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A Dietary Analysis of *Hippoglossina stomata* Eigenmann and Eigenmann, 1980 (Pisces: Bothidae) along the Western Coast of Baja California, Mexico

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Abstract.—A benthic trawl survey was conducted at depths of 38 to 218 m in September of 1990 along the western coast of Baja California on board the R/V El Puma. A dietary analysis of 67 *Hippoglossina stomata* stomachs was made in order to contribute to the knowledge of the diet of this species. Crustaceans, principally *Pleuroncodes planipes* (44.8%), and stomatopods, *Hemisquilla ensigera californiensis* (41.3%), were the most important prey items. Small crustaceans such as Malacostracea, Penaeidae, Decapoda not identified represent 5%. Fish and others were also consumed (8.4%).

The geographical and bathymetric range of the bigmouth sole, *Hippoglossina stomata* spans from Monterey Bay, California, USA to Cabo San Lucas and into the Gulf of California, México (Roedel 1953; Berdegué 1956; Eschmeyer et al. 1983) at depths from 30 to 240 m (Martínez and Ramírez 1992).

The bigmouth sole is a relatively abundant flatfish inhabiting soft sediments on the continental shelf of southern Baja California, Mexico. It could be of commercial importance (300 mm) due to the excellent quality of its meat (Berdegué 1956). Ecologically it is important since it preys on mysids, gammarideans and amphipods (Allen 1982), as well as the red crab, *Pleuroncodes planipes* (Ramírez-Murillo 1995). In turn, this species serves as food for the California sea lion, *Zalophus californianus* (Aurioles et al. 1984).

The taxonomy of the genus *Hippoglossina* was studied by De Buen (1961). Leonard (1971) studied the larvae of *Hippoglossina oblonga.* Yany et al. (1977) surveyed the food intake of *Hippoglossina macrops* in Valparaiso. Goldberg (1982) studied the seasonal spawning cycles of *Hippoglossina stomata* in Magdalena Bay, Mexico and Ramírez-Murillo (1995) examined the age and growth of *H. stomata* in Baja California. The purpose of the present study was to provide a preliminary knowledge of the food intake of *H. stomata,* off the western coast of Baja California, Mexico.

Materials and Methods

During September of 1990, a demersal trawl survey was conducted along the western continental shelf off Baja California from the northern portion of Bahia Vizcaino to the southern part of Magdalena Bay, between 24° and 28°30′N latitude and 111°30′ and 114°30′W longitude (Fig. 1).

The samples were collected by the R/V El Puma, at depths between 38 and 218 m using a shrimp otter trawl net, with a mouth opening of 21 m and 3 cm

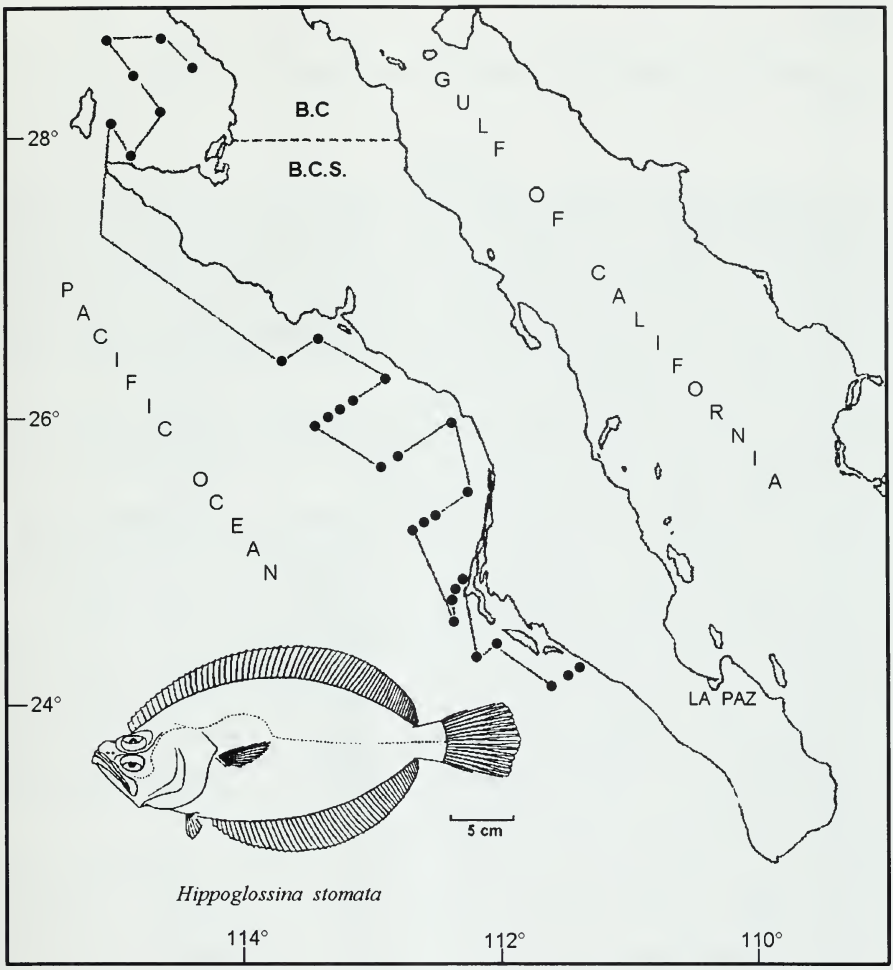

Fig. 1. Sampling stations from the EP9009 cruise, September, 1990.

mesh size. The catch was discharged on the deck and its contents counted and identified.

The *H. stomata* specimens were separated into plastic bags and fixed in 10% formalin for later transport to the laboratory.

The dietary analysis involved the following:

1. Stomachs were extracted, fixed and maintained in 10% formalin.
2. Food items were identified and counted. Those too difficult to identify were considered unknown remains and were not considered in the analysis.
3. State of digestion of prey was noted according to the method of Banner (1948a, b) and Brusca (1980).
4. Numeric, volumetric, frequency of occurrence and relative importance (IRI) of each taxon to the diet of these fish were determined using the methods of Pinkas et al. (1971): IRI = (% N + % V)(FO)

where:

N: numeric percentage; V: volumetric percentage; FO: frequency of occurrence.

Results

Of the 30 trawling operations carried out off the west coast of Baja California, *H. stomata* was present in 25 hauls (83% FO), rendering a total of 450 specimens with the greatest abundance in the area between the 24th and 27th N parallel. The minimum standard length of the fish sampled was 70 mm and the maximum 258 mm with an average of 171 mm. The main species associated with *H. stomata* were *Prionotus stephanophrys, Citharichthys xanthostigma, C. fragilis, Merluccius augustimanus,* and *Synodus lucioceps.*

Among the total of 67 *H. stomata* stomachs sampled, 11 were empty (16.4%). The remaining 56 stomachs belonged to individuals of standard length between 87 and 125 mm, with an average of 106.8 mm.

Analysis of the diet indicates that *H. stomata* feeds on a benthopelagic fauna as well as an epibenthic one. The stomachs analyzed are from relatively small and immature individuals. Crustaceans were the most important prey groups overall in the diet of this species, followed by osteichthyes and others (Table 1).

Among the 105 prey items observed, 7 families, 6 genera and 2 species could be identified by means of the analysis. The most abundant food item was the red crab, *Pleuroncodes planipes* with 45.4% V, 29.8% FO and 44.8% IRI, while in some stations the stomatopod, *Hemisquilla ensigera californiensis* was more abundant, with 29.8% V, 30.3% FO and 41.34% IRI. It does suggest some trends, when the distribution of *Pleuroncodes* is juxtaposed with the shift in dominance of the diet from *Pleuroncodes* to stomatopods.

Preference for eating the red crab, *Pleuroncodes planipes* (44.8% IRI) occurs when this species is most abundant. When *P. planipes* is absent, it is replaced in the diet by other species, like *Hemisquilla ensigera californiensis* (41.34% IRI), which live in shallower waters, and by other species, including fish, which total 13% IRI. Thus, diet diversifies based on food availability. As indicated by its large mouth and eyes and by its tooth type, *Hippoglossina stomata* feeds by settling to the bottom and waylaying its food.

Discussion

Studies of ecological communities are based on the organisms and their environmental relationship, which could be observed by analysing the feeding habits, selection of prey, transportation of energy, and nutrients. Methods and habits of food intake are highly related to internal and external morphology of the organism (Cailliet et al. 1986).

Frey (1971) states that the young flatfish settle on the bottom, eat small crustaceans, polychaetes, molluscs and fish, but, as they grow, they eat larger food items of the same groups. In this paper, more than 91.5% of the crustacean, *Pleuroncodes planipes* (44.8%) are the food intake of *H. stomata* on the Pacific coast of Baja California.

Allen (1982) found that bigmouth sole, *H. stomata* and California halibut, *Paralichthys californicus* eat mysids, gammarideans and amphipods. He did not men-

Table 1. Prey consumed by *Hippoglossina stomata* in Baja California Sur (No: number of organisms, V: volume in ml, FO: frequency of occurrence and IRI: index of relative importance).

	No.	% No.	V	% V	FO	% FO	IRI	% IRI
ARTHROPODA								
CRUSTACEA								
STOMATOPODA								
HEMISQUILLIDAE								
Hemisquilla ensigera californiensis	31	29.5	11.93	29.8	21.0	30.3	1856.0	41.34
ANOMURA								
GALATHEIDAE								
Pleuroncodes planipes	24	22.9	18.20	45.4	20.0	29.8	2035.3	44.80
AMPHIPODA								
TALITROIDEA	20	19.0	0.25	0.6	5.0	7.5	147.00	3.23
DECAPODA								
CANCRIDAE								
Cancer spp.	3	2.9	0.60	1.5	2.0	2.6	11.44	0.30
PENAEIDAE								
Sicyonia spp.	4	3.8	3.53	8.8	3.0	3.8	47.88	1.10
PALAEMONIDAE								
Palaemon spp.	8	7.6	1.60	4.0	2.0	2.6	30.16	0.70
OSTEICHTHYES								
PARALICHTHYIDAE								
Citharichthys spp.	1	1.0	1.0	2.5	1.0	1.5	5.23	0.12
Other	14	13.3	2.98	6.4	13.0	19.4	382.13	8.41
Σ	105	100	40.09	100			4334.9	100

tion, however, that they eat red crab and stomatopods as well, possibly because his samples were taken in shallower waters. Also Allen (op. cit) established 3 groups according to length: A, within the range of 6.3 to 10.0 cm; B, 11.4 to 18.9 cm and C, 19.2 to 30.8 cm. The first and second group consisted of immature fish and the main food intake were mysids and gammarideans. He also mentioned that most of the food was taken from the bottom. In the present paper the size of the fish could be compared to groups A and B, but here they prefer to eat anomurs and stomatopods.

Haig in 1955 (in Yany 1977) mentioned that *Pleuroncodes monodon* is found on the coast of Chile which spans to Ancud, and *Pleuroncodes planipes* appears on the Mexican coast off Baja California. In the study area *P. planipes* was found between 24° and 27°N latitude, although it was more abundant at 27°N (Aurioles-Gamboa 1995). According to Yany et al. (1977), *Hippoglossina macrops* has as preferred food the crustaceans, "langostino amarillo," *Cervimunida johni* in San Antonio, Punta Gallo, Laguna Verde, Concon, Quintero and Papudo; and *Pleuroncodes monodon* in Mejillones, Chile (Tomicic 1973 in Yany et al. 1977). This could indicate a close trophic relationship with similar taxa between the feeding habits of these flatfish representative of the Galatheidae family, which could be due to the distribution and abundance of these species. In either case, when the red crab is abundant in the coastal areas of Mexico and Chile, flatfish feed preferentially on this resource and on other additional groups when red crabs are scarce.

The main food source for *H. stomata* in Mexico is the red crab, *Pleuroncodes planipes,* and for *H. macrops* in Chile, the closely related *P. monodon*, due to the great abundance of these crustaceans. However, to the south of the 27th North parallel, *Hemisquilla ensigera californiensis,* which is less abundant than the red crab, is always found in the stomach content of *H. stomata* together with other species.

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