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Feeding habits of the blue shark *Prionace glauca* (Linnaeus, 1758) off the coastal waters of Ivory Coast (West Africa)

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Abstract

The diet of blue shark, *Prionace glauca* (Linnaeus, 1758), off the coastal waters of Ivory Coast (west Africa) was studied according to sexes, maturity groups and hydrological seasons from August 2014 to November 2016. Stomach contents of 262 specimens ranging from 195 to 320 cm total length caught by artisanal driftnet fishery were analysed. Of the stomach contents examined, 94 were empty (36%). The large number of empty stomachs may be the result of using hooks, which cause high stress resulting in regurgitation. Diet was described using the Index of Relative Importance (% IRI) combining occurrence, numerical and weight percentages. The overall diet consisted of cephalopods, teleost fishes, cartilaginous fishes, crustaceans and mammals of which cephalopods (84.2%) represented by *Haliphron atlanticus* (27.7%), *Histioteuthis macrohista* (22.0%) and *Abraliopsis gilchristi* (9.8%) were the main preys. The diet did not vary greatly according sexes, maturity groups and seasons. The Morisita-Horn index and the Spearman rank correlation coefficient showed similarity of diet between sexes ($C\lambda$ = 0.70, Rs = 0.41, p = 0.0035), maturity groups ($C\lambda$ = 0.49, Rs = 0.73, p = 0.00002) and seasons ($C\lambda$ = 0.62, Rs = 0.58, p = 0.004) in this area. The low trophic niche breadth associate to a large prey trophic spectrum found in this study indicate that blue shark is an opportunist predator.

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Introduction

The blue shark *Prionace glauca*, as most shark species, are considered as top predators and opportunistic or generalist consumers (Cortés, 1999) and have a high position in the marine food web. They play an important role in the regulation of the size of prey populations, and composition of marine ecosystems (Camhi *et al.*, 1998). Blue shark is found worldwide in temperate and tropical oceans from latitudes of about 60°N to 50°S, but can also occasionally occur closer to shore, especially in areas where the continental shelf is narrow (Last and Stevens, 2009). This species is highly targeted in shark's fin trade (Pusineri *et al.*, 2008) and is one of the shark species most frequently caught as a by-catch in the longline and gillnet fisheries targeting the swordfish and/or tunas in the North and southwest Atlantic (Campana *et al.*, 2009). Despite an increasing interest in their conservation and management, there is still little quantitative information on their population genetics, growth rates, reproduction, diet and migratory behaviour. Ecological risk assessment methods, conducted in 2012 concluded that blue shark had an intermediate vulnerability level, characterized by high productivity within the pelagic sharks and high susceptibility to pelagic long line fishing gear (Cortés *et al.*, 2015). So, the disappearance of these predators from marine ecosystems may have consequences for their functioning and resilience (Heithaus *et al.*, 2008; Ferretti *et al.*, 2010).

Knowledge the feeding habits of fishes in the natural environment is a necessary step to understanding biology, ecology and their survival (El Bakali *et al.*, 2010). For most of authors, information on the diet of fishes is important to understand the basic functioning of fish assemblages and is widely used for ecological work and modelling to know the trophic status of species (Pauly *et al.*, 1998; Kulbicki *et al.*, 2005). It is becoming an increasingly important component in ecologically based management (Pauly *et al.*, 1998). Due to its high proportion in commercial catches around the world, blue shark is a well-studied species with regard to distribution and migration.

There is information on its diet around the world, with feeding biology studies carried out for several ecosystems. These studies have been done mainly in the north Pacific and Atlantic waters, where the species has presented a wide trophic spectrum (Cortés, 1999), including cephalopods, epipelagic fishes and crustaceans as their most important preys (Cortés, 1999; Vaske *et al.*, 2009; Markaida and Sosa-Nishizaki, 2010). However, no information is known on its feeding habits in the central eastern Atlantic and specifically in the Gulf of Guinea. Thus, it is imperative that we achieve a more detailed understanding of the feeding biology of this species, by analysing the prey composition according to sexes, maturity groups and seasons.

Materials and Methods

Sampling and data collection

Samples were obtained at the fishing harbour of Abidjan, from commercial catches of the artisanal driftnet fishery targeting tuna species between latitudes 4°N and 5°N and longitudes 2.30°W and 8°W (Fig. 1). The specimens were sampled monthly from August 2014 to November 2016. All specimens were sexed and the total length (TL) was measured in a straight line from the snout tip to the end of the upper tail to the nearest cm. Stomachs were frozen immediately after removal for later laboratory examination.

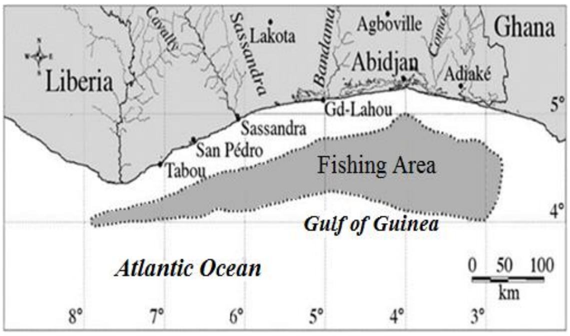

Fig. 1. Blue shark sampling locations in the coastal waters of Ivory Coast (West Africa).

Stomach content analysis

At laboratory, each stomach content was screened through a mesh sieve of 0.5mm and the presence or absence of preys was noted.

The remaining food was sorted, identified to the lowest possible taxonomic level and grouped within prey categories. The preys were counted and weighted and all undetermined preys were considered as unknown preys and classified into a group. The state of prey digestion was classified following Cabrera *et al.*, (2010): (i) fresh = preys that could be identified by external characteristics (skin, scales and fins) because they were undigested; (ii) intermediate = preys which had a part digested or lost some external characteristics; (iii) advanced = well digested preys which showed the skeleton (fish) or exoskeleton (crustaceans) and; (iv) digested = only skeleton or beaks from cephalopods or some isolated parts of crustaceans were found. All cephalopod parts and lower beaks retrieved from stomachs were used for prey identification by comparison with field and beak identification guides as well as personal cephalopod lower beak reference collections (Lu and Ickeringill, 2002 and Xavier and Cherel, 2009). The crustacean remains such as the telsons and chitinous parts, the meat balls of mammals, were counted and considered as one prey. In fishes, the identification guides of Fisher *et al.*, (1981) and Schneider (1992) were used.

As the stomach contents have been influenced by the digestion process, the initial weight of each item was reconstituted. The wet weight of fishes in the intermediate digestion state was calculated by extrapolation; while those of cephalopods was determined following regression equations between the biomass and size of beak established by Lu and Ickeringill (2002) and Xavier and Cherel (2009).

Data analysis

The importance of each food item in the diet was obtained by the Index of Relative Importance (IRI) proposed by Pinkas *et al.*, (1971) and the percent IRI (%IRI) by Cortés (1997) using these equations:

$$IRI = \%F \text{ x } (\%N + \%W) \quad (1)$$

$$\%IRI = \frac{IRI}{\sum IRI} \text{x} 100 \quad (2)$$

Where %F = percentage frequency of occurrence (number of stomachs containing prey category i divided by the total number of stomachs), % N = numerical percentage of abundance (number of prey items i divided by the total number of prey items) and %W = Weight percentage (weight of prey items i divided by total weight of prey items).

The classification of prey items followed the method of Rosecchi and Nouaze (1987). For this purpose, preys were first sorted in decreasing order of importance according to their IRI and then a cumulative %IRI was calculated. The first single item, or group of items, for which cumulative %IRI was ≥ 50% was regarded as the preferred food. The %IRI values of other important prey items were then added to that of the preferred food until the %IRI reached 75%, and these were regarded as secondary prey. Food items between an %IRI of 75 and 100% were regarded as incidental prey. The IRI was compared among sexes, maturity groups and seasons.

To study diet variation with fish size, specimens were divided into two categories according to gonad maturity: sub-adults (size of the smallest mature fish $TL < L_{50}$) and adults ($TL > L_{50}$).

The Shannon-Wiener Index (H') based on the abundance of all prey items was used to calculate the diversity of the trophic spectrum of blue shark, which assigns ranks from 0 to 6. A value below 3 shows that the diet is based on a small variety of prey whereas a value above 3 shows a diet based on a greater variety of prey (Labropoulou and Eleftheriou, 1997). The trophic niche breadth was described by using the Levin's standardized Index (B_i). This index ranges from 0 to 1. The values below 0.6 indicate a diet of specialist predators, while values above 0.6 indicate generalist diets (Labropoulou and Eleftheriou, 1997).

The values of both indices (H' and Bi) were compared to corroborate the specialist, generalist or opportunist feeding behaviour of *P. glauca*. For example, high values of diversity and niche breadth correspond to generalist predator, low values of diversity and niche breadth correspond to specialist predator and high values of diversity, but low values of niche breadth correspond to opportunist predator (Flores-Martinez *et al.*, 2016).

The intraspecific dietary overlap between sexes, hydrological seasons and maturity groups was determined using the Morisita-Horn index (C_λ). Values between 0 and 0.29 indicate a lower overlap while values of 0.30-0.59 and over 0.60 indicate a medium overlap and higher overlap respectively. The Spearman's ranks correlation coefficient (Rs) was used to test the similarity of diet between all categories.

Results

Overall diet

A total of 262 specimens comprising 139 males and 123 females of size ranging from 195 to 320cm total length were analysed. Of the specimens examined, 168 individuals had food items in their stomachs, whilst 94 were empty.

The overall vacuity index was 36.0%. Teleost fishes were in an intermediate and advanced digestive state, whereas most cephalopods and all crustaceans in an advanced state of digestion. The overall diet consisted of Teleost fishes, cephalopods, cartilaginous fishes, crustaceans and mammals of which cephalopods (%IRI = 84.2%) represented by *Haliphron atlanticus* (%IRI = 27.7%), *Histioteuthis macrohista* (%IRI = 22.0%) and *Abraliopsis gilchristi* (%IRI = 9.8%) were the main preys (Table 1). Among teleost fishes (%IRI = 9.6%), *Sarda sarda* was more consumed (%IRI = 6.1%). Seabird feathers and plastic wrapping were also observed in stomachs. Other taxa, namely cartilaginous fish, crustaceans and mammals were minor components (%IRI < 6%) of the diet. Food indices calculated show a high diversity of the preys (H' = 3.1). However, the trophic niche breadth (B_i = 0.3) of the diet of blue shark found to be low.

Table 1. Overall diet composition of blue shark caught by artisanal driftnet fishery in coastal waters of Ivory Coast (West Africa) from August 2014 to November 2016.

Taxon	Prey items	% N	% W	% F	IRI	% IRI
Teleosts						
Histioteuthidae	*Histioteuthis miranda*	1.59	1.97	6.67	23.74	0.80
	Histioteutis bonnelli corpuscula	1.27	0.37	5.33	8.78	0.29
	Histioteuthis macrohista	6.69	20.62	24.00	655.47	21.98
Alloposidae	*Haliphron atlanticus*	20.38	2.56	36.00	825.85	27.69
Mastigoteuthidae	*Magnoteuthis microlucens*	4.78	1.03	16.00	92.99	3.12
	Mastigoteuthis sp	5.41	1.15	18.67	122.60	4.11
Vampyroteuthidae	*Vampyroteuthis infernalis*	1.59	0.49	6.67	13.85	0.46
Cycloteuthidae	*Cycloteuthis akimushkini*	0.64	1.06	2.67	4.53	0.15
Enoploteuthidae	*Abraliopsis gilchristi*	12.10	1.59	21.33	292.00	9.79
Chiroteuthidae	*Chiroteuthis veranyi*	0.96	0.17	4.00	4.48	0.15
Onychoteuthidae	*Moroteuthis robsoni*	3.18	5.32	9.33	79.33	2.66
	Onychoteuthis banskii	0.64	0.22	2.67	2.27	0.08
Octopoteuthidae	*Octopoteuthis* sp	1.59	1.22	4.00	11.24	0.38
	Taningia danae	0.96	10.88	4.00	47.36	1.59
Octopotidae	*Octopus berrima*	0.32	0.00	1.33	0.43	< 0.01
Gonatidae	*Gonatus* sp	1.59	0.42	4.00	8.04	0.27
Cranchiidae	*Mesonychoteuthis hamiltoni*	0.32	0.54	1.33	1.14	0.04
	Taonius sp	1.59	0.63	6.67	14.79	0.50
Lepidoteuthidae	*Lepidoteuthis grimaldii*	1.27	4.03	5.33	28.27	0.95
Ommastrephidae	*Eucleoteuthis luminosa*	0.32	0.02	1.33	0.45	0.02
	Ommastrephes bartrami	2.23	3.60	6.67	38.85	1.30
	Unidentified cephalopods	4.78	6.99	20.00	235.31	7.89
Teleosts						
Scombridae	*Auxis thazad*	1.59	2.69	4.00	17.12	0.57
	Katsuwonus pelamis	0.64	3.01	2.67	9.71	0.33
	Sarda sarda	3.82	11.38	12.00	182.47	6.12
	Thunnus thynnus	0.32	1.70	1.33	2.69	0.09
	Unidentified tuna-fish	0.96	1.51	4.00	9.88	0.33
Bramidae	*Brama brama*	0.64	0.59	2.67	3.27	0.11
Carangidae	*Trachurus trecae*	0.32	0.05	1.33	0.49	0.02
Clupeidae	*Sardinella maderensis*	0.64	0.47	2.67	2.94	0.10
Echeneidae	*Remora remora*	0.32	0.01	1.33	0.44	< 0.01
Gempylidae	*Ruvettus pretiosus*	0.32	0.20	1.33	0.70	0.02

Taxon	Prey items	% N	% W	% F	IRI	% IRI
Teleosts						
	Thyrsites atun	0.96	0.95	2.67	5.07	0.17
Molidae	*Mola mola*	0.64	1.44	2.67	5.53	0.19
Trachichtchyidae	*Hoplasthetus atlanticus*	0.32	0.34	1.33	0.88	0.03
Trichiuridae	*Lepidopus caudatus*	1.59	0.26	5.33	9.87	0.33
	Unidentified bony-fish	2.87	0.87	9.33	34.86	1.17
Elasmobranchs	*Elasmobranch*	1.91	1.18	8.00	24.71	0.83
Crustaceans	*Crustacean remains*	1.27	0.26	2.67	4.09	0.14
Mammals	*mammal remains*	5.73	6.61	22.67	145.89	4.89
Undetermined	*Unidentified prey*	0.96	1.63	4.00	10.32	0.35
TOTAL						
All cephalopods		74.20	64.86	208.00	2 511.79	84.21
All teleosts		15.92	25.47	54.67	285.93	9.59
Elasmobranchs		1.91	1.18	8.00	24.71	0.83
Crustaceans		1.27	0.26	2.67	4.09	0.14
Mammals		5.73	6.61	22.67	145.89	4.89
Undetermined		0.96	1.63	4.00	10.32	0.35

Interactions between sex, maturity groups and season

The diet did not vary greatly according sexes, maturity groups and seasons (Table 2). The diet of males included *Histioteuthis macrohista* (% IRI = 20.2%), *Haliphron atlanticus* (%IRI = 18.2%), *Abraliopsis gilchristi* (% IRI = 17.9%) and *Sarda sarda* (%IRI = 14.7%) whereas females fed on *Haliphron atlanticus* (%IRI = 33.6%), *Histioteuthis macrohista* (%IRI = 18.3%), *Mastigoteuthis* sp. (%IRI = 8.3%) and mammals (%IRI = 10.3%).

Regarding the maturity groups, subadult (N = 77) mainly fed on *Histioteuthis macrohista* (%IRI = 46.1%), *Haliphron atlanticus* (%IRI = 12.4%), *Abraliopsis gilchristi* (%IRI = 9.1%) and *Mastigoteuthis* sp. (%IRI = 5.5%). In adults (N = 185), the main prey items were *Haliphron atlanticus* (%IRI = 34.9%), *Histioteuthis macrohista* (%IRI = 9.4%) and *Sarda sarda* (%IRI = 14.1%).

Diet according seasons showed that in cold season, *Histioteuthis macrohista* (%IRI = 27.5%), *Haliphron atlanticus* (%IRI = 20.20%) and *Abraliopsis gilchristi* (%IRI = 10.3%) were preferential preys whereas *Sarda sarda* (%IRI = 9.8%), *Mastigotheutis* sp. (% IRI = 4.1%) and *Mastigoteutis microluence* (%IRI = 3.2%) were secondary eaten. The other preys represented less than 3% of the diet were minor components. In hot season, the diet was dominated by *Haliphron atlanticus* (%IRI = 45.5%) and mammals (%IRI = 14.5%) followed by *Abraliopsis gilchristi* (%IRI = 6.0%), *Taningia danae* (%IRI = 3.9%), *Histioteuthis macrohista* (%IRI = 3.9%) and *Mastigoteutheis* sp. (%IRI = 3.1%).

The trophic overlaps according sexes and seasons were high ($C\lambda$ = 0.70 and C_λ = 0.62 respectively) whereas there was medium overlap between subadult and adult (C_λ = 0.49). The spearman rank correlation coefficient between sexes (N = 27; Rs = 0.41; p = 0.0035), maturity groups (N = 28; Rs = 0.75; p = 0.00002) and seasons (N = 22; Rs = 0.58; p = 0.004) were significant.

Table 2. Percentages IRI of prey items in stomach contents of blue shark caught by artisanal driftnet fishery by sexes size groups and seasons.

	% IRI sexes		% IRI Maturity groups		% IRI Seasons	
Prey items	Male	Female	Subadult	Adult	Cold season	Hot season
Cephalopods						
Histioteuthis miranda	0.71	0.69	1.03	0.57	0.65	1.07
Histioteutis bonnelli corpuscula	0.43	0.11	0.53	0.16	0.49	0.00
Histioteuthis macrohista	20.17	18.23	46.13	9.39	27.51	3.87
Haliphron atlanticus	18.16	33.55	12.42	34.92	20.16	45.50
Magnoteuthis microlucens	3.70	1.78	1.35	3.97	3.18	2.14

	% IRI sexes		% IRI Maturity groups		% IRI Seasons	
Prey items	Male	Female	Subadult	Adult	Cold season	Hot season
Mastigoteuthis sp.	1.24	8.25	5.48	2.89	4.14	3.10
Vampyroteuthis infernalis	0.86	0.08	0.51	0.38	0.50	0.28
Cycloteuthis akimushkini	0.09	0.20	0.00	0.35	0.05	0.75
Abraliopsis gilchristi	17.92	1.70	9.06	8.87	10.31	5.97
Chiroteuthis veranyi	0.18	0.08	0.12	0.15	0.25	0.00
Moroteuthis robsoni	4.65	0.49	1.64	2.95	2.97	0.00
Onychoteuthis banskii	0.22	0.00	0.00	0.17	0.13	0.00
Octopoteuthis sp	1.08	0.00	1.23	0.08	0.62	0.00
Taningia danae	4.47	0.00	0.81	1.87	0.86	4.79
Octopus berrima	0.04	0.00	0.00	0.03	0.02	0.00
Gonatus sp	0.00	1.19	0.90	0.05	0.24	0.29
Mesonychoteuthis hamiltoni	0.11	0.00	0.26	0.00	0.06	0.00
Taonius sp	0.96	0.07	0.53	0.41	0.52	0.33
Lepidoteuthis grimaldii	0.67	1.07	0.68	0.93	1.06	0.25
Eucleoteuthis luminosa	0.04	0.00	0.00	0.03	0.03	0.00
Ommastrephes bartrami	0.89	1.39	0.84	1.36	1.49	0.42
Unidentified cephalopods	2.76	14.05	5.67	7.96	7.61	6.44
Teleosts						
Auxis Thazad	0.28	0.84	1.24	0.23	0.93	0.00
Katsuwonus pelamis	0.28	0.29	0.43	0.23	0.52	0.00
Sarda sarda	14.70	0.14	0.00	14.06	9.84	0.00
Thunnus thynnus	0.26	0.00	0.00	0.21	0.00	1.62
Unidentified tuna-fish	0.10	0.67	0.25	0.34	0.54	1.35
Brama brama	0.07	0.14	0.21	0.05	0.04	0.52
Trachurus trecae	0.00	0.07	0.11	0.00	0.00	0.24
Sardinella maderensis	0.00	0.44	0.15	0.06	0.00	1.59
Remora remora	0.00	0.06	0.10	0.00	0.00	0.21
Ruvettus pretiosus	0.07	0.00	0.00	0.05	0.04	0.00
Thyrsites atun	0.17	0.00	0.00	0.39	0.10	1.12
Mola mola	0.53	0.00	0.34	0.10	0.30	0.00
Hoplasthetus atlanticus	0.00	0.13	0.00	0.07	0.05	0.00
Lepidocus cautdatus	0.05	0.88	0.68	0.15	0.03	2.98
Unidentified bony-fish	2.22	0.18	1.40	0.89	1.00	0.00
Elasmobranchs	1.96	1.96	0.38	1.01	0.54	0.20
Crustaceans	0.09	0.09	0.00	0.32	0.08	0.32
Mammals	1.53	10.34	5.43	3.90	2.84	14.45
Undetermined preys	0.10	0.72	0.10	0.46	0.33	0.20
Total						
All cephalopods	79.35	82.93	89.20	77.50	82.80	75.20
All teleosts	18.72	3.96	4.90	16.80	13.40	9.60
Elasmobranchs	1.96	1.96	0.38	1.01	0.54	0.20
Crustaceans	0.09	0.09	0.00	0.32	0.08	0.32
Marine mammals	1.53	10.34	5.43	3.90	2.84	14.45
Undetermined preys	0.10	0.72	0.10	0.46	0.33	0.20

Discussion

The percentage of empty stomachs from the present study was relatively high (36.0%). This high vacuity index is common to most shark species (Joyce *et al.*, 2002; Cabrera *et al.*, 2010) and particularly to blue shark (Markaida and Sosa-Nishizaki, 2010). To explain such high level of vacuity index, it is fundamental to understand the interaction predator-prey and how often or how does the shark consume. Sharks have been frequently described as intermittent feeders, with small periods of frenetic active feeding and longer periods of time characterized by reduced predatory activity consequence of slow digestion rates and different feeding behaviour at different life stages (Simpfendorfer *et al.*, 2001). Another possibility is the type of fishing gear used, as fishermen used baited hooks in association to driftnet, so many animals caught with bait had gone a substantial period without eating. It is apparent that most sharks that were attracted to bait were those which had relatively empty stomachs or those which had recently eaten but were still inclined to consume additional food. In addition, hooks cause high stress at the time of capture often resulting in the regurgitation of stomach contents or the whole stomach of several individuals during the data collection. This may partly explain the large number of empty stomachs as observed in *Carcharhinus falciformis* and *Sphyrna lewini* (Cortés, 1997; Alatorre-Ramirez *et al.*, 2013). A high incidence of empty stomachs may also reflect a long time between capture and examination (McCord and Campana, 2003).

Most of fishes were encountered in a state of intermediate or fresh state, while cephalopods and crustaceans showed mostly a state of advanced digestion or well digested. The states of prey digestion observed here suggest that *P. glauca* feed constantly in the area. Similar results have been obtained by Mendonça (2009) and Cabrera *et al.*, (2010). Tricas (1979) reported that for *P. glauca*, the preys into stomachs were in a state of advanced digestion 10-24 hours after ingestion. These results would suggest that most of specimens had fed at least 10 hours before being captured. The presence of fresh teleost in stomach assumes that these specimens were taken after their feeding.

A total of 37 taxa were identified in the stomachs of *P. glauca*. However, the Levin index indicates a dominance of few preys in the diet. The low trophic niche breadth associated to a large prey trophic spectrum indicate that blue shark is an opportunist predator as noted by Flores-Martinez *et al.*, (2016). The blue sharks has been reported to feed mainly in cephalopods (Mendonça, 2009; Markaida and Sosa-Nishizaki, 2010), which was also shown in the present results, with a relative importance of this group around 84.2%. Inorganic items such seabird feathers and plastic wrapping were also observed in stomachs as reported by Joyce *et al.*, (2002). Among cephalopods, *Haliphron atlanticus*, *Histioteuthis macrohista* and *Abraliopsis gilchristi* were the most abundant prey items of this species. Preference for mesopelagic cephalopods of families Alloposidae, Histioteuthidae, Enoploteuthidae and Mastigoteutidae indicates that this species preys upon animals of low mobility, because it is not a fast-swimming predator like other carcharhinids and lamnids.

This species also fed in minor quantity on several teleost fishes, including members of the Scombridae family, mammals, cartilaginous fishes and crustaceans. Blue shark seems to feed on these types of prey with high energy content to compensate the lost energy during incursions to the research of deep water preys with slow mobility. In other areas, teleost fishes were found as the main component of the diet of this species (McCord and Campana, 2003; Lopez *et al.*, 2010). The feeding strategy of these migratory pelagic fishes might depend on the environmental availability of their prey as they have great movements and habitat shifts, so they might have a wide food spectrum (Cortés, 1997; 1999). On the other hand, the adaptation of blue shark to different type of taxa may be a feeding strategy to cope at reproductive requirements related to environmental characteristics; which making this migratory species one of the most widely distributed in the world.

The importance of food categories analysed according to sexes, maturity groups and seasons showed a preponderance of cephalopods. Based on previous studies indicating that both sexes reach maturity at above 200 cm, TL (Pratt, 1979; Hazin, 1991), juveniles were not encountered in the study period. Diets according sexes and maturity groups showed similarity and almost completely overlapped.

This indicates that males and females as well as subadults and adults occupy similar areas or encounter similar preys. However, preference for cephalopods was observed for females and subadults whereas, males and adults fed on cephalopods, teleost fishes and mammals. This similarity and overlapping in the diet of blue shark was observed according seasons, with a decrease of cephalopod abundance in hot season. Clarke and Stevens (1974) noted a monthly decrease in cephalopod occurrence as the season advances in the English Channel.

Conclusion

Our results indicate that *P. glauca* feed on a large variety of prey, mainly mesopelagic cephalopods. This species is considered as carnivorous predator with a selective pelagic species feeding strategy, which seems to be associated with prey availability in the area.

Despite these results, further investigation is required and, given the high variability of prey items, larger samples including juveniles are mandatory for a better understanding of the feeding habits.

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