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Food of the cuttlefish *Sepia officinalis* and *S. elegans* in the Ria de Vigo (NW Spain) (Mollusca: Cephalopoda)

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(With 3 figures in the text)

A study of the diet of *Sepia officinalis* and *S. elegans* in the Ria de Vigo has shown that crustaceans are the most abundant prey in both species, followed by fish. Changes in the food composition of both species occur with growth. The type of prey eaten by the two sexes of these species is very similar. The possibility of trophic competition between juveniles of *S. officinalis* and *S. elegans* is discussed.

Contents

Introduction

The Galician rias are drowned tectonic valleys of moderate depth. The maximum depth of the Ria de Vigo is 45 m (Fig. 1). The water circulation is estuarine. Seasonal upwellings of water from the Atlantic Ocean produce very high rates of productivity (Fraga & Margalef, 1979).

Sepia officinalis L., 1758 and *Sepia elegans* Blainville, 1827 are relatively abundant, and local fisheries have developed using trawls, traps and gill-nets.

Sepia officinalis lives and spawns throughout the ria, including the inner area where the influence of the fresh water is greatest, and there are large fluctuations in salinity. It is a more euryhaline species than *S. elegans* which does not live in that zone of the ria (Guerra, 1984).

The life-cycle of *S. officinalis* in the Ria de Vigo (Guerra, 1984; Alonso-Allende & Guerra, 1984) is very similar to that observed in other places (Mangold-Wirz, 1963; Boletzky, 1983). The life cycle of *S. elegans* has only been studied by Mangold-Wirz (1963), with whom our observations in the ria are in agreement.

Abundant information on the diet of *Sepia* in captivity is available (Boletzky & Hanlon, 1983). However, very little is known about the natural food of the species. The only previous analyses of the stomach contents of *S. officinalis* are those of Najai & Ktari (1979) from the Gulf of Tunis and the brief information given by Scalera Liaci & Piscitelli (1982) from the Lesina Lagoon (Italy). Nothing is known on the diet of *S. elegans*.

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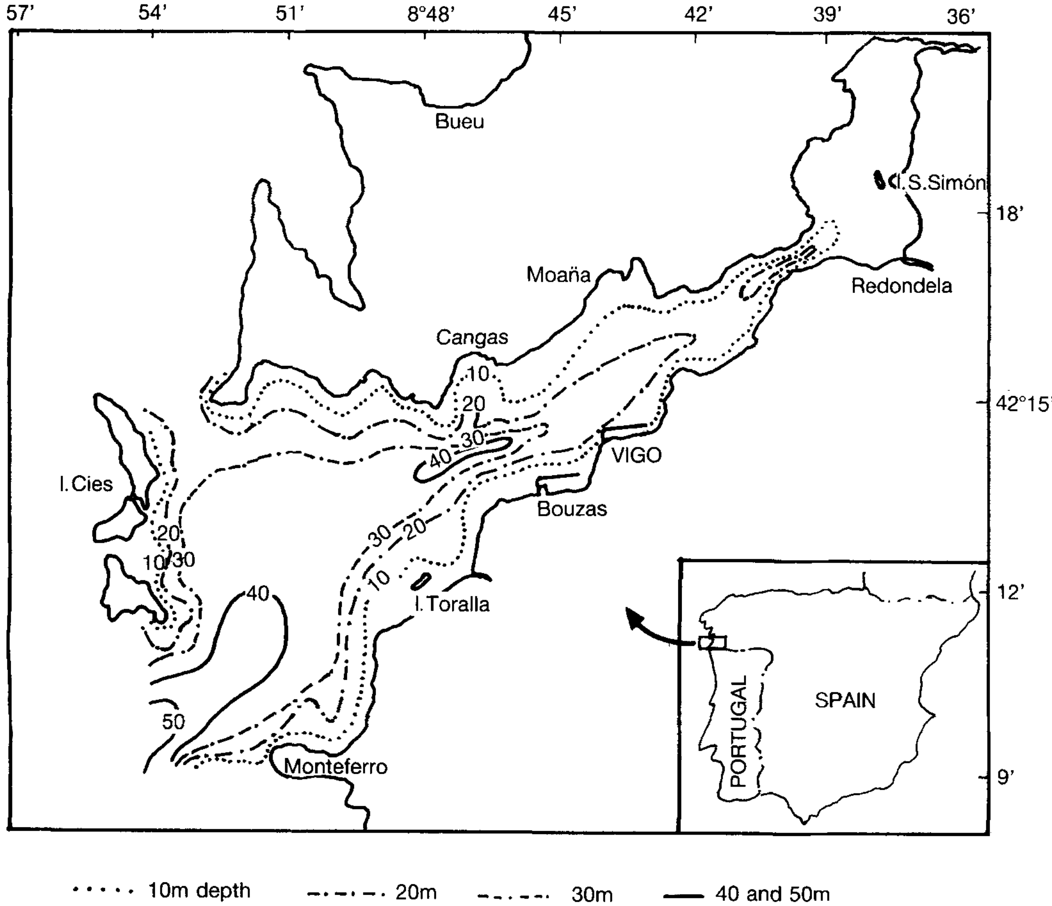

FIG. 1. Map of the Ria de Vigo. The isobars are in metres.

The aim of this work is to contribute to our knowledge of the natural diets of cephalopods. Such information is at present very scarce, despite the important rôle which cephalopods play in oceanic food webs (Clarke, 1983). This paper is the first report concerning the food of *S. elegans*.

Material and methods

The contents of full stomachs of 150 *S. officinalis* and of 72 *S. elegans* have been examined. The specimens were captured in 316 daytime trawls. The sampling period extended from April 1982 to April 1984. The vessel used was a trawler 13 m long. The gear was a small trawl whose doors weighed 15 kg each, and the mesh size of the net was 30 mm in the bag. Each trawl was usually of 20 min duration, but of only 10 min where the bottom had a dense covering of algae, *Zostera marina*, *Posidonia oceanica*, or abundant fragments of broken shells. The speed of the ship was 1–1·5 knots. Sampling operations were carried out twice each month. A total of 476 *S. officinalis* and 302 *S. elegans* was captured. The depths sampled ranged from 3–45 m.

On board ship, the animals were stored in labelled boxes, and the details were recorded on filing cards. In the laboratory, the material was studied as soon as possible after landing. The dorsal mantle length (DML), total body weight, sex and stage of maturation were determined for each specimen. Sizes of the cuttlefish whose stomach contents were analysed ranged from 20–210 mm DML in *S. officinalis* and from 14–65 mm in *S. elegans*. Composition by sexes was 59 males, 81 females and 10 undetermined in the first species, and 39 males, 32 females and 1 undetermined in the second.

The stomach contents were stored in vials with 70% ethyl alcohol.

The prey eaten was identified to the lowest taxonomic level possible. The remains found in the stomachs included scales, otoliths and pieces of flesh from fish; appendages, chelipeds and pieces of carapace from crabs; and pieces of arms, clubs, remains of beaks and radulae, as well as pieces of flesh from cephalopods.

The reference collection of otoliths prepared by the authors, U. Labarta and M. J. Ferreiro were used to aid the identification of fish, together with the papers by Chaine & Duvergier (1934), and Chaine (1935) on otoliths. Zariquiey (1968) and Ingle (1980) were consulted on the identification of crustacean remains. A. J. Figueras helped in the identification of Natantia, and J. M. Alonso-Allende with the Reptantia.

TABLE I

Food items identified from the stomachs of two cuttlefish species

	Sepia officinalis	*Sepia elegans*
CRUSTACEA		
Amphipoda	unidentified	*Gammarus* sp.
		unidentified
		eggs
Decapoda		
Natantia Caridea	unidentified	
Palaemonidae	*Palaemon adspersus*	*Palaemon adspersus*
	Palaemon serratus	*Palaemon serratus*
Crangonidae	*Crangon crangon*	*Crangon crangon*
Reptantia Brachyura		
Portunidae	*Polybius henslowii*	*Polybius henslowii*
	Liocarcinus corrugatus	*Liocarcinus* spp.
	Liocarcinus depurator	
	unidentified	
Atelecyclidae	*Atelecyclus undecindentatum*	unidentified
Brachyura	unidentified	
Reptantia Anomura		
Porcellanidae	*Pisidia longicornis*	*Pisidia longicornis*
	Porcelana platycheles	unidentified
	unidentified	
	eggs probably of *Pisidia*	
PISCES		
Gobioidei		
Gobiidae	*Gobius* spp.	
	Lesueurigobius friesii	
	probably *Aphia minuta*	probably *Aphia minuta*
	unidentified	unidentified
Pleuronectoidei		
Bothidae	*Arnoglossus laterna*	
	Arnoglossus sp.	
Soleidae	*Buglossidium luteum*	
	unidentified	
CEPHALOPODA		
Sepioidea		
Sepiolidae	*Sepiola* sp. (*S. atlantica*?)	
Sepiidae	*Sepia officinalis*	
Also piece of	*Posidonia oceanica*	*Posidonia oceanica*
	Zostera marina, algae and sand	*Zostera marina*, algae and sand

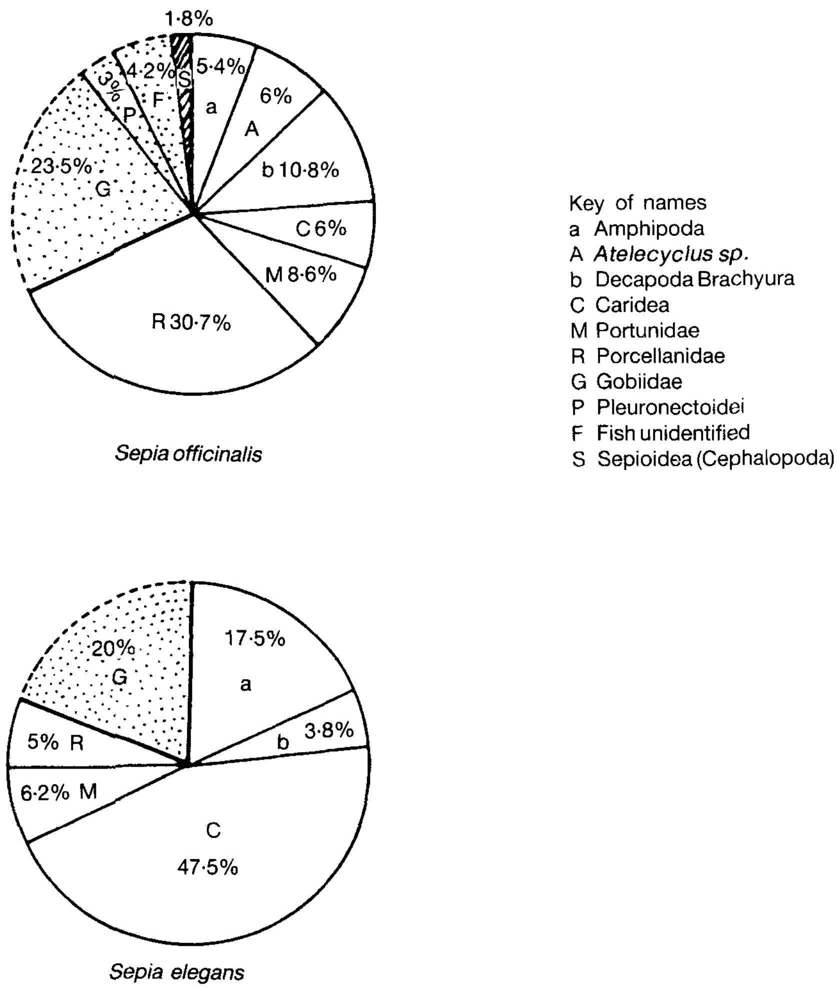

FIG. 2. Percentages of each type of prey found in *Sepia officinalis* and *S. elegans*. ◘ Crustaceans; ▫ Fish; ▨ Cephalopods.

Results

The food in each category identified from the stomach contents of the two species is shown in Table I.

In Fig. 2, the percentages of each type of prey found is given. More than one class of prey was found in 9% of *S. officinalis* and 2% of *S. elegans* stomachs.

Crustaceans were the major food category in the stomachs of *S. officinalis*, and comprised 67·5% of the total prey. Those belonging to the Porcellanidae were the most abundant. The frequency of fish remains in this species was 30·7% of the total, which included at least three Gobiidae and three Pleuronectoidei. Remains of the goby *Lesueurigobius friesii* were the most abundant. The cephalopods eaten represent 1·8% of the total food. Two cases of cannibalism were observed in specimens of 115 and 150 mm DML. Remains of *Zostera marina*, *Posidonia oceanica*, various species of algae, and grains of sand were also encountered in the digestive tract.

TABLE II
Occurrence of food items by sex in both species

Food Category	*Sepia officinalis*					*Sepia elegans*				
	Males (%)	Females (%)	Undet. (%)	Total No.	Total %	Males (%)	Females (%)	Undet. (%)	Total No.	Total %
Amphipoda	1·20	1·20	3·20	9	5·4	7·5	5·0	5·0	14	17·5
Caridea	2·40	2·40	1·20	10	6·0	25·0	22·5	—	38	47·5
Portunidae	2·40	6·20	—	14	8·6	2·5	3·7	—	5	6·2
Atelecyclidae	1·20	4·80	—	10	6·0	—	—	—	—	—
Porcellanidae	13·85	16·85	—	51	30·7	2·5	2·5	—	4	5·0
Brachyura	5·40	5·40		18	10·8		3·8	—	3	3·8
Gobiidae	12·03	11·47	—	37	23·5	10·0	7·5	2·5	16	20·0
Pleuronectoidei	1·80	2·40		7	3·0	—	—	—	—	—
Other fish	0·60	2·40	—	5	4·2	—	—	—	—	—
Sepioidea	1·80		—	3	1·8	—	—	—	—	

The type of prey taken by *S. elegans* differed somewhat from that of *S. officinalis*. Crustaceans were the major food category, representing 80% of the total diet; Palaemonidae and Crangonidae comprised 47·5% of the total, followed by Amphipoda (17·5%), whereas in *S. officinalis* these groups formed only 6% and 5·4%, respectively, of the total diet. The crabs Portunidae and Porcellanidae were also eaten by *S. elegans* but their frequencies were lower than in the other species of cuttlefish. All the fish otoliths identified in *S. elegans* stomachs were of the same species, probably the goby *Aphia minuta*. The fleshy remains may have belonged to other gobies.

No traces of polychaetes have been observed in the stomach contents of either species in the Ria de Vigo.

Figure 3 shows the type of prey taken by both species in relation to size, expressed in mm DML. The histograms in 3(a) show the number of stomachs of *S. officinalis* found with fish and cephalopod remains, and in 3(b) with crustacean remains. The number of stomachs of *S. elegans* with crustacean and fish remains are shown in Figs 3(c) and 3(d), respectively.

Figures 3(a) and 3(b) show that the food of *S. officinalis* changes with growth. Specimens of 20–45 mm DML feed mainly on Amphipoda and Caridea. These are not present in the diet of individuals larger than 55 mm DML, which feed mainly on Porcellanidae, Brachyura and different species of fish, which *S. officinalis* can capture and eat from its early stages. The frequency of this type of food increases with size, and they become the main prey, together with Portunidae, in the large, old cuttlefish.

Sepia elegans (Figs 3(c) and 3(d)) of 15–40 mm DML eat mainly Amphipoda and Natantia, and also the goby *Aphia minuta*. From 45–65 mm DML they can also eat Portunidae and Porcellanidae, but these are only found sporadically in their stomach contents.

Comparison of the prey taken by the two cuttlefish species shows that the composition of the crustacean diet of young (20–45 mm DML) *S. officinalis* is very similar to that of *S. elegans*.

Table II shows the percentage and total occurrence of each food category in both sexes of the two species. In both species the diet of males and females is similar.

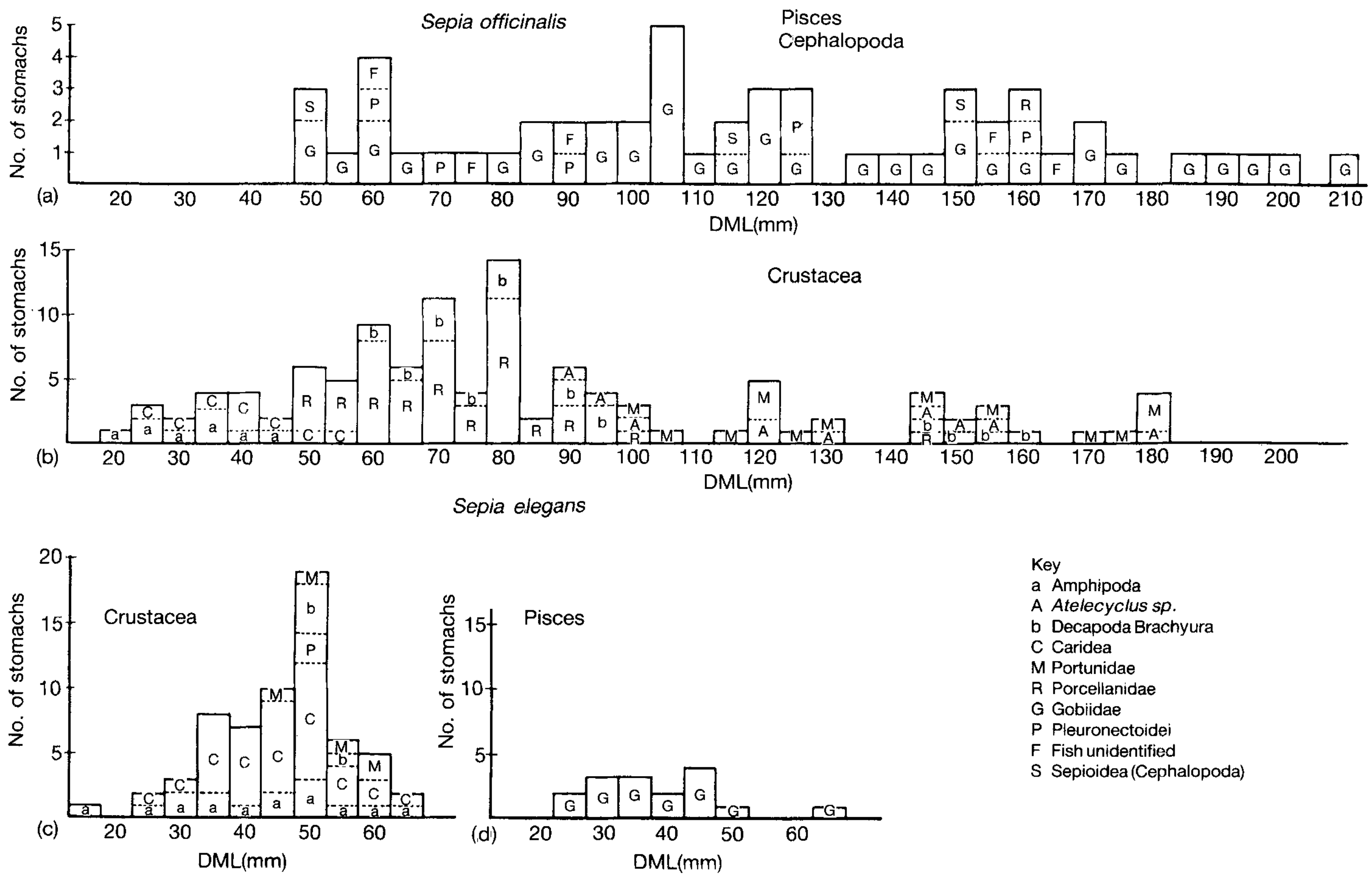

FIG. 3. Prey taken by the two cuttlefish. 3(a) Histograms showing the types of fish and cephalopods eaten by *S. officinalis* in relation to their sizes (DML: dorsal mantle length in mm); 3(b) crustaceans eaten by *S. officinalis*; 3(c) crustaceans found in the stomachs of *S. elegans*; 3(d) fish in the stomachs of the same species.

Discussion

Crustaceans are the most frequent prey found in the stomach contents of *S. officinalis* in the Gulf of Tunis (Najai & Ktari, 1979). Their contribution to the total diet (64·9%) is very similar to that found for this species in the Ria de Vigo. However, the composition of this type of food is different for each locality. No isopods, copepods or ostracods were found in the digestive tract of the common cuttlefish of the ria. The carideans and anomurans were not found in this species on the Tunisian coast.

The frequency of fish found in both diets in both areas is about the same: 30·7% of the total diet in the ria and 31% in the gulf. It is impossible to compare the species of fish eaten by *S. officinalis* in the two places because the report of Najai & Ktari includes all the fish eaten under the general term of teleosts.

The cephalopods represent 7·4% of the total food found in *S. officinalis* of the gulf. Octopod and decapod remains are cited as prey, mainly in the adults, and cases of cannibalism have also been observed in big specimens. No remains of octopods were found in the stomach contents of this species in the ria, and the percentage of cephalopods in the total diet was lower than in *S. officinalis* from Tunisia.

The presence of pteropods, gastropods and bivalve molluscs (3·3%) is shown by Najai & Ktari. The food eaten by *S. officinalis* in the ria revealed no remains of these molluscs, although they are abundant there. Najai & Ktari do not give details of whether shells or other parts of these molluscs were observed in the stomachs. At present, nothing is known on the ability of *Sepia* to bore mollusc shells, as has been verified in *Octopus vulgaris* (Nixon, 1979). The absence of any trace of these organisms in the stomachs of *S. officinalis* and *S. elegans* contrasts with the observation of authors cited above.

The most frequent prey organisms found by Scalera Liaci & Piscitelli (1982) in *Sepia officinalis* from the Lesina Lagoon (Italy) were *Palaemonetes antennarius*, *Palaemon adspersus* and *Palaemon serratus*, followed by the isopods *Sphaeroma serratum* and *Idothea balthica*. Remains of *Crangon crangon* and *Carcinus aestuarii* were also observed. Among fish, *Atherina boyeri* and the goby *Potamoschistus* sp. were the most abundant, and *Sygnatus abaster* and *Aphanius fasciatus* occasional prey. The total diet of this species in the lagoon comprised 46·1% crustaceans and 69·7% fish.

Mangold-Wirz (1983) has reviewed certain aspects of food and feeding behaviour in several cephalopods, and comments that most species change their diet as they grow, as seems to happen with *S. officinalis* and *S. elegans* in the Ria de Vigo. However, this change could be due, at least in part, to modifications of the diet with depth, as has been observed in *Loligo opalescens* on the California coast by Karpov & Caillet (1978).

Guerra (1984) and Alonso-Allende & Guerra (1984) give evidence that *S. officinalis* and *S. elegans* coexist in the greater part of the ria. As the diet of young *S. officinalis* is practically identical to that of *S. elegans*, there may be trophic competition between them. Messenger (1977) has demonstrated that acquisition of the complete learning of capture and retention of prey takes four months in *S. officinalis*. This process is very closely related to the total development of the vertical and superior frontal lobes in the brain. This suggests that young *S. officinalis* may be at a disadvantage compared with *S. elegans*. *Sepia elegans* becomes an adult at a size at which *S. officinalis* is still juvenile; the maximum size of the first species observed in the ria has been females of 68 mm DML, while *S. officinalis* can reach 240 mm DML and is still immature at 80 mm DML.

If competition for food occurs, it can be avoided by spatial segregation of the two species. This has been observed in many congeneric species which coexist within the same ecosystem (Margalef, 1974). Comparison between the dorsal mantle length frequencies of both species living in the same places of the ria (52·7% of the total sample), and those that live in different places, give us some indication that *S. elegans* takes the place of young *S. officinalis* where they coexist. As many factors may be involved, this possibility needs to be checked most carefully.

Summary

The diet of *Sepia officinalis* and *Sepia elegans* in the Ria de Vigo (NW Spain) has been studied from 150 and 72 full stomachs, respectively. Samples were taken from April 1982 to April 1984. All parts of the ria were sampled. Depths ranged from 3 to 45 m.

Crustaceans are the most frequent prey in both species (67·5 and 80%, respectively, of the total food), followed by fishes (30·7 and 20%, respectively). Two cases of cannibalism in adults of *Sepia officinalis* were observed. The different types of prey for the two cuttlefish species are given.

Changes of the diet with growth have been observed in both species. The types of prey taken by *S. elegans* differed somewhat from that of *S. officinalis*, but a very similar diet, composed of amphipods and Carideans, has been found in *S. elegans* and young *S. officinalis* smaller than 40 mm dorsal mantle length. The possibility of the existence of trophic competition between these species is discussed.

The diets of males and females of both species is similar.

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