Length-weight relationships adapted to freshwater prawn Macrobrachium rosenbergii morphological types.

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ABSTRACT

The social organization in a *Macrobrachium rosenbergii* population involves the emergence of different subpopulations (blue and orange claws males, small males, berried and non-berried females). In a population, prawns of a same size can get different weights. So using a simple length-weight relationship doesn't provide a good accuracy on the calculated mean weight of the whole population. Therefore there is a need for adapted, precise and reliable length-weight relationships for each morphological type.

These length-weight relationships have been adjusted at IFREMER's experimental station in Kourou, French Guiana. Equations between orbital length and wet weight have been obtained by linear regression on the logarithm transformed values. They take the form $W = a.L^B$, with a = cst and B varying between 2,9 and 3,3. "R" tests realised on correlation cofficients showed a significant correlation ($P < 0,05$).

Used with size histogram for prawn morphological types, the length-weight relationships make easier the different subpopulations growth survey inside the whole population. Applyings are numerous in discontinuous systems as continuous ones.

INTRODUCTION

The interest of the length-weight relationships is to get a mean weight using a size histogram. These relationships reduce the working time of a sampling as well as the stress that intervention can cause on animals. However, in *Macrobrachium* population, social organization leads to the emergence of different morphological types. So prawns of a same size but which belong to different morphological types will have different weights. That's why use of a simple length-weight relationship is unsatisfaying to calculate the mean weight of a group of prawns, because it doesn't provide a good accuracy. Therefore there is a need for an adapted, precise and reliable tool : we have to use length-weight relationships adapted to morphological types.

MATERIALS AND METHODS

1014 individuals have been randomly caught in the ponds of the IFREMER's experimental station in Kourou (Fig. 1), using a statistical net. They were identified according to their sex and morphological type, then measured and weighted. Sex determination is based upon the observation of the gonopores and ovaries if possible.

Prawns with a size inferior to 60 mm are considered as "juveniles". Males are identified using criterions as their size, the color of the P2 claws and finally the *claw length/body length* ratio (Brody and al., 1980; Cohen and al., 1989). They are classified as small males, orange claws or blue claws. Difference between the females is only based upon the presence or not of eggs (berried or non berried females)in incubating chamber.

We recorded the prawn size commonly using orbital length (L), defined as the distance from the posterior edge of the eye orbit to the posterior end of the telson (Fig. 2); It's noted to the nearest millimeter.

Wet weight (W) is measured. For each group of prawns, table 1 shows minimun and maximum recorded sizes and weights and number of measured individuals.

The allometric law, first applied by Huxley (1924) to the crustacea growth, gives a mere mathematical relation between wet weight and orbital length. This function is written :

$$W = a.L^{B}$$ where a and B are two constants.

Ln-transformed datas supply a linear relation between the two variables W and L. This relation has the following form :

$$\text{Ln } W = \text{Ln } a + B.\text{Ln } L$$

Using a linear regression, we get the best equation linking the two variables. This processing gives the slope values **a** and the origin ordinate point **B**. A "**r**" test applies to each correlation coefficient shows for each category of morphotypes, the important link between the two variables. Length-weight relationship adapted to morphological types are defined using the different regression equations. Similarity between these equations leads to test if it's possible to regroup them in a single mean equation; covariance analysis is used to show if there are differences between them.

RESULTS AND DISCUSSION

1- Regression equations between size and weight.

Table 2 shows, for each morphological type the results of the linear regression processed on the Ln-transformed datas.

Regression equations are similar with a slope varying from 2.86 to 3.34. The 6 correlation coefficients are close to 1 and show that the allometric relation between orbital length and wet weight is satisfaying. The test used to verify if these values have been obtained by random sampling or if they signify (with an error risk of 5 %) that a correlation actually exists between the two variables, are all very highly significant. Taking a 0.1 % error risk, the result of the tests stays the same and confirms with a 99.9 % certitude, there is a strict correlation between the two variables.

These observations support these made by Wang in 1985 who finds, with a r equal to 0.9889, an allometric relation between the orbital length and the wet weight of the freshwater prawn *Macrobrachium rosenbergii.* The Wang relation has the following form :

$$W = 3.2\ 10^{-5}\ (TL)^{3.2615}$$

In the same way, Jayachandran and Joseph (1988) obtain for *Macrobrachium idella* and *Macrobrachium scabriculum* males and females, similar relations applying the allometric law between the total length and the wet weight of the prawns.

2- Covariance analysis on the regression equations.

Application conditions for a covariance analysis need the previous verification of :

a- variance equality for the wet weight variable between each morphotypes group,

b- distribution normality of the datas.

We consider that the second condition is satisfayied, seeing the usually reported normality in all ours samples. To verify the variance equality hypothesis, we compare step by step :

all the variances,
the males variances (SM, OC and BC),
females variances (berried and non berried),
males + juveniles variances,
females + juveniles variances.

Results of these comparisons (Bartlett tests) are presented in the table 3. Variance equality is only accepted for males and clearly refused in all the other cases.

Therefore, the covariance analysis in only applied to the 3 categories of males. The F test used to verify the hypothesis on the equality of the 3 regression line slopes gives a calculated value clearly superior to the critical value found in the Fisher-Snedecor table. The main stages for calculations and decision of the test are presented in table 4.

The tests show that in spite of their similitudes, the 6 regression equations between the orbital length and the wet weight, are significantly different. It's not necessary to try to regroup them in a single mean equation. Length-weight relationships are defined using the equations obtained for each morphological type. They are presented in table 5.

3- A few applyings using the length-weight relationships.

Using length-weight relationships adapted to morphological types, we easily and precisely can calculate the mean weight of a prawn population. These relations also reduce the sampling working time as well as the stress that intervention can cause on animals.

Used with a size histogram for morphological types, they supply the calculated mean weight of a group of individuals inside the whole population; so we can follow their growth. For example, we precisely can analyse the growth of females according to different rearing conditions (density, feeding, intervention of a selective harvest or not).

LITERATURE

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		Males			Females	
Groups	**Juveniles**	**Small males**	**Orange claws**	**Blue claws**	**Non berried**	**berried**
Look–color of the claws	thin, colorless	thin colorless or rose	long and high orange	long, strong with bristly bottom thick, dark blue	dark orange	dark orange
Claws length/ body length	< 0.5	< 1	1 – 1.5	1.5 – 2	≈ 1	≈ 1
Number	160	130	179	178	218	149
Size (mm) min	20	60	85	75	60	75
Size (mm) max	59	94	129	119	119	114
Weight (g) min	0.14	5.5	15.5	12	4.8	11.9
Weight (g) max	5.5	21.9	67.1	66.3	48.8	47.3

Table 1 : Main characteristics of the different morphological types, with min and max sizes and weights.

Groups	Regression equations	r	Test decision with α = 5 %
Juveniles	$W = 0.855\ 10^{-5}\ (OL)^{3.2537}$	0.9994	Highly significant
Small males	$W = 4.879\ 10^{-5}\ (OL)^{2.8617}$	0.9983	id
Orange claws	$W = 1.344\ 10^{-5}\ (OL)^{3.1654}$	0.9997	id
Blue claws	$W = 0.707\ 10^{-5}\ (OL)^{3.3422}$	0.9980	id
Females	$W = 1.314\ 10^{-5}\ (OL)^{3.1570}$	0.9991	id
Non berried	$W = 2.385\ 10^{-5}\ (OL)^{3.0536}$	0.9976	id

Table 2 : **Regression equations, correlation coefficients and result of the "r test".**

Groups	degree of freedom	calculated B.	critical value at the α risk	Decision
all	5	307.3	11.1 α = 5 %	highly refused
only males	2	6.9	7.4 α = 2.5 %	accepted
only females	1	48.4	3.8 α = 5 %	refused
males + juveniles	3	245.6	7.8 α = 5 %	highly refused
females + juveniles	2	159.6	6.0 α = 5 %	highly refused

Table 3 : **Bartlett tests results on the variances comparison.**

Source of variation	Total residual errors	Degree of freedom	Residual variances	calc F	critical F
All males	$4.209255\ 10^{-11}$	481			
3 parallel lines	0.306051753706	483	0.0006336	241.5	3.012
Slopes differences	0.306051753748	2	0.1530259		

Table 4 : **Covariance analysis : residual errors, degree of freedom, variances and F values.**

Size (mm)	weights (g)	Males weights (g)			Females weights (g)	
	Juveniles	Small males	Orange claws	Blue claws	non-berried	berried
20-24	0.2					
25-29	0.4					
30-34	0.7					
35-39	1.1					
40-44	1.6					
45-49	2.4					
50-54	3.3					
55-59	4.4					
60-64		6.6		6.9	6.0	
65-69		8.2		9.0	7.6	
70-74		10.1	10.2	11.4	9.6	
75-79		12.2	12.6	14.3	11.9	13.
80-84		14.6	15.4	17.6	174.5	16.7
85-89		17.3	18.5	21.5	17.4	20.0
90-94		20.3	22.1	25.9	20.8	23.7
95-99		23.7	26.1	30.9	24.6	27.8
100-104		27.3	30.6	36.6	28.8	32.4
105-109		31.3	35.7	42.9	33.5	37.5
110-114		35.7	41.2	50.0	38.7	43.1
115-119		40.4	47.3	57.8	44.4	49.3
120-124		45.6	54.0	66.5	50.7	56.0
125-129			61.3	76.1	57.6	63.3
130-134			69.3	86.6	65.0	71.3
135-139			78.0	98.0	73.2	79.8
140-144			87.3	110.5	81.9	89.1
145-149			97.5	124.0	91.4	99.0
150-154			108.3	138.7	101.5	109.6

Table 5 : Length-weight relationhips adapted to the Macrobrachium rosenbergii morphological types.