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Seasonal changes in RNA: DNA ratio of marine clam *Katelysia opima* at Kalbadevi estuary, Ratnagiri coast, Maharashtra

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ABSTRACT

In present investigation shows the seasonal changes in RNA : DNA ratio in different tissues of *Katelysia opima*. The RNA and DNA ratio in the calm was found increased in adductor muscle, gonad and hepatopancreas than gill, mantle, siphon & foot at the time of gametogenesis in early monsoon. Similarly in that period the protein content was also increased in particular tissuses. In monsoon, the gametogenesis was triggered by temperature and the requirement of protein was increased, so the RNA content was also increased during that period and DNA was dependent on the increasing and decreasing content of RNA.

Introduction

Generally species distribution depends on the various environmental conditions. Different hormones and stress conditions may exert control over synthesis, activity and breakdown of nucleic acids (Khanuja, 1981). Oxidative damage, including damage to DNA and RNA, occurs when free radical production overwhelming cells ability to detoxify the free radicals (Halliwell and Gutteridge, 1999). Decreased DNA: RNA ratio indicates reduced levels of protein synthesis, as could occur with stress or decreased growth rate (Elser *et al.* 2000; Dahlhoff, 2004).

Many workers have studied the DNA, RNA synthesis in various environmental stress conditions in various animals. (Elson, 1965; Bulcow, 1970; Swada and Okada, 1976; Modig 1976; Tariq *et.al.*, 1977; Sotomayer *et.al.*, 1979; Tayyaba *et.al.*, 1981; Bhartiya and Jaimala, 1988; Patil and Lomte, 1990; Durairaj and Selvarajan, 1992).

Kirk Mclean (1976), studied some aspects of RNA synthesis in early development of the oyster at swimming stage, the nuclei become increasingly active in RNA synthesis. Kidder (1976) reported the localization, amplification and multiplicity of the r RNA cistrons in gametes of the coot clam, *Mulinia lateralis*. Hoffmann and Somero (1996), studied the evidence for protein damage due to environmental temperature, when intertidal mussel *Mytilus trossulus* exposed to various seasons

Alliegro *et.al*. (2006) has isolated androsomes parameters of the surf clam *Spisula solidissima* and purified a unique set of RNA's. Joyner-Matos *et.al.* (2007) recorded measurement of DNA and RNA oxidation in a natural population, when environmental stress increases inversely to clam abundance.

Material and Methods

The clams, *Katelysia opima* were collected from Kalbadevi estuary, Ratnagiri. They were sacrificed and various tissues like gill, siphon, mantle, gonad, hepatopancreas and foot were separated properly, blotted them and weighed. The tissues were homogenized in 10 ml ice cold distilled water and processed it for further determination of Ribonucleic acid (RNA) and Deoxyribonucleic acid (DNA) by following the method of Dische (Stroev and Makarova, 1989).

Result

In the present study, attempts have been made to find out the seasonal variations in the nucleic acid (DNA: RNA ratio) contents of mantle, gill, gonad, hepatopancreas, adductor muscle, siphon and foot of the marine bivalves *K. opima.* The DNA: RNA ratio was summarized in Table –1.

In winter season the RNA content (mg/g) was maximum in adductor muscle and minimum in foot. RNA content (mg/g) in *K. opima* in winter season was high in adductor muscle (113.26) followed by gonad (97.19) and hepatopancreas (88.23), gill (25.74) followed by mantle (21.90), siphon (15.71) and minimum in foot (13.31.).

The maximum values for DNA content (mg/g) was recorded in hepatopancreas and minimum in siphon. DNA content (mg/g) was maximum in hepatopancreas (19.51) followed by adductor muscle (18.85), gill (17.07), foot (16.36), mantle (16.05) and minimum in siphon (14.33) mg/g. Maximum RNA and DNA ratio was high in adductor muscle (6.00) followed by gonad (5.81), hepatopancreas (4.52), gill (1.50), mantle (1.36), siphon (1.09) and minimum in foot (0.81) (Figure -1).

In summer season, the RNA content (mg/g) was maximum in adductor muscle (123.87) followed by gonad (123.37), hepatopancreas (76.51), gill (29.36), siphon (25.87), mantle (19.46) and minimum in foot (17.55). The maximum values of DNA content (mg/g) was obtained in adductor muscle (21.05) followed by gonad (18.86), gill (15.52), mantle (14.77), foot (13.65) and minimum in siphon (12.73). The RNA content (mg/g) was high in adductor muscle and low in foot whereas DNA values were maximum in adductor muscle and minimum in siphon. The RNA and DNA ratio in summer season was maximum in gonad (6.54) followed by adductor muscle (5.70), hepatopancreas (4.95), siphon (2.03), gill (1.89), mantle (1.31) and minimum in foot (1.28) (Figure -1).

The RNA values obtained in monsoon season were maximum in adductor muscle (148.91) and gonad (77.19).

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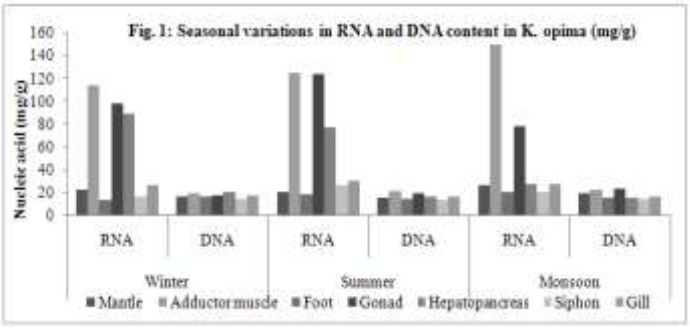
Comparatively, in other tissues the RNA content (mg/g) was lower than these two tissues. The RNA content was low in gill (27.26) followed by hepatopancreas (27.10), mantle (25.99), siphon (19.66) and foot (19.42). The maximum DNA content was obtained in gonad (23.20) followed by adductor muscle (21.65), mantle (18.76), gill (15.56), hepatopancreas (14.89), foot (14.46) and minimum in siphon (14.40).

The RNA to DNA ratio obtained in monsoon season was maximum in adductor muscle (6.87) followed by gonad (3.32), gill (1.75), mantle (1.38), siphon (1.36) and minimum in foot (1.34) (Figure -1).



In winter season, the RNA content was high in mantle compared to summer season, but in all the other tissues it was higher. In adductor muscle and mantle the RNA content was gradually increased from winter to monsoon season and in other tissues it was decreased.

The DNA content was increased in monsoon season as compared with winter and summer season. The mantle has maximum RNA content in winter and monsoon than the summer season. The RNA content in gill and siphon was higher in summer season than winter and monsoon season; while winter season shows high RNA content in gonad and adductor muscle compared to summer and monsoon. In *K. opima* the RNA:DNA ratio was maximum in adductor muscle, hepatopancreas and gonad in all three seasons whereas in foot it was minimum.

Discussion

In present study, the RNA and DNA ratio in both the calms was found increased in adductor muscle, gonad and hepatopancreas at the time of gametogenesis. Similarly protein content was also increased. In early summer, the gametogenesis was triggered by temperature and the requirement of protein was increased, so the RNA content was also increased during that period and DNA was dependent on the increasing and decreasing content of RNA.

The increase in RNA concentration appears to be the result of a more efficient utilization of protein intake, leading subsequently to an increased protein synthesis (Khan and Jafri, 1991). Dagg and Littlepage (1972) found increased amount of RNA content during the experimental growth phase of the *Artemia salina*, but they did not find any significant change thereafter. The present finding of RNA concentration agree with the above observations. When the natural conditions become adverse the RNA content was decreased. In monsoon season the RNA content in *K. opima* was decreased might be due to adverse conditions like low salinity, turbidity etc. Any factor that prevents or slows down is known to be reflected by a reduced RNA concentration (Buckley, 1979, 1980, 1982, 1984; Martin et. al., 1985).

In bivalve the weight of the body increases with the relation seasonal changes in availability of food material and environmental stresses. These factors can affect an increase or decrease in level of RNA and DNA ratio. The weight of body increase, when the absorbed water is gradually replaced by protein and DNA controls the development of the organism by controlling the formation of RNA (Thomas, 1993). Growth in terms of accumulation of protein is always accompanied by high turnover rate of RNA concentration, which is a prime factor of protein synthetic machinery. Since the DNA content per cell is generally constant, the RNA –DNA ratio reflects the growth (Buckley, 1984).

The depletion in RNA level suggests increased proteolysis and possible utilization of the products of their degradation for metabolic purpose. Increase in RNA content of gill is supported by Brachet (1955) and Ali *et. al.* (1992). In gonad, the RNA content was increased in summer season. The temperature triggers the spawning process and during that period the content of protein has increased. Nakata *et. al.* (1994) studied the relation between egg productivity and RNA / DNA ratio in *Paracalanus* species and found positive correlation between RNA / DNA ratio and egg productivity. Nucleic acid content is considered as an index of capacity of an organism for protein synthesis.

The level of DNA in different tissues indicates cell number (Goss, 1966) and it is constant for a species. In the present study, decrease in DNA level may be due to reduction or absence of the essential factors controlling DNA synthesis which are the substrates (4 – Deoxyribonucleoside triphosphates), enzymes (polymerase), template activity of deoxyribonucleic – protein and activators like Mg^{++} and other divalent ions (Altman et. al., 1970; Bhartiya and Jaimala, 1988). Contamination of heavy metals can reduce the DNA content. RNA content has reduced particularly in liver and brain but increased in gill of fresh water fish *Cyprinus carpio* due to heavy metal toxicity (Muley *et. al.*, 2000). In the present study data indicates that the RNA and DNA content vary with seasonal fluctuation of physico-chemical and biochemical parameters.

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Table 1. Seasonal variations in RNA and DNA content (mg/g) of *K. opima*

Seasons / Tissues	Winter			Summer			Monsoon		
	RNA	DNA	Ratio	RNA	DNA	Ratio	RNA	DNA	Ratio
Mantle	21.90 ±1.53	16.05 ±1.40	1.36	19.46 ±1.04	14.77 ±2.50	1.31	25.99 ±2.84	18.76 ±1.31	1.38
Adductor Muscle	113.26 ±2.01	18.85 ±2.92	6.00	123.87 ±2.17	21.05 ±1.92	5.70	148.91 ±2.52	21.65 ±2.01	6.87
Foot	13.31 ±2.00	16.36 ±3.19	0.81	17.55 ±1.98	13.65 ±2.02	1.28	19.42 ±0.58	14.46 ±1.04	1.34
Gonad	97.19 ±1.77	16.7 ±2.40	5.81	123.37 ±2.75	18.86 ±1.01	6.54	77.19 ±2.69	23.20 ±2.21	3.32
Hepato-Pancreas	88.23 ±2.32	19.51 ±1.63	4.52	76.51 ±3.72	15.44 ±2.98	4.95	27.10 ±1.27	14.89 ±1.52	1.82
Siphon	15.71 ±1.20	14.33 ±1.78	1.09	25.87 ±1.30	12.73 ±2.47	2.03	19.66 ±0.71	14.4 ±1.06	1.36
Gill	25.74 ±4.16	17.07 ±1.70	1.50	29.36 ±0.73	15.52 ±2.37	1.89	27.26 ±2.87	15.56 ±2.36	1.75

All values are mean of three; ± Standard deviation

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