

**The ecology of free-living nematodes  
in nearshore marine and estuarine sediments  
of the microtidal lower west coast of Australia.**

Submitted by

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It has been a long and bumpy road my friends, but it's time to turn from the past with the lessons we have learnt and look to the future with our new-found knowledge.



## Quotes of note

*"We must not recoil with childish aversion from the examination of the humbler animals. In every realm of nature there is something marvellous."*

-Aristotle-

*"Those who truly love small life are deep lovers of mother nature."*

-Takashi Amano-

*"Sometimes a scream is better than a thesis."*

-Ralph Waldo Emerson-



# Declaration

I declare that this thesis is my own account of my research and contains as its main content work which has not previously been submitted for a degree at any tertiary education institution.

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Mathew Hourston



## Abstract

The overarching aim of this thesis was to describe the ecology of the assemblages of free-living nematodes in the sediments of nearshore marine and estuarine waters on the microtidal lower west coast of Australia. The thesis also provides descriptions of ten previously undescribed species as well as develops and tests a habitat classification scheme for the Swan River Estuary using these biotic assemblages.

The first section of my thesis has determined the ways in which the characteristics of the nematode assemblages in nearshore marine waters along the microtidal lower west coast of Australia are related to habitat type, time of year and shore-perpendicular zones. Three habitat types, which had previously been identified on the basis of a suite of enduring environmental characteristics, could be broadly described as highly sheltered from wave activity and containing dense seagrass (habitat type 1), moderately sheltered from wave activity and with sparse seagrass (habitat type 2) and relatively exposed to wave activity and with no seagrass (habitat type 6). Sampling in five consecutive seasons yielded > 15 000 nematodes, representing 75 species. The number of species and densities in habitat type 1, and particularly those in its subtidal zone, were far greater than those in the other two habitat types. Both of these biotic variables underwent marked seasonal changes, declining to low levels during winter. The compositions of the assemblages differed significantly among the three habitat types, with the differences between habitat types 1 and 6 being particularly marked.

*Paracomesoma siphon*, *Dichromadora* sp., *Marylynnia annae* and *Pomponema* sp., which, on the basis of their buccal cavity morphology, are assumed to feed primarily on benthic diatoms, were particularly abundant at the most sheltered habitat type, whereas *Gonionchus australis*, *Theristus* sp. and *Bathylaimus australis*, which are assumed to be deposit feeders, were relatively abundant at the most highly exposed habitat type. The

compositions of the assemblages differed among seasons and were most discrete in spring, due to marked increases in the densities of certain species. However, differences in the compositions in the different zones of each habitat type were relatively small, presumably reflecting the influence of the small tidal regime of this region.

The second component of this thesis has determined the ways in which the density, number of species, species composition and trophic structure of free-living nematode assemblages in the subtidal waters of a large microtidal estuary change spatially and temporally, and has explored whether those four biotic characteristics are related to certain environmental factors. Based on data derived from samples collected seasonally at 12 sites throughout the estuary, the densities and number of species of nematodes decreased progressively with distance from estuary mouth, to reach a minimum at sites where salinities were most variable, and then increased slightly in the uppermost part of the estuary where salinities were least. Densities were also generally greatest in spring, due largely to increases in the abundance of epistrate-grazing species at the time when the amount of primary food (microphytobenthos) peaked. The spatial distribution of the composition of the nematode assemblages was closely correlated with salinity and, to a lesser extent, grain-size composition and amount of particulate organic material in the sediment (%POM). Although species composition changed sequentially along the estuary, the change was particularly pronounced between sites above and below the area where salinities started to decline markedly and become more variable and %POM increased markedly. This reflected, in particular, far greater abundances of *Spirinia parasitifera* at the six downstream sites, and of *Theristus* sp. 1 at the six sites further upstream. Species composition underwent pronounced seasonal cyclical changes at all sites, presumably reflecting interspecific differences in the timing of peak reproduction and thus of recruitment. The trophic structure of the nematode assemblages changed both spatially and temporally in relation to the relative abundance of different food

sources. Thus, for example, non-selective deposit feeders, such as *Theristus* sp. 1, dominated samples in the upper estuary, where %POM was by far the greatest, and was rare or absent at downstream sites. Conversely, epistrate grazers, such as species of the Chromadoridae, were most abundant at downstream sites in spring, when the density of the microphytobenthos reached its maximum.

The data for the nematode assemblages in nearshore subtidal marine sediments of the lower west coast of Australia were compared with those in nearshore subtidal sediments in the upper and lower regions of the Swan River Estuary. The densities and average species richness in cores from the marine environment were much lower than in cores from both estuarine regions. However, the total number of species found in the marine environment was much greater than in the estuary. The compositions of the nematode assemblages were more variable in marine than estuarine sediments. The assemblages from the two estuarine regions were far more similar to each other than to those from the marine region at a species level, and also, but to a lesser extent, at the generic and family levels.

While the trophic compositions of the nematode assemblages in the upper estuarine region was dominated by non-selective deposit feeding species and those of the lower estuarine region were dominated by epistrate grazing species during spring and non-selective deposit feeding species in other seasons, the dominant functional feeding groups varied among the sites representing the marine region. That variability presumably reflects differences in the relative contributions of the different potential food sources. Surprisingly, the trophic composition in the upper estuarine region, *i.e.* comprising predominantly non-selective deposit feeders, was similar to that at the very different environment of the most exposed marine site. The dominance of this feeding group at the marine site is assumed to be attributable to the fact that the only food source of any note is POM and, even then, it occurs in only small amounts.

Taxonomic descriptions have been produced for ten new species of nematodes found during the ecological studies of the free-living aquatic nematofaunas of south-western Australia. These species were chosen because they were members of families for which the other species had been described and, in a number of cases, were important for distinguishing between the compositions of *a priori* groups. They comprised four species of Axonolaimidae, representing the genera *Ascolaimus*, *Parascolaimus*, *Odontophora* and *Parodontophora*, and six species of Desmodoridae, representing single species of *Bolbonema*, *Eubostrichus*, *Catanema* and *Leptonemella* and two species of *Onyx*.

As a complement to the nematological study of the Swan River Estuary, a novel habitat classification system was developed and then applied in this environment. This system was based on enduring environmental characteristics and employed the relatively new multivariate statistical routines SIMPROF and LINKTREE. The applicability of habitat types produced by this classification system to biotic assemblages was tested using the data for the estuarine nematode assemblages described above. The results demonstrate that the compositions of the assemblages differed significantly among each of the habitat types defined by the classification system. While there were also significant differences between the compositions of the nematofaunas at sites belonging to the same habitat type, the extent of these differences were generally less than those between habitat types. A significant and strong correlation was also found between the spatial pattern exhibited by the environmental characteristics used to define habitat types, and that of the nematofauna.

## Publication list

The contents of Chapters 2 and 3 are published as peer-reviewed journal articles, the references for which are listed below. Additionally, publications detailing the habitat classification procedure and the taxonomic descriptions contained in Chapters 4 and 5, respectively, are currently in press. Chapter 6 is currently being prepared for publication.

### Chapter 2

Hourston, M., Warwick, R. M., Valesini, F. J. & Potter, I. C. (2005) To what extent are the characteristics of nematode assemblages in nearshore sediments on the west Australian coast related to habitat type, season and zone? *Estuarine, Coastal and Shelf Science*. **64**:601-612.

### Chapter 3

Hourston, M., Potter, I. C., Warwick, R. M., Valesini, F. J. & Clarke, K. R. (2009) Spatial and seasonal variations in the ecological characteristics of the free-living nematode assemblages in a large microtidal estuary. *Estuarine, Coastal and Shelf Science*. **82**:309-322.

### Chapter 4

Valesini, F.J., Hourston, M. Wildsmith, M.J., Coen N.J. & Potter, I.C. (in press) New quantitative approaches for classifying and predicting local-scale habitats in estuaries. *Estuarine, Coastal and Shelf Science*.

### Chapter 5

Hourston, M. & Warwick, R.M. (in press) New species of free-living aquatic nematodes from south-western Australia (Nematoda: Axonolaimidae and Desmodoridae) *Records of the Western Australian Museum*.

### Chapter 6

Hourston, M., Warwick, R.M., Potter, I.C.P., & Valesini, F.J. (in prep) Comparisons between nematode assemblages of nearshore marine and estuarine environments of south-western Australia: The importance of taxonomic resolution

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- Figure 6.1** Mean values for (a) number of nematode species and (b) density in each region in each season. For the sake of clarity the overall mean

± 95 % confidence interval for each variable is shown to the right of its respective plot.

**Figure 6.2** Two-dimensional nMDS ordinations of the mean densities of the various nematode taxa at each site in each season in marine and estuarine sediments, coded for region. The nematode taxa were represented by the species, genus, family and FFG levels on plots (a), (c), (e), and (g), respectively. Ordinations based on standardised data, representing species, genus and family taxonomic levels are shown in (b), (d), and (f), respectively. (h) PCA plot constructed from the standardised densities of the four FFGs, coded for season, and in the case of marine samples, site.

**Figure 6.3** Two-dimensional nMDS ordination of the similarity matrix constructed from the mean densities of the various nematode species at sites 1-12 in the Swan River Estuary in each season between summer 2004/5 and spring 2005, coded for habitat type.