New information from predator diets on the importance of two Ommastrephidae: *Sthenoteuthis oualaniensis* in the Indian Ocean and *Hyaloteuthis pelagica* in the Atlantic Ocean

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Squid are widely distributed in the open ocean, where they constitute a key group in marine food webs (Rodhouse and White, 1995). They are among the most abundant in number and biomass of nektonic epipelagic organisms, and the large squid of the family Ommastrephidae (e.g. *Dosidicus* and *Illex*) support major fisheries in both neritic and oceanic waters around the world (Rodhouse, 1997). This commercial importance has made the large ommastrephids the target of many scientific investigations, and consequently their biology is reasonably well-known (Nigmatullin *et al*., 2001; Zuyev *et al*., 2002; Bower and Ichii, 2005; Markaida, 2006). However, the biology and ecological role of the unexploited squid species remain poorly known in many areas of the world ocean. Research cruises devoted to the study of squid are few, and in addition, cephalopods are difficult to collect by nets. Large pelagic fishes (e.g. tunas and tuna-like species), mammals and seabirds can be efficient biological samplers for collecting information on cephalopods, due to their opportunistic feeding behaviour (Cherel and Weimerskirch, 1999; Potier *et al*., 2007). In addition, cephalopod predators catch larger specimens and a greater diversity of species than sampling gear (Rodhouse, 1990; Cherel *et al*., 2004). In the stomach contents of large pelagic predators, cephalopod beaks, indigestible hard structures, accumulate over time. The beak morphology allows identification to species level of most of the accumulated items found in predators' stomachs (Clarke, 1986; Imber, 1992). Therefore, the description of dietary habits, which allows a better understanding of trophic interactions in the marine ecosystems, can also provide useful information on species composition, distribution, abundance and ecology of cephalopods occurring within the predators' foraging range. In this note, we illustrate the usefulness of cephalopod predators for describing the importance of *Sthenoteuthis oualaniensis* (Ommastrephidae) in the pelagic food webs of the western Indian Ocean, and of *Hyaloteuthis pelagica* (Ommastrephidae) in the Atlantic Ocean.

In the Indian Ocean, the biomass of the purpleback squid *S. oualaniensis* has been estimated to be approximately 2 millions tonnes (Zuyev *et al*., 1985). In the northern part of the Arabian Sea, its density could reach up to 4-8 tonnes km^{-2} (Gutsal, 1989), although the population structure of *S. oualaniensis* is poorly known. Nesis (1993) described three different forms, which differ by anatomy, geographic distribution and period of spawning: (1) the giant form is found exclusively in the Red and Arabian Seas; (2) the dwarf form, with no photophores, inhabits the equatorial waters of the Indian Ocean, and spends most of its life in the upper mixed layers; (3) the third form, characterised by photophores on the mantle, is the most common, and has a wider geographic repartition with a much deeper vertical distribution than the dwarf form.

In the equatorial waters surrounding the Seychelle Islands, *S. oualaniensis* constituted a dominant or a significant prey in the diet of swordfish and subsurface tunas (yellowfin and bigeye) caught by a longliner (Potier *et al*., 2007). *S. oualaniensis* accounted for 19.1% and 15.9% of the whole reconstituted weight, and contributed 13.3% and 9.0% by number in the diet of yellowfin tuna and swordfish, respectively (Potier *et al*., 2007). In Russian studies that have been carried out in the same area, *S. oualaniensis* represented 26.7% and 15.1% of the total index of relative importance (IRI) in the diet of subsurface yellowfin and bigeye tunas (no published data). However, stomach content analyses of tunas caught by surface purse-seine fisheries in the same area have shown that *S. oualaniensis* did not contribute significantly to the diets: it represented only 3.2% and 0.1% by number in the diet of yellowfin and bigeye tunas (Potier *et al*., 2004). Such tunas caught by purse seiners occur generally in dense schools at the surface and several studies have shown that these tunas seek out and feed on large concentrations of monospecific prey (Bard *et al*., 2002; Ménard and Marchal, 2003; Potier *et al*., 2004). Once a concentration is detected, feeding involves successive capture of individuals of the same species. Therefore, in the equatorial waters surrounding the Seychelles, we hypothesize that the purpleback squid does not occur in concentrations that are sought out by surface predators during the daylight hours. However, purpleback squid can also undertake diel migration in order to avoid predators chasing at the surface during daytime.

The size distribution of the beaks of the purpleback squid found in the stomachs of yellowfin tuna and swordfish are clearly different (Fig. 1): swordfish catch larger specimens than yellowfin tuna. Swordfish are known to undertake large vertical migrations, enabling them to prey actively at greater depths than yellowfin tuna. Therefore, it can be assumed that *S. oualaniensis* adults, which are fed on by swordfish, have a greater vertical range than the juveniles, which are fed on by yellowfin tuna. On the other hand, it is possible that the two predators could feed on two forms of *S. oualaniensis,* each having different size and bathymetric distributions (Nesis, 1993).

Russian studies have shown that the importance of the purpleback squid in the diet of large fish predators decreases in the tropical waters around Mauritius (6.2% of the IRI for subsurface yellowfin tuna; unpublished data). Furthermore, preliminary studies conducted in the Mozambique Channel have shown that another ommastrephid (*Ommastrephes bartrami*) has replaced *S. oualaniensis* in the diet of swordfish. However, *S. oualaniensis* plays a major role in the diet of tropical seabirds breeding on islands in the Mozambique Channel. This prey species contributed 19% by number in the diet of great frigatebirds (Weimerskirch *et al*., 2004) and 15.4% by reconstituted weight in the diet of the red-tailed tropicbird *Phaeton rubricauda* (Le Corre *et al*., 2003). In the diet of the sooty tern *Sterna fuscata*, *S. oualaniensis* occurred in 53% of the stomachs sampled on Europa and Glorieuses Islands and was ranked first by the IRI. On Juan de Nova Island, *S. oualaniensis* occurred in 33% of the stomachs and ranked third by the IRI (Jaquemet *et al*., in prep). Figure 1 displays the size distribution of the beaks found in the stomachs of sooty terns. Sooty terns catch the smallest specimens of *S. oualaniensis* (with mean sizes significantly different for the three predators). We suspect that the three forms of *S. oualaniensis* that were described by Nesis (1993) are found in the Mozambique Channel..

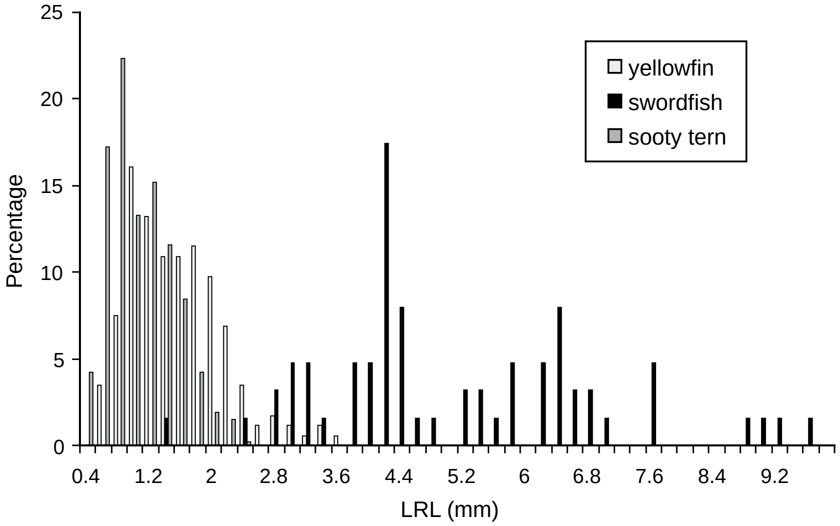

Figure 1. Frequency distribution of lower rostral lengths (LRL) (mm) of the beaks of *Sthenoteuthis oualaniensis* eaten by yellowfin tuna, sooty tern and swordfish in the western Indian Ocean.

In a recent study, Cherel *et al*. (2007) described the importance of the glassy flying squid *Hyaloteuthis pelagica,* Bosc, 1802 in the diets of large pelagic fishes sampled in the central tropical Atlantic Ocean. *H. pelagica* is the smallest ommastrephid, reaching a maximum mantle length of only 90 mm (Nesis, 1987). *H. pelagica* was by far the most important cephalopod prey of the community of large predatory fishes sampled during research cruises in autumn 2000. *H. pelagica* was a major prey of white marlin (*Tetrapturus albidus*) and a common food item of albacore (*Thunnus alalunga*), longbill spearfish (*T. pfluegeri*) and sailfish (*Istiophorus albicans*). All fishes fed upon the same size range of *H. pelagica*, including both juvenile and adult squid, but overall the fishes preyed on squid of different mean sizes: white marlin and longbill spearfish fed more on adult squid than did albacore and sailfish. The ommastrephid *Sthenoteuthis pteropus*, usually abundant in the tropical Atlantic Ocean, was surprisingly absent in fish diets in the study of Cherel *et al*. (2007). The authors hypothesize that *S. pteropus* was not an important and available nektonic prey organism at the time of sampling.

These two examples emphasise the usefulness of marine predators to gain valuable information on the biology and the distribution of their prey. In addition, our studies show that cephalopods constitute a link in the transfer of energy from lower trophic levels (most likely mesozooplankton) to higher trophic levels (including tunas, billfishes and swordfish).

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