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STUDIES ON WEIGHT CHANGES IN *LYCASTIS INDICA* SOUTHERN

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Introduction

Polychaetes, by their ability to regulate the volume or weight, survive in waters whose salinity conditions vary markedly (Beadle, 1937 ; Panikkar, 1948 ; Jorgensen & Dales, 1957 ; Krishnamoorthi, 1962). Such ability varies in different groups of polychaetes as well as in the same species collected from different habitats and during different seasons (Schlieper, 1929 ; Beadle, 1937 ; Ellis, 1937 ; Smith, 1955). Ellis (1937) expressed the view that the physiological differences exhibited by *Nereis diversicolor* from two geographical regions, Roscoff and Bangor, are racial rather than environmental. However, it has been pointed out that by gradual acclimation marked changes in the normal osmotic behaviour of animals may be induced (Beadle, 1939, 1943 ; Topping & Fuller, 1942 ; Gross, 1963).

Smith (1963) compared the rate of salt loss in *N. diversicolor* after adapting them to different salinity conditions. When the worms thus adapted were transferred to distilled water, those from higher concentrations lost more salts and showed more marked swelling. This may suggest that the rates of volume increase and salt loss are functions of the salinity gradient between the internal and external media, the increase being influenced by the concentration of the medium in which they were previously kept. Hence, the salinity gradient between the two media concerned are of significance in relation to their regulatory ability. Since salinity conditions vary widely in the estuarine and backwater regions from where the worms have been collected, it is possible that such variations may have a bearing on their weight regulatory ability (Beadle, 1937 ; Smith, 1955).

The present study is an attempt to investigate the relation, if any, between salinity of the environment to which they are acclimated prior to experimentation and the weight regulatory ability of *Lycastis indica* Southern. Panikkar (1948) suggested that the amount of increase in weight and the time taken for the restoration of the final equilibrium may be taken as parameters to compare the regulatory ability of worms. Accordingly, in the present study the weight changes of *Lycastis indica* under osmotic stress have been taken as indices of water influx and efflux and of their regulatory ability.

Material and Methods

Lycastis indica were collected from the Cooum backwaters, which is characterised by wide fluctuations in salinity ranging from 0.6‰ to 21‰. The worms were acclimated to media of varying grades of salinity ranging from 4‰ to 34‰. The steady level attained in the total chloride content of the worms was taken as a standard to decide the time taken for acclimation. For the estimation of chloride content Conway's microdiffusion method was employed (Conway, 1950).

Estimations of chloride were made at intervals of few days. Though a steady level of chloride content was attained in worms kept in all the media within 15 days of immersion, the animals were kept in the media for 30 days to ensure complete acclimation before subjecting them to osmotic stress. Dilute sea water of salinity 6‰ (12% sea water) was taken as an experimental medium to impose osmotic stress. The worms acclimated to the media of salinity, 10-12‰ (30% sea water), 18-20‰ (50% sea water) and 25-28‰ (70% sea water) and 33-34‰ (full strength sea water; were transferred separately after weighing to 25 cc. of the experimental media contained in beakers of capaciy 250 cc. The worms were blotted dry on filter paper and weighed accurately to the nearest milligram at regular intervals. Adequate precautions were taken to minimise evaporation from body surface by weighing the worms in a closed plastic box and immediately transferring them to the experimental medium. To minimise the adverse effect of repeated wiping and exposure of a single worm, many worms of almost the same weight were used simultaneously. By adjusting the period of transfer from the media into the experimental medium a continuous recording of the weight changes over a prolonged period was made possible. Since only the percentage weight change was taken into consideration, the slight individual variation in weight may not have an appreciable effect on the general pattern of regulation. To avoid the effect of differential feeding on the weight, the worms were not fed during the experimental period. Estimations were made in duplicate in animals acclimated to each of the four media selected. The weight increase and decrease are expressed in terms of percentage original weight.

Results and Remarks

It is found that in all the worms investigated there is a marked rise in the weight of the animal within four hours of immersion into the experimental medium (Table I). After a sudden rise, the weights gradually decrease towards the initial weight. A steady state was not observed and the weight changes were continuous. In this respect the weight regulation curve of *Lycastis indica* differs from that of *N. diversicolor* as reported by Beadle (1937) and Ellis (1937). Though the general pattern of the curve showing a steep rise and a subsequent fall tending towards the attainment of the original weight are the same in both the nereids, the nature of the curve differs. In *Lycastis indica* the gain (represented by a peak) fluctuates with the loss of weight (represented by a fall) the magnitude of the gain diminishing as the weight gradually approaches the original weight. In *N. diversicolor* after the weight falls to a particular level, it is maintained almost constantly above the original weight and is represented by a straight line gradually sloping towards the original weight. This may probably be explained on the basis of the suggestion that the average weights of a number of worms taken at longer intervals may have concealed the individual variations of the worms.

The fluctuations in weight observed in *Lycastis indica* may suggest evidences of effort on the part of the animal working against passive diffusion of water into the animal along the osmotic gradient. As suggested by Beadle (1943), " there is no such thing as a ' static equilibrium ' and that even the most primitive of marine animals maintain a ' dynamic steady state ', by which a difference in concentration of several ions is established across the external membranes, which can be maintained only by some active process."

In the first phase of the regulatory process in *L. indica* consisting of an increase in weight, it is found that the worms acclimated to different salinity conditions differ

TABLE I

Changes in weight of Lycastis indica *acclimated to salinity* 33-34‰ *following transfer to salinity* 6‰

Initial weight in gms.	Time in hrs.	Final wt. in gms.	Weight change in gms.	Percentage weight change
0.454	1	0.740	0.286	62.99
	2	0.770	0.316	69.60
	3	0.812	0.358	78.84
	4	0.772	0.318	70.03
	5	0.762	0.308	67.84
	6	0.751	0.297	65.41
	7	0.737	0.283	62.33
	8	0.717	0.263	57.93
	24	0.621	0.167	36.78
	25	0.620	0.166	36.56
	26	0.610	0.156	34.36
	27	0.604	0.150	33.04
	28	0.600	0.146	32.16
	31	0.582	0.128	28.19
	48	0.549	0.095	20.92
	50	0.540	0.086	18.94
	51	0.570	0.116	25.55
	53	0.575	0.121	26.65
	56	0.565	0.111	24.44
	74	0.560	0.106	23.34
	96	0.540	0.086	18.94
	99	0.530	0.076	16.74
	101	0.528	0.074	16.29
	103	0.526	0.072	15.86
	104	0.511	0.057	12.55
	120	0.540	0.086	18.94
	122	0.533	0.079	17.40
	124	0.534	0.080	17.62
	126	0.521	0.067	14.76
	128	0.510	0.064	14.09
	144	0.525	0.071	15.64
	148	0.514	0.060	13.21
	150	0.495	0.041	9.031
	152	0.497	0.043	9.471
	168	0.520	0.066	14.543
	172	0.507	0.053	11.658
	174	0.489	0.035	7.709
	176	0.481	0.027	5.947
	193	0.506	0.052	11.495
	219	0.498	0.044	9.692
	223	0.487	0.033	7.268
	264	0.515	0.061	13.44
	266	0.473	0.019	4.185
	269	0.465	0.011	2.423
	288	0.460	0.006	1.321
	293	0.451	0.003*	0.6607*
	312	0.467	0.013	2.863
	316	0.456	0.002	0.4404
	317	0.458	0.004	0.8810
	319	0.455	0.001	0.2203
	321	0.450	0.004*	0.8810*
	337	0.441	0.013*	2.863*
	340	0.422	0.032*	7.047*
	345	0.416	0.038*	8.370*

* Decrease below the original weight.

markedly in their behaviour. Comparing the maximum weight attained by the worms under osmotic stress, it is found that the worms acclimated to the salinity 10-12‰ show very little increase in weight and the maximum weight increase may be only about 4% (Fig. 1) of the original weight and those acclimated to the salinity

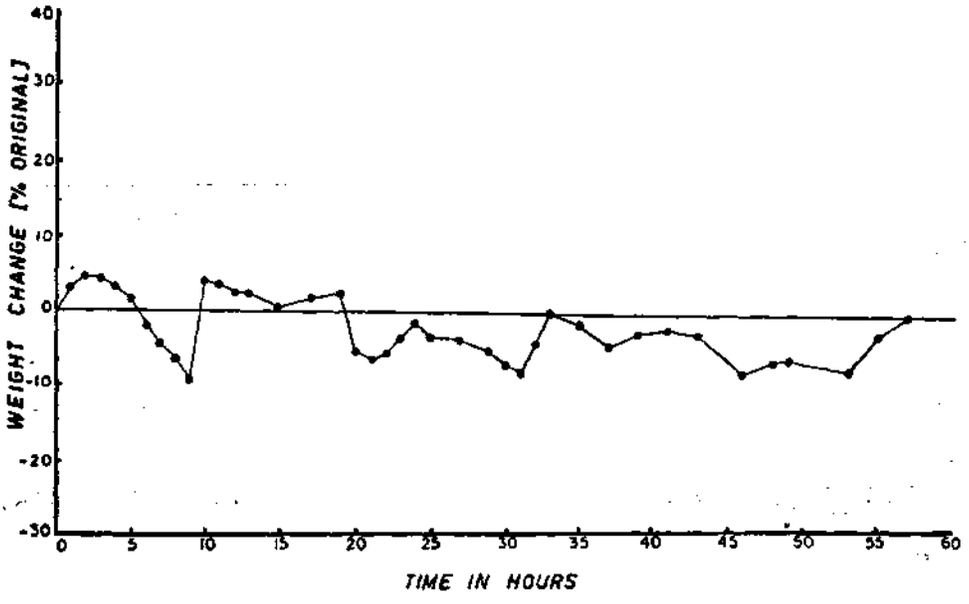

FIG. 1. Changes in weight of *Lycastis indica* acclimated to salinity 10-12‰ following transfer to salinity 6‰.

18-20‰, 25-28‰ and 33-34‰ show a maximum weight increase of about 23% (Fig. 2), 41% (Fig. 3) and 79% (Table I) of their original weights respectively. It is found that the time taken by the worms to regain their original weights also differs according to the salinity of the medium to which they are acclimated. The worms acclimated to a salinity 10-12‰ regained their original weights after about 5 hours, while those acclimated to the salinity of about 18-20‰, 25-28‰ and 33-34‰ regained their original weights at the end of 24, 51 and 293 hours respectively.

Though it has been accepted that the initial increase in weight is due to the inflow of water along the osmotic gradient, the reason for a sudden decrease has not been sufficiently explained except by the suggestion of Beadle (1937) and Ellis (1937). It is said that the decrease in weight after a maximum increase is due to an active excretion of water against the concentration gradient. Beadle (*loc. cit.*) further suggests that in *N. diversicolor* the initial osmotic entry of water results in an increase in internal hydrostatic pressure, which in turn determines the amount of fluid excreted by the nephridia, consistent with this suggestion, the differences in size and blood supply of the nephridia in *Lycastis indica*, *Nereis chilkaensis* and *Perinereis nuntia* have been shown to be associated with the need for the elimination of water (Krishnan, 1952). In the light of the above finding, it may be suggested that the weight decrease after an initial rise observed in *Lycastis indica* in the present study may be due to the efflux of water that has entered the animal along the osmotic gradient.

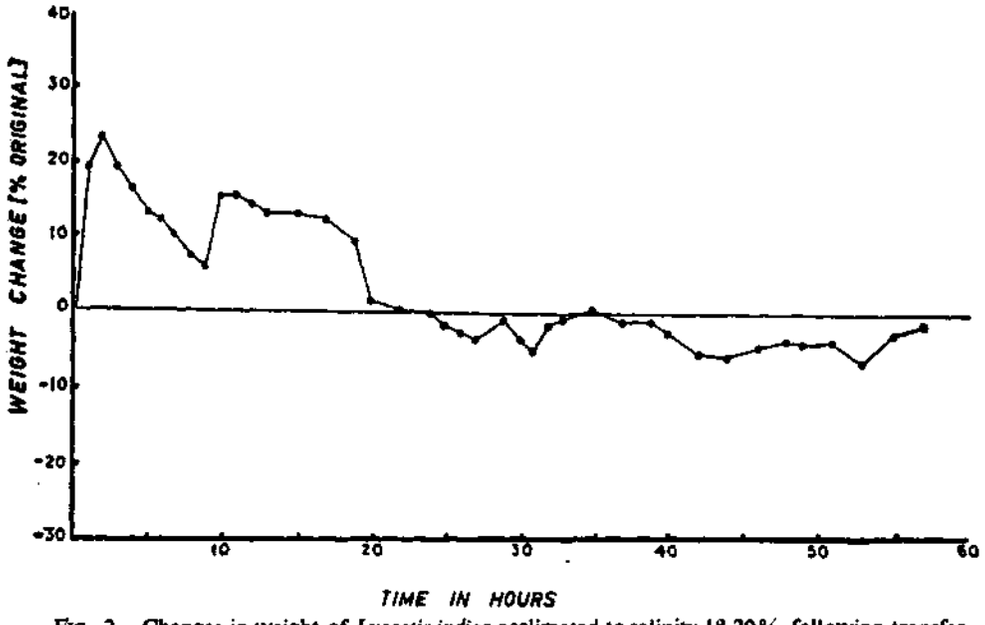

FIG. 2. Changes in weight of *Lycastis indica* acclimated to salinity 18-20‰ following transfer to salinity 6‰.

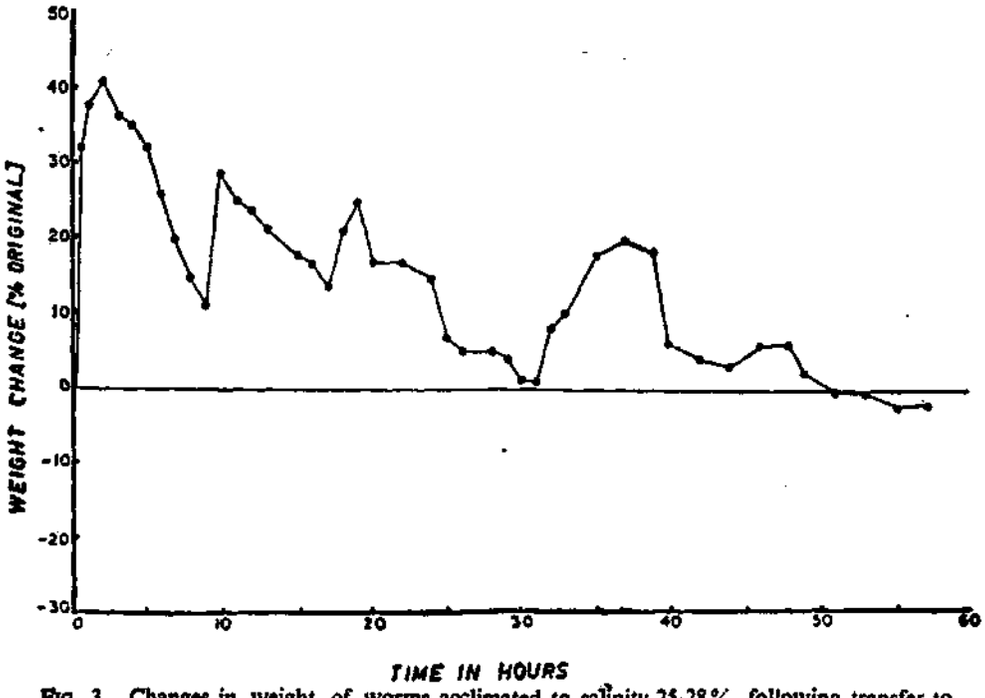

FIG. 3. Changes in weight of worms acclimated to salinity 25-28‰ following transfer to salinity 6‰.

Discussion

It has been suggested that regulation of body fluid concentration in relation to the medium, ability to regulate the body volume and to accommodate the tissues to the changes in the internal concentration are a few important means by which marine invertebrates could survive the passage into brackish water. Beadle (1931) from a comparative study of a stenohaline worm, *Perinereis cultrifera* and the euryhaline *N. diversicolor* showed that in diluted sea water the weight increase is more in the former than in the latter. Further more, in *P. cultrifera* the weight continues to remain at the maximum level, while in *N. diversicolor* the weight decreases to a limited extent after an initial rise. Schlieper (1929) observed that dilute sea water of salinity 8‰ killed specimens of the stenohaline *N. pelagica*, while *N. diversicolor* survived and showed moderate swelling (see Krogh, 1939). Thus, *N. diversicolor* is able to resist and regulate the inflow of water to a greater extent than the two stenohaline nereids (*P. cultrifera* and *N. pelagica*) and it is possible that the weight regulatory ability may account for its euryhalinity. In comparison, it may be suggested that *Lycastis indica* exhibits weight regulatory ability to a more marked degree, in view of the fact that it shows a tendency to approximate the original weight irrespective of the initial increase in weight, while in other nereids the final weight attained tends to remain at a level higher than the normal. It may, therefore, be argued that the high degree of salinity tolerance of *Lycastis indica* both in the natural habitat and in the laboratory, may perhaps be traced to their efficient weight regulatory mechanism.

Recently Oglesby (1965) reported that *N. succinea* and *N. vexillosa* on transference from a medium of higher chloride concentration to that of a lower chloride concentration, exhibited initial increase in weight followed by a gradual decrease in weight. But as in other nereids, in these worms also the original weight was not regained, the final weight remaining at a level above the normal. Oglesby (*loc. cit.*) suggests that after reaching a 'steady state equilibrium' in the lower salinity condition, the worms become hydrated and remain so apparently permanently. Further more, he comments that restoration of original weight in all such cases that have been reported so far may be due to other factors such as frequent handling, which affect the weight of the animals. In the light of the present observation on *Lycastis indica*, it is suggested that the differences noted in the ability to regain normal weight may reflect different degrees of weight regulatory efficiency. Worms such as *Lycastis indica*, which show a tendency to approximate the original weight and an ability to accommodate themselves to fluctuating salinity conditions of the environment, may indicate a more effective regulatory mechanism.

In polychaetes, it has been observed that the maximum volume/weight reached and the regulatory ability, depend on the intensity of the osmotic stress imposed (Beadle, 1931 ; Sayles, 1935 ; Krishnamoorthi, 1962). Such an inference does not take into account the influence of an important factor like the salinity of the medium from which the animals are taken prior to experimentation. It is seen from the present study that the stress being the same, the worms show varying degrees of weight regulation and this may be attributable to the previous treatment of the experimental worms to different salinity conditions. Hence, it may be suggested that the weight regulatory ability of the worms is influenced by external factors such as salinity, which perhaps may be associated with what has been considered as differences in the physiological behaviour of the members of the same species of *N. diversicolor* collected from different regions and at different seasons (Beadle, 1937 ; Ellis, 1937).

Summary

Weight regulation of *Lycastis indica* under osmotic stress was studied and compared with those of the allied *Nereis diversicolor* and other nereids. *Lycastis indica* possesses a more marked weight regulatory ability and consequently a better survival capacity in fluctuating salinity conditions compared to other nereids so far studied. *Lycastis indica* were acclimated to various dilutions of sea water and their weight changes under similar osmotic stress were followed. The weight regulatory ability of these worms is found to vary according to the medium to which they are acclimated. The adpative significance of the weight regulatory ability of *Lycastis indica* and the role of salinity as an environmental factor influencing its weight regulatory ability are discussed.

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