Diet composition and breeding cycle of blacktail, *Diplodus sargus capensis* (Pisces: Sparidae), caught off St Croix Island, Algoa Bay, South Africa

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The contents of the alimentary tracts of *D. sargus capensis* were analysed to establish diet composition. The importance of analysing stomach, intestine and total alimentary tract, separately, is emphasized. *D. sargus capensis* is an omnivore preying on lower intertidal and shallow subtidal benthic species. Cirripedia and algae were the most important groups and constitute *ca.* 60% of the total dietary composition. *Ulva* sp., *Perna perna* and *Balanus* spp. were prefered species. A new index for ranking prey items, which combines the modified points method and the frequency of occurrence method, is suggested. It is especially useful for omnivorous fish where prey items such as seaweed and colonial organisms are difficult to enumerate. Ambosexual individuals differentiate into functional males or functional females. Active spermatogenesis in the ovo-testis suggests a special type of protandric development. *D. sargus capensis* has an extended breeding cycle with a peak spawning period from October to December.
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Die inhoud van die spysverteringskanale van *D. sargus capensis* is geanaliseer om die samestelling van die dieet vas te stel. Die belangrikheid om die maag, intestinum en totale spysverteringskanaal afsonderlik te analiseer, word beklemtoon. *D. sargus capensis* is 'n opportunistiese omnivoor wat die bentiese spesies van die lae intergety- en subgetyvlak vreet. Cirripedia en seewiere was die belangrikste groepe en het tesame *ca.* 60% van die totale dieet uitgemaak. *Ulva* sp., *Perna perna* en *Balanus* spp. was gesogte spesies. 'n Nuwe indeks om prooi-items volgens voorkeur te rangskik word voorgestel. Dit kombineer die teenwoordigheidsfrekwensiemetode en die gewysigde puntemetode en is veral toepaslik op omnivore visse, waar prooi-items soos seewiere en koloniale organismes moeilik is om te tel. Amboseksuele individue gee oorsprong aan funksionele mannetjies of funksionele wyfies. Aktiewe spermatogenese in die ovo-testis suggereer 'n spesiale tipe protandriese ontwikkeling. *D. sargus capensis* het 'n verlengde broeiseisoen met 'n piek kuitskietperiode vanaf Oktober tot Desember.
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The blacktail, *Diplodus sargus capensis* is abundant around the coast of southern Africa (Smith 1972) where it is commonly found in both rocky and sandy areas (Joubert 1981a; Coetzee & Baird 1981a; Lasiak 1982, 1983). Juveniles and sub-adults also occur in estuaries (Winter 1979; Day, Blaber & Wallace 1981; Beckley 1983; Marais 1983) and tidal pools (Christensen 1976; Beckley 1985).

A survey of anglers' catches off St Croix Island in Algoa Bay, from December 1975 to February 1978, showed that *D. sargus capensis* was one of the most important angling species in terms of both numbers and mass caught (Coetzee & Baird 1981a). Although *D. sargus capensis* does not attain a large size (current South African angling record — 2,9 kg, Van der Elst 1981), it is much sought after by light-tackle angling enthusiasts. Its importance as an angling fish is also documented by Wallace & Van der Elst (1983) in the listing of priority species of the South African Marine Linefish Programme.

Studies on the feeding and breeding biology of *D. sargus capensis* to date refer to juveniles and sub-adults (Christensen 1978; Lasiak 1982, 1986) or report on fish from Natal (Joubert & Hanekom 1980). The present paper is specific to Algoa Bay and complements work done elsewhere, illustrating the influence of different coastal regions on the diet and spawning period.

Material and Methods

Fish were obtained from anglers' monthly catches on St Croix Island (Figure 1) during December 1975 through February 1978 (Coetzee & Baird 1981a). All length measurements are from the tip of the snout to the end of the longest caudal fin (total length, TL).

Alimentary tracts were fixed in 10% neutral formalin. Analysis of stomach and intestine contents were done separately, the food items identified to species level whenever possible and expressed by modified points and frequency of occurrence methods described by Coetzee & Baird (1981b). As the former method gives an estimate of volume, a 'Relative Importance Value' (RIV) was calculated for ranking the important prey items:

$$RIV = \%\ \text{volume} \times \%\ \text{frequency of occurrence}$$

Gonads collected during the whole sampling period were examined macroscopically. The procedures and reproductive stage classification systems used in this study were those described by Coetzee (1983).

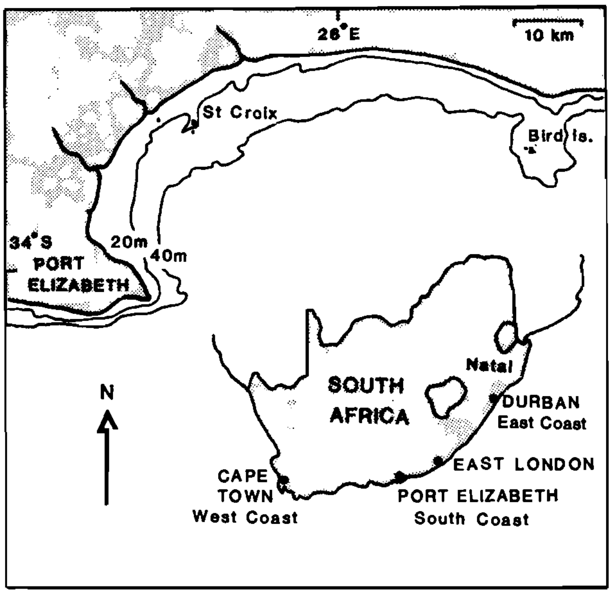

Figure 1 Map of Algoa Bay showing the location of the offshore island, St Croix. Inset: coastline of South Africa, indicating the major regions discussed in the text.

Results

Diet composition

One hundred and ninety three alimentary tracts were examined; of these 29,5% of the stomachs and 20,2% of the intestines were empty. Volumetrically, intestines contained more food than stomachs.

The dietary composition of the stomachs, intestines as well as complete alimentary tracts is given in Table 1. Fish had a mean size of 329 mm TL and were within the size range of 210 mm to 420 mm TL.

Stomach and intestine contents reflected similar trends in the relative importance of food items, although the latter frequently showed higher values for certain items. This is due to retention of food undergoing digestion and the accumulation of undigested exoskeletons and shell fragments.

The contribution of food items to total diet is best reflected by the RIV, calculated for the whole alimentary tract (Table 1 and Figure 2). Cirripedes and algae were the most important and constituted approximately 60% of the total dietary composition. A further *ca.* 25% is contributed by bivalves, brachyura, ascidiacea and echinoidea (miscellaneous remains excluded). Species commonly present in the alimentary tract were: *Ulva* spp., *Cheilosporum cultratum, Amphiroa* sp., *Jania* sp., *Parechinus angulosus, Perna perna, Pseudonereis variegata, Balanus* spp. and *Plagusia chabrus.*

Breeding cycle

The gonads of 299 blacktail of a size range similar to the fish used for dietary analysis were examined. *D. sargus capensis* exhibits hermaphroditism, with the functional females being larger (mean TL 335 mm) than functional males (mean TL 317 mm) and those with distinct ovo-testes being the smallest (mean TL 293 mm). The size frequency distribution of the two functional sexes are presented in Figure 3.

Histologically the ovo-testis, functional ovary and functional testis of *D. sargus capensis* were similar to those described by Coetzee (1983) for *Cheimerius nufar*. All fish caught were sexually mature adults and testicular tissue was rarely evident in the functional ovaries, whilst the functional testes were found to have a rudimentary oviduct.

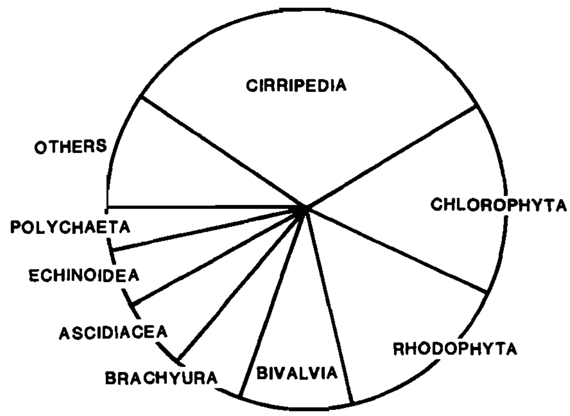

Figure 2 The diet composition of *Diplodus sargus capensis*, based on the Relative Importance Values (RIV) of major food categories found in the whole alimentary tract.

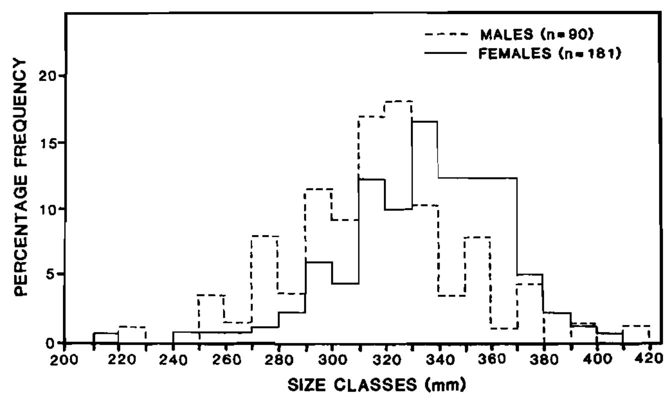

Figure 3 Length – frequency distribution of female and male *Diplodus sargus capensis* (total length measurements), caught off St Croix island from December 1975 to February 1978.

The ovarian part of the ovo-testes showed no seasonal activity until sex separation was almost complete. No yolk formation was evident in these ovo-testes and the most advanced oocyte development stages present were early and late peri-nuclear oocytes. In contrast, ovo-testes with at least 60% testicular tissue showed active spermatogenesis and signs of sperm discharge during the spawning season.

To illustrate seasonal changes in functional females and males over a year, results from the whole sampling period were pooled (Figure 4). Both sexes have mature or ripe gonads throughout the year, with spawning taking place during the months October to February. A noticeable increase in spermiogenesis within the testicular lobules was apparent towards the beginning of October. Residual and/or newly formed sperm were present in the main sperm ducts of functional males throughout most of the year. The peak spawning period, October to December, is shorter and more distinct in the functional females, as it is apparent that the functional males remain reproductively active for a longer period (Figure 4).

Discussion

Diet composition

Various methods are commonly used to analyse the contents of fish alimentary tracts (Ricker 1971; Hyslop 1980). The methods used are variable and there is no single technique providing satisfactory information regarding the importance of prey items. Investigators also use methods that are

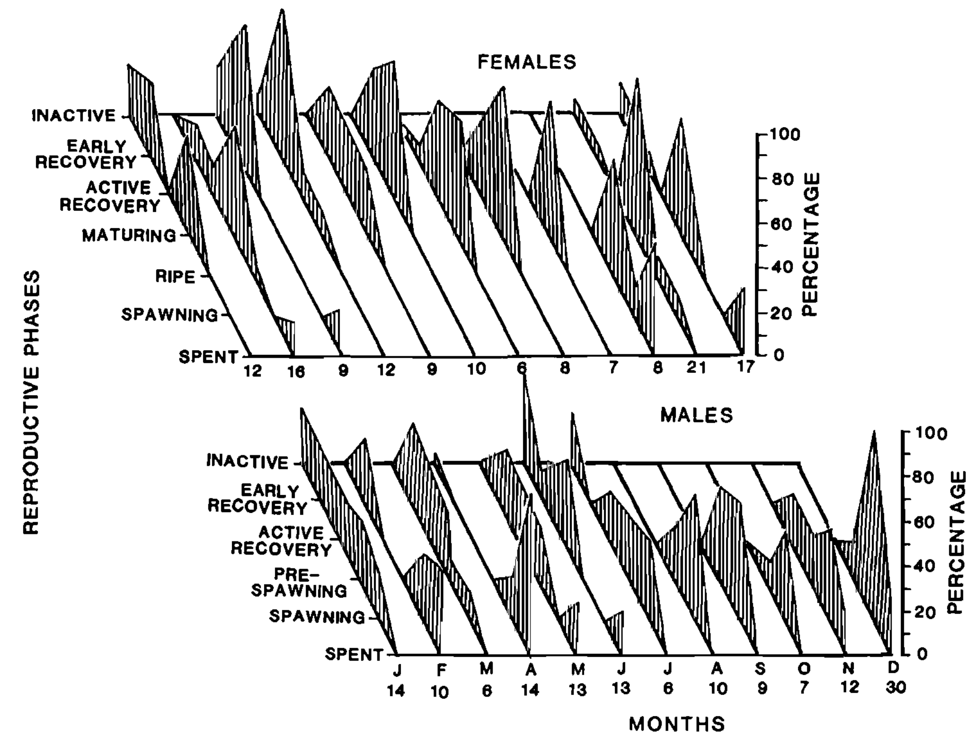

Figure 4 Monthly percentage occurrence of different reproductive phases for female and male *Diplodus sargus capensis*. Number of fish sampled per month is indicated.

Table 1 The composition of stomach, intestine and whole alimentary tract contents of *Diplodus sargus capensis*

	Points method			Frequency of occurrence			RIV		
Food component	Stomach %	Intestine %	Whole alimentary %	Stomach %	Intestine %	Whole alimentary %	Stomach	Intestine	Whole alimentary
Porifera	1,5	0,7	0,8	3,7	3,9	6,8	5,6	2,7	5,4
Hydrozoa	5,1	2,0	3,2	20,3	23,4	28,6	103,5	46,8	91,6
Lytocarpus sp.	1,3	0,2	0,6	2,2	2,6	2,5	2,9	0,5	1,5
Aglaophenia pluma	1,3	0,03	0,5	2,2	3,3	4,3	2,9	0,1	2,2
Antenella africana, Thecocarpus sp. *Sertularella* sp. *			0,01*			1,8*			0,02*
Ectocarpus sp.	0,2	–	0,1	2,2	–	1,2	0,4	–	0,1
Anthozoa	1,7	0,4	0,9	3,7	3,3	4,3	6,3	1,3	3,9
Polychaeta	7,1	2,3	4,2	23,5	27,9	35,4	116,9	64,2	148,7
Pseudonereis variegata	2,0	1,0	1,4	6,6	11,7	13,7	13,2	11,7	19,2
Lysidice sp.	0,2	0,5	0,4	2,9	3,3	5,0	0,6	1,7	2,0
Ophionereis porrecta, Polynoe scolopendrina, Lumbinereis coccinia, Lepidonotus semitatus & *Pomatoleios krausii* *			0,07*			1,2*			0,08*
Sipunculida	0,4	0,04	0,2	0,7	1,3	1,9	0,3	0,05	0,4
Pycnogonida	0,1	0,1	0,1	2,9	6,5	6,8	0,3	0,7	0,7
Endeis sp., *Nymphon* sp. *Nymphopsis cuspidata* *			0,02*			1,2*			0,02*
Cirripedia	11,2	11,5	17,8	37,5	71,4	74,5	420,0	821,1	1326,1
Balanus algicola	3,1	2,3	2,6	4,4	6,5	8,1	13,6	15,0	21,1
Balanus amphitrite	1,0	1,8	1,5	2,2	9,1	9,9	2,2	16,4	14,9
Balanus maxillaris	0,2	0,4	0,3	0,7	4,6	4,3	0,1	1,8	1,3
Balanus trigonus	0,7	0,1	0,9	3,7	4,6	6,2	2,6	0,5	5,6
Balanus spp.	2,6	2,8	2,7	15,4	29,9	57,8	40,0	83,7	156,1
Chthalamus sp.	0,3	0,3	0,3	0,7	0,7	1,9	0,2	0,2	0,6
Octomeris angulosa	0,5	1,1	0,9	1,5	3,3	3,7	0,8	3,6	3,3

Table 1 Continued

Food component	Points method: Stomach %	Points method: Intestine %	Points method: Whole alimentary %	Frequency of occurrence: Stomach %	Frequency of occurrence: Intestine %	Frequency of occurrence: Whole alimentary %	RIV: Stomach	RIV: Intestine	RIV: Whole alimentary
Amphipoda, Isopoda, Tanaidacea	2,2	0,7	1,3	38,2	45,5	52,2	84,0	31,9	67,9
Brachyura	6,9	5,7	6,2	19,9	30,5	39,1	137,3	173,9	242,4
Dehaanius sp.	0,04	0,3	0,2	1,5	3,3	3,1	0,06	1,0	0,6
Leucisia squalina	–	0,05	0,03	–	2,0	1,9	–	0,1	0,06
Plagusia chabrus	2,4	3,7	3,2	2,9	7,1	8,1	7,0	26,3	25,9
Anomura	present	present	present	0,7	0,7	1,2	present	present	present
Natantia	0,9	0,002	0,4	2,2	0,7	1,9	2,0	0,01	0,8
Polyplacophora	–	0,04	0,04	–	0,7	1,7	–	0,03	0,07
Ischnochiton sp. & *Placophora binderi* *			0,01*			1,2*			0,01*
Gastropoda	1,6	1,9	1,8	14,7	45,5	48,4	23,5	86,5	87,1
Patella granularis	0,3	0,2	0,3	0,7	3,3	5,0	0,2	0,7	1,5
Fissurella mutabulis	0,2	0,3	0,3	3,7	19,5	21,1	0,7	5,9	6,3
Patella tabularis, P. barbara, P. miniata, Siphonaria capensis, Helcion pruinosus, Oxystele sp., *Haliotus parva, Vermetus* sp., *Turitella carinifera, Triphora africana* *			0,09*			1,9*			0,2*
Crepidula aculeata	0,6	0,6	0,6	1,5	11,0	7,5	0,9	6,6	4,5
Eatonella sp. & *Rissoa* sp. *	0,04	0,1	0,07	43,2	45,6	83,6	1,7	4,6	5,9
Bivalvia	6,1	6,4	6,3	25,7	59,1	59,6	156,8	378,2	375,5
Perna perna	5,0	6,0	5,6	18,4	42,9	44,1	92,0	257,4	247,0
Tapes corrugatus	0,1	0,1	0,1	2,9	12,3	11,8	0,3	1,2	1,2
Musculus cimeatis	present	0,1	0,1	0,7	5,9	6,8	present	0,6	0,7
Lima rotundata, Chlamys tinctus, Cardium turtoni & *Cardita variegata* *			0,05*			1,9*			0,1*
Cephalopoda	0,1	1,3	0,8	0,7	5,8	5,0	0,1	7,5	4,0
Bryozoa	1,7	1,7	1,7	11,0	23,4	25,5	18,7	39,8	43,4
Celleporella sp.	0,03	0,08	0,05	0,7	6,5	6,8	present	0,5	0,3
Alysidium sp.	0,5	1,1	0,9	1,5	4,6	3,7	0,8	5,1	3,3
Menipea crispa, Laminopora bimunita & *Cristidia* sp. *			0,05*			1,9*			0,1*
Onchoporella buskii	0,02	0,1	0,1	1,5	3,9	4,3	present	0,4	
Echinoidea	1,8	5,3	4,0	20,6	50,0	49,1	37,1	265,0	196,4
Parechinus angulosus	1,8	5,3	4,0	20,6	50,0	49,1	37,1	265,0	196,4
Asteroidea	0,7	0,1	0,3	1,5	1,3	1,9	1,1	0,1	0,6
Patiriella exigua	–	0,1	0,04	–	1,3	1,2	–	0,1	0,5
Henricia ornata	0,7	–	0,3	1,5	–	0,6	1,1	–	0,2
Ophiuroidea	0,5	0,3	0,4	3,7	10,4	11,2	1,9	3,1	4,5
Amphiotrix fragilis	0,3	0,04	0,2	1,5	0,7	1,2	0,5	present	0,2
Amphioplus integer, Ophiarachnella capensis, Ophiactis carnea & *Placophiotrix foveolata* *			0,03*			1,9*			0,6*
Crinoidea	0,6	1,2	0,9	3,7	9,7	8,7	2,2	11,6	7,8
Ascidacea	4,7	6,5	5,8	16,2	37,0	39,8	76,1	240,5	230,8
Didemnum spp.	3,9	4,9	4,5	14,0	28,6	33,5	54,6	140,1	150,8
Pisces	5,2	1,9	3,2	9,6	7,8	14,3	49,9	14,8	45,8
Etrumeus teres	1,4	–	0,5	0,7	–	0,6	1,0	–	0,3

Table 1 Continued

Food component	Points method Stomach %	Intestine %	Whole alimentary %	Frequency of occurrence Stomach %	Intestine %	Whole alimentary %	RIV Stomach	Intestine	Whole alimentary
Chlorophyta	18,1	10,2	12,4	34,6	43,5	52,2	626,3	443,7	647,3
Bryopsis sp.	0,9	0,1	0,4	1,5	2,6	4,0	1,4	0,3	1,6
Cladophora sp.	1,5	1,1	1,3	5,9	9,7	10,6	8,9	10,7	13,8
Enteromorpha sp.	3,3	1,4	2,1	7,4	11,0	12,4	24,4	15,4	26,0
Ulva sp.	8,8	6,1	7,1	25,0	33,8	39,8	220,0	206,2	282,6
Caulerpa sp. & *Codium lucassi* *			0,04*			1,3*			0,05*
Rhodophyta	8,3	12,7	10,0	35,3	53,9	59,0	293,0	684,5	590,0
Amphiroa sp.	0,3	1,1	0,8	5,2	14,3	15,5	1,6	15,7	12,4
Arthrocardia sp.	0,4	0,6	0,5	1,5	3,9	4,3	0,6	2,3	2,2
Champia compressa	0,8	0,1	0,3	5,2	2,6	6,2	4,2	0,3	1,9
Cheilosporum cultratrum	1,1	4,0	2,9	13,2	36,4	37,3	14,5	145,6	108,2
Corallina sp.	0,6	0,1	0,3	2,2	3,3	5,0	1,3	0,3	1,5
Gelidium sp.	0,7	0,2	0,4	3,7	5,8	7,5	2,6	1,2	3,0
Gigartina sp.	0,9	0,2	0,5	3,7	2,6	5,0	3,3	0,5	2,5
Gymnogongrus sp.	0,3	0,1	0,2	1,5	2,0	2,5	0,5	0,2	0,5
Hypnea spicifera	0,7	0,8	0,8	5,2	7,8	8,7	3,6	6,2	7,0
Jania sp.	0,9	2,2	1,7	2,9	17,5	15,5	2,6	38,5	26,4
Plocamium sp.	0,2	0,3	0,3	2,9	4,6	6,8	0,6	1,4	2,0
Laurencia sp., *Hildebranchia* sp., *Lithothamnion* sp., *Polysiphonia* sp., *Caulacanthus* sp., *Duthiophycus setchellii* & *Chondrococcus hornemanii* *			0,07*			1,9*			0,1*
Pterosiphonia cloiophylla	0,04	0,5	0,3	0,7	5,2	5,0	present	2,6	1,5
Phaeophyta	0,01	0,3	0,2	0,7	3,9	2,5	0,1	1,2	0,5
Dictyota sp.	0,1	0,3	0,2	0,7	3,9	2,5	0,1	1,2	0,5
Shell fragments	0,5	0,9	0,7	5,2	6,5	7,5	2,6	5,9	5,3
Miscellaneous (Unidentified remains of unknown origin)	12,7	25,5	16,3	32,4	66,9	71,4	411,5	1706,0	1163,8

*Values given are for all species combined

unsatisfactory for their specific study, but are useful for comparative purposes. Methods frequently used are: frequency of occurrence, numbers and the volumetric importance (volume or mass) of individual food items (Cailliet 1976; Hyslop 1980). Pinkas, Oliphant & Iverson (1971) incorporated these three methods in their 'Index of Relative Importance' (IRI) to provide a single system for ranking items.

In this study, a modification of the IRI was used, termed the 'Relative Importance Value' (RIV). The RIV incorporates frequency of occurrence and the modified points method used by Coetzee & Baird (1981b). The latter gives a volumetric estimate while the former describes the availability/selection of food items. The RIV excludes the numerical method because of the difficulty in estimating the number of algae, sponges, colonial organisms and fragmented barnacles/ molluscs ingested.

The importance of analysing components along the whole alimentary tract is evident in Table 1. Small gastropods, *Eatoniella* spp. and *Rissoa* spp., are similarly abundant in stomachs and intestines (43,2% and 45,6% respectively) yet their frequency almost doubled when the complete alimentary tract was considered (83,6%). Similarly, the relative importance of these two species is emphasized to a greater extent when the frequency of occurrence method is compared with the points method. The use of a ranking value, the RIV, places these species in perspective.

Algae and barnacles formed the main components of the diet. Joubert & Hanekom (1980) also found algae to be important, particularly *Ulva* species. In their study rhodophytes and chlorophytes occurred in more than 60% of stomachs analysed, compared to 35% in the present investigation. This however increased to *ca.* 50% if the whole alimentary tract is considered (Table 1). Both studies showed that algae pass through the alimentary tract without being digested. Joubert & Hanekom (1980) suggested that the seaweeds are ingested for their epiphytic diatoms. On St Croix Island, the rhodophytes *Jania, Corallina, Laurencia* and *Gelidium* form algal mats in the lower balanoid and cochlear zones, whereas the chlorophytes, *Ulva* and *Enteromorphoa* are more common in the shallow rock pools (Beckley & McLachlan 1979). The abundance of epifauna associated with these littoral seaweeds (Beckley & McLachlan 1980) could account for the presence of small gastropods and crustacea in the fish guts.

Similarly, hydroids, bryozoans and compound ascidians may be ingested for their associated fauna, *inter alia* polychaetes (*Lysidice* sp., *Lumbinereis conccinea*), gastropods (*Crepidula aculeata, Haliotus parva, Turitella carinifera*), bivalves (*Tapes corrugatus, Lima rotundata, Chlamys tinctus, Cardium turtoni, Cordita variegata*) and ophiuroids (*Amphiotrix fragilis, Amphioplus integer, Ophiarachnella capensis, Ophiactis carnea, Placophiotrix foveolata*) (Table 1).

Species inhabiting the mid-balanoid and lower balanoid intertidal zones, such as *Chthalamus dentatus, Octomeris angulosa, Patella granularis* and *Perna perna* (De Villiers 1976; Beckley & McLachlan 1979; Randall & Randall 1982), were frequently preyed upon by *D. sargus capensis*. Both large and small individuals of the brown mussel, *Perna perna*, were taken.

The latter size occur in seaweed tufts (Beckley & McLachlan 1979; Beckley 1979) that are often grazed. Another important prey species was the polychaete *Pseudonereis variegata* which occurs in dense *Perna perna* patches.

The results of Christensen (1978), Joubert & Hanekom (1980), Lasiak (1986) and the present study clearly show that *D. sargus capensis* is omnivorous. Although *D. sargus capensis* does show preference for certain prey species, e.g. *Ulva* spp., *Perna perna* and *Balanus* spp., it is opportunistic in its feeding behaviour.

The South African coastline is divided into three distinct geographic regions, i.e. west, east and south coasts, based on the littoral biota (Stephenson 1939; Branch & Branch 1981). *D. sargus capensis* caught along the east coast (Joubert & Hanekom 1980) and south coast (present study) have very similar diets, although the actual species preyed upon are specific to each geographic region. The present study indicates that *D. sargus capensis* feeds in the shallow sublittoral zone, making feeding excursions into the intertidal areas, thereby increasing its extensive array of prey items.

Direct comparison of different feeding studies done on *D. sargus capensis* are difficult owing to the absence of a uniform analytical method. The adoption of an Index of Relative Importance (Pinkas *et al.* 1971) or a Relative Importance Value as a means of expressing the 'importance' of prey items, could make comparisons between different studies more valuable.

Breeding cycle

In common with many species of Sparidae, *D. sargus capensis* exhibits hermaphroditism (Lissia-Frau & Pala 1968; Reinboth 1970). The fish undergoes sex separation to give rise to either a functional female or a functional male. Similar developments have been recorded for other sparids (Coetzee 1983).

Active spermatogenesis is evident in the testicular part of the ovo-testis, whereas oocyte development never progresses past the early and late perinuclear oocyte stages. Maturation of oocytes and spawning only takes place in sex separated females, i.e. after regression of testicular tissue. Gonadal cell development of functional females and functional males is similar to that of gonochoristic species. According to the results of Lissia-Frau & Pala (1968), Joubert (1981b) and the present study, *D. sargus capensis* can be considered a protandric species. However, it should be considered a special form of protandry as reproductively mature individuals could either be functional males, functional females or ambosexual functional males; the latter may develop secondarily into either sex.

Fish from the more tropical regions generally start spawning before those of the temperate and colder areas (Coetzee 1983). *D. sargus capensis* appear to follow this trend, although the results are less conclusive owing to its extended breeding season. In Natal the spawning period peaks between July and September (Joubert 1981b), whilst in the Eastern Cape Lasiak (1983) demonstrated the presence of ripe fish during June to November at King's Beach, Port Elizabeth.

Beckley (1983) recorded an influx of early juveniles into the Swartkops estuary (Eastern Cape) during November and December. According to data presented by Brownell (1979), larval *D. sargus capensis* take approximately two months to become early juveniles of the size recorded by Beckley (1983). Winter (1979) caught slightly larger juveniles in the same estuary between January and May. From the above evidence it thus appears that the peak spawning period for *D. sargus capensis* in the Eastern Cape is September/October. In this study, the peak spawning period was found to be in the early spring and summer period, October to December.

D. sargus capensis eggs collected in False Bay (Western Cape) by Brownell (1979) during the months July, August and September, only contributed approximately 1% to the total number of eggs collected throughout the whole year. Most *D. sargus capensis* eggs were found in October, November and January.

It is thus evident that *D. sargus capensis* has a prolonged breeding season along the whole coastline of southern Africa. Peak spawning in the sub-tropical Natal region occurs in late winter, whilst in more temperate areas it takes place during mid-summer. This pattern has also been documented for other sparids (Brownell 1979; Coetzee 1983).

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References

BECKLEY, L.E. 1979. Primary settlement of *Perna perna* (L.) on littoral seaweeds on St Croix Island. *S. Afr. J. Zool.* 14: 171.

BECKLEY, L.E. 1983. The ichthyofauna associated with *Zostera capensis* Setchell in the Swartkops estuary, South Africa. *S. Afr. J. Zool.* 18: 15 – 24.

BECKLEY, L.E. 1985. The fish community of East Cape tidal pools and an assessment of the nursery function of this habitat. *S. Afr. J. Zool.* 20: 21 – 27.

BECKLEY, L.E. & McLACHLAN, A. 1979. The littoral seaweed epifauna of St Croix Island. I. Physical and biological features of the littoral zone. *S. Afr. J. Zool.* 14: 175 – 182.

BECKLEY, L.E. & McLACHLAN, A. 1980. Studies on the littoral seaweed epifauna of St Croix Island. 2. Composition and summer standing stock. *S. Afr. J. Zool.* 15: 170 – 176.

BRANCH, G. & BRANCH, M. 1981. The living shores of Southern Africa. C. Struik Publishers, Cape Town. 272 pp.

BROWNELL, C.L. 1979. Stages in the early development of 40 marine fish species with pelagic eggs from the Cape of Good Hope. *Ichthyol. Bull. Rhodes Univ.* 40: 1 – 84.

CAILLIET, G.M. 1976. Several approaches to the feeding ecology of fishes. In: Fish food habits studies, (eds) Simenstad, C.A. & Lipovsky, S.J. University of Washington, Seattle, Washington, pp. 1 – 13.

CHRISTENSEN, M.S. 1976. Aspects of the feeding ecology of the common sparid fish in the littoral zone at Clayton's Rocks in the Eastern Cape, with notes on their biology. M.Sc. thesis, Institute of Ichthyology, Rhodes University, South Africa.

CHRISTENSEN, M.S. 1978. Trophic relationships in juveniles of three species of sparid fishes in the South African marine littoral. *Fishery Bull., Wash.* 76(2): 389 – 401.

COETZEE, P.S. 1983. Seasonal histological and macroscopic changes in the gonads of *Cheimerius nufar* (Ehrenberg, 1820) (Sparidae: Pisces). *S. Afr. J. Zool.* 18: 76–88.
COETZEE, P.S. & BAIRD, D. 1981a. Catch composition and catch per unit effort of anglers' catches off St Croix Island, Algoa Bay. *S. Afr. J. Wildl. Res.* 11: 14–20.
COETZEE, P.S. & BAIRD, D. 1981b. Age, growth and food of *Cheimerius nufar* (Ehrenberg, 1820) (Sparidae), collected off St Croix Island, Algoa Bay. *S. Afr. J. Zool.* 16: 137–143.
DAY, J.H., BLABER, S.J.M. & WALLACE, J.H. 1981. Estuarine fishes. In: Estuarine ecology with particular reference to southern Africa, (ed.) Day, J.H. A.A. Balkema, Cape Town. pp. 197–221.
DE VILLIERS, A. 1976. Ecology of macrofauna inhabiting plane surfaces in the littoral zone of St Croix Island with notes on the effects of ore dust. B.Sc. Hons. project. University of Port Elizabeth, Port Elizabeth.
HYSLOP, E.J. 1980. Stomach content analysis — a review of methods and their application. *J. Fish. Biol.* 17: 411–429.
JOUBERT, C.S.W. 1981a. A survey of shore anglers' catches at selected sites on the Natal coast, South Africa. *Investl Rep. oceanogr. Res. Inst.* (52): 1–15.
JOUBERT, C.S.W. 1981b. Aspects of the biology of five species of inshore reef fishes of the Natal coast, South Africa. *Investl Rep. oceanogr. Res. Inst.* (51): 1–16.
JOUBERT, C.S.W. & HANEKOM, P.B. 1980. A study of feeding in some inshore reef fish on the Natal coast, South Africa. *S. Afr. J. Zool.* 15: 262–274.
LASIAK, T.A. 1982. Structural and functional aspects of the surf-zone fish community in the Eastern Cape. Ph.D. thesis, University of Port Elizabeth, South Africa. 459 pp.
LASIAK, T.A. 1983. Recruitment and growth patterns of juvenile marine teleosts caught at King's Beach, Algoa Bay. *S. Afr. J. Zool.* 18: 25–30.
LASIAK, T.A. 1986. Juveniles and the surf zone habitat: implications for teleost nursery areas. *S. Afr. J. Zool.* 21: 51–56.
LISSIA-FRAU, A.M. & PALA, M. 1968. Ricerche sull 'ermafroditismo nei Saraghi: *Diplodus sargus* (L.), *Diplodus vulgaris* (Geoffr.), *Diplodus annularis* (L.) e *Puntazzo puntazzo* Cetti. *Studi Sassaresi* 2: 221–242.
MARAIS, J.F.K. 1983. Seasonal abundance, distribution and catch per unit effort of fishes in the Krom estuary, South Africa. *S. Afr. J. Zool.* 18: 96–102.
PINKAS, L., OLIPHANT, M.S. & IVERSON, I.L.K. 1971. Food habits of albacore, bluefin tuna, and bonito in California water. *Calif. Fish Game* 152: 1–105.
RANDALL, R.M. & RANDALL, B.M. 1982. The hard-shelled diet of African Black Oystercatcher chicks at St Croix Island, South Africa. *Ostrich* 53: 157–163.
REINBOTH, R. 1970. Intersexuality in fishes. *Mem. Soc. Endocrinol.* 515–544.
RICKER, W.E. 1971. Methods for assessment of fish production in fresh waters. 2nd Edn, Blackwells, Oxford. 348 pp.
SMITH, J.L.B. 1972. The sea fishes of southern Africa, 5th Edn, Central News Agency, Cape Town. 580 pp.
STEPHENSON, T.A. 1939. The constitution of the intertidal fauna and flora of South Africa. Part 1. *J. Linn. Soc. (Zool.)* XL: 487–541.
VAN DER ELST, R.P. 1981. A guide to the common sea fishes of Southern Africa. Struik, Cape Town. 367 pp.
WALLACE, J.H. & VAN DER ELST, R.P. 1983. Marine linefish programme priority species list. SANCOR Report no. 70, CSIR, Pretoria. 113 pp.
WINTER, P.E.D. 1979. Studies on the distribution, seasonal abundance and diversity of the Swartkops estuary ichthyofauna. M.Sc. thesis, University of Port Elizabeth, South Africa. 184 pp.