UNIVERSITI PUTRA MALAYSIA

THE ROLE OF THE MICROFLORA AND MICROFAUNA COMMUNITIES IN THE PRODUCTION OF UDANG GALAH (Macrobrachium rosenbergii (de Man) JUVENILES USING THE 'MODIFIED STATIC "GREEN-WATER" SYSTEM'

NG CHEE KIAT

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By

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DEDICATION

This work is dedicated to the many researchers in the country whose works have not been given due recognition, for the many hours spent in the laboratory and in the field to provide the country with solutions to a better life.

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Abstract of thesis submitted to the Senate of Universiti Pertanian Malaysia in fulfilment of the requirements for the Degree of Master of Science.

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Chairman : Professor Dr. Ang Kok Jee

The `modified static "green-water" system' for the production of udang galah juveniles was developed by Ang and Cheah (1986). However, studies on the microbial community are scant. Therefore, experiments were conducted to study the functioning of the `modified static "green-water" system' with respect to the microflora and microfauna community and the effect of light intensity on the system. Four series of experiments were conducted at various light intensities to study the effect of light intensity on the system with respect to community structure. Experiments were conducted for the duration of the larviculture period which ranged from 20 to 25 days. Results were compared using Morosita's index of similarity. Community structure for both the planktonic as well as sedentary communities were not seen to be affected by different light intensities. Change in community structure over time was more evident in planktonic communities as compared with the periphyton or epizoic communities. *Chlorella sp*. was found to be dominant in the phytoplankton community throughout the experimental period. In the epizoite community, *Vorticella sp*. was found to be dominant in the first week of culture while ciliates were dominant after the first week. For the zooplankton community, the later stages being dominated by the ciliate *Euplotes sp*. and the rotifer *Colurella sp*.. The dominant group in the periphyton community was the blue-green algae *Anacystis sp*. and the diatom *Cymbella sp*. while in the epizoite community, *Vorticella sp*. the stalked ciliate was dominant in the early period of experiments, followed later by *Euplotes sp*. and *Colurella sp*.. The phytoplankton group appears to be dependent on the dominant phytoplankton in the "green-water". Prawn larvae cultured in the absence of light did not survive past the second week of culture. Effect of the microflora and microfauna community on the growth and survival of the prawn larvae was not apparent except at zero light intensity.

Abstrak tesis yang dikemukakan kepada Senat Universiti Pertanian Malaysia sebagai memenuhi keperluan untuk ijazah Master Sains

ROL KOMUNITI MIKROFLORA DAN MIKROFAUNA DALAM PENGELUARAN BENIH UDANG GALAH DENGAN CARA `SISTEM MODIFIKASI "AIR-HIJAU" STATIK'

Oleh

NG CHEE KIAT

Januari 1995

Pengerusi: Professor Dr. Ang Kok Jee

Sistem pengeluaran benih udang galah secara `sistem modifikasi "air-hijau" statik' dimajukan oleh Ang dan Cheah (1986). Malahan, kajian ke atas komuniti mikrobe tidak banyak yang telah dijalankan. Beberapa kajian telah dibuat untuk memahami lagi `sistem modifikasi "air-hijau" statik' dari segi komuniti-komuniti mikroflora dan mikrofauna dan juga kesan keterikan matahari ke atasnya. Empat kajian telah dijalankan untuk tujuan tersebut. Kajian dijalankan dari masa telur menetas sehingga rega-rega udang menjadi post-larva iaitu selama 20 hingga 25 hari. Keamatan cahaya yang berbeza tidak mengubah struktur komuniti mikroflora dan mikrofauna . Keputusan dibanding dengan menggunakan indeks Morosita untok kesamaan. Perubahan komuniti mengikut masa lebih nyata dalam komuniti

terapung (planktonic) dari komuniti terlekat (sedentary and attached). Chlorella sp. didapati dominan dalam komuniti fitoplankton untuk seluruh jangka masa kajian. Dalam komuniti epizoit, Vorticella sp. didapati dominan pada minggu pertama kajian. Dalam komuniti zooplankton pada tahap akhir kajian didapati didominasi oleh Euplotes sp. dan Colurella sp. Kumpulan yang dominan dalam komuniti perifiton adalah Anacystis, sejenis alga jenis biru-hijau dan Cymbella iaitu sejenis diatom manakala dalam komuniti epizoit, Vorticella, sejenis ciliata didapati berpengarug pada tahap awal kajian dan diikuti oleh Euplotes dan Colurella. Komuniti fitoplankton didapati dipengaruhi oleh jenis fitoplankton yang dominan semasa tumbesaran "greenwater". Rega udang yang dipelihara dalam tangki tanpa cahaya didapati tidak hidup lebih dari dua minggu. Kesan komuniti mikroflora dan mikrofauna ke atas tumbesaran rega udang galah tidak nyata dilihat selain daripada keadaan tanpa cahaya.

CHAPTER 1

INTRODUCTION

The culture of the Giant Malaysian Freshwater Prawn (*Macrobrachium rosenbergii*, de Man) possesses a great potential for development worldwide (Rabanal, 1982; Sandifer *et al*., 1976; Sidthimunka and Bhukaswan, 1982; Suharto *et al*., 1982). In Malaysia because of its high retail value of up to M$16.50 per kilogram (Anon, 1987) as well as a high growth rate (Wickins, 1982), the Department of Fisheries has in fact earmarked this prawn, also known as the `udang galah', for development in aquaculture in the country (Ong, 1984). The process is however slow as nationwide production only increased by about 10 metric tonnes in two years, being at 68 metric tonnes in 1984 (Anon, 1984) and 78 metric tonnes in 1986 (Anon, 1986). This is in part due to inconsistent seed supply accompanied by a high price of post-larvae.

Larviculture of udang galah first achieved success worldwide at the Fisheries Research Institute in Penang, Malaysia (Ling and Merican, 1961).

Mass culture methods were subsequently developed by various workers including Fujimura (1966), Lee (1982) as well as Aquacop (1983). It has been shown that production of post-larvae does not differ very much between different larviculture systems (Menasveta and Piyatiratitivokul, 1980; Ang et al., 1990; Ang, 1995).

Ang and Cheah (1986) developed a larviculture system which allowed for less labour requirements called the `modified-static "green-water" system'. This system works on the principle that algae acts as a removal agent for toxic wastes like ammonia and nitrite, thereby the need for "green-water". This system has the advantage of production costs as low as M$10.00 per 1000 juveniles (Ang, pers. comm.).

Despite the advantages of the `modified static "green-water" system', very little literature is available about the microbial ecosystem which is present in the culture system. Also bearing in mind the importance of light in the functioning of the `modified static "green-water" system', the following objectives were set for this thesis.

1. To study the ecological succession of both the microfloral and microfaunal communities in the udang galah (Macrobrachium rosenbergii de Man) larviculture tanks and the roles they play in the environment.

2. To determine the effect of light intensity on the community development in the larviculture tank and its effect on post-larval production of udang galah and

3. To determine the growth rates of the larvae of the udang galah through analysis of the developmental stages of the larvae.

CHAPTER 2

LITERATURE REVIEW

"Green-water" as the term implies, is water that is predominantly rich with green algae of the Order Chlorophyceae. The main groups of algae present in the `modified static "green-water" system' are Chlorella sp., Scenedesmus sp. and also Chlorococcus sp.. The zooplankton community is believed to be dominated by rotifers (Ang, pers. comm.). The method employed in production of "green-water" is given in Appendix A. The principle is a continuous addition of nutrients together with constant aeration in order to ensure the water column has sufficient nutrients available for the continued growth of the algal populations.

Community development and successional patterns

In an ecosystem there will be some species which are more abundant than others. This is known as dominance and may be due to physical, chemical or biological factors (Hutchinson, 1967). Succession refers to a situation where there is a directional change in species dominance. Walker (1987) considers succession as a continuum from early stages where factors governing colonisation are most important, to late stages where factors governing senescence and mortality predominate. Disturbance generally prevents the community reaching the senescent stage. Reynolds et al., (1983) used the term "perturbation" for disturbance in plankton studies.

Biological factors

Biological factors responsible for species dominance are usually the result of species interaction. This may be due to competition amongst species for food and space (Odum, 1971) or it may be due to predation of one species on another (Rees, 1979). Examples of biologically related successional patterns or community changes are as reported by Dunn (1970). Biological interactions also occur between organisms from different communities (Roeder, 1977) but are usually more pronounced between trophic levels (Blazka et al., 1980).

Physico-chemical factors

The majority of successional and community change patterns that take place is a result of physico-chemical parameters (Prowse and Talling, 1958; Anderson, 1970; Hurlbert et al., 1972; Trimbee and Harris, 1984; Ashton, 1985; ; Gasith and Perry, 1985). The factors which affect species domination are light, temperature, chemicals, density, pressure and salinity (Odum, 1971; Bornefeld and Simonis, 1974).

Light

Light plays a very important role in the development of any plant community because of its role in the photosynthetic process.

Green algae was found to perform better than dinoflagellates at low light intensities while diatoms prefer an intermediate light intensity (Parsons et al., 1984b). Matthern et al., (1969), Quaraishi and Spencer (1971), Bader et al. (1976) and Young and King (1980) have also demonstrated the effect of light intensity on algae dominance. Corner and Davies (1971) showed that ammonia uptake in the dark was only 60% of the uptake rate in light while Dunaliella tertiolecta (Butcher) assimilated nitrite 20 times faster in the light than in darkness (Grant, 1967).

Excessive light can inhibit the growth of Chlorella (Flik, 1985). High light intensities can also increase uptake rates of phosphate (Kuhl, 1962). Syrett (1962) however showed that there was an inverse relationship between light intensity and the chlorophyll a content.

Plankton blooms in the natural environment are usually the result of favourable nutrient levels (Brockmann et al., 1977). The effect of nutrients on species domination has also been shown by Mickelson et al. (1979).

Phosphate is assimilated by algae directly in the form of orthophosphate which can be stored in the algae (Golterman and Kouwe, 1974). As a result of the storage capabilities, the uptake rate of phosphate is affected by its concentration in the water (Suttle and Harrison, 1986). The uptake of phosphate can also be affected by the availability of carbon dioxide (Young and King, 1980).

Algae are capable of utilising both ammonia and nitrate as its nitrogen source with ammonia being preferred in most cases (Morris, 1974). This is due to the fact that ammonia suppresses the synthesis of nitrate reductase, an enzyme essential for nitrate utilization by algae (Stewart, 1980). Some algae however exhibit a change in their preference of the nitrogen source as shown for Chlorella where ammonia is preferred in the earlier growth period and nitrate in the later growth period (Dvoradkova-Hladka, 1971).

Biology of the Udang Galah larvae

Water quality requirements

The larvae require brackish-water to complete its larval stages (Ling, 1969) cannot survive beyond five days in freshwater (Kurian and Sebastian, 1976). Uno and Kwon (1969) identified 11 developmental stages of the larvae (See Appendix F) from the egg till the post-larvae stage i.e., when the larvae lose their planktonic nature. The larvae is euryhaline, being able to withstand gradual changes in salinity from 3 ppt up to 21 ppt without much problems (Fujimura, 1966).

Their temperature tolerance is between 24°C and 32°C for optimum growth rates (Ling and Costello, 1976). pH values between 7.0 and 8.0 usually do not present problems to the larvae (Ling and Costello, 1976; Kurian and Sebastian, 1976). Ammonia toxicity to the larvae is reported to be at 0.6 ppm (Cohen et al., 1976) while nitrite was sublethal at 1.8 ppm (Armstrong et al., 1976).

Food and feeding habits

Various workers have studied the diets of prawn larvae especially using live feeds (Anderson and Smith, 1983). The larvae only starts feeding after metamorphosis into the second zoea or stage II larvae (Choudhury, 1971) and feed continuously on particulate food as long as it is available (Ling, 1969). Moller (1978) showed that the larvae will grasp particles of suitable size that it comes in contact with and does not actually have any particular preference for live food.

The importance of algae in the development of crustacean larvae has been shown by various workers (Broad, 1957; McConnaugha, 1985; Fox, 1983; Sandifer, 1972).

In fact, algae cultures are a key nutritional factor in the culture of penaeid larvae (Liao and Chao, 1983). Cohen *et al*. (1976) showed that the larvae ingests negligible amounts of algae. Maddox and Manzi (1976) however found that algal supplements added to larviculture tanks improved growth rates as well as survivability. Wickins (1972) however suggested that algae could get into the diet of the prawn larvae indirectly through the *Artemia* nauplii. Joseph (1977) suggested that the larvae may be able to utilize essential water soluble trace compounds from the algal diet.

The larvae has been successfully cultured on food organisms such as microcrustaceans including *Moina* sp. (Aniello and Singh, 1982) and *Artemia* (Biddle, 1977); minced cockle (*Anadara granosa*) (Lee, 1982); fish flesh, roe or chicken egg custard (Malecha, 1983); squid flesh and worms (New and Singholka, 1982).

Larvae ecology

In nature, the eggs are released near river mouths or estuaries. The eggs on hatching into larvae are planktonic and tend to aggregate in the earlier larval stages and are phototactic in nature (Ling, 1969).