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Short Note

Stomach Contents of a Subadult Mediterranean Monk Seal (*Monachus monachus*) from the Aegean Sea

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From the bustling colonies of ancient times (Johnson & Lavigne, 1999) to present days, Mediterranean monk seal (*Monachus monachus*) populations have been reduced to sad remnants of their once lively past. The species is currently considered critically endangered and is facing "high risk of extinction in the wild" (International Union for Conservation of Nature [IUCN], 2010). The main threats to the survival of this species are directly related to anthropogenic activities, which also include negative interactions with the fisheries industry such as deliberate killing by fishermen and accidental drowning in fishing gear (Johnson et al., 2006).

Even though its contribution to the Gross Domestic Product (GDP) is small (about 0.7% in 2003), the fisheries industry in Greece, the country with the largest remaining Mediterranean monk seal population in the world (Johnson et al., 2006), is considered important to the national economy because it contributes to maintenance of economic and social cohesion of large areas of the country (Conides, 2007). Despite operating in a biologically diverse environment (i.e., the total number of marine species recorded is 467 [IMAS-Fish, 2007]) and the occurrence of a recent structural reorganization that has resulted in increased fishing capacity, fisheries in Greece suffer from a continuous reduction of annual landings (Conides, 2007); while at the same time, interactions with marine mammals, and monk seals in particular, are a serious problem (Panou et al., 1993; Bearzi et al., 2003; Karamanlidis et al., 2008; MOm, 2009). A thorough understanding of Mediterranean monk seal–fisheries interactions is required to mitigate these interactions and promote effective conservation of this critically endangered species. Protecting Mediterranean monk seals is hampered, however, by the profound general lack of knowledge regarding the biology of the species. Currently, only limited information on monk seal dietary habits in the eastern Mediterranean Sea is available (Cebrian et al., 1990; Salman et al., 2001); further research is necessary. Even though the present study is based on the observation of a single stranded monk seal, it still represents a great opportunity to learn about the species. The study provides baseline information on the dietary habits of Mediterranean monk seals that are discussed in relation to the fisheries industry in Greece.

On 1 May 2009, a Mediterranean monk seal was found entangled in a fishing net near the village of Keratea at Attica, Greece (37° 48' 19.28" N, 24° 03' 46.19" E) (Figure 1). A full necropsy was performed on site the next day by trained staff of the MOm/Hellenic Society for the Study and Protection of the Monk Seal, according to a specific necropsy protocol for pinnipeds that was adapted to the Mediterranean monk seal (Rowles et al., 2001). Based on external morphological features (Samaranch & Gonzalez, 2000), wear of teeth, and the standard measures taken (total length [TL]: 180 cm; standard length [SL]: 161 cm; weight: 85 kg), this monk seal was identified as a subadult male, ~2 to 3 y old (Marchessaux, 1989). Externally, the animal did not show any signs of human aggression; small traumatic lesions were found around the body along the places entangled by the net. Skin appearance, organ coloration, and other indicators recorded during the necropsy allowed time of death to be estimated at less than 2 d. Blubber thickness (35 mm at the thorax, 40 mm at the abdominal area) and shape and color of the internal organs indicated good nutrition and health. Small pieces of net were found in the esophagus, and a fine, persistent froth was documented in the trachea and bronchi of the lung parenchyma.

For diet analysis, the complete stomach was removed from the abdominal cavity and the contents examined: each prey item was identified to the lowest possible taxon and preserved deep-frozen. Otoliths, bones, and scales were used when necessary to resolve issues regarding taxonomic identification. The stomach was full, weighed 8.5 kg

(net weight: 7.68 kg; i.e., ~9% of total body weight), and consisted of a mixture of mainly undigested prey items and a small amount of partially digested food remains. We separated 17 prey items (93% of total stomach content) and identified 14 species (Table 1). All prey items were either benthopelagic or reef-associated species, living within the 200 m isobath (Froese & Pauly, 2010); none of the fishes recovered had been eviscerated before ingestion.

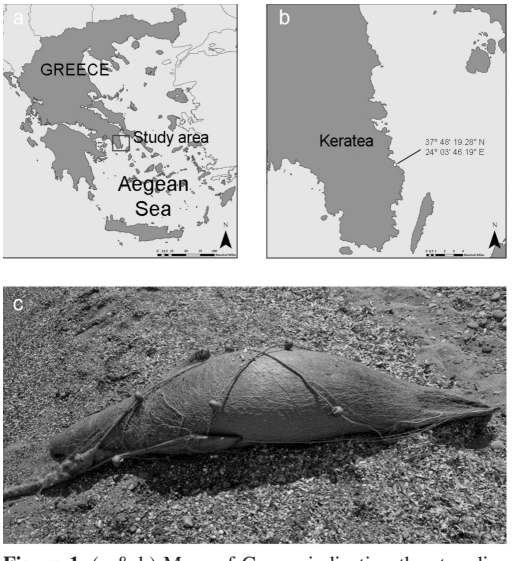

Figure 1. (a & b) Maps of Greece indicating the stranding location of a subadult Mediterranean monk seal, and (c) a subadult Mediterranean monk seal entangled in a fishing net

The stomach contents included prey items from several different families, suggesting the ability of the species to exploit a wide variety of food resources. These results are consistent with the results of previous small-scale studies (Cebrian et al., 1990; Salman et al., 2001) and a more recent, large-scale study from the same part of the species distribution using the same methodology (Pierce et al., 2011); the general assumption is that monk seals are "opportunistic" predators (Marchessaux & Duguy, 1977; Jacobs & Panou, 1988; Boutiba & Abdelghani, 1997). The total mass of prey consumed was also within the same range observed for monk seals in captivity (Caltagirone, 1995). Prey selection and the respective habitat preferences of the prey items were in accordance with the coastal nature of Mediterranean monk seals (Dendrinos et al., 2007). In contrast to what has been frequently observed for Mediterranean monk seals feeding on live fish (Duguy & Marchessaux, 1992; CBD-Habitat, 2004), none of the fishes found in the stomach had been eviscerated. This also has been observed in another case where the monk seal was assumed to have been feeding from a net (Cebrian et al., 1990); therefore, we speculate that eviscerating prey is not necessary when the prey is already dead.

It is noteworthy that more than 70% of the prey items identified in the stomach of this monk seal are among the most important demersal species targeted by professional fishermen in the area (Politou, 2007), suggestive of competition between monk seals and fishermen in Greece over the same resources. *Loligo vulgaris* and *Octopus vulgaris*, in particular, according to the National Statistical Service of Greece, are among the five most commonly landed cephalopod

Table 1. Species of prey items identified in the stomach of a subadult Mediterranean monk seal that was entangled in a fishing net along the coast of Attica, Greece

Species	Weight (g)	Length (cm)	Comments
Scorpaena porcus	100	18.0	Whole fish
Diplodus vulgaris	80	16.5	Whole fish
Not identifiable	160	17.5	Head and tail missing
Not identifiable	180	27.0	Whole fish
Symphodus tinca	90	18.5	Whole fish
Sarpa salpa	60	16.0	Head missing
Sarpa salpa	120	22.0	Whole fish
Not identifiable	160	27.0	Head missing
Pagellus erythrinus	260	30.0	Whole fish
Pagellus erythrinus	220	29.0	Whole fish
Pagellus erythrinus	160	25.0	Whole fish
Pagellus erythrinus	180	26.0	Whole fish
Pagellus erythrinus	170	25.5	Whole fish
Conger conger	2,000	87.0	Head missing
Conger conger	2,080	83.0 & 21.0	Cut in two pieces, body and head
Loligo vulgaris	160	--	Cut in two pieces
Octopus vulgaris	1,000	--	Whole octopus
Various partially digested material	500	--	--

species in Greece since 1982, and their importance in the local fisheries has been steadily increasing in recent years (Politou, 2007). It has been suggested that short-lived species, such as cephalopods, have become more important to local fisheries in Greece because of their ability to increase their biomass faster than longer-lived fishes, especially in areas that have been heavily exploited (Lefkaditou, 2007). If this is true and given the ability of Mediterranean monk seals to adjust feeding preferences in order to exploit the most readily available food resources (Marchessaux & Muller, 1987), the selection of cephalopods in Greece might be a response of the species to the dwindling fish resources (Papaconstandinou & Conides, 2007). Further research on the feeding habits of the species in the eastern Mediterranean Sea is required to evaluate overfishing of commercially valuable species as a threat to the survival of the Mediterranean monk seal. Additionally, assuming that the monk seal in our study had actually removed all prey items found in its stomach from the fishing net and considering that their total value is estimated at a minimum of 75 €, damages caused by the Mediterranean monk seal are an added burden to the already negative financial situation of coastal Greek fishermen (Conides, 2007). Further research is also needed to evaluate the overall financial impact of Mediterranean monk seals on the fisheries industry in Greece in order to promote effective conservation measures.

On the other hand, all evidence collected during the necropsy indicate that the cause of death of the subadult Mediterranean monk seal was drowning from accidental entanglement in the fishing net (Kuiken et al., 1994). Such interactions have been widely recorded for newborn and subadult marine mammals (Aliaga-Rossel et al., 2010) and are a major threat to the survival of the critically endangered Mediterranean monk seal (Karamanlidis et al., 2008).

Monk seal and fishery interactions have serious negative effects on each other: the survival of the Mediterranean monk seal and the livelihood of fishermen. Considering the precarious conservation status of *Monachus monachus* and the problematic state of demersal fish stocks throughout the Mediterranean (Fiorentini et al., 1997; Stergiou et al., 1997), new and effective measures that will mitigate this problem are urgently required. Considering the continuous decline in fisheries' landings per effort, new management regulations for fisheries that will complement existing rules have been requested (Stergiou et al., 2007). One such measure is the establishment of Marine Protected Areas (MPAs) (Browman & Stergiou, 2004; Tsikliras & Stergiou, 2007), which is also one of the main conservation measures suggested in the new National Strategy and Action Plan for the conservation of Mediterranean monk seals in Greece (Notarbartolo di Sciara et al., 2009).

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