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The osmotic and ionic regulation of *Branchinecta gaini* Daday

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Introduction

The anostracan crustacean, *Branchinecta gaini*, has been recorded from freshwater lakes and pools in many places in the Antarctic and from the southern tip of South America. On Signy Island, in the South Orkneys group, the animal occurs in two rather different types of habitat. It is found in large, relatively deep lakes and also in small, shallow pools on a rocky headland. The latter are occasionally influenced by salt spray from the sea. The seasonal chemical changes in one of the large lakes and the ecology of *Branchinecta* and other crustaceans in it have been studied in detail by Heywood (1967). A similar study on the smaller pools has been made by Goodman (unpublished).

The Anostraca are rather primitive crustaceans and have almost no defence against predation. They have managed to survive as a group by colonizing habitats free of predators. To do this they have produced many unusual adaptations. Although the group is predominantly a freshwater one, some species have colonized inland saline areas, the most notable of these being *Artemia salina* (L.) which can survive in media ranging from 10 to 600% sea water. The osmotic regulation of *Artemia* has been studied in detail by Croghan (1958 *a–e*). The only other work on an anostracan was by Panikkar (1941) working on *Chirocephalus diaphanus* Prévost, an animal found in temporary freshwater pools. On Signy Island and in other Antarctic localities *Branchinecta* has been able to survive by virtue of the fact that its most obvious predators, freshwater fishes, have been unable to reach these habitats.

The osmotic and ionic regulation of *Branchinecta* was studied at Signy Island during the Antarctic summer of 1965–66. This paper contains the results of this work.

Methods

Branchinecta was collected on Signy Island from a large lake and from a small pool influenced by salt spray. Although there are of course seasonal fluctuations in ion concentrations, an average value for the sodium concentration of the lake water may be taken as 35 mgNa/l. (Heywood 1967). For the small pool an average concentration would be 150 mgNa/l. (Goodman, personal communication). The water in both the lake and the pool may be defined as fresh water using the classification devised by the Venice symposium in 1958.

Haemolymph samples were collected from *Branchinecta* by puncturing the dorsal surface of the animal with a fine glass pipette. The haemolymph flowed readily into the pipette. and was then blown out under liquid paraffin in a siliconed watch-glass.

Osmotic pressure determinations on the haemolymph were made using the cryoscopic method of Ramsay & Brown (1955). Osmotic pressure is expressed in terms of the concentration of NaCl (in m moles/l.) having the same freezing-point depression. The sodium concentration was measured by flame photometry and chloride by the first method of Ramsay, Brown & Croghan (1955).

The animals were used on the day that they were collected and enough haemolymph could be collected from one animal for all three analyses.

The permeable areas of the cuticle of *Branchinecta* were localized by means of a silver-staining method that was essentially the same as that used by Croghan (1958*c*) in work on *Artemia*. The living animals were washed in a stream of deionized water to remove adherent chloride and then placed in dilute silver nitrate for several minutes. They were then washed again in deionized water to remove any adherent silver nitrate and put into photographic developer. This reduced any silver that had been taken up to black metallic silver. The principle of this technique is that silver ions will diffuse into the permeable areas of the cuticle, meet chloride ions from the animal and precipitate as silver chloride. This precipitate is developed to metallic silver.

Results

The haemolymph concentrations measured are shown in table 30. All the values are expressed as mmoles/l. NaCl. These results are almost the same as the published values for *Chirocephalus* (Panikkar 1941; Croghan 1958*b*). These are (mean values all expressed as m moles NaCl/l.) osmotic pressure, 73; sodium, 62; chloride, 51.

Table 30. The haemolymph concentration of *Branchinecta gaini*

(mmole/l. NaCl)

osmotic pressure	sodium	chloride
$82 \pm 3{\cdot}1$	$75 \pm 2{\cdot}8$	$63 \pm 4{\cdot}2$
$n = 17$	$n = 30$	$n = 23$

Mean ± standard error. n = number of observations

The cuticle of *Branchinecta* is appreciably permeable and when put into deionized water the animals quickly lose ions and die in a few hours. The permeable areas of the cuticle were demonstrated by silver-staining. The areas that stain on *Branchinecta* are the dorsal organ on the head, the branchiae, and the metepipodites of the first ten pairs of thoracic limbs. There are eleven pairs of thoracic limbs but the branchiae of the last pair do not stain. The dorsal organ is seen in all anostracans from the earliest naupliar stages and it is clear that it is the site of respiratory gas exchange and ion transport in the larval animal before the thoracic limbs develop.

The permeable areas of *Branchinecta* are exactly the same as in *Chirocephalus* and *Artemia* (Panikkar 1941; Croghan 1958*c*) except for one minor detail. In the adult *Artemia* the dorsal organ degenerates and there is no silver-staining patch on the head.

Discussion

As might be expected of an animal belonging to a group that is almost exclusively found in fresh water, *Branchinecta gaini* shows no physiological traces of a marine or brackish water ancestry. The Antarctic environments in which it is found have only been open to it for the last 10 000 years. This means that *Branchinecta* has colonized these areas from other freshwater habitats, presumably being distributed in the egg stage.

In conclusion it may be said that *Branchinecta* may be considered as a typical freshwater crustacean with reference to its osmoregulation and shows no special adaptations in this respect that might be related to its Antarctic environment.

Summary

1. The osmotic and ionic concentrations of the haemolymph of the anostracan *Branchinecta gaini* have been measured.

2. The permeable areas of the cuticle have been demonstrated.

3. The osmotic regulation of *Branchinecta* is that of a typical freshwater crustacean and shows no unusual features.

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