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Cephalopods from the CECAF area: fishery and ecology role

by

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ABSTRACT

The aim of this paper is to phocus attention on the role of cephalopd in the CECAF area (Central-eastern Atlantic). The high economical value of the fisheries based on this group of mollusc is not new. In the early sixties began the exploitation of the Saharan Bank by the Spanish an Japanese fleets. Nowadays, this continues by several national fleets, including same african countries which have now important fleets dedicated to this resource. Furthemore, the fisheries have extended to the south after finding high concentrations of *Sepia*. The most relevant species are *Octopus vulgaris*, *Sepia officinalis*, and *Loligo vulgaris*. Catches of these three species are around 200 000 mt every year.

Besides the above three species, there are a relatively high number of species which are fished in less quantities, and there are also some species which do not receibe any commercial attention. The later ones are mainly oegopsid squids, which seem to have an important ecological role. As an example of this, an analysis is presented here, in which was attempted to determine the ommastrephid biomass preyed by a large predator, the swordfish (*Xiphias gladius*).Thus, the estimation of the ommastrephid biommas consumed by swordfish was between 87 and 264 mt daily in this area.

FISHERIES AND CEPHALOPODS

In the Central-eastern Atlantic (CECAF area), the fishery production is very important. In this area you can find some of the most important fisheries in the world. In 1977 the total capture in the area reached a maximum of 3.8 millions mt, experiencing a decrease in 1985-86 until the 2.9-3.0 millions mt (FAO, 1991a); although, in 1990 that maximum increased, being the total capture obtained in the area 4.1 millions mt (FAO, 1994).

The most important fisheries, in biomass, correspond to sardines, carangids, tunas, and cephalopds (FAO, 1994). The exploitation of cephalopods in this area constitutes one of the most important fisheries worldwide, not only because the biomass obtained, but also because of their economical value. Thereby, during the last 70s, it was the second most important fishery in the world (Guerra y Pérez-Gándaras, 1983). Their position in 1988 was 4th (with 164723 mt; FAO, 1991b). This descent in the worldwide scale was a result of the important increase of catches in the southwestern Atlantic and eastern Pacific in the course of the eighties. It should be highlighted here that the high increase of the biomass obtained in the southwestern Atlantic corresponded to *Illex argentinus*, which had been captured as accompanying species in the fishery of the hake (*Merluccius hubbsi*) in quantities of about 5000 mt until 1977; but from that year on, the captures increased until reaching 200000 mt, since the demand raised and foreing fleets began to operate (Brunetti, 1990). On the other hand, in the cephalopod catches from the eastern Pacific there are different ommastrephid species: *Todarodes pacificus*, *Sthenoteuthis oualaniensis*, *Nototodarus sloani* and *Ommastrephes bartramii*.

In the CECAF area, the most important cephalopod catches are basically obtained in the northern zone of the area (26° N - 21° N), in the Saharan Bank (Coast of the Sahara). The activity directed to this resource has its origin at the beginning of the sixties, when catches of the target species at that time (red and gray seabreams) underwent a very important decrease (Bas *et al.* 1970; Cort y Pérez-Gándaras, 1973).

Initially the squid (*Loligo* spp.) was the most important species; but towards the middle of the decade, the common octopus became the species of most interest. Thus in 1965, Japan began their activity in this zone, getting, together with the Spanish fleet almost the total catch of octopus (Sato & Hatanaka, 1983). The most important species are *Octopus vulgaris*, *Sepia officinalis*, *Sepia hierredda*, *Loligo vulgaris* and *Illex coindetii*, the later really in lower comparative quantity (García-Cabrera, 1968; FAO, 1981; Guerra y Sánchez, 1985). Other cephalopod species are captured in smaller quantities. They are *Sepia bertheloti*, *Sepia orbignyana*, *Sepia elegans*, *Alloteuthis africana*, *Todaropsis eblanae* and *Todarodes sagittatus*. In the north of the area *Loligo forbesi* is also catched. These species are considered part of the by-catch, together with a great number of fishes and crustaceans species.

The catch of *Octopus vulgaris* fished by Spain in the Sahara coast was between 21638 and 67680 mt for the period 1979-1991 (FAO, 1994). The cephalopd fishery in Northwestern Africa has been very important for Spain, specially for the economic development of certain regions like the Canary Islands, and among these for Gran Canaria, and Galicia. This high importance is due not only to the level of cathes obtained by Spain, but also to other activities related to fisheries. The harbour of Gran Canaria has been used as a base port by the Spanish fleet, and by Japanish and Corean fleets amomg others as well.

Fisheries have extended to the south after finding high concentrations of *Sepia* spp. and same african countries which have now important fleets dedicated to this resource (i.e. Marruecos, 155 vessels in 1984).

Therefore, the economical role of cephalopod is very important in this area; on the other hand, there are other species which seem to have a very important trophic role. The following estimation attempts to draw the atention on the role of same non-commercial species.

ESTIMATION OF THE OMMASTREPHID BIOMASS CONSUMED BY THE SWORDFISH, *XIPHIAS GLADIUS*, IN THE CECAF AREA

In the calculations two values of the swordfish biomass have been utilized. The first one its weight, regarded as maximum value calculated by means of VPA for the Northeastern Atlantic. Therefore, it is an excessive value, since it includes the part of the population which inhabit in the north of the 36° N parallel. This hypothesis, that the population of the whole Northeastern Atlantic should be accepted as a part of the CECAF area, is sustained taking as a basis that the level of catches in latitudes beyond the 36° N parallel is lower than the one obtained between the 0°-36° N parallel. Moreover, the CECAF area includes the six first degrees of south latitude, geographical fringe where a great deal of fish are caught.

Thus, the biomass obtained for the ages 1 to 5+ was 733723 fishes in 1989 in the Northeastern Atlantic (ICCAT, 1991a). Starting from this value, the biomass (in weight) was calculated making use of the relation size-weight for this zone of the Atlantic ($W = 3.4333 \times 10^{-6} \times LJF^{3.2623}$; ICCAT, 1993) and considering an average size of 142.6 cm of LMF (Lower Mandible-Fork). This mean size could be regarded as valid since it is an intermediate size of the one obtained by the several countries which operated in the zone in 1989 (range: 130.3 cm by the Portuguese fleet, 154.7 cm by the Korean fleet) and very near to the mean size obtained by Spain (144.8 cm). It should also be considered that the greatest number of fish catched and of CPUE of the Spanish fleet are obtained from the classes of age 2-4; and besides this, that the Spanish fleet is the most important one as far as extraction is concerned. Thereby, the biomass in weight obtained for the Northeastern Atlantic was 26830.4 mt for 1989.

The second value used in the calculations was obtained from the data on catch of these countries: Benin, Brazil-Japan, China (Taiwán), Cuba, Spain, Japan, Korea and EE.UU. within the extension of the area (± 5°) for grids of 5°×5° (ICCAT 1991, 1992). In those cases in which the statistics only contained data on the number of fishes (such as for China, Cuba, Japan and EE.UU.) the biomass in weight was calculated according to the mean size obtained in the Japanese fishery in 1989 and utilizing the equation size-weight for the swordfish of the Southeastern Atlantic ($Weight = 4.3491 \times 10^{-6} \times LJF^{3.188}$; ICCAT, 1993); since from the total of 90227 fishes catched by these countries in the area, 72841 of them were caught by Japan and these catches were basically obtained within the first degrees of south latitude. The total catch in the Central-eastern Atlantic was 15098.3 mt in 1989. Obviously, this is a suitable value for the CECAF area, however the population is considered to be significantly bigger than the catched quantity. Moreover, we must also bear in mind that the weight calculated by using the aforesaid equation (the one for the Southeastern Atlantic) is lower than the real weight, since it is based on the weight of the fish without viscera. It is also possible that small quantities of this fish are catched by African countries.

Once known the values of the theoretical estimated biomass and of the swordfish catch biomass in the CECAF area, the following step was calculating the value of the daily ration (C) of the fish. This calculation includes, according to Elliot and Persson's model (1978, cited by Stillwell & Kohler, 1985) and applied in this study, the volume or average weight of the stomach contents (S) and the stomach evacuation rate (R) according to the reduced equation:

$$C = 24 \times S \times R$$

The mean value for S obtained through the analysis of 60 fish from the zone of the Strait of Gibraltar and from the zone located to the south of the Canary Islands was of 0.816 kg, equivalent to 1.7 % of the body average weight (Hernández-García, 1995). The reason for the difference between this value and the one obtained by Stillwell &Kohler (1985) (0.604 kg, S value) could be that in the calculation the total weight of the fish did not include the weight of the viscera, since they had been taken away before weighing each specimen just after landing. Hence, we consider the quantity of 0.604 kg valid as mean value for S. We regard the value suggested by Kohler & Stillwell (1981) for the blue shark (*Prionace glauca*) R= 0.0376 h^{-1} and the maximal value for R (0.0639 h^{-1}) obtained for the *Isurus oxyrinchus* shark (Stillwell & Kohler, 1982) as values for R which should be included in the equation. Therefore, the values obtained for the daily ration in the CECAF area were the same that those found by the aforesaid authors for the Northwestern Atlantic: 0.94 and 1.60% of the body weight as minimal and maximal values respectively. The acceptance of the value S= 0.604 kg is possible if you bear in mind that the average size of fish in this study (147 cm, based on Hernández-García, 1995) and the average size of catches of the different longline fleets are near to the average size (153 cm) of fish considered in Stillwell & Kohler's study (1985), and that the value for S obtained should be very similar to 0.604 kg if the weight of the viscera of each animal was considered.

On the other hand, there is not information on the stomach evacuation rates for swordfish, so we have used those of the two shark species, since this species occupy the same trophic levels and include similar species in their diets (Kohler & Stillwell, 1981; Stillwell & Kohler, 1982). Moreover, both species display a similar migratory daily activity, although they are opposite to those of the swordfish (Carey & Robison, 1981).

Table 1. Estimations of the total and ommastrephid biomass consumed by the swordfish (*Xiphias gladius*) in the Central-eastern Atlantic. ❶ = swordfish biomass estimated from VPA in the area (1989); ❷ = swordfish biomass catched in the area (1989).

Swordfish biomass (mt)	Food rate (% in weight and d^{-1})	Total biomass consumed (mt × d^{-1})	Ommastrephid biomass consumed (mt × d^{-1})
26830.4 (❶)	1.60	429.2	264.8
	0.94	252.2	155.6
15098.3 (❷)	1.60	241.6	149.0
	0.94	141.9	87.5

The estimation of the minimal and maximal biomass values of preys consumed by the swordfish was calculated taking as a basis the previous data. As a result the minimun value is 252.2 mt d^{-1} and the maximum 429.2 mt d^{-1} for the swordfish biomass. The values calculated for the biomass of the swordfish catched within the area (biomass below real level) are 141.9 mt d^{-1} and 241.6 mt d^{-1} for minimal and maximal values respectively (Table 1).

The best parameter in order to know to which extent a prey contributes to the diet of a predator, in terms of biomass, is the weight percentage (Bowen, 1985). For that reason in order to learn about the contribution of the Ommastrephidae family, the weight percentages of the nourishing groups were calculated, after calculating the reconstructed weight (or weight of the prey alive at the moment of being ingested) for a oceanic zone (Canary Islands). For this purpose the data obtained previously were used (Hernández-García, 1995). The resultant value of the weight percentage for the ommastrephids was 61.7%.

In the most unfavorable case, this is considering the biomass ingested for a minimal daily ration by the biomass of swordfish catched in the area (population below real level), the biomass of ommastrephid cephalopods consumed by the swordfish is 87.5 mt d^{-1} (Table 1). Notice that most of this biomass of ommastrephids consumed by the swordfish in oceanic waters belongs to the species *Sthenoteuthis pteropus* (Hernández-García, 1995).

DISCUSSION

Undoubtledly the trophic implications of the ommastrephids are very wide judging by the appreciable quantity of predators that they possess (Rees & Maul, 1956; Scott & Tibbo, 1968; Dragovich, 1970; Dragovich & Potthoff, 1972; Clarke & Stevens, 1974; Clarke & MacLeod, 1976; Clarke, 1985; Domanevsky et Patokina, 1987; García de los Salmones *et al.*, 1989; Ashmole & Ashmole, 1967; Hernández-García & Martin, 1994). Moreover, there is no information on the diet of many species of fishes in which the ommastrephids could be involved, and there are also same other aspects which have not been properly analysed such as marine birds. Anyway, it has been observed that from benthic species to pelagic ones of great size include in their diets one or more species of the Ommastrephidae family. Then, we must include them in the levels II to V in the trophic web, which was also exposed by Gaevskaya & Nigmatullin (1976). Therefore, they constitute an important source of diversification for energy fluxes. The importance of these cephalopods be ome ever more remarkable, if we bear in mind that the they are characterized by carrying out important vertical migrations (Clarke, 1966; Roper & Young, 1975; Lee *et al.*, 1985; Laptikovsky, 1989; Nakamura, 1991). So they are available for species which live in the epipelagic layer and also in the upper mesopelagic and facilitate the transfer of energy since they feed on the migratory zooplankton (Roger & Grandperrin, 1976).

The value of biomass consumed by the swordfish only is indicative one, since diverse hypotheses have been carried out, which are not always right for the marine environment. Thus, it is considered that all the population of *Xiphias gladius* inhabit in oceanic waters year round, since the weight percentage of cephalopod was calculated for such zones. This can be considered as right in the light of the results obtained by Carey & Robison (1981), which agree with the fact that a great deal of the catch is obtained in oceanic waters during the annual cycle (Mejuto *et al.*, 1992). In addition, if this fish inhabits in coastal waters, has a dayly pattern of migration that includes a movement toward superficial oceanic waters at night (Carey & Robison, 1981), where it can feed on oceanic cephalopods (Hernández-García, 1995). The lower quantity of squid in the diet of this fish in coastal waters is due to the greater number of pelagic fishes and to the ecology of these squid species, taking into account, that the ommastrephid species found in the swordfish stomachs are oceanic ones (only two specimens of *Todaropsis eblanae* were found in the zone of the Strait of Gibraltar (Hernández-García, 1995).

On the other hand, in the model of Elliot & Persson (1978) it has been considered that the value of the gastric evacuation (R) is affected neither by the size of the fish nor by the type of catch among other factors. On the contrary, we know that cephalopods are digested faster than fishes and crustaceans. Therefore, the knowledge of the energy requirements of a predator, their ingestion and evacuation rates are values that one is supposed to know as exactly as possible before introducing in a multiespecific model (Livingston, 1985). The previous information is especially important in relation to the estimate of the biomass of prey; and although the value of the mean weight of the stomach content is very similar to the one obtained by Stillwell & Kohler (1985), it is not considered the possible deviation in the rate of daily consumption generated by variations in the metabolic rates, since it is a different area. The rate of daily consumption will depend on the metabolic rate (that it is supposed to cover the minimum of the energy requirement, which could vary according to the size, sex and physiologic condition). Therefore, it would be adequate to carry out an estimate of the energy requirements of the fish population by means of controled feeding experiments, although the results will show differences to the experiments carried out in natural conditions, which will be due to the assumptions described in the model (Lavigne *et al.*, 1986). In spite of the unsuitability of the models to the reality, it is adequate to contrast them since the estimate about the studies of stomach contents and of defecations do not allow us to get a real image of the diet (structures such as the otoliths are affected in different way depending on the prey species (Joubling & Breiby, 1986; Hernández-García, 1995)); but anyway, it will always get an underestimation of the weight of the prey. Thereby, if it was calculated the rate of daily consumption as function to the energy requirement, it would be made an error face to the necessity of incrementing the number of preys consumed in order to cover the quantity of necessary energy (Jobling, 1987). Therefore, the biomass of the prey will overestimate doing it in reference to the predator population. Observe that this underestimation of the weight of prey and posterior overestimation of their number are not produced by cephalopod in anyway, because cephalopod beaks are not eroded (Hernández-García, 1995). The error that is generated in this sense is the result of an indirect increase of the percentage in weight of the cephalopods when fishes are underestimated.

Besides, undertaking the study only from the stomach contents point of view, it is found that the predator introduce for the different types of prey different digestion and evacuation rates, which produce a bias in the analysis of the stomach contents (Hyslop, 1980). So, for example, they were not found preys belonging to the miscellany category in the stomach content in any of the studied zones, although this category is not important in the diet of this fish (Scott & Tibbo, 1974; Stillwell & Kohler, 1985). As negative factor can be pointed out it can happen an accumulation of the refractory structures of certain species, like apparently happens to *Micromesistius poutassou* in the swordfish catched in the zone of the Strait of Gibraltar (Hernández-García, 1995). Other problems are produced by the migratory character of some species, like it happens with swordfish, which migrate through the Strait of Gibraltar (De la Serna y Alot, 1990). Also, it is necesary to bear in mind that the biomass of swordfish could not preserved in the area, this could diminish in a time $t+dt$ because of migration or well could increase for the same reason.

Beside than the Ommastrephidae family, there are other cephalopod families, mainly oceanic ones (Histioteuthidae, Cranchiidae, Pholidoteuthidae), which seem to have certain ecological relevance too (Hernández-García & Martín, 1994; author un-published data). Therefore, cephalopods have a high economical and ecological value in the CECAF area. These are animals that grow very fast and have a short life-span, thus taking advantage on the suitable oceanographical conditions (high productivity because de upwelling among others).

REFERENCES

Ashmole, N. P., & M. J. Ashmole (1967). Comparative feeding ecology of sea birds of a tropical oceanic island. *Bull. Peabody Museum of Natural History*, 24: 1-131.

Bas, C., E. Morales y J. S. Feliú (1970). Pesquerías de cefalópodos en el Banco Sahariano. *Publ. Téc. Dir.*

Gen. Pesca Mar., 9: 129-151.
Bowen, S. H. (1985). Quantitative description of the diet. En: *Fisheries techniques*. Nielsen, L. A., and David L. Johnson (Eds.). American Fisheries society. Virginia, pp: 325-336.
Brunetti, N. E. (1990). Evolución de la pesquería de *Illex argentinus* (Castellanos, 1960). *Inf. Tec. Invest. Pesq.*, 155: 1-19.
Carey, F. G., & B. H. Robison (1981). Daily patterns in the activities of swordfish, *Xiphias gladius*, observed by acoustic telemetry. *Fish. Bull. U. S.*, 79: 277-292.
Clarke, M. R. (1966). A review of the systematics and ecology of oceanic squids. *Adv. mar. Biol.*, 4: 91-300.
Clarke, M. R. (1985). Cephalopods in the diet of cetaceans and seals. *Rapport. Commission Internationale pour la Mer Mediterranée*, 29(8): 211-219.
Clarke, M. R., & N. MacLeod (1976). Cephalopod remains from sperm whales caught off Iceland. *J. mar. biol. Ass. U.K.*, 56: 733-749.
Clarke, M. R., & J. D. Stevens (1974). Cephalopods, blue sharks and migration. *J. mar. biol. Ass. U.K.*, 54: 949-957.
Cort, J., y G. Pérez-Gándaras (1973). Estudios de pesca de los cefalópodos (*Octopus vulgaris, Sepia officinalis* y *Loligo vulgaris*) del banco pesquero sahariano. *Boletín del Instituto Español de Oceanografía*, 172: 1-63.
De la Serna, J. M., y E. Alot (1990). Consideraciones relativas a los desplazamientos efectluados por el pez espada (*Xiphias gladius*) en el área del Estrcho de Gibraltar y otras cobservaciones relacionadas con la biología de la reproducción. ICCAT, Colección de Documentos Científicos, SCRS/89/34, XXXII(2): 353-359.
Domanevsky, L. N., et F. A. Patokina (1987). Le role des cephalopodes dans la nourriture des poisssons. En: *Comite des peches pour l'Atlantique Centre-Est, COPACE/SERIES* 86/41: 31-45.
Dragovich, A. (1970). The food of skipjack and yellowfin tunas in the Atlantic ocean. *Fishery Bulletin*, 68(3): 445-460.
Dragovich, A., & T. Potthoff (1972). Comparative study of food of skipjack and yellowfin tunas off the coast of west Africa. *Fishery Bulletin*, 70(4): 1187-1110
Elliott, J. M., & L. Persson (1978). The estimation of daily rates of food consumption for fish. *J. Anim. Ecol.*, 47: 977-991.
FAO (1981). Fishery information, Data and Statistics Service. Statistical Bulletin for the Fishery Committee for the Eastern Central Atlantic (CECAF) No. 3. Nominal Catches 1969-1979. *FAO*, Rome.
FAO (1991a). Examen de la situación de los recursos pesqueros mundiales. Circular de Pesca N° 710 (Rev. 7), 88 pp. Roma.
FAO (1991b). Fishery information, data and statistics Service. Statistical Bulletin for the Fishery Committee for the Eastern Central Atlantic (CECAF) No. 6. Nominal Catches 1977-1989. *Bulletin of Fisheries Statistics*, 29: 189 pp.
FAO (1994). Fishery information, data and statistics Service. Statistical Bulletin for the Fishery Committee for the Eastern Central Atlantic (CECAF) No. 7. Nominal Catches 1979-1991. *Bulletin of Fisheries Statistics*, 33: 243 pp.
Gaevskaya, A. V., & Ch. M. Nigmatullin (1976). Biotic relatioships of *Ommastrephes bartrami* (Cephalopoda, Ommastrephidae) in the north and south Atlantic. *Zoologicheskii Zhurnal*, 55(12): 1800-1810.
García-Cabrera, C. (1968). Biología y pesca del pulpo (*Octopus vulgaris*) y choco (*Sepia officinalis hierredda*) en aguas del Sáhara español. *Publ. Técn. J. Est. Pesc.*, 7:141-198.
García de los Salmones, R., O. Infante y J. J. Alio (1989). Reproducción y alimentación de los peces de pico, *Istiophorus albicans*, *Tetrapturus albidus* y *Makaira nigricans*, en la costa central de Venezuela. *ICCAT, Colección de Documentos Científicos*, SCRS/88/55, XXX(1): 436-439.
Guerra, A., y G. Pérez-Gándaras (1983). Las pesquerías mundiales de cefalópodos: situación actual y pespectivas. *Inf. Técn. Inst. Inv. Pesq.*, 102-104: 1-141.
Guerra, A., y P. Sánchez (1985). Comparación de las pesquerías de cefalópodos de dos áreas de afloramiento de la costa occidental africana. En: *Simposio Internacional sobre las Areas de Afloramiento más importantes del Oeste Africano (Cabo Blanco y Benguela)*. Vol. II. Bas, C., R. Margalef y P. Rubies (Eds). Instituto de Investigaciones pesqueras, Barcelona, pp: 749-760.
Hernández-García, V. (1995). The diet of the swordfish *Xiphias gladius* Linnaeus, 1758, in the central east Atlantic, with emphasis on the role of cephalopods. *Fish. Bull.*, 93(2): 403-411.

Hernández-García, V., & V. Martín (1994). Stomach contents of two short-finned pilot whale (*Globicephala macrorhynchus* Gray, 1846) (Cetacea, Delphinidae) off the Canary Islands: A preliminary note. *ICES*. CM. / N: 16. 9 pp. (Mimeo).

Hyslop, E. J. (1980). Stomach contents analysis-a review of methods and their aplication. *J. Fish. Biol.*, 17: 411-429.

ICCAT, (1991). *Colección de datos estadísticos*, XXXII . Madrid, 387 pp.

ICCAT, (1992). *Colección de datos estadísticos*, XXXIII . Madrid, 285 pp..

ICCAT, (1993). *Colección de datos estadísticos*, XXXIV. Madrid, 367 pp.

Jobling, M. (1987). Marine mammal faeces samples as indicators of prey importance - A source of error in bioenergetics studies. *Sarsia*, 72: 255-260.

Joubling, M., & A. Breiby (1986). The use and abuse of otoliths in studies of feeding habits of marine piscivores. *Sarsia*, 71: 265-274.

Kohler, N. E., & C. E. Stillwell (1981). Food habits of the blue shark *Prionace glauca* in the northwest Atlantic. *ICES, C.M.* / H: 61, 7pp. (Mimeo).

Laptikhovsky, V. V. (1989). Twenty-four hours vertical migrations of the arrow-squid *Todarodes angolensis* Adam (Cephalopoda, Ommastrephidae) in Namibia Waters. *Okeanologiya*, 29(5): 836-837.

Lavigne, D. M., S. Innes, G. A. J. Worthy, K. M. Kovacs, O. J. Schmitz & J. P. Hickie (1986). Metabolic rates of seals and whales. *Can. Journal of Zoology*, 64: 279-284.

Lee, S. D., Y. S. Son & Y. C. Kim (1985). A study on the vertical distribution of common squid, *Todarodes pacificus* (Steenstrup), in the Eastern Waters of Korea. *Bull. Fish. Res. Dev. Agency*, 36: 23-28.

Livingston, P. A. (1985). An ecosystem model evaluation: the importance of fish food habits data. *Marine Fisheries Review*, 47(4): 9-12.

Mejuto, J., P. Sánchez & J. M. de la Serna (1992). Nominal catch per unit of effort by length groups and areas of the longline Spanish fleet targeting swordfish (*Xiphias gladius*) in the Atlantic, years 1988 to 1990 combined. *ICCAT, Collective Volume of Scientific Papers*, SCRS/91/49, XXXIX(2): 615-625.

Nakamura, Y. (1991). Tracking of the mature female of flying squid *Ommastrephes bartrami*, by an ultrasonic transmiter. *Bull. Hokkaido Natl. Fish. Res. Inst.*, 55: 205-207.

Overholtz, W. J., & G. T. Waring (1991). Diet composition of pilot whales *Globicephala* sp. and common dolphins *Delphinus delphis* in the Mid-Atlantic Bight during Spring 1989. *Fishery Bulletin*, 89: 723-728.

Rees, W. J., & G. E. Maul, (1956). Cephalopods of Madeira. Records and Distribution. *Bulletin of the British Museun (Natural History), Zoology*, 3(6): 257-281.

Roger, C., & R. Grandperrin (1976). Pelagic food web in the Tropical Pacific. *Limnology and Oceanography*, 21(5): 731-735.

Roper, C. F. E., & R. E. Young (1975). Vertical distribution of pelagic cephalopods. *Smithsonian Contributions to Zool.*, 209: 1-51.

Sato, T., & H. Hatanaka (1983). A review of assessment of japanese distant-water fisheries for cephalopods. En: *Advances in assessment of world cephalopod resources*. Caddy, J. F. (Ed.). *FAO Fish. Tech. Pap.*, 231: 145-180.

Scott, W. B., & S. N. Tibbo (1968). Food and feeding habits of swordfish, *Xiphias gladius*, in the Western North Atlantic. *J. Fish. Res. Bd. Can.*, 25: 903-919.

Scott, W. B., & S. N. Tibbo (1974). Food and feeding habits of swordfish, *Xiphias gladius* Linnaeus, in the Northwest Atlantic Ocean. En: *Proceedings of the International Billfish Symposium*. Shomura, R. S., and R. Williams (Eds.). Kailua-Khna, Hawaii, 9-2 Aug. 1972. Part 2. Review and Contributed Papers, U. S. Dep. Comm., NOAA Tech. Rep. NMFS SSRF-675: 138-141.

Stillwell, C. E., & N. E. Kohler (1982). Food, feeding habits and estimates of daily ration of the shortfin mako (*Isurus oxyrinchus*) in the northwest Atlantic. *Can. J. Fish. aquat. Sci.*, 39: 407-414.

Stillwell, C. E., & N. E. Kohler (1985). Food and feeding ecology of the swordfish *Xiphias gladius* in the Western North Atlantic Ocean with estimates of daily ration. *Mar. Ecol. Prog. Ser.* 22: 239-247.