AN ASSESSMENT OF THE USE OF *BACILLARIOPHYCEAE* AS BIOLOGICAL MONITORS OF HEAVY METAL POLLUTION IN AUSTRALIAN TROPICAL STREAMS

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ABSTRACT

During the recessional flow period of 2004, benthic diatoms were sampled from four catchments in the tropics of the Northern Territory of Australia. Each of the catchments showed evidence of acid mine drainage. Diatoms were used in conjunction with physical and chemical water parameters to provide a biomonitoring approach with the ultimate goal to assess the water quality of the mine impacted catchments. A total of 267 species of diatoms from 45 genera were recorded from 50 sites in the Northern Territory.

One of the primary aims of this study was to assess diatom classification techniques, morphological and genetic, for the accurate identification of the morphologically variable taxon, *Nitzschia palea*. A second primary aim was to determine the degree to which diatom taxa and community structures can be effectively used as biological indicators and monitors of heavy metal pollution in tropical aquatic environments. To address the lack of diatom floristic studies from the Northern Territory, an iconograph of the most abundant taxa was created.

Forty eight *Nitzschia palea*-like cells were cultured and then grouped by hierarchical cluster analysis (Ward's method). The reliability of the groups was tested with discriminant analysis. The morphological groups were compared to the phylogenetic grouping of 20 of the cultures which were each genetically sequenced using the nuclear-encoded small subunit rDNA. For monitoring studies, multivariate statistical techniques were used to produce models to infer environmental variables from diatom distributions. The three datasets used varied in terms of the level of taxonomic identification and the inclusion of bioavailable or total metal concentrations. The program AquaRisk was employed to determine the bioavailable concentrations of the heavy metals. Each dataset was related to water quality parameters using canonical correspondence analysis. The Simpson's index and the Shannon-Wiener diversity index were statistically related, together with species richness, to the variables pH and copper through bivariate regression analysis. To determine the usefulness of individual diatom taxa as indicators, species were selected based on their occurrence, weighted average optima and tolerance values, and species response curves. Additionally, teratogenic frustules were statistically correlated with environmental variables by bivariate and linear regression.

Although the *Nitzschia palea*-like cultures displayed morphological variation, which could be used separate the cultures into five distinct groups, the cultures were not found to be genetically variable. However, one new species, *Nitzschia* sp. 39, was defined genetically and described morphologically. As with other analyses of mine impacts, canonical correspondence analysis identified pH and aluminium as the principal environmental factors structuring the diatom communities. The calibration set models generated to infer pH and heavy metals had high predicative capabilities. Overall, the species dataset, rather than the datasets utilising genus level identification or bioavailable metal fractions, provided the statistically strongest results. Monitoring using diversity indices was less successful for indicating pollution. Contrary to findings from other studies, species richness tended to be higher in polluted waters than control sites. Unlike other studies of acidic environments, the species C*hamaepinnularia mediocris*, *Naviculadicta subtilissima*, *Nitzschia vasta* and *Pinnularia schoenfelderi* were found to be the best indicators. *Nitzschia vasta* was the only teratogenic diatom within the dataset. However, as with other analyses, the relationship between teratogenic valves and mine impact was not significant.

This study demonstrates the continued need for research in the tropics in order to better understand biological responses and enable study comparisons. Although at least one new

species was identified, the genetic research indicated that taxonomic texts produced for northern hemisphere regions can be applied to tropical diatom taxa as long as the risk of taxonomic force fitting is avoided. Additionally, the benefit of diatoms as biological monitors varies depending on the method utilised. In these highly impacted systems, transfer functions produced the strongest results. In contrast, it is evident that the abundance and distribution of teratological forms of diatoms are poor indicators of impact. Further work culturing diatoms and combining this technique with ecotoxicological work will help verify autecologies of taxa and their responses to co-varying pollutants. This will strengthen use of diatom taxa as indicator species. Continued monitoring of these sites can add much to our ecological understanding of these highly impacted systems which, in turn, will lead to better management of the systems for both sustainable resource development and conservation.

THESIS DECLARATION

This work contains no material which has been accepted for the award of any other degree or diploma in any university or other tertiary institution and, to the best of my knowledge and belief, contains no material previously published or written by another person, except where due reference has been made in the text.

I give consent to this copy of my thesis, when deposited in the University Library, being made available in all forms of media, now or hereafter known.

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