UNIVERSITI PUTRA MALAYSIA

SOME ASPECTS OF THE NUTRITIONAL REQUIREMENTS AND MANAGEMENT OF LAMPAM JAWA, *PUNTIUS GONIONOTUS* (BLEEKER), BROODSTOCK

S. PATHMASOTHY

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by

S. PATHMASOTHY

Dissertation Submitted in Fulfilment of the Requirements for the Degree of Doctor of Philosophy in the Faculty of Fisheries and Marine Science, Universiti Pertanian Malaysia.

February 1996

UPM

DEDICATION

This study is dedicated to:

my wife, Ashta Letchumi
my son, Arvind
my daughter, Sumitra

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SOME ASPECTS OF NUTRITIONAL REQUIREMENTS AND MANAGEMENT OF LAMPAM JAWA, *PUNTIUS GONIONOTUS* (BLEEKER), BROODSTOCK

by

S. PATHMASOTHY

FEBRUARY 1996

Chairman : Professor Law Ah Theem, Ph.D.

Faculty : Fakulti Perikanan dan Sains Samudera

The reproductive patterns, optimum level of protein and fat in the diets in regulating oocyte development and the carrying capacity of spent *Puntius gonionotus* broodstock in ponds were studied. In experiment 1, the culture of fish of the same age in 40 m^2 earthen ponds with stocking rates of 2,500, 5,000, 10,000 and 20,000 fish/ha for a duration of 5 months resulted in establishing distinct populations of same age but of different sizes. Utilizing similar populations from 400 m^2 ponds, macroscopic observations indicated that *P. gonionotus* attained first sexual maturation when 5 months old at a critical size of 190 g. Carcass analysis of the fish indicated that sexual maturation only occurs when an adult physiological profile is attained. The faster

growing fish attained adult physiological profile much earlier than the slower growing fish.

The second experiment determined the pattern of vitellogenesis and consecutive gonadal development of the spent broodstock in 40 m^2 earthen ponds . The required 50 spent females in each of the four trials were acquired by induce breeding all the fish simultaneously. GSI increments from these trials indicated that the same female could be spawned every 5 weeks. Based on changes in the HSI values, it indicated that the liver plays a major role in vitellogenesis and gonadal recrudescence which required 6 weeks. During this process, proximate analysis of the developing gonads indicated that, in terms of quantity, protein is required in the largest amount followed by fat, carbohydrate and minerals. Carcass analysis of the fish during this period indicated that there was no mass transfer of nutrients from the somatic components to the gonads during vitellogenesis and gonadal recrudescence. This suggested that all nutrients required for vitellogenesis and gonadal recrudescence were acquired directly from feed consumed

The third experiment on determination of protein requirement for oocyte development was conducted in 500-liter fiberglass tanks with 6 spent females per tank and 4 tanks or replicates to each treatment. The fish were fed ad libitum for a duration of 5 weeks using diets with variable protein levels of 17, 25 and 32% with a constant 6% fat level. Results indicated that 32% protein was critical for both somatic as well as reproductive growth.

The fourth experiment on evaluation of fat requirement for oocyte development was also conducted in similar fibreglass tanks with 6 spent females per tank and 4 tanks or replicates to each treatment. The fish were fed ad libitum for a duration of 5 weeks using diets with variable fat levels of 6, 9 and 12% with a constant protein level of 32%. Results indicated that a low fat level of 6% was sufficient for gonadal development while high levels of 9 and 12% were detrimental.

The last experiment was conducted in earthen ponds to determine the optimum carrying capacity of spent females which resulted in the availability of consecutive spawners within a period of 5 weeks. The spent females were stocked at rates of 2,500, 5,000 and 10,000 fish/ha in 40 m^2 ponds. Results indicated that the carrying capacity should not exceed 2,500 fish/ha based on high GSI increments and survival of the broodstock.

Abstrak disertasi yang dikemukakan kepada Senat Universiti Pertanian Malaysia sebagai memenuhi keperluan untuk mendapat Ijazah Doktor Falsafah

BEBERAPA ASPEK KEPERLUAN PEMAKANAN DAN PENGURUSAN INDUK LAMPAM JAWA, *PUNTIUS GONIONOTUS* (BLEEKER)

oleh

S. PATHMASOTHY

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Pengerusi : Profesor Law Ah Theem, Ph.D.

Fakulti : Fakulti Perikanan dan Sains Samudera

Ketentuan pola reproduksi, tahap optimum protin dan lemak dalam diet untuk mengawalatur perkembangan oosit dan kadar daya muatan induk *Puntius gonionotus* dalam kolam dikaji. Dalam kajian pertama, kultur ikan yang sama umurnya dalam kolam seluas 40 m^2 dengan kadar penebaran 2,500, 5,000, 10,000 dan 20,000 ikan/ha selama 5 bulan menghasilkan populasi yang begitu ketara di mana umurnya sama tetapi saiznya berbeza-beza. Penggunaan populasi yang sama dari kolam 400 m^2 menunjukkan *P. gonionotus* mencapai kematangan seksual yang pertama pada umur 5 bulan pada saiz 190 g. Analisa karkas ikan tersebut menunjukkan kematangannya seksual bermula apabila profil fisiologi dewasa tercapai. Profil fisiologi dewasa pada ikan dicapai terlebih awal untuk ikan yang menunjukkan pertumbesaran yang lebih cepat.

Kajian kedua menentukan pola vitelogenesis dan perkembangan gonad berturutan pada induk yang sudah bertelur di dalam kolam seluas 40 m^2. Lima puluh induk betina yang sudah bertelur yang diperlukan dalam tiap-tiap 4 percubaan dihasilkan melalui pembiakan aruhan ke atas semua ikan secara serentak. Peningkatan GSI daripada percubaan ini menunjukkan induk betina yang sama boleh membiak setiap 5 minggu. Perubahan nilai HSI menunjukkan organ hati memainkan peranan penting dalam vitelogenesis dan perangsangan gonad yang memerlukan 6 minggu. Ketika proses ini, analisa proksimat atas perkembangan gonad menunjukkan pada dasar kuantiti, protein lebih diperlukan, seterusnya lemak, karbohidrat dan galian. Analisa karkas semasa peringkat ini tidak menunjukkan perpindahan nutrien yang banyak daripada komponen somatik ke gonad semasa vitelogenesis dan perkembangan dan perangsangan gonad. Ini menunjukkan keperluan nutrient untuk kedua-dua faktor, vitelogenesis dan pembentukan/perkembangan gonad, didapati secara langsung daripada makanan yang diberi.

Percubaan ketiga dikaji untuk menentukan keperluan protein untuk perkembangan oosit dalam 500-l tangki gantian kaca. Setiap tangki mengandungi 6 induk betina yang telah bertelur dan 4 tangki ulangan dilakukan setiap rawatan. Ikan diberi diet yang mengandungi perbezaan tahap protein, iaitu, 17, 25 dan 32%, tetapi tahap lemak yang tetap, iaitu, 6%. Makanan diberi ad libitum selama 5 minggu. Keputusan kajian

menunjukkan 32% protein adalah kritikal untuk kedua-dua pertumbesaran somatik dan juga reproduksi.

Percubaan keempat untuk menentukan keperluan lemak dalam tangki gantian kaca yang sama. Setiap tangki terdapat 6 ekor betina yang sudah bertelur dan 4 tangki sebagai ulangan dalam setiap rawatan. Ikan ini diberi makan secara ad libitum selama 5 minggu dengan diet yang mengandungi perbezaan kandungan lemak, iaitu, 6, 9 dan 12%, tetapi tahap protein yang stabil, iaitu, 32%. Keputusan kajian menunjukkan tahap lemak 6% sudah mencukupi untuk perkembangan gonad. Tahap 9 dan 12% didapati membahayakan.

Kajian akhir dijalankan dalam kolam untuk menentukan kadar daya muatan yang optimum di kolam bagi induk betina yang telah bertelur supaya dapat menghasilkan induk yang membiak berterusan dalam jangka 5 minggu. Kadar penebaran yang dikaji ialah 2 500, 5,000 dan 10,000 ikan/ha dalam kolam seluas 40 m^2. Keputusan kajian menunjukkan kadar daya muatan optimum untuk membolehkan ikan membiak dalam jangka 5 minggu tidak seharusnya melebihi 2,500 ikan/ha berdasarkan pada kenaikan GSI dan tahap hidup induk.

CHAPTER I

GENERAL INTRODUCTION

Background of the study

Puntius gonionotus (Bleeker), previously known as *P. javanicus*, locally called Lampam Jawa, is one of the widely cultured freshwater carps in Malaysia, Thailand and Indonesia where it is called Tawes. In 1953, a stock of fish was originally imported from Indonesia and subsequently raised at the Tapah Fish Breeding Centre in Perak (Welcomme). Soong (1964) reported that of the original stock only 10 fish survived. In order to improve the genetic pool of the fish, another importation of *P. gonionotus* stock from Thailand was carried out in the late 1960's (Ang et al.,1989). This batch was then bred with the existing broodstock and the progeny then distributed among the Department of Fisheries' five breeding stations for mass breeding and distribution to farmers. It is also the primary species involved in the Department of Fisheries open-water stocking program since the 1960's (Ang et al.,1989).

The popularity of this fish for pond culture and release in open water bodies is mainly based on the fact that it is a herbivore. Its culture in ponds is viable with terrestrial plant materials, aquatic weeds such as *Hydrilla* and other filamentous algae thus

making this species ideal for weed control. However to increase its growth rate, some farmers provide them with supplementary feeds. The importance of this fish can be appreciated by studying its statistics for the past few years (Department of Fisheries, Annual Fisheries Statistics) as shown in Table 1. The 2,032 mt of *P. gonionotus* produced in the year 1991 accounted for 20% of the total freshwater fish produced. There has been a gradual increase in fry production from 4.329 million in 1987 to about 12.023 million in 1991, however statistics after 1991 were not available. Of these, 60% of the fry was supplied to fish farmers and the rest for stocking into natural water bodies. The release of *P. gonionotus* in public water bodies over the years has established this species as part of the Malaysian ichthyofauna.

Table 1

The numbers of *P. gonionotus* fry (millions) produced and total production in relation to other fishes(mt) from 1987 to 1991

Year	Fry production (millions)			Production (mt)	
	Farmers	Release [a]	Total [b]	*P. gonionotus*	Others [c]
1987	1.915	1.777	4.329	746	2734
1988	2.442	1.793	4.801	1929	7777
1989	6.191	1.691	7.882	1747	8050
1990	5.184	3.253	9.580	1765	9168
1991	8.119	2.935	12.023	2032	10500

[a] - release refers to stocking of all natural water bodies
[b] - total includes miscellaneous purposes
[c] - includes other freshwater carps, tilapias and catfishes

The techniques used in the propagation of this fish has not changed except for the introduction of hormones for induced breeding. The traditional method is to culture the

female and male breeders in separate ponds with supplementary feeds. The breeding ponds are prepared by drying and liming the ponds, after which they are filled with fresh water. The selected good females are judged by their bellies, and the males by their ability to milt freely. The breeding pairs are then introduced into the ponds where spawning occurs naturally. The fry are then collected after about a month. This traditional method of *P. gonionotus* propagation is described in detail by Hora and Pillay (1962). However, to ensure that spawning occurs, the females are nowadays administered hormones to induce them to spawn in tanks (Pathmasothy and Lim, 1988). The hatchlings are then cultured in nursery ponds for a month after which the fry are collected for distribution.

In traditional breeding, the spent females when reared in segregated ponds can only be utilized again for breeding purposes after four months. However the interval can be shortened to three months with proper preliminary treatment and feeding them with rice bran and leaves (Hora and Pillay,1962). In the case of other exotic carps such as the grass carp (*Ctenopharyngodon idellus*), bighead carp (*Hypophthalmichthys molitrix*), common carp (*Cyprinus carpio*) and local carps such as the Jelawat (*Leptobarbus hovenii*) and Temoleh (*Probarbus jullieni*), the method of broodstock management is similar to that of *P. gonionotus* except with some improvements. The broodstock ponds are stocked at low density. Tennakoon (1983) had utilized low stocking rate of 1,250 fish/ha with 3 kg grass carp with some success. In normal culture practice, stocking rate for this fish can be as high as 12,500 fish/ha. These breeders are fed with chicken pellets and if available, grow-out fish pellets. The ponds are usually fertilized with

organic fertilizers (cow dung and poultry manure) to ensure the availability of abundant natural food.

Statement of problem

The future expansion of freshwater carp culture in Malaysia will depend largely on the availability of frys or fingerlings. It is envisaged that aquaculture production in Malaysia will increase from present 76,800 mt to more than 206,070 mt by the turn of the century, making it into a viable bio-industry (Ubaidullah,1985). The realization of this huge production, which is being revised annually depends on the efficiency in exploiting suitable land for more ponds, increasing the production of existing ponds through intensive farming, and optimizing the rate of utilization of existing reservoirs for cage culture. The two main constraints facing the aquaculture industry envisaged in the future are the availability of cheap formulated feeds but the more critical is the constant availability of fish seeds or fish fry for culture and stocking into the various water-bodies. The availability of fish frys, even today, is still unreliable in terms of quality, quantity and consistency, largely attributed to the inconsistent manner of procuring broodstock (Ang,1990). Another major constraint highlighted is the lack of well-trained managers, hatchery technicians and general staff associated with aquaculture. In the case of seed supply, this can be mainly attributed to the lack of proven information made available to them on broodstock selection and management. This emphasizes the urgent need for research to furnish more information on broodstock selection and management.

At present, the main constraint in ensuring a consistent supply of fry is the deficiency in the availability of sexually matured spawners throughout the year. This can be attributed to a number of reasons. In captivity, some carps of economic importance do not reach final maturation and reproduce spontaneously even in the rainy season, mainly due to two reasons. The species is cultured outside its natural habitat where some chemical, biological and/or physical parameters are not conducive and inadequate to trigger final gonadal development (Slack,1962), or some environmental cue is lacking even with proper feeding. This phenomenon has been observed with the culture of riverine carp, *Tor tambroides* (Kelah), in static ponds at the Freshwater Fish Research Centre, Batu Berendam, Melaka, where the gonadal development of this species is hindered.

In the tropics, especially those closer to the Equator, where variations in photoperiod and temperatures can be considered negligible, most fishes tend to breed throughout the year (Lam,1983). It was observed that *Mystus nemurus*, a riverine catfish that breeds throughout the year, has two peaks coinciding with the monsoon periods (Khan,1987). Similar observation was also noted in the case of *Trichogaster pectoralis* showing that slight changes during the rainy season, when temperatures may drop and water quality parameters may change in association with flooding, there exist spawning peaks in the wild (Hails and Abdullah,1982). Ang (1973) working with *Betta pugnax* observed that breeding occurs throughout the year but more frequently during the rainy season, mainly due to the availability of food during this period. However, in the case of riverine carps, besides availability of food, the environmental parameters such as

flooding, swift water currents and high oxygen in the rivers, may influence these rheophilic fishes.

With proper feeding and good water management, some species of riverine origin do attain gonadal development in static ponds but the differences between the environmental condition in static ponds and those prevailing in the natural habitat, inhibit spontaneous breeding (Slack,1962; Chen et al.,1969). A good example is the popular grass carp (*Ctenopharyngodon idella*) which is indigenous to the rivers of China but cultured in a great many parts of the world (Donaldson and Hunter,1983). Fish that reach final maturation can be induced to spawn. With the availability of homoplastic and heteroplastic pituitary extracts as well as analogs of LHRH, HCG, pimozide, domperidone and Ovaprim, inducing females that reach final maturation to spawn is no longer a constraint (Peters et al.,1988; Thalathiah et al.,1988; Pathmasothy and Lim,1988). However, the main bottleneck is the availability of matured broodstock which is not consistent at present.

Some carps such as *P. gonionotus* and *C. carpio,* can reach final gonadal maturation and spawn naturally in static ponds but the number of female breeders available at any one time in terms of percentage is low. Such a situation calls for proper management of a large broodstock population to ensure the availability of breeders throughout the year, which will result in higher cost of broodstock maintenance.

Besides environmental parameters, it is common knowledge that with proper nutrition