THE SYSTEMATICS OF THE NEW ZEALAND SPECIES OF *POTAMOPYRGUS* (MOLLUSCA : HYDROBIIDAE), AND STUDIES ON THE BIOLOGY OF *POTAMOPYRGUS ANTIPODUM*

A thesis
presented in partial fulfilment
of the requirements for the degree of
Doctor of Philosophy in Zoology
at Massey University

MICHAEL JOHN WINTERBOURN

1968

ABSTRACT

This investigation has shown that only three species of *Potamopyrgus* Stimpson can be recognized from New Zealand, compared with the six species and three subspecies recognized by Suter (1913). The species are, *P. antipodum* Gray 1843, *P. pupoides* Hutton 1882, and *P. estuarinus* n. sp. *P. dawbini* Powell 1955 from the Auckland Islands is probably referable to *P. antipodum*, but the position of (?) *P. melvilli* (Hedley 1916) from the Kermadec Islands has not been determined. The European species *P. jenkinsi* (Smith 1889) cannot be separated from *P. antipodum* on morphological or anatomical grounds and may also be referable to that species. All species now placed in *Fluviopupa* Pilsbry 1911 should probably be referred to *Potamopyrgus*.

P. estuarinus and *P. pupoides* are both smooth-shelled, bisexual, non-ovoviviparous and confined to brackish water. *P. antipodum* is highly variable in shell size, shape and ornamentation, inhabits fresh and brackish water, is ovoviviparous, and populations may consist entirely of parthenogenetic females, or contain variable numbers of sexually functional males. Rearing of snails in the laboratory has shown that snails do not necessarily breed true with respect to shell ornamentation, and that shell shape and ornamentation is not determined primarily by environmental factors.

The shell of *P. estuarinus* cannot be distinguished from that of some *P. antipodum* but *P. pupoides* may be readily identified using shell characters alone. No significant interspecific differences in operculum, external morphology,

body pigmentation or structure of the male reproductive system are found but P. pupoides possesses minor radular differences, and P. antipodum differs in the condition of the female reproductive system. The diploid (2n) chromosome number of all three species is 24.

Qualitative paper chromatography of crude foot muscle and mantle edge extracts, and quantitative ion-exchange chromatography of shell periostracal protein have disclosed no important biochemical differences between species.

P. antipodum is widely distributed in fresh waters and no clear relationship between shell shape and ornamentation, and different kinds of habitat have been found. P. estuarinus has a fairly restricted brackish water habitat and is frequently found near river mouths in harbours where snails may regularly be exposed to the air for part of each tide cycle. P. pupoides is also restricted to brackish water but normally remains fully aquatic at all times. Experimental studies on salinity relationships, habitat selection and the effects of desiccation have demonstrated important differences in the environmental relationships of the three species which can be correlated with their distributions.

Life history and population studies made in three populations of P. antipodum (two ponds and a stream) over a 13-14 month period have shown that reproduction occurs throughout the year with peak activity in spring and summer. Generation time as indicated by laboratory rearing of snails is 9-12 months. Population age structures differed markedly between ponds and stream and reflected differences in the

physical environments of the two habitats. Distribution, occurrence in drift and effects of floods were examined in the stream. Snails were generally most abundant in places sheltered from the main current or among vegetation, and large numbers were present within mats of willow roots. P. antipodum is a regular member of the drift fauna and floods have an important role in regulating population age structure.

The distribution of P. antipodum in thermal waters was also investigated, and experimental work indicates that high water temperature is probably the most important factor limiting distribution. The maximum temperature at which snails were found in the field, 28°C, is also the temperature at which activity ceases and the snails enter a comatose state.

Finally, a study has been made of the parasites of Potamopyrgus. An unidentified protozoan (Sporozoa : Porosporidae), occurring in an encysted state, is the most important internal parasite with infection rates as high as 86% having been recorded. The larvae of 13 species of Trematoda were identified and briefly described and their rates of infection determined. The monostome cercariae are the most important group of parasitic trematodes. The commensal oligochaete Chaetogaster limnaei limnaei was found in association with P. antipodum in Lake Pupuke, Auckland, and was observed to be predacious on embryonic snails.

PREFACE

A thorough investigation of the systematics of the New Zealand species of Potamopyrgus has long been overdue and is the main aim of this thesis. Comparative examinations of morphological, anatomical and biochemical factors, as well as environmental relationships have been made in the search for species differences and in order to describe the extent of inter- and intraspecific variation within the component species. All factors have been examined primarily for any systematic information they may yield rather than to elucidate structure and function for its own sake.

In the systematic section of this thesis the conclusions reached as a result of the study are presented before the detailed account of the investigations leading to their formulation. This has permitted a more cohesive account to be written with the emphasis being placed on interspecific differences.

The secondary aim of this work has been to examine some aspects of the biology of the freshwater species P. antipodum. This has involved studies of the life history and population dynamics in three populations, field and experimental work on thermal relations, and an examination of the snails' parasites and their rates of infection.

ACKNOWLEDGMENTS

I am pleased to acknowledge and thank those people who have assisted me during the course of this work, in particular Dr. T.J. Brown for his interest and criticism throughout. The advice and criticism of Dr. W.C. Clark and Mr. L. Gurr of the Zoology Department, Massey University, and Dr. R.K. Dell and Mr. W.F. Ponder of the Dominion Museum, Wellington, has also been greatly appreciated, as has the help given by Dr. G.G. Midwinter, Department of Chemistry and Biochemistry, Massey University, with biochemical analyses, and Miss Pauline Campbell and Mr. D. Greenwood for technical assistance.

Dr. Dell and Mr. Ponder have kindly allowed me to examine material in the Dominion Museum collections and have introduced me to much relevant literature. Collections of snails have been made for me by Messrs. John McLean of Auckland and Ian McLellan of Westport. Mr. Tom Warwick of the University of Edinburgh has sent me living material of *P. jenkinsi*, and Mrs. Shirley Rhind of the Zoology Department, University of Canterbury, has lent me trematode material. It gives me pleasure to acknowledge the help given by all these people.

All figures in this thesis were reproduced by the Massey University, Central Photographic Unit.

INDEX TO FIGURES