THE BLOOM DYNAMICS AND TROPHIC ECOLOGY OF SALPS AND DOLIOLIDS IN STORM BAY, TASMANIA

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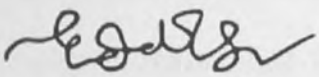
The research associated with this thesis abides by the international and Australian codes on human and animal experimentation, the guidelines by the Australian Government's Office of the Gene Technology Regulator and the rulings of the Safety, Ethics and Institutional Biosafety Committees of the University.

Signed



Nurul Huda Ahmad Ishak

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"Tenang-tenang air laut,

Sampan kolek mudik ke tanjung

Hati terkenang mulut menyebut

Budi baik rasa nak junjung"

I feel that neither English nor Malay can possibly say what I feel.

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ABSTRACT

Zooplankton are important grazers of primary production and play a central role in the transfer of energy from primary producers to higher order consumers. Zooplankton are sensitive to environmental variability, making them useful indicators of climate change; importantly, their physiology is strongly coupled to temperature, they exhibit generally short life cycles and they are excluded from most pressures associated with commercial fishing. However, given the diversity of organisms found in the pelagic environment the responses of different groups of zooplankton to environmental variability are most likely different. In this study I have investigated the bloom dynamics and trophic ecology of dominant thaliaceans in Storm Bay: two species of salp (*Thalia democratica* and *Salpa fusiformis*) and two species of doliolid (*Dolioletta* sp. and *Doliolum* sp.). Storm Bay is a region of dynamic oceanography that is influenced by (i) warm, low nutrient waters from the East Australian Current in the summer, (ii) cooler, nutrient-rich subantarctic waters in the winter, (iii) the Leeuwin (Zeehan) Current flowing along the west coast and (iv) flows from the Derwent Estuary. Key challenges in this study included the fragility of the gelatinous zooplankton, their unpredictable presence in Storm Bay and the absence of doliolids during certain years.

Monthly field trips were undertaken to Storm Bay for three consecutive years (November 2009 to March 2012) to investigate the blooms of salps and

doliolids and the causes of their patchy distribution. Collections of zooplankton were made at five sites and seven environmental parameters were recorded (temperature, salinity, rainfall, diatom stocks, chlorophyll *a* concentration, presence of the heterotrophic dinoflagellate *Noctiluca scintillans* and total phytoplankton abundance).

Relationships between the distribution of thaliaceans and environmental parameters in Storm Bay were examined using the BIOENV (Biology-Environment) procedure of PRIMER, which highlighted that the bloom patterns of salps and doliolids in Storm Bay were not uniform in time or space due to the variability in environmental parameters. The top three drivers of thaliacean distribution and abundance, according to BIOENV, were salinity, temperature and diatom stocks, with a correlation of 0.433. It was clear that each species showed different environmental preferences. Of the doliolids, *Dolioletta* sp. preferred lower temperatures (mean SST 13.42-14.93 °C) and higher salinity (mean SSS 33.91-34.62) than *Doliolum* sp. (mean SST 16.35-16.76 °C; mean SSS 32.95-33.83). The salp *T. democratica* showed a preference for higher temperatures (mean SST 15.85-17.4 °C) and slightly lower salinity (mean SSS 34.34-34.40) than *S. fusiformis* (mean SST 14.64-15.38 °C; mean SSS 34.57-35.11).

The dietary preferences of salps were investigated using two methods of gut content analysis: Scanning Electron Microscopy (SEM) and High Performance Liquid Chromatography (HPLC). Using SEM, I obtained micrographs of 31 different species of plankton, including copepods, in the guts of the four species

of thaliaceans. HPLC confirmed that diatoms, cryptophytes and green algae were the main dietary preferences for salps.

To investigate further where each species of salp fitted within the planktonic food web in Storm Bay, carbon and nitrogen concentrations and stable isotopic profiles were measured on *T. democratica* and *S. fusiformis*. Because of the fragility of salps, an extension of this research project involved comparing three different methods of preparation of salps for elemental analyses (freshly collected and incised salps rinsed with small volume of Milli-Q filtered water, thawed salps incised and rinsed in small volume of Milli-Q filtered water and freshly collected salps incised and rinsed with ammonium formate). The best method was then used for isotopic analysis of salps and seawater. Carbon and nitrogen elemental analyses were found to show the most consistent results if fresh specimens were incised and rinsed with Milli-Q prior to analysis. *T.democratica* had higher carbon and nitrogen values than *S. fusiformis*, and solitary forms of both species had higher carbon and nitrogen contents than the aggregate forms. Comparison with the literature confirmed the relatively low carbon and nitrogen concentrations of these gelatinous organisms when compared to crustacean plankton. The present study does point to the need to consider the life stages separately for any research, e.g. ecosystem modelling, that is attempting to produce realistic carbon budgets for a system.

This study provided further insight into the current understanding of the impacts of environmental variability on important marine zooplankton; specifically on salps and doliolids. Further, this study increased our knowledge of

the dietary preferences of salps and added significant information to the little-known diets of doliolids. It also identified some issues with methods used for preparing gelatinous species for biochemical analyses and provided recommendations for optimal preparation of specimens. These findings will significantly increase our ability to determine how climate-driven oceanographic changes will affect the distribution of these important zooplankton species in Australian waters and in other areas globally.