Comparing test systems to measure the salinity tolerance of freshwater invertebrates

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Abstract

There have recently been several studies into acute salinity tolerance of freshwater invertebrates using different methods, making comparisons between studies difficult. The alternatives focus on experimental flow regimes and ionic proportions. In this study non-rheophilic riverine taxa collected in South Africa and south-east Australia were variously exposed to solutions of sodium chloride (NaCl) and the artificial sea salt, Ocean Nature, in flowing and still water. South African species: *Euthraulus elegans* (Ephemeroptera: Leptophlebiidae), *Micronecta piccanina* (Hemiptera: Corixidae), *Burnupia stenochorias* (Gastropoda: Ancylidae) and *Caridina nilotica* (Decapoda: Atyidae); Australian collected species: *Daphnia carinata* (Cladocera: Daphniidae), *Micronecta annae* and *Physa acuta* (Gastropoda: Physidae). The main findings were:

- The salinity tolerances of a range of taxa were not affected by flow regimes
- Taxa were less sensitive to the artificial sea salt than NaCl
- There was, however, a direct relationship between the LC_{50} values from both salts. This relationship was used to compare the LC_{50} values from studies testing (artificial or natural) sea-water or NaCl.
- The comparison indicated variation in the mean LC_{50} between studies that is probably, at least in part, due to the range of taxonomic groups and rarities of species tested.

When comparing the acute salinity tolerance of non-rheophilic invertebrates, the salt source and criteria for choosing species affect the results, but the flow environment probably does not.

Keywords: stream invertebrates, acute salinity tolerance, test system

Introduction

Salinity in rivers and wetlands is increasing in many arid and semi-arid regions of the world including Southern Africa and Australia (Williams, 1987). There is considerable uncertainty about the effect of this increase on aquatic biota and detailed investigations of salinity tolerance are needed (Hart et al., 1991; Clunie et al., 2002). A number of studies have used a variety of different methods to investigate the acute salinity tolerance of macroinvertebrates making comparisons difficult.

A variety of different salt sources and experimental systems have been used in laboratory salinity tolerance experiments. In both Australia (Kefford et al., 2003; 2004) and South Africa (Kefford, 2002) non-flowing water has been used as a simplified and standardised system for rapidly testing many species. Other studies in South Africa, Palmer et al. (1996), Goetsch and Palmer (1997), Palmer and Rossouw (2000) and Palmer and Scherman (2000), have used a flowing environment to mimic a natural stream. Kefford et al. (2003, 2004) used artificial sea-water because in Australia most inland waters have ionic proportions similar to sea-water (Bayly and Williams, 1973: 1; Williams and Buckney, 1976a; b; Herczeg et al., 2001). Palmer and co-workers used sodium chloride (NaCl) and sodium sulphate (Na_2SO_4) because most agriculture-induced salinisation in South Africa is NaCl dominated and most saline industrial and mine effluents are SO_4^{2-} dominated (Dallas and Day, 1993). Other studies have also used NaCl (Clemens and Jones, 1954; Williams et al., 1999; Blasius and Merritt, 2002) or sea-water (Shirgur and Kewalramani, 1977; Mills and Geddes, 1980; Williams, 1984; Williams and Williams 1998) to investigate the salt tolerance of freshwater macroinvertebrates. Although Na^+ and Cl^- are the most common ions in sea-water, the presence of other ions may result in differences in the tolerance of macroinvertebrates to NaCl and (natural or artificial) sea-water. For example, *Daphnia magna* 48 h LC_{50} values for various salts ranged from 0.63 to 7.98 g/ℓ for various salts (Mount et al., 1997). Direct comparisons between studies using different salts are therefore difficult.

There are also differences in the criteria for choosing species to investigate. Palmer and co-workers chose one to six species per publication, sometimes considering the same species collected from different locations in different publications, and only included species collectable in high numbers. They mostly tested Ephemeroptera but tested fewer species of Trichoptera and Gastropoda. Ephemeroptera, especially Baetidae, are salt-sensitive compared with other macroinvertebrates (Clemens and Jones, 1954; Hart et al., 1991; Short et al., 1991; Williams and Williams, 1998; Kefford et al., 2003). The tolerances of species from this order are therefore unlikely to reflect the salinity tolerance of most members of natural communities (see Forbes and Calow, 2002). Kefford (2002) and Kefford et al. (2003) attempted to select species from orders in approximate proportion to which the orders were found in the locality where they were collecting macroinvertebrates. This resulted in a relatively large number of taxa (49 and 57, respectively) from many higher taxonomic groups (9 and 16 orders, respectively),

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