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Population structure of *Munida microphthalma* Leach (Crustacea: Decapoda: Galatheidae) from the northern coast of Rio de Janeiro State, Brazil

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Abstract: We analyzed the demographic structure (sex ratio, size-frequency distributions) and morphometry of Munida microphthalma Leach, 1820 from a sample collected in the north coast of Rio de Janeiro, Southeastern Brazil. A total of 174 individuals were obtained (80 males and 94 females); 58.06% of the females were ovigerous. Sex ratio did not depart from the expected 1:1 proportion. Carapace length for males ranged from 9.11 to 20.73 mm, while in females it ranged from 9.78 to 20.72 mm. The allometric equations showed differences on relative growth between males and females.

Keywords: Anomura, squat lobster, allometric growth, morphometrics, deep water.

Resumo. Estrutura populacional de *Munida microphthalma* Leach (Crustacea: Decapoda: Galatheidae) da costa Norte do Estado do Rio de Janeiro, Brasil. Foi analisada a estrutura demográfica (razão sexual, distribuição da freqüência de tamanhos) e a morfometria de uma amostra de Munida microphthalma Leach, 1820 coletada na costa do Rio de Janeiro, Sudeste do Brasil. Um total de 174 indivíduos foi obtido (80 machos e 94 fêmeas); 58,06% das fêmeas se encontravam ovadas. A razão sexual não diferiu da proporção esperada 1:1. O comprimento da carapaça para machos variou de 9,11 a 20,73 mm, enquanto para as fêmeas variou de 9,78 a 20,72 mm. As equações alométricas demonstraram diferenças no crescimento relativo entre machos e fêmeas.

Palavras-chave: Anomura, lagostim, crescimento alométrico, morfometria, águas profundas.

Introduction

Galatheidae Samouelle, 1819 is an anomuran crab family particularly abundant at mid latitudes (Tapella *et al.* 2002). *Munida* Leach, 1820 is probably the most representative genus (Melo 1999), with around 100 widespread species, presenting a broad bathymetric distribution, ranging from 10 m to more than 2,300 m (Melo-Filho 1992).

After Melo (1999) there are records for 16 species of *Munida* from Brazil. He also cited five species from Rio de Janeiro state: *Munida flinti* Benedict, 1902, *M. forceps* A. Milne-Edwards, 1880, *M. irrasa* A. Milne-Edwards, 1880, *M. pusilla* Benedict, 1902, and *M. spinifrons* Henderson, 1885. *M. microphthalma* A. Milne-Ewards, 1880 was previously recorded from Espírito Santo and São Paulo states, in depths from 750 m to 1,700 m.

Relative growth studies on Crustacea reveal several phases of growth. Normally, these phases are correlated with changes on relative growth, so they can reveal the moult that the individuals pass from sexually immature to sexually mature (Hartnoll 1978). The allometric relation between body size and other organs has been used to estimate size at sexual maturity, assuming that the secondary sexual characters change their growth in the transitional phase (Barreto *et al.* 2006). Recent work on *Munida* reproduction recognized that the change in cheliped growth rate indicates the transition to morphometric maturity (Tapella *et al.* 2002). Morphological studies were also used to compare similar species of the genus *Munida* (Tapella & Lovrich 2006).

The objective of the present paper is to characterize the relative growth of the galatheid crab *Munida microphthalma* from Southeastern Brazil and determine possible secondary sexual characters for this species and size at sexual maturity using the morphological data. Also we provide data available on this species population structure that could be extracted from the samples collected.

Materials and Methods

Data gathering

Two samples were obtained using trawling techniques in the northern coast of Rio de Janeiro State, Southeastern Brazil. The first trawling (21º17’44’’S/40º04’38’’W) was carried out in March 2002 at 1,340 m deep, and the second (22º09’16’S/40º04’38’’W) in May 2002 at 1,192 m deep. Collected specimens were preserved in alcohol 80 %. In the laboratory, crabs were identified, counted and sexed. The sex ratio and the proportion of ovigerous females were calculated. The specimens have been deposited in the Coleção Carcinológica do Departamento de Zoologia Instituto de Biologia/UFRJ, numbers DZUFRJ2758 and DZUFRJ2759.

Statistical analyses

For testing the sex ratio a simple Chi-square test was used. For comparing carapace length and cheliped length between sexes and cheliped symmetry Student´s *t*-test ($p<0, 01$) was used.

For the morphometric analysis the following measurements were made with a digital caliper, with a precision of 0.1mm: carapace length (CL), the distance between the ocular orbit and the posterior margin of the carapace; carapace width (CW), the distance between the left and the right fifth lateral spine of the carapace; rostrum length (RL), the distance between the tip of the rostrum and the posterior margin of the ocular orbit; supra-ocular spine length (SOL), the distance between the tip of the supra-ocular spine and the posterior margin of the ocular orbit; cornea diameter (CD); propodus height (PH) measured at the larger dorso-ventral distance of the propodus; cheliped length (CH), maximum length between the tip of the propodus and the proximal margin of the coxa; palm length (PL), distance between the proximal margin of the propodus and the insertion of the dactylus; dactylus length (DL), distance between the tip of the dactylus and its proximal margin. Carapace length was chosen to be the reference for all morphometric analyses. In the study of relative growth of the dactylus in relation to palm, the latter was used as reference.

The morphometric index (MI%) for different dimensions related to the distinct CL class was calculated according to the equation: MI (%) = Measure 1 X 100 /Measure 2 (CL) (Alencar et al. 1998). This index represents the ratio of growth of a dimension in relation to the CL.

For the analysis of relative growth, the allometric equation $y = ax^b$ was used in its logarithmic form $\log y = \log a + b \log x$ (Hartnoll 1978), where the constant “b” indicates the allometry in the regression graph. In this paper we considered that values higher than 1.1 ($b>1.1$) indicate positive allometry, values between 0.9 and 1.1 ($0.9<b<1.1$) indicate isometry and values lower than 0.9 ($b<0.9$) indicate negative allometry (Moraes-Riodades & Valenti 2002). All the values obtained for “b” in the logarithmic equations were tested against the isometry value (1) using Student´s *t*-test at 5% of significance level.

Size at morphometric maturity was the CL of the inflexion point observed on the Major Cheliped (MCL) growth, as the change in the allometry of cheliped growth represents the acquisition of secondary sexual characters (Hartnoll 1978).

Results

Population structure

A total of 174 individuals (80 males and 94 females) were analyzed. The sex ratio did not differ statistically from 1:1 ($X^2 = 0.56$; $p < 0.05$). Ovigerous females made up 58.06 % of total females.

Carapace length for males ranged from 9.11 to 20.73 mm, while in females it ranged from 9.78 to 20.72 mm (Table I); ovigerous females ranged from 10.71 to 20.72 mm. For males, the modal class was the 17-19 mm CL class, whereas that for female was the 13-15 mm CL class (Fig. 1). Males were significantly larger than females ($p<0.01$).

Growth

CL/CW growth is isometric for males and positive for females (Fig. 2). The allometric growth equations demonstrated isometry for CL/RL, CL/SOL, in both sexes. On the other hand, both sexes showed negative allometry for the following regressions: CL/CD and PL/DL for both chelipeds. Males showed positive allometry for all cheliped-related ratios except for PL/DL. The females showed negative allometry for CL/PH for left cheliped; isometry for CL/PH for right cheliped, CL/CH for both chelipeds, CL/PL, CL/DL (Table II).

Table I. *Munida microphthalma*. Statistics for morphometric dimensions of males and females. Min (Minimal values); Max (Maximum values); SD (Standard-deviation); N (sample size).

Morphometric Dimensions (mm)	MALES					FEMALES				
	N	Max	Min	Mean	SD	N	Max	Min	Mean	SD
CL	76	20.73	9.11	16.03	2.5	90	20.72	9.78	14.36	2.03
CW	71	17.24	7.16	13.17	2.07	83	17.28	7.8	11.76	1.79
RL	76	11.05	4.75	7.56	1.31	87	8.78	4.56	6.6	1.04
SOL	81	3.33	1.39	2.11	0.4	90	2.62	1.03	1.93	0.33
CD	83	2.03	1.06	1.58	0.2	91	1.68	0.88	1.41	0.16
Left CH	69	77.76	24.47	51.51	14.98	83	55.17	24.95	36.2	5.51
Right CH	70	80.64	24.74	52.87	13.98	77	48.99	25.05	36.48	5.47
Left PL	70	17.71	5.07	11.13	3.89	83	11.16	4.52	6.9	1.19
Right PL	70	19.88	4.87	11.62	3.91	77	9.74	4.64	6.89	1.17
Left DL	68	15.86	5.18	10.78	2.97	83	11.63	5.39	7.78	1.25
Right DL	70	17.13	5.2	11.14	2.84	76	10.77	5.31	7.84	1.34
Left PH	69	5.07	1.48	2.97	0.87	83	3.36	1.63	2.29	0.42
Right PH	71	4.85	1.55	3.07	0.78	77	3.32	1.67	2.3	0.41

CL –carapace length; CW – carapace width; RL – rostrum length; SOL – supra-ocular spine length; CD – cornea diameter; CH – cheliped length; PL – palm length; DL – dactylus length; PH – palm height.

Table II. *Munida microphthalma*. Statistics for the allometric equation log y = log a + b log x between independent (X) and dependent (Y) dimensions. n=sample size; a = y-intercept constant; b = allometric constant ;r^2 = coefficient of determination; r = coefficient of correlation ; AL= allometry.

Table IIa: MALES

REGRESSION	PARAMETERS (Log CL X Log Others)					
	n	a	b	r^2	r	AL
CL/CW	71	-0.1183	1.0227(0.992 – 1.052)*	0.9869	0.9934	=
CL/RL	76	-0.2300	0.9218(0.810 – 1.033)*	0.8025	0.8958	=
CL/SOL	81	-0.7312	0.8765(0.701 – 1.051)*	0.5811	0.7623	=
CL/CD	82	-0.7059	0.751(0.686 – 0.815)*	0.8802	0.9382	-
CL/Left CH	69	-0.2027	1.5873(1.416 – 1.757)*	0.8523	0.9232	+
CL/Right CH	70	-0.1937	1.5856(1.431 – 1.739)*	0.8718	0.9337	+
CL/Left PL	70	-1.1847	1.8441(1.575 – 2.113)*	0.7549	0.8688	+
CL/Right PL	70	-1.2371	1.8972(1.663 – 2.130)*	0.8097	0.8998	+
CL/Left DL	68	-0.7837	1.508(1.347 – 1.667)*	0.8577	0.9261	+
CL/Right DL	70	-0.8213	1.5458(1.403 – 1.687)*	0.8842	0.9403	+
CL/Left PH	69	-1.0548	1.2635(0.983 – 1.543)*	0.5755	0.7586	+
CL/Right PH	71	-0.9795	1.2109(0.986 – 1.434)*	0.6496	0.8060	+
Left PL/ Left DL	68	0.2419	0.7616(0.722 – 0.800)*	0.9621	0.9809	-
Right PL/ Right DL	70	0.2342	0.7692(0.730 – 0.807)*	0.9632	0.9814	-

CL –carapace length; CW – carapace width; RL – rostrum length; SOL – supra-ocular spine length; CD – cornea diameter; CH – cheliped length; PL – palm length; DL – dactylus length; PH – palm height. * Confidence intervals.

Table IIb: FEMALES

REGRESSION	PARAMETERS (Log CL X Log Others)					
	n	a	b	r^2	r	AL
CL/CW	83	-0.1580	1.0634(1.028 – 1.098)*	0.9789	0.9894	+
CL/RL	87	-0.2812	0.9499(0.829 – 1.070)*	0.7442	0.8627	=
CL/SOL	90	-0.8250	0.9567(0.778 – 1.134)*	0.5672	0.7531	=
CL/CD	90	-0.6105	0.6574(0.548 – 0.765)*	0.6217	0.7885	-
CL/Left CH	83	0.4076	0.9955(0.914 – 1.076)*	0.8829	0.9396	=
CL/Right CH	77	0.4099	0.9926(0.891 – 1.093)*	0.8363	0.9145	=
CL/Left PL	83	0.3208	1.0019(0.863 – 1.140)*	0.7225	0.8500	=
CL/Right PL	77	-0.3444	1.0178(0.863 – 1.172)*	0.6973	0.8350	=
CL/Left DL	83	-0.2906	1.0214(0.913 – 1.129)*	0.8158	0.9032	=
CL/Right DL	75	-0.2896	1.0220(0.916 – 1.127)*	0.8365	0.9146	=
CL/Left PH	83	-0.5350	0.7666(0.545 – 1.005)*	0.2901	0.5386	-
CL/Right PH	77	-0.6502	0.8701(0.649 – 1.090)*	0.4522	0.6725	=
Left PL/ Left DL	83	0.1493	0.8840(0.801 – 0.966)*	0.8491	0.9215	-
Right PL/ Right DL	75	0.1601	0.8782(0.817 – 0.938)*	0.9192	0.9587	-

CL –carapace length; CW – carapace width; RL – rostrum length; SOL – supra-ocular spine length; CD – cornea diameter; CH – cheliped length; PL – palm length; DL – dactylus length; PH – palm height. *Confidence intervals

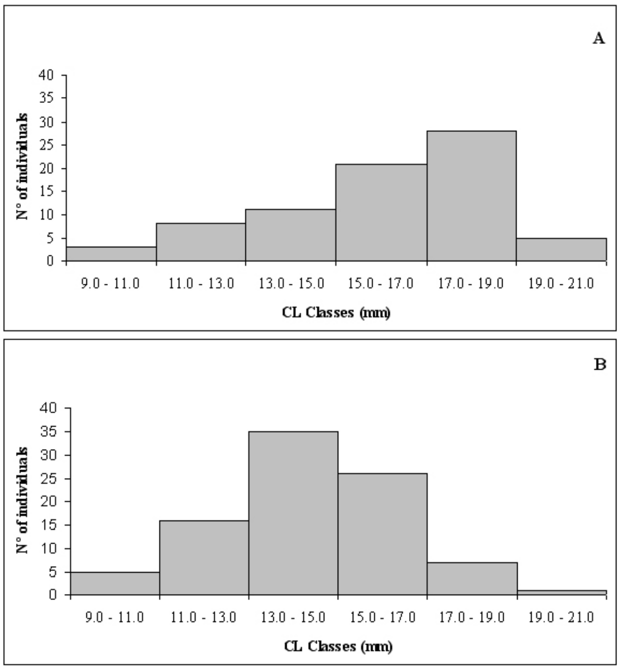

Figure 1. Carapace Length -frequency distributions for the sample of *M. microphthalma* (mm). A – males; B – females.

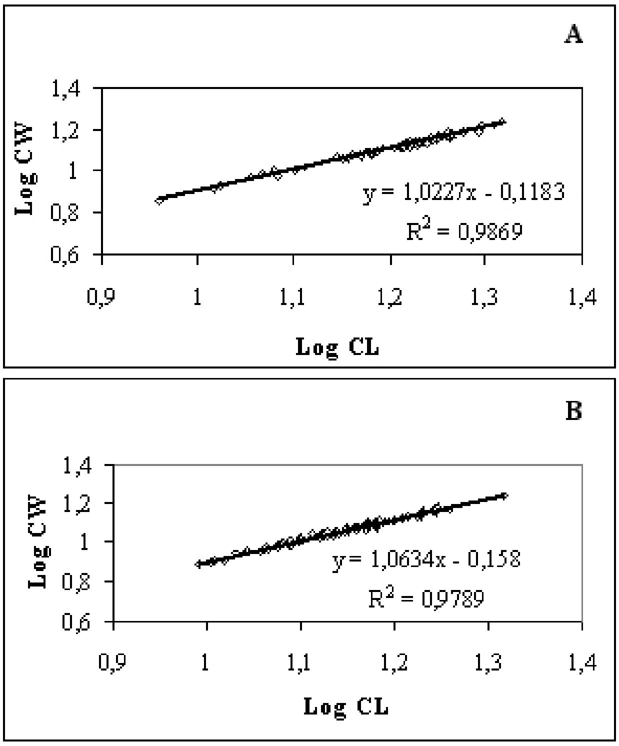

Figure 2. Relative growth of carapace width for male and female *M. microphthalma*. A – males; B – females.

The analysis of the Major Cheliped Length (MCL) for males showed an inflexion point at a CL value of 15.16. For juveniles growth of the MCL is isometric to CL; on the other hand, adult growth has a positive allometry, being the MCL growth faster than CL growth. (Fig. 3) (Tab. III).

The morphometric index (Table IV) found for the different CL classes presented similar variations for both sexes, except for those related to chelipeds, which showed a significant increase of size in males. Male CH was statistically larger than female CH for both chelipeds ($p<0.05$). Chelipeds were symmetric for males and females ($p<0.05$), being the cases of observed asymmetry associated with the commonly known behavior of crustaceans to autotomise its pereiopods under stressful moments, which leads to a delayed growth of the autotomised cheliped.

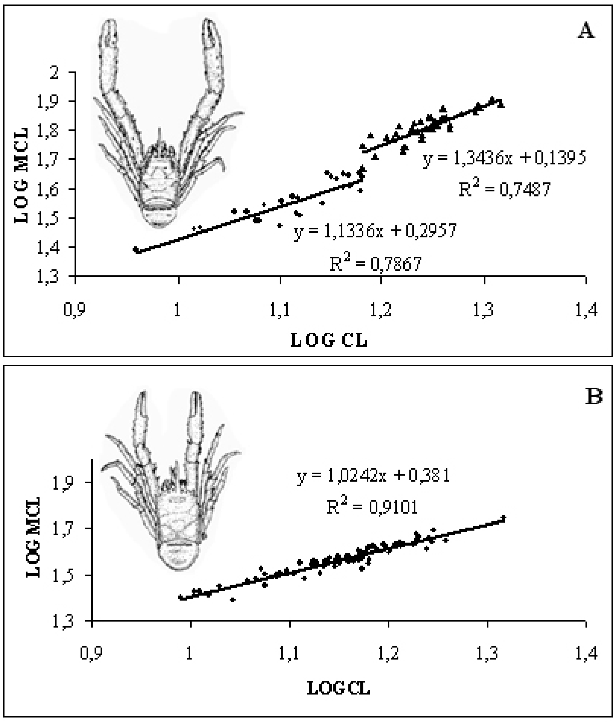

Figure 3. Relative growth between Major Cheliped Length (MCL) and Carapace Length (CL) for male (A) and female (B) *M. microphthalma.*

Discussion

This species is newly recorded from Rio de Janeiro State, in depths from 1,190 m to 1,340 meters.

Although based on only two samples, the sex ratio found for this species might be considered as it was obtained from a random sample. Unfortunately, sampling for this species is not easy due to its bathymetric range, so we used all available data to extract as much information as possible on this species population structure.

Hueguet *et al.* (2005) report that males reach larger sizes than females in *Munida rutlanti* Zaraquiey Álvarez, 1952, *Munida intermedia* A. Milne-Edwards and Bouvier, 1899 and *Munida tenuimana* G. O. Sars, 1882 populations. Our work shows that, in average, males are larger than females in *M. microphthalma*, although the larger female had reached almost the same size of the larger male.

Table III. *Munida microphthalma*. Statistics for the allometric equation log y = log a + b log x between independent (x) and dependent (y) dimensions. n=sample size; a = y-intercept constant; b = allometric constant; r^2 = coefficient of determination; r = coefficient of correlation ; AL= allometry; X=inflexion point.

REGRESSION		PARAMETERS (LOG CL X LOG MCL)					
		n	r	r^2	a	b	AL
CL X MCL (X=15,16) (MALE)	<X	25	0.8869	0.7867	0.2958	1.1335 (0.879 - 1.388)	=
	>X	39	0.8654	0.7488	0.1395	1.3436 (1.084 - 1.603)	+
CL X MCL (FEMALE)		88	0.9541	0.9103	0.3806	1.0245 (0.955 - 1.093)	=

CL – capapace length; MCL – major cheliped length.

Table IV. *Munida microphthalma*. Morphometric Index for males and females. See text for abbreviations of dimensions.

		MORPHOMETRIC INDEX (MI%)											
SEX	CL Classes	CW	RL	SOL	CD	Left CH	Right CH	Left PL	Right PL	Left DL	Right DL	Left PH	Right PH
MALES	1	79.66	49.87	14.36	11.47	274.75	275.80	54.74	53.97	59.48	58.39	17.37	17.81
	2	69.73	48.71	13.79	10.25	266.31	272.45	51.82	53.54	57.48	58.45	16.89	17.74
	3	81.31	47.41	13.44	10.24	274.93	279.16	54.99	55.70	58.70	59.88	17.11	17.74
	4	80.61	47.58	12.87	10.04	302.59	337.50	66.50	68.08	63.79	70.78	17.28	17.49
	5	81.38	47.02	13.32	9.56	347.68	337.40	77.36	76.34	66.78	70.83	18.15	19.39
	6	82.29	47.91	13.65	9.46	370.40	367.09	81.25	86.84	74.84	76.51	19.43	19.65
	MEAN	79.16	48.08	13.57	10.17	306.11	311.56	64.44	65.75	63.51	65.81	17.71	18.30
FEMALES	1	79.47	47.47	12.87	10.70	254.66	200.17	50.24	37.52	54.54	43.79	16.99	13.08
	2	81.75	46.09	13.52	10.73	238.48	235.96	45.32	44.58	51.18	48.20	15.72	14.97
	3	82.53	44.84	13.88	9.84	251.53	250.23	47.44	46.46	53.80	54.00	16.10	16.00
	4	82.38	41.98	12.87	9.62	252.59	255.19	48.31	49.11	54.62	55.17	15.68	16.11
	5	83.50	45.96	13.66	9.27	252.36	253.83	48.49	48.39	54.52	55.51	14.75	15.51
	6	83.40	42.37	12.36	7.82	266.26	219.93	53.86	39.33	56.13	48.02	15.78	11.05
	MEAN	81.93	45.27	13.36	10.03	249.93	239.08	47.96	45.21	53.73	51.34	15.85	15.13

CL –carapace length; CW – carapace width; RL – rostrum length; SOL – supra-ocular spine length; CD – cornea diameter; CH – cheliped length; PL – palm length; DL – dactylus length; PH – palm height.

Previous work on *Munida subrugosa* (White, 1847) reproduction (Tapella *et al.* 2002) stated that male and female physiological sizes at maturity occurred at very similar sizes. This may not be true for *M. microphthalma*, since the morphological size at maturity observed in our work for males (CL=15.16 mm) is very high when compared to the smallest ovigerous female (CL=10.72 mm). In the same previous work Tapella *et al.* (2002) showed that only 3% of their male fraction of the population was composed of morphologically mature males, which leads them to believe that it wouldn't be adaptive to the species to rely on morphometric mature males to ensure mating and offspring production; in our sampling 67.1% of the males were morphologically mature, making possible that these males ensure the next offspring production.

The equation $y = ax^b$ in its logarithmic form log y = log a + b log x showed varying results. The isometric growth observed in males for CL/CW indicated that there is a proportional carapace growth in both length and width, as both dimensions grow in the same ratio. For females a positive allometry was observed for CL/CW which indicates that CW grows faster than CL; this may be due to an increase of carapace volume related to an increase of gonad volume in females. The cheliped relations also showed differences between sexes. The positive allometry found for males represents that the chelipeds grow faster than carapace length. For females the cheliped regressions showed that the cheliped grows in the same proportion as carapace length. Only in regressions related to palm height a negative allometry was observed in cheliped, demonstrating that they become thinner with size increase (Table II). For both sexes CL/RL and CL/SOL relations were isometric, indicating that rostrum and supra-ocular spine grows in the same rate as the carapace; a negative allometry was found for CL/CD showing that cornea diameter grows slower than the carapace.

In the allometric relationship PL/DL a negative allometry was found for both sexes, which indicated that the dactylus grew slower than the palm in *M. microphthalma*. In this way younger individuals have its DL longer than its Palm length, while older ones have the opposite relation, as PL is longer than DL. Current taxonomical literature (Melo 1999) indicates the size relationship between dactylus and palm as an important character for this species diagnosis. The results obtained in this paper disagree with that remark, as dactylus/palm ratio change with age.

Morphometric index results clearly indicated a sexual dimorphism related to cheliped size. The MI% for cheliped growth in males displayed a variation of 100 between classes 1 and 6, what means that the chelipeds of larger males added almost one carapace length during growth in relation to smaller ones (Table IV).The importance of the chelipeds on feeding is presented for *Munida sarsi* (Huus 1935) as an important food selecting and handling tool; works on other groups of Crustacea state the importance of the chelipeds on territory occupation and defense, social structure management, and reproduction behavior (Moraes-Riodades & Valenti 2002; Masunari *et al.* 2005). The size difference observed in our work may be related to reproductive behavior, such as competition for females and female handling, for *M. microphthalma*, as the CL differentiation is clearly seen in mature males.

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