Diet elucidation: Supplementary inferences from mysid feeding appendage morphology

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Scanning electron microscope investigations were made of the mandibles, feeding baskets and gut armatures of *Mesopodopsis slabberi* and *Gastrosaccus psammodytes* collected in Algoa Bay, southern Africa. Comparison of the structure of the feeding appendages of these two marine mysid species allows dietary inferences supplementing data derived from gut content analyses. Both species occur in abundance in the surf zone off sandy beaches where they contribute significantly to energy transfer through the food web.

Skandeerelektron-mikroskopiese ondersoeke is gedoen van die mandibels, voedselmandjies en gepanserde ingewande van *Mesopodopsis slabberi* en *Gastrosaccus psammodytes* wat in Algoabaai, Suidelike-Afrika versamel is. Afleidings gemaak van die strukture van voedingaanhangsels van hierdie twee mariene mysid spesies word gebruik om data verkry van maaginhoudanalises, aan te vul. Beide spesies kom in groot getalle voor in die brandersone van sandstrande waar hulle 'n betekenisvolle bydrae lewer tot energie-oordraging deur die voedselweb.

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Two species of mysid shrimp, *Mesopodopsis slabberi* and *Gastrosaccus psammodytes,* occur in abundance off sandy beaches in the eastern Cape, southern Africa. Their prominence in the sandy beach ecosystem has led to a number of recent studies, including trophic interactions (McLachlan 1983; Webb, Perissinotto & Wooldridge 1987; Webb, Perissinotto & Wooldridge 1988). The diatom *Anaulus birostratus,* as the principal primary producer in these inshore waters, has also been intensively investigated by Talbot & Bate (1986).

The two species of mysid are omnivorous (Brown & Talbot 1972; Mauchline 1980; Wooldridge & Bailey 1982), while more recent work has suggested that they extensively utilize *Anaulus birostratus* and detritus as a food source (Webb *et al.* 1987; Webb *et al.* 1988). Examination of gut contents reveals that the food of mysids, like that of many crustaceans, is macerated and stomach contents primarily consist of unidentifiable, fine particulate matter, allowing only the most robust food items to be identified. Nevertheless, further information on diet can be deduced from the structure of feeding appendages (Anraku & Omori 1963; Grice & Lawson 1971; McClatchie & Boyd 1983) and gut armature (Schaefer 1970).

Scanning electron microscope investigations were therefore made of the feeding appendages and gut armature of *Mesopodopsis slabberi* and *Gastrosaccus psammodytes* to complement our understanding of the diet and feeding of these two species within the beach ecosystem in Algoa Bay.

Materials and methods

The gut contents of freshly caught *M. slabberi* and *G. psammodytes* collected off the Sundays River beach during day and night sampling were examined under a compound microscope (× 400) in an attempt to determine food types ingested in the field. Digestive tract contents of these mysids fed *Anaulus birostratus* in the laboratory were also examined to determine the degree to which these diatoms are macerated in the feeding process.

Examination of the mandibles and the pereiopods forming the feeding basket of small adult *M. slabberi* (11 mm body length) and *G. psammodytes* (13 mm body length) was carried out using scanning electron microscopy. Formalin-preserved specimens were prepared for SEM by gradual ethanol fluid replacement, impregnation with osmic acid and critical point drying with CO_2. Mandibles and pereiopods were dissected out, mounted on stubs using double stick tape, sputter coated with gold and examined in a Cambridge Stereoscan 150 Mk 2 scanning electron microscope.

Mesh intervals of the filtering basket were measured between the inner margins of the bases of the primary setae. Intersetule distances, taken as the interval between the inner bases of adjacent secondary setae, were measured at intervals along the primary setae while microsetule intervals were estimated from SEM photographs. Measurement of the mandibles and the mandibular processes were also made from SEM photographs.

Guts were dissected from freshly caught animals, opened from the dorsal aspect and mounted on stubs using double stick tape. These were then freeze dried overnight, sputter coated with gold and examined in the scanning electron microscope. Gut armature structures were examined and measurements of spines, mills and ripping structures were made from SEM photographs.

Results

Both *M. slabberi* and *G. psammodytes* fed actively on *A. birostratus* in the laboratory. Analysis of gut contents of these two species after being fed *A. birostratus* revealed that the feeding appendages of *G. psammodytes* pro-

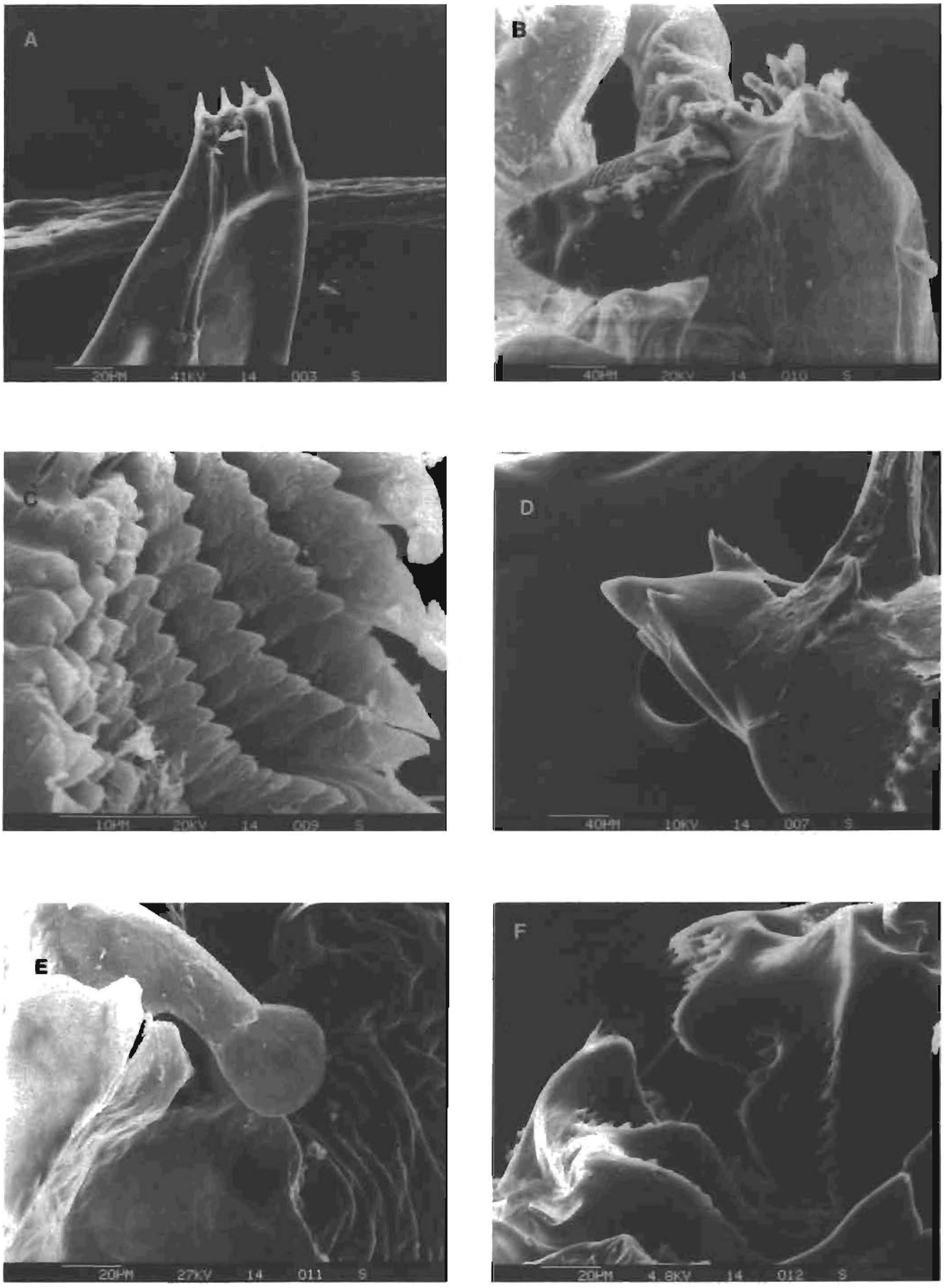

Figure 1 *Mesopodopsis slabberi:* A — denticulate cutting edge of right mandible; B — spinose teeth at anterior base of right mandible. *Gastrosaccus psammodytes:* C — pars molaris region of mandible; D — serrated spine found in passage between the cardiac and pyloric stomachs; E — 'mortar and pestle' structure; F — serrated folds in stomach.

Table 1 Comparison of the mandibles, feeding baskets and gut linings of adult *Mesopodopsis slabberi* and *Gastrosaccus psammodytes*

	Mesopodopsis slabberi	*Gastrosaccus psammodytes*
Mandibles	Cutting surface with long cusps and wide valleys appear suitable for cutting detritus.	Separate grinding and biting regions.
Feeding baskets	Thoracic limbs bear a series of paired setules approximately 40μm apart. One of the pair twice as thick as the other. Neither bear secondary setules.	Thoracic limbs bear a series of setules at 40μm intervals. Secondary setules, 22μm apart and 30 μm long, are found at 45° to the primary setules. These secondary setules bear a single row of micro-setules 4μm apart. Mesh size adequate to filter smallest *Anaulus birostratus* cells encountered.
Gut lining	Smooth	Well developed gut amature which consists of spines, serrated edges and grinding structures

duced finely ground material whereas the diatoms in the gut of *M. slabberi* were merely cracked open.

Examination of the gut contents of animals taken in the field revealed only amorphous material in *M. slabberi* while detritus, granular plant materiai, diatoms and copepods fragments were found in *G. psammodytes*. A marked switch in diet from detritus to copepods and granular plant material was noted after dark in *Gastrosaccus psammodytes*. This granular plant material was suspected to be ground *A. birostratus* cells.

The structure of the mandibles, feeding baskets and gut linings of *M. slabberi* and *G. psammodytes* are compared in Table 1 while Figure 1 illustrates the cutting edge on *M. slabberi* mandibles as well as the gut lining structures and mandibles (pars molaris region) of *G. psammodytes*.

Discussion

M. slabberi has been recorded feeding on copepods (Mauchline 1980) as well as cannibalistically (Wooldridge, pers. obs.), but no crustacean fragments were found in the guts of animals taken in Algoa Bay. The sharp, cusped denticulate edges of the mandibles suggest that they are better suited for cutting soft material than piercing and grinding prey. Only amorphous plant material was found in the guts of field sampled animals and laboratory feeding experiments revealed that the mouthparts produced broken open, but unground, *A. birostratus* frustules.

The structure of the mandibles of *G. psammodytes* appear typical when compared with descriptions of other species belonging to this genus (Mauchline 1980; Wooldridge 1978, 1987). The pars molaris region seems well suited for crushing and grinding hard shelled food items such as diatoms and the rows of small teeth in this area indicate specialization for fine grinding. The sharp, well developed incisor processes would pierce and shred prey before they are passed to the molar processes for grinding, prior to entering the gut.

Feeding experiments on mysids collected in Algoa Bay suggest that the filtering basket of *M. slabberi* allows for efficient filtering of diatoms, but gut content analyses and the structure of feeding appendages both suggest that detrital material would constitute a preferred food source.

The setules of *G. psammodytes* form a sieve of dimensions well suited to filtering particles in the *A. birostratus* size range (Kruger & Wilson 1984). Gut content analyses and grazing experiments indicate that *G. psammodytes* feeds efficiently on diatoms, detritus and copepods.

The gut armature of *G. psammodytes* is heavy, consisting of spines, tearing edges and mills and it is likely that larger food particles in the gut of *G. psammodytes* are pulped by a shearing action of the barbed teeth and serrated edges while smaller (< 20 μm) hard structures may be fractured in the 'mortar and pestle'.

The distribution of detritus and *A. birostratus* in the Algoa Bay sandy beach ecosystem (Talbot & Bate 1986) allows both sources of food to become available to both mysid species, especially at night when both populations feed behind the breaker line (Wooldridge 1983; Webb *et al.* 1987).

Comparison of the structure of the mandibles, feeding baskets and gut armatures of *M. slabberi* and *G. psammodytes* suggests that these two species do not compete directly for food resources but utilize overlapping portions of the supply, i.e. *M. slabberi* is more suited to feeding on detritus while *G. psammodytes* feeds on a wider food range which includes detritus, *A. birostratus,* more robust diatom species and small crustaceans.

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