Feeding habits of the common two-banded sea bream, *Diplodus vulgaris* (Sparidae), in the eastern Adriatic Sea

by

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ABSTRACT. - The feeding habits of the common two-banded sea bream, *Diplodus vulgaris*, from the eastern Adriatic were investigated with respect to fish size and seasons. Stomach contents of 728 specimens, 12.1-34.0 cm TL, collected by beach seine from 1999 to 2001, were analyzed. Of the total number of stomachs examined, 134 were empty (18.1%). This percentage varied significantly by season with a maximum number of empty stomachs recorded during the autumn (35.5%) and a minimum number recorded during the summer (4.5%). A total of 42 different prey species belonging to eight major groups: Echinoidea, Decapoda, Bivalvia, Gastropoda, Polychaeta, Mysidacea, Polyplacophora and Amphipoda were identified in stomach contents. Echinoidea constituted the main prey (%IRI = 40.9), especially for fish less than 25.0 cm TL. With fish growth, the proportion of echinoids decreased while that of decapods crustaceans and bivalves increased. The mean weight of stomach contents increased significantly for fish larger than 25.0 cm TL, while the mean number of prey items significantly declined. Diet composition showed a seasonal variation; echinoids were the most important prey item in autumn, winter and spring, whereas decapods were the most important prey item during summer. The lowest intensity of feeding was recorded during spawning (autumn) as well as in a period of lower sea temperature (winter). The mean weight and mean number of prey significantly increased in spring and summer. The results indicate that the common two-banded sea bream feeds on a wide range of prey items and can be considered an opportunistic predator.

RÉSUMÉ. - Alimentation du sar à tête noire, *Diplodus vulgaris* (Sparidae), en mer Adriatique.

Les habitudes alimentaires du sar à tête noire, *Diplodus vulgaris*, de la mer Adriatique ont été étudiées en fonction de la taille des poissons et de la saison. Les contenus stomacaux de 728 spécimens, 12,1-34,0 cm TL, capturés par seine de plage de 1999 à 2001 ont été analysés. Au total, 134 estomacs étaient vides (18,1%). Ce pourcentage a changé de manière significative selon les saisons, avec un nombre maximal d'estomacs vides enregistré pendant l'automne (35,5%) et un nombre minimal enregistré pendant l'été (4,5%). Au minimum 42 espèces de proies ont été répertoriées, appartenant à 8 groupes principaux: les échinides, les crustacés décapodes, les mollusques bivalves et gastropodes, les annélides polychètes, les crustacés mysidacé, les mollusques polyplacophores et les crustacés amphipodes. Les échinides constituent les proies principales (%IRI = 40,9) surtout parmi les classes de taille inférieure à 25 cm LT. La proportion d'échinides diminue avec la croissance, tandis que celle des décapodes et des bivalves augmente. Le poids moyen du contenu stomacal augmente de manière significative pour les poissons de taille supérieure à 25,0 cm LT, alors que le nombre moyen des proies diminue de manière significative. La variation de composition du régime alimentaire est saisonnière; les échinides ont été dominants en automne, hiver et printemps, tandis que les décapodes sont dominants pendant l'été. La plus faible intensité d'alimentation a été enregistrée pendant la période de reproduction (automne), quand la température est la plus basse (hiver). Le poids moyen et le nombre moyen de proies augmentent de manière significative au printemps et en été. Les résultats indiquent que la sar à tête noire s'alimente à partir d'un large éventail de proies et qu'il peut être considéré comme un prédateur opportuniste.

Key words. - Sparidae - *Diplodus vulgaris* - MED - Adriatic Sea - Feeding habits.

The common two-banded sea bream, *Diplodus vulgaris* (Geoffroy Saint-Hilaire, 1817) lives throughout the Mediterranean, eastern Atlantic and western Black Sea coast, inhabiting littoral waters above rocky and sandy-muddy bottoms with phanerogams, up to the 130 m depth (Bauchot and Hureau, 1986). It is very common in the Adriatic Sea (Jardas, 1996) where it spawns in autumn during the months of October and November (Grubišić, 1988). Jardas (1996) reported that the annual catch of the two-banded sea bream in the eastern Adriatic is around 15 tons. Although different aspects of its biology have been studied in the Adriatic (Jug-Dujaković and Glamuzina, 1988), Mediterranean Sea (Garcia-Rubies and Macpherson, 1995; Gordoa and Moli, 1997; Vigliola 1997; Arculeo *et al*., 2003) and Atlantic Ocean (Gonçalves and Erzini, 2000; Pajuelo and Lorenzo, 2003) studies of diet are relatively scarce. Ara (1937), Rosecchi (1987) and Sala and Ballesteros (1997) studied the feeding habits of *D. vulgaris* in the Mediterranean Sea, and Gonçalves and Erzini (1998) provided some information from the Atlantic Ocean.

However, little is known about the trophic ecology of the common two-banded sea bream in the Adriatic Sea. Onofri (1986) and Jardas (1996) generally noted molluscs, crustaceans, polychaets and echinoderms in the stomach contents.

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The purpose of the present study was to examine the diet of *Diplodus vulgaris* in the eastern Adriatic Sea. The effect of predator size and season on stomach contents was analysed to provide a more comprehensive examination of the trophic ecology of this species.

MATERIAL AND METHODS

Samples of *Diplodus vulgaris* were taken at 10 localities in the eastern Adriatic Sea (Fig. 1) with a stretched beach seine (12 mm mesh-size). A total of 728 specimens were collected between January 1999 and January 2001: 169 specimens during winter, 197 during spring, 221 during summer and 141 during autumn. Samples were taken during daylight hours. Total length (TL) of fish was measured to the nearest 0.1 cm and weighed to the nearest 0.1 g. Immediately after capture, fish were dissected and the guts were removed and preserved in a 4% formalin solution. Evidence of regurgitation was never observed in any fish. In the laboratory, prey identification was carried out to the lowest possible taxonomy level. Species abundance and wet weight to the nearest ± 0.001 g, after removal of surface water by blotting on tissue paper, were recorded.

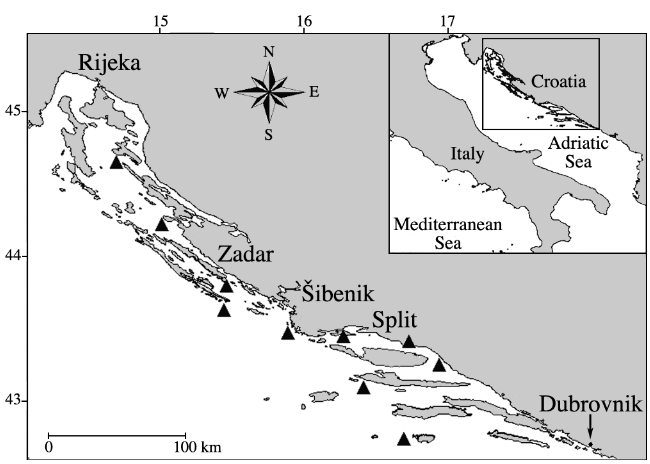

Figure 1. - Study area and sampling localities of *Diplodus vulgaris* in the Adriatic Sea. *[Zone d'étude et localités de captures de* Diplodus vulgaris *en mer Adriatique.]*

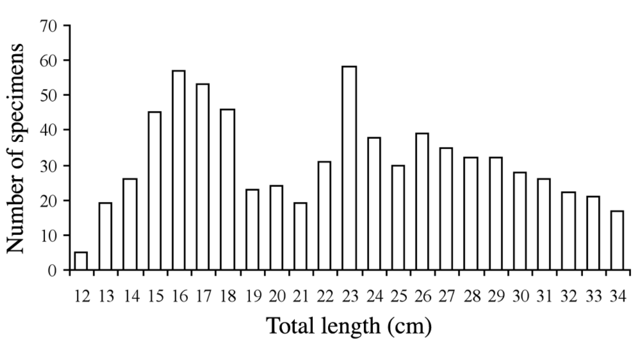

Figure 2. - Length frequency distribution of 728 individuals of *Diplodus vulgaris* caught in the Adriatic Sea. *[Distribution de fréquence de taille des 728 spécimens de* Diplodus vulgaris *capturés en mer Adriatique.]*

Total length of the fish examined ranged from 12.1 to 34.0 cm (Fig. 2). To assess for possible changes in diet with respect to size, fish were divided into three size-classes: small (< 17 cm, N = 205), medium (17-25 cm, N = 269) and large (> 25 cm, N = 254).

Numerous indices have been described for quantitatively expressing the importance of different prey in the diets of fish (Berg, 1979; Hyslop, 1980; Tirasin and Jørgensen, 1999). Those used in the present study were:

Vacuity index (VI) is the proportion (in %) of empty stomachs. VI = (number of empty stomachs / total number of stomachs) x 100.

Percentage frequency of occurrence (%F) is the frequency of occurrence of prey items in the total number of non-empty stomachs. %F = (number of stomachs including a prey item / number of non-empty stomachs) x 100.

Percentage numerical abundance (%Cn) is the abundance of prey items in the total number of prey items identified in the total number of non-empty stomachs. % Cn = (number of prey items / total number of prey items) x 100.

Percentage gravimetric composition (%Cw) is the wet weight of prey items in the total wet weight of non-empty stomachs. %Cw = (weight of prey items / total weight of prey items) x 100.

The main food items were identified using the index of relative importance (IRI) of Pinkas *et al.* (1971), as modified by Hacunda (1981):

IRI = %F x (%Cn + %Cw)

This index has been expressed as:

%IRI = (IRI/ ∑ IRI) x 100

Prey were sorted in decreasing order according to IRI and then cumulative %IRI was calculated.

Statistical differences ($p < 0.05$) in diet composition with respect to size and season were assessed by a chi-square test (Sokal and Rohlf, 1981), applied to the frequency of a given prey. The variation in vacuity index was also tested by a chi-square test. The significance of variation of mean number (Nm/ST) of prey items and mean weight per stomach (Wm/ST) among size classes and seasons were tested by analysis of variance (ANOVA), while Tukey's test was employed to locate the source of significant differences (Zar, 1984).

RESULTS

Feeding intensity

Of the 728 stomachs examined, 134 were empty (18.4%). This percentage varied significantly over the year ($\chi^2 = 56.4$, p < 0.05), with a maximum of 35.5% during autumn and a minimum of 4.5% during summer (Fig. 3). Vacuity index (20.4% in small size-class, 18.9% in medium size-class and 16.1% in large specimens) did not differ significantly among the size classes ($\chi^2 = 1.5$, $p > 0.05$).

Diet composition

The stomach content of the common two-banded sea bream consisted of 42 different prey species belonging to eight major groups: Echinoidea, Decapoda, Bivalvia, Gastropoda, Polychaeta, Mysidacea (including Cumacea and Isopoda in small quantity), Polyplacophora and Amphipoda. Table I shows the frequency of occurrence, numerical and biomass composition and the Index of Relative Importance of different prey groups and prey species found in stomachs. Echinoids constituted the most important ingested prey, constituting 40.9% of the total IRI, followed by decapods (%IRI = 29.8) and bivalves (%IRI = 16.9), while other prey groups were comparatively lower and of less importance. At the species level, two echinoids *Echinoscyamus pusillus* (%IRI = 16.4) and *Psammechinus microtuberculatus* (%IRI = 5.0) were the most frequent prey.

Food in relation to fish size

Diet composition for size classes of the eight main prey groups is shown in the table II. Index of Relative Importance varied with specimen size. The IRI of decapods, bivalves and gastropods increased with fish size, whereas the IRI of echinoids, polychaeta, polyplacophora, mysids and amphipods decreased. A chi-square revealed only non-significant differences between ingestion of gastropods ($\chi^2 = 4.6$, $p > 0.05$). The total amount of food ingested, shown by the mean weight of stomach contents (Wm/ST), varied significantly among size classes ($F = 19.6$, $p < 0.05$). Tukey's test revealed that the mean weight of stomach contents for specimens in large size classes differed significantly from the others (Fig. 4). The mean number of prey (Nm/ST) significantly declined in the large size-class ($F = 15.2$, $p < 0.05$). Tukey's test revealed that the mean number of stomach contents for specimens in small and medium size-classes differed significantly from large size group (Fig. 4).

Seasonal variation in the diet

Diets of common two-banded sea bream varied seasonally. Echinoids were the most important prey group in autumn (%IRI = 35), winter (%IRI = 36) and spring (%IRI = 38) while decapods crustaceans predominated during summer (%IRI = 39). The contribution of bivalves in diet was important in autumn (%IRI = 19), and winter (%IRI = 20), while polychaeta, mysids, amphipods and polyplacophora occurred during all seasons, but in smaller quantities (Fig. 5).

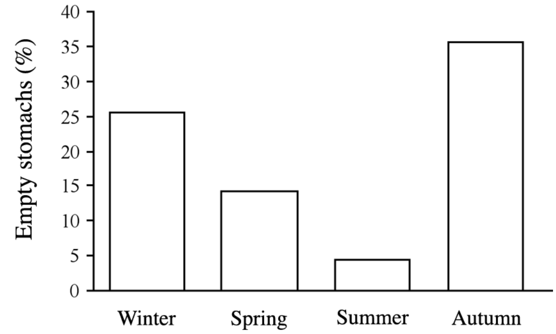

Figure 3. - Seasonal variation in percentage of empty stomachs for *Diplodus vulgaris*. *[Variations saisonnières en pourcentage d'estomacs vides chez* Diplodus vulgaris.*]*

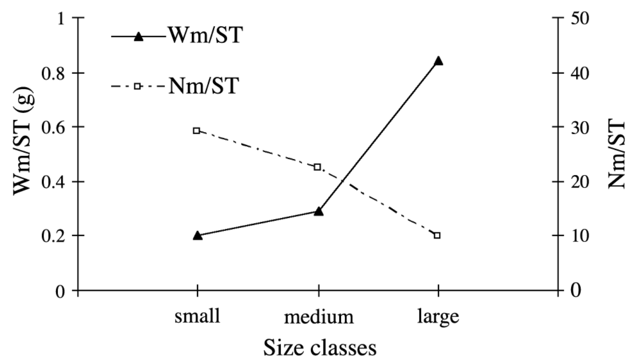

Figure 4. - Mean weight of prey per stomach (Wm/ST) and mean number of prey items per stomach (Nm/ST) as a function of *Diplodus vulgaris* size. *[Poids moyen des proies par estomac (Wm/ST) et nombre moyen de proies par estomac (Nm/ST) en fonction de la taille de* Diplodus vulgaris.*]*

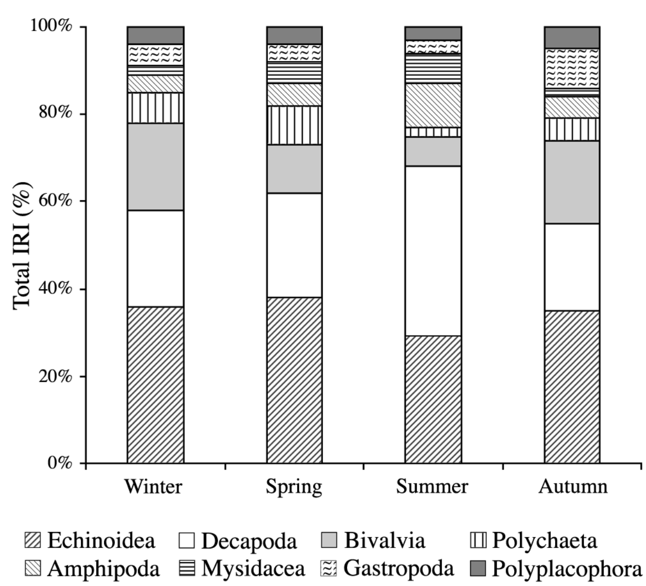

Figure 5. - Seasonal variation of *Diplodus vulgaris* diet based on the %IRI values of the major prey groups. *[Variation saisonnière du régime alimentaire de* Diplodus vulgaris *fondée sur les valeurs de %IRI des principaux groupes de proies.]*

Table I. - Diet composition of 594 *Diplodus vulgaris* containing food (%F = percentage frequency of occurrence; %Cn = percentage of numerical composition; %Cw = percentage of gravimetric composition; IRI = index of relative importance). *[Composition de l'alimentation de 594* Diplodus vulgaris *contenant de la nourriture (%F = pourcentage de la fréquence de présence ; %Cn = pourcentage de la composition numérique ; %Cw = pourcentage de la composition pondérale ; IRI = index d'importance relative).]*

Food items	%F	%Cn	%Cw	IRI	%IRI
Mollusca					
Polyplacophora					
Lepidopleurus cajetanus	2.5	1.6	1.4	7.5	0.3
Chiton coralinus	1.7	0.8	0.9	2.9	0.1
Chiton olivaceus	1.4	0.6	0.6	1.7	< 0.1
Ischnochiton rissoi	1.1	0.4	0.5	1.0	< 0.1
Callochiton laevis	0.8	0.4	0.3	0.6	< 0.1
Acanthochitona fascicularis	0.5	0.2	0.1	0.1	< 0.1
Unidentified Polyplacophora	2.2	0.8	1.3	4.6	0.2
Total Polyplacophora	4.9	4.8	5.1	48.5	2.0
Gastropoda					
Gourmya sp.	1.7	0.4	1.5	3.2	0.1
Bittium reticulatum	1.4	0.4	1.0	1.9	< 0.1
Rissoa variabilis	1.1	0.2	0.9	1.2	< 0.1
Gibberula clandestina	1.1	0.2	0.7	1.0	< 0.1
Diodora graeca	0.8	0.2	1.0	0.9	< 0.1
Haliotis lamellosa	0.5	0.2	0.4	0.3	< 0.1
Lunatia sp.	0.5	0.2	0.5	0.3	< 0.1
Unidentified Gastropoda	3.7	2.1	3.8	21.8	0.9
Total Gastropoda	5.2	3.9	9.8	71.2	2.9
Bivalvia					
Cardium sp.	7.1	5.7	6.6	87.3	3.6
Arca noae	4.8	1.0	1.8	13.4	0.6
Chlamys sp.	4.5	1.3	1.5	12.6	0.5
Pitar rude	4.0	1.3	1.4	10.8	0.4
Cerastoderma edule	3.1	0.8	1.0	5.6	0.2
Venerupis sp.	2.8	0.8	0.8	4.5	0.2
Parvicardium exiguum	1.7	0.4	1.6	3.4	0.1
Ostrea sp.	2.5	0.6	0.4	2.5	0.1
Tellinella puchella	1.4	0.4	0.6	1.4	< 0.1
Modiolus barbatus	1.1	0.2	0.4	0.6	< 0.1
Mytilaster minimus	1.1	0.2	0.3	0.5	< 0.1
Unidentified Bivalvia	8.5	2.1	3.2	45.0	1.8
Total Bivalvia	11.9	14.8	19.6	409.4	16.9
Polychaeta					
Unidentified Polychaeta	8.6	2.2	1.0	27.5	1.1
Crustacea					
Decapoda					
Macropipus sp.	8.0	1.6	5.5	56.8	2.3
Alpheus dentipes	7.1	1.5	4.1	39.8	1.6
Ebalia sp.	6.3	1.4	4.4	36.5	1.5
Pagurus sp.	6.3	1.3	4.2	34.6	1.4
Ethusa mascarone	5.7	1.3	3.9	29.6	1.2
Parthenope angulifrons	5.7	1.1	3.6	26.7	1.1
Galathea sp.	5.1	1.1	3.6	24.0	1.0
Pillumnus hirtelus	4.2	1.0	3.1	17.2	0.7
Inachus sp.	4.2	0.9	2.5	14.3	0.6
Upogebia pusilla	1.1	0.2	1.7	2.1	< 0.1
Macropodia rostrata	0.8	0.1	1.1	1.0	< 0.1
Unidentified Decapoda	4.0	0.9	2.5	13.6	0.6
Total Decapoda	13.7	12.4	40.2	720.6	29.8
Mysidacea					
Anchialina agilis	2.2	2.0	0.7	5.9	0.2
Unidentified Mysidacea	4.8	2.7	1.3	19.2	0.8
Total Mysidacea	5.3	4.7	2.0	35.5	1.0
Amphipoda					
Caprella sp.	5.7	1.9	1.1	17.1	0.7
Elasmopus rapax	4.0	1.5	0.7	8.8	0.4
Unidentified Amphipoda	10.8	4.5	2.0	70.2	2.9
Total Amphipoda	12.2	7.9	3.8	142.7	5.9
Unidentified Cumacea	2.8	1.4	1.0	6.7	0.3
Unidentified Isopoda	5.4	1.9	0.9	15.1	0.6
Echinoderma					
Echinoidea					
Echinocyamus pusillus	12.3	28.9	3.5	398.5	16.4
Psammechinus microtuberculatus	8.0	12.1	3.0	120.8	5.0
Echinus melo	3.1	0.8	1.4	6.8	0.3
Sphaerechinus granularis	1.4	0.6	0.6	1.7	< 0.1
Unidentified Echinoidea	1.7	1.5	1.8	5.6	0.2
Total Echinoidea	18.3	43.9	10.3	991.9	40.9
Ophiuroidea					
Ophiotrix sp.	0.5	0.1	0.4	0.2	< 0.1
Amphineura sp.	0.2	0.1	0.2	0.06	< 0.1
Unidentified Ophiuroidea	0.5	0.1	0.3	0.2	< 0.1
Total Ophiuroidea	0.8	0.2	0.9	0.9	< 0.1
Unidentified Bryozoa	0.2	0.1	0.2	0.06	< 0.1

Table II. - Dietary groups for each size range of *Diplodus vulgaris* with regard to the percentage frequency of occurrence (%F), percentage of numerical composition (%Cn), percentage of gravimetric composition (%Cw) and index of relative importance (IRI). *[Type d'alimentation par taille de* Diplodus vulgaris *en comparaison du pourcentage de la fréquence de présence (%F), pourcentage de la composition numérique (%Cn), pourcentage de la composition pondérale (%Cw) et index d'importance relative (IRI).]*

	< 17 cm				17 - 25 cm				> 25 cm			
	% F	% Cn	% Cw	IRI	% F	% Cn	% Cw	IRI	% F	% Cn	% Cw	IRI
Polyplacophora	46.2	6.3	12.5	868.5	17.2	5.9	5.5	196.1	4.9	2.2	1.1	16.1
Gastropoda	11.7	1.6	9.4	128.7	15.8	4.4	12.9	273.3	18.3	8.2	9.8	329.4
Bivalvia	16.2	2.3	16.0	296.4	46.9	17.0	22.1	1833.8	64.6	36.0	23.8	3863.1
Polychaeta	32.3	4.8	3.7	274.5	4.9	0.8	0.4	5.8	3.9	0.4	0.1	1.9
Decapoda	16.8	2.4	18.4	349.4	24.8	10.8	38.3	1217.6	80.6	34.2	61.0	7673.1
Mysidacea	42.9	11.0	7.8	806.5	7.8	1.5	3.4	38.2	-	-	-	-
Amphipoda	58.9	15.1	11.4	1560.8	15.1	6.3	3.8	152.5	-	-	-	-
Echinoidea	95.1	56.1	20.5	7284.6	39.0	52.9	13.3	2581.8	14.3	18.8	4.0	326.0

Significant differences among seasons were found for echinoids ($\chi^2 = 21.1$, $p < 0.05$) decapods ($\chi^2 = 12.9$, $p < 0.05$), bivalves ($\chi^2 = 19.8$, $p < 0.05$) and mysids ($\chi^2 = 16.8$, $p < 0.05$).

Mean weight and mean number of prey significantly increased from autumn ($F = 19.7$, $p < 0.05$) to spring-summer ($F = 5.1$, $p < 0.05$) period. In both cases Tukey's test shows that spring and summer samples differed significantly from those of winter and autumn (Fig. 6).

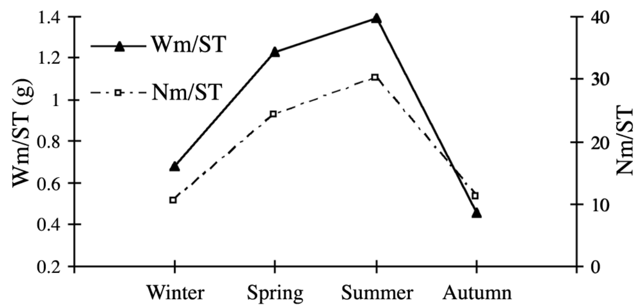

Figure 6. - Mean weight of prey per stomach (Wm/ST) and mean number of prey items per stomach (Nm/ST) of *Diplodus vulgaris* through the year. *[Poids moyen des proies par estomac (Wm/ST) et nombre moyen de proies par estomac (Nm/ST) chez* Diplodus vulgaris *au cours de l'année.]*

DISCUSSION

Our study indicates that the common two-banded sea bream living in the Adriatic Sea is exclusively a carnivorous fish. According to obtained data, benthic echinoids *Echinoscyamus pusillus* and *Psammechinus microtuberculatus* were the most common prey and can therefore are classified as main food for *D. vulgaris* in Adriatic waters. Decapods and bivalves were secondary in importance, except for fish in the largest size classes, where they are the most important prey. Other prey groups were of minor importance and indicated occasional food.

Prey groups with firm body exoskeletons primarily constituted the food of this species. Common two-banded sea bream have special teeth for crumbling such food. Jaws are heterodont with teeth differentiated by incisors (front teeth) and molars (the rest), set in a number of rows (Onofri, 1986; Bauchot and Hureau, 1986). Molar teeth are strong and their function is to crumble firm body armour of molluscs and decapods (Onofri, 1986). Similar teeth set (Onofri, 1986) and also very similar food composition were recorded from other species of the genus *Diplodus* (Onofri, 1986; Rosecchi, 1987; Sala and Ballesteros, 1997). Onofri (1986) also established that adult *D. vulgaris* had larger numbers of molars. Our results confirm these statements, since the prey with markedly firm armour, particularly decapods (Brachyura, Natantia and Anomura) and bivalves were considerably more frequent in food of larger specimens.

In our study, the stomach contents of the common two-banded sea bream indicated that this species could be an opportunistic predator, feeding on a variety of prey items including mostly benthic organisms, and a wide range of prey size and morphology. The data of Rosecchi (1987), Sala and Ballesteros (1997) and Gonçalves and Erzini (1998) confirm presumption of its opportunistic behaviour. Rosecchi (1987) in the French waters and Gonçalves and Erzini (1998) in the Portuguese waters found 19 different benthic prey groups in the stomach contents of *D. vulgaris*, while Sala and Ballesteros (1997) in the Spanish waters noted 25 different prey groups and considered *D. vulgaris* omnivorous. In the last mentioned study bivalves represented the most important prey, followed by ophiures, polychaeta and benthic algae. Ara (1937) in Naples (Italy) reported that the two-banded sea bream was a generalist feeder, with crustaceans and molluscs forming the basis of its diet. Rosecchi (1987) considered this a carnivorous species, feeding mainly on echinoderms, decapods crustaceans, molluscs, amphipods, with teleosts being relatively rare. Results of Rosecchi (1987) are generally similar to our results, although in our study, teleosts were not found in the diet. Generally similar diets from the Adriatic and French waters suggest selective feeding and/or similar benthic faunal communities in two areas. From the Portuguese waters, Gonçalves and Erzini (1998) reported that despite the occurrence of algae, *D. vulgaris* is essentially an opportunistic carnivore. The versatile feeding behaviour of the common two-banded sea bream is often noted by divers who are followed by this fish, which ingest any prey uncovered by the diving activity (Gonçalves and Erzini, 1998).

Our results indicate that the diet of *D. vulgaris* changes with its growth. Smaller specimens mainly feed on echinoids, polyplacophora, polychaeta, amphipods and mysid crustaceans (including cumacea and isopods) that are abundant and have small weights. As these fish grow the proportion of decapods, gastropods and bivalves increases and that of echinoids, polyplacophora, polychaeta and small crustaceans decreases. In this respect the mean weight of prey (Wm/ST) significantly increases towards the large size-classes as a consequence of the presence of larger crustaceans, gastropods and bivalves. Mean prey size increases with increasing predator size in order to optimise the energy per unit effort (Ware, 1972; Stoner and Livingston, 1984). Due to the smaller presence of echinoids, polyplacophora and smaller crustaceans the mean prey number per stomachs (Nm/ST) is reduced in the largest size classes. These changes may be simply due to an evolution in feeding preferences with increasing size, as determined by relationship between prey size and mouth dimension (Ross, 1978; Stoner, 1980;

Rosecchi, 1983), or to changes in habitat (e.g. depth) (Gonçalves and Erzini, 1998). Larger specimens of common two-banded sea bream occur in deeper waters on rocky substratum between crevices and steep slopes while smaller fishes prefer closed and shallow waters on sandy-muddy bottoms with phanerogams (Grubišić, 1988). Such changes in food habits with fish size could decrease intraspecific competition (Langton, 1982). Data obtained in this study on the changes of food content are consistent with those of Gonçalves and Erzini (1998) and Rosecchi (1987). Namely, Gonçalves and Erzini (1998) reported that smaller specimens of *D. vulgaris* consume more small crustaceans while with the increase in length they switch to larger crustaceans, bivalves and gastropods. Rosecchi (1987) also stated that the stomachs of the smallest specimens contained mostly planktonic crustaceans and those of larger ones, predominantly larger crustaceans, echinoderms and teleosts. There is evidence that size differences reflect changing food preference with growth and the ability of large individuals to capture larger prey.

The composition of the common two-banded sea bream diet indicated that there was a seasonal variability. The echinoids dominated their diet in autumn, winter and spring while decapods were the most important during the summer. The observed seasonal changes in relative importance of echinoids and decapods probably reflect the fluctuations of the available prey in the environment. For example, the significant increase in decapods consumption during the summer coincides with the period of the new recruits of the decapods species, which may be present in the high densities (Robertson, 1984).

Feeding intensity is negatively related to the percentage of empty stomachs (Bowman and Bowman, 1980). The highest values of stomach emptiness were recorded in the autumn and winter. Spawning period, which takes place in the autumn, seems to have an effect on feeding intensity. Feeding behaviour of most fish species considerably oscillates during the year as a consequence of physiological changes during reproduction. Feeding intensity of *Scropaena porcus* (Pallaoro and Jardas, 1991) and *Chromis chromis* (Dulčić, 1996) showed markedly lower values during spawning. Many fishes show a decrease in the feeding rate as the temperature drops (Tyler, 1971). Poorer feeding intensity in winter is probably related to lower seawater temperatures in the study area (Zore-Armanda *et al.*, 1991), which slowly lowers the metabolism, and thereby further results in reduced feeding. This assumption may be confirmed by the values of mean weight (Wm/ST) and mean number (Nm/ST), which were significantly highest in spring-summer, and were decreasing in autumn-winter periods. Intensified feeding extends throughout summer probably due to higher temperatures, which stimulate metabolism and increase food demands. Furthermore, our results suggest that energy accumulated through the spring-summer, when feeding activity is more pronounced, is spent for gametogenesis and reproductive activity through autumn.

In summary, *D. vulgaris* is an opportunistic predator, whose diet in the eastern Adriatic Sea, as well as in the French, Italian, Spanish and Portuguese waters, consists of many diverse benthic groups. In the Adriatic Sea echinoids were the most important prey in autumn, winter and spring and are more present in small specimens, whereas decapods constituted the main food during the summer and are more present in large-size specimens.

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