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Macrobrachium Macrobrachion (Herklots, 1851) Length-Weight Relationship and Fulton's Condition Factor in Luubara creek, Ogoni Land, Niger Delta, Nigeria

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Abstract: *Macrobrachium macrobrachion* length-weight relationship and Fulton's condition factor was studied in Luubara creek of Ogoni land in the Niger Delta region of Nigeria for a period of two years (January, 2006-December, 2007). A strong positive relationship exist between the shrimp length and weight for males in 2006; length and weight in females in 2006 and length and weight in both sexes in 2006(b<3) except for both sexes in 2006 with b = 3.13. Hence growth in the individual sex is allometric (b<3), but when the sexes were combined the growth was also allometric (b>3). The values obtained from the length/weight relationship (LWR) showed that there was a high and significant correlation between the total length and weight. The high correlation coefficient r =0.95 was an indication of a strong association between length and weight. This means that as the length of fish increases the weight increases in the same proportion. Coefficient of determination r^2 was also high (0.91) which indicted that the model used for the analysis fits the data, confirming the fitness of the model. The results of the Fulton's condition factor, K. In males, the highest condition factor (K = 0.00718) was recorded in August, 2007 while the lowest result in male (K = 0.001) was recorded in July, 2006. In females, the lowest condition factor (K = 0.000066) was in December, 2006 while the highest condition factor (K = 0.00157) for females was in October, 2006. In the berried females, the month of March, 2007 has the highest condition factor (K =0.002) while the lowest K value of 0.00097 was recorded in February and September, 2006. In 2006 the range of K was from 0.00084 to 0.00194, (females); 0.00066 - 0.00015 (males) and 0.00097 - 0.00144 for berried females. In 2007, the condition factor ranged from 0.00718 to 0.00109 (male), 0.00097 to 0.00147 (female) and 0.00099 - 0.002 (berried female). The mean condition factor was both sex and season dependent. There were significant variations between sexes. The differences in condition factors were in male and females may be attributed to the presence of ovigerous females.

Key words: Fulton's condition factor, length-weight relationship, Luubara creek, *Macrobrachium macrobrachion*, Niger Delta, Nigeria, Ogoni Land

INTRODUCTION

The fresh water shrimp; *Macrobrachium macrobrachion* belongs to the Phylum, *Arthropoda*, Class, *Crustacea*; Subclass, *Malacostraca*; Series, *Eumalacostraca*; Order, *Decapoda*; Suborder, *Natantia*; Section, *Caridea*; Family, *Palaemonida*; Genus, *Macrobrachium*; Species, *M. macrobrachion* Powell (1980). It can also be found in low salinity brackish water (Powell, 1985).

The body is divided into three main divisions: the head, thorax and abdomen. The head and thorax are joined to form a cephalothorax, which carries the mandibles, flagella, rostrum and the eyes containing a stalk and has five pairs of walking legs. The abdomen has six body segments with the last segment bearing a uropod or telson. The other five segments bear swimming apparatus known as swimmerets. A definite feature of *Macrobrachium* is that the second walking legs are modified to form the chelae. Most species are distinctively colored having either blue or brownish colors. The legs also have definitive features such as hairs or furs.

Significant differences exist between the male and female. Mature males are considerably larger than females and the second walking leg is much thicker. The cephalothorax is also proportionally larger in the male than female while abdomen is narrower in the female. The genital pores of the male are between the bases of the fifth walking leg (New and Singholka, 1982). The female's genital pores situates at the base of the third walking legs. The pleura of the abdomen are lower and broader in the

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female than in the male. The pleura of the female form a brood chamber in which the eggs are carried between laying and hatching. A ripe ovigerous female can easily be identified because the ovaries can be seen as large orange-colored mass occupying a large portion of the cephalothorax.

The gear used for collecting the shrimp is locally known as "Kara". It is cone shaped and has two non-return value mechanisms at the center of the trap. The trap is constructed from either the blades of bamboo plant or blades of raffia fronds which are woven around three round frames made from cane. The total length of each trap was between 0.95 and 1 m while the opening aperture was between 25 and 30 cm. Fresh palm oil fruits were used as bait to set the trap along the creek lets against the water current.

Shrimps and prawns of the genus *Macrobrachuim* and *Penaeus* are highly cherished by the people of the Niger Delta. They are used as condiments in the preparation of food because of their high protein value (Umoh and Bassir, 1977; Deekae and Idoniboye-Obu, 1995). They are highly priced and are in high demand in the market (Marioghae, 1990). It has been observed that there is significant reduction of the natural stock of shrimps in our coastal waters (Nwosu, 2007). This may be due to environmental degradation which is detrimental to the abundance and life cycle of *M. macrobrachion*. Also, there are few fishers now to exploit the available species as a result of rural migration.

The unfriendly fishing methods of local fishers who use poisons and chemicals are affecting the shrimp catch. Therefore understanding the biology, environmental parameters and population structure is essential to optimize production from the wild. The shrimp *M. macrobrachion* is exploited in Luubara creek Rivers State in large quantities yet there are no reports on the population biology of this species in the area. A study of the class structure and sex ratio of *Macrobrachium macrobrachion* from Luubara creek provides base line data for management decision in the management of the species in the area and similar water bodies.

Length-weight relationship of fish is an important fishery management tool. Its importance is pronounced in assessing the average weight at given length group (Beyer, 1987; Hart and Abowei, 2007) and in assessing the relative well being of a fish population (Bolger and Connoly, 1989; Abowei *et al*., 2008). Condition factor compares the well being of a fish and is based on the hypothesis that heavier fish of a given length re in a better condition (Bagenal and Tesch, 1978; Abowei and George, 2009). Condition factor has been used as an index of growth and feeding intensity (Fagade, 1979; Abowei *et al*., 2009). Condition factor decreases with increase in length (Bakare, 1970; Fagade, 1979; Abowei, 2009a, 2010a) and also influences the reproductive cycle in fish. Incidentally, most studies on length weight relationship are on fishes from other water bodies (Abowei, 2009b, 2010b). A study on the length weight and condition factor from Luubara creek provides information to bridge that gap and management decision for the management of *M. macrobrachium*, other shrimps, Luubara fishery and similar water bodies.

MATERIALS AND METHODS

The study area: The study was carried out in Luubara creek of Ogoni land in the Niger Delta region of Nigeria for a period of two years (January, 2006 - December, 2007). The creek is a tributary of the Imo River and is located between longitudes 7º15′E - 7º32′E and latitudes 4º32′- 4º37′N in the eastern part of the Niger Delta. The upper part of the creek extends from Bori and meanders through Wiiyaakara, Luegbo, Duburo and joins the Imo River at Kalooko.

The creek is divided into two distinct sections brackish water and freshwater. The brackish water stretch is between Bane and Kalooko while the freshwater stretch extends from Bane to Bori. The brackish water area has the normal mangrove vegetation comprising of trees such as Rhizophora racemosa, Avecenia africana, Laguncularia racemosa etc. whereas the freshwater has dense vegetation comprising of large trees, various palms and aquatic macrophytes at the low intertical zone. In freshwater area are Cocos species, Eliasis species, Nymphea species, Lemna species and Raffia species.

It is characterized by high ambient temperature usually about 25.5ºC and above; high relative humidity which fluctuates between 60 and 95% and high rainfall averaging about 2500 mm (Gibo, 1988). This high rainfall often increases the volume of water in the creek hence providing good fishing opportunity for the residents. Fishing is one of the major activities going on along the creek because it is the main water route of the Khana people in Ogoni area of the Niger Delta.

The fishes caught in the area include *Chrysichthys auratus*, *C. nigrodigitatus, Hydrocynus forskalii*, *Clarias gariepinus*, *Pellonula leonensis*, *Malapterurus*, *electricus*, *Gymnarchus niloticus*, *Synodontis nigri Hepsetus odoe*, *Hernichromis*, *fasciatus*, *Tilapia zilli*, *Tilapia guineensis*; *Sarotherodon melanotheron and Eleotris senegalensis and shellfish (crabs and shrimps) especially Uca tangeri Callinectes amnicola*, *Goniopsis pelli*, *Cardisoma armatum M. macrobrachion*, *M. vollenhoveni*, *M. equidens*; *Palaemonetes africanus*; *Caridina africana and Desmocaris tripisnosa*.

Specimen sampling: The shrimp samples were collected fortnightly from three stations along the creek: namely Wiiyaakara, Luegbo and Duburo. Selection of the stations was purposefully based on fishing activities, ecological

zonation and accessibility of site. For each station five fishermen were engaged and three traps were used. At each station the fisher men set the three sets of traps against the water current among aquatic macrophytes and left them overnight. The traps were retrieved the following day after about twelve hours corresponding to another low tide. The shrimps collected at each station were sorted into male and female; females were later separated into berried (ovigerous) and non-berried (non-ovigerous). Sampling lasted for twenty-three months from January 2006 to November 2007. The shrimp samples were then preserved in 4% formaldehyde and transported to the RSUST Fisheries laboratory for analysis after each day's sampling. The species was identified by use of the keys of Powell (1980; 1982) and Holthius (1980).

For each shrimp the Total length (the distance from the tip of the rostrum to the end of telson) and the carapace length (the distance from the base of rostrum to the first body segment) was measured with a Vernier caliper to the nearest 0.1 mm. The shrimps were then weighed with an Ohaus balance to the nearest 0.1 g. Measurements were taken for each monthly collection and recorded accordingly.

The length - weight relationship of the shrimp was estimated using linear regression (Pauly, 1983; Wahua, 1999). The technique is incorporated in the FAO ICLARM, Stock Assessment Tool (FiSAT) (Gayanilo and Pauly, 1997) which is used in fisheries. The length weight relationship was obtained from the relationship.

$$W = aL^b \text{ (Pauly; 1983; Sparre } et\ al.\text{, 1989)} \quad (1)$$

where,
W = Weight of shrimps (g)
L = Length of shrimps (mm)
a = Intercept
b = Slope

The values of a and b were given a logarithm transformation according to the following formula:

$$\log W = \log a + b\log L \text{ (Pauly, 1983)} \quad (2)$$

The intercept "a" in the formula was estimated with the formula:

$$a = \left[\frac{\sum y}{n} - \frac{(b\sum x)}{n}\right] \quad (3)$$

Or logarithm transformed as:

$$a = \left[\frac{\sum \log W^y}{n} - \frac{b\sum \log W^x}{n}\right] \quad (4)$$

While the slope "b" was estimated by the formula:

$$b = \frac{\sum xg}{\sum x^2} - \frac{\frac{(\sum x)(\sum y)}{n}}{\frac{(\sum x)^2}{n}} \quad (5)$$

or $$b = \frac{n\sum xy}{n\sum x^2} - \frac{(\sum x)(\sum y)}{(\sum x)^2} \quad (6)$$

or log transformed as:

$$b = \frac{n\sum \log x - \log_{10} Y - (\sum \log_{10})(\sum \log_{10} Y)}{n\sum \log_{10} x^2 - \sum \log_{10}(x)} \quad (7)$$

where,
X = Length of shrimps
Y = Weight of shrimps
N = Number of shrimps (sample size)

The correlation i.e., the degree of association between the variables were determined by computing the correlation co-efficient (r) (Wahua, 1999; Ogbeibu, 2005) using the relationship:

$$r = \sqrt{r^2} \quad (8)$$

$$r^2 = \frac{\left(\sum xy - (\sum x)(\sum y)^2\right)}{\left(\sum x^2 - (\sum x)^2\left(\sum y^2 - (\sum y)^2\right)\right)} \quad (9)$$

or log transformed as:

$$r^2 = \frac{\sum \log_{10} x \log_{10} y - (\sum \log_{10} x)\left(\sum \log_{10} y^2\right)}{n} \quad (10)$$

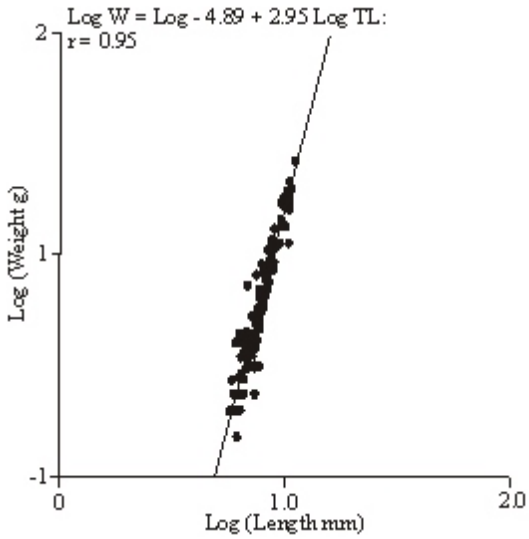

Fig. 1: Length-weight relationship in male *Macrobrachium macrobrachion* in Luubara creek (2006)

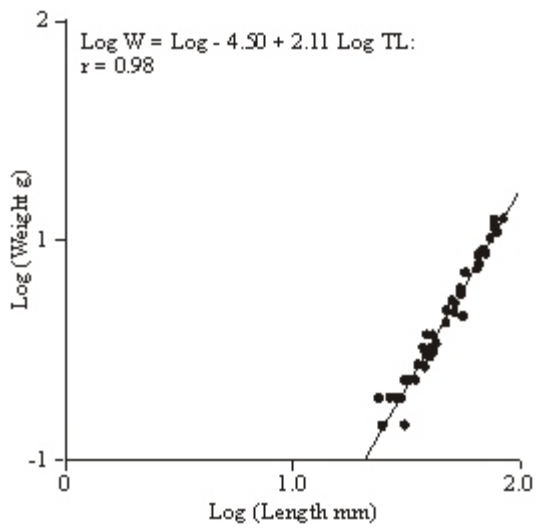

Fig. 2: Length-weight relationship in female *Macrobrachium macrobrachion* in Luubara creek (2006)

$$= \left[\sum \log_{10} x^2 - \frac{\sum \log_{10} (x)^2}{n} \right] \left[\frac{\sum \log_{10} y^2}{10} - \frac{\log_{10} y^2}{n} \right] \quad (11)$$

Condition factor is the plumpness of a shrimp. It determines the well being of a shrimp species in a particular water body. The condition factors of the shrimps were estimated from Fulton's condition (CF) as suggested by Enin (1994):

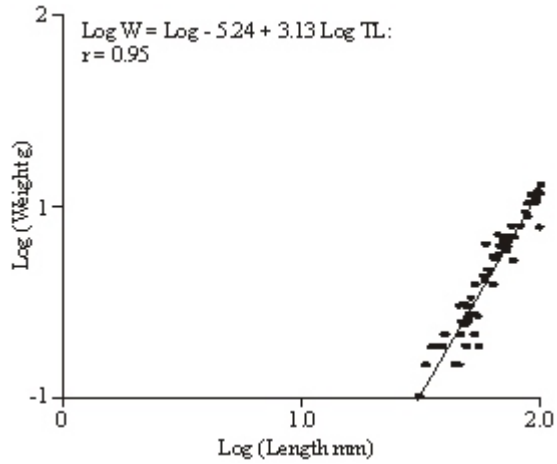

Fig. 3: Length-weight relationship in both sexes of *Macrobrachium macrobrachion* in Luubara creek (2006)

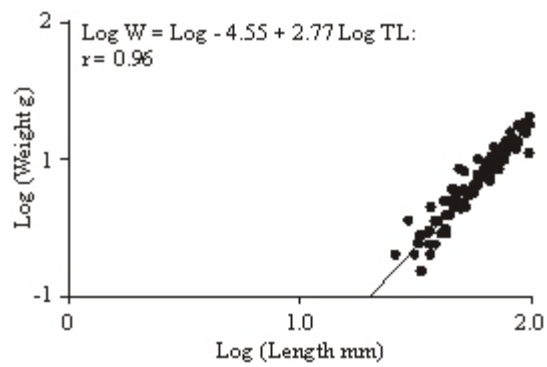

Fig. 4: Length-weight relationship in male *Macrobrachium macrobrachion* in Luubara creek (2007)

$$CF = \frac{\overline{W} \times 100}{\overline{TL^3}} \quad (12)$$

where,

CF = Fulton's condition factor

$\overline{W}$ = Mean ungutted weight (g)

$\overline{TL^3}$ = Mean total length (mm)

CF was determined for each month during the study.

RESULTS

Plots of the length/weight relationship of male and female *M. macrobrachion* from Luubara creek are shown in Fig. 1, 2, 3, 4 and 5. A strong positive relationship was observed between the shrimp length and weight for males in 2006; length and weight in females in 2006 and length and weight in both sexes in 2006. The values of a, b, and r, are given in Table 1). The b values were not greater

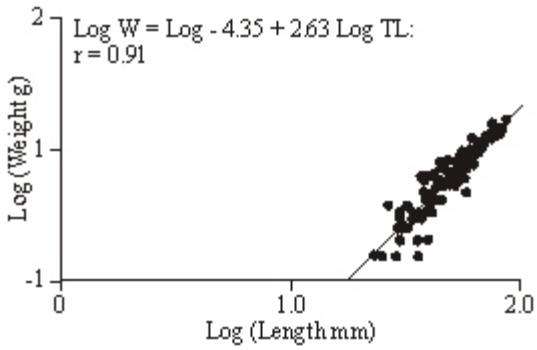

Fig. 5: Length-weight relationship in female *Macrobrachium macrobrachion* in Luubara creek (2007)

Table 1:Parameters of length-weight relationship of *Macrobrachium macrobrachion* in Luubara Creek (2006-2007)

Sex/Year	n	a	b	r	r^2
Male 2006	194	-4.89	2.95	0.95	0.91
Female 2006	76	-4.50	2.11	0.98	0.96
Both 2006	116	-5.24	3.13	0.95	0.91
Male 2007	133	-4.55	2.77	0.96	0.92
Female 2007	143	-4.35	2.633	0.91	0.84

n = number of specimens, a = regression co-efficient, b = regression co-efficient, r = correlation co-efficient, r^2 = correlation co-efficient

than 3 except for both sexes in 2006 with b value of 3.13. Hence growth in the individual sex is allometric (b values less than 3), but when the sexes were combined the growth was also allometric (b value is only slightly greater than 3).

The results of the Fulton's condition factor, K, determined for shrimps in Luubara creek are shown in Fig. 6 and 7. In males, the highest condition factor (K = 0.00718) was recorded in August, 2007 while the lowest result in male (K = 0.001) was recorded in July, 2006. In females, the lowest condition factor (K = 0.000066) was in December, 2006 while the highest condition factor (K = 0.00157) for females was in October, 2006. In the berried females, the month of March, 2007 has the highest condition factor (K = 0.002) while the lowest K value of 0.00097 was recorded in February and September, 2006. In 2006 the range of K was from 0.00084 to 0.00194, (females); 0.00066-0.00015 (males) and 0.00097- 0.00144 for berried females. In 2007, the condition factor ranged from 0.00718 to 0.00109 (male), 0.00097 to 0.00147 (female) and 0.00099-0.002 (berried female).

DISCUSSION

The values obtained from the length/weight relationship (LWR) of *M. macrobrachion* in Luubara creek showed that there was a high and significant correlation between the total length and weight. The b values (2.11-3.13) and r values (0.91-0.98) obtained in this study are within the range obtained by Enin (1994) for Cross River estuary (b = 3.28, r^2 = 0.968). Marioghae (1982) similarly reported positive relationship between the carapace length and weight of

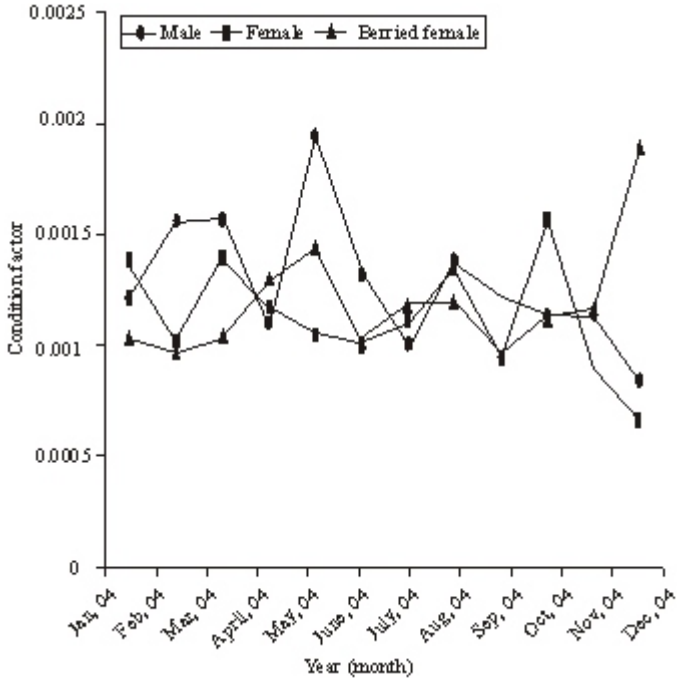

Fig. 6: Condition factor of *Macrobrachium macrobrachion* in *Luubara creek* (2006)

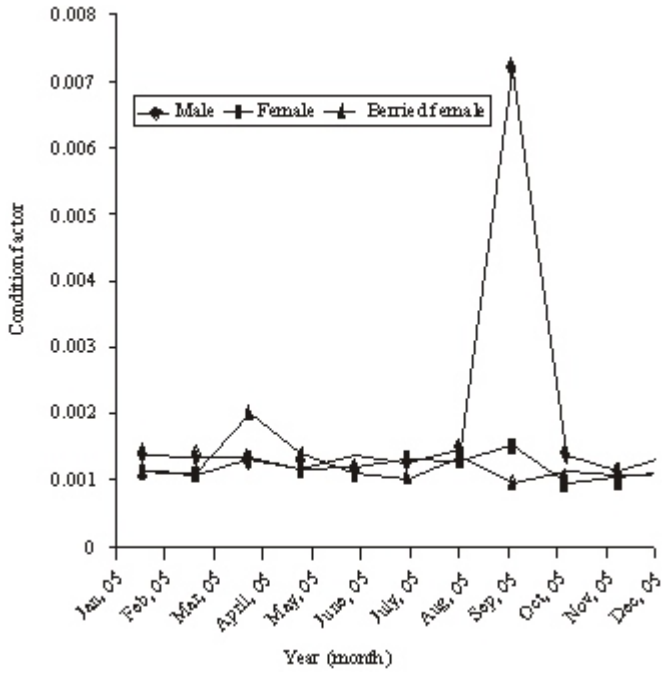

Fig. 7: Condition factor of *Macrobrachium macrobrachion* in *Luubara creek* (2007)

M. macrobrachion in the Lagos Lagoon area. Waribugo (2005) reported that the growth pattern of *Nematopalaemon hastatus* and *Palaemon maculatus* were isometric (i.e., b>3).

When both sexes of *M. macrobrachion* in Luubara creek were considered the b value was 3.13, indicating that the growth is allometric. This agrees with the results of Yakubu and Ansa (2007) on *Penaeus notialis* and *Penaeus monodon* who observed that both shrimp species showed allometric pattern of growth in Buguma Creek. The slight variation in the values of b and r is understandable because length - weight relationship of a species could vary according to locality and season (Medina-Reyha, 2001; Prasad, 2001).

The high correlation coefficient r of 0.95 obtained in this study showed that there is a strong association between length and weight. This means that as the length of fish increases the weight increases in the same proportion. Coefficient of determination r^2 was also high (0.91) which indicted that the model used for the analysis fits the data, confirming the fitness of the model.

The mean condition factor obtained from this study was both sex and season dependent. There were significant variations between sexes. The difference in condition factors was in male and females may be attributed to the presence of ovigerous females. Branco and Masunari (2000) reported differences in condition factors of males and female *Callinectes donae* from Conceicao lagoon system, Santa catarina, Brazil. They observed that it was probably due to higher weight of the females gonads of he crabs. However, in contrast to this result, Lawal-Are and Kusemiju (2000) observed differences in the condition factor of the different sexes of *Cllinectes amnicola* in Badagry Lagoon, Lagos lagoon and its adjacent creeks. The non-seasonality, non significant variations between sexes was related to food regime of fish species utilizing food resources and accumulating a large quantity of flesh as was observed by Ikomi and Sikoki (2001).

CONCLUSION

- *M. macrobrachion* growth in Luubara creek for both sexes was allometric.
- The correlation coefficient 'r' was high, an indication of a strong association between length and weight. This means that as the length of fish increases the weight increases in the same proportion.
- Coefficient of determination r^2 was also high which indicted that the model used for the analysis fits the data, confirming the fitness of the model.
- The mean condition factor obtained from this study was both sex and season dependent.
- There were significant variations between sexes.
- *M. macrobrachion* from Luubara creek was in a good and stable environmental condition.

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