared to other drying methods. Moreover, the drying time decreased with increasing temperature. Overall, for the three indoor drying methods total lipid content and fatty acid profile of the dried Artemia in most cases was not significantly different from the frozen Artemia (control). Although sun drying resulted in significant reductions of these nutrients, it is much less energy consuming. The intermittent MWHA drying is a promising technique, which could produce high quality dried products in short drying times. However, it may not be appropriate for large-scale application in the coastal area of the Mekong delta because of high capital investment and operating costs (Section I). Therefore, another experiment was conducted to compare the performance of convective solar drying with open sun drying for Artemia biomass under various weather conditions in the South of Vietnam. The results indicated that when drying Artemia biomass on sunny days or days with sunny intervals, the drying time was substantially reduced with 45% and 25%, respectively, compared to open sun drying. However, on cloudy/rainy days the reduction was only 7%. Generally, total lipid content, lipid class composition and fatty acid profile was better in solar-dried Artemia than in sun-dried Artemia samples. This preliminary work has proven that the use of a natural convective solar drier for drying Artemia biomass can be a cheap and easily adoptable method for farmers at household level, which could produce an acceptable quality of dried Artemia (Section II).

The use of different Artemia biomass preparations as feeds in the larviculture and nursery phases was also investigated for a few important cultured species in the Mekong delta (Chapter 5). A first study evaluated the effect of formulated feeds containing fresh or dried Artemia biomass as live food supplement in the larval rearing of black tiger shrimp, Penaeus monodon (Section I). We found that the time of metamorphosis of the shrimp larvae in the different stages was the same and shrimp survival in all developmental stages showed no statistical differences among feeding treatments (P>0.05). Nonetheless, postlarval performance in the combination treatments (commercial INVE feed and Artemia-based formulated diets) were better or equal compared to those fed commercial feed alone as seen by the better growth rate and higher resistance to formalin stress. The results
indicate that feed containing fresh or dried *Artemia* can partially supplement live feeds for larval rearing of *P. monodon*.

A second study dealt with the effect of fishmeal replacement with *Artemia* biomass as protein source in practical diets for the giant freshwater prawn *Macrobrachium rosenbergii*. Nine experimental diets were formulated by replacing 0, 25, 50, 75 and 100% of the fishmeal protein in a standard diet with either dried or frozen *Artemia* biomass. In the 0% *Artemia* treatment, Peruvian fishmeal was the main protein source. Results demonstrated that survival and growth performance of prawn PL were enhanced with increasing dietary *Artemia* protein inclusions. It can be suggested that *Artemia* biomass may totally replace fishmeal in practical diets for PL of the prawn *M. rosenbergii* (Section II).

Furthermore, the use of different forms of *Artemia* was tested as feed for mud crab, *Scylla paramamosain*. Instar 1 crablets were reared both individually and communally. Data on survival and growth suggested that crab performance decreased in the order: live *Artemia>*frozen *Artemia>*fresh shrimp meat>dried *Artemia*-based formulated diet. Our findings illustrate the high potential for local utilization of *Artemia* biomass in Vietnam for reliable production of mud crab juveniles (Section III).

In the following, feeding trial *Artemia* biomass was evaluated for fingerlings of the goby *Pseudapocryptes elongatus*. The results proved that survival of the goby was not affected by the feeding treatments. The goby fed the fishmeal control diet and the commercial feed had a similar growth performance (mean final body weight, weight gain, specific growth rate) and feed utilization (total feed intake, feeding rate, feed conversion ratio, feed efficiency and protein efficiency ratio). Both were however significantly poorer compared to the groups fed dried *Artemia* and the groups fed the *Artemia* based-diets from the 50% replacement level onwards. This suggests that both dried *Artemia* and *Artemia* based-diets can be used for feeding goby *P. elongatus* fingerlings (Section IV).

All the feeding trials in the current study demonstrated that *Artemia* biomass can be used either as direct feed or as ingredient in formulated feeds. Moreover, valorisation of *Artemia* biomass for local commercial culture of fish or shrimp could enhance the income of *Artemia* producers and contribute to reduce the reliance on fishmeal in aquafeeds, which is of high socio-economic relevance in the Mekong delta, Vietnam.
The knowledge obtained through this thesis work could contribute to the optimization of *Artemia* pond production and a more sustainable development of *Artemia* farming, leading to a better understanding of the drying methods for *Artemia* biomass, and to the development of applications of *Artemia* biomass in the culture of aquaculture species in the region.