Feeding habits of the giant clingfish *Chorisochismus dentex* (Pisces: Gobiesocidae)

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The feeding habits of the giant clingfish *Chorisochismus dentex* in the eastern Cape Province, South Africa, are described. Juveniles share a diet of small crustaceans with numerous other fish species but adults feed on sea urchins as well as on a rarely used resource — limpets (Patellidae) which are firmly attached to rocks in the intertidal zone. The limpets are removed by levering with the large upper incisiform teeth. Undigested shells are eliminated whole encased in mucous capsules.
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Die eetgewoontes van die groot suiervis *Chorisochismus dentex* in die Oos-Kaap-Provinsie, Suid-Afrika, word beskryf. Die jong visse deel 'n dieet van klein skaaldiere met baie ander vissoorte, maar die volwasse visse eet seekastaiings asook 'n voedselsoort wat selde deur ander visse geëet word — klipmossel (Patellidae) wat ferm geheg aan die rotse in die tussengety voorkom. Die klipmossels word verwyder deur dit op te lig met hulle groot bo-snytande. Onverteerde skulpe word heel in 'n slymkapsule verwerp.
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The Gobiesocidae is a small, widely distributed family of fishes. The largest species, *Chorisochismus dentex* (Pallas 1769), which reaches a maximum length of 300 mm (Smith 1964), is endemic to South Africa (Briggs 1955). It is found from South West Africa to Natal and is an inhabitant of rock pools and intertidal and marginally subtidal zones.

The food and feeding habits of *C. dentex* have received only scant mention in the literature. Jackson (1950) found that all food found in the stomachs of *C. dentex* contained molluscs. Smith (1964) stated that *C. dentex* eat various crustacea, chiefly crabs, also molluscs, usually different species of *Patella* Linn. which it apparently mostly swallows whole. Gow (1968) found that *Patella* is the main food animal. Branch (1971) records that predators of *Patella* are largely unknown, but the suckerfish *C. dentex* frequently contains whole limpet shells in its gut.

The availability of a moderate sample of *C. dentex* in the eastern Cape facilitated the first detailed examination of the feeding habits of this species. It was found that X-ray techniques were adequate to determine food composition, thus allowing the use of specimens collected for systematic study or live fish which could be returned to the sea. Further interest stems from the unusual method which adult clingfish use to obtain their prey, and the manner in which large shells are voided.

Methods

Clingfish were collected in tidal pools at LWS from Kenton-on-Sea (33°41′S: 26°40′E) and Port Alfred (33°36′S: 26°54′E). The fish were collected with small dip nets or rotenone and immediately placed into separate containers where regurgitated or defaecated food, if any, could be examined. Fish collected for feeding studies in the laboratory were held in aquaria for three days without food to ensure that all food taken in the wild had been digested and residual matter voided.

Standard lengths of freshly killed fish were measured to the nearest millimetre. Prey size was measured to the nearest 0,5 mm using a dial caliper. Voucher specimens of *C. dentex* used in this study have been lodged in the J.L.B. Smith Institute of Ichthyology, Grahamstown.

X-rays of prey in clingfish stomachs were made on Kodak type M film using a Picker portable unit (Model 6231) with exposures at six mA for 30 s and between 32 and 65 kV. Prey identification and measurements were made direct from the plates. Where identification of prey

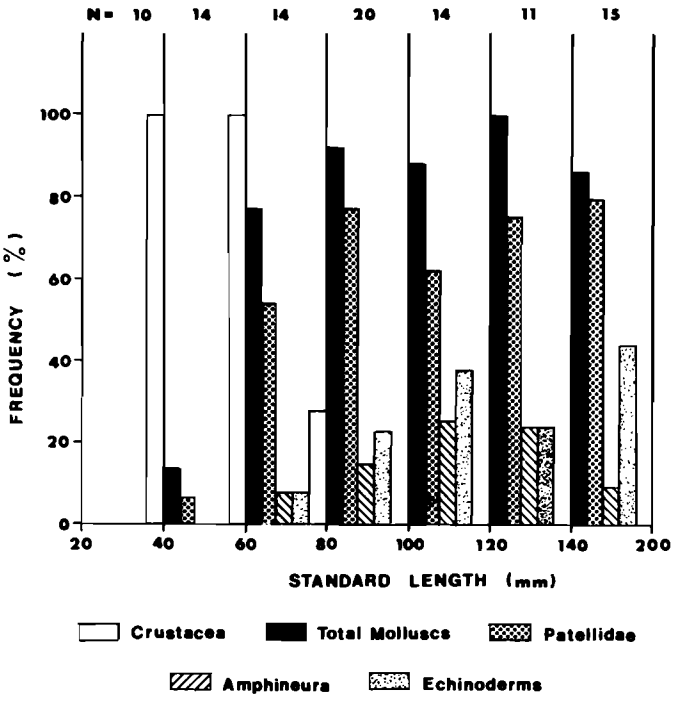

Fig. 1 Percentage frequency of different food items for different length groups of *Chorisochismus dentex*.

items proved inconclusive further X-rays were made at different orientations of the fish or the fish was dissected.

Live fish were held in glass aquaria measuring 1×0,5 m and 0,25 m deep. The same tanks were used for feeding observations and trials on the time taken for shell expulsion.

Results

The food preferences of *C. dentex*..

Ninety-eight fish were examined for gut content; 24 by dissection and 74 by X-ray, 19 of which were later dissected to confirm the X-ray findings or to establish the total number of mollusc shells. Eighteen fish had empty guts. The gut content/length class histogram of the remaining 80 fish is shown in Fig. 1. Clingfish of less than 40 mm contained only Crustacea, whereas between 40 and 80 mm the number of fish containing Crustacea decreased and those containing molluscs increased.

Analysis of food items from 55 fish containing non-crustacean food items (Table 1) shows that 73,5% of food items were patellid molluscs (mainly *Helcion pruinosus*). *Parechinus angulosus* (Echinodermata) formed 12,3%, chitons (6,5%) and other gastropod molluscs (7,7%) made up the remainder of the diet. It is clear that in the area under investigation the limpet *H. pruinosus* forms the dominant prey with other Patellidae, Echinodermata and Amphineura being consumed to a lesser degree.

The almost total absence of *Siphonaria* spp., which are very common and only adhere comparatively loosely to the substrate, is noteworthy. *Siphonaria* spp. secrete a copious mucus which may be protective.

Removal of patellid prey

Branch and Marsh (1978) recorded that the mean total force exerted by South African limpets ranged from 1,95 kg/cm² (*Patella oculus*) to 5,18 kg/cm² (*P. cochlear*). This considerable force together with its close-fitting shell makes limpets very difficult to dislodge from their hold. Gow (1968) observed that *C. dentex* removed limpets with a 'quick grabbing action'. Aquarium observations confirmed this: fish were seen to ignore some limpets but grab at others which were immediately swallowed whole.

An 8 mm ciné film was made of three instances in which *C. dentex* removed and swallowed limpets in the aquarium. The sequence of feeding is illustrated in Fig. 2. This film clearly showed that those limpets that were ignored were closely adhering to the aquarium glass whereas those that were eaten had raised their shells and extended their epipodial tentacles.

After a clingfish has discovered a limpet about to move, it positions itself facing the mollusc. After watching the limpet for 2 − 3 s the clingfish leaps forward and upward, dives onto the shell with mouth opened, inserts its upper teeth under the shell and with the forward momentum resulting from the leap, levers the limpet off the substrate and swallows it immediately (Fig. 2). The whole process from

Table 1 The food of *C. dentex* collected from tidal pools at Port Alfred and Kenton-on-Sea (1973-1977) in the eastern Cape Province: analysis of food items from fish containing molluscs and echinoderms

Food species or group	Frequency	% frequency	Number	% of total
Patellid molluscs: Total	40	72,7	114	73,5
Helcion pruinosus (Kr.)	13	23,6	68	43,9
Helcion pectunculus (Gm.)	7	12,7	12	7,7
Patella barbara Linn.	6	10,9	8	5,2
Patella longicosta Lam.	7	12,7	8	5,2
Patella oculus Born	5	9,1	10	6,5
Patella cochlear Born	5	9,1	6	3,9
Patella sp.	1	1,8	1	0,6
Siphonaria sp.	1	1,8	1	0,6
Amphineura: *Chiton* sp.	8	14,5	10	6,5
Other gastropod mollusca	7	12,7	12	7,7
Echinodermata:				
Parechinus angulosus (Leskr.)	13	23,6	19	12,3

Total number of clingfish examined = 98
Number of clingfish with stomach contents = 55
Total number of prey found in 55 clingfish = 155

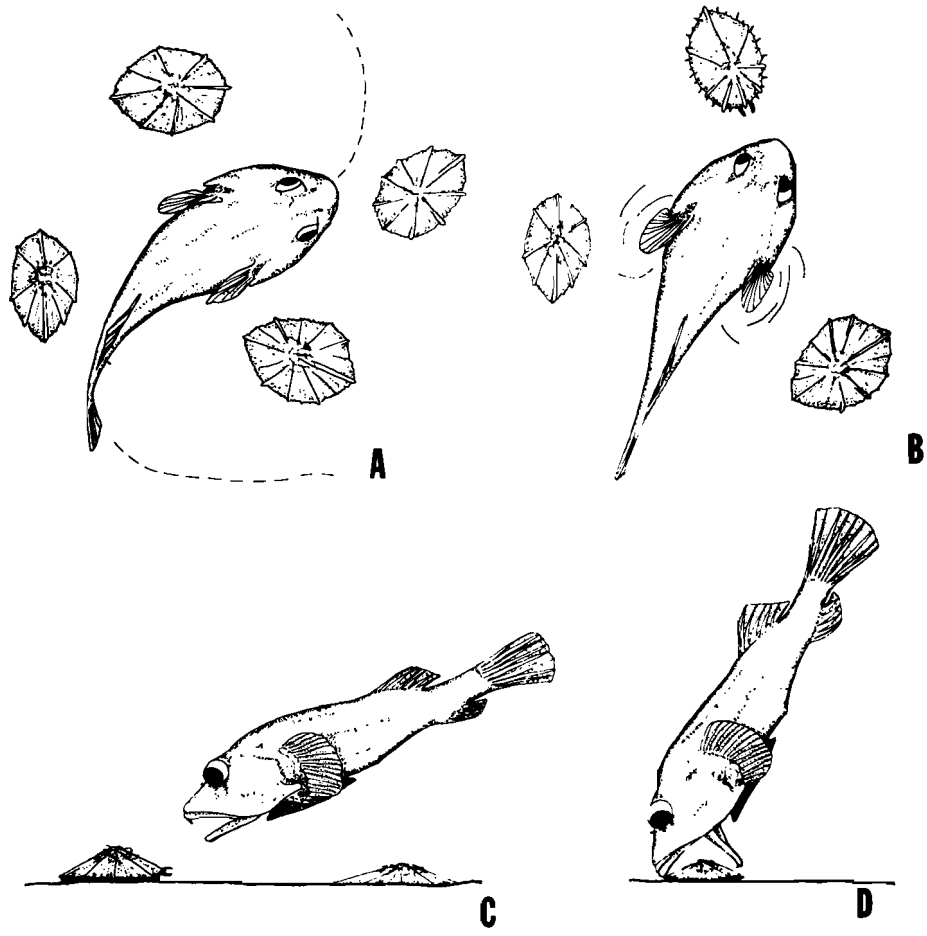

Fig. 2 Prey recognition and attack manoeuvres of *Chorisochismus dentex*. A. Random movements, when limpets adhere closely to the substrate. B. Recognition of raised limpet with epipodial tentacles extended. C. Attack on raised limpet. D. Levering off limpet using upper incisiform teeth.

initial leap to swallowing the shell is very rapid. The three filmed sequences gave times of 0,81 1,06 and 1,31 s. These observations confirm the suggestion made by Smith (1964) that the large incisiform teeth might play an important part in levering off adhering limpets.

Voiding of patellid prey

Smith (1964) stated that *C. dentex* eventually digests even the shell. None of the limpet shells examined in this study, however, showed any decalcification and most, apart from slight edge chips or surface etching, were in perfect condition.

It is evident from external examination that the anus is capable of considerable dilation but it seemed improbable that large, spinous limpet shells and echinoderm tests were capable of being passed *per ani*. One fish of 122 mm had inside its stomach a 31 mm *Patella cochlear* which would require considerable distension to void.

An experiment to determine whether ingested shells were regurgitated or defaecated and to determine the digestion time was set up in an aquarium devoid of substrate or rocks. Six clingfish, two juveniles of under 60 mm and four adults of over 120 mm, were introduced into the aquarium. After three days without food the fish were fed with *Helcion pectunculus, H. pruinosus* and the small shrimp *Palaemon pacificus* Stimps. until satiated. All uneaten food was then removed. Within minutes the two juveniles and two adults had each regurgitated a single small mucoid capsule containing from two to four undigested shrimps. A close watch was kept for the next eight hours during which time no fish regurgitated or defaecated. At intervals of four hours thereafter any shells or mucoid capsules were removed and the number of shells noted.

Twenty-six of 32 shells (81%) were expelled between 20 and 44 h after feeding (fig. 3). Three mucoid capcules containing digested remains of *P. pacificus* were found after 8 h (1) and 12 h (2).

Only one observation of defaecation has been made. On 20th July, 1978, a 136 mm *C. dentex* was captured and while being transported in a clean bucket was seen to be defaecating a mucoid capsule which measured 40×19 mm. Within this capsule there were three *Parechinus* tests measuring 16,8; 16,5 and 14,0 mm diameter; two digested *H. pruinosus*, the shells of which measured 17,9×14,9 mm, and 17,6×14,8 mm, and a single piece of a *Patella* shell measuring 25,5×15,6 mm. It is suggested that large aggregates of non-digestible matter are eliminated by defaecation.

Dentition

In order to ascertain whether the dietary change in *C. dentex*, from a predominantly crustacean eater when young to a mollusc eater when adult, was accompanied by a change in dentition, 22 fish were dissected and their tooth length and premaxilla length were compared to fish length (Fig. 4). No change in ratio between body length and either tooth or premaxilla length in fish between 28 and 155 mm could be demonstrated. Prey size increased in direct ratio to fish size (Fig. 5) and juvenile *C. dentex* should be capable of removing small limpets: that they do not must be ascribed to other reasons and not to any change in dentition.

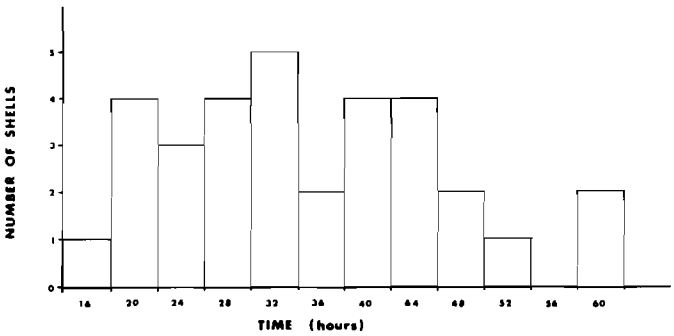

Fig. 3 Expulsion time, after ingestion, of shells of *Helcion pectunculus* and *H. pruinosus* by *Chorisochismus dentex*.

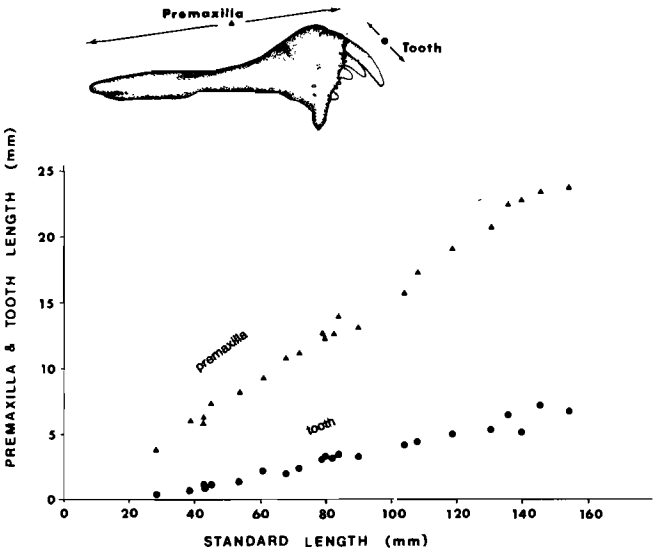

Fig. 4 Relationship between premaxilla and tooth length and standard length of *Chorisochismus dentex*.

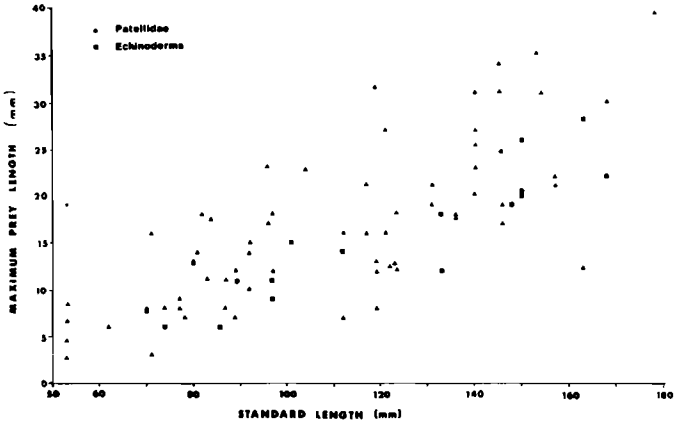

Fig. 5 Relationship between standard length of *Chorisochismus dentex* and maximum length of major prey (Patellidae and echinoderms).

Discussion

The present study confirms the statements made by Jackson (1950), Smith (1964), Gow (1968) and Branch (1971), that *C. dentex* eats limpets. It is clear, moreover, that this food source forms the major part of the diet of adult *C. dentex*. Furthermore, since in South Africa neither the intertidal cheilodactylids (Butler 1975), juvenile sparids (Christensen 1976) nor gobiids (Pitt-Kennedy 1968; Winterbottom 1976) which together dominate the intertidal fish fauna, utilize more than the occasional small limpet, adult *C. dentex* may be the major fish predator on an otherwise seldom utilized food resource of the South African intertidal zone.

Gould (1965) reported the presence of excretory capsules in the emerald clingfish, *Acyrtops beryllinus* (Hildebrand & Ginsberg). Gow (1968) found that *C. dentex* voided shells intact, neatly fitted into each other, within a mucous sheath. In the current work it was found that all material excreted by *C. dentex* was encased in mucoid capsules. All digested gut contents examined during dissection were also mucous-encased. Some undigested molluscs found in the stomach were surrounded by an amorphous mucous mass. It is possible that the mucoid capsules prevent damage which would otherwise be caused to the fish by sharp-edged or spinous shells and echinoderm spines. Finally it is conjectured that food within the stomach can be regurgitated if necessary but that once it has passed beyond the stomach it is defaecated in the normal manner.

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