

Main Species of *siluriformes* from the Flooded Fields of the Maranhão Plain with Zootechnical Potential

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Abstract:- The flooded fields of Maranhão form an immense floodplain, variable according to the rainfall regime in the region, whose characteristics are conducive to the feeding, reproduction and growth of various species, with considerable commercial interest and with morphophysiological aspects that suggest a adaptability for feedlot fish production. Thus, this study aimed to elucidate the main species of *siluriformes* in the flooded fields of the plains of Maranhão with zootechnical potential. Through literary review, three catfish species of the order *Siluriformes*, *Pimelodus blochii*, *Hemisorubim platyrhynchos* and *Trachelyopterus galeatus*, whose size reached 25, 50 and 18 cm, respectively, were identified. The studies approached suggest that different sizes of granules in the diets are administered according to the size of the species, also varying the percentages of proteins in the composition of the diets according to the feeding habits and the confinement periods, observing the stock densities and the feed conversion rates. As the consumption of these species of fish is very frequent in regional cuisine, the intense demand has led to practices that include overfishing and the imprisonment of fish in flooded lakes and fields, making it difficult to conclude processes of reproductive and food migration. Thus, with more studies in the literature, it will be possible to obtain more knowledge about techniques that assist in zootechnical production, which will allow the knowledge of methods of confinement and the massification of large-scale production, which will provide services to a population in need of food, in addition to the conservation and restoration of the natural stocks of these fish species.

Keywords:- *Pisciculture, Siluriformes, Fish production, Zootechnics.*

I. INTRODUCTION

The neotropical region, which comprises the continental environments of the extreme south of North America (Southern México), all of Central and South America, is certainly more diverse, with more than 7.000 species of fish recognized [1]. Only the Brazilian territory, in the area, represents more than 50% of the Neotropical region [2].

Among the countries with the greatest potential for aquaculture, Brazil has a prominent role, especially for its water availability, favorable climate and natural occurrence of aquatic species that make zootechnical and market interests compatible [3]. In this way, the production of native fish has been growing significantly in national aquaculture and has a strong popular appeal, either because of cultural factors or even due to the pleasant taste of the meat of most of them.

In Brazil, aquaculture has advanced due to the diverse species of fish that have shown potential for commercial production, in addition to the availability of inputs and the diffusion of technologies aimed at fish production [4]. Studies have shown that the Brazilian population already consumes fish above the average recommended by the World Health Organization (WHO), approximately 12.0 kg per inhabitant / year [5].

Due to the growing situation, as well as the potential observed, it is suggested to intensify studies, which include aspects such as resistance to pathogens, adaptability to cultivation and feed conversion of some native species from the rivers Mearim, Pindaré, Grajaú and Pericumã, which, when overflow, form an immense flooded plain [6]. These fish use the flooded fields during the flood period as habitat, for breeding and feeding, and are occasionally confined as a result of entering the structures by production through pumping during the dry season.

The hydrological cycle of the region establishes that the mentioned natural fields are always flooded during the first semester of the year, a period popularly known as “winter”, the region's rainy season. In the second semester, “summer”, these regions become dry, a time when the land is transformed into pasture [7]. With the spread of commercial fish farming in the region and the overexploitation of fish stocks, the construction of excavated tanks for the intensification of fish production stands out, which also allows the impoundment of rainwater [8].

Relating the three species of the order *Siluriformes*, the *Pimelodus blochii* (*P. blochii*), *Hemisorubim platyrhynchos* (*H. platyrhynchos*) and the *Trachelyopterus galeatus* (*T. galeatus*) selected for the present study, despite the morphophysiological differences, have a strong popular appreciation, being consumed regionally, evidencing the need to investigate the spread of fish farming with native species [9], the largest portion of which reaches the consumer comes from extractive fishing. However, due to

dams in the rivers, their pollution and the deforestation of riparian forests, caused a reduction in stocks, and the inclusion of these animals in commercial fish farming is increasingly recommended [10]. Thus, this study aimed to elucidate the main species of *siluriformes* in the flooded fields of the plains of Maranhão with zootechnical potential.

II. METHODOLOGY

A. Study area

The Maranhense microregion (1° 59' - 4° 00'S and 44° 21' - 45° 33'W) belongs to the northern Maranhense mesoregion and is located west of the state of Maranhão. The region is divided into 21 municipalities and has an area of 17,579,366 km², with an estimated population of 563,877 inhabitants (Figure. 1) [11]. It is a region subject to the peculiarities of the water regime, formed by the hydrographic basins of the Mearim, Pindaré, Pericumã, Aurá and Turiaçu rivers, which annually overflow and flood the low plains of the region [12].

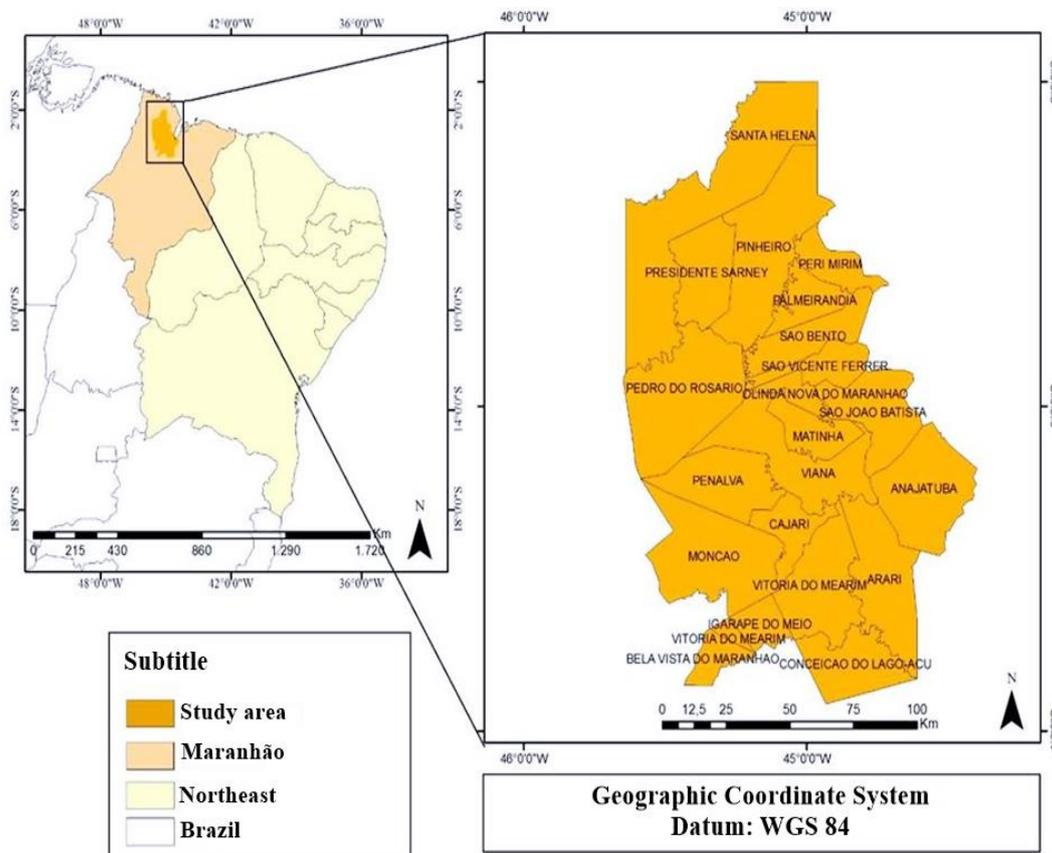


Fig 1:- Illustrative image of the study area.

B. Literary review and data analysis

This research followed the descriptive method through a review based on research in national and international databases. Thus, collecting information from articles, books, Dissertations and theses. The research followed the method of Souza and collaborators [13], with some modifications. The study was carried out between January and August 2019, where publications from the last 10 years were

selected, considering the Portuguese and English languages. The databases used in this research were: Crossref Metadata Search, Directory of Open Access Journals (DOAJ), Electronic Scientific Online Library (SciELO) and CAPES Magazine Portal. Thus, species of fish native to the flooded fields of the Maranhão microregion were chosen for this study. The descriptors used were: Maranhão flooded fields, Pisciculture and *Siluriformes*.

III. RESULTS

In the databases used in this study, few articles, theses and patents related to the descriptors were obtained, and in the Scielo database, using the descriptor: “Fields flooded in Maranhão”, only one article was found, with the title: “Chemical composition and antioxidant activity of geoproducts produced by *Melipona fasciculata* (Meliponinae) in flooded fields and cerrado areas of Maranhão State, northeastern Brazil”. And for the

descriptor: “Piscicultura”, 422 studies were found, from articles, theses and patents, of which 304 are from Brazil, 55 from Colombia, 24 from Chile, 10 from Venezuela, 6 from Spain, 5 from Argentina, 5 from Costa Rica, 5 from Peru, 5 Portugal, 2 from Mexico and 1 from Uruguay. The findings for the descriptor: “*Siluriformes*”, 653 studies were found, of which 543 are from Brazil, 25 from Chile, 24 from Colombia, 21 from Costa Rica, 16 from Argentina, 11 from Mexico, 7 from Peru, 5 from Venezuela and 1 from Paraguay, as shown in Table 1.

Countries	Keywords		
	Flooded fields in Maranhão	Piscicultura	<i>Siluriformes</i>
Brazil	1	304	543
Chile	-	24	25
Colombia	-	55	24
Costa Rica	-	5	21
Argentina	-	5	16
Mexico	-	2	11
Peru	-	5	7
Venezuela	-	10	5
Paraguay	-	-	1
Spain	-	6	-
Portugal	-	5	-
Uruguay	-	1	-
Total	1	422	653

Table 1:- Studies found in the Scielo database with the descriptors: Flooded fields in Maranhão; Piscicultura; and *Siluriformes*.

In the Crossref Metadata Search database, a total of 56,793 studies were found related to “flooded fields in Maranhão”, with 55,208 of these studies being articles, 1026 dissertations and 559 books. For the descriptor

“Piscicultura”, 153 studies were found, of which 141 are articles and 12 dissertations, and for the descriptor: “*Siluriformes*”, 3,852 studies were found, with 1894 being articles and 32 dissertations, as shown in Table 2.

Publication Type	Crossref Metadata Search		
	Flooded fields in Maranhão	Piscicultura	<i>Siluriformes</i>
Articles	55.208	141	1894
Dissertations	1.026	12	32
Books	559	-	-
Total	56.793	153	3.852
Publication Type	Directory of Open Access Journals (DOAJ)		
	Flooded fields in Maranhão	Piscicultura	<i>Siluriformes</i>
Articles	1	383	862
Total	1	383	862
Publication Type	CAPES Magazine Portal		
	Flooded fields in Maranhão	Piscicultura	<i>Siluriformes</i>
Articles	-	2.777	6.906
Dissertations	-	-	-
Books	5	14	4
Theses	-	8	-
Total	5	2.799	6.910

Table 2:- Studies found in the Crossref Metadata Search database, Directory of Open Access Journals (DOAJ) and CAPES Journal Portal with the descriptors: Flooded fields in Maranhão; Piscicultura; and *Siluriformes*.

In the DOAJ database, few studies related to ichthyofauna were also found, where the findings for the descriptor “flooded fields in Maranhão” were of only one article, with the title “Species-area relationship in murundus fields with different histories of perturbação”, for the descriptor “Piscicultura”, 383 articles were found and for the descriptor “*Siluriformes*”, 862 articles were found, as follows in Table 2.

For the CAPES Journal Portal database, the results are similar, using the descriptor “Flooded fields in Maranhão”, 5 studies were found, where the 5 are books. For the descriptor “Piscicultura”, 2,799 studies related to pisciculture were found, of these, 2,777 are articles, 14 books and 8 theses. For the descriptor “*Siluriformes*”, 6,910 studies were found, of which 6,906 are articles and only 4 are books, as shown in Table 2.

These results show the need for studies related to potentially productive fish that inhabit production for consumption, as well as for the Maranhão microregion. The lack of extensive data on ichthyofauna is evident, however, 21 fish species were identified and captured in the municipality of São Bento-MA [14]. In the book “Peixe do Mearim” published by Soares in 2005 [15], it has a survey of the fish species that live in the Mearim River, of these, 60 species are found in the flooded fields of the Maranhão microregion, with favorable conditions for feeding and reproduction.

The ichthyofauna in the region is subject to the overflow of the Mearim, Pindaré, Grajaú and Pericumã rivers. Thus, a large number of fish are found in these wetlands, however, the scientific data that correlate biological characteristics to a zootechnical profile of these fish is insufficient [15].

Several species of fish native to the region are of great importance in human nutrition, especially for riverside dwellers and fishermen, which is why they are the target of intense fishing, also presenting desirable zootechnical characteristics for confinement, among which we highlight three catfish of the order of the *Siluriformes*, *Trachelyopterus galeatus*, *Pimelodus blochii* and *Hemisorubim platyrhynchos* that have great commercial interest due to the intense demand of the population, which suggests a review of the literature on these species, as well as their potential.

A. *Trachelyopterus galeatus*

The *Trachelyopterus galeatus* (*T. galeatus*), popularly known as “Capadinho” is a species of the order *Siluriformes*, of the family Auchenipteridae, with relative economic importance and much consumed by the population of the Maranhão region (Figure 2). It is an omnivorous species, with its diet based on fruits, seeds and invertebrates, mainly ants, termites, spiders, hemiptera, odonata, crustaceans and mollusks [16]. It has a nocturnal habit, is sedentary, with internal fertilization (with the presence of a gonopod) and spawning in installments [17].

The species is an important link in the transfer of energy from the terrestrial system to the aquatic system [17].

Studies on the feeding of adults of this species in different hydrographic basins classify it as omnivorous, with a tendency towards insectivory, which was verified through a study carried out on the morphological development of the digestive tract, with emphasis on the mouth and the digestive tube, where they verified the modification of the diet along the ontogeny, where it was found that the initial diet of *T. galeatus* was composed mainly of aquatic insects and microcrustaceans, however, there was an intraspecific variation between the preferred items, as well as in the number of prey consumed along of its development, which demonstrates that the species has a high protein demand, suggesting that in the formulation of diets for the species, a high content of protein of animal origin is used [18].



Fig 2:- Illustrative image of a fish *Trachelyopterus galeatus*.

Regarding reproductive characteristics, as well as the adaptability of the species to induced reproduction, Santos and collaborators [19] mention that *T. galeatus* reached gonadal maturation for pituitary between October and February, coinciding with the local rainy season, and that males and females, were subjected to hormonal induction through intraperitoneal injections of crude carp pituitary extract (CPE), showing that spawning induced by hypophysation can be considered satisfactory for the species, since 67% of the females released healthy, fertilized oocytes using methodology.

B. *Pimelodus blochii*

The *Pimelodus blochii* (*P. blochii*), popularly called “mandi”, has a wide distribution in flooded rivers, being this name applied to any fish of the genus *Pimelodus* (Figure 3) [20]. The *P. blochii* lives and feeds mainly at the bottom of rivers, with a varied diet, composed of insect larvae, algae, molluscs, fragments of fish and vegetables. It is considered an important species for subsistence fishing, has low commercial cost due to its small size and great abundance. According to production, species may have an industrialization potential, obtained from fishing or cultivated in tanks [21].



Fig 3:- Illustrative image of a *Pimelodus blochii* fish.

Studies conducted in the middle Magda Lena River Basin, Colombia, analyzed 384 specimens of *P. blochii* collected, and found that individuals consumed at least 58 different items during the three capture periods, mainly planktonic, benthic and macrophyte macroinvertebrates. At least 16 different taxa have been identified in the river dams: various types of insects, crustaceans and fish and even some terrestrial insects [*Orthoptera* and *Hymenoptera* (families *Vespidae*, *Formicidae* and *Ecytoninae*)]. Within plant material, it was common to find macrophyte root system absorbers and various types of seeds: grasses and legumes (*Fabaceae* family) [20].

Information on the reproductive behavior of *P. blochii*, in its habitat and in a confined environment is scarce, and for the production of its progenies to be successful, the use of hormonal substances is necessary to induce final maturation and ovulation [22]. *P. blochii* larvae were obtained by artificial reproduction of sexually mature individuals, using intraperitoneal injections in a single dose of Ovaprim®. Due to the rapid larval development of *P. blochii* in relation to other species of the same family, it was possible to know that the exact moment of the beginning of exogenous feeding was 24 h after hatching, which makes it possible to provide adequate food (in the size of $\pm 18 \mu\text{m}$ of particle texture), aiming to decrease the high mortalities that appear in this stage [22].

C. *Hemisorubim platyrhynchos*

The *Hemisorubim platyrhynchos*, popularly known as "Lírio" or "Jurupoca", is a medium-sized species, belonging to the *Pimelodidae* family and occurs in the great rivers of South America, in the basins of the Amazon, Maroni, Orinoco and Paraná rivers (Figure 4) [23]. It is a carnivore, predator of benthic and fish microfauna, with a longevity of 11.4 years, reaching up to 64 cm in length. The first sexual maturation occurs with 30.1 cm in length, with its spawning action during the flood period between December and January. In addition, *H. platyrhynchos* is a long-distance migratory species, in addition to being a species susceptible to environmental degradation and predatory fishing [23].



Fig 4:- Illustrative image of a *Hemisorubim platyrhynchos* fish.

In Brazil, it is considered a noble species and of great commercial value. This species has great potential for consumption, with a representative value in fisheries production of inland waters, due to the size of the animals and the quality of the meat, which presents an attractive color, firm texture, low fat content and absence of intramuscular bones - spines. It is also used in ornamental fish farming, due to the color pattern of the species [24].

Studies of induced reproduction were carried out on specimens of *H. platyrhynchos* from the upper Paraná River basin, at the Jupiá Fish Farming Station, belonging to Companhia Energética de São Paulo (CESP), in the municipality of Castilho, State of São Paulo, in 2007. After the spawning action of females induced to reproduction, samples were collected according to the degree of development of eggs and larvae. Eggs were collected immediately after hydration, with two-hour intervals until hatching. The larvae were collected from hatching to complete absorption of the yolk sac, at intervals of two to six hours. After this period, larvae and juveniles were collected periodically every twelve hours. Eggs, larvae and juveniles were previously anesthetized with benzocaine and later fixed in a 4% formaldehyde solution buffered with calcium carbonate. *H. platyrhynchos* showed embryonic development with characteristics similar to those of most freshwater teleosts [23].

According to the work reported above, the species responds positively to hormonal induction, requiring studies related to the physical-chemical parameters of the water, necessary for maximum possible survival, as well as later levels of proteins required at each stage of development. Studies were conducted by Oliveira et al [25]. Using *H. platyrhynchos*, in a net tank in mining ponds, aiming at rehabilitation of the area and concluded that the cultivation of the species can be considered ideal in the stocking density of 15 fish for m^3 , where weight and length gains were favorable to the development of confined fish, indicating that the production of this species in the Amazon has a high potential for adaptation, suggesting cultivation in the southeast region and in mining ponds.

IV. DISCUSSION

Among the more detailed studies related to the taxonomic survey of the ichthyofauna in the flooded fields, we can mention the book “Peixe do Mearim”, conducted by Soares (2005) [15] in the lower São Francisco region, whose content reports biological and morphological characteristics of the main species present in hydrographic basin. In a previous analysis it was possible to detect that the difference in the average growth patterns between the catfishes covered, where *T. galeatus* reaches 18 cm in length, despite the small size being the most appreciated species in the cuisine of the municipalities that cover the lowered, whose average price practiced in local markets and open markets reaches the value of R\$ 25.00 in Brazil. The *P. blochii*, reaches an average size of 25 cm in length, being the most common species among the three, and *H. platyrhynchos* the largest species analyzed, whose total length is 50 cm [17] [22] [23].

After the literary review, whose works report zootechnical peculiarities of the three catfish species of the order of the *siluriformes* and here in question, *P. blochii*, *H. platyrhynchos* and *T. galeatus*, it is emphasized that all have zootechnical conditions, conducive to cultivation, being widely accepted among the population of the micro-region addressed, reaching excellent market values. Regarding the protein content of the artificial diet, studies show that *T. galeatus* and *P. blochii*, despite being omnivorous, have an insectivorous tendency, indicating the need for a high and specific protein content in the constitution of the feed [21] [24].

Associated with this, *H. platyrhynchos*, has a carnivorous food habit, consequently demand for a higher protein percentage of animal origin. According to Sousa et al. [26], the larger ratio of the size of the specimens is related to the amount of food available in view of the high fishing productivity that can partly be associated with the available organic matter. Right from works with the reproduction of *T. galeatus*, or offering commercial feed to fish confined in cultivation structures, it is possible to obtain larger and more robust fish.

Thus, the evaluation of body composition is important for the commercial use of its meat, because according to the body yield, the species may have a potential for industrialization, whether obtained from fishing or cultivated in tanks. The average yield of the 50.32% fillet registered for *P. blochii* is slightly higher than that registered for other species of *siluriformes*, indicating that this species has great potential for commercial exploitation. Based on these results, combined with its commercial value, *P. blochii* can be configured as an alternative to be used as food for the low-income population, also presenting a positive aspect for possible commercial exploitation. However, further studies on reproduction, eating habits and growth of this species are necessary [21].

Still on the fish mentioned in this study, we highlight the zootechnical development of the species, which point to considerable morphometric and physiological characteristics for production, in addition, we highlight management and feeding techniques that can be adopted in large scale fish production, providing the population riverside, biological and commercial aptitude for social and sustainable development.

V. CONCLUSION

Bibliographic surveys show the need for studies on ichthyofauna, as the number of studies available in the literature is not sufficient to obtain data regarding the various fish species in the micro-region, the results are even smaller for studies of ichthyofauna in the micro-region of Maranhão, the which makes it impossible for the community in general to obtain information for technical and social enrichment, in addition to hindering the scientific community about the types of fish in the micro-region and the types of zootechnical production developed.

However, it is possible to obtain results that show a richness of the maranhão micro-region, where secular fishing practices are linked to the region of flooded fields and the water cycle, whose peculiarities allow the reproduction of countless fish species present in Mearim, Grajaú, Pindaré and Pericumã rivers.

From this review, the profile of three fish of the order of the *siluriformes* was drawn, *P. blochii*, *H. platyrhynchos* and *T. galeatus*, whose characteristics point to an excellent zootechnical potential, suggesting that there are complementary scientific studies that allow confinement and the massification of large-scale production, which will provide services to a population that lacks food, in addition to the conservation and restoration of the natural stocks of these species.

Note: Our study does not require ethics committee permission.

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