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Diet of Risso's dolphin (*Grampus griseus*) in the western Mediterranean Sea

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SUMMARY: The diet of Risso's dolphin in the Mediterranean is described based on 15 animals stranded between 40º25'N 00º32'W and 37º35'N 00º45'E from April 1987 to January 2003. The prey were mainly oceanic cephalopods. Pelagic octopods, especially *A. argo*, were the most abundant (mean = 41.28%; SD±34.32). Species belonging to the families Ommastrephidae, Histioteuthidae and Onychoteuthidae were also frequent components of its diet. The bathymetric distribution of cephalopods shows that Risso's dolphin preferentially feeds on the middle slope (600 to 800 m depth) in the Mediterranean.

Keywords: *Grampus griseus*, cetacean, cephalopods, diet, slope, Mediterranean.

RESUMEN: DIETA DEL DELFÍN DE RISSO (*GRAMPUS GRISEUS*) EN EL MEDITERRÁNEO OCCIDENTAL. – Se ha analizado el contenido gastrointestinal de quince ejemplares de *Grampus griseus* varados en el Mediterráneo occidental entre 40º25'N 00º32'W y 37º35'N 00º45'E durante el período1987 a 2003. Los resultados indican una dieta teutófaga, basada principalmente en cefalópodos oceánicos destacando los octópodos pelágicos, especialmente *Argonauta argo*, como la presa más abundante (media = 41,28%; SD±34,32). Algunas especies pertenecientes a las familias Ommastrephidae, Histioteuthidae y Onychoteuthidae son también componentes frecuentes de la misma. La distribución batimétrica de los cefalópodos indica que el área de alimentación de este delfín se localiza preferentemente sobre el talud continental medio (600-800 m de profundidad).

Palabras clave: *Grampus griseus*, cetáceo, cefalópodos, dieta, talud, Mediterráneo.

Risso's dolphin, *Grampus griseus* (Cuvier, 1812) is a moderately large and cosmopolitan dolphin species that lives in deep tropical and warm temperate oceanic waters. Data on its distribution in the Mediterranean are very scarce but sightings seem to indicate that the species prefers the slope, mostly where the slope is closest to the coastline (Notarbartolo di Sciara *et al.*, 1993). There are few studies on the diet of Risso's dolphin and they are frequently based on one or two individuals, except for data coming from the east coast of South Africa (Cockroft *et al.*, 1993). In general its diet has been considered mainly teuthophagous with fish as an occasional component (Goodall and Galeazzi, 1985). The diet of Risso's dolphin includes neritic, oceanic and bottom dwelling cephalopods. Data on its diet in the Mediterranean comes from studies on one harpooned (Pilleri and Gihr, 1969) and one or two stranded individuals, which were summarised by Clarke (1996) and which corroborate the teuthophagous character of the diet. The aim of this note is to provide more complete information about the poorly known diet of this dolphin.

The gastrointestinal tracts analysed in the present work came from fifteen Risso's dolphins stranded on the Mediterranean west coast between 40º25'N

00º32'W and 37º35'N 00º45'E from April 1987 to January 2003. Gastrointestinal tracts were stored deep frozen (-20ºC) and the contents were subsequently flushed through 0.4 mm and 0.2 mm mesh and preserved in 70% ethanol.

Single strandings of Risso's dolphins have occurred over the last 15 years in this part of the western Mediterranean coast, with an average of 1.4 individuals stranded per year. The cause of death was not established but seems to be natural. None of them were injured; only one 260 cm length male was caught by trawling fisheries. Table 1 shows some biological data and the stranding dates of the dolphins analysed in this study.

A summary of the contents of the digestive tract of *G. griseus* is shown in Table 2. One female (165 cm length) was excluded from the table as its gut only contained a single cephalopod eye lens. Cephalopod remains, lenses and especially beaks were the common remains in the gastrointestinal tract, particularly in the stomach. Minute remains, including a few cephalopod beaks, lenses and teuthoid statoliths, were the most frequent hard remains found in the intestine. Cephalopod remains consisted mainly of beaks, which were identified using guides (Clarke, 1986a) and reference material. Taxonomic keys were used to identify thaliaceans (Godeaux, 1998) and isopods (Richardson, 1972); cephalopod mantle length was estimated from the morphometric relationships given by Clarke (1986a), Würtz *et al*. (1992) and Smale *et al*. (1993).

The smallest individual (165 cm length) with hard remains in its stomach was a calf less than one year old according to age determination from reading GLGs (A. Raduán, 2004, personal communication); this early solid food intake in the life cycle of Risso's dolphin shows that lactation may be quickly complemented with solid food as occurs in other marine mammals (Stewart and Stewart, 2002).

The teuthophagous component of the diet of *G. griseus* in the western Mediterranean was made up of 25 species of cephalopods belonging to 13 families. Prey were mainly oceanic and pelagic (97.2%) with a muscular body (79%) and only 27.9% were luminous species. Squids and octopods were the main component of this dolphin's diet, pelagic octopods (mainly *A. argo*) were the most abundant prey (average numerical abundance = 41.28%; SD±34.32). Biological data on these species items have already been published in Blanco et al., 2005. Species of families Ommastrephidae and Histioteuthidae have been cited previously as the main component of the diet of Risso's dolphin in the Mediterranean (Clarke, 1996), but this study confirms the importance of octopods in its diet in the western Mediterranean, as found in other seas (Clarke, 1996; Cockroft *et al*., 1993). Nevertheless, the pelagic character of most octopods, mainly *A. argo*, contrasts with the benthic character of the most frequent octopod prey, *Eledone cirrhosa* in the Atlantic (Clarke and Pascoe, 1985; González *et al*., 1994; Santos *et al*. 1996) and is similar to the results concerning diet for the southern Indian Ocean (Cockroft *et al*. 1993). Pelagic octopods seem to be characteristic of its diet, which does not apply to other cetaceans in the Mediterranean (Meotti and Podestá, 1997; Blanco and Raga, 2000; Roberts, 2003) and other seas (Clarke, 1996). Benthic octopods appear in the diet of bottlenose dolphins (Blanco *et al*., 2001) in the Mediterranean. The fact that they are benthic species shows that these two dolphins have different feeding habitats.

TABLE 1. – Biological data of stranded Risso's dolphin in the western Mediterranean. N, number of cephalopod prey; Nsp, number of cephalopod prey species; F, fish; C, cephalopods; Cr, crustaceans; T, tunicates; B, bryozoans.

sex	date	length (cm)	prey	N sp	N
♀	04/ 09/ 1989	165	C	1	1
♀	04/ 02/ 1993	210	C, Cr	3	4
♀	06/ 06/ 1995	230	C	5	27
♀	19/ 11/ 1998	289	C	3	16
♀	20/ 03/ 1999	290	C	2	2
♀	13/ 04/ 2002	292	C,T	13	199
♀	21/ 01/ 1997	304	C	4	5
♀	25/ 01/ 2002	305	C	10	55
♀	02/ 04/ 1990	320	C	5	46
♂	05/ 10/ 2002	172	C,T, F,B	1	2
♂	20/ 03/ 2002	260	C	16	322
♂	14/ 02/ 1992	272	C	8	29
♂	03/ 01/ 2003	285	C	7	15
♂	31/ 01/ 1995	295	C	4	11
♂	12/ 05/ 1999	308	C	4	6

Despite the numerical importance of pelagic octopods, ommastrephids, mainly *O. bartramii* and *Todarodes sagittatus,* may be assumed to be more important in terms of biomass due to their larger size. Furthermore, the mantle muscle has a higher calorific value than in other medium sized squids with an ammoniacal mantle, such as histioteuthids (Clarke, 1986b).

This dolphin's most common squid prey, *T. sagittatus*, *Ancistroteuthis lichtensteinii*, *Histioteuthis reversa* and *H. bonnellii,* which are most frequent in 600 to 800 m depth (Quetglas *et al*., 2000), have been considered indicator species of the middle

TABLE 2. – Gastrointestinal content of Risso's dolphin (N=14) in the western Mediterranean. N, number and F, frequency of cephalopod prey; LRL, lower rostral and LH, hood cephalopod beak length (mm); ML (mm), estimated mantle length of cephalopods and total length in other taxa.

		N	%N	F(%)	LRL/LH*	ML
Cephalopoda						
Teuthoidea						
Ommastrephidae	*Todarodes sagittatus*	46	6.2	50.0	2.47-9.85	395.3
	Todaropsis eblanae	19	2.6	14.3	1.36-5.37	177.8
	Illex coindetti	39	5.3	28.6	2.13-3.09	140.7
	Ommastrephes bartramii	4	0.5	14.3	5.74-13.74	432,0
Histioteuthidae	*Histioteuthis reversa*	38	5.1	50.0	1.64-3.75	78,0
	Histioteuthis bonnellii	62	8.4	35.7	1.20-10.74	244.9
Onychoteuthidae	*Ancistroteuthis lichtensteinii*	54	7.3	50.0	1.83-5.51	151.4
	Onychoteuthis banksii	26	3.5	28.6	1.76-2.90	148,0
Mastigoteuthidae	*Mastigoteuthis* sp.	29	3.9	35.7	2.66-5.93	170.7
Cranchiidae	*Megalocranchia* sp.	2	0.3	7.1	1.88-4.13	210.5
	Galiteuthis armata	5	0.7	7.1	5.28-6.11	261.4
Enoploteuthidae	*Abraliopsis pfefferi*	8	1.1	7.1	1.12-1.67	39.5
	Ancistrocheirus lesueurii	16	2.2	21.4	2.45-5.51	183.2
Brachioteuthidae	*Brachioteuthis riisei*	9	1.2	28.6	2.17-2.69	70.6
Chiroteuthidae	*Chiroteuthis veranii*	3	0.4	21.4	3.50-6.45	169.2
Loliginidae	*Loligo vulgaris*	2	0.3	7.1	2.02-2.56	173.5
Sepioidea						
Sepiolidae	*Heteroteuthis dispar*	2	0.3	14.3	1.14	22.5
	Sepiola sp.	2	0.3	7.1	1.01-1.12*	16.2
Sepiidae	*Sepia officinalis*	5	0.7	21.4	4.60-5.28*	113.4
Octopoda						
Argonautidae	*Argonauta argo*	336	45.5	78.6	1.31-5.87*	35.3
	Ocythoe tuberculata	11	1.5	21.4	5.07-11.47*	
Octopodidae	*Eledone cirrhosa*	13	1.8	28.6	2.41-5.20*	141.6
	Octopus vulgaris	5	0.7	14.3	2.81-5.33*	138.1
	Octopus macropus	2	0.3	7.1	3.75-4.07*	106.7
	Octopus salutti	1	0.1	7.1	3.91*	102.7
Tunicata						
Ascidiacea	colony; undetermined	8		7.1		
Pyrosomidae	*Pyrosoma atlanticum*	4		7.1		52.5
Salpidae	*Salpa fusiformis*	7		7.1		29.1
	Iasis zonaria	1		7.1		55.8
Crustacea						
Isopoda	undetermined	3		7.1		
Teleostei	cycloid scales; undetermined	2		7.1		
Bryozoa	*Sertella* sp.?	1		7.1		

slope in the western Mediterranean (González and Sánchez, 2002); they are also present in the 200 to 600 m depth stratum where other species of the family Ommastrephidae are abundant. *Onychoteuthis banksii* and some teuthoid species which are less frequent in its diet such as *Ancistrocheirus lesueurii*, *Brachioteuthis riisei*, *Chiroteuthis veranii* and *Heteroteuthis dispar* have only been found in the aforementioned deeper stratum (Belcari and Sartor, 1993). The occasional catches of *A. argo* in the Mediterranean provide little information about its specific distribution, but it is considered to be an epipelagic species of oceanic waters. A similar offshore distribution in the western Mediterranean is also inferred from occasional catches of other species. Species belonging to families Mastigoteuthidae and Cranchiidae are considered to be oceanic; *Galiteuthis armata* catches have been associated with bottoms deeper than 1000 m, as found for *O. bartramii* (Villanueva, 1992); *A. lesueurii* has been caught on slopes deeper than 500 m (D'Onghia *et al*., 1997); only *Octopus macropus*, which represents 0.3% of the prey, is considered a littoral species.

A colonial ascidian, two similar small teleostean cycloid scales (<2.5 mm) and a bryozoan were found in the intestine of a juvenile (172 cm length); *Salpa fusiformis*, *Iasis zonaria* and *Pyrosoma atlanticum* were found partially digested in the stomach of an adult female (292 cm length) stranded in April; three specimens of isopods were found undigested in the most anterior part of the oesophagus of a female (210 cm length). Cephalopods are assumed to be the main component of the diet of *G. griseus*; however, the importance of thaliaceans may be underestimated because they are easily degraded

in the gut and their remains are difficult to identify. They have previously been reported as dolphin prey in Commerson's dolphin (Goodall and Galeazzi, 1985) and in beaked and bottlenose whales (Dixon *et al*., 1994, Walker and Hanson, 1999, Walker *et al*., 2002). In other marine mammals pelagic tunicates have been considered appropriate prey because juveniles have a more limited ability to capture swift prey (Bowen and Siniff, 1999). In this study, pelagic tunicates also appeared in the adult diet. We suggest that thaliaceans should be considered as an occasional component of the diet of Risso's dolphin, which would perhaps take advantage of the high biomass occasionally reached by some thaliacean species (Andersen, 1998). The ascidian colony, fish, bryozoans and isopods may be indirect or incidental prey, considering their infrequent occurrence and smaller size.

We conclude that Risso's dolphin feeds in the Mediterranean along the slope but preferentially on the middle slope (600 to 800 m depth). Further studies on feeding habitats of other top predators are needed to explain why this dolphin is preferentially associated with an area of the slope where cephalopod biomass and species richness is low compared to shallower strata (Quetglás *et al*., 2000; González and Sánchez, 2002).

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