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An attempt to quantify spear fishing catches in a French Riviera Mediterranean area

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Abstract: Spear fishing was studied during the low season (May and June) and the high season (July and August) on a 7.5 km long stretch of the French Mediterranean coast situated between Toulon and Saint-Tropez (Rayol-Canadel-sur-Mer and Cavalaire, French Riviera). The study area is difficult of access for spear fishermen and can be considered as a model of less visited parts of the French Mediterranean coast. Nevertheless, the area is overexploited by professional fishermen. Frequentation and catches were quantified on the basis of a 46 day random sampling. The number of spear fishermen is 2-4 times greater on Saturdays and Sundays than on the other days. Mean duration of a spear fishing outing is 2h 35 min. Most species caught are Cephalopoda, Labridae, Sparidae and the scorpion fish *Scorpaena porcus*. Cephalopoda account for 51% of wet weight catches. The mean yields range from 1.0 kg wet mass/fisherman/h (low season) to 1.4 kg/fisherman/h (high season) on week-ends, and from 2.0 to 1.3 kg/fisherman/h respectively on other days. During the studied period, spear fishermen caught about 2 500 individuals (1 330 kg). This represents, when extrapolated over the whole year (on the basis of frequentation data), about 5 100 individuals (3 050 kg, i.e. 1.3 t/km²).

Résumé: **Essai de quantification de la chasse sous-marine dans un secteur de la Côte d'Azur (Méditerranée, France).** La chasse sous-marine au fusil-harpon a été étudiée en basse saison (mai-juin) et en haute saison (juillet-août) le long d'un secteur de côte de 7.5 km de longueur situé dans le Var (Rayol-Canadel-sur-Mer et Cavalaire, France), entre Toulon et Saint-Tropez. Ce secteur, difficile d'accès, est représentatif des zones les moins fréquentées du littoral méditerranéen français. Il est toutefois surexploité par la pêche professionnelle. La quantification de la fréquentation et des prises a été réalisée par un échantillonnage aléatoire portant sur 46 jours au total. Le nombre de chasseurs est 2-4 fois plus important le samedi et le dimanche que les autres jours de la semaine. La durée moyenne d'une chasse est de 2h 35 min. Les espèces les plus pêchées sont des Céphalopodes, des Labridae, des Sparidae et la rascasse *Scorpaena porcus*. En masse, les Céphalopodes représentent 51% des prises. Le rendement moyen de la chasse, le week-end, est de 1.0 kg masse humide/chasseur/h en basse saison et de 1.4 kg/chasseur/h en haute saison ; en semaine, il est respectivement de 2.0 et 1.3 kg/chasseur/h. Pour la période étudiée, les chasseurs sous-marins ont capturé environ 2 500 individus et 1 330 kg, ce qui représente, en extrapolant à une année entière (à partir des données sur la fréquentation), 5 100 individus et 3 050 kg, soit 1.3 t/km².

Keywords: Spear fishing, Catch per unit effort (CPUE), Mediterranean.

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INTRODUCTION

A large number of studies have been carried out which deal with the professional fishing industry. Data are available on fish catches even though these values are probably unreliable and under-estimated for artisanal (= small scale) Mediterranean fishing. Recreational (amateur) fishing, however, has received very little attention in the Mediterranean whether this be spear fishing or angling.

The Mediterranean is an oligotrophic sea in which the ichthyological resources are lower than they are in other parts of the world. The catches of the professional fishing industry are between 1 200 000 and 1 300 000 t/year, or in other words 1.5% of total world wide catches. Since the mid 1980s, the landed catches has remained constant or has declined, particularly in the Gulf of Lions (Caddy, 1990; Stamatopoulos, 1993; Griffiths, 1996). The French fishing industry is responsible for only about 7% of the landed catch in the Mediterranean (FAO-CGPM data). This catch does not meet the demand of the coastal populations (4 Mt/year). As supply is less than demand, due to the fact that fishing in the Mediterranean is often on a small-scale, and as a large part of the fish caught are high value species, the Mediterranean fishing industry represents 5% of the world's fishing income. The same is true for the French fishing industry: the Mediterranean catch represents 8% of the national production while accounting for 14% of the national fisheries income (Rodríguez, 1982; Charpentier *et al.*, 1995; Rey, 1996).

The volume of recreational fishing as compared to the professional fishing industry is not known. It is possible that it is relatively low by comparison. Under conditions of resource overexploitation, however, such as those found in the Mediterranean, the recreational fishing catch, when added to the professional fish catch, may play an important role in the overexploitation of resources.

The aim of the present study is to propose a method for assessing the recreational fish catch and to provide preliminary data on the least studied method of recreational fishing, underwater spear fishing. The site chosen for this study was a stretch of coast of low frequentation situated in the Var (French Riviera). This particular site was selected so that the extrapolations performed could not be suspected of being overestimations: frequentation (density of casual users of the coastline) at sites in the neighbouring localities is 5 times higher than that of the studied site.

MATERIALS AND METHODS

The studied area is a 7.5 km stretch of the coastline (measured from a 1/50 000° scale map) located between Le Rayol-Canadel-sur-Mer and Cavalaire-sur-Mer (Var, France: 6°27'E, 43°09'N and 6°38'E, 43°10'N,

respectively). The surface area of the site studied (from the shore to the 50 m isobath) is about 7.8 km_. Spear fishing is always carried out at less than 30 m depth. This type of fishing is thus fully covered by this study. The site is difficult of access by land and is distant from the large urban and tourist centres of Provence and the French Riviera and, as a result, levels of frequentation are relatively low.

The study period was from May 1 to June 30 ("low season") and from July 1 to August 15, 1996 ("high season"). Observations were made over 23 days for both the low and high seasons. The days were chosen at random but with the same number of day sessions for each day of the week (Monday, Tuesday, ... Sunday). Observations were made from a small boat, weather permitting. For days when sea conditions did not allow navigation, the observations were performed from the coast, particularly from elevated areas which gave an overview of the studied area. The "sampled population" (N) is made up of all the spear fishermen observed during the studied period (132 fishermen outings). The "investigated population" (n) is that fraction of the sampled population for which catches were quantified and who were asked to answer a few questions (33 fishermen outings). A survey card was filled in for each spear fisherman which included information on: (1) the duration of the fishing activity up to the moment of questioning, (2) the estimated time of departure, (3) fishing technique, (4) apnea duration and depth attained, (5) age and sex, (6) place of residence, (7) holiday address for tourists, if necessary, (8) the regularity of frequentation, (9) knowledge of the regulations related to spear fishing, (10) level of technical skills, (11) subjective impressions on changes in the diversity and size of the species caught. The number of fishes and cephalopods caught (and other catches when these occurred), the species and size (to the nearest cm) of each individual were noted. For the fish, size measurement were taken as being the longest length between the head and the tip of the caudal fin (total length) while for the cephalopods size measurement was the distance between the top of the "head" and the tip of the longest tentacle.

The quantification of catches and the questioning were only performed for a fraction of the fishermen observed due to the time needed to carry out these operations and to the necessity of covering the entire study area. On the basis of the total number of spear fishermen present, the quantification and questioning operations involved nearly of the fishermen sampled; the decision of whether to quantify and interrogate depended on the order in which they were encountered during the East-West or West-East survey passages of the study area.

The mean length of a spear fishing outing is relatively short in our study area (2 to 3 h). Given the time interval during which the survey was conducted, the time between two survey passages in the study area and

the duration of daylight hours[1], a certain number of spear fishermen may have escaped observation. A correction coefficient (c = 1.5) was therefore estimated.

In order to calculate the "theoretical population" TP (in terms of spear fishermen outings), which represents the total number of fishermen outings in the studied area for a given period of time (low season or high season, during the week or at week-ends), from the sampled population, we used the following equation: TP = N*c*A/B where

N = the sampled population (number of spear fishermen outings),
c = correction coefficient,
A = total number of days for a given period of time,
B = total number of days studied for a given period of time.

In order to transform the fish size data into wet weight results, the size-mass relationships present in the literature for each species or group of species were used (López-Capont, 1977; Maxim, 1982; Dorel, 1986; Guerra and Manríquez, 1980; Francour, 1990; Miniconi, 1994).

In order to estimate total catches IC (in number of individuals) or MC (in biomass) for a given period of time, we used the following equation: IC or MC = CPUE*TP*D, where

CPUE = catch per unit effort (hour-spear fisherman) in numbers of individuals or in wet weight,
D = mean duration (in hours) of a spear-fishing outing.

RESULTS

Throughout the study period (May to August), 420 spear fisherman outings were recorded in the study area; 50% of these came from the Var, 25% came from neighbouring departments and only 25% were tourists. The great majority (75%) of the fishermen frequent the area regularly (from 8 to 50 days per year). They are almost exclusively men (98%). Daily frequentation levels are higher over the week-end (Saturday and Sunday) than during the rest of the week: 4 times higher during the low season and twice as high in high season. On week-days, however, there is no significant difference between low and high season frequentation.

Most of the spear fishermen (2/3) use a Tahitian arrow (single arrowhead) while the others use a trident. Their fishing gear is relatively simple which confirms the leisure activity nature of this sport. This is substantially different from the situation in other parts of the Western Mediterranean where a number of spear fishermen practice this activity in a semi-professional manner barely within the law. The single technique used is "hole spear fishing": fish are driven back into a hole where they are speared. Apnea lasts 50 s on average (sd = 27) and the

mean depth attained is in the order of 7 m. The spear fishermen examined in the present study never dove deeper than 20 m so that the surface area actually exploited is only 2.4 km².

Knowledge of the fishing regulations are quite limited: possession of a fishing permit or licence (15%), minimum distance authorized for a boat or a professional fishing device (25%), minimum catch sizes and protected species, the prohibited catching of crustaceans (30%), the prohibition of the use of compressed air spear guns (50%) and the compulsory use of a fishing buoy (57%). The catching of a protected crustacean *Scyllarides latus* (Decree of November 22nd, 1992) was observed.

Locating fish from a boat is quite common (in approximately 10% of cases): one spear fisherman steers the boat while the other keeps his head under water. This practice makes it possible to increase both the duration of the fishing outings and the probability of finding fish. There is no legislation regarding this practice, although it should perhaps be banned.

The mean number of individuals caught per fisherman per hour (catch per unit effort, CPUE) is between 1 and 3. The CPUE value is significantly greater at week-ends than on week-days (Mann-Whitney U test; $\alpha = 0.02$) and during low season than during high season ($\alpha = 0.02$) (**Table I**). Conversely, the caught biomass per fisherman per hour (CPUE), and the mean duration of a spear fishing outing (2 h 35 min) do not significantly differ with the days or the season.

Table I. Catch per unit effort (CPUE) in terms of numbers of individuals and wet weight (biomass) as well as the mean duration of a spear fishing outing. () = standard deviation.

	Period	CPUE (number of individuals/fisherman/h)	CPUE (biomass in g/fisherman/h)	Mean duration of a spear fishing outing (min)
Week-day	Low season	2 (6)	1 962 (2 270)	113 (60)
	High season	1 (1)	1 257 (2 853)	153 (68)
Week-end	Low season	3 (3)	974 (625)	185 (101)
	High season	2 (2)	1 358 (1 383)	193 (78)

In number of individuals (Table II), the most caught species or groups of species are cephalopods (*Octopus vulgaris*: 16%), Labridae (especially *Symphodus tinca*: 28%), black scorpion fish *Scorpaena porcus* (20%) and Sparidae (12%, mainly *Boops boops* and *Diplodus annularis*). In biomass (**Table II**), the catches mostly consist of cephalopods (51%) followed by the Labridae (8%); catches of *Mustelus mustelus* are to be regarded as incidental.

Table II. Amount (expressed as a percentage) of cephalopod and fish species in the catches. + = < 1%. The five most abundant taxa are in bold-type. Not taking into consideration *Mustelus mustelus* (see text) would accentuate the cephalopod dominance.

Species	Number of individuals (%)	Biomass (%)
Cephalopods		
Octopus vulgaris	**15**	**28**
Sepia officinalis	6	**23**
Fishes		
Boops boops	3	+
Conger conger	1	2
Dentex dentex	1	2
Diplodus annularis	5	+
Diplodus puntazzo	1	+
Diplodus sargus	1	+
Gobius sp.	+	+
Labrus merula	+	+
Labrus viridis	3	3
Mullus surmuletus	3	+
Mustelus mustelus	+	**25**
Muraena helena	1	1
Sarpa salpa	1	+
Scorpaena porcus	**19**	4
Seriola dumerili	1	4
Serranus scriba	5	1
Symphodus tinca	**27**	5
Synodus saurus	+	+

The total catches (in terms of biomass but especially in terms of the number of individuals) are higher in low season than in high season (Table III). During the study period (May to August), spear fishermen caught 1 330 kg (wet weight; confidence interval: 650-2 000; a = 5%) It would clearly be hazardous to try to extrapolate a yearly value[2] from our results which cover only the months from May to August. By assuming that the values obtained for the low season can be applied to the months of April, September, October and November and by considering underwater spear fishing activity to be nil from December to March (which is probably an underestimate), the total annual catches would be in the order of 5 100 individuals and 3 050 kg. This would represent a biomass of 1.3 t/km^2/year if we consider the 2.4 km^2 surface area which is actually exploited.

Table III. Extrapolation, for the period of May 1 to August 15, of the number of spear fishermen outings, the number of individuals caught and the biomass (wet weight) caught by spear fishermen. week = week-days, w.end = week-end (Saturday and Sunday).

	Fishermen outings			Individuals caught			Biomass caught (kg)		
	week	w.end	total	week	w.end	total	week	w.end	total
Low season	99	159	258	376	1 481	1 857	369	481	850
High season	88	74	162	228	412	640	287	197	484
TOTAL	187	233	420	604	1 893	2 497	656	678	1 334

DISCUSSION

Generally, the spear fishing pressure is greater in the rocky zones than in the *Posidonia oceanica* seagrass beds. This is due to the fact that rocky zones are richer in target fish species than are the seagrass beds (see Francour, 1989, 1992, 1994, among others). In addition, the rocky areas are shallower and thus easier of access from the shore and favour "hole spear fishing" (the technique the most frequently used in the study area). The fact that fishermen are less numerous during the summer (high season) than during low season can be explained by the interaction with pleasure boating activities which are much more frequent during the summer (Chavoin, unpublished results).

As a general rule, species diversity of the fish in the study area is low. The reason for this seems to be overexploitation by professional fisheries but also the high levels of *Posidonia oceanica* bottom cover which reduces habitat diversity (J.G. Harmelin, pers. comm.). In another region of the French Riviera (between Cap Lardier and Cap Camarat), where habitat diversity is higher, the number of fish species (in particular target species) is indeed greater (S. Sartoretto, pers. comm.).

The spear fishermen at the site studied are, for the most part, true amateurs which is in contrast with other areas of the Mediterranean where some spear fishermen are semi-professional and sell their fish (which is illegal). In addition, their level of technical skill is somewhat limited. This fact, together with the poorness in fish of the area, helps to explain why catches are mostly made up of the octopus *Octopus vulgaris* and of the black scorpion fish *Scorpaena porcus,* a relatively common prey which is easy to catch. In underwater spear fishing competitions, cephalopods and crustaceans are forbidden and fish weighing under 300 g are not taken into consideration[3]. Conversely, the moray eel *Muraena helena* and the European conger *Conger conger* are authorised despite the fact that these species are relatively easy to catch (S. Ruitton, pers. comm.). The low catch levels for the latter species in the present study (Tables II and IV) can be explained by their scarcity in the region studied. In Italy, at the end of the 1970s, the brown grouper *Epinephelus marginatus* represented 25% of all catches while the Sparidae *Diplodus sargus, D. vulgaris* and *D. puntazzo* also made up 25% of catches (Battiato, 1981). It is assumed that the importance of these species in today's catches has greatly decreased.

If we compare the results of the present study with those from a spear fishing competition, and if we eliminate the octopus data from our results, since catching them is forbidden in competitions (Table IV), then we observe that the mean biomass caught per fisherman and per day is substantially lower. Furthermore, for the competition examined, the mean mass caught per fisherman hides huge differences between good spear fishermen who caught between 10 and 30 kg/day and poorer fishermen (over one quarter of the fishermen) did not catch anything (S. Ruitton, pers. comm.).

Table IV. Comparison between the mean quantities fished at the study site (May to August, 1996) and during a spear fishing competition at Marseilles (two days in June, 1997). The corrected biomass (the last column) corresponds to the elimination of cephalopods from the gross biomass caught (previous columns).

Type of fishing	Number of catches per fisherman per day	Species most often caught	Biomass caught per fisherman per day (kg)	Main species caught in terms of biomass (kg)	Biomass caught per fisherman per day, corrected (kg)
Recreational (present study)	4	*Octopus* and Labridae	3.1	*Octopus* (28%) *Sepia* (23%) *Mustelus* (25%)	1.5
Competition	4	Labridae, *Conger*, *Diplodus*, Mugilidae, *Phycis*	6.8	*Conger* (71%) *Muraena* (12%)	6.8

In Italy, the number of spear fishermen at the end of the 1970s was estimated at 249 000 (15% of which used SCUBA). The tonnage landed was estimated to be in the order of 824 t/year (Cinelli and Fresi, 1979; Battiato, 1981). A few data values are also available for recreational angling. In the Port-Cros National Park (Var, France), Combelles (1991) assessed these catches as representing 10t/year (Table V). If we consider the surface area of the park, these catches are in the order of 0.6 t/km²/year, which is less than the estimates that we propose for the spear fishing catches in the study area (1.3 t/km²/year). In the Var (which represents 362 km of coastline[4]), professional fishing catches (fish, cephalopods and crustaceans) vary around 1 000 t (Charmoille-Durand and Ponzio, 1992[5]). If we consider that our estimates are based on only 7.5 km of coast, that the site studied has low frequentation levels and that angling catches should also be taken into consideration (fishing from the shore or from a boat), it would appear that recreational fishing is far from negligible as compared to the professional fishing industry.

Table V. Estimates of fish catches by recreational angling (expressed in metric tons of wet weight/year) from a boat and from the shore in the Port-Cros National Park (from Combelles, 1991). It should be noted that spear fishing is prohibited in Port-Cros and that, since this study, recreational angling has also been banned.

	Fishing from a boat	Fishing from shore	Total
High season (3 months)	2.0	1.5	3.5
Low season (9 months)	3.5	3.0	6.5
Total	5.5	4.5	10.0

Outside the Mediterranean, several studies have examined spear fishing (Bohnsack, 1983; Johnson, 1985a, 1985b; Jennings and Polunin, 1995). Their objectives, however, were different and they thus cannot serve for comparison with our results. Nevertheless it is interesting to note that in Australian spear fishing competitions, mean catches range from 0.6 to 1.7 fish/fisherman/h (Johnson, 1985a, 1985b).

In hermaphrodite species (protogynous or protandrous), the overexploitation of ichthyological resources can lead to the disappearance of breeding stocks and to an increase of the relative amount of juveniles in the population concerned (Frontier and Pichod-Vialle, 1991). This phenomenon has been observed by anglers for the Labridae and in particular for the rainbow wrasse *Coris julis* (Chavoin, unpublished results). On the basis of observations made by the spear fishermen questioned, it would appear that the species usually sought after have become scarcer and that the size of caught individuals has decreased over the last fifteen years. The decline in the European conger *Conger conger* populations has been observed over the last ten years.

The regulations concerning spear fishing seem to be poorly known. However, we recorded only one catch of the Mediterranean locust lobster *Scyllarides latus* and no catches of the brown grouper *Epinephelus marginatus* for which spear fishing is prohibited (Decree of the Préfet de la Région Provence-Alpes-Côte d'Azur, April 2nd, 1993).

CONCLUSIONS

The aim of the present study was to propose a method for qualitative and quantitative assessing of spear fishing, rather than to provide representative results adaptable for large scale extrapolation. Our results concern only one part of the year. Furthermore, a substantially larger sampling effort would be required in order to take into consideration rare catches. As a result, these results are to be considered with caution.

Despite the relatively low frequentation levels occurring at the study site, it would appear that underwater spear fishing catches (1.3 t/km²/year) are not negligible as compared to those of the professional fishing industry, especially within the context of resource overexploitation. In addition, spear fishing represents only a fraction of recreational fishing catches: it is necessary to add angling catches (fishing from a boat or from the shore). It is evident that the spear fishing catches in areas attracting a greater number of tourists, or in areas exploited by semi-professional spear fishermen, will generate catch levels per km² or per kilometre of coastline which are greater than those presented here.

Knowledge of the existing regulations for spear fishing seems rather limited both from a technical and a species preservation point of view. A publicity policy is therefore necessary. In addition, the enforcement of these regulations calls for greater efficiency on the part of the surveillance authorities at sea (Affaires maritimes and Coast Guard): in 46 days spent at sea, no representatives of these authorities was seen.

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REFERENCES

BATTIATO A., 1981.- Nota preliminare sulle specie oggetto di caccia subacquea e sulla influenza della stessa sulla produzione ittica nazionale. *Thalassia salentina*, Ital., 11: 1-10.

BOHNSACK J.A., 1983.- Resiliency of reef population after a spearfishing ban at Looe Key National Marine Sanctuary: progress report. *Proc. Assoc. Isl. Mar. Lab. Caribb.*, 17: 24.

CADDY J.F., 1990.- Tendances récentes des pêches méditerranéennes. *Etudes Revues Cons. gén. Pêches Médit.*, 63: 1-53.

CHARMOILLE-DURAND A., PONZIO F., 1992.- *Données économiques et sociales Provence - Alpes - Côte d'Azur. Edition 1993.* INSEE publ., Fr.: 1-232.

CHARPENTIER C., GLASS B., KUZUCUOGLU C., LOCQ C., CHATAIN C., 1995.- *L'environnement méditerranéen; contribution française.* Minstère de l'Environnement publ., Fr.: 1-214.

CINELLI F., FRESI E., 1979.- Contributo alla valutazione dell'effettiva incidenza della pesca subacquea sul patrimonio biologico delle acque costiere italiane. In: *Atti XI Congresso SIBM*, Ital.: 330-338.

COMBELLES S., 1991.- *Pêche amateur dans les eaux du Parc National de Port-Cros.* Parc National de Port-Cros publ., Hyères, Fr.: 1-63.

DOREL D., 1986.- *Poissons de l'Atlantique Nord-Est. Relations taille-poids.* IFREMER, Direction des Ressources vivantes publ., Fr.: 1-185.

FRANCOUR P., 1989.- Les peuplements ichtyologiques de la Réserve de Scandola: influence de la réserve intégrale. *Trav. sci. Parc nat. rég. Rés. nat. Corse*, Fr., 21: 33-93.

FRANCOUR P., 1990.- *Dynamique de l'écosystème à Posidonia oceanica dans le Parc National de Port-Cros. Analyse des compartiments matte, litière, faune vagile, échinodermes et poisson.* Thèse Doctorat Océanol. Univ. Paris 6, Fr.: 1-373.

FRANCOUR P., 1992.- Ichtyofaune de la Réserve Naturelle de Scandola (Corse, Méditerranée nord-occidentale). Analyse pluriannuelle de l'effet réserve. *MEDPAN News*, Actes du Colloque d'Ajaccio, 3: 3-9.

FRANCOUR P., 1994.- Pluriannual analysis of the reserve effect on ichtyofauna in the Scandola natural reserve (Corsica, northwestern Mediterranean). *Oceanologica Acta*, 17 (3): 309-317.

FRONTIER S., PICHOD-VIALLE D., 1991.- *Ecosystèmes, structure, fonctionnement, évolution.* Masson publ., Fr.: 1-392.

GRIFFITHS R.C., 1996.- Etat du milieu marin et littoral de la région méditerranéenne. *MAP techn. Rep. Ser.*, Athens, Greece, 101: 1-149.

GUERRA A., MANRIQUEZ M., 1980.- Parámetros biométricos de *Octopus vulgaris*. *Inst. invest. pesq.* Barcelona, 44 (1): 177-198.

JENNINGS S., POLUNIN N.B.C., 1995.- Relationships between catch and effort in Fijian multispecies reef fisheries subject to different levels of exploitation. *Fish. Managem. Ecol.*, 2 (2): 89-101.

JOHNSON J.E., 1985a.- Spearfishing competitions in South Australia (1983/84). 1. Shore and boat events. *Fish. Res. Pap. Dep. Fish. South Austr.*, 12: 1-17.

JOHNSON J.E., 1985b.- Spearfishing competitions in South Australia (1983/84). 2. Australian skindiving convention. *Fish. Res. Pap. Dep. Fish. South Austr.*, 14: 1-15.

LOPEZ-CAPONT F., 1977.- Muestreo de conservas y control de qualidad. S. Pulpo (*Octopus vulgaris*) en aceite y salsa. *Rev. Agroquim. Tecnol. aliment.*, 17 (3): 325-333.

MAXIM C., 1982.- Structure du peuplement d'*Octopus vulgaris* Cuvier de la zone de l'Atlantique Est central (20° 46' - 19° 36' N). - *Cercet. mar., Rech. mar.*, 15: 133-139.

MEINESZ A., ASTIER J.M., LEFEVRE J.R., 1981-. Impact de l'aménagement du domaine maritime sur l'étage infralittoral du Var, France (Méditerranée occidentale). *Ann. Inst. océanogr.*, 57 (2): 65-77.

MINICONI R., 1994.- *Les poissons et la pêche en Méditerranée. La Corse.* Editions Alain Piazzola and La Marge, Fr.: 1-505.

REY H., 1996-. Pêches méditerranéennes: de l'économie informelle à la norme communautaire. *Terres marines*, Marseille, Fr., 11: 4-9.

RODRIGUEZ J., 1982.- *Oceanografía del mar Mediterráneo.* Pirámide publ., Madrid: 1-174.

STAMATOPOULOS C., 1993.- Trends in catches and landings - Mediterranean and Black Sea fisheries: 1972-1991. *FAO Fisheries Circular*, 855.4, FAO, Rome: 1-177.

[1] Spear fishing by night is prohibited.

[2] Outside MPAs (Marine Protected Areas), the spear fishing is authorized year-round in France.

[3] During an European underwater spear fishing competition held at Marseilles (June 1997), speared fishes weighing less than 300 g amounted for 5% of total catches (S. Ruitton, pers. comm.).

[4] Measured from 1/25 000° to 1/14 000° scale maps (Meinesz *et al.*, 1981).

[5] Data dealing with the year 1991.