DIET COMPOSITION OF THE EAGLE RAY, *MYLIOBATIS AQUILA* (CHONDRICHTHYES: MYLIOBATIDAE), IN THE EASTERN ADRIATIC SEA

by

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RÉSUMÉ. - Régime alimentaire de la raie-aigle, *Myliobatis aquila* (Chondrichthyes, Myliobatidae) en mer Adriatique orientale.

Le régime alimentaire de la raie-aigle, *Myliobatis aquila*, a été étudié en analysant les contenus stomacaux de 165 spécimens, de 19,1 à 76,5 cm d'envergure, récoltés par chalutages en mer Adriatique orientale, entre 1998 et 2002. Sur l'ensemble des estomacs étudiés, 24 étaient vides (14,5%). Les proies identifiées dans les estomacs appartenaient à six groupes principaux : némertes, mollusques, polychètes, siponcles, crustacés décapodes et téléostéens. Les proies les plus abondantes étaient les mollusques (%IRI = 57,1), comprenant les scaphopodes, les gastéropodes, les bivalves et les céphalopodes, puis les siponcles (%IRI = 23,1). Les autres groupes, décapodes, polychètes, némertes et téléostéens, étaient bien moins représentés et constituaient probablement des proies accidentelles. Les espèces-proies les plus abondantes étaient un siponcle, *Aspidosiphon mulleri* (%IRI = 16,9) et deux bivalves, *Pteria hirundo* et *Cardium* sp. (%IRI = 5,6). La variété des proies trouvées dans l'estomac de la raie-aigle indique que cette espèce est un prédateur généraliste qui se nourrit d'organismes benthiques variés, présentant une large gamme de tailles et de formes.

Key words. - Myliobatidae - *Myliobatis aquila* - Eagle ray -MED - Adriatic Sea - Diet.

The eagle ray, *Myliobatis aquila* (Linnaeus, 1758), is common throughout the Adriatic (Jardas, 1984), Mediterranean and eastern Atlantic, from English Channel to South African waters (McEachran and Capapé, 1986). It lives above sand and soft substrates up to 200 m in depth (Jardas, 1984). Descriptions of eagle ray diet in the Adriatic Sea are rare, generally not very current, and deal only with qualitative aspects. Published information only points out that bottom-living crustaceans and molluscs are the main dietary components (Bini, 1967; Jardas, 1996), but otherwise, there are not other studies of the diet of the eagle ray in the Adriatic Sea. Azouz and Capapé (1971) and Capapé and Quignard (1974) provided some data on diet composition in the Mediterranean Sea, and Capapé (1976) quantified the diet more thoroughly in the Mediterranean waters of Tunisia, by calculating the occurrence of prey items.

The purpose of the present study was to provide a quantitative description of the diet of the eagle ray in the eastern Adriatic Sea.

MATERIAL AND METHODS

Eagle rays were taken during survey cruises conducted by the Institute of Oceanography and Fisheries in Split, in the eastern Adriatic. A total of 165 specimens were collected using a bottom-trawl with a cod-end of 22 mm stretched mesh size from four stations, between 30 and 90 m depth (Fig. 1), from 1998 to 2002. Disc-width (DW) of fish examined ranged from 19.1 to 76.5 cm (Fig. 2). Disc-width of fish was measured to the nearest 1 cm and weight to the nearest 1 g. Immediately after capture, fish were dissected and the gut removed and preserved in a 4% formalin solution to prevent food digestion. Evidence of regurgitation was never observed in any fish. In the laboratory, identification of prey was carried out to the species level whenever possible. We counted the prey items and

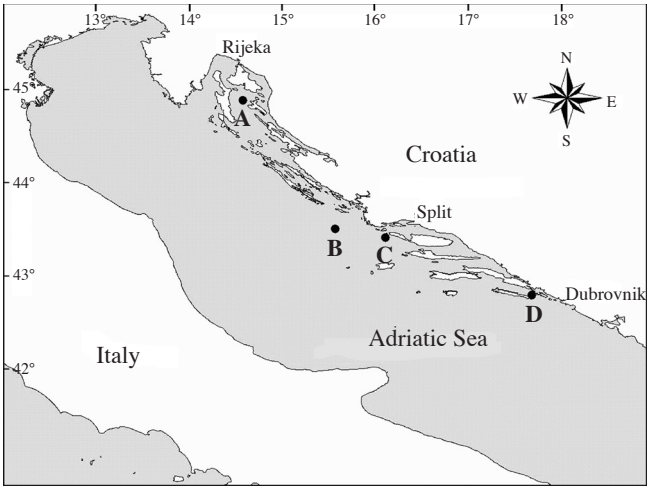

Figure 1. - Study area and sampling localities of *Myliobatis aquila* in the eastern Adriatic Sea: **A**: Kvarnerić; **B**: Blitvenica fishing area; **C**: South off Maslenica; **D**: Malostonski bay. *[Zone d'étude et localités de capture de* Myliobatis aquila *en Adriatique orientale.]*

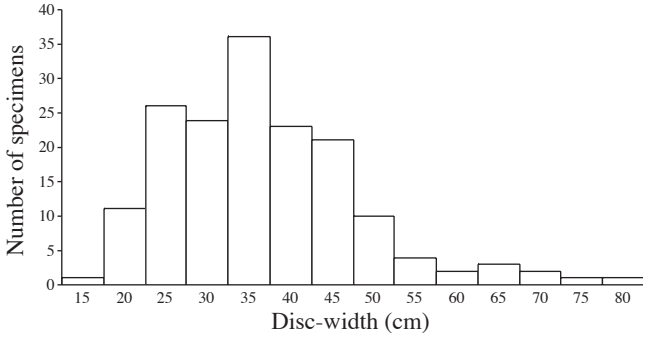

Figure 2. - Disc-width (DW) frequency distribution of 165 specimens of *Myliobatis aquila* caught in the eastern Adriatic Sea. *[Fréquence de distribution de la largeur du disque (DW) pour 165 spécimens de* Myliobatis aquila *capturés en Adriatique orientale.]*

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Food items	(%F)	(%Cn)	(%Cw)	IRI	%IRI
Nemertina					
Tubulanus sp.	2.08	0.35	0.21	1.1	-
Lineus sp.	1.38	0.23	0.12	0.4	-
Unidentified Nemertina	2.77	0.58	0.59	3.2	0.1
Total Nemertina	3.10	1.16	0.92	6.4	0.2
Mollusca					
Scaphopoda					
Dentalium agile	2.77	0.82	0.88	4.7	0.1
Dentalium sp.	2.77	1.17	0.25	3.9	0.1
Unidentified Scaphopoda	5.55	2.00	0.59	1.4	-
Total Scaphopoda	5.91	3.99	1.72	33.7	1.1
Gastropoda					
Turritella sp.	6.94	6.00	1.82	54.2	1.7
Murex sp.	4.86	5.52	0.88	31.1	1.0
Natica sp.	2.77	3.29	0.67	10.9	0.3
Calliostoma sp.	2.77	3.05	0.59	10.0	0.3
Unidentified Gastropoda	12.50	12.47	8.09	257.0	8.4
Total Gastropoda	14.91	30.33	12.05	631.8	20.6
Bivalvia					
Cardium sp.	11.11	6.35	9.24	173.2	5.6
Pteria hirundo	9.72	7.64	9.98	171.2	5.6
Cardium aculeatum	4.16	3.76	3.36	25.4	0.8
Pecten jacobeus	2.77	3.41	1.72	14.2	0.4
Chlamys sp.	2.77	2.11	1.18	9.1	0.3
Apporhais pes-pelecani	1.38	1.52	0.84	3.2	0.1
Unidentified Bivalvia	13.88	8.23	10.02	253.3	8.2
Total Bivalvia	15.11	33.0	35.34	1,032.6	33.7
Cephalopoda					
Loligo vulgaris	5.55	0.47	3.47	21.8	0.7
Ommatostrephes sagittatus	1.38	0.23	2.05	3.1	0.1
Unidentified Cephalopoda	0.69	0.11	0.83	0.6	-
Total Cephalopoda	6.93	0.81	6.35	49.6	1.6
Polychaeta					
Sternaspis scutata	9.02	3.52	10.24	124.1	4.0
Unidentified Polychaeta	5.55	1.17	1.37	14.0	0.4
Total Polychaeta	9.02	4.69	11.61	147.0	4.8
Sipunculida					
Aspidosiphon mulleri	21.52	12.47	11.57	517.3	16.9
Phycosoma granulatum	2.77	0.47	0.39	2.3	-
Unidentified Sipunculida	6.94	2.82	0.99	26.4	0.8
Total Sipunculida	24.66	15.76	12.95	707.9	23.1
Crustacea					
Decapoda					
Pagurites arrosus	10.41	3.29	4.05	76.4	2.5
Pagurites oculatus	5.51	2.00	4.30	34.7	1.1
Galathea intermedia	2.77	0.58	2.86	9.5	0.3
Processa caniculata	4.16	1.17	0.46	6.7	0.2
Galathea strigosa	1.38	0.35	2.57	4.0	0.1
Munida rugosa	1.38	0.35	1.84	3.0	0.1
Processa longirostris	2.08	0.82	0.40	2.5	-
Unidentified Decapoda	5.55	1.17	1.83	16.6	0.5
Total Decapoda	15.91	9.73	18.31	446.1	14.5
Teleostei					
Unidentified Teleostei	2.08	0.60	0.75	2.8	-

Table I. - Diet composition of 141 *Myliobatis aquila* (%F: frequency of occurrence; %Cn: percentage numerical composition; %Cw: percentage ponderal composition; IRI: index of relative importance). Only prey species with a contribution to the %IRI of more than 0.1 are listed (- indicates less than 0.1%). *[Régime alimentaire de 141* Myliobatis aquila *(%F : fréquence d'occurrence ; %Cn : composition numérique en pourcentage ; %Cw : composition pondérale en pourcentage ; %IRI : index d'importance relative). Seules les proies dont le %IRI est supérieur à 0,1% sont listées (- indique moins de 0,1%).]*

weighted them to the nearest 0.001 g after removal of surface water by blotting on tissue paper.

We used the following indices to quantify the importance of different prey items in the diets (Berg, 1979; Hyslop, 1980; Tirasin and Jørgensen, 1999): percentage frequency of occurrence (%F), the number of stomachs, in which a food item was found, expressed as a percentage of the total number of stomachs; percentage numerical abundance (%Cn), the number of each prey type in all stomachs, expressed as a percentage of the total number of all food types in all stomachs; and percentage ponderal composition (%Cw), the wet weight of each prey type, expressed as a percentage of the total weight of stomach contents in a sample. All calculations were based on the number of non-empty stomachs.

We also used the index of relative importance (IRI; Pinkas *et al*., 1971), IRI = %F x (%Cn + %Cw) expressed as a percentage to quantify the diet:

$$\%IRI = (IRI / \sum IRI) \times 100$$

Prey were sorted in decreasing order according to their %IRI, and the cumulative %IRI was calculated.

RESULTS

Of the 165 stomachs of *Myliobatis aquila* examined, 24 were empty (14.5%). The diet of eagle ray consisted of six major systematic groups: Nemertina, Mollusca, Polychaeta, Sipunculida, Decapoda crustaceans and Teleostei (Tab. I). Molluscs (including scaphopods, gastropods, bivalves and cephalopods) were the most frequently observed prey, constituting 57.1% of the total IRI, followed by sipunculids (%IRI = 23.1). Among molluscs, bivalves made an important contribution to the diet (%IRI = 33.7), followed by gastropods (%IRI = 20.6). The relative importance of decapods, polychaets, nemertins and teleosts was comparatively low. The most exploited identifiable prey were a sipunculid *Aspidosiphon mulleri* (%IRI = 16.9) and two bivalves *Pteria hirundo* and *Carduim* sp. (%IRI = 5.6).

DISCUSSION

This study indicates that molluscs are the most abundant prey of *Myliobatis aquila* in the eastern Adriatic Sea. This prey group, which represents more than 50% of total IRI, can be classified as main food (Rosecchi and Nouaze, 1987). Sipunculids, such as *Aspidosiphon mulleri,* are the secondary prey and the remaining

prey, decapods, polychaets, nemertins and teleosts, are of minor importance and probably represent accidental food.

The diet of the eagle ray collected in the Mediterranean coast of Tunisia generally agree with our finding (Capapé, 1976). This author found that bivalves were the preferential prey (%F = 0.61), whereas gastropods (%F = 0.24) and decapods (%F = 0.20) were secondary food, and all other prey groups occurring as accidental food (%F < 0.1). Other studies have confirmed that bivalves were major components in the diet of the eagle ray (Azouz and Capapé, 1971; Capapé and Quignard, 1974).

Our study indicates that eagle rays feed almost exclusively on benthic invertebrates that live on the sand and soft bottom sediment. Although data on eagle ray feeding in the Adriatic Sea are poor, Bini (1967) mentioned gastropods, bivalves and decapods (*Pagurites* and *Maia* genus) as their food. Jardas (1996) also quoted fish as prey items of eagle rays in addition to molluscs and crustaceans. These data generally agree with ours.

In general, the prey groups found in eagle ray stomachs indicate that *Myliobatis aquila* is a generalistic predator that feeds on various types of benthic organisms, with a wide range of sizes and morphologies. The data of Azouz and Capapé (1971), Capapé and Quignard (1974) and Capapé (1976), showing that eagle rays collected in Tunisian waters consumed a wide range of benthic organisms (bivalves, gastropods, cephalopods, decapods, annelids, sipunculids, echinoderms and ascidians) and some teleosts (mainly species of *Gobius, Callionymus*, and *Blennius* genera) further support a generalistic behavior for this species.

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Reçu le 06 novembre 2003.
Accepté pour publication le 08 mai 2004.