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Feeding habits of *Cataetyx alleni* (Pisces: Bythitidae) in the deep western Mediterranean*

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SUMMARY: This study examines the feeding habits of *Cataetyx alleni*, the fifth most abundant species below 1000 m depth on the deep slope of the Catalan sea (western Mediterranean), between 1000 and 1800 m depth. *Cataetyx alleni* is a euryphagic predator, feeding on small epibenthic and endobenthic crustaceans and polychaetes. Predominate prey are small isopods and gammaridean amphipods and, in some cases, endobenthic and epibenthic decapods. *Cataetyx alleni* has bathymetric changes in diet marked by the capture of different prey-items and also by the reduction in the size of the prey with increasing depth. Seasonal fluctuations in the feeding pattern are clearly seen among the individuals of the same depths.

Key words: *Cataetyx alleni*, feeding ecology, western Mediterranean, deep sea variations.

RESUMEN: HÁBITOS ALIMENTICIOS DE *CATAETYX ALLENI* (PISCES: BYTHITIDAE) EN EL MEDITERRÁNEO PROFUNDO OCCIDENTAL. – *Cataetyx alleni* es la quinta especie íctica más abundante, por debajo de los 1000 m de profundidad, en el talud profundo del Mar Catalán (Mediterráneo occidental). Este estudio analiza los hábitos alimenticios de esta especie entre 1000 y 1800 m de profundidad. *Cataetyx alleni* es un depredador eurífago, que se alimenta de pequeños crustáceos epibentónicos y endobentónicos y de poliquetos. Las presas preferentes son isópodos y anfípodos gammarianos de pequeño tamaño y, en algunos casos, decápodos endobentónicos y epibentónicos. *Cataetyx alleni* presenta cambios batimétricos en su dieta que vienen determinados por la captura de diferentes artículos presa y también por la reducción del tamaño de las presas cuando aumenta la profundidad. Así mismo, se han observado entre los individuos de las mismas profundidades fluctuaciones estacionales en los patrones alimenticios.

Palabras clave: *Cataetyx alleni*, ecología alimenticia, Mediterráneo occidental, variaciones de aguas profundas.

INTRODUCTION

The genus *Cataetyx* is represented in the Mediterranean by two species, *Cataetyx alleni* (Byrne, 1906) and *Cataetyx laticeps* Koefoed, 1927 (Nielsen, 1986). Both species are closely associated with depths greater than 1000 m (Stefanescu *et al*., 1994).

Cataetyx alleni was first noted in the Mediterranean in 1971 (Relini-Orsi, 1971) and in the Catalan sea (western Mediterranean) in 1983 (Matallanas, 1983). According to Relini-Orsi (1974), *Cataetyx alleni* is benthic, and usually found below 600 m. However, in the Catalan Sea, it is only occasionally caught at depths of less than 1000 m, is found in greatest abundance at 1000-1450 m and is absent below 1851 m (Stefanescu *et al*., 1992a). Only a few specimens of *Cataetyx alleni* are known from the west coast of Europe (Koefoed, 1927; Nielsen and Nybelin, 1963), but in the Catalan sea it typically inhabits the middle lower slope and is the fifth most abundant demersal fish below depths of 1000 m (Stefanescu *et al*., 1992a).

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In recent years, an effort is being made to study the biology of the deep-sea Mediterranean fauna. The feeding habits of some fish and decapods in the Catalan Sea have been studied (Carrassón *et al*., 1997; Cartes, 1998a; Maynou and Cartes, 1998; Carrassón and Matallanas, 1998, 2001; Cartes and Maynou, 1998). However, there are few detailed accounts of the biology of *Cataetyx alleni*. Morphological and morphometric characteristics of the alimentary tract, growth and depth-size trends are covered by Carrassón and Matallanas (1994), Morales-Nin (1990) and Stefanescu *et al*. (1992b, 1993, 1994). There is some generic information about the trophic habits of *Cataetyx alleni* limited to commercial fishing grounds (700 m) (Relini-Orsi, 1974). Some preliminary data on the diet below 1000 m depth have been reported by Carrassón and Matallanas (1990).

The purpose of this paper is to present detailed information on the diet of *Cataetyx alleni* taken from depths of 1000-1800 m in the NW Mediterranean.

MATERIALS AND METHODS

All material was collected from the continental slope of the Catalan Sea (Western Mediterranean, 38º15' to 41º22'N, 01º05' to 03º19'E) during five cruises carried out within the framework of the BATIMAR and ABISMAR projects (1987 to 1989). The specimens were captured on board the RV García del Cid, using a semi-balloon otter-trawl (OTSB14) towed from a single warp (cf. Merret and Marshall, 1981).

A total of 358 specimens of size ranging between 33 and 128 mm (standard length) were collected between 1000 and 1800 m depth in July and October in order to examine feeding activity. The general procedure for data obtaining and processing exactly follows that described in previous papers (Carrassón and Matallanas, 1998).

The quantitative importance of each prey group in the diet was determined by the frequency of occurrence of the food item (%F), the numerical percentage of a food item in the stomachs (%N) and the percentage by weight of a food item in the stomachs (%W).

The diet, the trophic diversity (H' was calculated in terms of mean %weight of prey-items) and the dietary overlap (Schoener index) were analysed according to season (summer and autumn) and depth (two bathymetric strata: 1000-1425 m and 1425-1800 m). These groups are in agreement with the two distinct assemblages at 1000-2250 m depth in the NW Mediterranean (Stefanescu *et al*., 1993).

RESULTS AND DISCUSSION

Of the 358 specimens of *Cataetyx alleni* analysed, 65 were found with the stomach everted, and of the remaining 293, 187 had empty stomachs. The vacuity coefficient (% specimens with empty stomachs) did not show significant differences ($p>0.05$, χ^2 criterion) between seasons and depths. *Cataetyx alleni* is a euryphagic predator on a wide variety of prey. We identified thirty-nine categories of prey items from the stomachs containing food (Table 1). Of all the demersal species of fish in the Catalan sea below a depth of 1000 m, it has the highest dietary diversity (Table 1), together with the macrourids (Carrassón and Matallanas, 1998, 2001, 2002; Carrassón *et al*., 1992, 1997).

Cataetyx alleni on the deep slope of the Catalan sea feeds on small epibenthic and endobenthic crustaceans and polychaetes, and occasionally benthic fish. Isopods were the most frequently captured prey (%F = 47.6) and gammaridean amphipods the most abundant prey group (%N = 30.21). In autumn at 1000-1425 m, gammaridean amphipods were more abundant and more frequently captured (%N = 43.5, %F = 33.3) than isopods (%N = 30.4, %F = 20.8). Polychaetes were the major accidental prey in autumn at 1000-1425 m (%N = 17.4) and in summer at 1425-1800 m depth (%N = 14.8). The gill rakers of *Cataetyx alleni* (blunt, with a large number of spines) (Carrassón and Matallanas, 1994) favour the retention of small prey. The dominant preys, the isopods, are in contrast to the preliminary data of Carrassón and Matallanas (1990), in which isopods were accidental. The observed extension to the endobenthic prey, which can be observed at 1000-1425 m in summer, is due to the decapod *Calocaris macandreae* (%F = 14.3, %W =22.3), which is still relatively abundant at that depth (Cartes and Sardà, 1992) and totally disappears from the diet and the environment at 1600 m.

At 600 m depth in the Mediterranean, from 12 specimens of Geneva Gulf Relini-Orsi (1974) described a stenophagous diet of benthic origin, essentially based on polychaetes, complemented by some amphipods and occasionally *Calocaris macandreae*. The main difference is based on the

TABLE 1. – Composition of the diet of *Cataetyx alleni* in the bathymetric and seasonal groups established. %F = percentage frequency of occurrence; %N = numerical percentage of a food item in the stomachs; %W = percentage by weight of a food item in the stomachs.

	1000-1425 m						1425-1800 m					
	Summer			Autumn			Summer			Autumn		
No. of specimens (total) with food	(85) 35			(77) 24			(65) 28			(66) 19		
Trophic diversity (H')	3.86			3.48			4.06			2.84		
	%F	%N	%W	%F	%N	%W	%F	%N	%W	%F	%N	%W
POLYCHAETA												
Polychaeta unid.	11.4	7.1	0.4	12.5	13.0	10.2	7.1	3.4	2.7	10.5	11.8	1.0
Aphroditimorfa	-	-	-	-	-	-	17.9	8.0	8.4	-	-	-
Nereidae	-	-	-	-	-	-	3.6	1.1	5.6	-	-	-
Eunicidae	-	-	-	4.2	4.4	16.0	-	-	-	-	-	-
Glycera sp.	-	-	-	-	-	-	3.6	2.3	7.1	-	-	-
CRUSTACEA												
Crustacea unid.	2.9	1.8	0.2	-	-	-	7.1	2.3	2.0	10.5	11.8	1.2
COPEPODA												
Copepoda unid.	5.7	3.6	0.1	-	-	-	3.6	1.1	0.3	-	-	-
Copepoda Calanoida	8.6	5.4	0.3	-	-	-	3.6	1.1	0.1	-	-	-
AMPH. GAMMARIDEA												
Amph.Gammaridea unid.	2.9	1.8	0.2	12.5	13.0	10.9	17.9	5.7	5.6	5.3	5.9	1.0
Orchomene humilis	2.9	1.8	0.1	4.2	8.7	1.6	-	-	-	-	-	-
Orchomene sp.	-	-	-	-	-	-	3.6	19.3	5.7	-	-	-
Lysianassidae	2.9	1.8	0.0	-	-	-	-	-	-	-	-	-
Bruzelia typica	-	-	-	-	-	-	3.6	1.1	1.0	-	-	-
Pseudotiron bouvieri	2.9	1.8	0.1	-	-	-	10.7	3.4	1.8	-	-	-
Lepechinella echinata	2.9	1.8	0.2	-	-	-	-	-	-	-	-	-
Idunella pirata	-	-	-	-	-	-	10.7	4.6	0.9	-	-	-
Rhachotropis caeca	5.7	3.6	0.5	4.2	4.4	5.4	-	-	-	-	-	-
Rhachotropis sp.	5.7	5.4	0.3	-	-	-	-	-	-	5.3	5.9	0.3
Eusirus longipes	5.7	3.6	0.3	8.7	8.7	7.8	-	-	-	-	-	-
Monoculodes sp.	2.9	1.8	0.1	-	-	-	10.7	3.4	1.3	-	-	-
Oediceropsis brevicornis	-	-	-	4.2	4.4	3.6	-	-	-	-	-	-
Melphidippella macra	-	-	-	4.2	4.4	4.0	-	-	-	-	-	-
ISOPODA												
Isopoda unid.	22.9	14.3	1.2	4.2	4.4	0.5	17.9	8.0	6.8	15.8	17.7	0.7
Gnathia sp.	-	-	-	8.3	8.7	0.7	21.4	6.8	0.9	5.3	5.9	0.4
Munnopsurus atlanticus	-	-	-	-	-	-	3.6	1.1	2.5	-	-	-
Eurycopidae	5.7	12.5	0.4	4.2	4.4	0.9	14.3	5.7	3.0	-	-	-
Ilyarachna sp.	5.7	3.6	0.3	8.3	8.7	5.1	25.0	8.0	8.4	5.3	17.7	6.6
Janirella sp.	-	-	-	4.2	4.4	1.6	-	-	-	-	-	-
TANAIDACEA												
Apseudidae	2.9	1.8	0.6	-	-	-	-	-	-	-	-	-
CUMACEA												
Leucon longirostris	2.9	1.8	0.2	-	-	-	-	-	-	-	-	-
Diastyloides sp.	-	-	-	-	-	-	7.1	2.3	1.0	-	-	-
MYSIDACEA												
Mysidacea unid.	-	-	-	4.2	4.4	0.2	17.9	5.7	5.4	-	-	-
Erythrops neapolitana	2.9	1.8	0.1	-	-	-	-	-	-	-	-	-
Parapseudomma calloplura	11.4	7.1	0.7	-	-	-	3.6	2.3	2.4	-	-	-
DEC. MACRURA NATANTIA												
Pontophilus norvegicus	2.9	1.8	2.0	-	-	-	-	-	-	5.3	11.8	63.0
DEC. MACRURA REPTANTIA												
Dec. Macrura Reptantia unid.	-	-	-	4.2	4.4	31.6	10.7	3.4	27.0	10.5	11.8	25.9
Calocaris macandreae	14.3	8.9	22.3	-	-	-	-	-	-	-	-	-
DEC. ANOMURA												
Paguridae	5.7	3.6	11.5	-	-	-	-	-	-	-	-	-
PISCES OSTEICHTHYES												
Moridae	2.9	1.8	58.1	-	-	-	-	-	-	-	-	-

extension to other prey below 1000 m depth, which makes it much more euryphagous. The abundance of resources decreases with depth in the NW Mediterranean waters (Cartes and Sardà, 1992; Cartes and Sorbe, 1993, 1999; Cartes, 1998b) and this less intense specialisation in a type of resource leads the deep predator to be more adaptable to the scarcity of resources. Relini-Orsi (1974) also postulated that *Cataetyx alleni* catches prey by stalking, and seems incapable of capturing fast prey like fish. The presence of copepods, morids and *Pseudotiron bouvieri* with a considerable swimming capacity (Kt = 0.232) (Cartes and Sorbe, 1999), however, confirms that *Cataetyx alleni* can capture mobile prey.

Bathymetric differences and seasonal fluctuations were found in the diet of *Cataetyx alleni*, as in that of other fish species of the Catalan sea (Carrassón and Matallanas, 1998, 2001; Carrassón *et al.*, 1992, 1997). The average weight of the prey items decreases with the increase in depth (0.036 g for the prey of summer individuals at 1000-1425 m and 0.004 g at 1425-1800 m). The practical disappearance from the environment of *Calocaris macandreae* at 1400 m (Cartes and Sardà, 1992) probably contributes to this reduction in the size of the prey observed. The decrease in resources reported in the Catalan sea below 1000 m shows up in the diet of the *Cataetyx*, so that, for example, the polychaetes lose importance at 1425-1800 m, as also happens with the amphipods, whose density diminishes below 1000 m depth in the environment (Cartes and Sorbe, 1999). This decrease is also accompanied by a substitution of dominant species. Thus, *Orchomene humilis*, *Eusirus longipes* and *Oediceropsis brevicornis* are abundant between 1000 m and 1300 m in the environment (Cartes and Sorbe, 1993, 1999), the range where they are consumed by *Cataetyx* (Table 1). *Bruzelia typica* appears in the diet below 1300 m, coinciding with higher dominance in the environment (Cartes and Sorbe, 1999).

Seasonal fluctuations in the feeding pattern of *Cataetyx alleni* are showed by the low coefficients of overlap in the Schooner index among the individuals at the same depths (Schoener $_{\text{summer 1000\_1425 m with autumn 1000\_1425 m}} = 0.24$; Schoener $_{\text{summer 1425\_1800 m with autumn 1425\_1800 m}} = 0.33$). Dietary overlap was higher between groups from the same season (Schoener $_{\text{summer 1000\_1425 m with summer 1425\_1800 m}} = 0.35$; Schoener $_{\text{autumn 1000\_1425 m with autumn 1425\_1800 m}} = 0.46$). The seasonal variations might be caused generally by the fluctuations of the prey abundance in the environment (e.g. greater abundance of *Eusirus longipes* in autumn (Cartes and Sorbe, 1999) and of *Calocaris macandreae* in summer (Cartes, 1998b)). These seasonal fluctuations in the diet might provide an explanation for the seasonal growth observed in the otoliths of *Cataetyx alleni* (and of other species of Mediterranean demersal fish), as Massutí *et al*. (1995) and Morales-Nin (1990) suggested. In the Mediterranean, temperature and salinity are fairly constant below 150-200 m (Salat and Font, 1987) and thus presumably do not play any significant role in the periodicity of otolith ring formation.

A bathymetric segregation of the respective niches of *Cataetyx alleni* and other species of different genera (e.g. *Polyacanthonotus rissoanus* and *Coryphaenoides guentheri*), also preying on infauna, occur in the Catalan Sea. Both species, euryphagous with a diet based on small-size organisms (Carrassón and Matallanas, 2002), probably contribute to the disappearance of *Cataetyx alleni* below 1851 m. A clear inverse relationship is observed between the abundance of *Cataetyx alleni* and *Polyacanthonotus rissoanus* in the environment and its trophic overlap.

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