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SHORT COMMUNICATION

BIOMASS AND PRODUCTION ESTIMATES FOR AN ESTUARINE MEIOBENTHIC COPEPOD, WITH AN INSTANTANEOUS ASSESSMENT OF EXPLOITATION BY FLATFISH PREDATORS

It has long been known that estuarine basins playa critical role as nursery areas and sheltered feeding habitats for the juveniles of a number of commercially important fish species. Yet within New Zealand the precise value of such ecosystems from this point of view remains largely unexplored. In his summation of a seminar on nutrient processing and biomass production in New Zealand estuaries, held at the Cawthron Institute in 1982, Knox (1983) concluded that most current data were fragmentary and took little account of the broader interactions between various components of the estuarine biota. Moreover, one of the most severe handicaps was the lack of even the most fundamental quantitative data on abundance, trophic interactions, and estimates of biomass and secondary production. Before any generalizations can be made about how typical New Zealand estuaries might be compared with their more intensively studied counterparts elsewhere in the world, there is an urgent need to make available, even in preliminary form, estimates of functional characteristics such as biomass, production, and food web relationships.

The meiobenthic harpacticoid copepod *Parastenhelia megarostrum* Wells, Hicks and Coull, is the dominant epibenthic metazoan on Mana Bank in Pauatahanui Inlet, Porirua Harbour. This species is not only extremely abundant at this locality, but it also constitutes the principal item of prey for young post metamorph flatfish during their first half year of benthic life (see Hicks, 1984). These a-group fish are within a size range of about 8.0 to 35.0 mm standard length, and may be observed occupying the same realised niche in estuaries and shallow harbour flats throughout New Zealand. This note, which complements an earlier report (Hicks, 1984), provides a first assessment of biomass and secondary production of the P. *megarostrum* population in Pauatahanui Inlet, and evaluates the consequences of predatory removal by flatfish.

Fortnightly sampling was undertaken from March 1981 to April 1982 from an intertidal fine sand bank (Mana Bank) in Pauatahanui Inlet, the eastern arm of Porirua Harbour (41 °06'5; 174°54'E). Details of sampling procedures and environmental characteristics are available in Hicks (1984).

Preliminary estimates of biomass and production were obtained as follows. Dry weight values were predicted from body length / dry weight regressions presented in Goodman (1980) and Fleeger and Palmer (1982), but with allowance made for a body morphology appropriate to P. *megarostrum* (see Hicks and Coull, 1983, p.72). An adult female thus has a dry weight ≈ 2.30μg. A more conservative approach which accommodates some individuals within the juvenile (copepodite) size range, is to calculate average dry mass weights according to Faubel's (1982) definite size class method. This yields a generalized mass of 0.56μg. individual^{-1}. Standing stock determinations using this latter value or that predicted from adult females, are here regarded as lower and upper estimates respectively. Biomass (B) was derived as the product of the mean annual population density (March 1981-March 1982 = 263 individuals. 10 cm $^{-2}$) and individual dry weight (adult female = 2.30μg) as 0.605 grams ash free dry weight. m $^{-2}$ yr $^{-1}$,or assuming 40% of dry weight is organic carbon (e.g. Feller, 1982), 0.242 g C. m $^{-2}$ yr $^{-1}$. This upper value can be set against the lower one derived from a definite size class measurement (0.56μg. individual^{-1}) of 0.147 gafdw. m^{-2} yr^{-1}, or 0.059 g C. m^{-2} yr^{-1}.

Production to biomass (P / B) ratios of 9 have been widely used for meiofaunal organisms when information on the number of generations is not available (Heip *et al.,* 1982). When the number of generations is known, P / B ratios have been shown to vary greatly between 2 and 26 per year (Gerlach, 1971; Heip, Herman and Coomans, 1982). Based on 14 months *in situ* population data for *P. megarostrum,* I concluded that up to 7 generations might be produced annually (Hicks, 1984), although these overlapped greatly, making precise cohort identification impossible. Accepting that the 5 major recruitment pulses evident in this population represent discrete and successive yet merging generations (Hicks, 1984, Fig.4), and assuming Waters' (1969) generalized ratio of 3 for cohort production to mean standing crop, this gives an annual *P/B* or turnover ratio of 15. Annual production (P) in carbon equivalents is the product of population biomass and *P/B* ratio and gives an upper level of 9.074 gafdw. m $^{-2}$ yr^{-1}, or 3.630 g C. m $^{-2}$ yr $^{-1}$ and a lower value, derived from the definite size class measurement of 2.205 gafdw. m $^{-2}$ yr $^{-1}$ or 0.882 g C. m $^{-2}$ yr $^{-1}$. These upper and lower estimates take no account of nauplius production which some authors demonstrate may represent 30-40% of total production (Feller, 1982; Fleeger and Palmer, 1982). Yet both estimates are significantly higher than those so far recorded for other meiobenthic harpacticoids where P has been derived from *P/B* ratios (Table 1). The lower estimate is, however, within the range ofr *Huntemannia jadensis* Poppe (Feller, 1982) (Table 1), where production was estimated directly from empirical stage-biomass data.

A measurement of instantaneous predation pressure on P. *megarostrum* by juvenile flatfish was undertaken in January 1984. Prey densities at this time were high (see below) and within the range of those earlier recorded (Hicks, 1984). Similarly, frequent yet non-quantitative field observations of flatfish density made over the 3 previous years, indicated that predator abundance is also around its highest in January. Fish spanning those size categories where consumption of the copepod is known to be maximal (see Hicks, 1984), were caught by pushnet, dissected and the number of copepods in the entire alimentary tract of each fish counted. The product of the average number of copepods in the guts (264.8 ± 143.3, n = 15) and mean fish density (2.10 ± 2.14 individuals. M^{-2}, N = 10), was divided by the ambient sediment density (x = 442.0 ± 179.9 individuals. 10 cm $^{-2}$, n = 5) of the copepod, including nauplii. Data are standing crop of prey in guts expressed as a proportion of the sediment density available for ingestion. Correcting for daily gut clearance rates for O-group flatfish of 3-4 (Grogan, 1982 unpubl.), suggests that about 0.0038% of the copepod population is consumed per day.

Previously, it had been assumed (Hicks, 1984, p.56) that flatfish were responsible for declines in population density of the copepod immediately following pulses of juvenile recruitment and hence peaks of total density. Reductions in density to levels which might threaten the viability of the population have, however, not been observed on Mana Bank, in contrast to fish-predated harpacticoid populations elsewhere (e.g. Feller and Kaczynski, 1975; Sibert, 1979). This, together with the insignificant levels of removal indicated here tend to suggest that flatfish predation has very little overall impact on the abundance of P. *megarostrum,* despite the large numbers found in fish guts at anyone time. Further estimates are obviously needed at different times of

Table 1: *Abundance, biomass and production estimates for meiobenthic harpacticoid copepods. ((1) represents upper value, (2) represents lower value, see text for derivation.)*

Species	Location	Density (No.m^{-2})	Biomass (gC. m $^{-2}$ yr $^{-1}$)	Production (gC. m $^{-2}$ yr $^{-1}$)	Reference
Derived from P/B ratios					
Copepoda (10 species)	Asko, Sweden	147000	0.048	0.54	Ankar and Elmgren, 1976
Canuella perplexa	Dievengat, Belgium	31700	0.037	0.11	Heip, 1980
Paronychocamptus nanus	Dievengat, Belgium	247600	0.019	0.11	Heip, 1980
Tachidius discipes	Dievengat, Belgium	32300	0.011	0.04	Heip, 1980
Harpacticus uniremis	Nanaimo Estuary, Canada	6300	0.007	0.069	Sibert, 1979
Parastenhelia megarostrum	Pauatahanui Inlet, New Zealand	263000	0.242	3.630	This study (1)
			0.059	0.882	This study (2)
Derived by other methods: respiration, stage-biomass					
Copepoda (8 species)	Lynher Estuary, U.K.	279000	0.317	5.697	Warwick et al., 1979
Tachidius discipes	Lynher Estuary, U.K.	-	-	1.6-1.9	Teare, 1978
Huntemannia jadensis	Puget Sound, U.S.A.	160000	0.452	0.7-1.7	Feller, 1982
Microarthridion littorale	South Carolina, U.S.A.	188000	0.083	0.06	Fleeger and Palmer, 1982

year to assess the overall predation rate, but the instantaneous estimate obtained here is so low as to suggest that the harpacticoid population probably represents a non-limiting food resource in Pauatahanui Inlet, at least to predators of epibenthic meiofaunal-sized organisms. Such a conclusion is consistent with the generalized belief that estuaries are food-rich areas for nursery and feeding activities of young fish and other wildlife.

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