



## Status of Investigation on *Potamon ebonyicum* (Freshwater Crab) in Ebonyi River Basin: A Strategic Review

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**Abstract:** Freshwater crabs are sensitive to environmental degradation and pollution, which determine adaption and redistribution to favourable habitats. Many of them have been redistributed as a result of rapid changes in their environment. *Potamon ebonyicum* found in large numbers in Ebonyi state has such adaption capacity as other freshwater crab species which has been expressed by a non-linear relationship between morphometric and reproductive variables. Unfortunately, waste discharge and emissions from stone crushing activities in the basin have resulted in bioaccumulation of nonessential elements in some of the crabs. This phenomenon has however not diminished the essential-element content of most of them. The decline in the population of the crab species in recent years may have been induced by environmental restructuring, agricultural development and over exploitation in the state. The male population was higher than that of females and the food conversion rate in small crabs was higher than in the big ones. Most of the investigations carried out in intensive aquaculture systems resulted in insignificant growth. However, the growth rate of the male was lower than that of the female and use of the earthen or enclosure systems with soil substrate might enhance the rate. Further investigation on gender population dynamics, reproduction capacity, and behaviour might ensure sustainable management of the crab resources.

**Keywords:** Freshwater crab, *Potamon ebonyicum*, Ebonyi River basin, Research status, Review

### 1. INTRODUCTION

Freshwater crabs are shell fish with distinct reproductive behaviour. The main reason is that most of the land adapted species must return to water to release their eggs (Collin 1990; Akpaniteaku 2013). They are redistributed throughout the tropics and subtropics, and display direct developmental and maternal care of a small number of offsprings compared to marine crabs. The marine species can release thousands of larvae and pre-adaptation for terrestrial living is just the needed physiological change as the crabs have often evolved from the freshwater (Dobson 2004). They can burrow into the mud in environments that are sometimes kilometres away from their original habitats. Limitations of adaptive traits and their inability to complete reproduction process on land are very important in the biology of the crab. Also the abundant resources in the wild are yet to be properly managed as couple of investigations are ongoing. The regional investigation could however rely on a few available data (Akpaniteaku 2014a). Mudflats have been identified as areas that could support a high density of freshwater crabs as many of them have been sighted in one location. However, a few species are responsible for dominant percentage of the overall population. Their wide distribution and a relatively high number in different localities, the population was highly fragmented. Nevertheless, they could be under immediate and long term threats being influenced by human activities in their environment (Akpaniteaku & Emmanuel 2017). The impact of human activities on the environment such as drainage, water diversion, rice cultivation, habitat disturbance, pollution, and harvesting has resulted in degeneration of crab resources (Cumberlidge 2010, Akpaniteaku 2014a, Akpaniteaku & Emmanuel 2017). They are now found in habitats without mangroves and have an independent relationship with the forest. The crab can also relocate instinctively in the night when most of them are active.

The specie *Potamon ebonyicum* are very sensitive to new environments and would struggle to quickly escape from captivity. The rough surface is of the essence and supportive during the movement as they navigate their way (Akpaniteaku 2014a). This observation was based on how they could struggle

to escape in the night, especially the males. Specimens from various habitats around the Ebia stream in the Ebonyi River basin were the culprits (Akpaniteaku 2013). Environmental conditions and feeding habits were probably responsible for this nocturnal movement. Enclosing the crab species in a smooth-surface receptacle during the investigation was better than in other kinds of receptacles. Most of the regional investigations, notably aquaculture were more interested in such genera as *Scylla*, *Potamon* and *Eriocheir* than other freshwater crabs, and many of the rearing facilities were dependent on wild seed stock. However, pesticides and industrial influence have gradually contributed to the reduction in their population as well as insufficiency in supply of the seeds (Akpaniteaku Pers. obs.). Although some research works were focused on a few of the crab species, the investigators were mainly interested in the marine crabs probably due to availability of relevant information. As a recently introduced freshwater crab species, the *P. ebonyicum* has not attracted much attention and the present review could provide some relevant information. The review could also serve as a guide to further investigations.

## 2. AQUACULTURE POTENTIAL OF EBONYI MUD CRAB

Population size and fecundity are some of the crucial aspects of the ongoing investigation (Table 1). The size of the egg and abdominal flap could be responsible for a comparably low population of the freshwater crab species. The species exhibits a negative correlation between weight and fecundity and between size and fecundity. The population of the males surveyed between March and May 2014 was higher than that of the females especially in the endemic area (Akpaniteaku 2014b). The size of the gravid female could not be a yard stick for determining the population of offspring as their reduction in the wild necessitated investigation on the preliminary aspect of cultivation. The population size and reproduction capacity are some of the factors that could determine the sustainability of crab aquaculture (Akpaniteaku 2014a). Microhabitats around rivulets and swampy areas could be exploited with local gear made of sliced bamboo and such attractants as pieces of polyethylene material or edible insects (Akpaniteaku & Emmanuel 2017). The abdominal flap of the female has the same red colourations as the crab, while that of the male (white colouration) is different from its colour. This can be used in addition to a U-shape abdomen to isolate the female from experimental specimens. The abdomen of mature female must change from the rounded form, and gravid ones should be identified by pressing and pushing the first abdominal segment next to the carapace (Akpaniteaku 2014b)

**Table 1.** Aspects of the survey carried out on *Potamon ebonyicum* in Ebonyi river basin

Type of Investigation	Sample Zone	Habitat	Year	Carapace Width(CW)	Weight range (g)
Cultivability and feeding	Ebia stream	Flood plain	2013	----	25.00–54.00
Fecundity survey	Ebia stream	Flood plan	2014	3.50 – 5.20	43.00–58.00
Gravid crab condition	Ogalagu community	Flood plain	2015	4.70 – 5.20	58.00–85.00
Feed utilization	Okpurukpu stream	Farm land	2016	3.50 – 5.60	51.00–67.00
Larval acclimatization and feeding	Okpurukpu stream	Farm land	2017	0.48 – 0.49*	0.06 – 0.07

\*mm

*Source:* Akpaniteaku (2013, 2014, 2015, 2016 & 2017)

The growth rate in the male with higher initial weight was lower than that of the female (Akpaniteaku 2015) and they could initially survive for 3-4 weeks in captivity with freshwater depth of 5cm or more. Prior to casualty records, some of the females were able to survive for more than 3 weeks in holding tanks. The growth rate was insignificant and uneven as recorded across population densities. Morphometric range for experimental specimens included, weight 31.10 - 67.00 g, carapace width (CW) 1.80 to 2.60 cm, and carapace length (CL) 1.10 to 1.70 cm (Akpaniteaku and Oguayo, 2019). The scarcity of data on population density and its effect on survival was apparent at the beginning of the investigation, thus the need for preliminary experimentation on stocking density (SD). Acclimatization in a plastic receptacle with a water depth of 5 cm, p<sup>H</sup> of 6.92 and temperature of 31.30<sup>0</sup>c can last for 72 hrs. Residual stress resulting from poor handling could affect the rate of survival in captivity. Loss of appetite and resultant weight reduction could be induced by water quality related stress (Akpaniteaku & Oguayo 2019). A negative correlation between experimental

treatments and termination values was possible and dependent on gender ratio just as stocking of equal number of males and females might result in better yield even at a reasonably high stocking density. The size of crabling has been recognized as one of the major determinants of yield in experimental aquaculture since acclimatization must be properly done before stocking (Akpaniteaku & Oguayo 2019).

### **3. BIOLOGY AND FISHERIES**

A large number of the population of the *P. ebonyicum* appeared to have been established around tributaries of the river basin (Akpaniteaku 2014b). Stray ones occasionally observed around homestead and walkways were comparably lower than the sizeable number in recent years. The population growth index could be determined with further investigation around the Ogalagu and Idembia areas of the basin. The weight of the crab (WC) can be easily determined with variables, the weight of the trap (WT), the weight of specimen (WX) and the WC using the formula,  $WC = WX - WT$  (Akpaniteaku 2014b). The impact of weight (WI) on gravid females is determined by using the variables, weight of the gravid female (WG), weight of extracted eggs (WE), and weight of the crab without the eggs (WC). The  $WE = WG - WC$ , and  $WI = WE \times 100 / 1$  (Akpaniteaku 2014b). Morphometrics of the specimens can be obtained with flexible calibrated rule from the tip of the anterior carapace to the distal extremity at the precision of 0.5 mm (Akpaniteaku et al. 2018). The fecundity can be determined by direct enumeration and resultant data is analyzed by regression and correlation coefficient. Plotting of the fecundity against the weight and carapace width could be used to establish any relationships. The population isolates of male and female in an endemic area of the basin is 70% and 30% respectively. Percentage abundance in sampled areas was in favour of the male. The CW of the female ranged between 3.5 and 5.2 cm, and its weight ranged between 43.0 and 58.0 g. The relationship variable was insignificant and a correlation did not exist between fecundity and weight. The fecundity ranged between 49 and 184 eggs during verification and even among specimens with the same body weight. A population ratio of 2.0:1.0 (male:female) has so far been established in the basin (Akpaniteaku 2014). The maturity of the female could be attained at carapace width of 3.5 cm but the fecundity varied with the size and weight. There is no record of relationship between the fecundity and any of the morphometric variables (size and weight). Unlike in the marine crab species, the *P. ebonyicum* shows direct maternal care of a small number of offspring. The presence of the abdominal flap and the size of the egg could be the reason for relatively low fecundity (Akpaniteaku 2014b).

Body-mass index (BMI) for the crab species have been calculated using the total weight of the crab (TWC) including eggs in grams (g) and CW in centimeter squared ( $cm^2$ ),  $BMI = TWC \text{ g} / CW \text{ cm}^2$ . The BMI values ranged between 4.0 and 2.0 during the investigation. Most of the values that differed significantly were obtained between March and May. The eggs could be enumerated in a Petri dish after stripping. The colour can be determined without stripping just by opening the abdominal flap. The unripe ones are sticky and may not be able to detach from the sponge. Ocular micrometer is very useful in determining the size of the eggs (SE). The weight (EW) can be estimated using sample SW, the number of eggs sampled (NS), and the resultant formula  $EW = SW / NS$ . The weight of the egg mass (WM) using SW, NS, and the number of eggs in the ovary (NE) resulted in the formula  $WM = SW \times NE / NS$ . The egg mass index (EMI) can be determined by using WM and WC and the formula  $EMI = WM / WC \times 100 / 1$ . Although maximum (Max) and minimum (Min) EMI could change over time, 29.6 and 2.3 have been recorded for the months of April and May respectively (Akpaniteaku 2015). As reviewed in a recent survey, there were significant gaps in between the Min and Max EMI. The gaps probably indicate that the sponge is not as compact as the gonad of non shell fish. Characteristic colours of maturing eggs change between March and May. The egg could change from reddish through orange to dark orange during the period. And the egg colouration could be used for possible intervention in breeding (Akpaniteaku 2015).

Poor correlation exists between WC and CW, and also between EW and SE. There is no correlation between WC and egg mass. The BMI of the crab species has revealed that the weight of the female is usually enhanced during egg maturation. At full maturity the BMI could be possibly used to determine weight-related parameters in males and non gravid females. The dark-orange eggs are usually observed around May indicating that the embryo is transforming into a larva (zoea) (

Akpaniteaku 2015). The dark-orange colouration probably precedes the last prior to the release of zoea. Some of the specimens are laden with zoeae in April indicating that the period of spawning is variety specific. However, more mature eggs and hatchlings can be observed in May than in other months (Akpaniteaku 2015).

#### 4. CONSERVATION STRATEGIES

The poor correlation that exists between weight and size may have implicated the body structure of most crab species including the *P. ebonyicum*. And this could be a reflection of their capacity for adaptation. Fecundity variation in females with the same body weight could be proof that crab size is not a factor in estimating offspring. Seed intervention for the purpose of increasing the population of adult crabs is a conservation strategy that became necessary at the early stage of reproduction (Akpaniteaku 2015). The investigation could ordinarily emanate from the idea of evaluating growth performance with readily available fish feed. But as omnivores, the crab species might derive nutrients from the same feed stuff as catfish. Most of the specimens were obtained from Ishieke and Okpoto, latitude 6°25' 50.76" N longitude 7° 56' 16.37" E and latitude 6° 21' 41" N longitude 7°51' 50" E respectively. Randomly collected specimens from Ishieke and those from the bank of Okpurukpu (a seasonal stream) at Okpoto were all agile. Wholesome males and female weighing 52.2 - 53.9g and 63.4 - 66.8 g respectively could be acclimatized within 48 hrs (Akpaniteaku & Onyemara 2016). The nutrient composition of their feed (fish meal, wheat meal, and rice grains, and vegetable and fish oil) was the same as that of the catfish (Fig 1) which was well tolerated during the investigation. They could feed on pellets and regularly defecate in the water. Feed pellets of 9mm have been tried at 1.0 and 2.5% body weight, and they can be fed between 17.00 and 18.00 hrs. Dropping the pellets in the water would attract and encourage them to start feeding. They could get scared initially but would later cling to the pellets with their pincers (Akpaniteaku 2016).

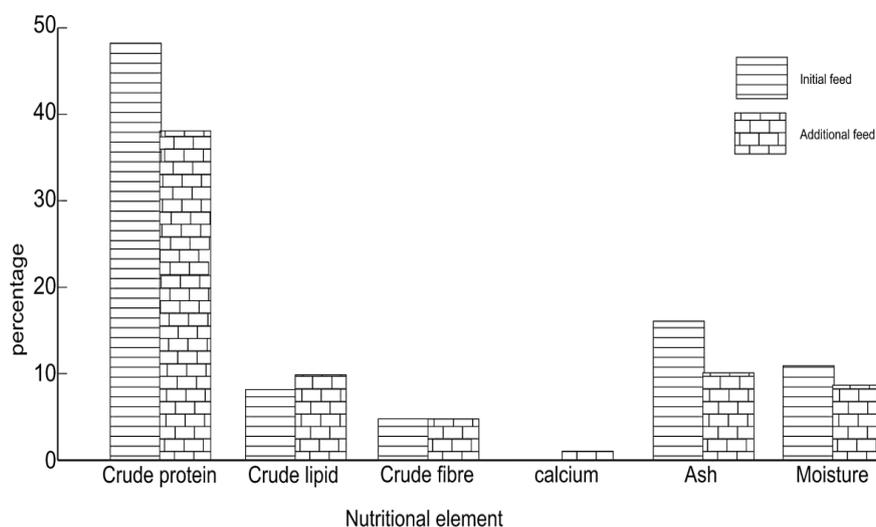


Fig 1: Nutrient composition of feed used during the investigation on *Potamon ebonyicum*

Source: Akpaniteaku (2013).

Sampling should be done with water renewal and such basic materials as a trap, measuring tape, and weighing scale are required during the process. The WC can be determined by subtracting the weight of the trap (WT) from the weight of the specimen and trap (WCT),  $WC = WCT - WT$ . Food conversion ratio (CR) can be determined by dividing the weight of food consumed (FC) by the value of the weight obtained after subtracting weight at stocking (WS) from the weight obtained during sampling i.e. weight at harvest (WH),  $CR = FC / (WH - WS)$ . The correlation between increment in CW and weight gain in both males and females is strong. A significantly low but gender-based growth increment has been observed during the investigation. The rate of growth was higher in the male than in the female. Small specimens tend to gain more weight and also grow faster than the big ones. The highest weight has been recorded in the male at CR 5.21 and in the female at CR 3.24. Food conversion is low in heavy females and sometimes at the rate of 21.02.

Small crabs have proved to be more efficient in food conversion than the big ones. Groups of small males and females have however recorded CR of 32.16 and 19.95 respectively. The latent growth reserve (LGR) in the small crab could be responsible for the relatively high CR (Akpaniteaku 2015).

Biomass value in the freshwater crabs is sometimes under estimated but sustainability of conservation is as feasible as in the cultivation. The zoea can be easily identified as they crawl around the pouch of the female brooder. They can be separated from the brooder and transferred into a plastic receptacle with a water depth of 5.0cm. They have successfully gone through rough transit conditions for about 2 hours. They could cling on to one another forming a temporary colony (zoea bulb) in transit. The “zoea bulb” could be a defensive mechanism of the early and delicate stage, which has not been investigated. The zoeae can remain in colony form throughout the transit period, especially on a rough route. This transportation system could encourage cannibalism as the population would often decrease after being dispersed. Unlike in crabbing and some adults, the legs of the zoea would comfortably hold on to the plastic surface and the urge to escape might last for more than 3 days. The acclimation process might take 2 - 4 days, and feeding should be avoided on the first day (Akpaniteaku 2017).

The zoea can be sparingly fed with the catfish feed and decapsulated artemia at 5% body weight. Natural and supplementary food can be fed once a day between 18.00 and 20.00 hrs. Renewal of water in the receptacle could start from the third day of the experiment with frequency dependent on response and accumulation of feed remnants and fecal matter. Hanging out occasionally on the surface of the receptacle is their common behavior, especially at the early stage of the experiment (Akpaniteaku 2017). When fully acclimatized the zoea would respond to any external aggression by quickly crawling back to the water. At this stage of the experiment, most escapees could find their way back to the position of the receptacle. Seed stock from the wild might take up to 7 days to acclimatize. The mortality rate could be higher in the first few days after stocking than in the rest of the experimental period. Gender differentiation is difficult even at the 0.5 mm stage of growth, except with the aid of a microscope. Moulting of the zoea is possible, especially during the full moon (Akpaniteaku 2017). Moulting of the carapace beginning from 14-17 days after separation from the brooder and during the full moon aligns growth with an increase in gravitational pull which is associated with the period. The survival rate of the zoea during the experiment might depend on the level of cannibalism even at that stage of development (Akpaniteaku 2017).

## **5. CONCLUSION**

The research status of the *P. ebonyicum* is relevant to further inquiry and sustainable management of the crab fishery. Nutrient flexibility and cultivable characteristics of the crab species have already been exposed through preliminary investigations. Holding the crab species captive with catfish feed as a source of nutrient was very strategic for further investigation in crab aquaculture. Disparity in gender population could be resolved by selective breeding and regulatory authority should ensure that crabbing efforts are not targeted at gravid females, especially those that are laden with dark-orange eggs. Conservation activities that would enhance the population of the crab species and promote extensive aquaculture could be initiated to encourage brooders to release zoeae in controlled pools and flood ponds. Adequate arrangements should be made by investigators to transport larval specimens with the brooder so that colony formation and cannibalism can be minimized. Promoters of crab aquaculture should embark on follow up research and also assist financially in such investigations that aim at minimizing crabbing efforts. The crab population in the wild might still be optimized and appropriate measures should be taken progressively through strategic innovation, cultivation, and careful exploitation.

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