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# ACTIVITY OF *MARPHYSA GRAVELYI* SOUTHERN (POLYCHAETA) UNDER HETEROSMOTIC CONDITIONS

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## INTRODUCTION

*Marphysa gravelyi* Southern is a common polychaete which occurs in the muddy substratum of the brackish-water regions of Madras, where salinities fluctuate over a wide range (Panikkar and Aiyar, 1937). In the laboratory under experimental conditions the worm is able to tolerate dilutions of sea-water ranging from 20–70% without any ill-effects (Krishnamoorthi, 1951). An attempt was made to see the extent to which the tissues of the animal would tolerate sea-water dilutions. Similar studies have been reported by Wells and Ledingham (1940). A knowledge of the toleration of the tissues to hypo- as well as hypertonic media, will help in understanding the importance of the constancy of an internal fluid and its regulation.

## MATERIAL AND METHODS

*Marphysa gravelyi* was collected in the brackish-water regions of the Adyar estuary. The worms were washed in the medium and kept in water collected from the estuary. Survival rate was good and the worms remained in a healthy condition for over a week. The estuarine water at the time of collection was of the same strength as 30% sea-water (salinity of sea-water: 32·0‰).

The preparation for recording the activity consisted of a small strip of the animal 3·2 cm. long. The head was removed and the first few anterior segments were utilised. One end of the worm was pinned on to a piece of cork and the other end was connected to an isotonic lever. The preparation was exposed to dilutions of sea-water in a glass tube of 30 ml. capacity. The movements were recorded in a kymograph drum, rotating at a very slow speed of 1·5 cm. per minute for 5–6 hours. The preparation was exposed to a constant volume of the experimental medium for a period of only 15 minutes so that the shock effects of the change in medium rather than slow acclimatisation were studied.

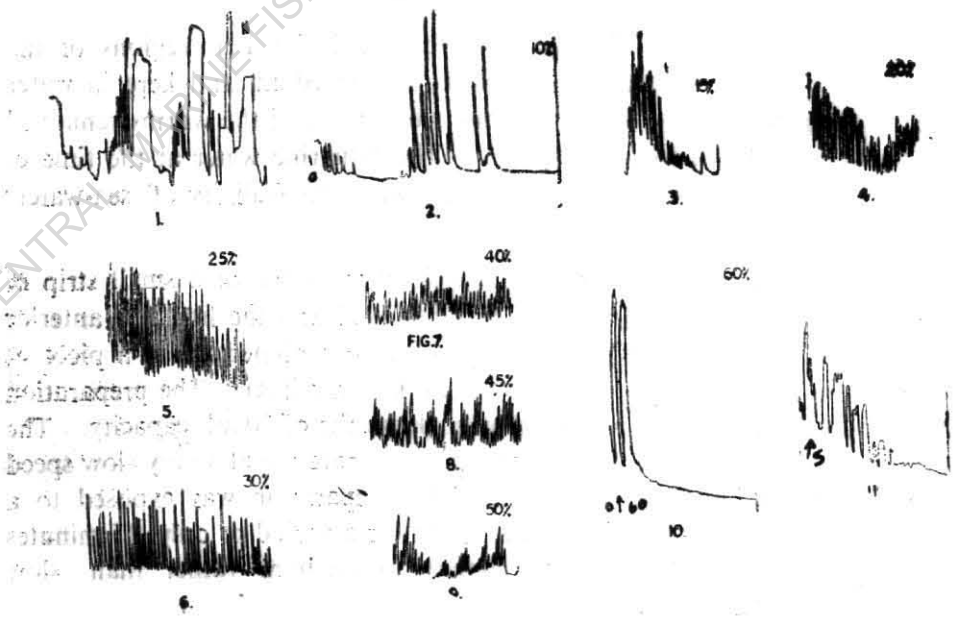
## RESULTS

### 1. *Effect of Hypo- and Hypertonic Media*

Whole worms (Fig. 1) as well as bits of worm (Fig. 6) exhibited spontaneous activity which was maintained for long periods of time. No rhythmicity could be recognised in the activity. In normal medium there is a continuous peristalsis going on, there being rapid contractions and relaxations of the body muscles which is clear from the traces.

When the medium (30% sea-water) is replaced with 25% and 20% sea-water, there is an increase in activity which is maintained for several hours (Figs. 4 and 5). The preparation exhibits very rapid contractions of the body. There is a definite drop in the height attained indicating that the preparation is in a slightly relaxed condition. In 15% sea-water it is very vigorous to begin with but trails off at the end of a few minutes (Fig. 3). When the medium is changed and replaced with 10% sea-water, there is very little activity at first, but becomes more active at the end of a few minutes only to remain quiescent again (Fig. 2). If replaced with distilled water there is practically no activity. In all the hypotonic media below 20% the markings do not touch the base line indicating of the preparation being always in a slightly contracted condition.

The preparation, when transferred to hypertonic media of sea-water diluted to 40–45% and 50%, continued to be active (Figs. 7, 8, 9). In 60%,




FIGS. 1–11.

70% and higher concentrations the worm contracts and remains so (Fig. 10). When sucrose or urea is added to the preparation in 30% sea-water, there is a sudden decrease in activity suggestive of the worms responding to osmotic stress which seems to be the main factor affecting the behaviour of the worm (Fig. 11).

2. *Effect of Ions*

Preliminary experiments conducted in the laboratory show that there is a loss of salts from the worm in hypotonic medium as indicated by change in conductivity (Table I). It was therefore felt desirable to study the effect of various ions so as to see how they affect the activity of the animal.

TABLE I

| Time | Reading at 1 hr. intervals in dilutions of sea-water* | | | | | | |
|---|---|---|---|---|---|---|---|
| | 10% | 20% | 30% | 40% | 50% | 60% | 70% |
| Initial .. | $0{\cdot}60\times10^{4}$ | $1{\cdot}23\times10^{4}$ | $1{\cdot}70\times10^{4}$ | $2{\cdot}20\times10^{4}$ | $2{\cdot}60\times10^{4}$ | $3{\cdot}10\times10^{4}$ | $3{\cdot}90\times10^{4}$ |
| 1 hr. .. | $0{\cdot}65\times10^{4}$ | $1{\cdot}25\times10^{4}$ | $1{\cdot}70\times10^{4}$ | $2{\cdot}20\times10^{4}$ | $2{\cdot}60\times10^{4}$ | $3{\cdot}10\times10^{4}$ | $3{\cdot}90\times10^{4}$ |
| 2 hrs. .. | $0{\cdot}68\times10^{4}$ | $1{\cdot}25\times10^{4}$ | $1{\cdot}70\times10^{4}$ | $2{\cdot}14\times10^{4}$ | $2{\cdot}55\times10^{4}$ | $3{\cdot}10\times10^{4}$ | .. |
| 3 hrs. .. | $0{\cdot}67\times10^{4}$ | $1{\cdot}27\times10^{4}$ | $1{\cdot}71\times10^{4}$ | $2{\cdot}19\times10^{4}$ | $2{\cdot}58\times10^{4}$ | $2{\cdot}90\times10^{4}$ | .. |
| 4 hrs. .. | $0{\cdot}63\times10^{4}$ | $1{\cdot}25\times10^{4}$ | $1{\cdot}68\times10^{4}$ | $2{\cdot}21\times10^{4}$ | $2{\cdot}59\times10^{4}$ | $3{\cdot}10\times10^{4}$ | .. |

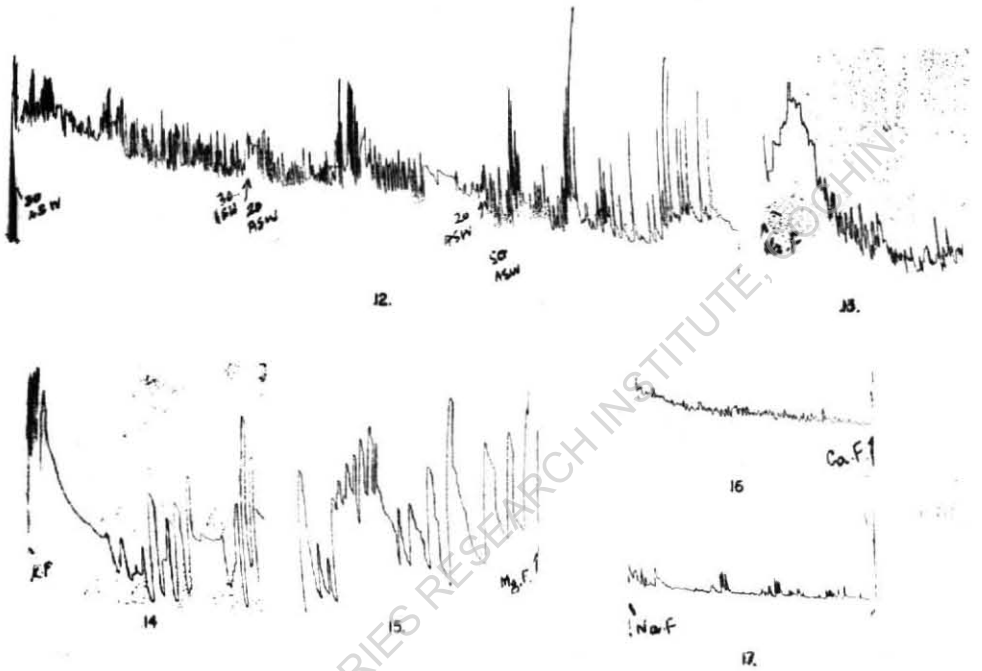
* All values are in $\mu$ mhos taken with a Mullard Conductivity Bridge and a dip-type of electrode.

Artificial sea-water prepared according to the formula given by Pantin (1948) and diluted to 30% also elicited responses comparable to normal medium. The preparation remained active and healthy for several hours (Fig. 12). The activity in artificial sea-water without the particular ion is shown in Table II. When worms first treated with $Ca^{+}$ free sea-water, were subjected to $Na^{+}$ free water, they showed reduced activity (Fig. 17).

TABLE II

| Ion | Remarks |
|---|---|
| $Na^{+}$ free | Activity present (Fig. 13) |
| $K^{+}$ free | Activity as in $Na^{+}$ free (Fig. 14) |
| $Ca^{+}$ free | Completely contracted but activity present (Fig. 16) |
| $Mg^{+}$ free | Complete relaxation. Considerable activity present (Fig. 15) |

From Table II it would be clear that in $K^+$, $Na^+$ and $Ca^+$ free ions the activity is maintained. In $Mg^+$ free sea-water the animal shows greater activity as evident from the traces (Fig. 15).




FIGS. 12-17.



## REMARKS

The results reported in the present paper clearly show that *Marphysa gravelyi* Southern tolerates sea-water dilutions ranging from 20 to 70%, while the muscles are active only in ranges from 20 to 50%. Thirty per cent. seems to be the optimal salinity where the animals exhibit considerable activity. Wells and Ledingham (1940) observed a similar behaviour in four species of polychaetes. The results presented, however, cannot be compared with the results obtained by Wells and Ledingham (*loc. cit.*) as only the shock effects and not the prolonged gradual acclimation have been studied here. The body volume changes very rapidly on transferring to hypotonic media. Therefore, there is very little " damping effect " due to body integument. That the animal becomes very active is very interesting. In hypotonic media the spontaneous activity is quite evident and shows that the muscles are capable of working under conditions of reduced salinity up to a point. The effects of ions clearly show that $Na^+$, $K^+$ are essential. Absence of $Ca^+$ produces very little contraction. In the absence of magnesium ions the preparation remains very active. Wells and Ledingham (*loc. cit.*) found that the high $Mg^+$ con-

centration depresses the activity whereas low $Mg^+$ content increases the activity. The present experiments have shown clearly that there is likely to be a regulation of the essential ions by the worm as indicated by the retention of activity in very low concentrations of sea-water and also from the results obtained with ions. Presence of $Na^+$, $K^+$ and $Ca^+$ appears to be essential for a proper functioning. It will be interesting to study the ionic regulation in this animal to see if any particular ion is regulated.

## Summary

1. Whole worms as well as body wall preparations of *Marphysa gravelyi* exhibit spontaneous activity in full strength as well as diluted sea-water.

2. The preparation is very active in sea-water dilutions from 20 to 50%.

3. In $Na^+$, $K^+$, $Ca^+$ free sea-water activity is present. In $Mg^+$ free sea-water, the preparation appears to be completely relaxed.

4. While the whole worms tolerate sea-water dilutions ranging from 20 to 70% the muscle preparation appears to tolerate only from 20 to 50% sea-water.

## References

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