

REARED BROODSTOCK OF *PENAEUS MONODON*

AQUACOP*

Centre Océanologique du Pacifique
CNEXO-COP B. P. 7004 Taravao, Tahiti (French Polynesia)

ABSTRACT

Since 1975, maturation and spawning in captivity of *Penaeus monodon* has been achieved in the 'Centre Océanologique du Pacifique', a CNEXO Centre in Tahiti. The five first animals have been imported from Fiji Islands and in May 1979, four generations have been obtained.

Under the rearing conditions followed at the Centre, reproduction is achieved all throughout the year. Maturation is induced by unilateral eyestalk ablation on pond reared animals maintained in tanks on adequate food.

Results concern mating behaviour, ovarian development, number of spawnings per female and egg viability. The rearing and the maintenance conditions of the captive broodstocks are particularly important to obtain reliable results necessary to sustain commercial hatcheries. Mass production of postlarvae is routinely achieved.

INTRODUCTION

A RELATIVELY stable environment in French Polynesia allows year round culture of penaeid shrimp. As no local shrimp of commercial interest lives in the surrounding waters, different foreign species were tested and the prerequisite was the possibility to obtain maturation and reproduction in captivity. Since 1973 the

Centre Océanologique du Pacifique (COP) has achieved this goal on seven different species using unilateral eyestalk ablation to induce ovarian maturation. AQUACOP 1975, 1977a, 1977b and successive generations have been obtained. For tropical conditions and specially high water temperatures 25°C-35°C *Penaeus monodon* is one of the best candidate (AQUACOP 1977 a). This paper deals with the results obtained so far at the COP in rearing broodstock and closing the cycle for that Indo-Pacific species which is particularly abundant in the Philippines, Taiwan and Indonesia where it is cultured mostly mixed with *Chanos chanos* (Ling, 1972).

* Aquaculture team of the 'Centre Océanologique du Pacifique'

- Algae and mollusc cultures: J. L. Martin, D. Coatanea, O. Millous, Y. normant, O. Le Moine, G. Oudin, T. Belle.
- Nutrition: A. Febvre, J. J. Lainé, J. M. Peignon, P. Maréchal.
- Water quality control and treatment: J. Calvas, V. Vonnau.
- Pathology: J. F. Le Bitoux, G. Breuil, S. Robert.
- Crustacean and fish cultures: P. J. Hatt, M. Jarillo, J. P. Landret, J. Goguenheim, F. Fallourd, O. Avalle, J. Moriceau, S. Brouillet, H. Crieloue, H. Pont, D. Amaru, V. Vanaa, A. Bennett, D. Sanford.
- Technology: J. F. Virmaux.
- Aquaculture program coordinator in tropical area: A. Michael.

MATERIALS AND METHODS

The COP is located in the Vairao lagoon where the water is largely renewed by the swell action above the barrier reef; this provides a true oceanic water which gives a stable environment. The temperature fluctuates from 25°C in the winter to 29°C in the summer, the salinity is 35 ppt and pH remains constant at 8.2. The load in organic matter is always low.

The first broodstock has been constituted from 14 juveniles and adults captured in the wild in Fiji and New Caledonia. All the other animals are born and reared in captivity through the new generations.

Different kind of ponds and tanks are used to grow the shrimps to the maturation size: earthen ponds from 700 to 2,500 m² and concrete tanks with compacted coral bottom from 700 to 1,200 m² where the daily renewal of the water varies around 10% of the total volume. The new constituted broodstocks are transferred in a 400 m² tank of 2 m water depth where the water is injected in the sand bottom through imbedded perforated plastic pipes.

The largest and healthiest animals selected by divers are stocked in 12 m² circular maturation tanks previously described (AQUACOP, 1975; 1977 b): the water depth is 80 cm, the substrate is coral sand and the water renewal is 2-3 times daily. The temperature varies from 24° to 19°C. 20 females from 50 to 150 g and 20 males from 40 to 60 g mean weight are placed in each tank. Compound pellets of 60% protein with a supplement of frozen squid flesh are distributed twice a day. Unilateral eyestalk ablation is practised on the females by simple pinching of the eyestalk and each is double tagged: ring of an elastic silicone tube bearing a label is inserted around the remaining eyestalk and an other label is glued on the carapace or inserted on the rostrum. When moulting the first tag stay on the animal as the other one is found on the discarded carapace.

This technique allows to follow each female individually in a tank. The females are examined every day at dawn for ovarian development without handling to avoid stresses: this is done under the beam of a water proof handlight as the dark carapace does not allow a direct viewing of the ovaries. The developing ones are removed in smaller tanks from 150 l to 2 m³ where a supplement of Troca flesh and fresh mussel is added. Eggs

are collected by passing the water through a sieve of 100 μ . The spawning quality is determined by the percentage of normal, abnormal and unfecundated eggs. Larvae are reared using the Galveston technique in 500 l or 2 m³ tanks at density of 50 to 100 post-larvae/litre.

RESULTS

In the described rearing conditions and in selecting the biggest animals it takes about 9 to 12 months to constitute a new broodstock: 6 months to reach 30 g size and 3 to 6 months more to reach 50 to 120 g size when maturation occurs (Fig. 1). The first spawning was

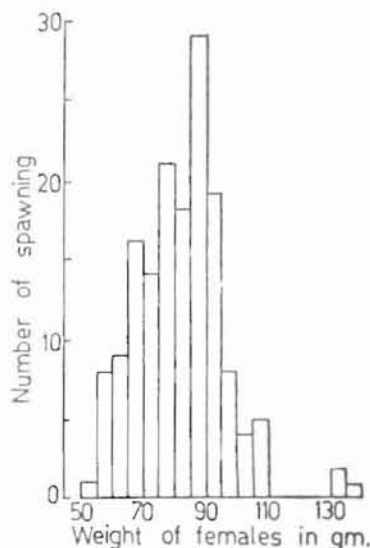


Fig. 1. Number of spawning in relation to weight of females.

obtained in November 1975 and in May 1979 F₄ generation was achieved.

In the maturation tanks adults *P. monodon* lie on the sand substrate and rarely burrow,

their swimming activity is also low day and night. The moulting periodicity for epedunculated females is about 3 weeks. An extension of this period is an indication of too old or weak animals.

If the eyestalk epedunculation is done on healthy animals no mortality occurs except for freshly moulting females.

Above 25°C and for epedunculated animals maturation and spawning occur throughout the year although the ovarian development is minimal during the coldest period from July to September. The few spawnings of non-epedunculated females have been recorded in May and June. The observed courtship and mating behaviour takes place at dawn just after the moulting of the females when the shell is soft; it agrees with the detailed description of Primavera (1979). The success of the impregnation can be seen the next morning by a remaining whitish jelly hanging from the thelycum splits.

After ablation the minimum time for a female to develop full ovaries and to spawn is three days, maximum time is three to four weeks and in this case one moult happens before the maturation begins.

The duration of the ovarian development itself is also variable; for some animals it takes three to four days for others it can last two weeks (Table 1).

The colour of the developing gonad is first whitish then it turns greenish to be dark green on spawning day; there is some exceptions and the colour could be only whitish the spawning day. For some females it is quite easy to determine exactly the spawning day as their ovaries show a large swelling in the first abdominal segment, unfortunately females can also spawn when the ovaries are just developed without swelling. The texture is more significant and must be granulous but it is necessary to handle the animal with a subsequent stress.

Table 1 and 2 and Fig. 2 give the detailed results of some particular experiment in maturation tanks. It can be seen.

— the number of maturation and subsequent spawning is high during a two month period after that the number and the quality of spawning decreased heavily as the healthy state of the stock decreased (Table 2).

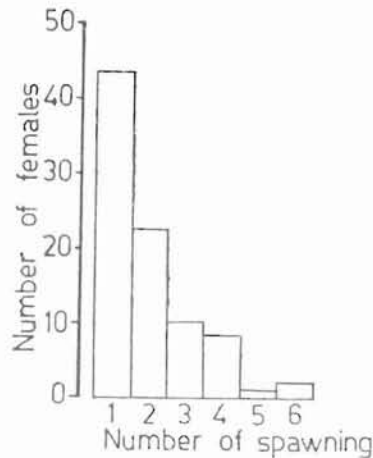


Fig. 2. Spawning frequency in *P. monodon*.

— each female can give several spawnings in a short period of time between two moults: after each spawning the gonad is completely empty but can start again to develop the next day (Table 1 and Fig. 2).

The same stock of sperm is used for the different spawnings and the number of fertilized eggs generally seems in relation with the quantity of sperm injected in the thelycum.

— regression of developing ovaries occurs. Stress during handling can be suspected but is also occurs with undisturbed females.

TABLE I. *Individual experiments on females of Penaeus monodon*

No. ♀	Date	D.M.	N.w	% Fec.	W ♀
14(1)	07.02	6	120,000	87	95
	18.02	—	Molt —	—	—
	23.03	4	240,000	0	95
	29.03	3	310,000	0	95
2(7)	13.09	6	250,000	70	68
	26.09	—	Molt —	—	—
	04.10	2	90,000	0	65
	07.10	2	100,000	0	65
	11.10	4	40,000	0	65
20(6)	08.11	3	150,000	25	65
	17.11	7	160,000	0	65
	22.11	—	Molt —	—	—
	06.12	6	90,000	0	70
9(12)	10.12	10	330,000	80	132
	13.12	2	540,000	90	135
	16.12	2	490,000	80	135
12(12)	22.10	3	150,000	80	—
	29.10	3	180,000	95	83
	02.11	2	180,000	85	85
	06.11	2	65,000	85	85
21(12)	24.11	16	310,000	95	102
	30.11	5	Regression	—	—
	04.12	—	Molt —	—	—
	13.12	3	60,000	50	105
	16.12	2	310,000	80	105
	19.12	2	290,000	58	105

N w : Number of eggs ; D.M : Beginning of maturation (days) ; W ♀ : Weight of females (grams) ;

TABLE 2. *Experiments on P. monodon in a maturation tank during 1979*

Month	Number ♀	Maturation	Regression	Spawning	No. eggs	\bar{N} eggs/♀	%Fecundation ♀	ω	Weight g/♀
13.12 to 31.12	25	2	0	2	530,000	265,000	2	25	75
01.01 to 31.01	22	22	8	14	3,085,000	107,000	14	55	82
01.02 to 28.02	19	19	7	11	1,500,000	205,000	6	70	86
01.03 to 14.03			Complete Darkness						
15.03 to 31.03	19	12	5	7	1,310,000	187,000	0	0	86
01.04 to 19.04	19	2	1	1	120,000	320,000	0	0	80

No. eggs : Number of eggs \bar{N} eggs/♀ : Number of eggs by female.

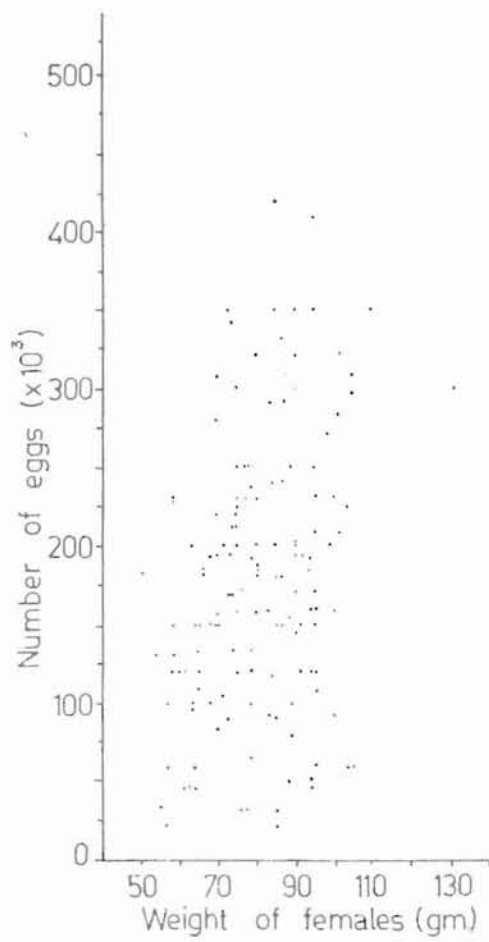


Fig. 3. Relationship between the number of eggs and weight in *P. monodon*.

— experiments on tank in complete darkness have been realized: some maturations have been obtained, but females don't seem to be fecundated by males and we never see fertilized eggs (Table 2).

The spawning process takes place between 8 p.m. and 1 a.m. in the tanks by sudden jumps and activities of the female. Then the pleopods actively disperse the newly extruded eggs. The number of eggs depends on the weight of the

Generally the totally unfertilized spawnings are due to lack of sperms in the thelycum but in some case it happens also with well impregnated females. This has been specially the cause in 1977 when the females were fed only with pellets and did not receive fresh food during the last days of the maturation process.

The larval rearing of *P. monodon* is one of the most difficult among the penaeid species.

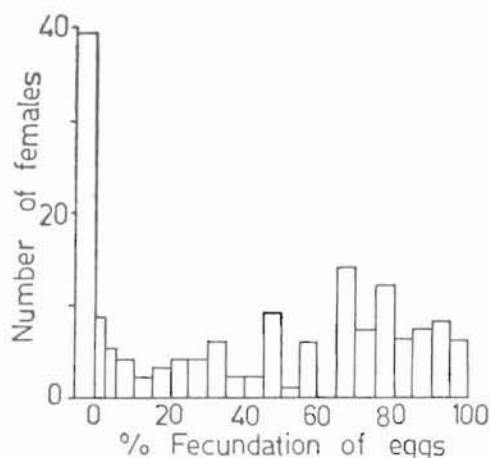


Fig. 4. Percentage of normal eggs produced in different spawnings.

female from 60,000 to 600,000 for 45 to 130 g size animals. This number has not decreased in the successive generations (Fig. 3).

Ten hours after spawning the eggs under the microscope are of three types (AQUACOP, 1977): unfertilized with two or three big cells and many small ones; normal fertilized eggs with a fecundation membrane and the presence of well developed nauplii with developing setae; fertilized eggs in which development has stopped at various stages.

The percentage of normal eggs varies according to the spawning. It can reach 95% (Fig. 4).

The larvae in our conditions are very sensitive to a bacterial disease causing rapid necrosis of the appendages (AQUACOP, 1977 a) mainly between Zoea (Mysis) II and P₅. In the absence of bacterial attack survival is around 80% at a density between 25 and 140 P₁/litre.

DISCUSSION

The constitution of broodstocks is one of the essential pre-requisites to achieve reproduction in captivity. It is necessary to have all the year enough animals of appropriate size in good health, so that maturation can be

induced. Right now we have selected the largest animals at the end of growth experiments in ponds or tanks. It appears that it would be better to rear the postlarvae and the animals which contribute the new broodstock in low density the animals which will constitute a new broodstock. The following results could be presented on broodstock development in a pond of 1,000 m².

— 1 pond with a stocking density of 4 animals/m² will furnish in six months an harvesting density of 3 animals/m² giving 3,000 shrimps between 20 and 40 g; 1,500 specimens of larger sizes may be selected to stock (1.5 animals/m²)

in another pond so as to obtain an harvesting density of 1 animal/m² in 4 months giving 1,000 animals between 60 and 120 g.

It would take 10 months to constitute a new broodstock, and 1,000 animals would be reared in 8 maturation tanks for a 6 months period with a complete renewal of the animals every two months. Also a new broodstock must be started every six months.

Affording one result of spawning/month/female on a routine basis each tank will give a minimum of 4 millions eggs/month which would sustain a production of 2 millions P₆.

REFERENCES

- AQUACOP, 1975. Maturation and spawning in captivity of penaeid prawns *Penaeus merguensis* de Man, *Penaeus japonicus* Bate, *Penaeus aztecus* Ives, *Metapenaeus ensis* de Haan, and *Penaeus semisulcatus* de Haan. *Proceedings of the Sixth Annual Meeting World Mariculture Society*.
- , 1977 a. Reproduction in captivity and growth of *P. monodon* Fabricius in Polynesia. *Proceedings of the Eight Annual Meeting World Mariculture Society*.
- , 1977 b. Observations sur la maturation et la reproduction en captivité des crevettes Pénéides en milieu tropical. *Third Meeting of the I.C.E.S. Working group on Mariculture, Brest, France. Actes de Colloques du CNEOX*, 4: 157-178.
- , 1977 c. Penaeid reared broodstock closing the cycle of *P. monodon*, *P. stylirostris* and *P. vannamei*. *Proceeding of the ninth Annual Meeting World Mariculture Society*.
- PRIMAVERA, J. H. 1979. Notes on the courtship and mating behaviour in *Penaeus monodon* Fabricius. *Crustaceana*, 37: 287-292.