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Volume regulation in a euryhaline oligochaete, *Pontodrilus bermudensis* Beddard*

B V S S R SUBBA RAO
Department of Zoology, Andhra University, Waltair 530 003

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Abstract. Experimental data on weight/volume and water regulatory capacity of a littoral oligochaete, *Pontodrilus bermudensis* Beddard are presented. The results presented are of the weight/volume and water regulatory capacities under heterosmotic media ranging from 5 to 30‰ for a period of 72 h or more. The magnitude of the increase in weight is inversely proportional to the external medium concentration. The final weights attained are higher in lower salinities and lower in higher salinities. The weight/volume regulatory capacities of the worm are comparable to those reported in a number of brackish/estuarine polychaetes.

The changes in water content under heterosmotic media support the findings of its weight/volume regulatory capacities. The worm showed a narrow range of variation in percentage body water content under heterosmotic media from 5 to 30‰. The regression slope for water content change compares favourably with those reported in some polychaetes.

Keywords. *Pontodrilus bermudensis*; weight/volume regulation; euryhaline oligochaete.

1. Introduction

A prolonged survival in varying salinity situations, seems to require capacities for weight/volume regulations (Schlieper 1964). Capacities for weight/volume regulations have been demonstrated in a number of estuarine/brackish water organisms (Smith 1957; Oglesby 1969 for an extensive literature; Oglesby 1970, 1973; Pierce 1971; Fletcher 1974 a,b,c). Weight/volume regulatory studies have also been reported on some semiterrestrial oligochaete worms such as *Pheretima posthuma*, *Lumbricus terrestris*, *Allolobophora caliginosa* and *Eisenia foetida* (for complete literature Oglesby 1969; Dietz and Alvarado 1970). Bahl (1945) found a limited weight control in a semiterrestrial oligochaete, *Pheretima posthuma*, in fresh water after a period of 6 days. Stephenson (1945) investigated weight changes at an equilibrium state in *Lumbricus terrestris* in different concentrations of various cation solutions and sea water concentration gradient. There is, however, no previous work on the weight/volume regulatory capacities of aquatic oligochaetes.

Pontodrilus bermudensis, a littoral oligochaete, occurs in large numbers in the Southern Lighter Channel in the Visakhapatnam harbour, where the salinity fluctuates from 6 to 33‰ (Ganapati *et al* 1958). The present work was undertaken

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with a view to study its weight/volume regulatory capacity, under laboratory conditions, when subjected to the range of salinity concentrations in its natural habitat. Laboratory experiments have also shown that long term survival is possible both in low and high salinity concentrations (Subba Rao 1974).

2. Material and methods

The worms collected from their natural habitat were acclimated to laboratory conditions as described in an earlier publication (Ganapati and Subba Rao 1972). The concentration of pre-acclimation salinity of the environment, from where the worms were collected, ranged from 32·61 to 28·64°/$_{oo}$. Two series of experiments were performed in the present investigation—one on weight changes and the other on a total body water content changes under different salinity concentrations. A simple conventional method of weighing individual animals at different periods after subjecting them to experimental media concentrations was followed in determining the weight changes. The weight increase or decrease was expressed in terms of percentage original weight. All experiments were carried out at laboratory temperature (28 ± 2°C). In the second set, the total body water content was determined by comparison of wet weights and dry weights. Worms acclimated for a period of 4-5 days to 25–30°/$_{oo}$ ranges were subjected to test salinities ranging from 5 to 30°/$_{oo}$ for a period of 3 days. The total water content as a percentage of wet tissue weight was calculated from the following equation

$$\text{Total water as \% wet weight} = \frac{\text{(Wet weight)} - \text{(Dry weight)}}{\text{(Wet weight)}} \times 100.$$

Percentage values for individual worms in a given salinity were averaged and standard deviation and error calculated and plotted against the salinity concentration tested.

3. Results

Pontodrilus bermudensis showed a pattern of weight increase or decrease in all experimental media tested (figures 1 to 6). An initial gain in weight immediately after one hour of transfer was noticed. The maximum weight increase was found between 2–4 hr of transfer to different test salinities except in 30°/$_{oo}$. Thereafter, the worms started decreasing in weight to reach the original weight by the end of 72 hr. In other words, the worms gradually increase in weight to attain a maximum weight and gradually lose water to return towards the original weight. But in 30°/$_{oo}$ the worms maintained their weight below the original weight after one hour of transfer. An appreciable initial gain in weight with decreasing salinities below 25°/$_{oo}$ was observed. At higher salinities, 25°/$_{oo}$ and 30°/$_{oo}$, the initial gain in weight was comparatively smaller. A prolonged experiment in a salinity of 25°/$_{oo}$ for 6 days showed that the final weight attained at the end of 72 hr was maintained even after 5–6 days (figure 7). This indicates that maintenance of an equilibrium weight is possible in this worm. Furthermore, the extent of increase and the final weights attained at the end of 24, 48 and 72 hr varied with the experimental salinities. Both the initial weights at the end

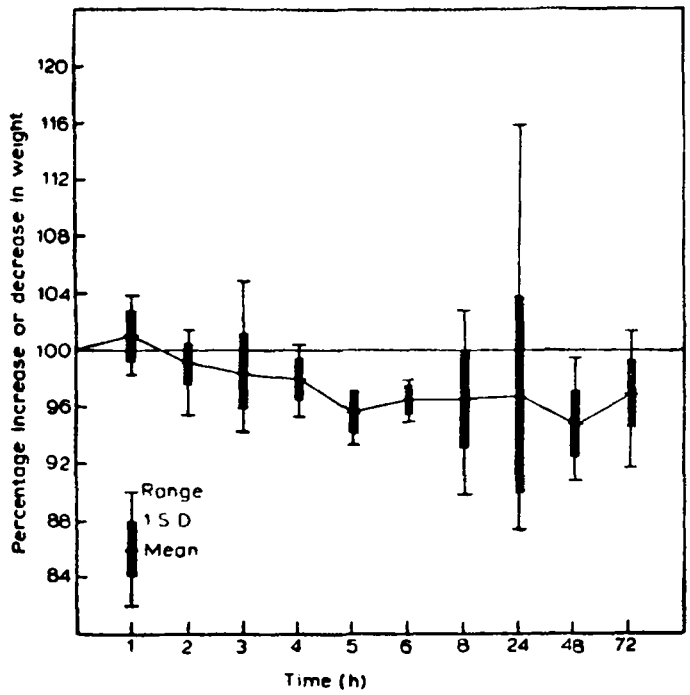


Figure 1

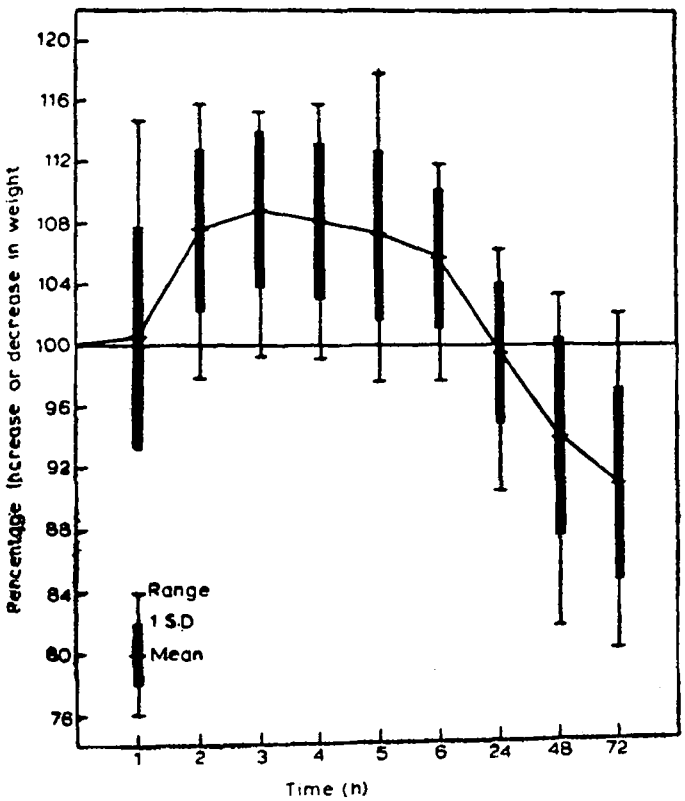
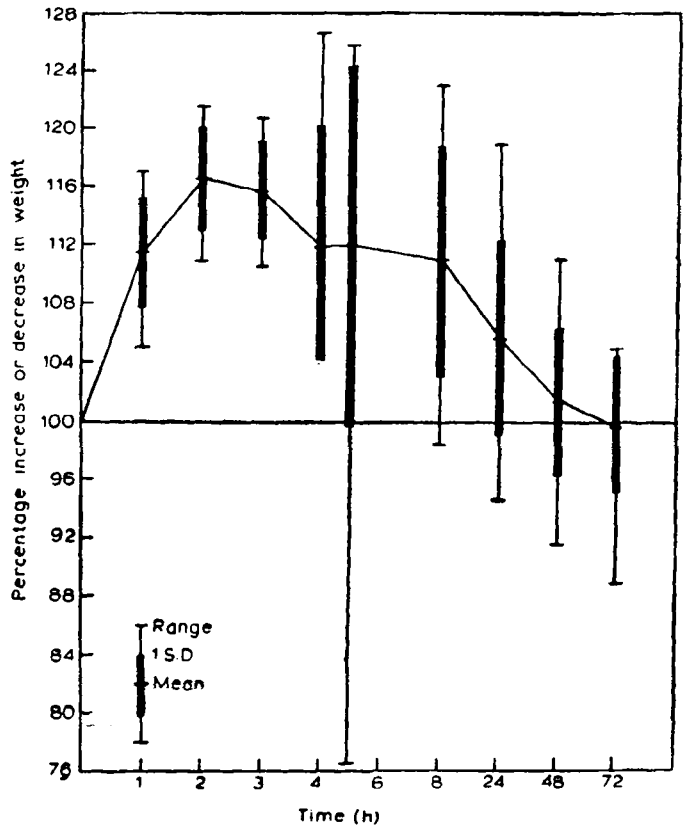


Figure 2



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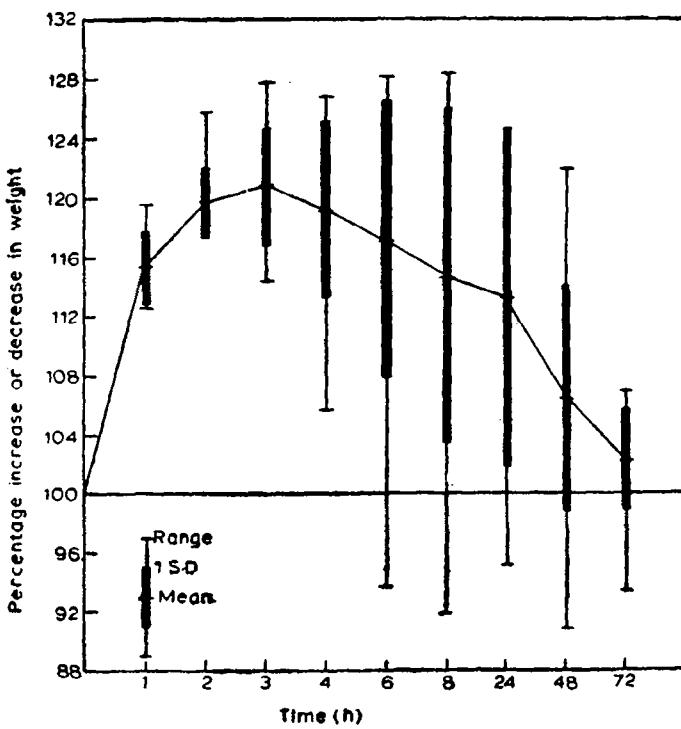

Figure 4

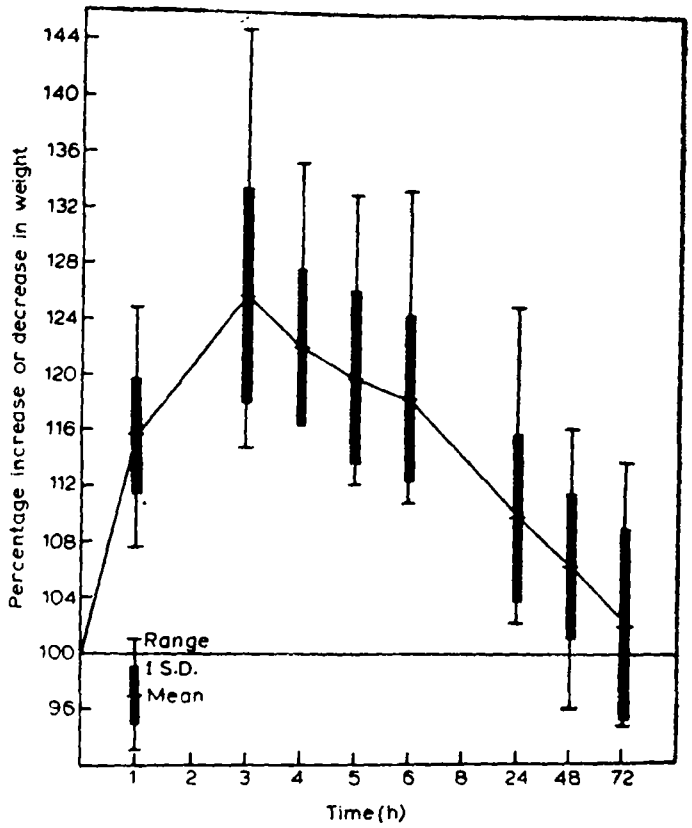

Figure 5

of 2–4 hr and the final weights attained at the end of 24, 48 and 72 hr were lower in higher salinities and higher in lower salinities. In other words, the magnitude of gain in weight was higher in lower salinities and lower in higher salinities. The initial increase in weight may be due to osmotic influx of water and decrease due to efflux of water and salts or active excretion of salts and water against the concentration gradient. Certain oscillations found in weight after initial loss are perhaps due to individual efforts of worms to reduce or increase weight against the osmotic gradient.

The percentage values of the whole body water content of *P. bermudensis* and the calculated regression line are shown in figure 8. The data show that *P. bermudensis* becomes hydrated with lowering salinities. The mean percentage water content of the whole worms ranged from 81 to 84% in salinities ranging from 30 to 5‰. The range in the whole worm body water content is narrower compared to the range of the experimental salinities. Incidentally this may also have a bearing on the reduction in permeability as suggested earlier by several workers in euryhaline polychaetes (Krishnamoorthi 1962; Smith 1964; Oglesby 1968, 1969).

4. Discussion

The percentage of increase in weight i.e. 42·58%, 25·72%, 20·82% and 15·72% in salinity concentrations of 5‰, 10‰, 15‰, and 20‰ respectively of

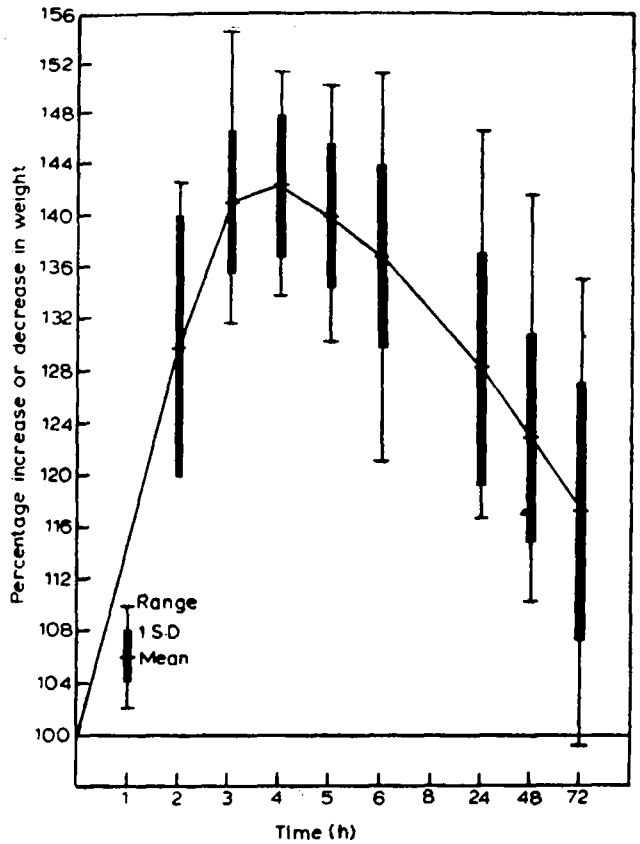

Figure 6

Figures 1–6. Time course changes in percentage body weight in *P. bermudensis* over a period of 72 hr. Temperature: 28 ± 2°C. **1. & 2.** Transfer to 30‰ and 25‰ respectively. Each point is the mean of 10 experiments. **3. & 4.** Transfer to 20‰ and 15‰ respectively. Each point is the mean of 11 experiments. **5.** Transfer after 10‰. Each point is the mean of 14 experiments. **6.** Transfer after 5‰. Each point is the mean of 18 experiments.

P. bermudensis is comparable and more or less matching with those observed in some euryhaline polychaetes like *Nereis limnicola*, *Nereis diversicolor*, *Leonereis culveri* and *Marphysa gravelyi* under comparable salinities (Jørgensen and Dales 1957; Oglesby 1965; Krishnamoorthi and Krishnaswamy 1966). In other words, the capacities for weight regulation in *P. bermudensis* are well developed as in euryhaline brackish water polychaetes.

Though a similar pattern of weight regulation was found in *P. bermudensis* in all test media, the extent of increase and the final weights attained at the end of 24, 48 and 72 hr varied with the external/experimental salinities. Both the initial increase at the end of 2-4 hr and the final weights attained at the end of 24, 48 and 72 hr were higher in lower salinities and lower in higher salinities. In other words, the weight control in *P. bermudensis* is a function of the salinity concentration gradient as has been reported in a number of polychaetes (Oglesby 1969).

Oglesby (1969) reviewed the results of total percentage body water content of a number of semi-terrestrial and fresh water Oligochaete worms adapted to various environmental conditions. Similar work on brackish or marine oligochaete species is

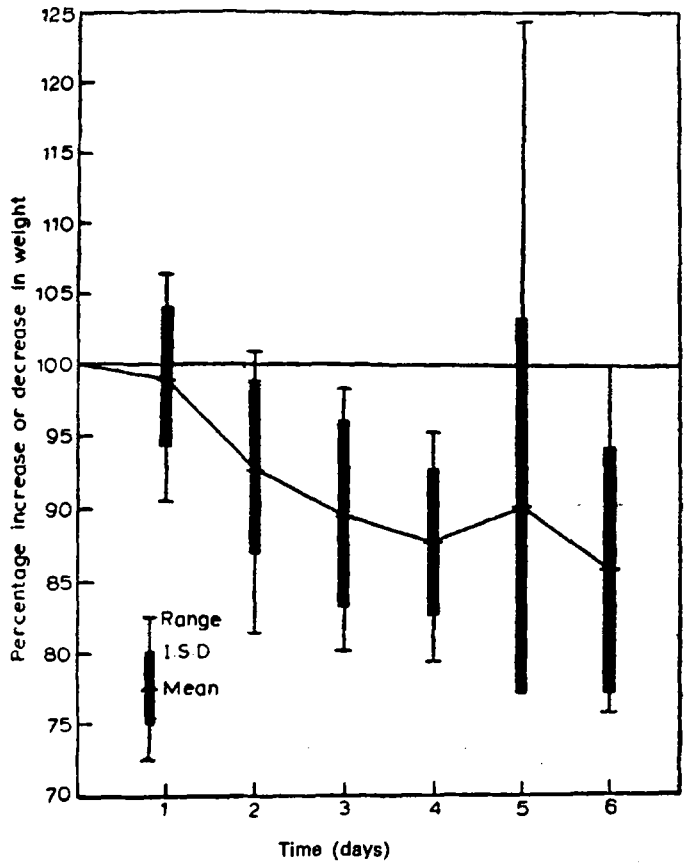

Figure 7. Time course changes in percentage body weight in *P. bermudensis* over a period of 6 days in a medium of 25°/₀₀. Temperature: 28 ± 2°C. Each point is the mean of 9 experiments.

lacking. The percentage water content values of whole worms of *P. bermudensis* in various sea water concentrations (5-30°/₀₀) are more or less similar to those ob tained for a number of semi-terrestrial species. In brackish/estuarine organisms the relationship of the water content of the organisms to salinity concentrations adapted has been considered as an index of their capacities for body volume control. The percentage water content of the whole body under heterosmotic conditions have been reported in a number of euryhaline polychaete annelid worms. The percentage water content ranged approximately from 88 to 89 in *Nereis limnicola* (Oglesby 1965, 1968, 1969); from 83 to 85 in *Nereis diversicolor* (Bryan 1963; Bogucki and Wojtezak 1964; Oglesby 1965, 1969, 1970); from 78 to 92 in *Nereis Vexillosa* (Oglesby 1965, 1969); from 79 to 89 in *Nereis succinea* (Oglesby 1965, 1969) and from 85 to 93 in *Aberinicola pacifica* (Oglesby 1973). The salinity ranged approximately from 35 to 5°/₀₀ for all the above species. Thus, the percentage water content of the whole worms is narrower in more euryhaline species compared to that of less euryhaline and stenohaline species. The percentage body water content in *P. bermudensis* varied from 81 to 84 in salinities ranging from 30 to 5°/₀₀. In comparable salinities the values of percentage body water content in *P. bermudensis* are more or less similar to those in *N. diversicolor*. Also, at all the salinity concentrations the body water

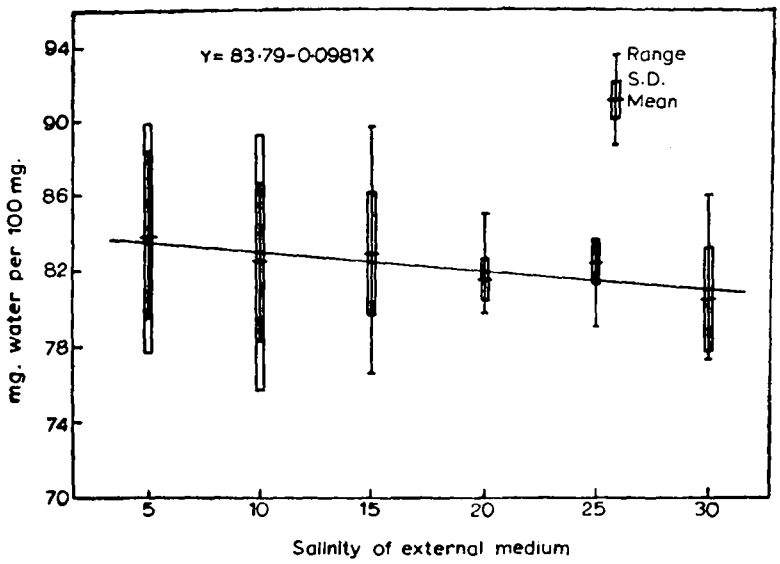

Figure 8. Relationship of water content of *P. bermudensis* to salinity of the medium after adaptation to external salinity concentrations from 5 to 30‰. Temperature: 28 ± 2°C. Each point is the mean of 12 to 30 estimations.

content in *P. bermudensis* is less than that in *N. limnicola* but comparable to *N. diversicolor*. The reason for this is not known. However, regression slopes obtained by Oglesby (1965) for *N. limnicola* and *N. diversicolor* approximate with that of *P. bermudensis*. But according to Oglesby (1970) the regression slope obtained for *N. diversicolor* from River Wansbeck, Northumberland differs from *N. limnicola*. Nevertheless, the water regulation capacities, show a better index of weight/volume control in *P. bermudensis*.

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