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Comparative Study on the Condition Factor, Hematological and Serum Biochemical Parameters of Wild and Hatchery Collected Broodfish of the African Catfish *Heterobranchus longifilis* (Valenciennes 1840)

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Authors' contributions

This work was carried out in collaboration between both authors. Author EVO designed the study, performed the statistical analysis, wrote the protocol, and wrote the first draft of the manuscript. Author ANN managed the literature review and analyses of the study. Both authors read and approved the final manuscript.

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ABSTRACT

This study was conducted to investigate the condition factor, hematological and serum biochemical parameters of wild and hatchery collected broodfish of the African Catfish (*Heterobranchus longifilis*) and used as an indicator of their health condition. A total of 30 wild broodfish of the African Catfish, *Heterobranchus longifilis* (15 males and 15 females) of mean length (62.13 ± 0.80 cm) and mean body weight (1506.50 ± 44.82 g) were collected from Ayadehe, Itu Head Bridge and 30 broodfish (15 males and 15 females) of mean length (61.93 ± 0.69 cm) and mean body weight (1499.84 ± 46.28 g) were collected from a private hatchery located in Calabar, Cross River State, Nigeria, and used for the study. Results showed that there was no significant difference ($P > 0.05$)

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in the hematological parameters including PCV, WBC, Hemoglobin, RBC, MCV, MCH and MCHC of both male and female wild and hatchery-bred broodfish of *H. longifilis*. Similarly, there was no significant difference (P>0.05) in the serum biochemical parameters including cholesterol, triglyceride, total protein, albumin, globulin, glucose and urea in both male and female wild and hatchery-bred broodfish of *H. longifilis*. Condition factor of male, female and pooled sex of both the wild and hatchery broodfish of *H. longifilis* showed that the fishes were in healthy condition. Hematological and serum biochemical parameters are very useful tools in analyzing the health status of broodfish as they provide reliable information the stress status which could influence broodfish reproductive performance. The result of this study, along with other findings will provide a reference for catfish breeders and aquaculturists evaluating the health status of hatchery and wild *H. longifilis*.

Keywords: Condition factor; hematological parameters; serum biochemical parameters; wild broodfish; hatchery broodfish; African catfish Heterobranchus longifilis.

1. INTRODUCTION

With the annual increase in global population which has a projection of over nine billion people by 2050, sustainable food production to meet the demand has become serious challenge of global concern. Issues of under-nutrition such as micronutrient deficiencies continue to remain problematic especially in developing countries. In Nigeria, fish protein is a major part of diet since fish it is one of the cheapest sources of protein that is nutritionally rich and could be used to drastically reduce the issue of under-nutrition. According to Eyo et al, [1] and Awom and Eyo [2], the African Catfish is rich in nutrients such as omega-3- fatty acid, riboflavin, iron, thiamine, vitamins A, vitamin D, phosphorus, and calcium which is necessary for tissue development and good health. Declination in fish production through capture fisheries resulting from poor management of wild fisheries has indicated the need for a more resilient and responsible fish production system. According to World Bank [3], the future of fish supply-demand scenarios indicates that to meet growing global demand, there is need to double the production of fish and other aquatic animals by 2030. Aquaculture now becomes the most resilient, reliable and responsible means of producing fish at sustainable levels without leaving any footprint on the environment. However, for aquaculture to meet the present and future demand of fish protein, there is a need for aquaculture expansion and intensification [4]. In Nigeria, expansion, and intensification of aquaculture is hindered by several challenges. Scarcity and high cost of high-quality feed is a major challenge that farmers and intending farmers are facing. Lack of high-quality fingerlings produced from healthy broodfish is another challenge that has discouraged farmers due to poor growth of fish resulting in loss of money or very low profit margin. *Heterobranchus longifilis* is a species of the African Catfish belonging to the family Clariidae. According to Afia and Ofor [5], this species can grow up to the size of 14 kilograms. Documentation of Eyo and Ivon [6] shows that *H. longifilis* is an important aquaculture species in Nigeria due to several biological attributes such as hardy nature, fast growth rate, disease resistance, appreciable size, high fecundity, ease of induced breeding, tolerance of poor of environmental conditions, tolerance of high stocking densities, acceptability of artificial feed, nice taste, high market value and meat quality. Hematological and biochemical parameters of fish are biological tools used as indicators in evaluating fish health conditions [7] and [8]. Hematological and biochemical parameters can also be used to assess the health condition of the environment [9]. According to Francesco [8], hematological and biochemical parameters can easily give information about the existence, status and intensity of possible sickness in fishes. Therefore, understanding these parameters is important since it can also be used to monitor the pathological and physiological changes in fishes. One of the challenges in evaluating the health status via blood parameters in natural fish population has been the lack of reliable information on the normal fish condition [10,11]. In literature, normal ranges for various hematological and biochemical parameters of the African Catfish have been established by different authors [5,12,13,14,15] and [16]. In Nigeria, cost of hatchery raised broodfish of the African Catfish is on the increase with price ranging from N4000.00/kg (USD 11.11) or even more depending on the locality. The high cost of broodfish has resulted in fish breeders searching for alternative sources of healthy broodfish that will be cheaper. Therefore, the objective of this

study was to investigate the condition factor, hematological and serum biochemical parameters of wild and hatchery collected broodfish of the African Catfish (*Heterobranchus longifilis*) and used as an indicator of their health condition.

2. MATERIALS AND METHODS

2.1 Study Area Description

This study area (Fig. 1) for this research was Ayadehe, Itu Head Bridge located between Akwa Ibom State and Cross River State, Nigeria. Geographically, it is located at latitude 5°14'30''N and longitude 806'0''E. Its distance is about 57km from Calabar, Cross River State. The study area has a rain forest vegetation with amphibious mangrove system such as *Rhizophora racemose.* The mangrove system is a spawning and feeding ground for shrimps and fish species such as *Chrysichthys nigrodigitatus* and *Macrobranchium sp.* The study area has a climate characterized by two seasons (dry season and wet season). The wet season begins from April and ends in October while the dry season begins from November and ends in March. Economic activities in the study area include farming, fishing, sand mining, fish processing and petty trading.

2.2 Collection and Transportation of Fish Samples

A total of 30 healthy wild broodfish (15 males and 15 females) were collected from Ayadehe, Itu Head Bridge between April and June 2017. The samples were bought from landings of artisanal fishermen from the study area. For hatchery broodfish, a total of 30 healthy samples (15 males and 15 females) were collected from a private hatchery located in Calabar, Cross River State, Nigeria. The collected samples were transported immediately to the Fisheries and Aquaculture laboratory, Institute of Oceanography, University of Calabar, Nigeria for blood collection.

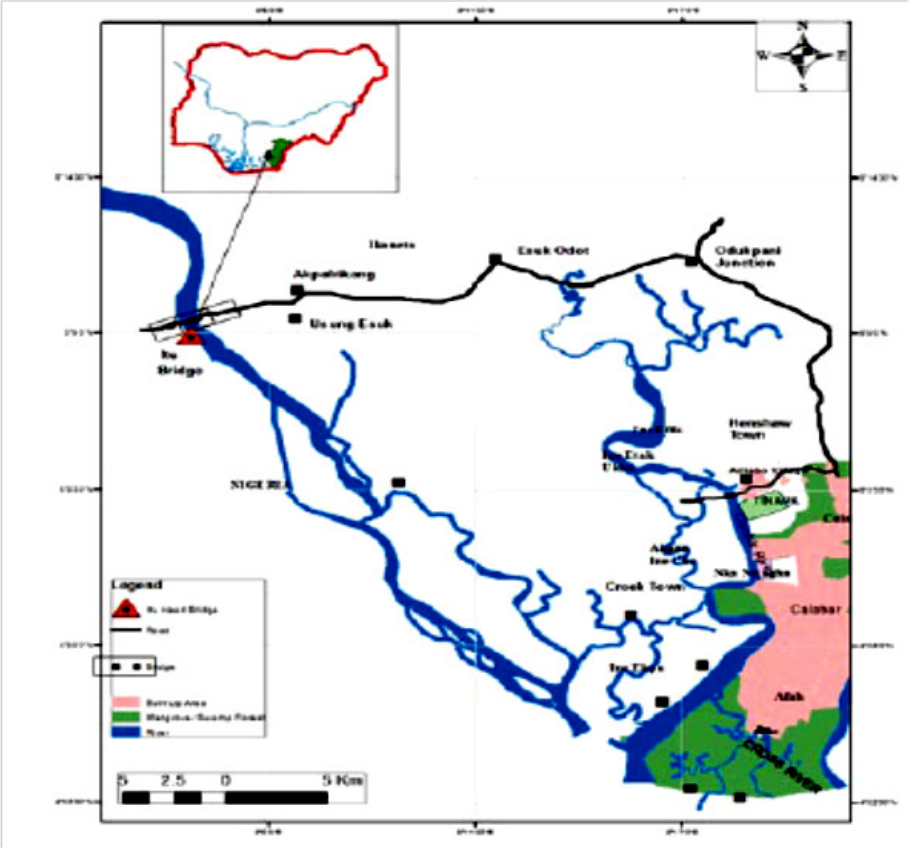

Fig. 1. Map of the study area showing Ayadehe, Itu Head Bridge where wild broodfish were collected

2.3 Collection of Blood Samples for Hematological and Biochemical Parameters

Before collection of the blood samples from the experimental fishes, the morphometric measurements including standard length (SL – cm) and total weight (TW – g) were measured and recorded for each sample. Blood samples from both the wild and hatchery broodfish were collected following the method described by Francesco [8] by direct heart and caudal vein puncture with the aid of a 2.5 mL sterile plastic syringe and hypodermic needles. About 4 ml of blood was collected from each sample and transferred into two different blood sample bottle (2 ml per sample bottle). One of the sample bottle contained EDTA as an anticoagulant agent whereas the other did not contain any anticoagulant. The blood samples transferred to EDTA sample bottles were used for the determination of hematological parameters and blood samples transferred to sample bottles without EDTA were used for the determination of biochemical parameters. The blood samples collected from wild and hatchery collected broodfish were subjected immediately to hematological and biochemical analysis in the Hematology Laboratory, University of Calabar Teaching Hospital, Calabar. Hematological parameters were analyzed using an Automated Mindray Hematological Machine (Model BC-2800). Measured serum biochemical parameters including glucose, triglycerides, globulin, cholesterol, total protein and serum albumin were determined using bioanalytic test kits and a Shimadzu spectrophotometer.

2.4 Condition Factor

Condition factor was calculated using Fulton's equation as given below:

$$100W/L^3$$

2.5 Water Quality Measurement

Water quality parameters of the two sampling areas including salinity, pH, water temperature (ºC) and dissolved oxygen (mg/l) were measured. Salinity was measured with a digital salinometer KEDIDA CT-3088, pH was measured with the aid of Portable waterproof pH/EC/TDS Hanna meter (high range) - HI991301, water temperature was measured with the aid of a mercury in glass thermometer and water dissolved oxygen was measured with the aid of Portable Hanna dissolved oxygen meter Model HI9142.

2.6 Statistical Analysis

Data obtained from the experiment was subjected to T-test Analysis to test for significant difference in hematological and biochemical parameters of wild and hatchery bred broodfish of *H. longifilis* using Predictive Analytical Software (PASW) windows software program for statistical analysis (version 18.0). Effects with a probability of ($P<0.05$) was considered significant.

3. RESULTS

3.1 Condition Factor of Wild Collected and Hatchery Bred Broodfish of the African Catfish *H. longifilis*

Condition factor (Table 1) of wild collected broodfish of male *H. longifilis* ranged from 0.57 – 0.63, with a mean of 0.61 ± 0.03 while the range of condition factor for hatchery bred male broodfish was 0.56 – 0.62, with a mean of 0.60 ± 0.01. Female broodfish collected from the wild had condition factor ranging from 0.63 – 0.66, with a mean of 0.65 ± 0.04 while the range of condition factor for hatchery bred female broodfish was 0.64 – 0.67, with a mean of 0.66 ± 0.03.

3.2 Hematological Parameters of Wild Collected and Hatchery Bred Broodfish of the African Catfish *H. longifilis*

Results of hematological parameters obtained in this study (Table 2) showed that in male broodfish of *H. longifilis* collected from the wild, PCV was 41.48 ± 1.03%, WBC (5.46 ± 0.06 L^1), Hemoglobin (13.54 ± 0.21 g/dl), RBC (5.93 ± 0.09 L^{-1}), MCV (70.06 ± 1.10 fem.), MCH (22.96 ± 0.24 Pg) and MCHC (33.52 ± 0.23 g/dl). For female broodfish of *H. longifilis* collected from the wild, PCV was 41.53 ± 0.89%, WBC (5.37 ± 0.28 L^1), Hemoglobin (13.59 ± 0.13 g/dl), RBC (5.90 ± 0.11 L^{-1}), MCV (70.16 ± 1.05 fem.), MCH (22.99 ± 0.16 Pg) and MCHC (33.58 ± 0.13 g/dl). For hatchery bred male broodfish of *H. longifilis*, PCV was 41.76 ± 0.96%, WBC (5.52 ± 0.08 L^1), Hemoglobin (13.52 ± 0.16 g/dl), RBC (5.97 ± 0.05 L^{-1}), MCV (70.42 ± 1.16 fem.), MCH (23.13 ± 0.43 Pg) and MCHC (33.71 ± 0.18 g/dl). For hatchery bred male broodfish of *H. longifilis*, PCV was 41.60 ± 0.75%, WBC (5.49 ± 0.11 L^1),

Hemoglobin (13.56 ± 0.08 g/dl), RBC (5.95 ± 0.09 L^{-1}), MCV (70.33 ± 1.02 fem.), MCH (23.21 ± 0.26 Pg) and MCHC (33.65 ± 0.20 g/dl).

3.3 Biochemical Parameters of Wild Collected and Hatchery Bred Broodfish of the African Catfish *H. longifilis*

Results of biochemical parameters obtained in this study (Table 3) showed that in male broodfish of *H. longifilis* collected from the wild, cholesterol was 2.42 ± 0.25 mmol/L, triglyceride (1.19 ± 0.06 mmol/L), total protein (59.10 ± 0.38 g/L), albumin (29.50 ± 0.38 g/L), globulin (29.39 ± 0.41 g/L), glucose (5.02 ± 0.05 mmol/L) and urea (1.82 ± 0.18 mmol/L). For female broodfish of *H. longifilis* collected from the wild, cholesterol was 2.45 ± 0.12 mmol/L, triglyceride (1.17 ± 0.05 mmol/L), total protein (59.21 ± 0.24 g/L), albumin (29.37 ± 0.54 g/L), globulin (30.30 ± 0.32 g/L), glucose (5.08 ± 0.10 mmol/L) and urea (1.83 ± 0.07 mmol/L). For hatchery bred male broodfish of *H. longifilis*, cholesterol was 2.44 ± 0.32 mmol/L, triglyceride (1.18 ± 0.04 mmol/L), total protein (59.27 ± 0.13 g/L), albumin (30.16 ± 0.29 g/L), globulin (29.89 ± 0.26 g/L), glucose (5.06 ± 0.15 mmol/L) and urea (1.84 ± 0.15 mmol/L). For hatchery bred female broodfish of *H. longifilis*, cholesterol was 2.41 ± 0.41 mmol/L, triglyceride (1.21 ± 0.15 mmol/L), total protein (59.24 ± 0.11 g/L), albumin (30.09 ± 0.47 g/L), globulin (29.93 ± 0.43 g/L), glucose (5.04 ± 0.25 mmol/L) and urea (1.84 ± 0.20 mmol/L).

Table 1. Condition factor of Wild collected and Hatchery bred broodfish of the African Catfish *H. longifilis*

Parameters	Male (♂) *H. longifilis*		Female (♀) *H. longifilis*	
	WBF	HBF	WBF	HBF
Number of broodfish	15	15	15	15
Mean Length (cm)	62.13 ± 0.77	62.36 ± 0.49	62.13 ± 0.87	61.50 ± 0.88
Mean weight (g)	1438.00 ± 22.90	1454.67 ± 27.17	1575.00 ± 66.67	1545.00 ± 65.39
Range of Condition factor	0.57 – 0.63	0.56 – 0.62	0.63 – 0.66	0.64 – 0.67
Mean Condition factor ± SE	0.61 ± 0.03	0.60 ± 0.01	0.65 ± 0.04	0.66 ± 0.03

**Mean values having the same superscript are not significant (P > 0.05), WBF = Wild broodfish, HBF = Hatchery broodfish*

Table 2. Hematological parameters of Wild collected and Hatchery bred broodfish of the African Catfish *H. longifilis*

Hematological parameters	Wild broodfish (WBF)		Hatchery broodfish (HBF)	
	Male (♂)	Female (♀)	Male (♂)	Female (♀)
Pack Cell Volume (%)	41.48 ± 1.03 [a]	41.53 ± 0.89 [a]	41.76 ± 0.96 [a]	41.60 ± 0.75 [a]
White Blood Cell Count (L^{-1})	5.46 ± 0.06 [a]	5.37 ± 0.28 [a]	5.52 ± 0.08 [a]	5.49 ± 0.11 [a]
Hemoglobin (g/dl)	13.54 ± 0.21 [a]	13.59 ± 0.13 [a]	13.52 ± 0.16 [a]	13.56 ± 0.08 [a]
Red Blood Cell Count (L^{-1})	5.93 ± 0.09 [a]	5.90 ± 0.11 [a]	5.97 ± 0.05 [a]	5.95 ± 0.09 [a]
MCV (fem)	70.06 ± 1.10 [a]	70.16 ± 1.05 [a]	70.42 ± 1.16 [a]	70.33 ± 1.02 [a]
MCH (Pg)	22.96 ± 0.24 [a]	22.99 ± 0.16 [a]	23.13 ± 0.43 [a]	23.21 ± 0.26 [a]
MCHC (g/dl)	33.52 ± 0.23 [a]	33.58 ± 0.13 [a]	33.71 ± 0.18 [a]	33.65 ± 0.20 [a]

**Mean values having the same superscript are not significant (P > 0.05)*

Table 3. Serum biochemical parameters of Wild collected and Hatchery bred broodfish of the African Catfish *H. longifilis*

Serum biochemical parameters	Wild broodfish (WBF)		Hatchery broodfish (HBF)	
	Male (♂)	Female (♀)	Male (♂)	Female (♀)
Cholesterol (mmol/L)	2.42 ± 0.25 [a]	2.45 ± 0.12 [a]	2.44 ± 0.32 [a]	2.41 ± 0.41 [a]
Triglyceride (mmol/L)	1.19 ± 0.06 [a]	1.17 ± 0.05 [a]	1.18 ± 0.04 [a]	1.21 ± 0.15 [a]
Total protein (g/L)	59.10 ± 0.38 [a]	59.21 ± 0.24 [a]	59.27 ± 0.13 [a]	59.24 ± 0.11 [a]
Albumin (g/L)	29.50 ± 0.38 [a]	29.37 ± 0.54 [a]	30.16 ± 0.29 [a]	30.09 ± 0.47 [a]
Globulin (g/L)	29.39 ± 0.41 [a]	30.30 ± 0.32 [a]	29.89 ± 0.26 [a]	29.93 ± 0.43 [a]
Glucose (mmol/L)	5.02 ± 0.05 [a]	5.08 ± 0.10 [a]	5.06 ± 0.15 [a]	5.04 ± 0.25 [a]
Urea (mmol/L)	1.82 ± 0.18 [a]	1.83 ± 0.07 [a]	1.84 ± 0.15 [a]	1.84 ± 0.20 [a]

**Mean values having the same superscript are not significant (P > 0.05)*

3.4 Water Quality Parameters of the Hatchery Pond and River Water

Water quality parameters of the hatchery pond and river water (Table 4) showed that all the parameters were within the recommended range for freshwater fish culture.

Table 4. Water quality parameters of the hatchery pond and river water

Parameters	Pond water	River water
Dissolved oxygen (mg/l)	5.2	5.6
Water temperature (℃)	30 .1	31
pH	7.3	6.4
Salinity (ppt)	0.0 0	0.35

4. DISCUSSION

Generally, the physiological condition in matured fishes which could be used as a tool for their selection as broodfish can be reliably determined by hematological parameters [8]. In fish physiology, blood comprising 1.3 – 7% of the total body weight is one of the most important and active components that helps in metabolic processes by ensuring exchange of gas between the environment and organism [17]. Since blood parameters in teleost fishes are influenced by factors such as food selection, ecological habitat, temperature and mode of life, to establish any normal values fishes becomes difficult [8]. However, collection of data for different species as well as similar species under varying conditions will result in establishment of some normal ranges of blood parameters which can be used as a valuable diagnostic aid in fisheries science and aquaculture [18]. Results obtained in this study showed that there was no significant difference ($P > 0.05$) in all the blood parameters evaluated in this study such as PCV, WBC, Hemoglobin, RBC, MCV, MCH and MCHC for both the wild and hatchery broodfish. Studies of hematological parameters in fish is a widely and accepted approach for examining the health status of fish. It is also useful in understanding the relationship of blood characteristics to the fish habitat and fish adaptability to the environment [19]. The non -significant variation observed in this study for wild and hatchery bred broodfish of *H. longifilis* indicates that the two different environment where the fish were collected were in a healthy state. PCV obtained in this study is within the range (33.70 - 49.87) reported by [16] for artificially spawned *H. longifilis* and higher than the range of 22.00 % - 35.50 % reported for juvenile *C. gariepinus* by [20]. Onyia et al, [21] reported a higher PCV range (51.93 - 53.40) of wild collected *Heterobranchus bidosalis*. WBC was also within the range ($4.78\ L^{-1} – 6.38\ L^{-1}$) reported by Afia and Ofor [5] for Catfish hybrid (*Heteroclarias*) fed at different feeding levels. Hemoglobin (Hb) is used to assess the functional status of the oxygen carrying capacity of the bloodstream. Higher values of haemoglobin indicates higher rate of transportation of oxygen to and removal of carbon (iv) oxide from the body tissues resulting in higher rate of metabolism and growth. In this study, there was no significant difference ($P>0.05$) in hemoglobin values obtained for wild and hatchery bred broodfish of *H. longifilis*. Hemoglobin values in the present study were within the range (5.88 – 14.24 g/dL) reported by [22] for *C. gariepinus* brood fish raised in water recirculating aquaculture system. The range of RBC obtained in this study for wild and hatchery bred broodfish of *H. longifilis* is higher than RBC range ($2.4 – 2.85\ L^{-1}$) reported by Afia and Ofor [5]. Blood parameters of fish is known to increase during follicular maturation, vitellogenic phase and spawning due to gonadoropins release from the hypothalamus of fish [23,24]. Peptides such as activin and gonadal steroids including estrogens and androgens directly exert their stimulatory effects on the gonadotropins or through the hypothalamus which causes changes in the blood parameters of brood fish [25]. MCV, MCH and MCHC for both male and female broodfish of *H. longifilis* collected from the wild and hatchery were not significantly different ($P>0.05$) and are similar to findings of Omitoyin [26]. Biochemical parameters are also vital parameters that can provide information on the existence, status and degree of sickness in aquatic organisms. According to Xiaoyun *et al.,* [27] and Bahmami et al, [28] biochemical indices is useful in analyzing the health status of farmed fishes as they provide reliable data on metabolic disorders, stress status and other deficiencies. Results of this study revealed that in both male and female broodfish of *H. longifilis* collected from the wild and hatchery, serum biochemical parameters including cholesterol, triglyceride, total protein, albumin, globulin, glucose and urea were not significantly different ($P>0.05$). According to [29], ranges of fish serum biochemistry vary from species to species and may also be affected by various biotic and abiotic factors such as seasonal pattern, water temperature, age, food and sex. Values obtained in this study for serum biochemical parameters is

within the range reported by Suleiman and Abdullahi [16] for artificially spawned *H. longifilis*. However, these values indicates that both the wild and hatchery broodfish were in healthy condition. Furthermore, the values obtained for condition factor of male, female and pooled sex of both the wild and hatchery broodfish of *H. longifilis* also indicates that the fishes were in healthy condition.

5. CONCLUSION

Hematological and serum biochemical parameters are very useful tools in analyzing the health status of broodfish as they provide reliable information the stress status which could influence broodfish reproductive performance. The study demonstrates that the wild and cultured *C. gariepinus* broodfish showed the same blood parameters, indicating that they are healthy. Result of this study, along with other findings will provide a reference for catfish breeders and aquaculturists evaluating the health status of hatchery and wild *H. longifilis*.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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