Sodium metabolism in some coastal animals as a function of salinity

by

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Working in the North Adriatic, where the coastal animals are often exposed to considerable variations in environmental conditions, it seemed reasonable to compare their response to changed salinity. Therefore using Na^{22} as a convenient tracer the sodium exchange in mussels, prawns and some fish was followed and from the kinetics of Na^{22} exchange in animals acclimated to various salinities their osmoregulatory capacity was estimated.

Materials and methods

As experimental animals prawns (*Leander squilla* L.,), mussels (*Mytilus galloprovincialis* Lam.) and a fish (*Crenilabrus* sp.) were used. The animals were acclimated to sea water of required salinity obtained by evaporation of normal (100 %) sea water or its dilution with distilled water. The normal sea water had 37,8 % salinity.

The acclimation was accomplished by gradual transfer of the animals into more concentrated or diluted sea water (12,5 % change per day). When the desired conc. of the external medium was reached, the animals were left ten days in basins with the same salinity. The basins were replaced daily by fresh ones.

On the tenth day the animals were transferred into the experimental basins with sea water of the same osmolar value containing 10 μ Ci of carrier free Na^{22} per litre. During the experiments and the acclimation period the temperature of the basins was 20 $\pm$ 1° C.

The kinetics of Na^{22} exchange was measured and the results evaluated as described in an earlier work [KECKEŠ *et al.*, 1966].

Results and discussion

The incorporation of Na^{22} was followed in 120 hour experiments. This was more than enough to reach the biological equilibrium, where the flux of Na^{22} from the animals into the sea and from the sea into the animals was equal. Using equation (1)

$$I = I_0 \ (1 - e^{-kt}) \qquad (1)$$

where I represented the concentration factors (CF) at time t (ratio of the activity in one gram of organism and in 1 ml of the basin), I_0 the CF at biological equilibrium and t the time from the beginning of the experiment, the turnover rate constants (k) and the biological half-lives (τ, the value for t when $I = I_0/2$) were calculated.

The results of these calculations are presented in Table 1 and the CF at equilibrium (I_0) are shown comparatively with the curves calculated for ideal regulation of sodium in Fig. 1. These curves were constructed on the assumption that the ideal regulation should result in CF which is inversely proportional to the salinity.

Rapp. Comm. int. Mer Médit., **19**, 5, pp. 865-867, 2 fig. (1969).

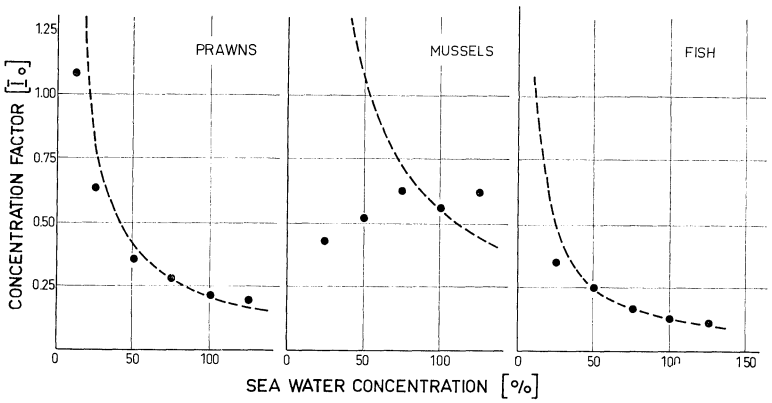

FIG. 1. — CF in prawns, mussels (soft tissues) and fish acclimated to various conc. of sea water. Each dot is the mean of the group. The broken line shows the theoretical CF at ideal regulation.

Assuming that using Na^{22} as a tracer we can investigate the real exchange of the total sodium, from the obtained results (Fig. 2.) it might be concluded that in a wide salinity range the fish and prawns have a powerful regulatory mechanism for maintenance of a constant sodium level in their body. In fish from 50 to 12.5 % sea water the deviation of the observed CF at equilibrium from the ideal values was within the error of the method. The CF in prawns corresponded very well with the ideal values and even in 12.5 % sea water indicated a relatively good regulation. We have not succeded to acclimate the fish to such low salinity. The mussels on the contrary showed no tendency to maintain a constant sodium level in their soft tissues. It seems even, that in the experimental basin with low salinity they had a lower conc. of sodium in their soft tissues than one could expect in the absence of any regulatory mechanisms.

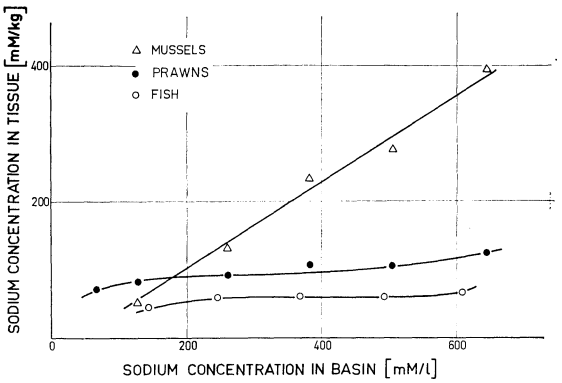

FIG. 2. — The dependence of the sodium conc. in acclimated prawns, mussels (soft tissues) and fish on its conc. in the surrounding medium.

To confirm the assumption that sodium is readily exchangeable in the animals used in our experiments, the loss of Na^{22} from the animals was followed. For these experiments the animals were first equilibrated with 100 % sea water containing Na^{22} and then transferred to running sea water without the radiosotope.

The loss of Na^{22} from the animals showed that our assumption was only partly correct. Whereas the shrimps and fish showed typical loss curves for one-compartment systems during 120 hours, the loss curve of mussels (soft part) indicated that in sodium metabolism at least two compartments are involved. According to our estimation one of these compartments contains 97 % of the total sodium and

Table 1. — The conc. factors at equilibrim (I_0), turnover rate constants (k), biological half-lives (τ in hours) and number of animals per experimental groups (No.) of prawns, mussels (soft tissues) and fish acclimated to various sea water concentrations in %.

Sea Water conc.	prawns				mussels				fish			
	No	I_0	k	τ	N°	I_0	k	τ	N°	I_0	k	τ
125	10	0.192	0.57	1.22	12	0.617	1.32	0.53	17	0.109	0.87	0.80
100	19	0.210	0.79	0.88	23	0.553	1.10	0.63	19.	0125	0.99	0.70
75	17	0.273	0.69	1.00	16	0.622	1.64	0.42	16	0.166	1.11	0.62
50	25	0.350	0.65	1.07	30	0.511	0.95	0.73	12	0.247	0.92	0.75
25	25	0.630	0.61	1.14	20	0.423	0.66	1.05	11	0.343	0.86	0.81
12.5	25	1.083	0.40	1.72	—	—	—	—	—	—	—	—

has a high turnover (k = 1.65, τ = 0.42 hours), while the other contains only about 3 % of the total sodium with a low turnover (k = 0.009, τ = 77 jours). The turnover of sodium in prawns and fish was practically the same as that calculated from the uptake equations (1).

The described results agree with those of PANNIKAR [1941], ROBERTSON [1957], LOCKWOOD [1962], POTTS & PARRY [1964] and others.

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