Can benthic invertebrates be used to predict impacts in streams with acid mine inputs?

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Benthic invertebrates are widely used as indicators of stream health. The real advantage of using these small animals is that they live permanently in streams and rivers, and therefore act as sentinels of long-term water quality conditions. Unlike water chemistry conditions invertebrate communities don't change radically unless they are subjected to some major disturbance.

We have about 670 described aquatic invertebrate species in New Zealand and almost all of these are endemic. Among these large numbers of species there is wide variation in tolerances to pollution. Thus benthic invertebrates have been successfully used to detect a number of differing types of pollution, particularly agricultural. However, acid mine drainage conditions on the West Coast of the South Island present a number of challenges to using invertebrates as pollution indicators. Firstly, many streams on the West Coast are naturally low in pH. Natural fluvic and humic acids generated by leaching from the temperate podocarp rainforest can result in pH down to about 4. Our research has indicated that a number of species may have adapted to these pH levels. Furthermore, some invertebrates groups which are widely used as indicators of pollution (e.g. stoneflies) have been shown to be remarkably tolerant of elevated dissolved heavy metals (Fig. 1). As a result, groups which are commonly recognized as pollution intolerant taxa elsewhere in New Zealand can be poor pollution indicators on the West Coast. Conversely, other groups which are generally recognized as pollution tolerant elsewhere (e.g. snails) are in fact very sensitive to low pH.

In this précis we present data from on-going studies of benthic invertebrate communities in 60 streams near Reefton, Greymouth, Denniston and Stockton many of which receive acid mine drainage (AMD).

Fig. 1 *The stonefly* Austroperla cyrene *coated in iron hydroxide precipitate.*

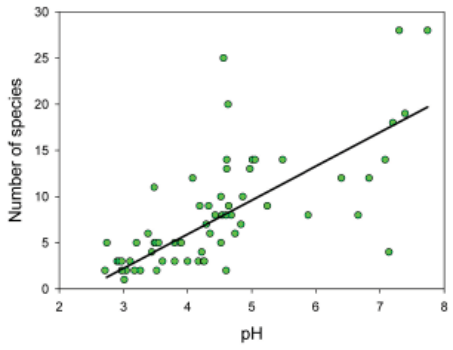


Fig. 2 *Number of benthic invertebrate taxa at differing pH. When pH is below 4 taxonomic richness decreases markedly*

Benthic invertebrate diversity can be strongly influenced by pH, when pH is <4 few taxa are generally present (Fig. 2), but as pH increases more taxa are likely to be present in a stream. Several taxa seem to be able to tolerate mine discharges including, the stoneflies *Spaniocercoides* and *Austroperla*, the caddisflies *Psilochorema* and *Oxyethira* as well as the orthoclad chironomids and scirtid beetles (Fig 3, 4).

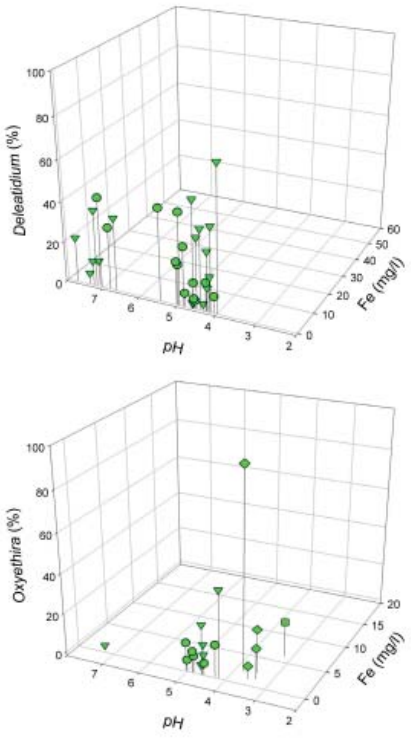


Fig. 3. *Common benthic invertebrate taxa can have quiet variable tolerances to pH and metals. The common New Zealand mayfly* Deleatidium *is generally absent from streams with pH < 4.5, while the caddisfly* Oxyethira *can tolerate low pH and elevated dissolved Fe concentrations.*

Unlike other types of pollution mayflies, stoneflies and caddisflies (EPT or Ephemeroptera, Plecoptera, and Trichoptera) are not necessarily good indicators of mine impacts (Fig. 5). In general, mayflies are almost entirely absent from streams with pH <4.5 and dissolved metals >2 mg/l (Fig. 5). Similarly, other indices, such as the MCI (Macroinvertebrate Community Index) don't always work in AMD streams (Fig. 6).

How can invertebrates be used to measure impacts in AMD?

As a number of traditional indices are not good indicators of mine impacts we are in the process of developing alternative techniques. In the mean time, using diversity (taxonomic richness) and % mayflies do give some indication of likely degree of AMD impacts.

Fig. 4. *Secreted tunnels produced by non-biting midges (Chironomids) which can be abundant in some AMD streams.*

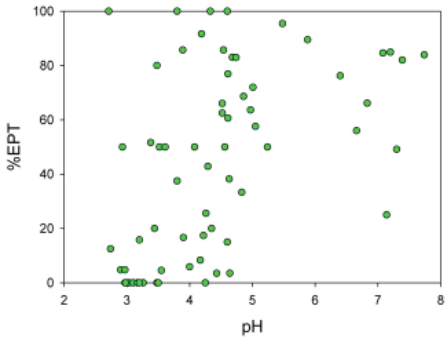
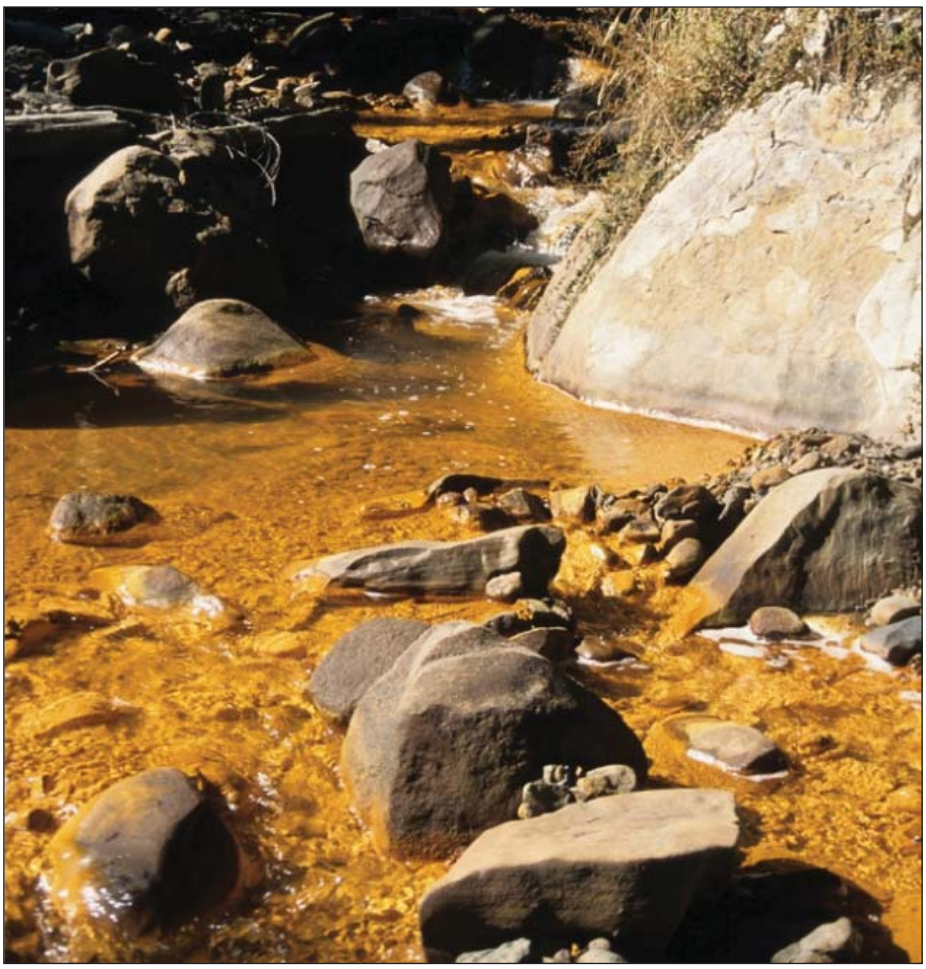


Fig. 5 *Comparison of %EPT in differing pH streams showing that EPT are poor indicators of acid mine impacts.*



A stream near Reefton with low pH (approx 3.5) and iron hydroxide percepitate. This stream had < 4 benthic invertebrate taxa present.

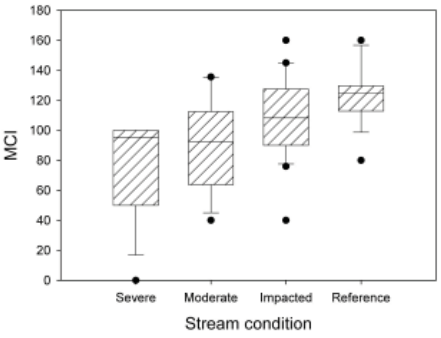


Fig. 6 *The Macroinvertebrate Community Index (MCI) which is commonly used as an indicator of pollution in agricultural areas does not always work in acid mine drainage streams. The MCI is based in tolerance scores of individual taxa, and as many taxa have differing tolerances to pH and metals the MCI can give false scores when used to assess AMD (Severe sites have pH < 4 and metals > 2mg/l).*

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