OVERVIEW OF THE CATFISHES AQUACULTURE

Philippe Cacot
CIRAD-EMVT (Centre de Coopération Internationale en Recherche Agronomique pour le Développement, Département d'Elevage et de Médecine Vétérinaire), Groupe Aquaculture. Montpellier, France.

Le Thanh Hung
CAF (College of Agriculture and Forestry), Faculty of Fishery and Aquaculture. Thu-Duc, Ho-Chi-Minh-City, Vietnam.

Keywords: Catfish, biology, aquaculture.

Contents

Summary

With about 370 000 tons per year, catfishes aquaculture contributes for 17.5 % of the overall production of freshwater fish culture. Production takes place mostly in tropical and subtropical areas of North America and Asia. Fifteen species from seven families are exploited, but only two families, Ictaluridae and Clariidae, represent more than 95 % of the whole production. Cultured catfishes have a fast growth, an omnivorous regime, a high tolerance to poor water quality and a non bony flesh.

In rearing conditions, some species can bred naturally (Ictaluridae, *Silurus glanis*, Clariidae), whereas reproduction has to be induced artificially in other species (Pimelodidae, Pangasiidae). The larval rearing can be conducted in tanks or in ponds, according to the food requirement of larva (natural or artificial food), their eventual cannibalism behavior and the value of fingerlings. After nursing, both extensive or intensive cultures can be applied for growing catfishes. Extensive conditions means fertilized pond with usually a low fish density, whereas intensive conditions involves high fish density, artificial food and running water in raceway or floating cage. After harvesting, catfishes are sold fresh and often alive, or processed and frozen, respectively on local market or far from the production area. Constraints and prospects of the catfish culture are also discussed.

1. Introduction

Siluroidei or Siluriformes, usually named "catfish", constitute one of the five orders in the Ostariophysi fishes (infradivision of the Euteleostei). Siluroidei fishes count 33 families, 416 genus and 2 584 identified species. Although most of the Teleostei fish are scaly, most of Siluroidei have only skin. Like cats, "catfishes" have also mustaches (four to eight) which are used as sensitive organs. Besides theses taxonomic figures, catfishes present zootechnical advantages leading to their exploitation in aquaculture.

In 1996, the estimated production of catfish in aquaculture was 360 896 tons, with an associated value of 574.3 millions USD (Figure 1). It contributed for 17.5 and 21.8 % of respectively the production and its associated value of the whole fish culture in freshwater. The catfish production is up 45.6 % on the past decade. However, the culture of other species has increased faster during the same period (+ 193.7 %). Fifteen catfish species from seven families are exploited for aquaculture. But only two families contributes for 96.8 % of the production, including Ictalurids (60.9 %) with *Ictalurus punctatus* and Clariids (35.9 %) with *Clarias gariepinus* and *C. macrocephalus* (Table 1). Ictalurids are mostly cultured in USA, and Clariids in Asia (India, Thailand, Indonesia).

Production in the other areas is very low, including Africa (2.5 %), Europe (1.1 %) and South America (0.1 %). However, it is to be noted that official statistics (i.e. FAO) are certainly underestimated in several species. For instance, in Viet Nam, the aquaculture of Pangasiids is not mentioned although about 30 000 tons are produced every year, whereas the overall estimated production is 7 954 tons in Thailand. Overall, most of catfish are tropical or subtropical species and only one major species (*Silurus glanis*) is

cultured in temperate countries (i.e. Europe). Pictures 1, 2 and 3 are showing three different catfishes.

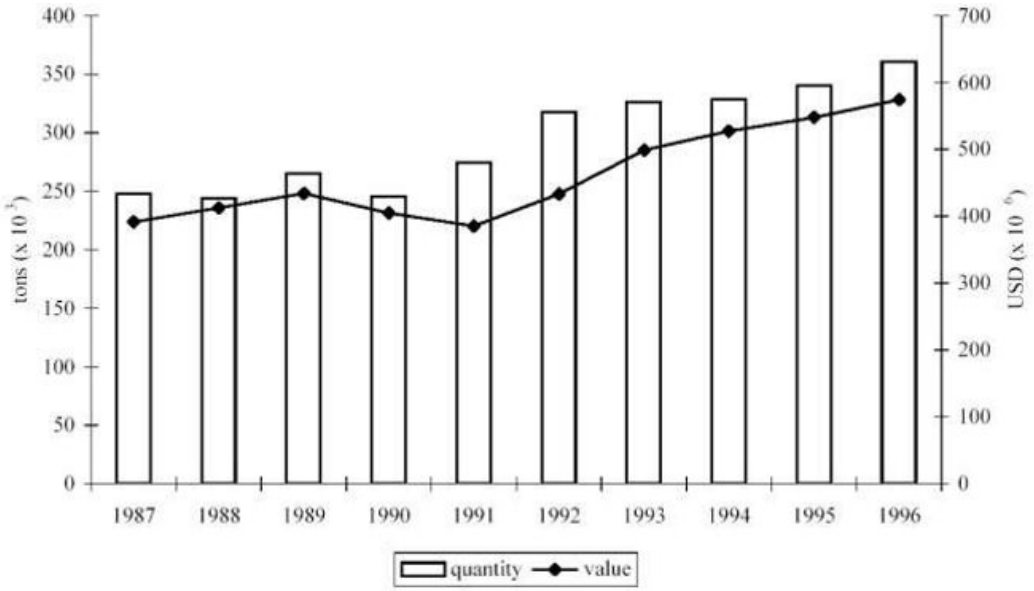

Figure 1. Evolution of the overall catfish aquaculture production.

	North America	**Asia**	**Africa**	**Europe**	**South America**	**total**
Ictaluridae	216 454 60.0 %	998 0.3 %	-	2 155 0.6 %	256 0.1 %	219 863 60.9 %
Clariidae	-	119 561 33.1 %	8 880 2.5 %	1 200 0.3 %	-	129 641 35.9 %
Pangasiidae	-	7 954 2.2 %	-	-	-	7 954 2.2 %
Siluridae	-	158 < 0.05 %	2 < 0.05 %	507 0.1 %	-	667 0.2 %
Bagridae	-	-	155 < 0.05 %	-	-	155 < 0 05 %
Pimelodidae	-	-	-	-	5 < 0 05 %	5 < 0 05 %
Prochilodontidae	-	-	-	-	3 < 0 05 %	3 < 0 05 %
other Siluroidei	-	2 596 0.7 %	-	-	12 < 0 05 %	2 608 0.7 %
Total	216 454 60.0 %	131 267 36.4 %	9 037 2.5 %	3 862 1.1 %	276 0.1 %	360 896 100.0 %

Productions in tons and percentages of the total production.

Table 1. Production of catfishes in 1996 per family and per geographic area.

Picture 1. Food Clariid from pond culture in Viet Nam, hybrid between female *Clarias macrocephalus* and male *Clarias gariepinus*.

Picture 2. Broodfish of *Pangasius bocourti* (Pangasiidae) stocked in pond in Viet Nam.

Picture 3. Food *Chrysichthys nigrodigitatus* (Bagridae) cultured in pen enclosure in Niger (Picture from Mr. Saurin Hem, IRD, France).

2. Interest of Catfishes for Aquaculture

2.1. Fast Growth

Most of the catfishes exploited for aquaculture show a fast growth, usually permitted by a special feeding behavior, including voraciousness and ability to consume a large amount of food. Catfish are usually able to consume large items of food such as whole fruits and mollusks in Pangasiids. In these species, the digestive tract content represents up to one quarter of the body weight in natural conditions. This performance is due to an extensive stomach and intestine, as well as the event and the body cavity. In aquaculture, fast growth allows short cycle of production and permits a large commercial fish size. In Viet Nam for instance, *Pangasius hypophthalmus* cultured in pond can reach 800 g within six months. However, some cultured species show a low growth rate and a small commercial size. That is the case of *Clarias macrocephalus* in Asia which is sold at only 200 g after several month of culture in pond conditions. But this species is greatly appreciated for of its flesh quality.

2.2. Omnivorous Regime

Beside voraciousness, most cultured catfishes are omnivorous, and, in natural conditions, they fed on a large variety of items including vegetables. For instance, *Pangasius pangasius* and *P. bocourti* in South Asia and South East Asia fed on fruits, leaves, roots, with also consumption of animal matter such as mollusks and insects. In *P. pangasius* and *Ictalurus punctatus*, it has been demonstrated that some enzymes in the digestive tract are involved in the digestion of starch. Otherwise, the feeding regime of catfish usually changes according to the food availability in the natural conditions. In rivers with a flood plain area, fruits and other vegetables are abundant during the high water time, and then catfish fed on it. But, in the low water time, fish has to fed on other items like mollusks.

The ability to digest starch is exploited for covering the energy and protein requirement. Therefore, the protein requirement in food of cultured catfish is on average 30 % crude proteins, lower than other strictly carnivorous fishes (i.e. Salmonids, *Lates calcarifer*). Raw material with high starch content such as wheat and rice bran, corn or cassava flour are widely used to feed catfishes. In Viet Nam for instance, rice bran contributes to half of the diet in *Pangasius bocourti* cultured in floating cage. Compared to other matters with high protein content such as fish meal, matters with high content of starch are much cheaper. Otherwise, in catfish culture, the low protein content of the food involves low nitrogen release in the water body. Consequently, on the feeding point of view, rearing of catfishes is cheap for the fish farmer and low polluting for the environment.

However, most of the catfishes are carnivorous in the early beginning of their life. This figure is associated with a very fast growth and then a high protein requirement. In *Pangasius pangasius*, juveniles fed mostly on insects. Afterwards, their feeding regime switch progressively to an omnivorous one. Consequently, for several weeks since the first food intake, larvae and juveniles have to fed on high protein diets. Otherwise, some species of cultured catfishes are strictly carnivorous such as *Wallago* sp. in South Asia.

As fishes like Channids, carnivorous catfishes are fed with forage fish usually abundant in some rivers or lakes.

2.3. Low Requirement in Water Quality

In natural conditions, tropical catfishes are often living in fluctuating hydrological environment. In flood plain river, the high and low water times are respectively associated with a high and low dissolved oxygen concentrations. Thus, most of the tropical catfishes can withstand in stagnant water. This capacity is permitted by a physiological adaptation used for complementary air breathing. In Clariids, gas blood exchanges occur behind the gill, in a cauliflower like organ. In Pangasiids, air breathing occurs in the swimbladder which contains numerous alveolus. Beside air breathing, Clariids can tolerate water with high organic matter content, and especially the high nitrogen concentration. In these species, ammoniac excretion can be limited and urea can be used for the protein synthesis.

Consequently, most of the catfishes can be cultured in poor water conditions i.e. stagnant water and high fish density. Such conditions are even not tolerate by other species like Cyprinids and Tilapias. However, non tropical species like the channel catfish (*Ictalurus punctatus*) and the European Silure glane (*Silurus glanis*) require good water quality i.e. low fish density and / or water aeration or water exchange. But such requirements are less important than other species living in running water like Salmonids.

The catfish distribution is almost restricted to the freshwater part of the continental water. Only two families present species mostly located in brackish and / or see water (Pimelotids and Ariids), but they are not cultured. However, three cultured species, *Chrysichthys nigrodigitatus* (Bagrid), *Heterobranchus longifilis* (Clariid) and *Pangasius pangasius* (Pangasiid), show a good tolerance to the salinity.

2.4. Quality of Flesh

Catfishes always present a non bony flesh, which is a great advantage when compared to the Cyprinids. Flesh is usually soft, with a good taste and a white or grew color appreciated by consumers. The softness, taste and flavor are mostly related to the lipid content in flesh, which is a bit high in catfishes (up to 13.2 % in *Ictalurus punctatus*). For this reason, in the Mekong delta, the most appreciated Pangasiids are usually the fat species (*Pangasius bocourti*, *P. larnaudi*) compared to the leaner fishes (*P. hypophthalmus*, *P. conchophilus*).

In catfish cultured in ponds such as the channel catfish (*Ictalurus punctatus*), bad taste and off-flavor can be caused by special components (geosmin and methyl-isoborneol), produced in water by some microorganisms (actinomycete, blue and green algae). In this case, fish has to be stored in pond during several weeks, until the flesh recover a good quality. In *Clarias macrocephalus*, the flesh has a clear yellow color, but this one is appreciated by the Asian consumers. However, in the Mekong catfish *Pangasius hypophthalmus*, the yellowish color is not appreciated.

3. Technical Bases of the Aquaculture Systems

The main figures of the aquaculture techniques in five major catfish species are presented in the Table 2.

3.1. Reproduction

3.1.1. Natural Reproduction

Catfish culture, as well as the other fish culture requires the supply for seeds (i.e. fish juveniles) in large quantity and appropriate size and time. Thus, cultured catfishes are usually bred in two ways, according to their ability to reproduce, or not, in rearing conditions. Reproduction can occur spontaneously in some species, like *Ictalurus punctatus*, *Silurus glanis*, *Chrysichthys nigrodigitatus* and *Clarias macrocephalus*. Sexually mature broodfishes are selected and placed in a pond for natural mating. These species have a parental behavior and the spawning substrate allows the eggs or the fry collection. Eggs are collected in a container in *I. punctatus* and *C. nigrodigitatus*, followed by incubation in tank with running water. In *S. glanis*, eggs are laid on a vegetal nest which is transferred in tank for incubation. In *Clarias macrocephalus*, the spawning takes place in an inundated rice field and then the newly hatch larvae are collected in the nest.

-
-
-

Bibliography

Cacot P. (1993). Présentation de la pisciculture en cages flottantes dans le Sud-Viêt Nam: Caractéristiques de l'élevage sur le Mékong de Pangasius pangasius (in French). 107 pp. CIRAD-EMVT, GAMET. Montpellier, France. [This presents an original technique of highly intensive catfish culture].

Chevey P., F. Le Poulain (1940). La pêche dans les eaux douces du Cambodge (in French). 193 pp. ex-Indochine Oceanographic Institute (Nha Trang, Viet Nam). [Available for consultation at the Monaco Oceanographic Institute. This underlines some ecological figures in catfishes of the lower Mekong basin].

Coche A.G. (1978). A review of fish cage culture as practiced in inland waters. Aquaculture **13**(2), 157-190. [This provides comparison between several fishes reared in floating cages, including the channel catfish Ictalurus punctatus].

Dung T.T., T.T.T. Hien, D.T. Dung, N.T. Phuong (1994). Ky thuat nuoi thuy san nuoc ngot - Technics of fish culture in freshwater (in Vietnamese). 36 pp. Can Tho University, Department of Freshwater Aquaculture. Can Tho, Viet Nam. [This presents the techniques of intensive and extensive culture in Clarias macrocephalus, C. gariepinus and their hybrid].

FAO (1998). Aquaculture production statistics 1987-1996. Food and Agriculture Organization (FAO). Roma, Italia.

Huet M. (1970). Textbook of fish culture. Breeding and cultivation of fish. 436 pp. Translated from French by Henry Kahn. Fishing News Books Ltd. Farnham, Surrey, England.

Legendre M., J.-P. Proteau (Eds.) (1996). The biology and culture of catfishes. 235 pp. Proceedings of the symposium 24-27 May 1994, Montpellier, France. Aquat. Living Resour. **9** (special issue). [This review includes results of researches in progress and status of the catfish aquaculture in the world (without Southeast Asia)].

Peignen A. (1993). Pisciculture en étangs au Sud-Viêt Nam - Fish culture in ponds in the South-Viet Nam (in French). 33 pp. GAMET, Groupe Aquaculture Méditerranéenne Continentale et Tropicale. Montpellier, France. [This provides information about the Mekong catfish (Pangasius hypophthalmus) aquaculture in an integrated farming system].

Roberts T.R., C. Vidthayanon (1991). Systematic revision of the Asian catfish family Pangasiidae with biological observations and descriptions of three new species. Proceedings of the Academy of Natural Sciences of Philadelphia 143, 97-144.

Vallod D. (1987). Le silure (Silurus glanis, L.) (in French). 70 p + annexes. Association pour le Développement de l'Aquaculture. Saint-André-de-Cubzac, France. [This presents the techniques of the European catfish aquaculture in several systems].

Biographical Sketches

Philippe CACOT

French, 30 years old, born the 10 Sept 1969 in New-Caledonia (France),

Scientist in the Aquaculture Unit of the CIRAD-EMVT [(1)]. He has been doing research since 1994 about the catfish aquaculture in southern Vietnam with the Can Tho University and the An Giang Fishery Company.

PhD in Aquaculture obtained in 1999 at the INAPG [(2)] about the artificial reproduction of two Mekong catfish species raised in southern Vietnam, *P.bocourti* and *P. hypophthalmus.*

Master's degree in sciences of animal productions obtained in 1993 at the INAPG [(2)].

Engineer in agronomy from the INAPG [(2)].

Bachelor's degree in biology-biochemistry from the ENSP [(3)].

[(1)]: Centre de coopération international en recherche agronomique pour le développement, Département élevage et médecine vétérinaire (Montpellier, France).

[(2):] Institut National Agronomique Paris-Grignon (France),

[(3):] Ecole Normale Supérieure de Paris (France).

Le Thanh Hung

Vietnamese, born in 1954 in Vietnam,

Scientist and lecturer, Vice dean of the Department of Fishery and Aquaculture of the CAF [(1)],

PhD in Aquaculture obtained in 1999 at the INAPG [(2)] about the larval rearing and the nutrition of two Mekong catfish species raised in southern Vietnam, *P.bocourti* and *P. hypophthalmus*.

Master's degrees in aquaculture obtained in 1989 at the AIT [(3)] and in sciences of animal productions in 1995 at the INAPG [(2)].

Engineer in aquaculture from the CAF [(1)].

[(1)]: College of Agriculture and Forestry, National University (Ho-Chi-Minh City, Viet Nam),

[(2)]: Asian Institute of Technology (Bangkok, Thailand),

[(3)]: Institut National Agronomique Paris-Grignon (France).