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Gut Contents of Two European Seahorses *Hippocampus hippocampus* and *Hippocampus guttulatus* in the Aegean Sea, Coasts of Turkey

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Abstract.- This study investigates the diet of adult wild seahorses, *Hippocampus hippocampus* and *Hippocampus guttulatus* from the Aegean Sea, along the coasts of Turkey. A total of 47 fish stomachs (*H. hippocampus* = 25, *H. guttulatus* = 22) were analyzed to determine diet according to fish size and sex. Twenty one of specimens of *H. hippocampus* (84%) had prey in their stomachs. The remaining 4 fish (16%) had empty stomachs. Sixteen *H. guttulatus* (72.73%) had prey in their stomachs. The remaining 6 fish (27.27%) had empty stomachs. Whereas Mysidaceae (26.92%) and Amphipoda (23.08%) were the main prey groups in diet of *H. hippocampus*, Mysidaceae (42.59%) and Decapod crustacean larvae (22.22%) constituted the most important food source of *H. guttulatus.* Because *H. guttulatus* is a moderately generalized benthonic predator, the food diversity in its gut was greater than in *H. hippocampus.* There were no differences in diets between males and females of either seahorse species.

Keywords*:* Syngnathidae, Seahorse, *Hippocampus hippocampus, Hippocampus guttulatus*, Gut content, Aegean Sea.

INTRODUCTION

Seahorses are typically captured either for their trade in aquarium fish or as curiosities and traditional chinese medicines (Storero and Gonzalez, 2008). They are also among the fish most greatly affected by nonselective fishing gears (Baum *et al.,* 2003; Garcia *et al.,* 2005). Their habitats and behaviors as well as some peculiarities of their natural history make seahorses highly sensitive to overexploitation (Vincent, 1995). As a result, the International Union for the Conservation of Nature (IUCN) considers most seahorse species as endangered, vulnerable or data deficient (Baillie *et al.,* 2004). *Hippocampus hippocampus* and *Hippocampus guttulatus* are two relatively poorly known seahorse species from the coastal area of the Turkish, Aegean Sea.

Most of the studies on the diet of seahorses have been conducted captivity whereas data on feeding habits in nature are limited to a few studies (Teixeira and Musick, 2001; Woods, 2002; Felício *et al*., 2006; Storero and Gonzalez, 2008). Most authors state that crustacean, especially copepods, amphipods and decapods are the main dietary items of seahorses (Tipton and Bell, 1988; Storero and Gonzalez, 2008; Kitsos *et al.,* 2008). According to Kitsos *et al.* (2008), *H. hippocampus* and *H. gutttulatus* mostly feed on Amphipoda, Anomura decapoda and Mysidacea. However, Storero and Gonzales (2008) suggested that the dominant crustacean species in the diets of seahorse are depend on the abundance of different species in the ecosystem in addition to selective predation by seahorses.

Various aspects of seahorse life history for animal from Turkey have been reported previously (Gurkan and Taskavak 2007; Gurkan *et al.,* 2007, 2010) but no detailed information on the feeding ecology of these fishes is available for the Aegean coast of Turkey. In this study we aim to provide data on feeding habits in *H. hippocampus* and *H. guttulatus* captured along the coasts of Turkey.

MATERIALS AND METHODS

A total of 79 seahorse specimens were used for diet analysis. Specimens were obtained from fishermen trawling along the Turkish coasts of the Aegean Sea from 2002 to 2008 (dates of captures for *H. hippocampus* October 2002 and 2007, February 2004 and March 2008; for *H. guttulatus* October 2002, February 2004, January 2006 and November 2008). However, only 47 seahorses were suitable for diet analysis. All specimens of *H.*

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hippocampus and *H. guttulatus* were kept in 10% formalin. In the laboratory, the specimens were weighted to the nearest g and standard length was measured nearest to mm (Lourie *et al.,* 1999). Sexes were recorded and fish were dissected following (Hyslop, 1980). The number of empty and full stomachs of the specimens was recorded. Stomach contents were recovered and homogenized in petri dishes and examined using a binocular stereo microscope. The prey items were identified to the lowest possible taxonomic level and assigned to different prey categories such as Copepoda, Isopoda, Gastropoda, Amphipoda, Crustacea and Mollusca. Next preys were counted under the binocular stereo microscope by immersing them in distilled water in a back-light petri dish. The diet was analyzed as frequency of occurrence (FO %) and numerical abundance (NO %) and the volumetric abundance (Hyslop, 1980). The importance of different prey groups in the diet was assessed using the relative importance index (IRI, Pinkas *et al.,* 1971).

One-way ANOSIM analysis was used to assess statistically differences in the diet composition between predefined of *H. hippocampus* and *H. guttulatus* individuals (Clarke, 1993). Statistical differences ($P<0.05$) in the diet composition with respect to fish size groups, sexes were assessed by a chi-square test (Sokal and Rolf, 1981).

RESULTS AND DISCUSSION

The goal of this study was to determine the diet of European seahorses, *H. hippocampus* and *H. guttulatus,* along the Turkish Aegean Sea coast. Data compared to previously published data for the Aegean coasts of Greece. Total lengths of 79 seahorse specimens were recorded (Table I). A total of 47 stomachs were examined. Of 25 *H. hippocampus* examined 21 (84%) contained prey and 4 (16%) were empty. Of 22 *H. guttulatus* examined 16 (72.73%) contained prey and 6 (27.27%) were empty. Preys found in the guts of the species examined are summarized in Table II. In *H. hippocampus* a total of 35 prey items (9 prey groups) were identified while in *H. guttulatus* total of 16 prey items (13 prey groups) were determined belonging to 5 main prey categories (Table I). The dominant prey categories are Mysidaceae (N% = 26.92) and Amphipoda (N% = 23.08) for *H. hippocampus* and Mysidaceae (N% = 42.59) and decapod crustacean larvae (N% = 22.22) for *H. guttulatus*.

Table I.- Descriptive statistics and estimated parameters of the length and weight data for *H. hippocampus* and *H. guttulatus* specimens collected from the, Aegean coast of Turkey (n, sample size; SE= Standard Error).

	n	Range	Mean±SE
Hippocampus hippocampus			
Standard length (cm)			
Male	9	8.60-11.50	9.94±0.32
Female	16	8.00-11.50	9.64±0.23
Weight (g)			
Male	9	0.74-5.03	2.70±0.46
Female	16	0.95-3.40	2.64±0.43
Hippocampus guttulatus			
Standard length (cm)			
Male	27	8.00-16.50	11.94±0.39
Female	27	8.70-15.60	11.09±0.35
Weight (g)			
Male	27	0.71-11.88	5.23±1.52
Female	27	1.19-8.44	3.82±0.44

Camouflage and slow approach to prey are remarkable feeding behaviors common to most members of the family Syngnathidae (Howard and Koehn, 1985). These feeding behaviors allow seahorses to prey on invertebrates from both benthic and pelagic zones (Howard and Koehn 1985). According to Kitsos *et al.* (2008), *H. guttulatus* is a relatively sedentary and ambushes plankton prey more frequently than *H. hippocampus*, resulting in a more diverse diet (Kitsos *et al.,* 2008). In our study, prey composition in the gut of *H. guttulatus* (13 prey group) was more diverse than that in *H. hippocampus* (9 prey groups) (One-way Anova, global $R = 0.999$ $P < 0.05$). Furthermore, significant differences in the diet of each seahorse could not be completely showed based on present values. Of the prey observed in the gut contents, Harpacticoid copepod and Amphipoda can be considered benthic preys while Decapod crustacean larvae can be considered pelagic.

Table II.- Gut contents of two seahorse species (percent number (N %), percent weight (W %), frequency of occurrence (F %), index of relative importance (I.R.I) and percent index of relative importance (IRI %) *Hippocampus hippocampus* (n=21) and *Hippocampus guttulatus* (n=22) n=sample size.

Prey Groups	*Hippocampus hippocampus*					*Hippocampus guttulatus*				
	NO%	W%	FO%	I.R.I	I.R.I%	NO%	W%	FO%	I.R.I	I.R.I%
Crustacea										
Copepoda (pelagic)										
Harpacticoida	7.69	6.08	5.26	72.49	1.88	-	-	-	-	-
Calanoida	-	-	-	-	-	4.32	7.40	14.29	167.41	1.44
Calanus sp.	-	-	-	-	-	1.85	3.07	9.52	46.86	0.40
Ostracoda	3.85	4.16	5.26	42.14	1.09	-	-	-	-	-
Cladocera										
Penilia avirostis	7.69	12.08	10.53	208.14	5.39	-	-	-	-	-
Isopoda						4.94	7.99	14.29	184.64	1.58
Amphipoda	23.08	8.16	21.05	657.63	17.04	16.05	2.10	47.62	864.33	7.41
Mysidacea	26.92	5.43	15.79	510.88	13.24	42.59	28.12	85.71	6061.07	51.99
Euphausiacea	-	-	-	-	-	1.23	0.67	4.76	9.08	0.08
Decapod crustacea larvae	19.23	14.80	26.32	895.58	23.21	22.22	14.46	100.00	3668.15	31.47
Brachyura larvae	-	-	-	-	-	0.62	0.13	4.76	3.56	0.03
Pycnogonida	3.85	14.16	5.26	94.78	2.46	0.62	12.74	4.76	63.59	0.55
Gastropoda	-	-	-	-	-	4.32	2.06	19.05	121.54	1.04
Bivalvia	7.69	13.12	10.53	219.09	5.68	0.62	6.89	4.76	35.76	0.31
Pisces										
Fish egg	-	-	-	-	-	0.62	3.57	4.76	19.95	0.17
Unidientified	0.00	22.22	52.63	1157.99	30.01	0.00	10.80	38.10	411.52	3.53

Based on the number and frequency the dominant preys of *H.guttulatus* are Decapod crustacean larvae, Mysidaceae, Amphipoda and unidentified prey. These results are consistent with previously published data Kitsos *et al*. (2008). For *H. hippocampus,* the dominant preys are decapod crustacean larvae, Mysidaceae, Amphipoda again consistent with previously published data (Kitsos *et al.,* 2008).

According to the relative importance index, unidentified preys (30.01) and decapod crustacean larvae (23.21) are the most important prey groups while other taxa *i.e.* Pycnogonida and Bivalvia were of less significance in the diet of *H. hippocampus* (Table II). In *H. guttulatus*, Mysidacea (51.99) and Decapod crustacean larvae (31.47) have the highest IRI scores, while other taxa such as brachyuran larvae and fish eggs were of less significance. Previous studies on Hippocampus species indicate that Amphipoda and Mysidacea typically constitute the most important prey in the diet (Woods, 2002; Kendrick and Hydnes, 2005).

In this study, no sexual differences in the diets of two seahorse species were observed (*H. hippocampus* P = 0.94, *H. guttulatus* P = 0.99) consistent with previously published data (Woods, 2002; Kitsos, 2008).

The examination of the diet composition relative to fish size showed that two groups could be recognized based on the weight percentage of the prey items ingested. In *H. hippocampus,* a mean prey weight of 0.05 g for fish size up to 10.9 cm, wad observed and increased to a mean prey weight of 0.06 g for a fish size up to 11.9 cm. Quantatively, almost all the prey of fish in the 8.0-8.9 and 10.0-10.9 cm ranges were decapod crustacean larvae (40.83%, 84.61%) but were replaced unidentified preys (95.92%) in the 9.0-9.9 ($\chi^2 = 8.00$ $P < 0.05$) and 11.0-11.9 cm ($\chi^2 = 5.44$ $P < 0.05$) size range in *H. hippocampus*. In *H. guttulatus,* mean prey weight of 0.027 g as observed for fish up to 10.9 cm but increased to a mean prey weight of 0.050 g for fish up to 16.9 cm in size. Almost the entire diets of fish in the 8-10.9 and 11.0-13.9 cm consisted of decapod crustacean larvae but was replaced by Mysidacea (83.33%) in the 14.0-16.9 cm size range ($\chi^2 = 11.64$ $P < 0.05$). Thus our data show that feeding habits of both seahorses change as fish

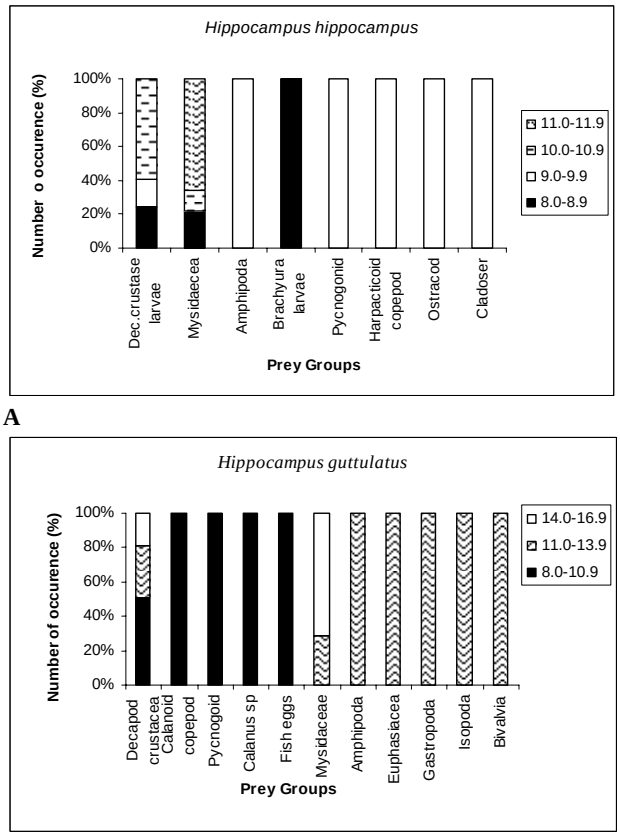

Fig 1. Relative numerical occurrence (N %) of main prey groups in the diet of *H. hippocampus* (above) and *H. guttulatus* (below) for different size classes.

grow. Small sized fish captured mostly planktonic prey captured, while large individuals of each species feed mostly on pelagic preys. These results are similar to what has been observed previously (Tipton and Bell, 2002; Kitsos *et al.*, 2008).

In conclusion, our data show that two seahorse species *H. hippocampus* and *H. guttulatus* are zooplanktophagous fishes. No significant differences were found between the diet compositions of males and females of in either species. Crustaceans especially decapod crustacean larvae, amphipoda and mysids are main prey groups for both seahorse species but the diet of *H. guttulatus* is more diverse than *H. hippocampus.*

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