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DIFFERENCES BETWEEN THE GROWTH PATTERNS OF CRANGON CRANGON AND NEPHROPS NORVEGICUS

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Abstract

A method developed for measuring indirectly the physiological condition of a fast growing shrimps species, Crangon crangon, and used also successfully on Penaeus brasiliensis, was tried on Nephrops norvegicus. The scarce information available about the life cycle of Nephorps suggest a pattern completely different from the life cycles of the above mentioned shrimps. The results of this research confirms the existence of great differences in the patterns of growth and moulting between N. norvegicus and C. crangon.

Introduction

In crustaceans a strong link exists between growth and moulting. As in any other organism, growth in crustaceans is a regular process following in general a regular pattern. In crustaceans however, the more or less rigid shell sets a limit to the regular increase of the body volume. Moulting, by which process the shell is enlarged intermittently, is not a parameter for already achieved growth but expresses the determination to continue growth in future and, at the same time enables the crustacean to do so.
The limits to growth set by the size of the shell are highly relevant to fast growing species like Crangon crangon and Penaeus brasiliensis (Boddeke, Dijkema and Siemelink, 1977). In these shrimp species the "shell" is an elastic membrane in which the hard parts of the shell are embedded. Between moults a certain increase in size is possible by stretching of this elastic cuticle (Meixner, 1969). In C. crangon moulting is not only coupled with growth but also with the incubation of the eggs, because the eggs are carried at the abdomen until hatching. In a period of fast growth the capacity to grow between moults by stretching the cuticle is utilized amply by berried females. Due to size increase of these

shrimps between two consecutive moults, a shift occurs in the relation between the body length and the surface area of certain hard parts of the cuticle. By this relation, the physiological condition of shrimps can be defined indirectly (Boddeke 1975 and 1976). The method developed on basis of this principle, to measure this relation in samples of shrimps (the so-called SA-L method), has proven to be valuable to explain patterns of migration and distribution in Crangon crangon and Penaeus brasiliensis.
Nephrops norvegicus however, is a species with a life cycle completely different in many aspects from those of the above mentioned shrimp species of which the life cycles are similar in many ways.
The shell of Nephrops is hard, for which reason it is unlikely that increase of the body length can take place between moults by stretching the membrane-like sutures of the shell.
Data about the life cycle of Nephrops are compiled in the reports of the Nephrops working group 1975 and 1977. They are used here to demonstrate the differences between N. norvegicus and the two shrimp species C. crangon and P. brasiliensis.
From ICES area IVa, spawning of Nephrops is reported to be in late summer and the eggs being carried by the female until they hatch in the following spring. In C. crangon and P. brasiliensis spawning is not restricted to such a short, well defined part of the year but takes place almost throughout the year.
Following Charuau (Anon. 1977) also the moulting cycle of Nephrops populations presents a rather strict periodicity. For sub-area VIII the percentage of Nephrops about to moult was high in March-May and in August-September. In C. crangon and P. brasiliensis, a populationwise periodicity in moulting does not exist.
Although data on growth are scarce, all available data suggest that Nephrops is a very slow growing species (Hillis 1976, Jones 1976). Data of Hillis (Anon 1977) from available Irish material indicate that a carapace length of 30 mm (corresponding with a body length of 101 mm in males and females, is reached in 4 years by males and in more than 5 years by females. Maturity of females usually occurs after 4 years at a carapace length of 24-26 mm (July). In comparison, females of C. crangon and P. brasiliensis reach the minimum size of sexually mature shrimps ($\pm$ 5 cm in C. crangon and 12-14 cm in P. brasiliensis in four months. (Boddeke and Becker 1976, Boddeke, Dijkema and Siemelink 1977).
Applying the SA-L method developed for fast growing shrimps on Nephrops was interesting as a test for the method and for the reliability of the present knowledge about the life cycle of Nephrops as well.

Methods and materials

For this purpose, a large sample of Nephrops, caught on 14-11-77 at 55°N and 4°E by the vessel KW 45 was taken in the IJmuiden auction. From this sample only very fresh undamaged specimens were chosen. Because only 11 berried females met this standard, the number of males and non-berried females was restricted to

11 too, following the length distribution in the sample. The body length of the berried females varied in length from 106.0 mm till 155.1 mm and the males from 126.2 till 146.3 mm. Body length and carapace length of all specimens were defined following the general method of measuring.

Table I - Berried females (N = 11).

x	y	REGRESSION	x mean	Sx	y mean	Sy	r
L^2	SA	y= 1.0725 + 0.0236.x	187.09	31.95	5.49	0.79	0.95
D.W.	$SA^{3/2}$	y= 0.4240 + 4.8620.x	2.588	0.496	13.006	2.819	0.85
D.W.	CL^3	y=- 7.9486 + 31.6901.x	2.587	0.496	74.056	17.462	0.90
A.D.W.	$SA^{3/2}$	y= 6.0855 + 7.2350.x	0.957	0.267	13.006	2.819	0.68
A.D.W.	CL^3	y= 27.330 + 48.849 .x	0.957	0.267	74.056	17.462	0.75

Table II - Non-berried females (N = 11).

x	y	REGRESSION	x mean	Sx	y mean	Sy	r
L^2	SA	y= 0.7568 + 0.024 .x	160.50	36.00	4.662	1.058	0.83
D.W.	$SA^{3/2}$	y=- 0.9430 + 5.041 .x	2.218	0.685	10.240	3.581	0.96
D.W.	CL^3	y=- 2.0460 + 28.323 .x	2.218	0.685	60.786	20.309	0.96
A.D.W.	$SA^{3/2}$	y= 1.709 + 10.439 .x	0.817	0.317	10.240	3.581	0.92
A.D.W.	CL^3	y= 10.944 + 60.992 .x	0.817	0.317	60.786	20.309	0.95

Table III - Males (N = 11).

x	y	REGRESSION	x mean	Sx	y mean	Sy	r
L^2	SA	y=- 0.1063 + 0.0280.x	193.05	23.44	5.458	0.847	0.80
D.W.	$SA^{3/2}$	y=- 0.3051 + 4.3556.x	3.022	0.668	12.857	2.968	0.98
D.W.	CL^3	y= 0.8536 + 25.3454.x	3.022	0.668	77.446	17.245	0.98
A.D.W.	$SA^{3/2}$	y= 6.3919 + 6.0291.x	1.072	0.396	12.857	2.968	0.80
A.D.W.	CL^3	y= 40.5419 + 34.4140.x	1.072	0.3960	77.446	17.245	0.79

For the SA-L method the shield of the second somite (tail segment) was used. To make measuring of the surface area possible, the hard shield were softened by storing them in water for several days. After the softening process, the surface area was defined following the method described extensively in a previous paper (Boddeke 1976). It was taken into account that in a species with a rather hard shell

like Nephrops, it is possible that the regular continuation of growth between moults is not shown by increase of the body length but only by increase of the amount of body tissue within the (wide) shell. Should the three different categories of Nephrops act as different groups concerning growth and/or period of moulting, these differences could perhaps be demonstrated only by the regression between the dry weight or ash free dry weight of the body tissue and a fixed measure of the shell.
For this reason also the dry weight and ash free dry weight of the tail muscle were defined.
Regression lines of the form $y = b_o + b_1.x$ were obtained by plotting the following sets of data:
Body length^2 (L^2) against the surface area of the shield of the second somite (SA).
Dry weight of the tail muscle (D.W.) against $SA^{3/2}$.
Dry weight of the tail muscle (D.W.) against the carapace length^3 (CL^3).
Ash free dry weight of the tail muscle (A.D.W.) against $SA^{3/2}$
Ash free dry weight of the tail muscle (A.D.W.) against CL^3.

Results

The results of the calculations are shown in tables 1-3 for berried females, non-berried females and males. In all these cases there was a high measure of correlation, the correlation coefficient (r) varied from 0.68 till 0.98. However, in spite of the high correlation the variation (expressed by Sx and Sy) was remarkably high. This high correlation was constant, so it can be considered to be a characteristic of this sample of Nephrops and perhaps also of the species.
In none of the regressions any clear difference could be demonstrated among the three categories, berried and non-berried females and males.
In this research on Nephrops no regular shift of regression lines occurred, as in the case of berried females of C. crangon during the incubation period of the eggs, nor a regular difference in this regression as between berried and non-berried females of C. crangon migrating together and in migrating males and females of P. brasiliensis.
On the contrary, in all the above mentioned regressions of Nephrops the points of the three plots formed a uniform cloud and the regression lines crossed each other in a varying pattern. Figure 1, showing the regression between CL^3 and A.D.W. is representative for all five of the regressions.

Conclusions

From the results of this research on a random sample of Nephrops no indication could be obtained that any of the current conceptions concerning the (slow) growth of Nephrops, the periodicity in moulting and spawning and the lack of migration should need a critical review.

References.

Anon., 1976: Report of the working group on Nephrops stocks. ICES. Coop. research report no. 55.

Anon., 1977: Report of the Nephrops working group. ICES. C.M. 1977/K:2.

Boddeke, R., 1975: The use of biological tags in shrimp research. ICES. C.M. K:45 (mimeo).

Boddeke, R., 1976: The seasonal migration of the brown shrimp Crangon crangon. Neth. J. of Sea Res. 10(1):103-130.

Boddeke, R. & Becker, H.B., 1976: A quantitative study of the fluctuations of the stock of brown shrimp (Crangon crangon) along the coast of the Netherlands. ICES, Special Meeting on the population assessments of shellfish stocks, no. 58 (mimeo).

Boddeke, R., Dijkema, R., & Siemelink, M.E., 1977: The patterned migration of shrimp populations. A comparative study of Crangon crangon and Penaeus brasiliensis. FAO, Fish. Rep. 200:31-49.

Hillis, J.P., 1976: Growth studies on the prawn Nephrops norvegicus. ICES, Special Meeting on the population assessments of shellfish stocks, no.59 (mimeo).

Jones, R., 1976: A preliminary assessment of the Firth of Forth stock of Nephrops. Special Meeting on the population assessments of shellfish stocks, no.24 (mimeo).

Meixner, R., 1969 Wachstum. Häutung und Forthplanzung von Crangon crangon (I.) bei Einzelaufzucht. Ber. Dtsch. Wiss. Komm. Meeresforsch., 20: 93-111.

Figure 1. - Regression between the carapace length^3 and the ash free dry weight of the tail muscle for three different categories of Nephrops norvegicus.