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EFFECTS OF SALINITY ON THE SURVIVAL OF THE *JAERA ALBIFRONS* Leach GROUP OF SPECIES (CRUSTACEA: ISOPODA)

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Abstract: Survival of the four British species of the *Jaera albifrons* Leach group has been investigated at various salinities at 17.5 and 8 °C. *J. ischiosetosa* Forsman is the most euryhaline species, showing survival for some days in distilled water. *J. albifrons* Leach is also able to live successfully in very dilute sea water but has a very poor survival rate in distilled water. Both *J. praehirsuta* Forsman and *J. forsmani* Bocquet have lower survival rates in dilute salinities than the other two species, with the latter being least tolerant of reduced salinity. These results together with field salinity and temperature observations suggest that differences in the toleration of reduced salinity are important factors which contribute to the ecological separation of the four species.

INTRODUCTION

The four species of *Jaera* which comprise the *Jaera albifrons* Leach group in Britain have been shown to have characteristic and persistent habitat preferences on an estuarine shore (Naylor & Haahtela, 1966; Jones & Naylor, 1971). Arising from these observations it has been suggested (Jones & Naylor, 1971) that salinity and temperature would be worthy of investigation as important ecological variables related to the specific microdistributions of each *Jaera* species.

Little is known concerning the physiology of the members of the *J. albifrons* group. Naylor & Slinn (1958), and Naylor, Slinn & Spooner (1961) have tested the survival of *J. albifrons sensu lato* in various salinities, and Sjöberg (1967) has investigated the survival, under various combinations of salinity and temperature, of two species of the *J. albifrons* group which range into the Baltic. One of the Baltic forms studied by the last author (*J. albifrons syei* Bocquet) does not occur in Britain and it seemed worthwhile to make a comparative study of the survival of all four British species in various combinations of salinity and temperature for comparison with other work on osmoregulation in the British forms (Jones, 1972a).

MATERIALS AND METHODS

The members of the *J. albifrons* group can be identified only on the secondary sex characters of the peraeopods of the males (Jones & Fordy, 1971; Naylor, 1972), the females being identical for all four species. To carry out the present study it was therefore necessary to make collections of animals from what were assumed to be

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species-pure populations, using the criteria and sampling stations described by Jones & Naylor (1971), but with one additional sampling site for *J. albifrons* at Pwll Du, Gower. *J. ischiosetosa* Forsman were collected from freshwater streams crossing the shore, *J. praehirsuta* Forsman were sorted from *Fucus serratus* L., *Jaera forsmani* Bocquet were searched for on stones in well drained areas at L.W.N.T., and *J. albifrons* Leach were collected from stones in pools at M.T.L. Salinity and temperature fluctuations during spring and neap tides were measured using a National Institute of Oceanography salinity–temperature bridge.

The animals were transported to the laboratory in water collected among the stones at the station or, in the case of *J. praehirsuta*, large polythene bags were filled with *Fucus serratus* on the shore and sorted in the laboratory. All material was placed in constant temperature rooms at 17.5 or 8 °C (±1 °C) for at least 24 h before the start of any experiment. The salinities used were 100 %, 50 %, 10 %, 1 % and 0 % sea water made by diluting double-filtered aquarium sea water with re-aerated distilled water. Ten animals were placed directly from the habitat water into 400 ml of each salinity in 1-litre crystallizing dishes, using washed habitat stones and washed *Fucus* as substrata. The dishes were left in continuous white light and checked daily over 9 days for survival. Following Sjöberg (1967) an animal was considered to be dead when the pleopods ceased to beat.

RESULTS

FIELD INVESTIGATIONS

Jaera ischiosetosa: For this species salinity and temperature fluctuations were recorded by placing the salinometer head in the stream flowing into the estuary during a summer spring tide at Black Tar, and a winter neap tide at Sandy Haven (Fig. 1, Station 1). These observations confirm that salinity changes are sudden and extensive in the *J. ischiosetosa* habitat and that in summer the temperature increase during the ebb may be extensive.

J. albifrons: The salinometer head was placed in a small rock-pool where this species was collected at M.T.L. at Pwll Du and records taken during low water of neap tides (Fig. 1, Station 2a) and high water of neap tides (Fig. 1, Station 2b). In this locality there was clearly little change in salinity and temperature during both tidal cycles. Other localities for *J. albifrons* may show more fluctuation since this species also occurs on shores with some surface freshwater run-off at low tide; it is a common species in estuaries (Naylor & Haahtela, 1966; Green, 1968; Jones & Naylor, 1971) and is a good osmoregulator (Jones, 1972a).

J. praehirsuta: Since the salinometer head has to be covered by water for recording it is difficult to record this variable among *Fucus serratus* where *Jaera praehirsuta* occurs: it seems likely that the algal fronds may prevent any marked salinity fluctuations by retaining sea water during the period of exposure.

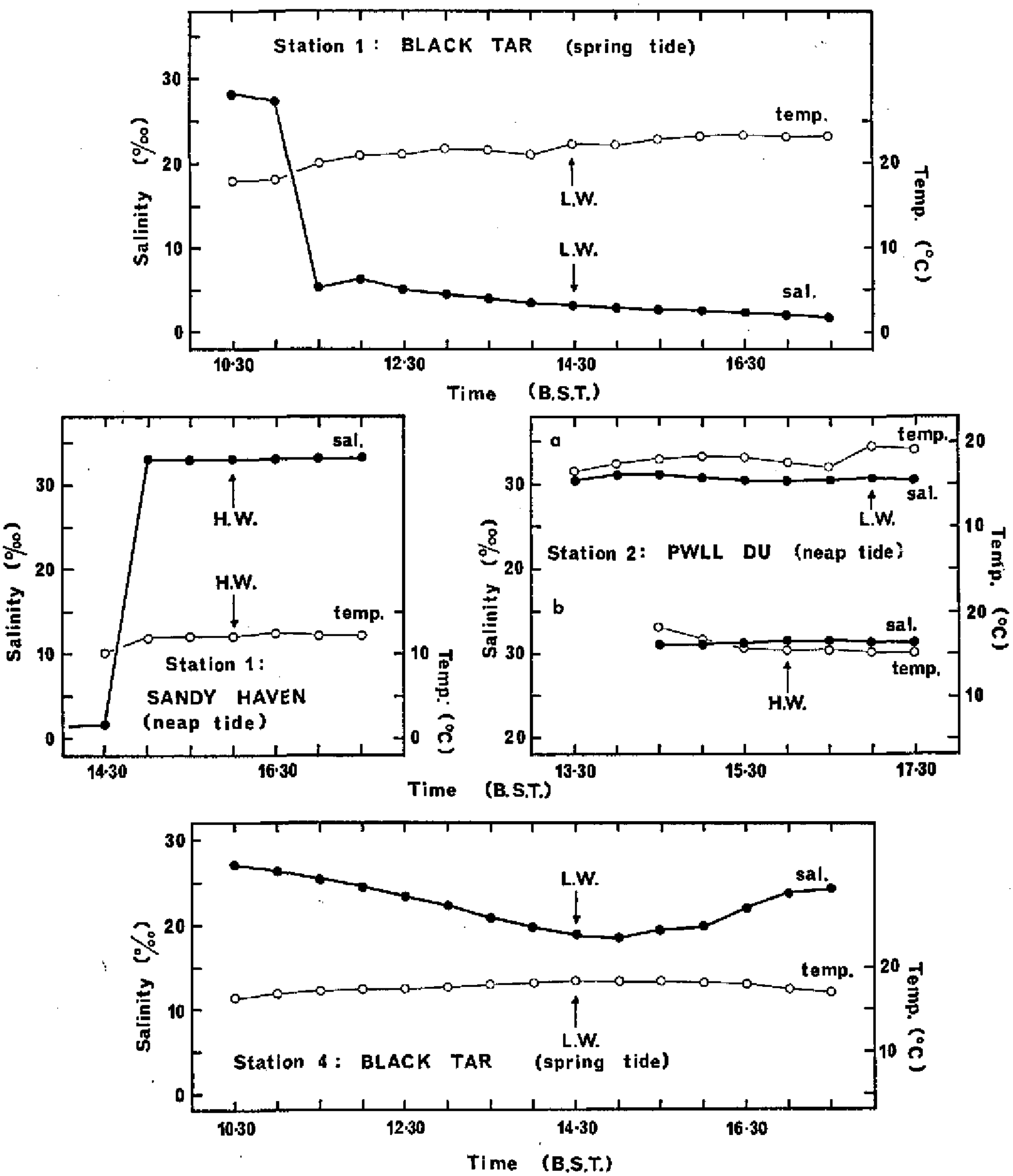

Fig. 1. Summary of the fluctuations of salinity and temperature recorded for the habitat of *Jaera ischiosetosa* (Station 1), *J. albifrons* (Station 2) and *J. forsmani* (Station 4).

J. forsmani: This species occurs on well-drained parts of estuarine shores and to record satisfactorily it was necessary to place the salinometer head in a small hollow scooped out at L.W.N.T. level at Black Tar. Here salinity dropped from ≈ 28.4 ‰

when observations began to 18.7 $^0/_{00}$ at low tide and rising to 24.9 $^0/_{00}$ when the recordings stopped on the flood tide (Fig. 1, Station 4). Salinity at low tide was atypically reduced in this locality owing to the fact that some freshwater run-off accumulated in the hole provided for the salinometer head. Normally the *Jaera* in this locality were not subjected to such run-off.

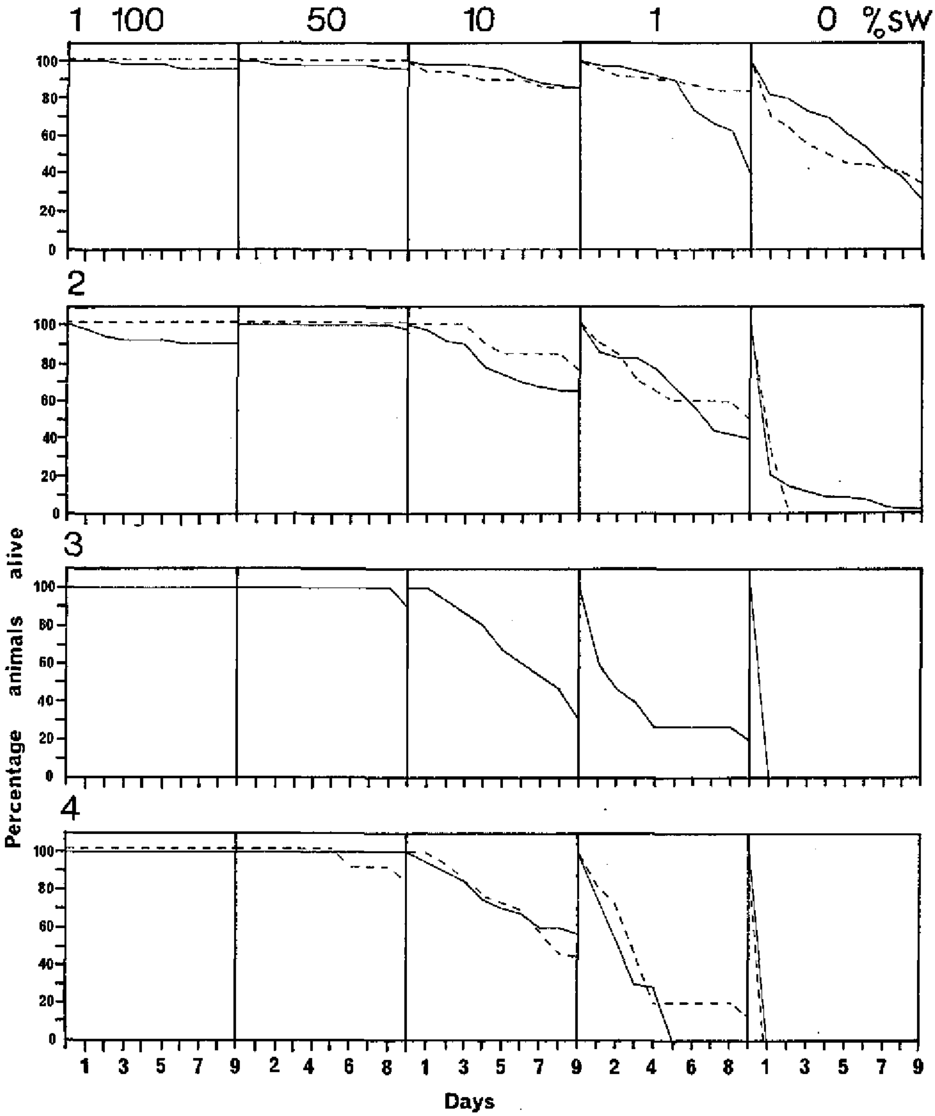

Fig. 2. Survival patterns for each *Jaera* species at 17.5 °C (solid line) and 8 °C (pecked line): 1) *J. ischiosetosa*, 2) *J. albifrons*, 3) *J. praehirsuta*, 4) *J. forsmani*.

Despite the limitations of the salinity recording procedure these observations demonstrate that the salinity changes experienced by *J. forsmani* and *J. albifrons* (and probably *J. praehirsuta*) are clearly much less than those experienced by *J. ischiosetosa*.

SURVIVAL EXPERIMENTS

All survival experiments were carried out on animals which were presumed to be feeding (see Jones, 1972b). The patterns of survival for the four *Jaera* species are shown in Fig. 2. Survival in 100 % and 50 % sea water was very similar for all four species at 17.5 and at 8 °C. Below 50 % sea water there were, however, differences which may be directly related to the ecological distribution of each species. Generally *J. ischiosetosa* (Fig. 2, 1) has the best survival with 26 % of the animals alive in distilled water after 9 days. *J. albifrons* (Fig. 2, 2) has good survival in 10 % and 1 % sea water but does not seem capable of any lengthy survival in distilled water. Survival of *J. praehirsuta* (Fig. 2, 3) and *J. forsmani* (Fig. 2, 4) were identical in 10 % sea water but the former species survived better in 1 % sea water. Both did not survive in distilled water.

Survival appeared to be slightly improved at 8 °C (Fig. 2) but not always consistently so. The difference in survival between the two temperatures is not as marked as that reported by Sjöberg (1967) who recorded better survival of *Jaera* at 5–7 °C as compared with that at 20 °C.

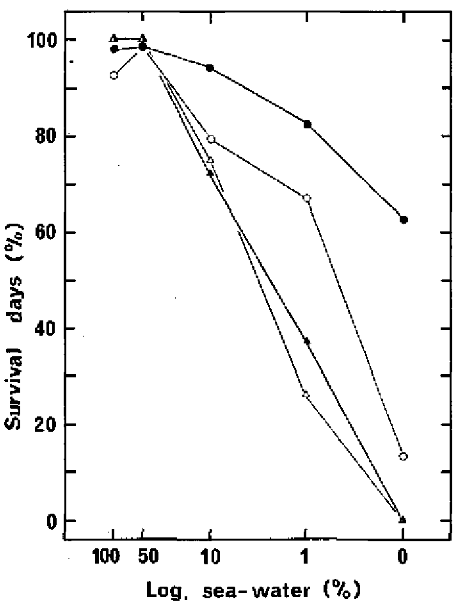

Fig. 3. Survival of *Jaera ischiosetosa* (●), *J albifrons* (○), *J. praehirsuta* (▲), and *J. forsmani* (△) at 17.5 °C: each point represents the mean of 5–6 experiments.

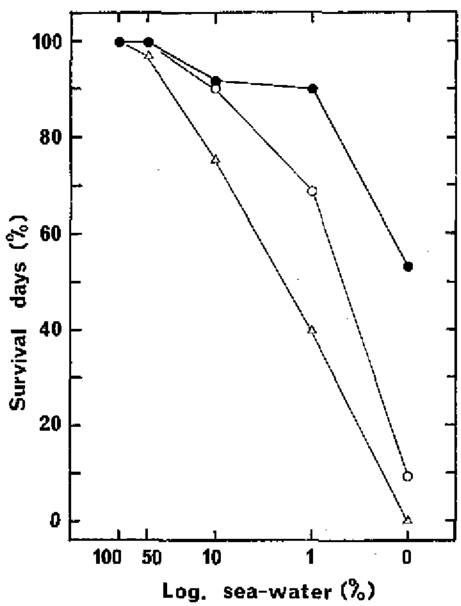

Fig. 4. Survival of *Jaera ischiosetosa* (●), *J. albifrons* (○), and *J. forsmani* (△) at 8 °C: each point represents the mean of 5–6 experiments.

The results of the survival experiments have been summarized in Figs 3 and 4. In this method of presentation survival has been expressed in 'percentage survival days': the values were derived by summing all the animals surviving each day of an experiment (Fig. 2) for a particular species in each salinity and temperature combination. Expressed in this way the results show clearly that *J. ischiosetosa* is the most euryhaline species in the *J. albifrons* group, followed by *J. albifrons*, while *J. praehirsuta* and *J. forsmani* are very similar and are less euryhaline than the other two *Jaera* species.

Discussion

The degree of euryhalinity shown by each member of the *J. albifrons* group suggest differences in their physiological characteristics which relate to their individual ecological distributions and their isolation on shores (Naylor & Haahtela, 1966; Sjöberg 1967, 1969, 1970; Jaždžewski, 1969; Jones & Naylor, 1971). The present field observations demonstrate marked salinity changes in the typical habitat for *J. ischiosetosa* (Fig. 1, Station 1), which is the most euryhaline species and which tolerates distilled water for a long period of time: from the survival experiments it seems clear that none of the other members of the *J. albifrons* group are capable of living in such a variable environment (Figs 2, 3, 4). The values obtained in the *J. albifrons*-type habitat show little fluctuation, but it should be emphasized that whereas these observations were made in a rock-pool on a marine shore, *J. albifrons* also lives successfully in estuaries and commonly occurs on areas affected by freshwater seepage. This is reflected in the results of the survival experiments which show that *J. albifrons* is able to withstand 1 % sea water for the duration of the experiment (Figs. 2, 3, 4) *J. praehirsuta* and *J. forsmani* occur in less variable habitats than the other two species although the latter is present in areas of a shore which dry out completely for short periods at low tide. Both *J. praehirsuta* and *J. forsmani* showed poor survival in distilled water, although the former species had a slightly better survival rate in 1 % sea water (Figs 2, 3).

Field observations and the present patterns of survival at different salinities combine to suggest, therefore, that differing degrees of tolerance of reduced or fluctuating salinity separate the *Jaera* species on shores where all four species occur together.

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