

COPPER AND PROTEIN IN THE HEMOLYMPH OF THE SPINY LOBSTERS (CRUSTACEA: PALINURIDAE)

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Under a physiological point of view, copper is found in the majority of tissues of marine and terrestrial invertebrates, fulfilling the most varied functions.

Severy (1923) found this element in the tissues of sixteen marine animals, in the most varied concentrations. Bryan (1964) studying the concentration of copper in the lobster *Homarus vulgaris* Milne Edwards, found it in approximately one dozen organs and tissues.

The objective of this paper is to determine the average quantity of copper and protein in the hemolymph of spiny lobsters *Panulirus argus* (Latreille) and *Panulirus laevicauda* (Latreille), with the aim of making a comparison with other species studied, as well as verifying the importance of the simple correlation between total length of the animals and the quantity of copper and protein in the hemolymph.

MATERIAL AND METHODS

The material on which this study is based consisted of 100 specimens of *Panulirus argus* and 100 of *Panulirus laevicauda*, the total of each species constituted by 50 males and 50 females.

The spiny lobsters were captured in the coastal waters of Fortaleza County (State of Ceará — Brazil), from November - 1967 to May - 1968, and were chosen in an aleatory manner.

Data were noted, concerning the sex and the total length of each spiny lobster studied. We considered the total length to be the distance between the notch of the rostral spines and the posterior border of the telson, in the simmetrical plane.

The hemolymph was collected by means of hypodermic syringes with 30/9 caliber needles, puncturing the second articulation of the antenna, until reaching the large an-

tennal sinus (Travis, 1955). For the collection of the hemolymph we did not use anticoagulant, however, it was manually agitated until the moment of centrifugation at 3,000 r.p.m. for 15 minutes. After centrifuging the hemolymph, the supernatant was decanted and used to make the copper determination by the method of Eden & Green (*in Blaya*, 1963), and protein, according Gornall *et al.* (1949).

After obtaining the data referring to the total length, copper and protein, we proceeded to calculate the arithmetic mean, standard deviation and coefficient of variation of each one of these variables (table I).

The comparative study of the behaviour of the variables, two by two, was made by the determination of the coefficients of simple correlation (Snedecor, 1966). All the statistical analyses were made at a level of $P = 0.01$.

The variables total length, copper and protein quantities were grouped two by two, in order to calculate the coefficients of correlation. Initially they were calculated by sexes, within each species, and after verifying the lack of a significant difference between the sexes, we proceeded to calculate them for the two sexes together (table II). Graphics were established for the significant correlations that were found (figures 1 and 2).

RESULTS AND DISCUSSION

The arithmetic means of copper in the hemolymph of the two species of spiny lobsters studied was 3.92 mg/100 ml for *Panulirus argus* and 4.47 mg/100 ml for *Panulirus laevicauda* (table I). These results are close to the one (3.87 mg/100ml) obtained by Allison & Cole (1940) for *Homarus americanus* Milne Edwards.

The arithmetic means of the protein concentrations in the hemolymph of the two studied species was 4.12 g/100 ml for *Panu-*

T A B L E I

Arithmetic mean (\bar{x}), range (r), standard deviation (s) and the coefficient of variation (C.V.) of the total length measures, and the total of copper and protein in the hemolymph of the spiny lobsters *Panulirus argus* and *Panulirus laeviscauda*.

Species	Total length (mm)				Copper (mg/100 ml)				Protein (g/100 ml)			
	\bar{x}	r	s	C.V.	\bar{x}	r	s	C.V.	\bar{x}	r	s	C.V.
<i>P. argus</i>	205.5	177-253	47.51	23.12	3.92	0.83-10.65	2.43	61.98	4.12	1.00-10.50	1.15	27.91
<i>P. laeviscauda</i>	184.7	162-269	50.24	27.21	4.47	1.10-9.98	2.30	51.45	4.88	1.25-9.10	2.00	44.64

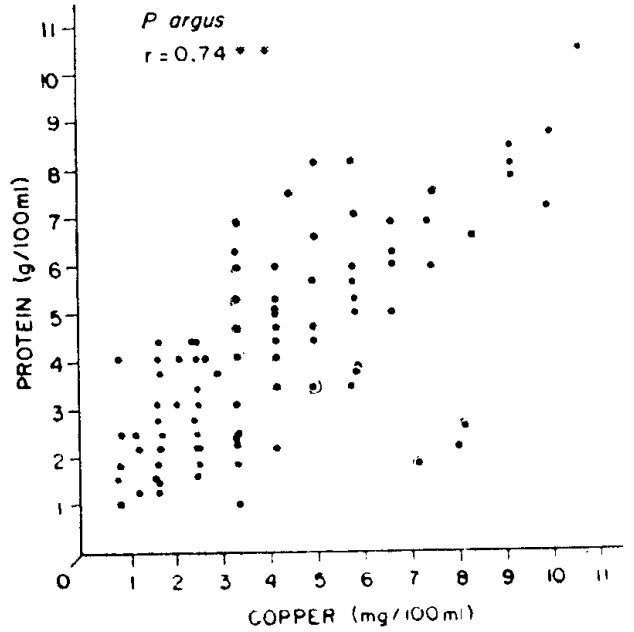


Figure 1 — Simple correlation graphic between quantities of copper and protein contents in hemolymph of the spiny lobster *Panulirus argus* (Latreille).

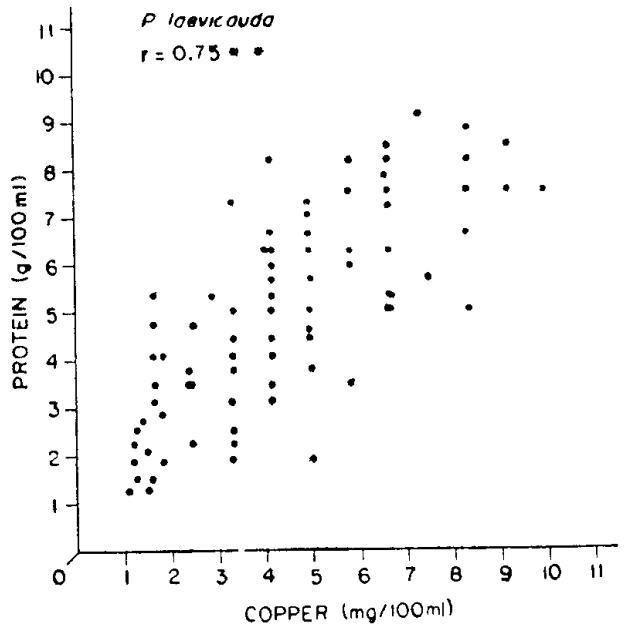


Figure 2 — Simple correlation graphic between quantities of copper and protein contents in hemolymph of the spiny lobster *Panulirus laeviscauda* (Latreille).

lirus argus and 4.48 g/100 ml for *Panulirus laeviscauda* (table I). These results are close to the one (4.16 g/100 ml) found by Stewart *et al.* (1967) for *Homarus americanus*.

The coefficients of simple correlation between total length-copper and total length-protein of the hemolymph of *Panulirus argus* and *Panulirus laeviscauda* were not significa-

TABLE II

Coefficient of simple correlation between total length and the quantity of copper and protein in the hemolymph of the spiny lobsters *Panulirus argus* and *Panulirus laevicauda*.

Species	Coefficient of simple correlation		
	Total length-Copper	Total length-Protein	Copper-Protein
<i>P. argus</i>	0.07	— 0.09	0.74 **
<i>P. laevicauda</i>	0.02	— 0.07	0.75 **

** — statistically significant at probability level $P = 0.01$.

tive, as the copper and protein contents in the hemolymph are independent of the spiny lobster lengths (table II). The coefficient of simple correlation between copper and protein in the hemolymph were significative for the two species studied (table II).

For each species as well as for two together, there was no significance correlation between the sexes and quantity of copper and protein.

Horn & Kerr (1963) obtained the same results when studying the copper and protein concentrations in the hemolymph of the blue crab, *Callinectes sapidus* Rathbun. This significance between copper and protein was expected, for copper is the central element of the metaloprotein found in the crustacean and molluscan hemolymph.

Allison & Cole (1940) verified that in the hemolymph, after complete removal of the clot, only one protein remains, the hemocianin. Tyler & Metz (1945) state that hemocianin is not the only protein in the crustacean serum although it is the predominant one.

CONCLUSIONS

1 — There does not exist a correlation between total length and quantity of copper in the hemolymph of the spiny lobsters *Panulirus argus* and *Panulirus laevicauda*.

2 — There does not exist a correlation between total length and quantity of protein in the hemolymph of the spiny lobsters *Panulirus argus* and *Panulirus laevicauda*.

3 — There does exist a correlation between the copper and protein quantities in the hemolymph of the spiny lobsters *Panulirus argus* and *Panulirus laevicauda*.

SUMÁRIO

Durante o período de novembro — 1967 a maio — 1968 foram amostradas 100 lagostas da espécie *Panulirus argus* (Latreille) e 100 da espécie *Panulirus laevicauda* (Latreille), com o objetivo de se estudar as correlações simples entre comprimento total e quantidades de cobre e proteína na hemolinfa.

As quantidades médias de cobre (mg/100ml) encontradas, foram 3,92 para *Panulirus argus* e 4,47 para *Panulirus laevicauda*. Os teores médios de proteína (g/100ml), também encontrados, foram 4,12 para *Panulirus argus* e 4,88 para *Panulirus laevicauda*.

Não existe correlação entre comprimento total e quantidades de cobre e proteína na hemolinfa, para ambas as espécies.

Existe correlação entre quantidades de cobre e proteína na hemolinfa, para as duas espécies estudadas.

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