Technical Manual for Artificial Propagation of the Indonesian Catfish, *Pangasius djambal*
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## Chapter III

# Broodstock Management

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Unpredictable and variable reproductive performance is an important limitation for the successful mass production of fish juveniles (Izquierdo *et al.*, 2001). It is known that results of artificial propagation depend largely on healthy condition of the breeders. Broodstock management is clearly one of the key factors for successful seed production.

This chapter gives information on rearing conditions, zootechnical performances, methods of broodfish management and assessment of sexual maturity. These methods, used successfully by the team of the "Catfish Asia" program, were developed for *P. djambal* from juveniles caught in the wild and reared in captivity up to their full sexual maturation. As *P. djambal* was bred in culture conditions for the first time in 1997 (Legendre *et al*., 2000), the results are based on 6 years of working experience on this species.

## REARING STRUCTURE, STOCKING DENSITY AND SEX RATIO

From their natural habitat (Indragiri River, Sumatra), *P. djambal* specimens were temporary stocked by anglers in floating cages then transferred to earthen ponds. Wild *P. djambal* has been rapidly and successfully adapted to these rearing structures.

After 6-year follow up, these new cultured fish showed a very high survival rate, a fast growth and reached full sexual maturity naturally in ponds.

A very good gonad development was observed also for both adults and premature fishes transferred from ponds to floating cages in a river of the central part of Sumatra. All together, these performances demonstrate a good adaptation of *P. djambal* to captivity and indicate that environmental conditions prevailing in the rearing structures meet the requirements of this species for growth and sexual maturation.

### Characteristics, advantages and disadvantages of ponds and floating cages

The characteristics of rearing structures used for *P. djambal* culture and the range of variation of the main environmental factors observed during the whole rearing period are presented here.

#### *Ponds*

The ponds used were man-made with four concrete walls and an earthen bottom. They were of 200 m² with 1 m depth at the Sukamandi station (Java) and 600 m² with 1.8 m depth at the JFADC station (Sumatra).

The supply of water depended on season and water shortage was sometimes observed for 1 or 2 months during the dry season.

| Parameter | Range |
|---|---|
| Stocking density | 0.1 – 0.8 fish per m² |
| Sex-ratio | 1 / 1 males to females ratio |
| Dissolved oxygen | 0.1 – 15 mg.L$^{-1}$ |
| Temperature | 27 – 32°C |
| Conductivity | 19 – 191 µS |
| pH | 5 – 9.7 |

Table III.1.

Range of fish stocking densities and environmental parameters observed during rearing of *P. djambal* broodfish in earthen ponds.

Figure III.1.

Fishponds at the Sukamandi station (RIFA).

*Advantages*

- suitable for flat lands;
- can be isolated in case of external pollution;
- natural production increases fish yield.

*Disadvantages*

- possibility of water renewal depends on the season;
- strong variations of water quality (pH, dissolved oxygen, etc.) between day and night;
- need for regular clean out of silt.

## Floating cages

The floating cages were (surface: 6 m², depth: 1.5 m) were built of wood according to the practice in Jambi region (Sumatra). These structures were settled in current to maximize water exchange between river and inner part of cage.

| Parameter | Range |
|---|---|
| Stocking density | 1.25 fish per m² |
| Sex-ratio | 1 / 1 males to females ratio |
| Dissolved oxygen | 5.9 – 8.1 mg.L$^{-1}$ |
| Temperature | 25 – 31°C |
| Conductivity | 35 – 75 µS |
| pH | 6 – 7 |

Table III.2.

Fish stocking densities and environmental parameters observed during rearing of *P. djambal* broodfish in river floating cages.

*Advantages*

- small volume and high fish stocking densities;
- inexpensive and simple technology;
- easy to manipulate and manage.

*Disadvantages*

- risk of fish escape in the river;
- risk of unexpected water pollution in the river.

Figure III.2.
Floating cages in the Batanghari River (Sumatra).

## FEEDING

### Feed quality and quantity

An appropriate food supply is required for maintaining broodfish in good health. It is well known that food restriction or deficiency in essential nutrients can affect growth and gonad maturation.

*P. djambal* is susceptible to high fat deposition, which may be unfavorable to gonad development as has been observed for other pangasiid catfishes in Vietnam (Cacot, 1999). It is recommended to rear them on a protein-rich diet with an adequate feeding rate.

*P. djambal* broodfish can be fed as follows:

- 35% crude protein pelleted feed;
- daily feeding rate depending on fish size (Table III.3).

Table III.3.
Daily feeding rate for *P. djambal* according to its mean body weight.

| Body Weight | Daily feeding rate |
|---|---|
| 500 g – 1000 g | 2.0% |
| 1000 g – 2000 g | 1.5% |
| > 2000 g | 0.8 – 1% |

In certain locations or for various reason (cost, supplier, etc.), it is not always possible to obtain and to distribute a high protein diet. Thus, in order to maintain an equivalent level of crude protein, it is recommended to revaluate the ration as detailed below.

### *Calculations*

1) Protein contained in Feed 1 / Protein contained Feed 2 = Protein ratio

35% / 25% = 1.4

2) Protein ratio x Daily feeding with Feed 1 = New daily ration

1.4 x 0.8% = 1.12%

The new daily feeding rate is 1.12% of the total biomass with the Feed 2.

| Type of feed | Daily feeding rate | Protein Content |
|---|---|---|
| Feed 1 | 0.8% | 35% |
| Feed 2 | 1.12% (after calculations above) | 25% |

Table III.4.
Daily feeding rate for 2 different types of feed given to maintain daily crude protein allowance.

### *Feeding practice*

Although, it is essential to consider the nutritional aspect, various factors such as physical characteristics of the feed, modalities and frequency of distribution, and regular revaluation of the distributed quantity also have an effect on broodfish condition.

- Feed characteristic: since *P. djambal* in captivity feeds on the bottom or in a dark part of water column, it is recommended to use sinking pellets rather than floating ones. The former has to be water-resistant enough to allow the fish to swallow them before desintegration.
- Frequency: 2 times per day and 6 days a week, 1 day of fasting per week is recommended.
- Modalities of distribution: the feed has to be distributed slowly in order to get fish used to artificial feed and allow all fish to eat. At the same time, farmers can observe fish behavior.
- Revaluation of the quantity: as the growth of *P. djambal* is very rapid, it is recommended to sample and weigh the fish every month in order to revaluate the feeding rate and obtain optimal growth and sexual maturation.
- Eliminate parasitic fish: undesirable fish present in the rearing structure could eat a significant part of the distributed feed preventing the broodfish from getting their full ration. To avoid this problem, all parasitic fish should be removed from the pond regularly.

## HANDLING AND METHOD TO REDUCE STRESS

Methods used to reduce fish stress in aquaculture have been already well described in the literature, in particular by Woynarovich and Horvath (1980) and Harvey and Carolsfeld (1993).

However, it is important to note that stress resulting from capture and handling may affect gonad maturation and growth. It is known that stress may reduce feed intake, weaken the fish and finally affect the spawning success.

It is obvious that the sensitivity to stress is higher for fish originally caught from the wild, as may be the case for first stock of *P. djambal*, than for fish already domesticated. Domestication is a long-term methods to reduce stress and increase handling tolerance (Harvey and Carolsfeld, 1993). As has been the case for *P. hypophthalmus*, we can expect that sensitivity to stress of captive *P. djambal* will decrease within a few generations.

However, without waiting for domestication, some simple and preventive method can be used to reduce stress and should be rapidly integrated as routine procedures.

## Feeding

### *Risk*

Fed fish need more oxygen and are more sensitive to stress than fasted fish. Handling of fed fish can cause unexpected mortalities in the broodstock.

### *Recommendation*

It is imperative that the day of sampling corresponds to a fasting day. It is strongly recommended to stop feed at least 24 hours before capture and handling.

## Capture

### *Risk*

During sampling, prolonged period in the net results in rubbing and stripping away the protective mucus of the fish. Overcrowding in the net can also cause injuries made by pectoral spines. As a result, fish could contract infection.

### *Recommendation*

To avoid a long holding period (1 hour or more) in the net, small sized ponds can be used in order to reduce the total fish population, which in most cases needs to be caught at the same time. During sampling operations, the number of fish maintained in the pouch of the net should not exceed 50 individuals. In case of wounds, local disinfectant can be applied and fish released promptly.

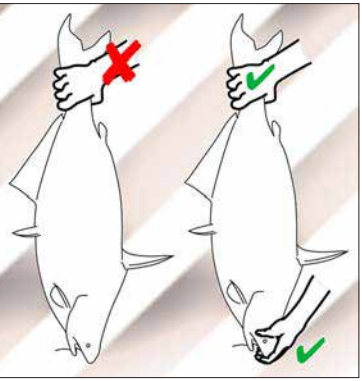
## Handling

### *Risk*

Catching fish roughly by the caudal peduncle (tail) is stressful and unsafe. Fish may struggle to escape and may be injured falling on the floor. Moreover this catching method, often observed on fish farms, results in stripping away protective mucus around the caudal peduncle.

### *Recommendation*

In order to better support the weight of the fish and hold it safely, catch its head and caudal peduncle at the same time with care, then place the fish slowly in a moist towel, cover the eyes and carry it “like a baby” (Figure III.3). Plastic or moist material bags are widely used to handle brooders. This operation has to be repeated for each individual.



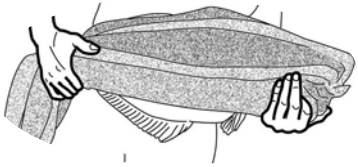


Figure III.3.
Handling recommendation for reducing the risks of stress and knocking.

## Selection and sampling

### *Risk*

In routine broodstock management, fish have to be weighed, measured or evaluated for their sexual maturity. During these operations, there are risks of struggle and injury for fish.

### *Recommendation*

From the net, place carefully the fish, free of towel or bag, in an anesthetic bath for few minutes. When fish has calmed down, it becomes easy to manipulate without stress and risk.

Fish may die from staying a long time in the anesthetic bath. It is imperative that fish regain consciousness in water without anesthetic before being returned to their rearing structure. Otherwise, they can stay in the mud at the bottom of the pond and die by suffocation.

### *Anesthetic use*

Two anesthetics were tested on *P. djambal*,

- MS222® (*tricaine methane sulfonate*) at 50 – 100 ppm;
- *2-phenoxyethanol* at 300 – 400 ppm.

The previous doses are given for fish above 2 kg body weight. *2-phenoxyethanol* is also used as an anti-bacterial and anti-fungal bath.

Anesthetic has to be carefully mixed with the water of the tank before placing fish in the bath.

As the effect of anesthetic depends of species, size and temperature, the applied dose may be excessive. The fish behavior in the anesthetic bath should be constantly observed so they can be removed in due time if necessary.

### General handling precaution

- Fish should be handled after a short fasting period (24 h).
- Fish should be handled with care.
- Fish should be wrapped in a moist towel before handling.
- Never throw fish into water of rearing structure; place them back gently.
- After anesthesia, give the fish enough time to recover before releasing it.

## TAGGING METHODS

Proper management of broodstock requires individual identification of brooders:

- to follow the livestock;
- to record individual events;
- to plan future induced breeding;
- to avoid multiple injections of the same fish;
- to identify and record the best brooders;
- to avoid inbreeding.

It is clear that tagging broodfish presents many advantages and facilitates broodstock management. Fish culturists, from simple to sophisticated ones, have used several different marking or tagging methods. Two of these techniques were tested and developed in *P. djambal*; PIT tags and encoded color spots.

### PIT tags

PIT (Passive Inductance Transponder) tags are internal tags relying on high-technology electronic methods. Although more expensive than others, this technique is widely used and presents many advantages:

- easy to implement;
- no tag rejection;
- unique individual code;
- easy to detect and read;
- not perishable.

Figure III.4.
Preparation of PIT tags.

### *Method of implantation*

- after disinfection with alcohol, PIT tag is inserted into an adapted needle;
- PIT tag is implanted in the muscle close to the dorsal fin;
- PIT tag is automatically detected and its number read using a PIT tag reader.

Figure III.5.
Implantation of PIT tags.

Figure III.6.
Reading of PIT Tags.

### Encoded spots

Figure III.7.
Dermojet filled with Alcian blue solution.

This marking method was initially developed and used by IRD for other catfish species (Slembrouck and Legendre, 1988; Hem *et al.,* 1994) and consists in individually tattooing blue spots on the skin of the fish belly. These blue spots correspond to 5 $g.L^{-1}$ aqueous Alcian blue solution injected using a Dermojet. This technique is cheaper than the PIT tag and easy to use but the Alcian blue spots are not permanent and tend to disappear with time.

Spots are placed in accordance with a number code (Plate III.1) and allow numbering around 1000 fish. On *P. djambal*, blue spots are visible for a period of 2 – 3 months. However, this is not a major constraint as it is easy and cheap to retag the fish with the dermojet when the blue spots become difficult to see.

Figure III.8.
Tattooing with Dermojet.

## ASSESSMENT OF MATURITY

*P. djambal* males and females do not develop any external charateristic allowing easy distinction of sexes and of sexual maturation stage. Even when females show large and soft belly, it corresponds in many cases to the presence of perivisceral fat.

In this species, males could be identified only when sexually mature by emission of sperm upon hand-pressure onto the abdomen and females when oocytes (follicles) could be sampled by intra-ovarian biopsy.

Although oocytes (follicles) could be able to develop fully mature gonads in captive condition, *P. djambal* does not reproduce spontaneously in the rearing structure. A hormonal treatment is necessary to induce final oocyte maturation and ovulation.

### Male

Assessment of sexual maturity of males is much easier than that of females and their maturation stage is determined according to the following scale:

**0** Absence of sperm.

**1** Presence of a little sperm after squeezing.

**2** Noticeable emission of sperm with normal hand-pressure.

**3** Abundant emission of sperm with slight hand-pressure.

Figure III.9.
Assessment of male maturity.

### Female

After intra-ovarian biopsy and clearing in Serra's fluid (30% formalin, 60% ethanol and 10% acetic acid), *P. djambal* oocytes never show migration of the germinal vesicle before the female has received an appropriate hormonal treatment. In contrast to some other fish species, nucleus position in the oocytes is not a criterion of maturity in *P. djambal*.

Modal diameter and homogeneity of oocyte diameter distribution remain the best criteria to determine readiness of *P. djambal* females.

## BIOPSY PROCEDURE


Figure III.10.
"Pipelle de Cornier" used for *P. djambal* biopsy.

A polypropylene tube with rounded end originally developed as an endometrial suction curette, called "pipelle de Cornier" (Figure III.10) is inserted into the ovary through the genital opening and gonoduct (Figures III.11, III.12).

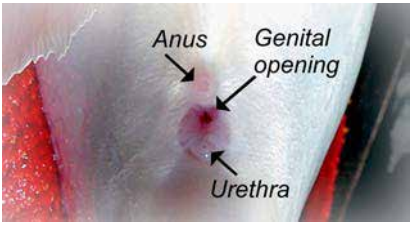



Figure III.11.
Detail of uro-genital papilla.

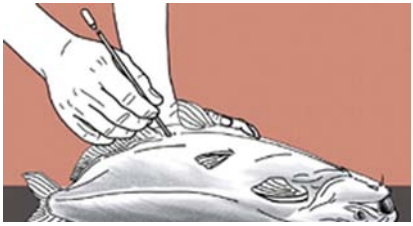


Figure III.12.
Intra-ovarian biopsy of anesthetized *P. djambal.*

A few dozen of oocytes are gently aspirated, scattered on a glass plate (Figure III.13) and measured with a micrometer under a binocular microscope at magnification of 25 X (Figure III.14) to determine the size distribution and modal diameter.

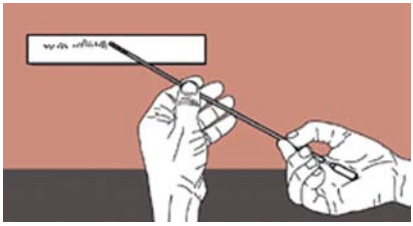


Figure III.13.
Scattering oocytes on a glass plate.

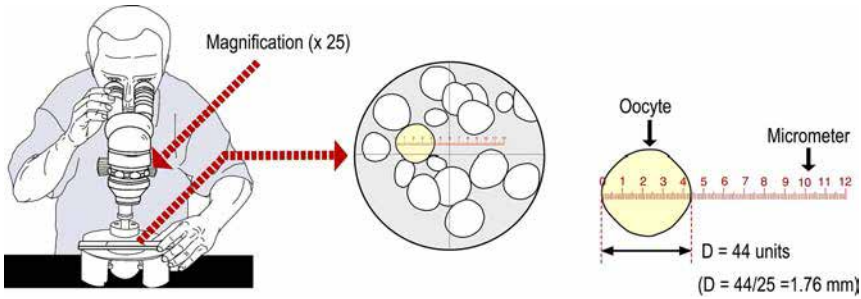



Figure III.14.
Measurement of oocyte diameter after intra-ovarian biopsy.

Biopsies made at regular intervals (e.g. monthly) allow following the evolution of sexual maturation of broodfish and selecting females ready for triggering ovulation.

## Oocyte diameter analysis

Correct maturity assessment requires measuring diameter of a sufficient number of collected oocytes for each female. It is recommended to measure the diameter of at least 50 oocytes in order to obtain a representative histogram of size distribution and to determine the modal diameter (Plate III.2.). The latter criterion is considered as the best indicator of ripeness for this species.

Our investigations have shown that *P. djambal* starts to be sexually mature when modal oocyte diameter reaches 1.6 mm and reaches full maturity at modal diameter between 1.7 and 2.1 mm. No ovulation was observed for females with oocytes of modal diameter smaller than 1.6 mm. Oocytes of diameter over 2.12 mm become overripe in most cases and do not ovulate after hormonal treatment (Plate III.2).

The index sheet presented in Plate III.2 shows an example of recording oocyte distribution and of their size evolution after successive biopsies made at regular intervals on one *P. djambal* female. This type of follow-up of broodfish maturity clearly represents useful background information for the farmer and is a key to successful induced spawning.

In order to provide detailed information, each data sheet should specify:

- species, origin, rearing structure and individual identification number;
- date of sampling;
- diameter in mm of each measured oocyte, constructing size distribution histogram as shown in Plate III.2.

### Visual aspect of oocyte sample

As the process of gonad maturation is gradual, oocyte size and appearance vary according to their development stage (see Plate III.2). For small-scale farmers, due to lack of equipment, the macroscopic aspect of oocytes is often the only way to evaluate fish maturity. In fact, with some experience, visual examination can also become an acceptable assessment of readiness.

In order to identify the final stage of gonad maturation, we give below some indications for evaluating readiness of *P. djambal* oocytes after sampling by biopsy.

- Color of the sample has to be homogeneous and ivory;
  - if the sample is clear with a few visible oocytes, it means that the gonad is not ripe enough;
  - if the bigger oocytes are clear (translucent), it indicates that over-ripening has started (process of atresia).
- Oocyte sample has to be almost dry or only slightly wet;
  - if the sample contains too much fluid, it suggests that many oocytes are already engaged in the process of atresia.
- An evaluation of the diameter with a centimeter ruler is strongly recommended. Oocyte size has to be homogeneous and the average diameter has to be 1.7 mm or greater;
  - heterogeneous oocyte size indicates that the final phase of gonad maturation has still not been reached.
- Oocytes must be easily separated from each other.

If these 4 points are observed, it means that the gonad has reached a stage of full maturity and that it will be possible to induce final oocyte maturation and ovulation by hormonal treatment.

## GROWTH AND AGE AT FIRST MATURITY

### Growth performances

The growth of *P. djambal* caught in the wild was followed over the long term in ponds using the rearing conditions (fish stocking density, feeding, etc.) described previously in this chapter.

Starting from a mean body weight of 550 g, *P. djambal* reached 6350 g after 990 days of rearing, corresponding to a mean growth rate of 6.0 g. day$^{-1}$. The shape of the growth curve was almost linear during the whole rearing period. This makes an important difference with *P. hypophthalmus* for which growth

drastically slowed down above 2 kg mean body weight (Figure III.15.).

Different experiments carried out with fish born in captivity showed that the growth of *P. djambal* was also significantly faster than that of *P. hypophthalmus* during the larval and fingerling stages (Legendre *et al*., 2000).

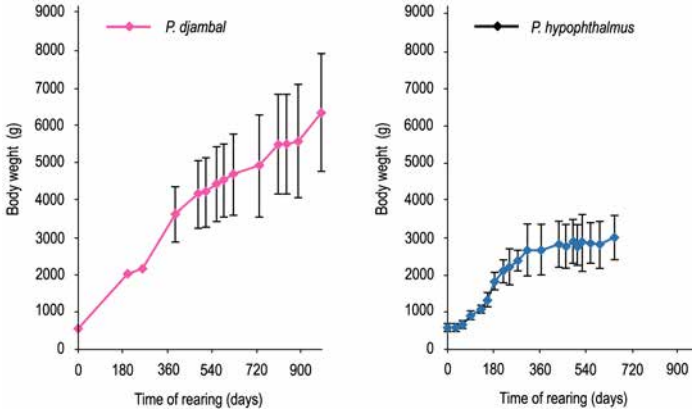



Figure III.15.

Growth of *P. djambal* and *P. hypophthalmus* reared in ponds up to the adult stage (mean ± sd).

## Sexual dimorphism for growth

In *P. djambal*, the respective growth of males and females could be compared because all of them were all individually tagged (PIT tags). In this species, the females presented a much faster growth rate than males above 3 kg mean body weight (Figure. III.16.). In males, the lowering of growth corresponded to the period at which most of them reached full sexual maturity.

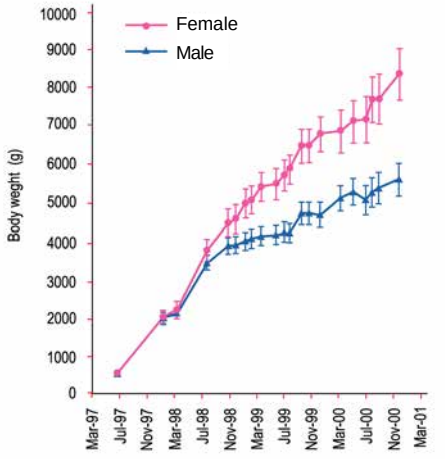



Figure III.16.

Growth of males and females of *P. djambal* in pond (mean ± sd).

### Age at first sexual maturity

The age of *P. djambal* at first sexual maturity was estimated from fish groups reared in ponds. Observations carried out either for fish initially caught in the wild or for fish born in captivity led to similar conclusions.

Sexual maturity is reached much earlier in males than in females.

The first mature males were observed at the age of 11 – 12 months and more than 80% of males were fluent (oozing sperm) at two years of age. By this time, males born in captivity were of 2 – 3 kg individual body weight under our rearing conditions.

The first mature females (stage 4) were observed at the age of three years. Nevertheless at 4 years all female broodstock of *P. djambal* could be considered as fully mature. At 3 years, females born in captivity had reached 4 – 5 kg individual body weight in our rearing conditions.

## SEASONAL VARIATION OF SEXUAL MATURITY

In *P. djambal*, once the first sexual maturity has been reached, sexually mature individuals (males at stage 2 or 3; females at stage 4) could be found all year long within the broodstock cultivated on Java and Sumatra Islands. However, clear seasonal variations in sexual activity were observed, showing a cycle repeated during four consecutive years of follow up. The proportion of mature females ranged between 50 and 100% during the period from September to March, corresponding to the rainy season, while it dropped to less than 30% between June and August, at the peak of the dry season. A similar tendency was observed in males with a slight lowering in the proportion of fluent fish during the dry season.

Seasonal variations in the quantity and quality of ova collected after induced breeding (see Chapter IV) were also observed. The mean fecundity and hatching rates were about two times lower during the dry season (April to August) than during the rainy season (September to March).

Even if larvae of *P. djambal* can be produced all year long, the most favorable period for production of fry lasts for about 7 months with a rise between November and January.

## EQUIPMENT AND TOOLS

### Feeding

1. Balance for weighing daily ration of feed (5 kg ± 10 g).
2. Plastic buckets for conveying and stocking feed for each rearing structure.

### Fish capture

1. Fishing net fitted with floats on the top part and chain or lead on the lower part; bamboo sticks fastened at both ends; length and depth exceeding one of the dimensions of the rearing structure.
2. Moist towel for transferring broodfish from the net to tank.
3. Plastic bag for short distance transportation.

### Handling fish

1. Disinfectant for treatment of the wounded broodfish.
2. Anesthetic; MS222® or 2-phenoxyethanol.
3. Tank for anesthetic bath.

### Anesthetizing fish

1. Measuring container to determine the quantity of water in the previous tank.
2. Pocket calculator for calculating anesthetic dose.
3. Graduated syringe for accurate measurement of anesthetic dose.
4. Tank with clean water for fish recovery before return to its rearing structure.

### Weighing fish

1. Balance for weighing broodfish (15 kg ± 50 g).
2. Index card for recording fish weight.
3. Plastic container placed on balance for weighing broodfish.
4. Pocket calculator for calculating the new daily ration.

### Tagging broodfish

#### *PIT Tag*

1. Internal tags.
2. Syringe with adequate needle for inserting PIT tags.
3. PIT tag reader.
4. Alcohol 70% for tag and needle disinfection.

#### *Encoded spot*

1. Alcian blue powder.
2. Distillated water for diluting Alcian blue (5 $g.L^{-1}$).
3. Dermojet.

### Assessment of maturity

1. Index card to record data for each broodfish (see Plate III.2).
2. “Pipelle de Cornier” or catheter made from adequate polyethylene tubing (3 mm external diameter; minimum 2 mm internal diameter).

**3** Glass plate for scattering oocytes from “Pipelle” or catheter.
**4** Low power stereo microscope (binocular x 25) with micrometer for accurate measurement of oocyte diameter.
**5** Magnifying glass for visual examination of oocytes.

## REFERENCES

Cacot, P., 1999. Description of the sexual cycle related to the environment and set up of the artificial propagation in *Pangasius bocourti* (Sauvage, 1880) and *Pangasianodon hypophthalmus* (Sauvage, 1878), reared in floating cages and in ponds in the Mekong Delta. In: *The biological diversity and aquaculture of clariid and pangasiid catfishes in Southeast Asia*. Proc. mid-term workshop of the “Catfish Asia Project” (editors: Legendre M. and A. Pariselle), IRD/GAMET, Montpellier. p. 71-89.

Harvey, B. and J. Carolsfeld, 1993. Induced breeding in tropical fish culture. Ottawa, Canada, IDCR, 144 p.

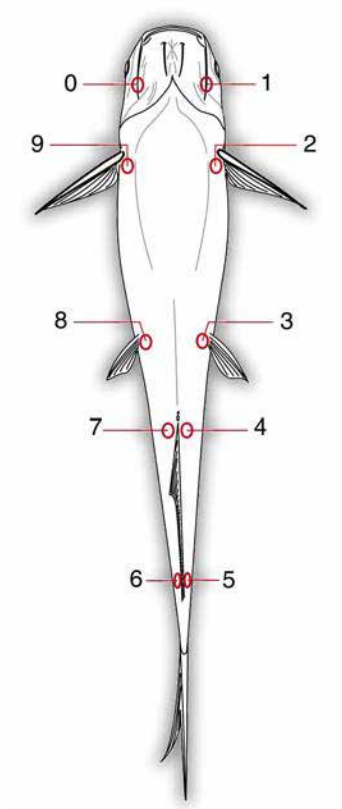
Hem, S., J. Nunez Rodriguez, J. Slembrouck and Z. J. Oteme, 1994. Marquage individuel des poissons-chats au bleu alcian par injection au dermojet. *Int. Workshop on Biological Bases for Aquaculture of Siluriformes (BASIL),* Montpellier 24-27 mai 1994. Book of abstracts, Cemagref Edition p. 106.

Izquierdo, M. S., H. Fernandez-Palacios and A. G. J. Tacon, 2001. Effect of broodstock nutrition on reproductive performance of fish. *Aquaculture*, 197: 25-42.

Legendre, M., L. Pouyaud, J. Slembrouck, R. Gustiano, A. H. Kristanto, J. Subagja, O. Komarudin and Maskur, 2000. *Pangasius djambal*: A new candidate species for fish culture in Indonesia. *IARD journal*, 22: 1-14.

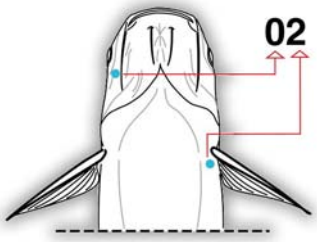
Slembrouck, J. and M. Legendre, 1988. Aspects techniques de la reproduction de *Heterobranchus longifilis* (Clariidae). Centre de Recherche Océanographique Abidjan, NDR 02/88, 19 p.

Woynarovich, E. and L. Horvath, 1980. The artificial propagation of warm-water fin fishes – a manual for extension*. FAO Fish. Tech. Pap.*, 201, Roma, Italy, FAO, 183 p.

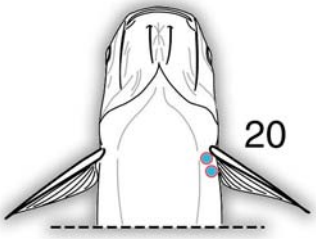



Number correspondence of the tagging spots as a function of their location on the fish body.
Spots are made with a 5 g.L$^{-1}$ Alcian blue solution injected using a Dermojet.

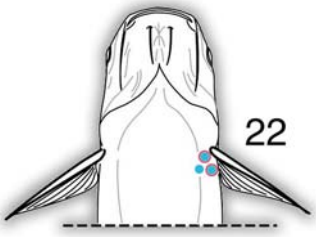
One spot at one place give the units (No. 0+2=02).




Two spots at the same place gives the tens (No. 20).




Three spots at the same place give tens and unit (No. 20+2=22).




Two spots at the same place give the tens, one spot at another place gives the units (No. 20+8=28).

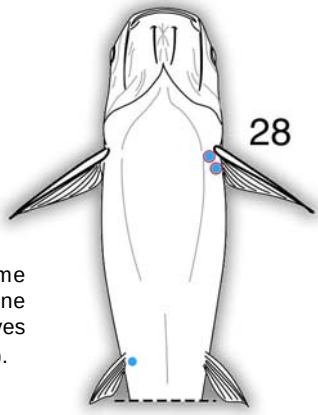
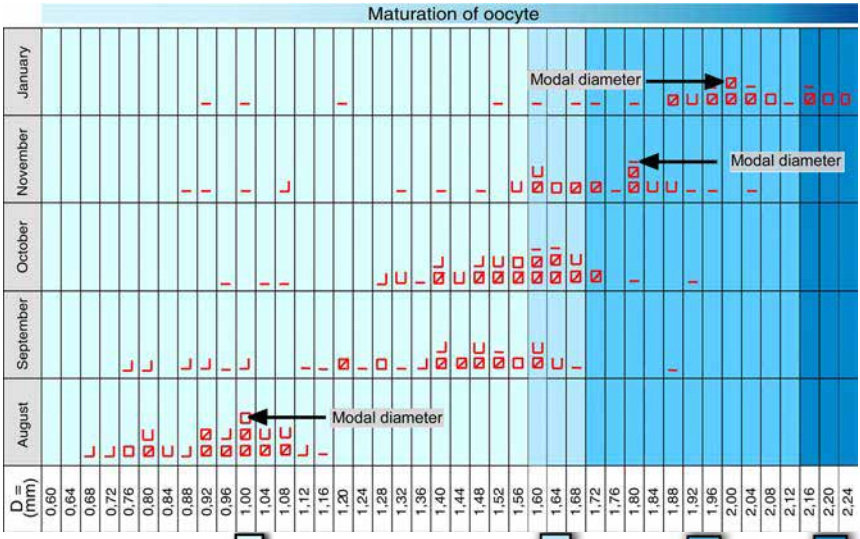



Plate III.1.

Tagging broodfish with encoded spots.
Examples of fish numbering by using different combinations of spots and location.

Species: *P. djambal* Origin: Indragiri River

PIT tag number: 425 916 0D2 8 Rearing structure: Pond 2




Maturing gonad: no ovulation after hormonal treatment.
Visual aspect: oocytes clear and difficult to separate from each over.

Final gonad maturation: 60 – 80% successful spawning after hormonal treatment.
Visual aspect: ivory color, more homogeneous diameter of bigger eggs, most of oocytes can be separated.

Full gonad maturation: 100% successful spawning after hormonal treatment.
Visual aspect: ivory color, homogeneous diameter and all oocytes can be easily separated.

Overripe oocytes: do not ovulate after hormonal treatment.
Visual aspect: mixed clear and ivory color, presence of intra-ovarian fluid and many degenerating oocytes.

Plate III.2.

Record of *P. djambal* oocyte development after successive sampling by intra-ovarian biopsy and measurement with a binocular microscope and micrometer.

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# Technical Manual For Artificial Propagation Of The Indonesian Catfish, *Pangasius djambal*


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