

Original scientific article
Received: 2007-07-19

UDC 597.317.5:591.53(262-17)

DIET OF THE MARBLED ELECTRIC RAY *TORPEDO MARMORATA* (CHONDRICHTHYES: TORPEDINIDAE) OFF THE LANGUEDOCIAN COAST (SOUTHERN FRANCE, NORTHERN MEDITERRANEAN)

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ABSTRACT

*A study of stomach contents of the electric marbled ray *Torpedo marmorata* Risso, 1810 has shown that the species is a rather active feeder, consuming mostly teleosts and, occasionally, cephalopods. This confirms the fact that *T. marmorata* is an ichthyophagous species, such as specimens from other areas and other species of the genus *Torpedo*.*

Key words: Chondrichthyes, *Torpedo marmorata*, diet, coast of Languedoc, Mediterranean Sea

ALIMENTAZIONE DELLA TORPEDINE MAREZZATA *TORPEDO MARMORATA* (CHONDRICHTHYES: TORPEDINIDAE) AL LARGO DELLA COSTA DI LANGUEDOC (FRANCIA MERIDIONALE, MEDITERRANEO SETTENTRIONALE)

SINTESI

*Lo studio dei contenuti stomacali della torpedine marezzata *Torpedo marmorata* Risso, 1810 ha evidenziato che la specie si alimenta attivamente, consumando in prevalenza teleostei e occasionalmente cefalopodi. I dati confermano che *T. marmorata* è una specie ittiofaga, come precedentemente riscontrato su individui provenienti da altre aree e su altre specie del genere *Torpedo*.*

Parole chiave: Chondrichthyes, *Torpedo marmorata*, alimentazione, costa di Languedoc, Mediterraneo

INTRODUCTION

The marbled electric ray *Torpedo marmorata* Risso, 1810 is known in the eastern Atlantic from the northern areas such as off Scandinavia (Muus & Dahlstrøm, 1964–1966) and off the British Isles (Wheeler, 1969) to the Gulf of Guinea (Blache *et al.*, 1970). Smith & Heemstra (1986) reported the species off South Africa, but this occurrence in the area needs confirmation. *T. marmorata* is reported throughout the Mediterranean, but it is rather abundantly reported in the western than in the eastern basin, and off the northern than off the southern shore (Capapé, 1989). The reproductive biology had previously been studied for specimens from the eastern Atlantic, north of the Strait of Gibraltar (France; see Mellinger, 1969, 1971, 1973, 1974, 1976), south of the Strait of Gibraltar (Senegal; see Capapé *et al.*, 2001), and off Tunisia (Capapé, 1979). In contrast, little has been studied regarding the diet and feeding habits of the marbled electric ray, which is known as a piscivorous species (Belbenoit, 1970; Belbenoit & Bauer, 1972). Additionally, Capapé (1979) reported observations on stomach contents of specimens from Tunisian coastal waters. Off the coast of Languedoc, *T. marmorata* had formerly been reported by Doumet (1860), Moreau (1881), Calvet (1905), Euzet (1960) and Quignard *et al.* (1962), and the species is the most common torpedinid recorded in the area (Capapé *et al.*, 2006). Observations based on several specimens caught in the area allow us to present herewith data on diet composition of the Languedocian electric marbled rays.

MATERIAL AND METHODS

A total of 102 specimens, 43 males and 59 females, were examined. The observed specimens were collected off the Languedocian coast (Fig. 1) by demersal gill-nets, at depths between 10 and 50 m, on sandy and muddy bottoms, between 2001 and 2004. Total length (TL) of all the specimens was measured to the nearest millimetre; they were weighed to the nearest gram. Males ranged from 230 to 320 mm TL and weighed from 270 to 550 g, while females ranged from 195 to 550 mm TL and weighed from 200 to 2940 g.

As soon as they were collected, the electric marbled rays were dissected and the stomach contents removed, sorted and identified to the lowest taxon (species level when possible) using key and fields guides (Riedl, 1963; Fischer *et al.*, 1981, 1987). The prey items were counted and weighed to the nearest decigram after removal of surface water by blotting on tissue paper. To analyse the diet composition of *Torpedo marmorata*, we used some indices following Berg (1979), Hyslop (1980) and Tirasin & Jörgensen (1999): vacuity index (VI) = number of empty stomachs divided by the total number of stomachs; percentage frequency of occurrence (% F) = the number of stomachs, in which a food item was found expressed as percentage of the total number of stomachs; percentage numerical abundance (% Cn) = number of each prey type, expressed as a percentage of the total number of all food types in all stomachs; percentage ponderal composition (% Cw) = wet weight of each

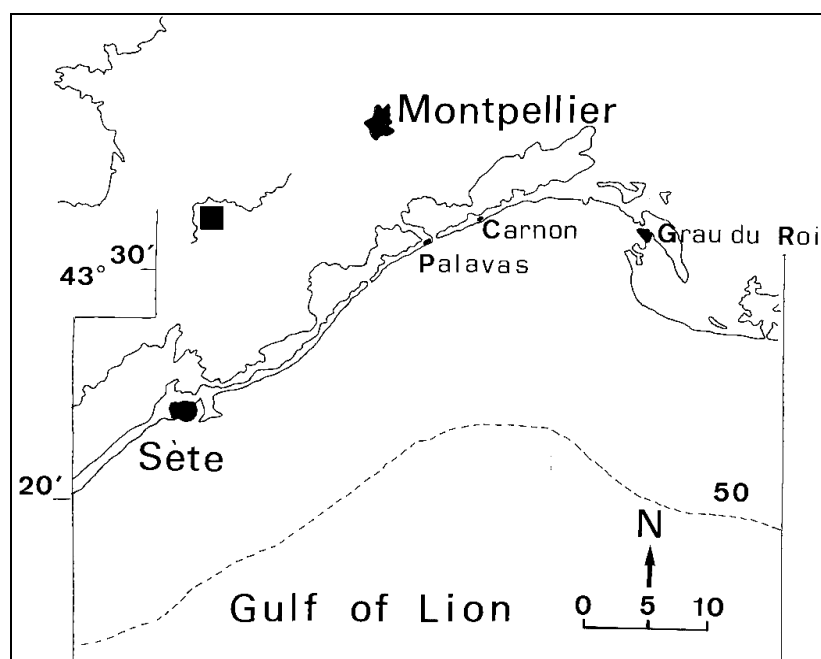


Fig. 1: Map of France with the coast of Languedoc (redrawn from Capapé *et al.*, 2000).
Sl. 1: Zemljevid Francije z obrežjem pokrajine Languedoc (po Capapé *et al.*, 2000).

prey type, expressed as a percentage of the total weights of stomach contents in a sample.

Additionally, we used the index of relative abundance, IRI (Pinkas *et al.*, 1971; Cortès, 1997) as $IRI = \% F \times (\% Cn = \% Cw)$, expressed as a percentage to quantify the diet as $\% IRI = (IRI / \Sigma IRI) \times 100$.

RESULTS AND DISCUSSION

Of the 102 stomach contents of *Torpedo marmorata* examined, 63 were empty ($VI = 61.76$). Significant differences were recorded between sexes, VI were 46.51 and 72.88 for males and females, respectively ($\chi^2 = 23.5$, $df = 1$).

The diet of the marbled electric ray consisted of two major systematic groups, cephalopods and teleosts, however, six species were ingested only (Tab. 1): the European squid *Loligo vulgaris* Lamarck, 1798, the elegant cuttlefish *Sepia elegans* Blainville, 1827, the dragonet *Callionymus lyra* Linnaeus, 1758, the red bandfish *Cepola rubescens* Linnaeus, 1766 and the leaping grey mullet *Liza saliens* (Risso, 1810), which was the most identifiable prey species ($IRI = 281.88$).

The vacuity index calculated for the Languedocian *T. marmorata* is lower than this observed for the Tunisian specimens. The latter specimens were captured thirty years ago, between 1970 and 1975 (Capapé, 1979); formerly, the Tunisian coast was not the focus of an intensive fishery during this period, consequently the biological environment was relatively rich (Lubet & Azouz, 1969). Specimens from Languedocian waters have more recently been examined in the second area that is intensively exploited by both commercial and craft fisheries. Fishing method could also explain differences in the va-

cuity index recorded between the two areas. Off the Languedocian coast, the marbled electric rays from our sample were caught by gill-nets, in which they spent all night and thus could not seek their prey; additionally, the prey consumed prior to the predators being caught could be entirely digested. A great number of both cephalopod and teleost prey items remained unidentified (see Table 1).

In contrast, off the Tunisian coast, they were caught by trawl, and they could accidentally ingest prey during capture. This could also explain why more teleost species were identified in Tunisian *T. marmorata* than in the Languedocian specimens, 13 vs. 3. Additionally, teleosts species constituted quantitatively and qualitatively the main prey species *T. marmorata* from both areas, whilst cephalopods were occasionally preyed, a single camarote shrimp *Penaeus kerathurus* (Forskäl, 1764) was accidentally found in the stomach of a Tunisian specimen. Similar patterns were observed in the diet of *T. marmorata* from off the coast of Senegal (*unpubl. data*), as well as in the diet of its close relative species, the common torpedo *Torpedo torpedo* (Linnaeus, 1758) from off the Tunisian coast (Quignard & Capapé, 1974). *T. marmorata* is a selective predator that feeds quasi exclusively on teleost species. This is due to the prey capture behaviour and feeding habits of the species of the genus *Torpedo*. Belbenoit & Bauer (1972) first videorecorded and described *T. marmorata* capturing its prey in captivity. Generally, *T. marmorata* at rest was waiting for prey while hidden in the sand. So, when a prey swims near a marbled electric ray at a short distance, 40 mm approximately, the latter jumps and simultaneously immobilizes the prey by its electric organ discharge. Prior to jumping, the predator detects the prey with its receptor

Tab. 1: Diet composition of the 102 marbled electric rays collected off the Languedocian coast. Legend: % F – frequency of occurrence; % Cn – percentage numerical composition; % Cw – percentage ponderal composition; IRI – index of relative importance.

Tab. 1: Sestava hrane v želodcih 102 navadnih električnih skatov, ujetih v obrežnih vodah pokrajine Languedoc. Legenda: % F – frekvenca pojavljanja; % Cn – številčnost v odstotkih; % Cw – biomasa v odstotkih; IRI – indeks relativne pomembnosti.

Food items	(% F)	(% Cn)	(% Cw)	IRI	% IRI
Cephalopods					
<i>Loligo vulgaris</i>	0.98	2.00	0.70	2.64	0.06
<i>Sepia elegans</i>	0.98	2.00	3.68	5.57	0.12
Unidentified preys	2.94	6.00	0.69	19.67	0.43
Total	4.90	10.25	5.07	27.88	0.61
Teleosts					
<i>Callionymus lyra</i>	0.98	2.00	1.32	3.25	0.07
<i>Cepola rubescens</i>	1.96	4.00	7.24	23.03	0.59
<i>Liza saliens</i>	1.96	4.00	43.75	93.59	2.05
Unidentified	37.25	76.00	42.53	4415.24	96.68
Total	42.15	86.00	94.84	4653.95	99.39

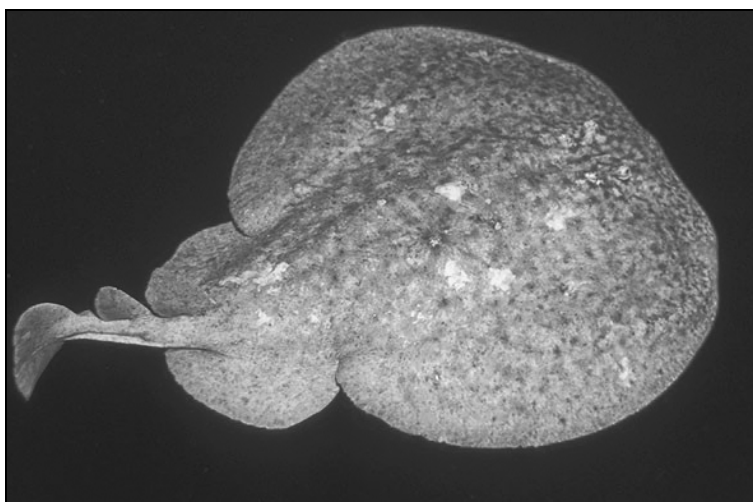


Fig. 2 / Sl. 2: *Torpedo marmorata*. (Photo / Foto: B. Furlan)

organs. The discharge is sufficient to break the vertebral column of the prey, which moves under the disc and is then absorbed. Active swimmers, such as teleosts, produce flue water that induces electric discharges. This explains their importance in the diet of *T. marmorata*, and offers us an opportunity to state, in agreement with previous papers, that the marbled electric ray is a piscivorous species (Fig. 2).

The diet composition of *T. marmorata* from both Tunisian and Languedocian coasts has shown that the spe-

cies feeds on more species than its close relative *T. torpedo* from the same area (Quignard & Capapé, 1974; Capapé, 1979). According to Capapé (1979), this phenomenon could be due to the fact that *T. marmorata* reaches a larger size than *T. torpedo* and is, consequently, a more active feeder. Similar patterns were reported in other elasmobranch species, such as rajids (Capapé & Azouz, 1976; Capapé, 1977a; Capapé & Quignard, 1977) and myliobatids (Capapé, 1976, 1977b; Jardas *et al.*, 2004).

PREHRANA NAVADNEGA ELEKTRIČNEGA SKATA *TORPEDO MARMORATA* (CHONDRICHTHYES: TORPEDINIDAE) V OBREŽNIH VODAH POKRAJINE LANGUEDOC (JUŽNA FRANCIJA, SEVERNO SREDOZEMSKO MORJE)

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POVZETEK

Analiza hrane v želodcih navadnega električnega skata *Torpedo marmorata* Risso, 1810 je pokazala, da se ta vrsta prehranjuje zelo aktivno, predvsem s pravimi kostnicami, občasno pa tudi z glavonožci. To potrjuje že znano dejstvo, da je *T. marmorata* ribojeda vrsta, tako kot osebki iz drugih območij in drugih vrst iz rodu *Torpedo*.

Ključne besede: Chondrichthyes, *Torpedo marmorata*, prehrana, obrežne vode Languedoca, Sredozemsko morje

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