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Evaluation of sexual dimorphism in the African snakehead fish *Parachanna obscura* (Günter, 1861) by morphometric parameters in Southern Benin

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Abstract
Parachanna obscura is a fresh water teleost that presents some difficulties in sex identification. The current study aims to evaluate the sexual dimorphism in specimens of *P. obscura* of Lake Nokoué (Benin) through morphometric parameters, particularly the technic of Sexual Dimorphism Coefficient (SDC). This evaluation has been carried out based on parameters such as total length (TL), standard length (SL), tail length (TaL), weight (W), body circumference (BC), head length (HL), head circumference (HC), eye diameter (ED), length of the dorsal fin (L. Dors.) and the length of the anal fin (L. An.). Our results showed that mean and range values of the different parameters measured didn't vary significantly ($p \geq 0.05$) in males and females of *P. obscura*. The SDC_1 varied from 0.16 to 0.23 though SDC_2 varied from 0.34 to 0.48 all sexes included. Comparison of SDC values to standard values (0.20 for SDC_1 and 0.40 for SDC_2) has revealed significant differences ($p \leq 0.05$). Results also showed that 68.42% of males of *P. obscura* were characterized by $SDC_1 \geq 0.20$ and 69.7% of females by $SDC_1 < 0.20$. By the same way, 73.68% of males of *P. obscura* have $SDC_2 < 0.40$ though 60.60% of females were characterized by $SDC_2 \geq 0.40$.

Keywords: *Parachanna obscura*, lake nokoué, morphometric parameters, sexual dimorphism coefficient

1. Introduction
Snakehead fishes (Baily, 1994) are fresh water perciforms belonging to the family of Channidae. They are native to Africa (Parachanna) and Asia (Channa). According to Teugels *et al.* (1984) [13], the snakehead fish is a food fish with high nutritive and economic value and can be produced in aquaculture. It's characterized by highest nutritive value than Carps and Tilapias in term of protein and fatty acids (Sharma and Simlot, 1971; Daniel Ama-Abasi and Anthony Ogar, 2013) [11, 3]. *Parachanna obscura* is one of Channidae encountered in West-Africa though Benin (Syndenham, 1976). The fish is requested due to its medicinal and rejuvenating virtue and is especially recommended to patients for prompt recovery after serious illness or deliverance (Mat Jais *et al.*, 1998) [8]. It is morphologically characterized by an elongate and cylindrical body covered by cycloid scales. We can see a tentacle beside each nostril. The jaw is composed by pointed teeth. The fish possesses an accessory respiratory organ that enables it to breathe air (Das and Sexena, 1956; Graham, 1997) [5]. *Parachanna obscura* is essentially carnivorous (Victor and Akpocha, 1992; Bolaji *et al.*, 2011) [15]. It's a rustic fish species with rapid growth able to reach 500 mm (Olaosebikan and Raji, 1998) [10]. All these above-mentioned factors make this fish species a good candidate for aquaculture in Africa in general and particularly Benin. However, the sexual dimorphism is not yet known in *Parachanna obscura* till today. There is not external morphological aspect yet enabling to distinguish male from female. The observation of uro-genital papilla doesn't enable sex distinction because it has the same aspect in male and female. The only method used by researchers for sex distinction in *Parachanna obscura* is the dissection and gonads observation. This technic doesn't guaranty the preservation of the species because specimens die just after dissection. The sexual dimorphism is indispensable for the mastery of the reproduction of a species in captivity. Any prior study has been carried out on the sexual dimorphism of *Parachanna obscura* except the work of Vodounnou *et al.*, 2017 [16] through the analysis of morphometric and meristic parameters, length-weight relationship and condition factor. According to Vodounnou *et al.*, 2017 [16], males have longer tail than females. An allometric growth ($b < 3$) was recorded in males though an isometric growth ($b \approx 3$) was noticed in females. Condition factor in males was the double in females (Vodounnou *et al.*, 2017) [16]. Our study is partly focused on the morphometric parameters but especially the sexual dimorphism coefficient. The current study aims to find a method for evaluation of sexual dimorphism in *P. obscura* through the analysis of some morphometric parameters such as total length (TL), standard length (SL), tail length (TaL), weight (W), body circumference (BC), head length (HL), head circumference (HC), eye diameter (ED), length of the dorsal fin (L. Dors.) and the length of the anal fin (L. An.) and the establishment of some ratios such as TaL/SL; BC/SL; HC/BC and HL/HC of the fish. The male: female sex ratio has also been calculated.

2. Material and methods
2.1 Sampling and study area
The current study was carried out on Lake Nokoué and the station of fish farming diversification of the Research Laboratory on Wetlands of the Faculty of Sciences and Technologies (FAST) at University of Abomey-Calavi (UAC) in Benin Republic. Fifty-two (52) specimens of *Parachanna obscura* were collected randomly in Lake Nokoué at landing stage of Ganvié from May to July 2019 (03 months) through fishermen. They were kept alive in plastic buckets of 20L capacity containing fresh water and

then brought to the experimentation site. Fishes were stored in circular cemented ponds and daily fed on fish viscera.

2.2 Morphometric analyses

Specimens of *Parachanna obscura* were starved three days before measurement of the different parameters in order to avoid regurgitation and other metabolic activity during the process. They were then randomly dispatched by lot (10 specimens per pond). Morphometric measurements such as total length (TL), standard length (SL), tail length (TaL), weight (W), body circumference (BC), head length (HL), head circumference (HC), eye diameter (ED), length of the dorsal fin (L. Dors.) and the length of the anal fin (L. An.) were taken on each specimen. These parameters are labeled as followed:

Total length (TL): Distance from the apex of the mouth to the end of the caudal fin (cm);
Standard length (SL): Distance from the apex of the mouth to the tail peduncle (cm);
Tail length (TaL): Distance from the tail peduncle to the end of the tail (cm);
Body circumference (BC): It's the diameter of the fish body at the uro-genital papilla (cm);
Head length (HL): Distance from the apex of the mouth to the end of the opercula (cm);
Head circumference (HC): It's the diameter of the head of the fish at the opercula level (cm);
Eye diameter (ED): It's the space occupied by the eye of the fish (cm);
Length of the dorsal fin (L. Dors.): Distance from the beginning to the end of the dorsal fin (cm);
Length of the anal fin (L. An.): Distance from the beginning to the end of the anal fin (cm).

These measurements were taken by using an ichtyometer (PENTAIR Aquatic Eco-Systems) and weights were taken using an electronic scale (OHAUS). Fishes were captured individually from ponds by using a net and then measurements were taken on each live specimen.

Sexual Dimorphism Coefficients (SDC) were calculated through the establishment of four different ratios (SDC_1; SDC_2; SDC_3; SDC_4) among certain morphometric parameters in each specimen. These ratios were established through the following formulas:

$SDC_1 = TaL/SL$
$SDC_2 = BC/SL$
$SDC_3 = HC/BC$
$SDC_4 = HL/HC$

Where SDC = Sexual Dimorphism Coefficient;
TaL = Tail Length;
SL = Standard Length;
BC = Body Circumference;
HC = Head Circumference;
HL = Head Length.

Sexes (male or female) were determined on the base of SDC values obtained in each specimen. All the fifty-two (52) specimens were dissected and gonads were observed in order to appreciate the reliability of the SDC method initiated in the current study.

2.3 Statistical analyses

Statistical analyses were carried out using Statistica Software version 6. The student "t" test was used for comparison of SDC values recorded in each specimen to a standard value (0.20 for SDC_1 and 0.40 for SDC_2). Differences were appreciated at 5% significance threshold.

3. Results

Total weights following by total lengths of specimens varied from 41g (20.7 cm TL) and 103g (25 cm TL). It's important to notify that biggest specimens (103g total weight; 25 cm TL) encountered in the current study are males. Direct observation of the uro-genital papilla doesn't enable to distinguish male from female in *P. obscura*. Mean and range values of diverse morphometric parameters didn't present any significant difference ($p \geq 0.05$) in both males and females of *P. obscura* (Table 1). So, males and females specimens of *P. obscura* are characterized by the same morphology. We cannot focus only on parameters such as total length (TL), standard length (SL), tail length (TaL), weight (W), body circumference (BC), head length (HL), head circumference (HC), eye diameter (ED), length of the dorsal fin (L. Dors.) and the length of the anal fin (L. An.) to evaluate the sexual dimorphism in *P. obscura*.

Indeed, SDC_1 and SDC_2 present values varying in relation to sex (Figures 1 and 2). The comparison of these means to a standard value (0.20 for SDC_1 and 0.40 for SDC_2) by the student "t" test revealed significant differences ($p \leq 0.05$). Over the 52 specimens dissected, 19 were males (36.54%) and 33 females (63.46%) (Figure 1). Thus, the male: female sex ratio is 1:1.74 showing preponderance of females of *P. obscura* in our sample. Considering SDC values, over the 19 male specimens, 13 (68.42%) were characterized by $SDC_1 \geq 0.20$ and 06 (31.58%) $SDC_1 < 0.20$ on the one hand (Figure 1) and 14 (73.68%) had $SDC_2 < 0.40$ and 05 (26.32%) $SDC_2 \geq 0.40$ on the other hand (Figure 2). By the same way, of the 33 female specimens, 10 (30.30%) were characterized by $SDC_1 \geq 0.20$ and 23 (69.7%) by $SDC_1 < 0.20$ (Figure 1) on the one hand and 13 (39.40%) had $SDC_2 < 0.40$ and 20 (60.60%) with $SDC_2 \geq 0.40$ (Figure 2) on the other hand. SDC_3 and SDC_4 values didn't vary in relation to sex.

Table 1: Morphometric parameters measured in males and females of *P. obscura*.

Parameters	Sex	Number	Minimum	Maximum	Mean ± Range	Probability
Total length	♂ ♀	19 33	22 21.4	25 25.4	23.5±2.12 23.4±2.83	p≥0.05
Standard length	♂ ♀	19 33	18.4 18.2	20.4 20.5	19.4±1.41 19.35±1.63	p≥0.05
Tail length	♂ ♀	19 33	3.6 3	4.6 4.5	4.1±0.71 3.75±1.06	p≥0.05
Weight	♂ ♀	19 33	63 61	103 101	83±28.28 81±28.28	p≥0.05
Body circumference	♂ ♀	19 33	7.3 7	9 8.5	8.15±1.20 7.75±1.06	p≥0.05
Head length	♂ ♀	19 33	6.1 6	7 7	6.55±0.64 6.5±0.7	p≥0.05
Head circumference	♂ ♀	19 33	8.7 8.4	10.5 10	9.6±1.27 9.2±1.31	p≥0.05
Eye diameter	♂ ♀	19 33	0.7 0.7	0.8 0.8	0.75±0.07 0.75±0.07	p≥0.05
Length of the dorsal fin	♂ ♀	19 33	12 12	14 14.5	13±1.41 13.25±1.77	p≥0.05
Length of the anal fin	♂ ♀	19 33	8 8	10.4 10.5	9.2±1.70 9.25±1.77	p≥0.05

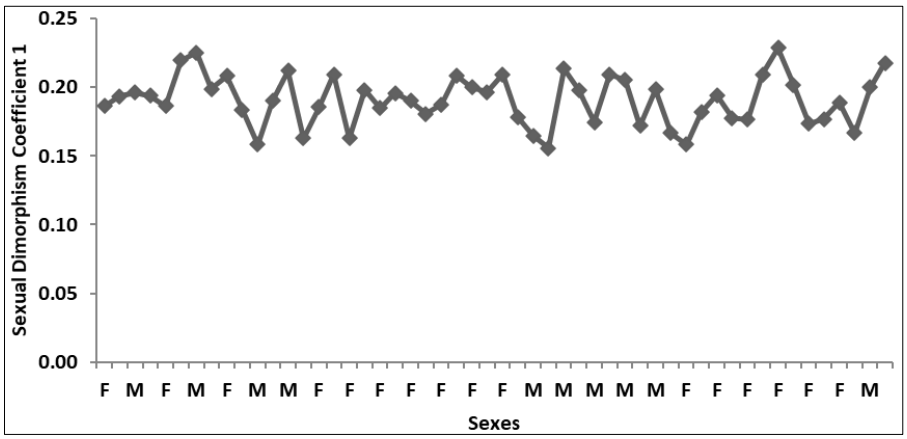

Fig 1: Variation of SDC_1 in relation to sex.

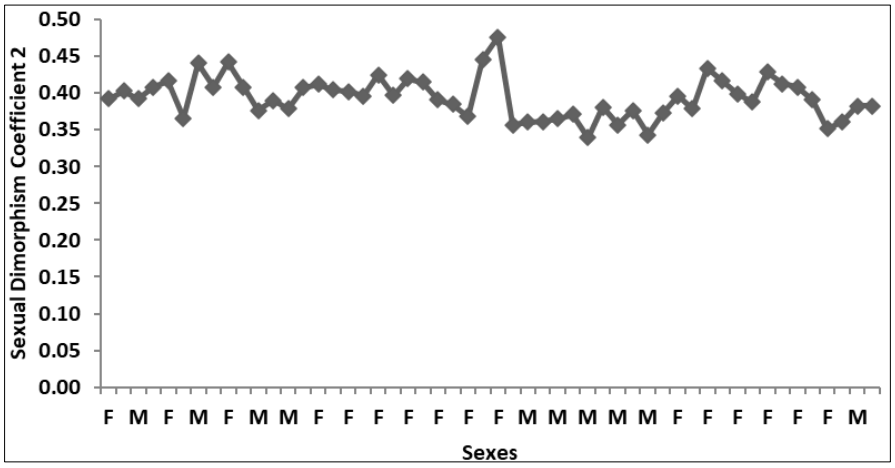

Fig 2: Variation of SDC_2 in relation to sex.

4. Discussion

As the selection was a random, male and female specimens of *P. obscura* were both sampled. Any external morphological characteristic was specific for sex distinction. Male and female present apparently the same morphology and their uro-genital papilla are similar. In addition, the biggest specimens (103g total weight; 25 cm TL) encountered in the current study were males. These results are in accordance with those of Isangedighi and Umoumoh (2011) [7] who reported that *Parachanna obscura* is a mono-morphic teleost characterized by an absence of viewable sexual dimorphism except the fact that males are bigger than females. Considering the tail length, mean and range values revealed that males have longer tail than females. These results are similar to those of Vodounnou *et al.* (2017) [16] who observed the same trend in specimens of *P. obscura* from Ouémé valley in Southern Benin. Although in our sample, some females have long tail. There are therefore some exceptions to our study.

The 1:1.74 male: female sex ratio obtained is in favor of females. Our results are higher than those of Odo *et al.* (2012) [9], Isangedighi and Umoumoh (2011) [7], Udoh and Daniel (2001) [14] who obtained respectively male: female ratios 1:1.3; 1:1.24 and 1:1.32. This sex ratio highly based on females in our study could be explained by the fact that specimens were sampled during a period of high reproductive activity where females are looking for spawning area and are so exposed to captures. According to the method of sexual dimorphism coefficient (SDC) developed in the current study, results showed that SDC_1 and SDC_2 vary in relation to sex. Indeed, high percentages of males of *P. obscura* 68.42% and 73.68% are respectively characterized by SDC_1 upper of equals to 0.20 and SDC_2 strictly lower than 0.40. We can conclude that to identify meanly 71% of males of *P. obscura* without dissecting them one can base on $SDC_1 \geq 0.20$ and $SDC_2 < 0.40$. Besides, 70% of females were characterized by SDC_1 strictly lower than 0.20 and 60.60% by SDC_2 upper or equals to 0.40. As a conclusion, to identify meanly 65% of females of *P. obscura* without dissecting them, we can base on $SDC_1 < 0.20$ and $SDC_2 \geq 0.40$. As SDC_3 and SDC_4 don't vary in relation to sex, they cannot serve to the evaluation of the sexual dimorphism in *P. obscura*.

5. Conclusion

Parachanna obscura is a teleost in which we meet some difficulties for sex identification. Our results showed that to target 71% of males of *P. obscura* without dissecting them, we can base on values of $SDC_1 \geq 0.20$ and $SDC_2 < 0.40$. By the same way, to identify 65% of females, we can base on values of $SDC_1 < 0.20$ and $SDC_2 \geq 0.40$.

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