Available online at www.sciencedirect.com
ScienceDirect
Aquaculture 259 (2006) 222–233
Aquaculture
www.elsevier.com/locate/aqua-online

Food sources of the sergestid crustacean, *Acetes sibogae*, in shrimp ponds

Frank E. Coman [a,b,*], Rod M. Connolly [b], Stuart E. Bunn [c], Nigel P. Preston [a]

[a] *CSIRO Division of Marine and Atmospheric Research, PO Box 120, Cleveland 4163, Australia*
[b] *Centre for Aquatic Processes and Pollution, School of Environmental and Applied Sciences, Griffith University, PMB 50, Gold Coast Mail Centre, Queensland 9726, Australia*
[c] *Centre for Riverine Landscapes, School of Australian Environmental Studies, Griffith University, Nathan Qld 4111, Australia*

Received 9 February 2005; received in revised form 3 May 2006; accepted 10 May 2006

Abstract

A combination of stable isotope measurements and gut contents analysis was used to determine the major food sources of the sergestid crustacean *Acetes sibogae*, in commercial shrimp ponds at two farms in southeast Queensland, Australia. Slight differences were observed between farms but overall the results were consistent. Although gut contents analysis gave a good indication of the range and temporal occurrence of food items consumed by *Acetes*, it was difficult to ascertain the contribution each item made to the diet. This was mainly due to the large proportion of unidentifiable material in the guts. All specimens examined contained unidentifiable material and about half the *Acetes* from both farms contained nothing identifiable. This unidentifiable material may be the result of processing by the *Acetes* gastric mill or the consumption of detritus, sediment or processed material from shrimp pellets. Only resilient items such as crustacean remains, diatoms and tinntinnids were commonly identified from the guts, and although present over the majority of the sampling period, FOCs were never greater than 25%.

Stable isotope signals were measured for *Acetes* and likely food sources including pelleted shrimp feed, zooplankton and macroalgae. The pattern of changes in isotopic signals of *Acetes* across the season showed that zooplankton was a primary food source. Changes in the signals of zooplankton were reflected by changes in *Acetes*, but the changes in *Acetes* signal were less pronounced. At both farms, *Acetes* were more enriched in ^{13}C and ^{15}N (−15‰ to −20‰ and 12‰ to 13.8‰) than the zooplankton (−18.9‰ to −23.7‰ and 5‰ to 13.1‰), during the whole season. The absolute difference between the $\delta^{13}C$ values of *Acetes* and zooplankton were more consistent than for $\delta^{15}N$, but both were greater than might be expected based on fractionation over a single trophic level. Furthermore, laboratory feeding trials showed that fractionation could not explain the greater than expected enrichment of the *Acetes* signal compared to that measured for zooplankton in the ponds. This, together with evidence from gut content analysis, showed that a food source other than zooplankton must also be important to *Acetes*. Macroalgae are the most likely additional source, although some minor contribution of pellets or microalgae cannot be ruled out entirely. There was no evidence from either gut contents or stable isotope signatures of dramatic dietary changes for *Acetes* either through a season or as they grew. It would appear unlikely that *Acetes* would have a great effect on shrimp production in ponds unless they were extremely abundant early in the season when the postlarvae are also feeding on zooplankton.

Keywords: Stable isotopes; Sergestids; Diet

* Corresponding author. CSIRO Division of Marine and Atmospheric Research, PO Box 120, Cleveland 4163, Australia. Tel.: +61 7 3826 7357; fax: +61 7 3826 7222.
E-mail address: frank.coman@csiro.au (F.E. Coman).

0044-8486/$ - see front matter.
doi:10.1016/j.aquaculture.2006.05.038

1. Introduction

The assemblages of zooplankton and epibenthic fauna in shrimp ponds in southeast Queensland have been well described (Preston et al., 2003; Coman et al., 2003), and factors influencing their dynamics have been investigated. In shrimp farms in this region and elsewhere in the world, shrimp gain nutrition from zooplankton (Chen and Chen, 1992; Martinez-Cordova et al., 1997; Coman et al., 2003), particularly early in the season (soon after stocking). As the grow-out season progresses the amount of nutrition gained from zooplankton decreases so that by the end of the season the shrimp are almost exclusively gaining their nutrition from formulated pellets (Preston, 1998).

Generally it is accepted that the pond zooplankton assemblages, which are usually dominated by copepods and barnacle nauplii, feed primarily on the phytoplankton blooms in the pond (Martinez-Cordova et al., 1997) and are not likely to compete with the stocked shrimp for resources. Due to their larger size, the feeding habits of the epibenthos may have a more direct impact on the stocked shrimp, however their feeding habits within the ponds have not been investigated. The sergestid, *Acetes sibogae*, is the most prominent epibenthic animal occurring in ponds in the study region (Coman et al., 2003). *Acetes* have feeding mechanisms to allow them to effectively prey on zooplankton (McLeay and Alexander, 1998) and will probably feed on the smaller zooplankton in the ponds. Many studies have concluded that *Acetes* species are omnivorous (Xiao and Greenwood, 1993), so it would seem possible that they also feed on pond phytoplankton, other pond fauna and flora, and pellets. The contribution of these different food sources may change across the season and could place sergestids as competitors for feed with the shrimp stocked into the ponds.

Two approaches commonly used in determining the diet of animals are gut contents analyses and stable isotope analyses. Gut content analyses have been more widely used, despite several problems with this technique. Generally this technique can detect only what was eaten very recently by an animal, and may not be very useful for looking at soft bodied prey (Gee, 1989). Also, the technique reveals ingestion but does not give an indication of what is assimilated. Further, for species such as *Acetes*, which have a gastric mill at the anterior end of their alimentary tract, much of the prey is broken down to fragments too small to identify confidently. Stable isotope analysis has advantages in that it indicates what organisms have assimilated and integrates this over time (Peterson and Fry, 1987; Grey et al., 2004). However, there can be problems in interpretation when more than one combination of dietary items can result in a similar isotopic signature for the consumer. This can be overcome to some degree by analysing multiple elements.

The aim of this study was to determine whether the major direct food source of *Acetes* occurring in the shrimp ponds was pellets or zooplankton, using gut contents and ^{13}C and ^{15}N stable isotope signatures. By simultaneously analysing the diet using these two techniques it was hoped this would overcome problems associated with using either technique in isolation.

2. Materials and methods

2.1. Pond sampling

2.1.1. Sampling sites

Samples were collected from a single pond at each of two shrimp farms in southeast Queensland, Australia. Moreton Bay prawn farm (MBPF) produced *Penaeus monodon* at Cleveland (27°30′S, 153°20′E). The grow-out season ran from December 1998 to April 1999. Rocky Point prawn farm (RPPF) reared *Penaeus japonicus* at a site several kilometres to the south of MBPF. The grow-out season at this farm ran from December 1998 to July 1999.

Farm management practices were similar at the two farms despite the stocking of different shrimp species. Both farms grew shrimp in earthen ponds up to 1 ha in surface area and 1.8 m depth in the centre. The farms were supplied water from nearby tidal creeks that was screened to approx. 1000 μm before entering the ponds. Water quality in the ponds was maintained by exchanging water as necessary. Ponds were filled several weeks before the shrimp postlarvae (PL15) were stocked. Stocking densities across the farms varied between 25 ind. m^{-2} and 50 ind. m^{-2}. The shrimp were fed a fishmeal based commercial pellet diet, usually between two and five times per night. The major difference between the farms was that RPPF used pellets with higher protein levels to grow *P. japonicus* than the pellets required to grow *P. monodon* at MBPF. Paddlewheels were used to circulate pond water and maintain dissolved oxygen levels in the ponds. Lime was added to maintain pH at close to 8 throughout the season. Phytoplankton blooms were maintained by fertilisation of the pond with chicken manure.