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Cycle of Gonad Maturation, Condition Index and Spawning of *Clarotes Laticeps* (Claroteidae) In the Lower River Niger

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ABSTRACT
A population of *Clarotes laticeps* (family Claroteidae) was investigated in the lower reaches of the River Niger, between Illushin in Edo State and Niger Bridgehead in Asaba, Delta State, Nigeria. The study lasted between, January, 2010 and December, 2012. Fish samples were taken every fortnight from the stretch of the River Niger studied and transported to the laboratory where each fish sample was evaluated for the cycle of maturation of gonads, length size at first sexual maturity, gonadosomatic index and condition factor. Each of these values were recorded against the period of the year the fish samples were collected. The frequency and seasonal distribution of these parameters were noted and used to determine the size at first maturity and spawning. Mean condition factor (k) and gonadosmatic index (G.S.I) obtained were 2.10 and 0.54, respectively, in January, with both reaching peak values in August (K, 2.81; G.S.I, 11.86), but dropped to 2.05 and 0.75, respectively, in October. The female specimens matured earlier at 30.5 cm, standard length, while the male specimens attained sexual maturity at 32 cm, standard length. There were increases in the frequency of mature gonads, condition factor, and gonadosomatic index between July and September. Both parameters began to fall in October, indicating that spawning occurs between July and October. A mean egg diameter of 2.92 mm recorded was considered as relatively large in size. This could support fry survival both in the wild, and in culture trials.

Keywords: *Clarotes Laticeps*, Spawning, Cycle of Gonad Maturation

1. Introduction
Fish production from the lower River Niger is strictly artisanal. Fisher- folks who live in that vicinity, by virtue of their proximity to River Niger, engage in fishing activities for sustenance, and to meet other economic needs. Thus, small scale fish production plays a vital role in the supply of fish to the people of the area. Therefore, there is the need for the sustainable management and exploitation of the commercially important fish species of the area, for improved fish availability.

A study on the development of gonads and maturity stages is required for prediction of the reproductive potential of the fish, time and frequency of spawning, egg size, and size of fish at first maturity. It could also help in the prediction of the fish population structure, its dynamics and the potential capacity of the population to sustain recruitment. Also, it is vital to understanding the estimated available crops that could be sustained in a given system. Thus, providing a basic tool for the sustainable management of the fish species [1, 2].

Fish condition coefficients are often known to vary with the stage of maturation. The trend in some fishes is a high condition factor value for sexually mature fish and a low one for immature fish [3]. The Gonadosomatic Index (G.S.I), which gives an indication of the percentage of the fish weight used for egg production when the eggs are about to be shed, attains the maximum value during the spawning season. Thus, both indices are correlated with spawning activities, and have been used to determine actual spawning period [4, 5, 6, 7, 8, 9, 1, 10].

Claroteslaticeps (Family Claroteidae) is an important commercial fish species of the Niger River. It constitutes a significant portion of the total fish caught by artisanal fishermen who exploit the River Niger for their economic benefit. Although it contributes greatly to commercial fisheries of the River Niger, information on aspects of its biology with respect to the lower River Niger is scanty. Thus, only a few works on the species can be readily accessed [11, 12, 13, 14, 15].

The fish can grow up to 10 kg in weight [13], and considered against the limited scope of choice of culturable fish species available to fish farmers in this region, a better understanding of its cycle of gonad maturation and spawning could help in the domestication of the fish in the lower River Niger and beyond. This in turn could imply increase fish availability to the people, and thus, improve the socio-economic status of the inhabitants of that area.

2. Materials and Methods

Fish samples were collected for three years between January, 2010 and December, 2012 from the lower reaches of the River Niger, between Illushin in Edo State and Niger Bridgehead, Asaba, Delta State, Nigeria. The study area which covered a distance of about 60 km along the stretch of the river, lies between longitude 6°34E, 6° 47E and 6⁰ 8N, 6O 40N. Fish sampling was carried out by means of gill nets, long lines and local 'mari' traps.

Captured fish samples were immediately transported to laboratory in clean transparent buckets for further examination. At the laboratory, the wet weight of fish samples were determined to the nearest 0.1 g and, the total and standard lengths were measured to the nearest 0.1 cm, while the gonads were weighed to the nearest 0.01g [16].

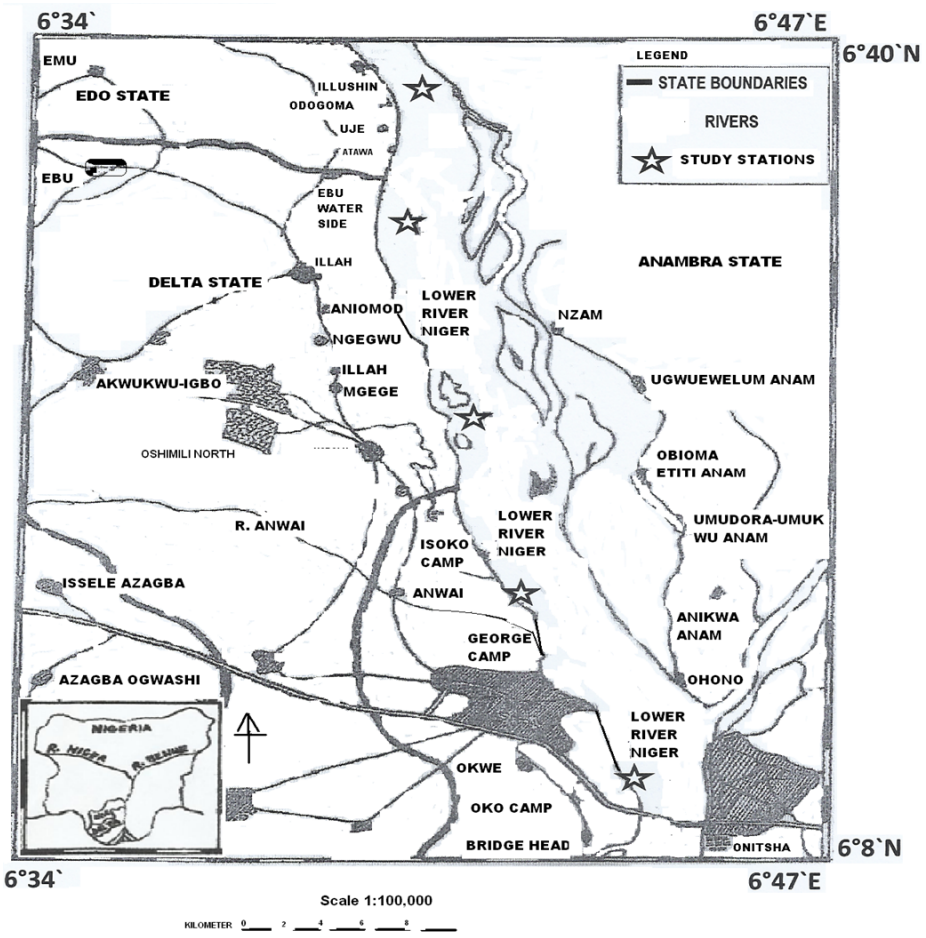

Fig 1: Location of study showing the sampling stations

2.1 Gonadal preservation and preparation

Histological examination of gonads involved dissecting (of ovaries and testes from the visceral region) and weighing of gonads to the nearest 0.01 g, using Ohaus analytical balance. Gonads were fixed in Bouins fluid for 24 hours and transferred to 70% alcohol for dehydration, and embedded in paraffin wax. Gonads were sectioned with a microtome at 10 µ thickness and then stained in Haematoxylin and Eosin [17].

The sections were mounted in Canada, Balsam and viewed. The diameter of oocytes were measured with calibrated ocular micrometer.

2.2 Length size at first sexual maturity

Fish samples at the third (III) and fourth (IV) developmental stages were recorded as sexually mature. They were used to determine the size at which the fish first attained sexual maturity. The frequency of occurrence of samples having mature gonads was plotted against the length of the samples. The size at first sexual maturity was deduced as the size class at which 50% (L_M50) of the individuals were mature [18].

2.3 Cycle of maturation of gonads

Gonads maturity stages were determined by gross anatomical examination of the excised gonads and light microscopy according to a maturity scale modified after Nikolsky [19].

Seasonal distribution of gonads at the various maturity stages in samples were determined monthly. The overall percentage frequencies of the gonadal stages observed were used to indicate the seasonal distribution of the maturity stages

2.4 Gonadosomatic Index (G.S.I)
The Gonadosomatic Index (G.S.I) which gives an indication of the percentage of the fish weight that is used in egg production was determined as follows:

$$G.S.I = \frac{\text{Weight of gonads}}{\text{Body weight}} \times 100$$

2.5 Fish condition factor (K)
Fish condition facto (k) was determined as:

$$K = \frac{W \times 100}{L^3}$$

Where W= Body weight (gms) and
L = Length (Standard length) in cm [20]

2.6 Spawning
Spawning period was deduced from the seasonal rise and fall in the values of gonadosomatic index (G.S.I) and condition factor 'K' of the fish. The two indices were monitored from the samples collected, and spawning period was determined as the period both indices attained peak values before a decline was observed [8, 9, 1]

3. Results
3.1 Seasonal distribution and cycle of gonad development
Fish samples collected between January and March contained predominantly, gonads in Stage I and II level of gonadal development. Females having mature gonads (Stage III) first appeared in samples in April while those having mature ovaries (Stage IV) were evident in June and August. Samples collected in September included females with running ovaries (Stage V) while spent females (Stage VI) were observed in October (Figure 2) Samples of males with maturing gonads stage (III) were first observed in the month of May and continued up to the month of July and extended to the month of October. Spent males were found in fish samples collected in the months of September, October and November. Stage V males (ripe running) were not identified during the period of study (Figure 2).

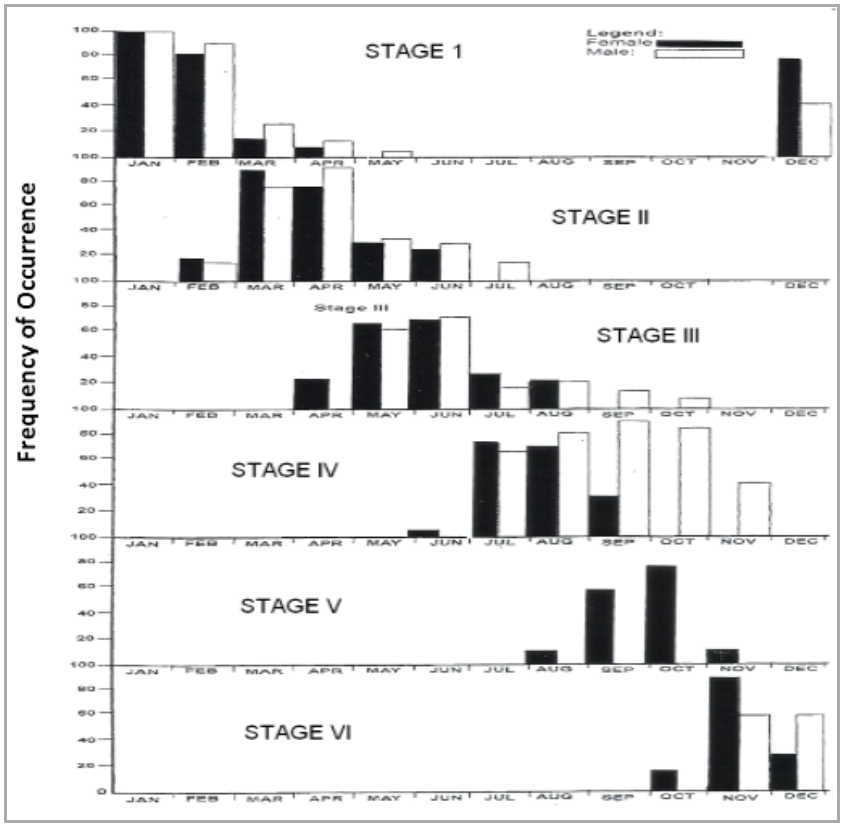

Fig 2: Percentage occurrence and seasonal distribution of gonad developmental stages of *C. laticeps* collected from the Lower Niger.

3.2 Size at first sexual maturity
The smallest female specimen with mature ovary had a standard length of 27.5 cm, while the least size of male recorded with mature gonads (Stage IV) was 30.5 cm. The minimum length (L_M50) at which at least 50% of the fish samples were mature during spawning is considered as the minimum size at which the fish attains sexual maturity. The L_m50 for the females was 30.5 cm, while that of males was 32.0 cm (Figure 3). All samples of females and males above 39.0 cm (standard length) had mature gonads.

3.3 Seasonal values of condition factor (k), gonadosomatic Index (G.S.I) and spawning
The mean condition factor (k) values for female samples obtained in December was 2.05, being the least, while the maximum, 2.81 was obtained in August. This same trend was observed with Gonadosomatic Index (G.S.I) values of the fish. Mean G.S.I values were lowest in January (0.54) and highest in August (11.36). Thus, both indices showed an increasing trend in values from the beginning of the year, with sharp rise in values as from June and peak values in August. Thereafter, these values decline sharply. Therefore, both indices showed a

seasonal cycle of rise and fall in values with maximum values around the months of July, August and September (Figure 4). The spawning season was deduced from the relative frequencies of cycles of gonad developmental stages, the seasonal peak values of condition factor and the gonadosomatic index of the female species. These indices had their greatest values between July and September. Also, greater proportion of Stage IV gonads were recorded during this period, suggesting that breeding occurred within this period. The drop in the values of the gonadosomatic index and the condition factor was associated with the release of eggs as a result of spawning.

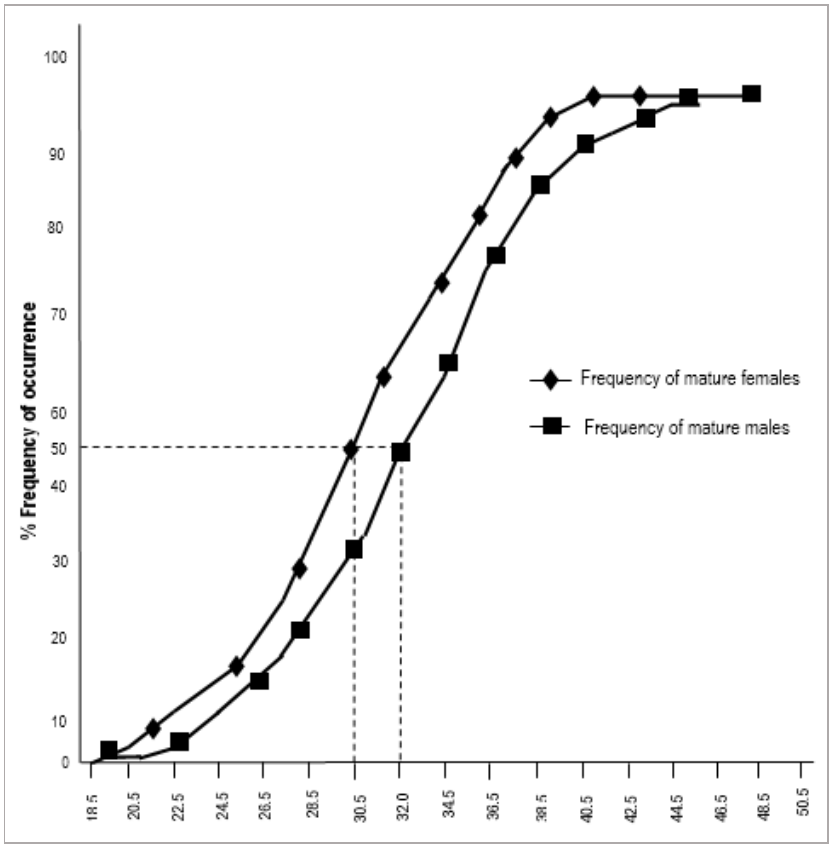

Fig 3: Fish size at first sexual maturity (cm)

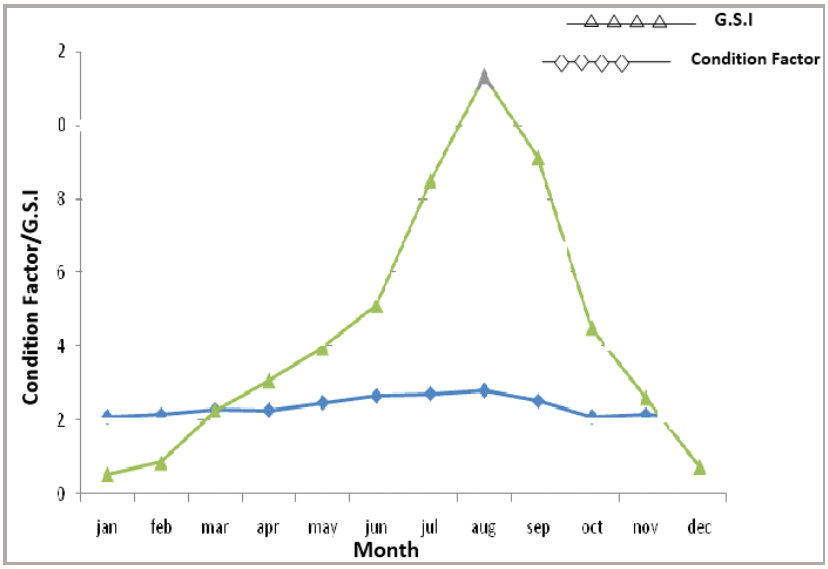

Fig 4: Monthly distribution of mean condition factor (k) and mean gonadosomatic attic index (GSI) of female *C. laticeps*

3.4 Developmental stages of gonads and Egg diameter

Stages of gonadal development in *C. laticeps* in the lower River Niger followed the scheme proposed by Nikolsky [19]. Six distinct stages were observed (Table 1).

Egg diameter in sexually mature females varied greatly. The least egg diameter observed in a stage IV sample was 0.71 mm while the maximum was 3.72 mm. Mean egg diameter was 2.91 mm. The egg size showed great variation within and between fish samples. Eggs of varied sizes were recorded in both smaller and bigger fish samples.

Table 1: Developmental stages of gonads of *Clarotes laticeps* in the lower River Niger

Gonad Maturity stages	Gonad developmental status	Description of Gonad	
		Female	Male
I	Immature inactive	Ovaries not visible to the naked eyes but their lobes are transparent. Accounts for less than 0.4% of body weight.	Testes too tiny, not visible to the naked eye.
II	Immature developing	Two distinct transparent lobes of gonads visible. oocytes not observed. The ovaries account for about 0.5% of body weight.	Testes are very thin, visible to the naked eye, creamy white in and smooth in texture.
III	Maturing	Ovaries occupy more than half of the body cavity, with clearly visible oocytes. Accounts for about 1.5% of the body weight. Most oocytes are opaque, ranging from whitish to slightly yellowish colour. Oocytes are not extruded by application of pressure and cannot be separated from each other.	Testes are white in colour and large with fingerlike outgrowth. Milt cannot be extruded with pressure on the abdominal cavity.
IV	Mature	The bilobed ovaries occupy about 2/3 of the abdominal cavity and account for about 5% of the body weight. Clearly visible roundish oocytes which are granular and yellowish to pinkish yellow in colour are observed. Oocytes are not easily separated by application of pressure.	Testes are large with conspicuous finger like outgrowth and creamy white in colour. Milt is not extruded with pressure or incision on the body wall of gonads.
V	Running or spawning	Ovaries are large and almost fill the body cavity. Most eggs were transparent and are loose in the ovary. They are easily separated by slight pressure applied on the abdominal	Not observed.
VI	Spent	Ovaries are greatly reduced in size. Ovary occupy 1/3 of the abdominal cavity. Few scattered reddish oocytes observed in the flaccid ovarian cavity.	Testes are flaccid or deflated and blood shot.

4. Discussion

4.1 Sexual Maturity

Females having maturing gonads were first observed in the month of April, with stage IV females appearing first in June, and continued to appear in samples till September. Males with stage IV gonads were first observed in July and continued in samples up till October, although they were relatively few. The study established that males were mature when they attained a standard length of 32.0 cm, while females mature at 30.5 cm (standard length), implying earlier maturity in females than in males.

It has been reported that males of pelagic fish mature at smaller size than females [4, 21]. In agreement with this observation, the males of a sister bagrid, C. *nigrodigitatus* were mature when the fish attained a total length of between 29 and 32 cm, while females mature at a total length of between 29 cm and 32 cm, implying earlier maturity in males than in females [22]. However, a contrary result had earlier been indicated for the same species when it was reported that females of *C. nigrodigitatus* mature earlier than males [5]. Though, while this view is in agreement with the present findings, it highlights the lack of definite maturity pattern with regards to sex among the bagrids. This lack of consensus on sexual maturity within the bagrid family is also very evident from works reported from other regions. For instance, while it was reported that the the females of the bagrid catfish, *Pseudobagrus Ichikawa* in the Tagiri River in Japan, mature earlier at smaller sizes than males [23], the males of the bagrid species *Mystus vittatus* mature earlier at smaller sizes than females [18].

4.2 Condition factor (K), Gonadosomatic Index and Spawning

The study recorded rising values in both condition factor (k) and the Gonadosomatic Index (G.S.I) for the fish samples with peak values coinciding with the months of August and September, while falling sharply from October to December. It had been reported that the peak values of these two indices correspond to the breeding period associated with tropical fresh water species [6]. The combination of G.S.I and Condition Factor has been suggested as appropriate indicator of spawning periods in teleosts [7], and both indices have been used by a number of researchers to determine the spawning period in tropical fishes [5, 8, 9]. Based on these reports, it is logical to state that breeding of *C. laticeps* in the lower River Niger occur around July and ends around September, since the G.S.I and K values rise rapidly and fall within this period. Caution however, must be exercised in the use of Condition Factor as a basis for predicting spawning periods as higher fish condition values could equally arise from non-spawning

activities, such as increased feeding, associated with food abundance that occur during the breeding season [24, 3].

In the course of this investigation, the artisanal fishermen who assisted in the sampling exercise, insisted that prior to this study, they had captured fish specimens with running eggs well beyond the month of December, suggesting that spawning extends beyond this period. However, this investigation, which lasted for 36 months, did not reveal any incidence of such observations. In biological populations such occurrence would not be totally out of place.

The population of gravid females in captured samples was quite low. Of the 672 female samples collected throughout the sampling period, only 186 were found to be maturing or matured. Out of this number only fifty (50) were in stage IV of gonadal development. Given that the samples were collected over a period of 36 months, it suggests a very low proportion of gravid females in the population. The incidence of low proportion of gravid females in fish samples have been reported in fish samples collected in the River Niger and associated tributaries [3, 8]. The low incidence of gravid females in the population of *C. laticeps* investigated could be due to the fact that females hide in submerged vegetation and rocky areas to avoid capture and to incubate their young ones [25, 22], while males which migrate to feeding ground from spawning grounds, are more likely to be captured [26]. This observation however, could not easily explain the phenomenon, as few males with matured gonads were equally captured in this study. A probable explanation could be that spawning of *C. laticeps* does not take place in the section of the River Niger investigated.

4.3 Gonadal development and egg diameter.

Gonadal development in *C. laticeps* followed the scheme proposed by Nikolsky [19]. Six distinct stages were observed. The egg diameter in sexually matured females varied greatly (0.71-3.75 mm)

Variations in egg diameter among the bagrid catfishes were reported [12, 27, 28, 8]. Several factors were adduced as causes of variability in egg size among population of fish. Among these factors were differences in individual ovulation time and the stage of egg development [5].

The largest egg diameter 3.72 mm recorded in this study is comparable to 4.00 mm that was reported for *C. nigrodigitatus* in Lake Kainji [4] and 3.50 mm for the same species recorded in the Cross River [8]. The mean egg size of 2.91 mm recorded in this study is relatively high, indicating that the egg is large enough to accommodate adequate yolk. The relatively large egg size of *C. laticeps* could enhance the survival if fry and larval viability [29]. Recorded mean egg diameter of 2.80 mm as a basis for recommending for *C. nigrodigitatus* has been used as a basis for recommending the fish species as a good culture fish, since it would make a good broodstock [5]. Thus, in the same vein, the egg characteristics of *C. laticeps* favors the cultural potential of the fish.

5. Conclusion

The study indicated that female *C. laticeps mature* at relatively smaller size of 30.5 cm and males at 32.0 cm (standard length), while breeding takes place between July and October. This information could be integrated into management plans towards sustainable management of the fish species in the wild, by prescribing appropriate mesh sizes of fishing nets and restricting fishing activities during the spawning season. In this way rational exploitation of the fish population is assured. Furthermore, the relatively large eggs of the fish has positive implications for successful domestication of the fish as fry survival is a function of egg size.

Thus, better management of the fish in the wild and efforts at the successful culture of the fish, is advocated, in order to meet the goal of increased fish production.

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