Acclimation of some coastal animals to changed salinity

by

ČEDOMIL LUCU*, STJEPAN KEČKEŠ** and BARTOLO OZRETIĆ*

**Institute " Ruder Boskovic ", Rovinj (Yougoslavie)*

***International Laboratory of Marine Radioactivity, I.A.E.A., Monaco*

The ability of various marine organisms to compensate the changes in total osmoconcentration of their environment is usually studied in the steady state conditions, while the changes during the acclimation were scarcely investigated.

In this work some experiments concerning the course of acclimation, i.e. the non-genetic adaptation to changed total osmo-concentration in coastal animals characteristic for the north Adriatic will be presented. The acclimation was followed in parallel measurements of sodium metabolism in animals which were and which were not acclimated to various salinities. The results obtained in acclimated animals are already described (LUCU et al., 1968) and here the experiments with nonacclimated animals will be given.

Animals and methods

For the experiments *Leander squilla* L., *Mytilus galloprovincialis* Lam. and *Crenilabrus* sp. kept in normal (100 ‰) sea water (salinity 37.8 ‰) and at constant temperature (20° ± 1°C) were used.

At the beginning of the experiment (time zero) the animals were placed in polyethylene basins containing aerated sea water of various salinity (12.5 - 125 ‰) and 10 μCi of carrier free Na^{22} per litre. The conditions in experiments were kept as close as possible to the conditions in parallel experiments with acclimated animals.

The kinetics of Na^{22} exchange was followed for 120 hours as was described in an earlier work [KEČKEŠ *et al.* 1966]. The mean concentrations of Na^{22} in animals over that in the experimental basin (cpm per g of animal/cpm per ml of basin) obtained at various intervals from the beginning of the experiment in basins containing sea water of various salinity are shown as dots in the figures, where for comparison the concentration of Na^{22} in acclimated animals, i.e. the uptake curves for Na^{22}, are given as solid curves.

Results

In 12.5 and 25 ‰ sea water the Na^{22} concentration is the same in acclimated and nonacclimated *Leander* from 24 hours on. In 50 ‰ sea water the levelling is reached somewhat earlier (about 12 hours), while in 75 ‰ sea water no significant differences were found between the Na^{22} uptake by acclimated and nonacclimated prawns (Fig. 1).

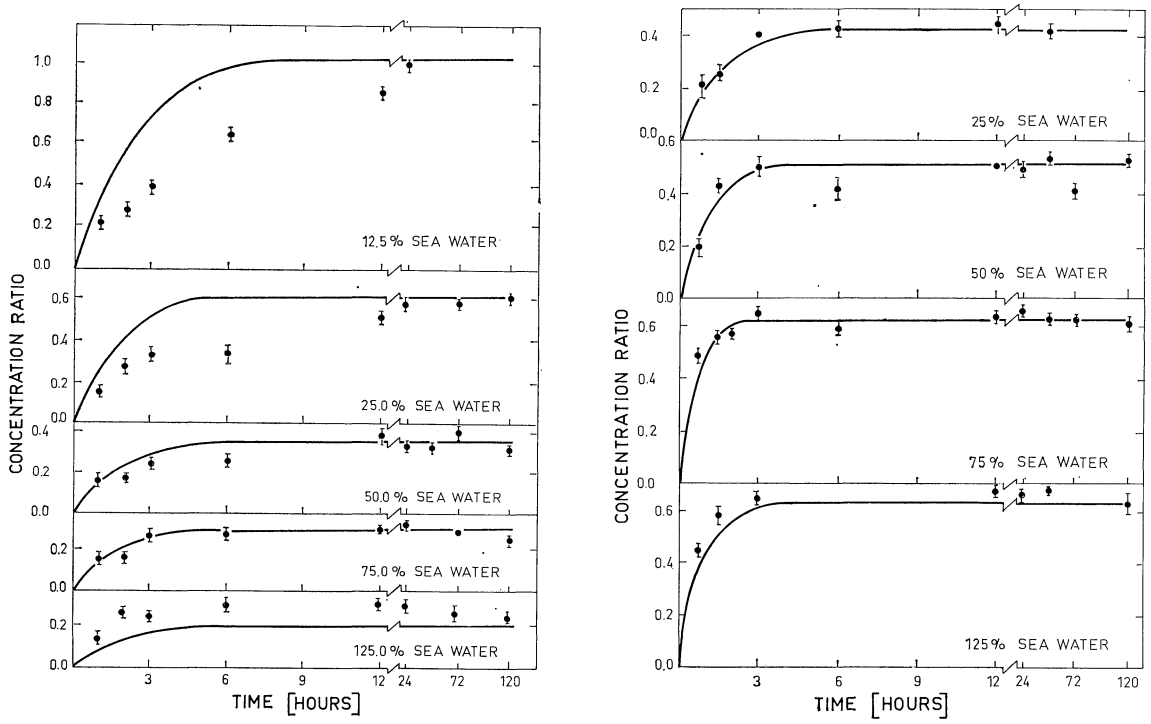
In 125 ‰ sea water the nonacclimated animals had higher Na^{22} concentration than the acclimated ones (" overshoot " reaction) and it seems that for the nonacclimated prawns at least five days are required to reach the " normal " Na^{22} concentration.

To ensure an immediate sodium exchange between the soft tissues of *Mytilus* and their environment, they were forced to be " open " during the experiments by fixing a wire between their shells.

Rapp. Comm. int. Mer Médit., **20**, 4, pp. 507-510 (1972).

The values for Na^{22} concentration were practically the samefor acclimated and nonacclimated *Mytilus* (Fig. 2). Only in 125 % sea water the nonacclimated animals had a slightly higher Na^{22} concentration than the acclimated animals.

In 50, 75 and 125 % sea water the same Na^{22} concentration in acclimated and nonacclimated *Crenilabrus* was observed. Only in extreme dilution (25 % sea water) the values for Na^{22} concentration in nonacclimated animals were much lower than for the acclimated ones (Fig. 3).



1 2

Fig. 1. — The Na^{22} uptake by acclimated (solid curves) and nonacclimated (dots) *Leander* in sea water of various salinity.

Fig. 2. — The Na^{22} uptake by soft tissues of acclimated (solid curves) and nonacclimated (dots) *Mytilus* in sea water of various salinity.

Discussion

Animals acclimated to a certain salinity should have a steady exchange of sodium between the surrounding medium and their body fluids and tissues, i.e. the sodium loss by all routes should just equal the total sodium uptake. When this exchange is followed by Na^{22} and expressed as the uptake of Na^{22}, it shows an exponential function.

The nonacclimated animals have to acclimate during the experiment and therefore the curves representing the uptake of Na^{22} should be more complicated, reflecting acclimation of sodium exchange mechanism to the new environmental conditions.

Assuming that the levelling of the Na^{22} exchange between the acclimated and nonacclimated animals means the de facto acclimation of nonacclimated animals, one might conclude that in *Leander* the acclimation is reached after about 24 hours in 12.5 and 25 % sea water, in 50 % sea water it is reached already after about 12 hours while in 75 % sea water even a shorter period is sufficient. All these results corroborate with those presented for prawns by PANNIKAR (1941) and for some other decapod crustacea by GROSS (1957).

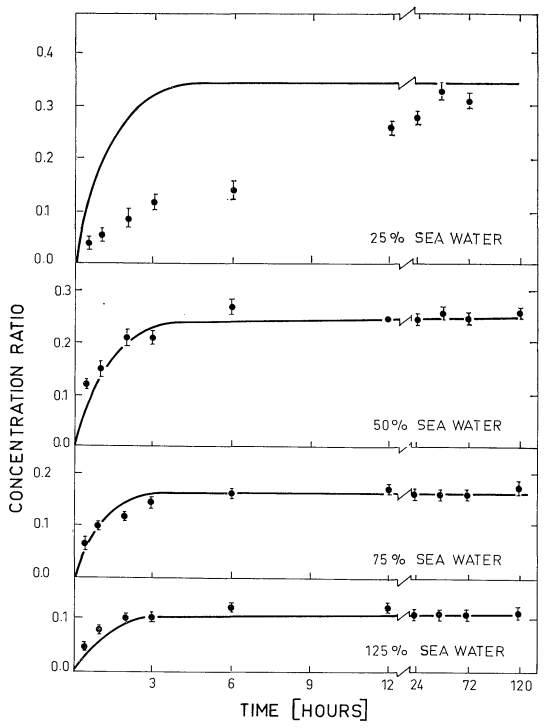


Fig. 3. — The Na^{22} uptake by acclimated (solid curves) and nonacclimated (dots) *Crenilabrus* in sea water of various salinity.

The " overshoot " reaction observed in nonacclimated *Leander* exposed to 125 % sea water indicate that at least five days are required for their acclimation to this osmoconcentration.

Generally it might be concluded that *Leander* can acclimate much quicker to hyposaline than to hypersaline media, probably because they are hyposmotic regulators [PANNIKAR, 1940] and invaded the sea from fresh water, as was suggested by PANNIKAR (1941).

Mussels are known as poor " regulators " [SCHLIEPER & KOWALSKI, 1957; LUCU *et al.*, 1968] and therefore the same course of Na^{22} uptake in acclimated and nonacclimated animals was expected. The experiments fully proved this anticipation and practically it means that in the salinity range from 10 to 48 ‰ the acclimation of mussels is a very quick but probably passive process. However, it does not mean that in situ, where they can actively reduce the contact with external medium, the acclimation is achieved so quickly.

The excellent regulatory ability of *Crenilabrus* [LUCU *et al.*, 1968] resulted in very rapid acclimation of sodium metabolism to the "normal" level in 50, 75 and 125 % sea water. Only in 25 % sea water, the values for Na^{22} concentration in nonacclimated animals were much lower than for the acclimated ones, indicating that the exposure to so low salinity represents for them a heavy stress.

Although in *Mytilus* and *Crenilabrus* a quick acclimation was found, it is of quite different type. In *Mytilus* as in typical " conformers ", the sodium level in tissues and body fluids follows the sodium concentration of the environment without delay and therefore by the method used, no difference was found in the Na^{22} uptake between the animals acclimated and those which have not been acclimated to a certain salinity. On the contrary, the regulatory mechanism for the sodium level in tissues and body fluids of Crenilabrus is so strong that it can in a very short time compensate the changed total sodium uptake and keep the body sodium level unchanged.

Acknowledgments

This work was supported by contracts with the International Atomic Energy Agency, Vienna (RB/201).

The authors wish to express their gratitude to M. BENETTA, M. MAREČIĆ and S. DRAGIĆ for their valuable technical assistance.

References

GROSS (W.J.), 1957. — An analysis of response to osmotic stress in selected decapod crustacea. *Biol. Bull., Woods Hole*, **112**, 1, pp. 43-62.

KEČKEŠ (S.), PUČAR (Z.) & KOLAR (Z.), 1966. — The turnover of sodium by some fishes. *Iugoslav. physiol. pharmacol. acta*, **1**, pp. 87-94.

LUCU (Ć.), KEČKEŠ (S.), OZRETIĆ (B.) & PUČAR (Z.), 1969. — Sodium metabolism in some coastal animals as a function of salinity. *Rapp. Comm. int. Mer Médit.*, **19**, 5, pp. 865-867.

PANNIKAR (N.K.), 1940. — Osmotic properties of the common prawn. *Nature, Lond.*, **145**, nº 3664, p. 108.

PANNIKAR (N.K.), 1941. — Osmoregulation in some palaemonid prawns. *J. mar. biol. Ass. U.K.*, **25**, 2, pp. 317-359.

SCHLIEPER (C.) & KOWALSKI (R.), 1956. — Quantitative Beobachtungen über physiologische Ionenwirkungen im Brackwasser. *Kieler Meeresforsch.*, **12**, 2, pp. 154-165.