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# Retrospective analysis of zooplankton community structure in the Benguela current large marine ecosystem

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## Project description

The overall objective of the project was to quantify changes in zooplankton abundance and community structure in the northern Benguela over the past 50 years, for comparison and integration with information on long-term changes in zooplankton abundance and community structure in the southern Benguela. The project was motivated by the need for baseline information on natural and anthropogenically forced changes in the Benguela ecosystem as a whole, which is a pre-requisite for ecosystem management.

The project started as a BENEFIT project, with a retrospective analysis of a small subset of the SWAPELS (South West Africa Pelagic Egg and Larvae Survey) zooplankton sample archive from the 1970s and 1980s by two post-graduate students (T. Mainoane and S. Tsotsobe). In 2004 the project was taken over by the BCLME Programme and expanded to include the full SWAPELS collection and more recent data collected on the NatMIRC monitoring line off Walvis Bay. BENEFIT continued to support the project, specifically through partial funding of a regional training workshop on zooplankton taxonomy and identification, and of a PhD student involved in the study.

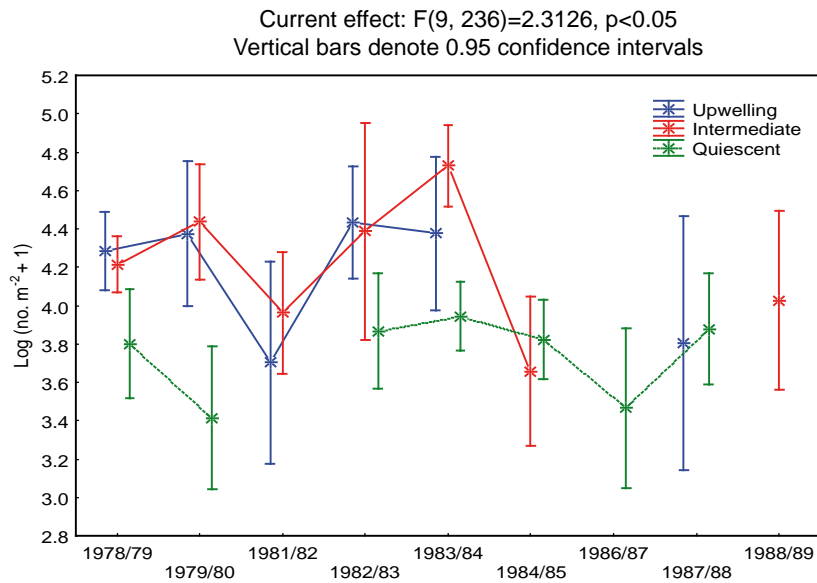
The bulk of the work comprised the curation and cataloguing of some 15000 zooplankton samples from the SWAPELS surveys, and the retrospective analysis of a representative subset of about 800 samples from this collection to quantify the abundance and describe the community structure of zooplankton in the northern Benguela during this period. Zooplankton samples routinely collected on the NatMIRC monitoring line since 2000 were analysed in the same way to provide an inter-decadal comparison for the Walvis Bay region, on which the SWAPELS analysis was initially focused.

A full-time sample curator and part-time sample analyst were engaged through the project, with initial financial assistance from the ENVIFISH and VIBES/IDYLE Programmes, in recognition of the collection's scientific value. The data management was contracted to the International Ocean Institute, University of the Western Cape, who were responsible for constructing a Benguela Plankton Portal to meet the BCLME's requirements for a comprehensive inventory of plankton metadata in the ecosystem. In addition, studentships were awarded to a PhD student (Fabienne Cazassus), and to a BSc Hons/ MSc student (Ignatius Kauvee) to work within the project. The training workshop was co-funded by BENEFIT and the Alfred P. Sloan Foundation through the Census of Marine Life (Zooplankton) Programme.

## Achievements

The achievements of the project have been reported in detail to the BCLME in the final report of BCLME Project EV/PROVARE/02/05, prepared by Hans Verheye and submitted in June 2007, from which the summary below has been compiled.

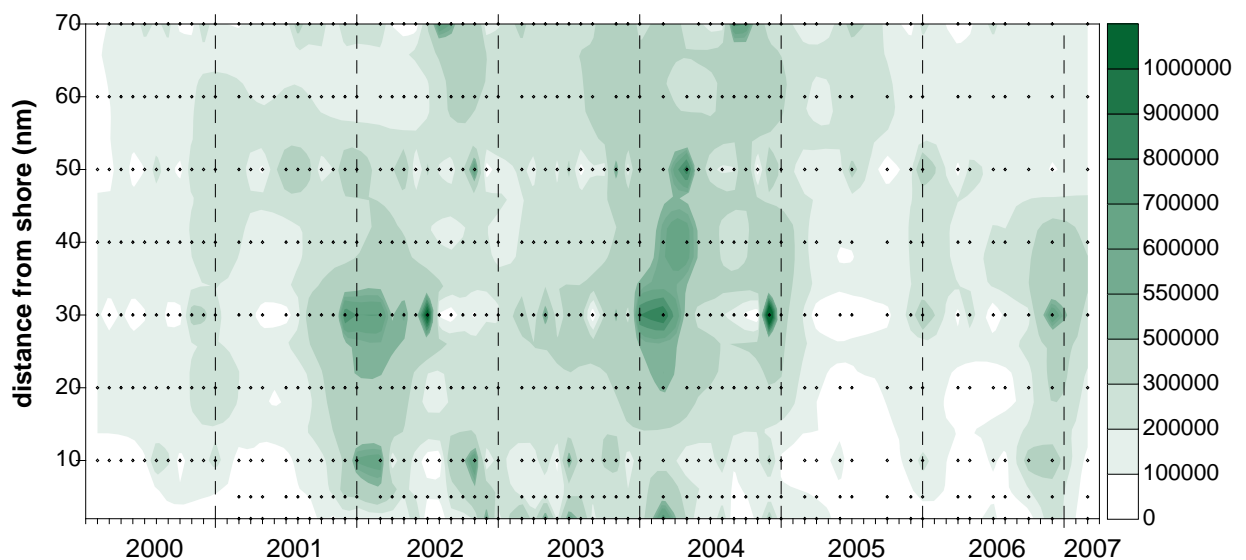
A major achievement has been the capture of zooplankton data from the enormous number (approximately 20000) of samples collected during the SWAPELS surveys, from which hitherto only the ichthyoplankton had been extracted and analysed. This has allowed inter-decadal changes in zooplankton abundance, distribution and community structure in the northern Benguela to be described for the first time, and to be compared with corresponding long-term changes in the zooplankton of the southern Benguela, thus providing an integrated overview of changes in zooplankton in the entire Benguela ecosystem over half a century. Some of the major features are summarised below.



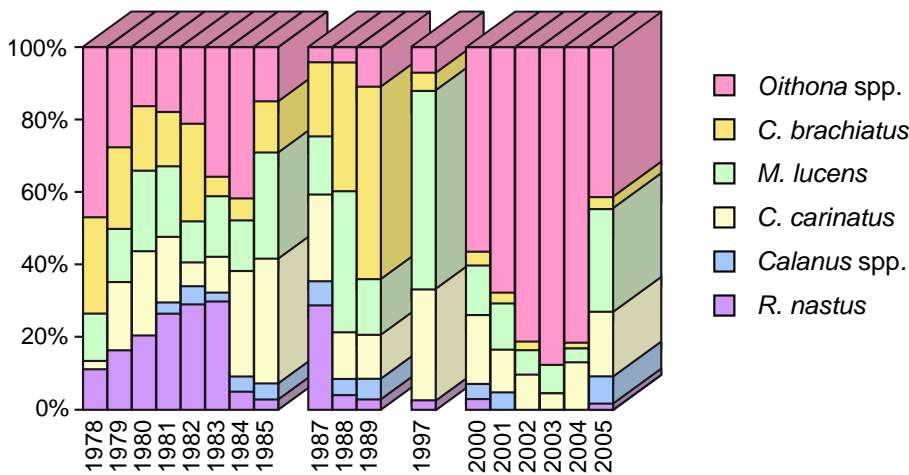
**Figure 1. Year and season effect on copepod abundance during the SWAPELS period from a GLM. The year runs from 1 July of one year to 30 June the next.**

During the SWAPELS period copepod abundance was consistently higher during the upwelling (August-October) and intermediate (November-January) seasons than during the quiescent (February-April) season, with maxima and minima in 1983/84 and 1984/1985 respectively (Fig. 1). This signal was so strong that it often masked inter-annual patterns. During the Benguela *Niño* in 1984, copepod abundance during the upwelling and intermediate seasons dropped dramatically, and only recovered slowly, with a much reduced seasonality in subsequent years. In contrast, copepod abundance was fairly consistent during the quiescent season over the entire time period. There were considerable inter-seasonal and inter-annual changes in the copepod communities during the SWAPELS period, with distinctly different community structures before, during, and after the Benguela *Niño* in 1984 (Fig. 3).

Copepod abundance was highly variable in the NatMIRC samples, again with clear seasonal cycles (Fig. 2), but changes in the community structure during the sampling period (2000-2006) were not significant. It was found that a reduction in primary productivity in the summer of 2005/2006 due to reduced upwelling was reflected in a significant reduction in copepod abundance off Walvis Bay, and that the copepod species composition in this period was significantly different to that in all other years.



**Figure 2. Copepod abundance (no m<sup>-2</sup>) between February 2000 and February 2007 along the Walvis Bay transect. The dots represent the station positions.**

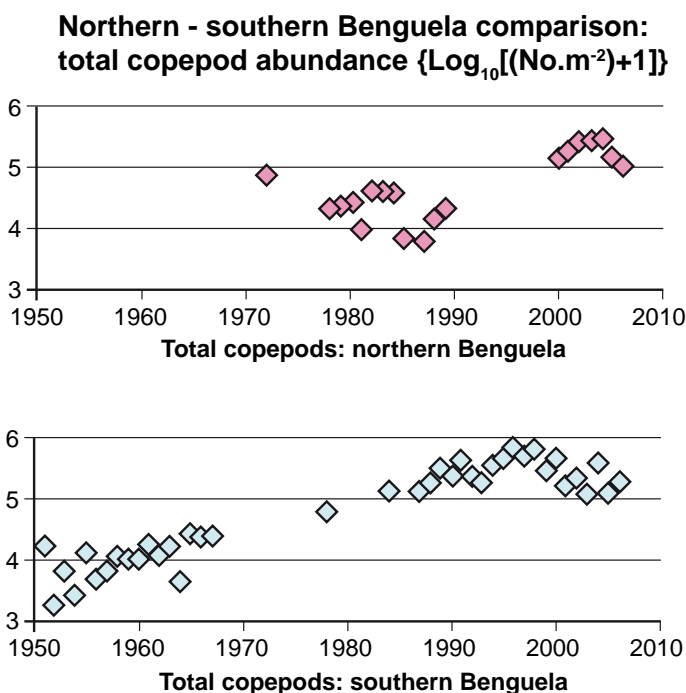


**Figure 3. Long-term, decade-scale changes in copepod community structure (expressed as percentage composition of the six most dominant species – adults and copepodites C5 combined, shown on the right) on the Walvis Bay transect since the 1970s.**

Overall, despite some gaps in the data set, it has been concluded that mesozooplankton biomass and total copepod abundance in the northern Benguela has been increasing over the past five decades. In addition, there is evidence to suggest considerable inter-decadal variability associated with large-scale changes in coastal upwelling. The “turning point” in upwelling and zooplankton appears to coincide with the Benguela *Niño* in 1984. There is evidence to suggest that another reversal occurred in the early 2000s.

Comparison with the southern Benguela (Fig. 4) shows that although there have been marked long-term changes in the abundance, distribution and structure of the copepod community there as well, the changes in the two sub-systems do not seem to have been in synchrony.

Another achievement of the project has been the construction of the plankton database, which currently contains 91964 records from 4465 samples at 648 stations, spanning the wider Benguela from its northern boundary to Durban in the Indian Ocean. Data are held from 1958 to 2001, with greater emphasis on the older data. The Benguela Plankton Portal, which consists of the metadata and metadata directory, the database itself and a comprehensive bibliography containing 233 publications at present, will continue to be an invaluable tool for further retrospective analysis of plankton data in support of research and management in the Benguela region, if properly maintained and supported by users.



**Figure 4. Comparison of time-series of total copepod abundance in the northern and southern Benguela since the 1950s. Data points are annual mean abundances.**

## **Outputs**

### **Data**

A major output of the project is the Plankton Database and Benguela (Zoo)plankton Portal described above.

### **Publications**

Hansen F.C., R.R. Cloete and H.M. Verheye. 2005. Seasonal and spatial variability of dominant copepods along a transect off Walvis Bay (23°S), Namibia. *African Journal of Marine Science* 27(1): 55-63.

Hutchings L., H.M. Verheye, J.A. Huggett, H. Demarcq, R. Cloete, R.G. Barlow, D. Louw and A. da Silva. 2006. Variability of plankton with reference to fish variability in the Benguela Current Large Marine Ecosystem - an overview. In: L.V. Shannon, G. Hempel, P. Malanotte-Rizzoli, C.L. Moloney and J.D. Woods (Eds.). *Benguela: Predicting a large marine ecosystem*. Elsevier Large Marine Ecosystems 14: 91-124.

Verheye H.M. 2000. Decadal-scale trends across several marine trophic levels in the southern Benguela upwelling system off South Africa. *Ambio* 29(1): 30-34.

### **Theses**

Kauvee I.K.V. assisted by M.J. Gibbons and H.M. Verheye. 2005. Observations on the composition of the copepod community either side of the Lüderitz upwelling cell. I.K.V. Kauvee BSc Hons thesis, University of the Western Cape, South Africa. 41pp.

Tsotsobe S.V. 2005. Temporal and spatial variability in copepod abundance, distribution and community structure off Walvis Bay in the northern Benguela current, 1979-1981. MSc thesis, University of the Western Cape, South Africa. 111pp.