

Experimental studies on the feeding ecology of *Munida subrugosa* (White, 1847) (Decapoda: Anomura: Galatheidae) from the Magellan region, southern Chile

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SUMMARY: Feeding behaviour and food uptake rates of the anomuran crab *Munida subrugosa* from the southern Magellan region (Chile) were studied under laboratory conditions. Crabs exhibited a marked preference for meat versus macroalgae, with uptake rates being 14 times higher. Different algal species were ranked according to structure and detrital cover. Observations suggest that scavenging and cannibalism, restricted to injured or moulting individuals, are regularly applied in the natural habitat, whereas active hunting is only performed on suitable prey. The main food resource is suggested to be of microscopic origin, given the time spent on typical food uptake movements for detritus and suspended food. The findings of this study, backed up by results of simultaneously carried out stomach analysis, proved *M. subrugosa* to be an opportunistic feeder that can make use of different forms of food uptake.

Key words: feeding habits, food choice, natural diet, anomuran crabs, *Munida subrugosa*.

RESUMEN: ESTUDIOS EXPERIMENTALES DE LA ECOLOGÍA ALIMENTARIA DE *MUNIDA SUBRUGOSA* (WHITE, 1847) (DECAPODA: ANOMURA: GALATHEIDAE) DE LA REGIÓN DE MAGALLANES, SUR DE CHILE. – Se estudiaron los hábitos alimentarios y tasas de ingesta de alimento del crustáceo anomuro *Munida subrugosa* en la Región de Magallanes (Chile) bajo condiciones de laboratorio. Los cangrejos mostraron una marcada preferencia por la carne versus las macroalgas, con tasas de ingesta 14 veces más altas. Diversas especies de algas fueron clasificadas en función de la estructura y la capa detrítica. Las observaciones señalan que la alimentación sobre carroña y el canibalismo (restringido al consumo de individuos dañados o en estado de muda) constituyen una estrategia aplicada frecuentemente en el hábitat natural. Sin embargo, se sugiere que la principal fuente de alimento es de origen microscópico, dada la conducta alimenticia observada en ejemplares vivos, que se alimentan de material particulado y en suspensión. Los resultados de este estudio, apoyado por los resultados de análisis de contenidos estomacales realizados simultáneamente, demuestran que *Munida subrugosa* es un predador oportunista, que puede hacer uso de diferentes formas de obtención de alimento.

Palabras clave: hábitos alimentarios, dieta natural, cangrejos anomuros, *Munida subrugosa*.

INTRODUCTION

Crabs of the galatheid genus *Munida* have a worldwide distribution, and currently over 150 different species have been recorded (Macpherson, 1994). Studies on the composition of the megaepifauna in the Magellan Region have shown that *Munida subrugosa*, with a circumpolar distribution

between 35°S and 58°S (Zeldis, 1985), is one of the most abundant decapods, and can constitute up to 50% of the benthic biomass south of the Beagle Channel (Arntz *et al.*, 1999). For many predators at a higher trophic level, *M. subrugosa* represents a large part of the diet composition (Moreno and Jara, 1984). However, the state of knowledge about the autecology of *M. subrugosa* is low. Previous work

has focused primarily on reproduction, growth and mortality (Rodríguez and Bahamonde, 1986; Tapella *et al.*, 2002), and stomach analyses were carried out only recently (Romero *et al.*, 2004).

The present study is part of the FONDEF project D001-1181: "Development of the Fishery of the Langostino de los Canales (*Munida subrugosa*) in the 12th Region, Magellan Region and Chilean Antarctica", initiated in 2001 to prove the suitability of *M. subrugosa* as a commercial alternative for the traditionally captured lithodids in the sample area. To ensure a sustainable exploitation detailed studies about the biology of the species are necessary. Feeding habits in particular are of considerable interest because they help to determine the role of *M. subrugosa* in the natural habitat and its position in the local food web. In this work, studies on feeding preferences and observation of live specimens kept in the laboratory were used to provide an initial understanding of the feeding ecology of the species.

MATERIAL AND METHODS

Samples of *M. subrugosa* were obtained from Bahía Santa María, a shallow bight in a semi-enclosed basin in the Magellan Strait (53°24'S; 70°21'W) from February to March 2002 at sampling depths of 10-20 m. Immediately after capture by the means of specially designed, bottom-lying fishbaited traps, live crabs were transferred to the laboratory. Feeding behaviour was recorded with 20-30 specimens each held in Plexiglas aquaria (30 x 40 x 50 cm) with seawater in a temperature-controlled room at 8°C ($\pm 1^\circ\text{C}$) under approximately natural light conditions. To provide more natural substratum conditions and examine specific feeding habits, the bottom of one observation aquarium was covered with a 3 cm thick sand layer. Food items comprised live prey including various species of polychaetes and crustaceans as well as lumps of meat and algae. Each item was placed onto the water surface.

Food uptake rates and preferences were established in two feeding experiments over a period of five days. Meat tissue of *M. subrugosa* was known to be appreciated, but special interest was placed on consumption rates of macroalgae, since these were regularly found during stomach analysis. Single adult crabs of similar carapace length were placed in 21 x 23 x 30 cm sized experimental tanks with fil-

tered seawater ($<0.2 \mu\text{m}$) and kept without food for 3 days. A pairwise choice test between meat tissue and the red algae *Polysiphonia* sp. was carried out. To detect any possible selectivity between algal species, a multiple choice test with 3 species of red algae, *Ceramium* sp., *Polysiphonia* sp. and *Ballia* sp., each with high abundances in the natural habitat, was run. The amount of ingested food was determined gravimetrically as wet weight. All resources were daily renewed, and leftover material was taken out thoroughly before new food was offered. Faecal pellets were analysed randomly.

RESULTS

M. subrugosa showed clear preferences in the comparison of meat versus macroalgae (Fig. 1). The mean daily ratio of meat consumption (560 mg) was 14 times higher than that of plant consumption (40 mg). Meat consumption showed a tendency to increase or at least continue on a high level throughout the experimental period, whereas algal uptake rates remained low.

The results of the multiple choice experiment with algae revealed a preference ranking by *M. subrugosa*: *Polysiphonia* sp. > *Ceramium* sp. > *Ballia* sp. (Kruskal-Wallis, $p = 0.018$). Nevertheless, all values lay far beneath meat consumption, ranging from 9 to 33 mg/Ind. /day (Fig. 2). Algal consump-

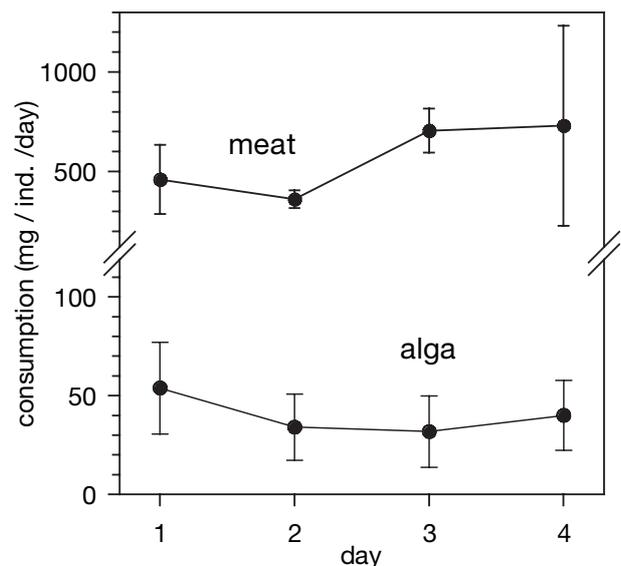


FIG. 1. – Daily average consumption rates of *Munida subrugosa* ($n = 5$) in a choice experiment between crab meat and the red alga *Polysiphonia* sp. during the experimental period of 5 days. Vertical lines are standard deviations.

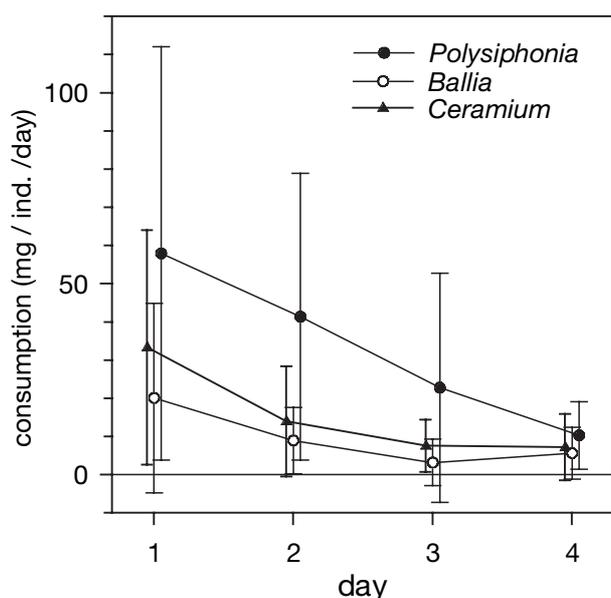


FIG. 2. – Daily average consumption rates of *Munida subrugosa* ($n = 5$) in multiple-choice experiments between three different species of red algae during the experimental period of 5 days. Vertical lines are standard deviations.

tion, regardless of species, showed a tendency to decline over the experimental period, especially after the first day.

Feeding behaviour in response to the investigated food items was highly specific. Algae were fed on rather hesitantly and were regularly rejected after a short period of time. Reaction intensity was very high in response to meat tissues as well as to live polychaetes. Immediately after supply a characteristic searching behaviour was exhibited, in which chelipeds were lifted and the endopods of the 3rd maxillipeds were used to comb through the water column. Shortly after localisation, the crabs performed quick movements towards the desired food and severe fights between several or even all individuals in the aquarium began. Large food objects, such as lumps of meat or polychaetes, were grasped with the chelipeds, cut or ripped into smaller pieces and handed over to the endopods of the third maxillipeds for consumption, while smaller pieces were taken directly with the third maxillipeds. The feeding process could last up to a few hours. Cannibalism was frequently observed on injured or dead specimens, whereas agonistic behaviour towards live, healthy crabs of the same and other species was never observed. In this context, we made an interesting observation: after removal from the aquaria for approximately 10 min crabs showed a behaviour referred to as “playing dead” on being put back into the water. The investigated crab sank to the bottom

motionless, predominantly landing in a supine position. Severe attacks of conspecifics forced it to recover its natural habitus after 2-3 minutes, whereupon the aggressiveness of the attackers abruptly stopped.

In the aquarium equipped with sand, the behaviour of “gathering sediment” was observed regularly and persistent in all animals in the case of lack of macroscopic food. Again, the endopods of the 3rd maxillipeds were used to collect sediment and only-ing particles. Additionally, a gathering of minute meat particles ranging from 0.2 to 2 mm out of the water column was observed, in which the endopods of the 3rd maxillipeds combed through the water acting as filtering devices.

DISCUSSION

Observations as well as feeding experiments suggest that *M. subrugosa* has a rather broad niche width and tends to be a generalist feeder, promoted primarily by the ability to make use of different feeding habits. The literature reports Galatheids to be largely feeders on small particles, while typical decapod predatory habits have been given up or reduced (Nicol, 1932; Kaestner, 1993). Results of this laboratory study demonstrate the significance of scavenging and active preying for the nutrition of *M. subrugosa*. Scavenging apparently represents the dominant form of meat uptake in the natural habitat, as shown by behaviour towards (seemingly) weak conspecifics. In addition, active preying, recently demonstrated for *Munida sarsi* (Hudson and Wigham, 2003), seems to be an opportunistic strategy occasionally applied on suitable prey. The high and lasting meat consumption rates in the laboratory suggest that the species has a gorging food behaviour, ignoring saturation in the event of meat encounter, which is favourable to fully utilising food fall. Rapid response of crabs after meat supply to the aquaria is indicative of some chemoreception ability at a distance of at least 30 cm, a capability previously not documented for Galatheids.

While scavenging and preying are valuable supplements for the diet of *M. subrugosa*, deposit feeding represents the basic nutrition, as is also shown in stomach analysis (Romero *et al.*, 2004). Another method of feeding on small particles seems to be filter feeding, a strategy which has not yet been documented for *Munida*, but is well known for the relat-

ed family Porcellanidae (Nicol, 1932), and effectively used for nutrition by *Galathea strigosa* (Havsfiskelaboratoriet, 1996). These two methods enable crabs to collect a wide range of particulate organic matter, thus apparently being specially adapted to the conditions in the sample area, where the lack of obligate filter organisms (Cattaneo-Vietti *et al.*, 1999) promotes a high amount of detritus on the seafloor as well as suspended organic matter in the water column. There is evidence that algae are also primarily selected because of the epiphytic, microbial or detrital cover, which correlates with algal surface, a behaviour known for some invertebrates (Kornijów *et al.*, 1995). The preferred *Polysiphonia* sp. with delicate ramifications is easy to handle and has the greatest surface. Selection by nutritional value is unlikely considering the state of the algae in faecal pellets, which suggests a low digestibility regardless of species.

In an environment like the Magellan region characterised by frequent events of disturbance (Antezana, 1999) leading to unpredictable food availability, *M. subrugosa*'s ability to adapt feeding strategies to external circumstances is advantageous for surviving periods of unfavourable conditions and allows it to build up great biomasses and co-exist with numerous other benthic decapods occurring in the sample area (Arntz *et al.*, 1999; Gorny, 1999). *M. subrugosa* is assumed to play a crucial role in the pelagic-benthic coupling in this sub-Antarctic environment, but further estimates of filtering and gathering rates are needed to assess the size of this impact.

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