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Changes in nucleic acids and protein content in relation to body size in the prawn *Penaeus indicus* H Milne Edwards

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Abstract. This study was carried out to find out the relationships of RNA, DNA content, RNA/DNA ratio and protein levels with different size length individuals of *Penaeus indicus*. RNA, DNA content, and RNA/DNA ratio were found to be high in small sized prawns, with increased amount of protein. There was a decline in RNA concentration as size of the prawns increased, thus showing an inverse relationship. Though DNA values also showed a slight decline with increase in size, among large sized prawns there was a tendency to conserve DNA content. RNA/DNA ratio has been found useful in correlating growth (in terms of protein increase) only in small sized prawns.

Keywords. Body size; nucleic acids; protein content; *Penaeus indicus*.

1. Introduction

Growth in animals has traditionally been expressed as an increase in either length or live weight or dry weight body mass (Buckley 1981). In recent times, a new tool has been introduced to determine the growth rate especially during the exponential phase of the growth of animals by measuring the RNA/DNA ratio in the cell or tissue (Bulow 1970; Buckley 1981, 1984). Considerable work has been carried out to correlate the concentration of RNA to growth rate in a number of marine organisms (Sutcliffe 1965; Pease 1968; Dagg and Littlepage 1972). Bulow (1970) described RNA-DNA ratio as indicators of growth rate in the fish *Notemigonus crysoleucas*. Buckley (1979a, b) found that the RNA/DNA ratio was an useful index of nutritional status in the larval Atlantic cod *Gadus morhua* and the winter flounder, *Pseudopleuronectes americanus*. Recent laboratory studies have also demonstrated positive relations between food availability and larval RNA and DNA ratio and between RNA/DNA ratio and growth rate of larval fish (Bulow 1970; Buckley *et al* 1984) and a juvenile crab, *Callinectes sapidus* (Wang and Stickle 1986). During the present study, an attempt has been made to find out correlations if any between RNA and DNA concentrations, RNA/DNA ratio and protein content in relation to different sized individuals of the penaeid prawn, *Penaeus indicus*.

2. Materials and methods

The penaeid prawns, *P. indicus* of different body lengths ranging from 24–147 mm were used. The prawns of smaller size ranging from 24–48 mm were collected from the nursery pools using scoop nets and the other size-groups up to the size of about 147 mm were collected from growout ponds of the Marine Prawn Hatchery Laboratory, Narakkal with the help of cast nets. The collected specimens were

transported to the laboratory either in transportation bags or 60 l capacity plastic bins as and when required for analysis. For the estimation of RNA, DNA and protein content, animals in the intermoult stage were isolated by the method of Diwan and Usha (1985). Generally the whole animal was used for analysis after removing the hard integument.

2.1 *RNA and DNA protein*

RNA was extracted as per the methods described by Schmidt and Thannhauser (1945) and further modified by Munro and Fleck (1966). Yeast RNA was used to prepare the standard curve. The DNA content of the sample was extracted by indole method (Ceriotti 1952). Highly polymerized calf thymus DNA was used to prepare the DNA standard curve. Protein was analysed by the Biuret method (Gornall *et al* 1949). Bovine serum albumin crystals were used to prepare the protein standards. Taking size as independent variable, polynomial regressions of the forms $Y=a+b_1x+b_2x^2$ were fitted where x referred to size, Y referred to RNA, DNA and protein respectively and a, b_1 and b_2 are constants determined by the method of least squares. All the coefficients were found to be significant at 5% level. Regression function was not fitted for RNA/DNA ratio since it is a derived value.

3. Results and discussion

Regression coefficients and their standard errors on the data obtained are given in table 1. The results of RNA, DNA content, RNA/DNA ratio and protein levels in relation to different size-length of animals are summarised in figures 1–4. The high level content of RNA, DNA and RNA/DNA ratio with increase in protein levels in smaller prawns of up to 42 mm recorded here, might be due to the faster growth in early phase of life cycle of the animal. Moreover, these animals were collected from nursery pools of the farm where artificial feeding was done regularly. From size 44 mm onwards, almost a decreasing trend for RNA values could be seen reaching a lowest value of 3·2 $\mu g\ mg^{-1}$ for the 147 mm size (figure 1). Dagg and Littlepage (1972) found increased amount of RNA concentration during early phase

Table 1. Regression coefficients and their standard errors.

	Coefficients	SE(b)
Polynomial regression of RNA on size	$a=15{\cdot}3792$	
	$b_1=-0{\cdot}1921$	0·0313
	$b_2=0{\cdot}00079$	0·00018
	$r^2=0{\cdot}7245$	
Polynomial regression of DNA on size	$a=1{\cdot}1382$	
	$b_1=-0{\cdot}0085$	0·0021
	$b_2=0{\cdot}000024$	0·000012
	$r^2=0{\cdot}7627$	
Polynomial regression of protein on size	$a=80{\cdot}9909$	
	$b_1=2{\cdot}0558$	0·0895
	$b_2=-0{\cdot}0064$	0·0005
	$r^2=0{\cdot}9882$	

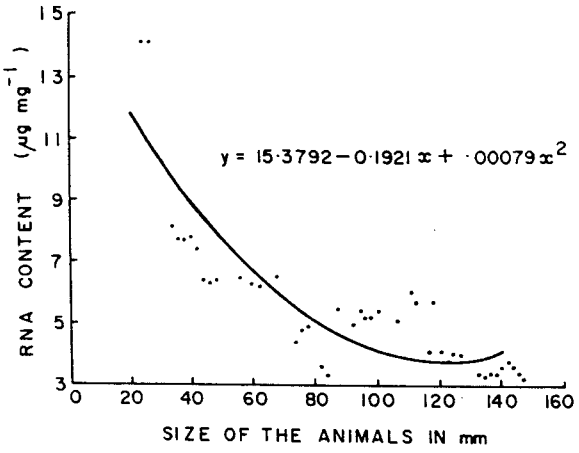

Figure 1. RNA content in different size lengths of *P. indicus*.

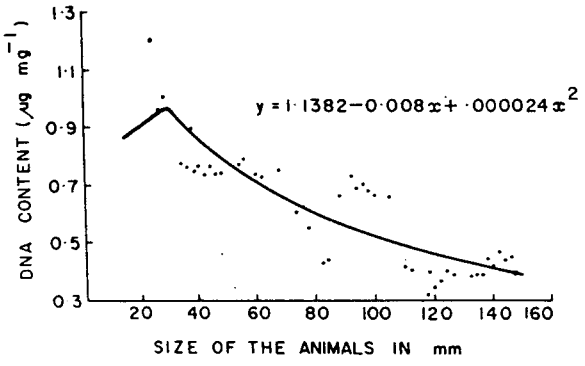

Figure 2. DNA content in different size lengths of *P. indicus*.

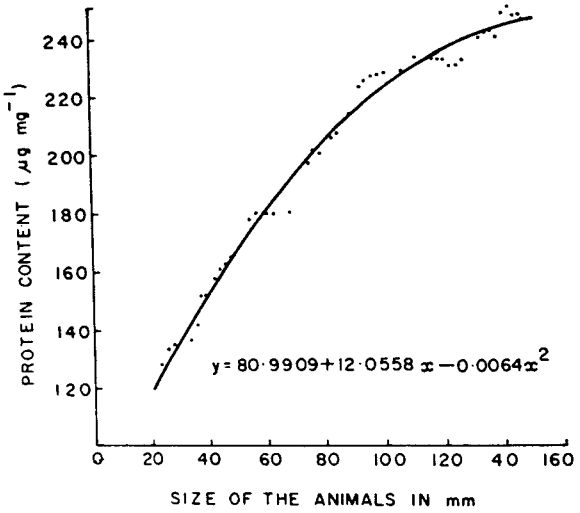

Figure 3. Protein content in different size lengths of *P. indicus*.

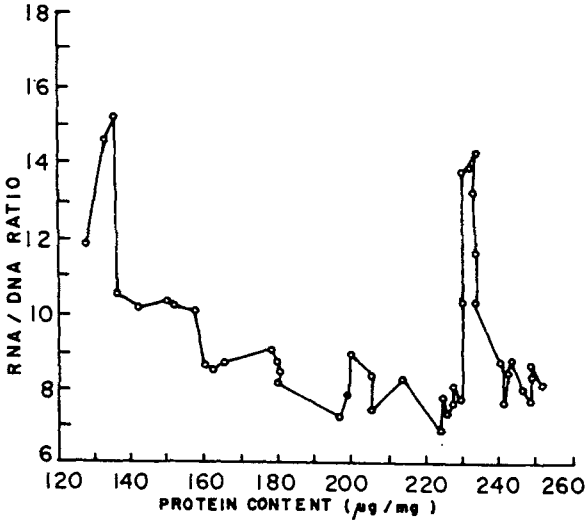

Figure 4. Variations in RNA/DNA ratio to protein content in different sized *P. indicus*.

of growth in *Artemia salina* but thereafter they did not find any significant change; they have also noticed the highest RNA concentration in youngest *Euchaeta elongata* and lowest in adults.

The highest DNA value was recorded for smallest-size *P. indicus* (24 mm) and thereafter up to the size of 106 mm, the values declined but remained steady. Sudden decline in the values were noticed from 110 mm size onwards but the values never reached lowest with increase in size like RNA content (figure 2). While estimating RNA/DNA ratio in relation to growth rate of a fish, Bulow (1970) found that there was slight decrease in DNA content with increased growth and slight increase with increased weight loss and further explained that this change was probably due to change in the cytoplasmic volume. While working on *A. salina* Dagg and Littlepage (1972) showed that the increased growth is represented by increase in protein and a decline in the DNA content but he was unable to predict the reason for such a decline. The present findings of decrease in DNA content with increase in size agrees with the observations of Bulow (1970) and Dagg and Littlepage (1972) but no inverse correlation was seen with increased protein level like RNA, as there was great variation in the DNA values. It could be noted that most of the times the animals maintained a general tendency to conserve DNA with increase in size.

Large amount of work has been carried out to correlate RNA/DNA ratios as a growth index. Bulow (1970) while working on fish 'golden shiners', demonstrated that RNA/DNA ratio gets affected due to starvation, thus reflecting growth index. Buckley (1981, 1984) in his works indicated the importance of RNA/DNA ratio and its correlation with protein growth rate especially in the phase of exponential growth. In the present work high ratio of RNA/DNA was observed up to 42 mm size, the highest was recorded for 28 mm size. The findings reported here for smaller prawns are similar to those observed for fish larvae by a number of workers (Bulow 1970; Buckley 1981, 1984). From 44 mm size onwards RNA/DNA ratios were slightly low but remained steady up to 106 mm and again for 132–147 mm sized

animals (figure 3). While the sudden rise in the values of ratio in the prawns of size 110–126 mm was interesting no proper reasons could be attributed. The only possible explanation is that, this high ratio could be a good indicator of the better nutritional status of the animals at the time of collection. Buckley (1984) while investigating RNA/DNA ratio values of cod, haddock and sand lance larvae, which were collected from varied locations found that, the majority of the larvae had high RNA/DNA ratio. Among the sand lance larvae 7% of the collected samples had low RNA/DNA ratio indicating that a substantial portion of sand lance collected were in poor condition, probably due to inadequate nutrition. It is stated that the high RNA/DNA ratios could indicate either healthy, well fed, rapidly growing fish, while those under stress have low ratios (Buckley *et al* 1984). In the present study prawns above 54 mm were collected from growout ponds of CMFRI laboratory. In such a situation as in Buckley's (1984) findings RNA/DNA ratios can be used as a good indicator of nutritional status of the animals. Irrespective of steadiness in the values of RNA/DNA ratio in large sized prawns, there was continuous increase in the protein content, thus showing no relationship between these two factors after attainment of a particular size (figure 4). In fact there is no information available at present about RNA/DNA ratio and its relation to protein content in adult sized animals.

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