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## **PRELIMINARY STUDY ON THE DIET OF THE DEEP-SEA KITEFIN SHARK *DALATIAS LICHA* (BONNATERRE, 1788) (CHONDRICHTHYES: DALATIIDAE) IN THE STRAIT OF SICILY**

### **STUDIO PRELIMINARE DELLA DIETA DELLO SQUALO ZIGRINO *DALATIAS LICHA* (BONNATERRE, 1788) (CHONDRICHTHYES: DALATIIDAE) NELLO STRETTO DI SICILIA**

**Abstract:** *Cartilaginous fishes are commonly recognized as key species in marine ecosystems. Effective management plans for cartilaginous fishes are still lacking due to the scarce knowledge about their biology and ecology. In this regard, the present work aims to provide new information on the diet of *Dalatias licha* (Bonnaterre, 1788), a rare deep-sea shark species in the Strait of Sicily (GSA16). Based on the analysis of stomach contents, several prey groups were identified suggesting a fairly generalized bentopelagic feeding behavior. In addition, predation on sharks confirms the high trophic position of the kitefin shark in the food web of the area. These results can contribute to shed the light on the role that this vulnerable species plays within the Mediterranean food webs and constitute the baseline for new studies.*

**Key-words:** *Chondrichthyes, *Dalatias licha*, stomach contents, fisheries bycatch, Mediterranean Sea.*

**Introduction** - Elasmobranchs have been widely recognized to have an important role in ecosystem health, diversity, and stability. Due to their k-selected life-history traits, cartilaginous fishes are particularly vulnerable to overfishing, but other factors such as habitat loss, changes in biological community composition, and climate change play an important role in shaping their abundances at the sea (Dulvy *et al.*, 2016). This has led to a rapid decline in the abundance of many Mediterranean shark and batoid populations observed over the past 50 years (Colloca *et al.*, 2020). The International Union for Conservation of Nature estimates that at least 53% of the 73 species currently inhabiting the basin are vulnerable, endangered or critically endangered (IUCN, 2016). However, effective management plans for cartilaginous fishes are still lacking due to the still scarce biological and ecological knowledge about them. Improving bio-ecological knowledge about these species, such as distribution, age and growth, reproduction, and feeding habits, is of paramount importance for predicting their vulnerability and therefore to help developing effective management measures. Among deep-water sharks, the kitefin shark *Dalatias licha* (Bonnaterre, 1788), is a medium-sized species reaching 180 cm total length and being patchily distributed in the Mediterranean Sea (Erguden *et al.*, 2017 in Kousteni *et al.*, 2021) at depths of 37-1,800 m. The species has no commercial value and it is discarded by fishers (i.e., rejected at the sea) in longline and bottom trawl fisheries of the Mediterranean Sea (e.g. Ragonese *et al.*, 2013 in Colloca *et al.*, 2020). Furthermore *D. licha* is classified as vulnerable by the IUCN in the Mediterranean Sea (Dulvy *et al.*, 2016). Therefore, from a conservation point of view, acquiring data on the biology and ecology of this species is needed. In this context, the present study provides new data on the diet composition of this

vulnerable species in the Strait of Sicily (SoS) FAO GFCM Geographical subarea 16 (GSA 16).

**Materials and methods** - A total of 46 specimens were sampled in the GSA 16 at depths ranging from 401 to 767 m during the MEDiterranean International Trawl Survey (MEDITS) from 2015 to 2019 (Fig. 1).

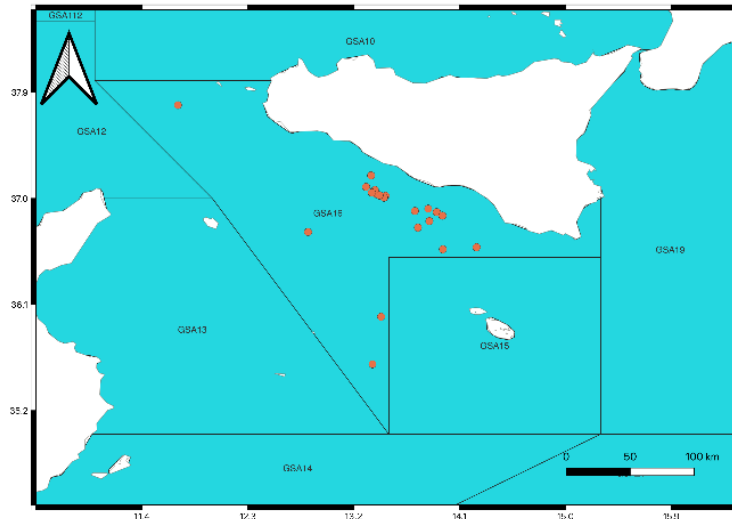


Fig. 1 - Distribution map of the specimens caught in the GSA 16.  
*Mappa di distribuzione degli esemplari catturati nella GSA 16.*

Specimens caught were frozen on board the fishing vessel to prevent digestion of stomach contents. Thereafter, the samples were brought to the CNR laboratory and biometry, such as total length (TL) to the nearest 0.5 cm, and total weight (TW) to the nearest 0.01 g, were collected individually. In addition, the specimens were sexed and the maturity stages were determined macroscopically according to the MEDITS maturity scale. The diet of the species was investigated through stomach content analysis. Stomachs were removed, weighed and preserved in 70% alcohol. Prey items were identified to the lowest taxonomic level and then pooled in higher taxonomic groups. In case of fragmented preys, identification and counts were based on the number of otoliths, eyes, beaks and other anatomical parts. When the state of digestion was more advanced, preys were classified into undetermined fish, crustaceans or cephalopods. In addition, parasitological analysis was carried out in the sampled stomachs. To describe the trophic spectrum of the species, the stomach fullness index (SFI), the vacuity coefficient (Cv), the percentage of abundance composition (%N), the percentage of biomass composition (%W), and frequency of occurrence of a type of prey group (F%) were calculated. The Cv was calculated as the number of empty stomachs out of the total number of stomachs analysed whereas the SFI was calculated as percentage ratio between the weight of the stomach contents and the total weight of the specimen. Lastly, the relative importance index IRI was calculated, according to Hacunda (1981), by the formula

$$IRI = (\%N + \%W) \times \%F.$$

**Results** - In our sample males significantly outnumbered females and the sex ratio (F:M) was 1:3; the individuals were in the early stages of maturation. Out of a total of 46 individuals, 21 full stomachs were recorded. The length range is presented in Tab. 1, specifically most of the observed specimens larger than 70 cm TL.

Tab. 1 - Length range of individuals divided by sex, considering both the totality of specimens and only those with full stomach.

*Range di lunghezza degli individui suddivisi per sesso, considerando sia la totalità degli esemplari che soltanto quelli con stomaco pieno.*

	Total specimens		Specimens with full stomach	
	Length min. (cm)	Length max. (cm)	Length min. (cm)	Length max. (cm)
Female	31	96.5	38.5	93.0
Male	31	94.0	43.5	94.0

The Cv was 54%, higher than described by Bottaro *et al.* (2023) while the SFI was only  $3.4 \pm 2.2$  (mean  $\pm$  standard deviation). Such relatively low SFI value could be due to the peculiar dentition of this species with large serrated teeth and powerful jaws that allows it to take big bites of larger sharks. This allows for greater and more effective crushing of ingested food and thus faster digestion. The trophic spectrum of the species in terms of F%, N%, W%, IRI, and IRI% is shown in Tab. 2.

Tab. 2 - Trophic spectrum of all the specimens analyzed. Frequency of occurrence values F%, percentage number N%, percentage weight W%, relative importance index IRI and IRI% are shown for all the identified prey categories as well as the totals for "higher taxa".

*Spettro trofico di tutti gli esemplari analizzati. Sono mostrati i valori di frequenza F%, numero percentuale N%, peso percentuale W%, indice di importanza relativa IRI e IRI% per tutte le categorie di prede identificate ed i totali degli indici per i "taxa superiori".*

TAXA	F%	N%	W%	IRI	IRI%
Decapoda	5.13	4.17	0.16	22.21	1.21
<i>Plesionika</i> spp.	2.56	2.08	0.61	6.89	0.38
<b>TOTAL Crustacea</b>	<b>7.69</b>	<b>6.25</b>	<b>0.77</b>	<b>53.98</b>	<b>0.86</b>
<b>Tunicata</b>	<b>5.13</b>	<b>4.17</b>	<b>2.04</b>	<b>31.86</b>	<b>0.51</b>
<i>Histioteuthis</i> spp.	7.69	6.25	2.27	65.52	3.57
<i>Illex</i> spp.	5.13	6.25	0.13	32.73	1.78
<i>Loligo</i> spp.	2.56	2.08	0.004	5.34	0.29
Octopoda	2.56	2.08	0.004	5.34	0.29
Ommastrephidae	2.56	2.08	3.42	14.08	0.77
Sepiolidae	2.56	2.08	0.002	5.33	0.29
<i>Todarodes sagittatus</i>	5.13	4.17	32.89	190.12	10.36
Cephalopoda n.i.	20.51	27.08	7.53	709.85	38.67
<b>TOTAL Cephalopoda</b>	<b>48.72</b>	<b>52.08</b>	<b>46.25</b>	<b>4790.64</b>	<b>76.36</b>
<i>Galeus melastomus</i>	10.26	8.33	36.87	463.75	25.26
<i>Etmopterus spinax</i>	2.56	2.08	4.35	16.46	0.9
Chondrichthyes n.i.	5.13	4.17	7.18	58.23	3.17
<b>TOTAL Chondrichthyes</b>	<b>17.95</b>	<b>14.58</b>	<b>48.39</b>	<b>1130.31</b>	<b>18.02</b>
<i>Hymenocephalus italicus</i>	2.56	2.08	0.38	6.3	0.34
Osteichthyes n.i.	<b>12.82</b>	<b>10.42</b>	<b>0.45</b>	<b>139.35</b>	7.59
<b>TOTAL Osteichthyes</b>	<b>15.38</b>	<b>12.5</b>	<b>0.83</b>	<b>205.02</b>	<b>3.27</b>
<b>OTHERS: <i>G. melastomus</i> egg-cases</b>	<b>5.13</b>	<b>10.42</b>	<b>1.71</b>	<b>62.23</b>	<b>0.99</b>

The results suggest a fairly generalized benthopelagic feeding behaviour, focused mainly on cephalopods such as *Todarodes sagittatus* (Lamarch, 1798) and *Illex* spp., followed by small demersal sharks such as *Galeus melastomus* (Rafinesque, 1810), including their eggs, bony fish and crustaceans, respectively (Fig. 2). These results are in agreement with those reported in the literature in other Mediterranean areas (Capapè *et al.*, 2008 in Kousteni, 2021; Navarro *et al.*, 2014; Mulas *et al.*, 2021), and support the high trophic level of  $4.2 \pm 0.4$  reported for the species on fishbase platform.

In particular, as reported in the western Mediterranean along the Catalan, Sardinian, and Maghreb coasts, respectively, the presence of prey such as tunicates, Sepiolidae, and eggs of *G. melastomus* was also observed. Since *G. melastomus* egg capsules were found intact, *D. licha* could not be a direct predator of eggs. These eggs would therefore be the remains of mature females of this species, swallowed after being crushed. In any case predation on sharks confirms the high trophic position of *D. licha* in the food web of the area. In addition, 86% of the examined stomachs were found to be parasitized, 50% of them by the genus *Otodistomum* (Platyhelminthes Digenea), as already described by Sperone and Milazzo (2018) in this species.

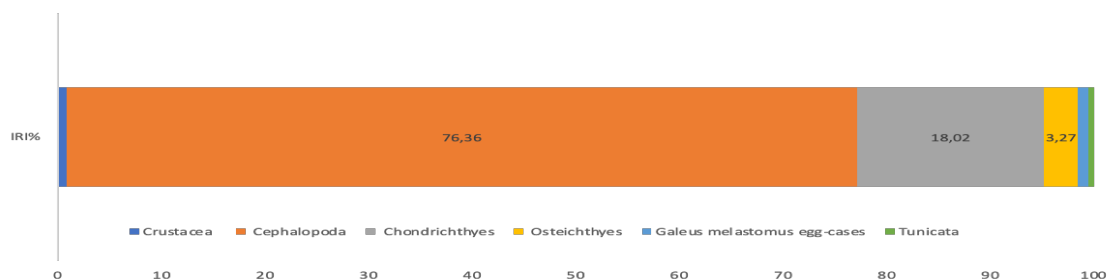


Fig. 2 - Percentage value of Relative Importance Index (%IRI) of "higher taxa," relative to the trophic spectrum of *D. licha* in relation to all specimens analysed.

Valore percentuale dell'indice di importanza relativa (%IRI) dei "taxa superiori" rispetto allo spettro trofico di *D. licha* in relazione a tutti gli esemplari analizzati.

**Conclusions** - The results of this preliminary study contribute to shed light on the role that this vulnerable species plays in the Mediterranean food webs. Improving the biological knowledge can provide the baseline for future studies and for a better assessment of the status of this rare and vulnerable species.

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