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Body Component Indices of an Intertidal Gastropod *Morula granulata* (Duclos) Subjected to Starvation

V UMA DEVI, Y PRABHAKARA RAO & D G V PRASADA RAO
Department of Zoology, Andhra University, Visakhapatnam 530003

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Effect of starvation (70 days) was studied on the wet as well as dry weights, water content and body component indices (foot, gonad-digestive gland (GDG) complex and viscera) of *M. granulata*. A significant ($P<0.05$) decrease was observed in the wet and dry weights of foot from 20 d of starvation. In GDG complex, the same trend was noticed for wet weights but the dry weights did not show much decrease ($P>0.05$). Wet and dry weights of viscera started to decrease significantly ($P<0.05$) from 40 d and at 70 d of starvation respectively. Changes in percentage water content were insignificant ($P>0.05$). A gradual decrease was observed in values of foot and GDG complex indices but this decrease was not much for visceral index values.

Importance of body component indices has been stressed[1,2] and these have been used as important parameters to study the difference between body biochemical level and content in different molluscs[2-4]. Several investigators have noticed a change in the body component indices during different periods of reproductive cycle[5-7]. In the present investigation, an attempt has been made to study the effect of starvation on the body component indices of an intertidal mollusc *Morula granulata* (Duclos).

Animals (300) of uniform size (80 to 100 mg wet wt of soft parts) were obtained from the rocks of Palm beach of Visakhapatnam on the east coast of India. They were thoroughly cleaned with seawater and acclimated to laboratory conditions in running seawater (sal. 32×10^{-3}) at $25^{\circ} \pm 0.5^{\circ}$C for 24 h. Twenty animals were sacrificed just before the beginning of the experiment and this batch serves as initial (0 days) control. Rest of the animals were subjected to starvation by placing them in Whatman 42 filtered seawater. The seawater was renewed daily. Earlier investigations on *M. granulata*[8] showed 50% mortality during starvation up to 70 d. Therefore, the sampling intervals were fixed for every 10 d. At each interval, 20 animals were sacrificed for different body component indices. Different body components (foot, gonad digestive gland complex—GDG complex and viscera) of each animal were dissected carefully and pooled up separately. As the gonad and digestive gland are inseparable, they were pooled and considered as GDG complex thereafter. Wet weights of pooled body components were taken before they were dried in an oven at 105°C for 48 h to a constant weight and dry weights of all the samples were also taken. Individual body component indices were calculated according to the method of Stickle[3]. Data are presented as mean ± SD and various starved groups were assessed using Students' *t* test[9].

Wet and dry weights of foot and GDG complex exhibited considerable decrease compared to viscera (Table 1). In foot, the wet and dry weights started to decrease significantly ($P<0.05$) from 20 d of starvation. Wet weights of GDG complex also showed a remarkable decrease ($P<0.05$) from 20 d of starvation but the decrease in dry weights of GDG complex was not much ($P>0.05$). In viscera, significant decrease in wet weight appeared from 40 d of starvation whereas the change in dry weight was significant ($P<0.05$) only at 70 d of starvation. Even though the percentage water content of foot, GDG complex and viscera has shown changes, they were not significant ($P>0.05$; Table 1). It is clear (Table 1) that there is a gradual decrease in the foot and GDG complex indices with the increasing period of starvation. However, the decrease in viscera index is not much (Table 1).

Deprivation of food has led to reduction in the wet as well as dry weight of the soft parts of *M. granulata*. The weight loss was observed to be gradual and occurred at slower rate. This is in agreement with the findings of Vernberg[10]. He reported that animals which lose relatively little body weight are supposed to possess greater resistance for stress conditions like starvation. As there is no remarkable change in the percentage water content (Table 1), it can be concluded that the loss of wet as well as dry weight is mainly due to the utilisation of body constituents during prolonged starvation. This utilisation is mostly from foot and GDG complex when compared to viscera. Baldwin[11] found that in starved *Helix pomatia*, there was reduction in the endogenous material which is accounted for the increased utilisation of the body constituents. Decrease in body weight was observed in most of the invertebrates when subjected to starvation[10,12-15].

Table 1—Effect of Starvation on Foot, GDG Complex and Viscera of *M. granulata*
(a: wet weight mg, b: dry weight mg, c: water content %, d: index)

No. of days	Foot				GDG complex				Viscera			
	a	b	c	d	a	b	c	d	a	b	c	d
0	935 ±114	283 ±41	69.80 ±0.71	1.132	381 ±71	196 ±84	50.48 ±12.96	0.785	942 ±111	304 ±70	68.07 ±3.69	1.215
10	821 ±102	272 ±80	67.44 ±5.73	1.195	369 ±63	180 ±60	52.33 ±8.19	0.790	850 ±120	295 ±62	65.59 ±2.42	1.295
20	668* ±106	208* ±53	69.25 ±3.08	0.910	314* ±58	136 ±36	57.22 ±3.60	0.595	835 ±90	289 ±83	65.93 ±6.29	1.270
30	651* ±68	200* ±44	69.58 ±3.59	0.885	311* ±66	135 ±35	56.95 ±2.15	0.600	833 ±82	284 ±59	66.20 ±3.77	1.255
40	629* ±119	181* ±37	71.29 ±0.45	0.820	300* ±58	132 ±42	55.76 ±7.11	0.600	801* ±70	273 ±41	66.07 ±2.16	1.240
50	618* ±110	177* ±68	72.23 ±6.11	0.810	289* ±74	130 ±40	55.53 ±2.50	0.595	777* ±96	262 ±47	66.47 ±1.91	1.200
60	589* ±132	158* ±44	73.45 ±1.55	0.775	272* ±57	127 ±37	53.98 ±4.01	0.625	765* ±83	241 ±42	68.68 ±2.10	1.180
70	529* ±112	149* ±24	71.58 ±1.50	0.685	260* ±50	121 ±41	54.55 ±7.11	0.560	760* ±80	222* ±37	70.94 ±1.81	1.025

*$P<0.05$.

The absence of variation in the water content of different body components may be due to higher per cent of bound water present in the soft parts providing free water supply for metabolic adjustments. Similar condition was observed in tropical freshwater crab *Paratelphusa hydrodromus*[16]. This insignificant change in the water content of *M. granulata* may also be probably due to the increased level of the free amino acids in the soft parts[8] which are responsible for the retension of tissue water and prevention of excessive escape of water from the soft parts.

Decrease in indices of foot and GDG complex associated with the decrease in their wet and dry weights during starvation reveals that both the organs play vital role in starvation. However, the participation of viscera during the period of starvation stress seems to be not much when compared to foot and GDG complex. When *M. granulata* are subjected to lack of food, the immediate alternative is that they have to depend on some stored food available. But according to Giese[1], there is no specialised storage organs in molluscs corresponding to that of adipose tissue in other animals. Therefore, the somatic or reproductive organs may have to take over the function of storage. It is evident from the present investigation that both foot and GDG complex serve as storage organs in *M. granulata* giving energy supply to the animal when it is really in need of it. Similar decrease in the body component indices was reported in *Thais lamellosa*[17] exposed to starvation for 91 days. In *T. lamellosa*, the decrease was high in the visceral index (41%) compared to foot index (20%). But *M. granulata* showed a greater decrease for foot index (40%) than the indices of GDG complex (29%) and viscera (16%). A change in the body component indices was also observed in molluscs during reproductive period, when the animals utilise the nutrient source from digestive gland[2,3,5–7,18].

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