

**Reproduction of the zooplankton, *Daphnia carinata* and *Moina australiensis*:
Implications as live food for aquaculture and
utilization of nutrient loads in effluent**

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Abstract

At present, recycle of resources from agricultural waste is in priority. In order to mitigate impacts cause by the high nutrient loads (N and P) in the agricultural effluent, the utilization of nutrient loads from the effluent is essential. Two South Australian species of zooplankton, *Daphnia carinata* and *Moina australiensis* are commonly found in agricultural effluent ponds in the Roseworthy district of South Australia. These studies compared the ability of both zooplankton species to utilise nutrients when cultured in anaerobically digested piggery effluent and their subsequent suitability for use as live feed for aquaculture.

In order to understand the start-up and maintenance of both species in culture, their reproduction was investigated. The study was carried out from Mar 2007 to Dec 2009 and designed to;

- a. determine the optimal culture conditions for asexual reproduction, based on nutrient tolerance (LC50 of un-ionized ammonia level), optimal culture temperature and photoperiod effects;
- b. identify conditions suited for sexual reproduction by focusing on stimuli to induce and hatch ephippia (resting egg), storage conditions for ephippia, sex ratio and embryonic development of the resting egg;
- c. determine the nutrient utilization efficacy of both zooplankton species; and

- d. quantify the nutritional profile of both species raised on effluent-grown algae to used be as live feed in aquaculture.

M. australiensis had greater ($P < 0.05$) tolerance at higher levels of un-ionized ammonia ($\text{NH}_3\text{-N}$) than *D. carinata*. Moreover, older neonates (<48 hrs old) could survive at higher concentrations of un-ionized ammonia nitrogen than younger neonates. Maximum reproductive performance for *D. carinata* and *M. australiensis* occurred at 0.5 and 4.5 mg/l $\text{NH}_3\text{-N}$ respectively. Both species had an optimum reproductive performance at 23°C. *M. australiensis* had a remarkably higher net reproductive rate (112.05) and intrinsic rate (0.62) than *D. carinata*. Hence *M. australiensis* is a faster growing species compared to *D. carinata*.

M. australiensis had a higher percentage of induced ephippial brood and cumulative hatching of ephippia compared to *D. carinata* under multiple stimuli of photoperiod, temperature and density. However, the survival percentage of *M. australiensis* was lower and the time to resume asexual reproduction was longer after release of ephippia. The male to female ratio of 5:5 (1:1) or 4:5 maximized the induction of ephippial brood of both species. The ephippia of both species preferred storage in wet conditions.

The zooplankton candidates (non-fed with algae) utilized higher levels of nutrients (TN and SP) compared to the fed group. In the case of *D. carinata* (non-fed), the reduction of TN, SP and BOD_5 was 18.8%, 18% and 60%, while in the case of *M. australiensis* (non-fed), the reduction of TN, SP

and BOD₅ was 16.9%, 12.3% and 64.5%. The mean reduction in BOD₅ provided further evidence that both species could utilize nutrients.

Both species contained an appreciable quantity of protein and lipid after being fed with effluent-grown algae. The essential amino acid content of *M. australiensis* met the requirements of both omnivorous and carnivorous fish fry, but *D. carinata* only met the requirements of omnivorous fish fry. Both species had over 50% unsaturated fatty acids which were mainly (n-6) poly-unsaturated fatty acids. Both zooplankton species have the capability of converting mono-unsaturated fatty acids (n-6) to poly-unsaturated fatty acids. The nutritional profile analysis showed that *D. carinata* and *M. australiensis* could be used as live food for freshwater fish larvae.

Declaration

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

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Yuk Fung Jaime Leung

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Foreword

This thesis has been prepared as a series of chapters in a format that will be suitable for future publication in scientific journals. In order to facilitate chapter publication, it was necessary to re-state from time to time some key information details.

The Abstract at the beginning of this thesis is the summary of the “Abstract” section of each of the data chapters (3, 4, 5 and 6). This enables chapters to be published separately without needing extensive cross-references.