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BIOLOGY AND FISHERY OF DOLPHINFISH AND RELATED SPECIES. *E. MASSUTÍ and B. MORALES-NIN (eds.)*

Fish fauna associated with floating objects sampled by experimental and commercial purse nets*

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SUMMARY: Based on the commercial surrounding nets traditionally used in the *Coryphaena hippurus* fishery, we designed an experimental purse seine (64 m long and 14 m high, with a purse line and a central codend of 2 mm mesh) for sampling fish fauna associated with flotsam. Taxa, number, biomass and sizes of fishes caught with both types of gear around fish aggregation devices were compared. From 63 hauls with the experimental net, we caught 11370 fishes belonging to 17 families and 26 species. In contrast, 816 fishes belonging to 7 species and 5 families were collected from 39 commercial hauls. Despite differences in number of hauls for each net, the curves of cumulative species richness showed that additional hauls could not increase the number of species collected with the commercial net. The most abundant species from experimental net catches were *Trachurus picturatus*, which represented over 80% of the specimens caught in spring and summer, *Naucrates ductor,* which represented about 50% of autumn catches, both in terms of abundance and biomass, and *Seriola dumerili,* which represented 46% and 21% of the samples taken in summer and autumn respectively. *Seriola dumeril* was also frequent in commercial net catches, in which *T. picturatus* did not appear, while *Coryphaena hippurus* and *N. ductor* represented more than 85% of both abundance and biomass. Large differences between the two types of net were also obtained in the mean fish weight and length frequency distributions of the catches by season. Fish caught with the experimental net ranged from 6 to 570 mm length, while fish collected from commercial hauls had a size range of 35 to 700 mm. The effectiveness of the experimental net in catching small fishes showed that it can be an optimal sampling method not only in the study of fish fauna associated with flotsam, but also in studies to catch early life stages.

Key words: FADs, fishes, sampling, purse seine, Balearic Islands, western Mediterranean.

INTRODUCTION

The addition of structures to the pelagic environment affects the spatial distribution of some species, enhancing the formation of fish schools (Hunter and Mitchell, 1967). The aggregation behaviour of fishes under floating objects is a well-known phenomenon which has been used for a long time to concentrate fish for harvest in artisanal fisheries for oceanic pelagic species (Sacchi, 1986). More recently, floating objects have been introduced into industrial fisheries for tropical tuna (Caddy and Majkowski, 1996). It is considered to be one of the significant fishery developments in recent years for enhancing recreational and commercial offshore fisheries (e.g. Feingenbaum *et al*., 1989; Buckley *et al*., 1989).

To explain the possible causes of aggregation, numerous authors have studied this behaviour by different techniques, such as direct observation (e.g. Rountree, 1989, 1990; Ibrahim *et al*., 1990) and experimental fishing (e.g. Wickham *et al*., 1973; Brock, 1985; Safran and Omori, 1990; Kingsford,

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1992; Druce and Kingsford, 1995; Laegdsgaard and Johnson, 1995). These studies have discussed the importance of several factors (protection, recruitment, predation) that explain the formation of these associations and influence the specific composition of this community. The association of fishes with flotsam also depends on oceanographic features such as fronts which influence the spatial distribution of fish as well as the composition of fish assemblages (Kingsford, 1993). According to this author, the lack of understanding of the importance of structures for fishes in the pelagic environment is partly due to the fact that most studies only deal with adult fish, probably because the sampling methods used do not collect the young stages. The majority of life forms that have been found associated with biotic and abiotic structures are postflexion larvae and juvenile fishes. Size, morphology and behaviour of larval and pelagic juveniles vary greatly (Moser, 1981), making representative sampling problematical. Thus, in studies on fishes associated with floating objects, sampling methods other than towed nets, such as purse seine nets (Kingsford and Choat, 1985), are necessary to provide better estimates of the abundance of young stages.

Although there are traditional small-scale fisheries of *Coryphaena hippurus* in the Mediterranean that use surrounding nets around fish aggregation devices (FADs) (Massutí and Morales-Nin, 1995), there are scarce data on fish assemblage associated with flotsam in this area. The only available studies are based on visual censuses in the Ligurian Sea (Relini *et al.*, 1994), and on data from the commercial fishery off Majorca (Reñones and Massutí, 1994). The aim of this paper is to describe an experimental purse seine net and compare its catch efficiency with that of the surrounding nets used in the commercial *C. hippurus* fishery. The experimental net was designed to develop an effective sampling technique to assess and monitor the fish fauna associated with fish aggregation devices. Herein we compare the taxa, number, biomass and size of the fish caught by the experimental gear and a standard commercial net.

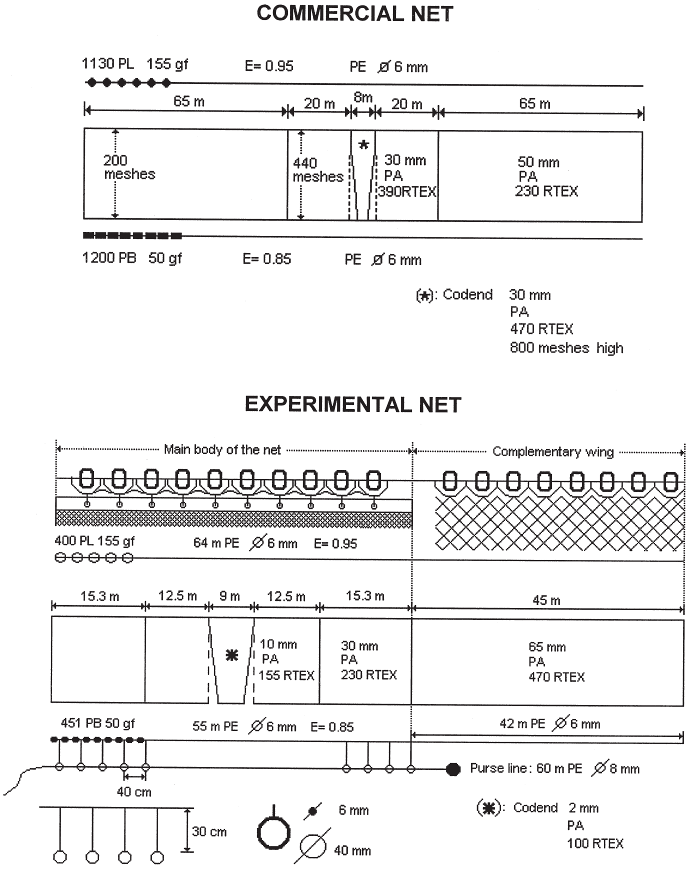

FIG. 1. – The design of commercial surrounding nets used in the *Coryphaena hippurus* fishery off the Island of Majorca (western Mediterranean), and experimental purse seine net designed for sampling fish fauna associated with flotsam. [E: hanging ratio; gf: floating and sinking power (100 gf~ 1 newton); PA: polyamide; PB: lead; PE: polyethylene; PL: plastic; RTEX: tickness of netting; Ø: diameter]

MATERIAL AND METHODS

Design of nets

The design of the experimental net was based on the commercial net used in the *Coryphaena hippurus* fishery off the island of Majorca. The dimensions of the net and the mesh size were chosen to capture the widest possible variety of post-larval and pelagic juvenile fishes.

The commercial gear used for comparative purposes was a surrounding net without a purse line, which was not very deep and almost rectangular (Fig. 1). The design of the net, with a central codend (30 mm mesh) in the form of a spoon and two lateral wings (50 mm mesh), made it possible to retain the shoal of fish when the two wings were hauled from the boat simultaneously. The net was 180 m long and 16 m high. Based on these measurements, it sampled about $46{\cdot}10^3$ m^3 of seawater.

The experimental net was also a surrounding net with a purse line, a central codend (2 mm mesh), and lateral wings composed of two different mesh nettings (10 and 30 mm) (Fig. 1). The net was 64 m long and 14 m high. To allow the boat to encircle the FAD and retrieve the sea anchor, a complementary wing 45 m long with a 65 mm mesh was attached between the sea anchor and the main body of the net. This seine net enclosed a maximum volume of seawater of about $13{\cdot}10^3$ m^3, and was thus approximately one third of the size of the commercial net.

Sampling area and sampling strategy

The sampling was carried out on the traditional fishing grounds for *C. hippurus*, off the east coast of Majorca (Balearic Islands, western Mediterranean), in oceanic waters over the continental slope 4 to 11 nautical miles off the coast, where the depth was 100 to 1000 m. The FADs used in this study were similar to those used in the commercial fishery, described by Massutí and Morales-Nin (1991). We deployed up to 25 FADs in the sampling area, although their number varied during the sampling period due to the relatively short life span of these structures.

The experimental hauls were carried out at dawn, when fish abundance under the FADs seems to be maximal, fortnightly from May 1995 to February 1997, weather permitting, using a commercial fishing vessel 11 m long with a hydraulic winch to haul the net. 83 experimental hauls were performed on 34 sampling dates. Data on the commercial catches (54 hauls from 17 fishing trips taken between August and December 1995 and 1996) were also collected from the same boat during the monitoring of the *C. hippurus* fishery in Portocolom harbour. The catches were sorted and identified to the most precise taxonomic level possible. Abundance and biomass were determined, and the lengths (total length TL or fork length FL depending on species) were measured.

Data analysis

Purse seines are difficult to operate in any but the best sea and weather conditions. For this reason, hauls made with both the experimental and the commercial net during unfavourable wind and current conditions, when the net did not deploy correctly, were not included in the analysis. Data from valid hauls by season are shown in Table 1. Abundance, biomass, percentage of the total catch and length frequency distribution were determined by gear and season. Species richness and mean fish weight were also calculated. Because FADs aggregate fish from an unknown volume and most species associated with them school and are patchily distributed under the FADs, we could not calculate absolute abundance and biomass. To compare the efficiency of capture between the experimental and the commercial net, we used the

TABLE 1. – Number of valid hauls, total catch (number and weight), mean catch per haul (parentheses) and number of specimens measured by season for the experimental (EXP) and commercial (COM) net.

Season	Number of hauls		Catch in number		Catch in grammes		Specimens measured	
	EXP	COM	EXP	COM	EXP	COM	EXP	COM
Spring	13	0	3213		25265 (2105)		1873	
Summer	28	11	7626	281	100426 (3586)	63706 (7788)	2967	281
Autumn	20	28	478	535	159256 (7963)	255904 (10286)	477	499
Winter	2	0	53		15976 (7988)		53	
Total	63	39	11370	816	300925	319610	5370	780

TABLE 2. – Number (n), weight (g) and frequency of appearance (f) of fishes captured with experimental (EXP) and commercial (COM) surrounding nets around fish aggregation devices off Majorca Island (western Mediterranean).

Family	Species	EXP n	 g	 f	COM n	 g	 f
Clupeidae	*Sardinella aurita*	89	2.57	9.5	0	0.00	0.0
Engraulidae	*Engraulis encrasicholus*	3	0.12	1.6	0	0.00	0.0
Myctophidae	*Ceratoscopelus maderensis*	1	0.02	1.6	0	0.00	0.0
Scomberesocidae	*Scomberesox saurus*	2	36.75	3.2	0	0.00	0.0
Macroramphosidae	*Macroramphosus scolopax*	6	5.74	4.8	0	0.00	0.0
Serranidae	*Polyprion americanus*	12	7419.43	17.5	2	2100.00	5.1
Carangidae	*Naucrates ductor*	529	117180.57	31.7	278	70676.48	30.8
	Seriola dumerili	368	16194.84	27.0	64	8185.81	25.6
	Trachurus sp.	4	0.10	3.2	0	0.00	0.0
	Trachurus mediterraneus	104	338.61	11.1	25	45.83	2.6
	Trachurus picturatus	9865	69343.48	36.5	0	0.00	0.0
	Trachurus trachurus	117	430.09	12.7	0	0.00	0.0
Coryphaenidae	*Coryphaena hippurus*	109	75259.63	9.5	431	238077.30	76.9
Mullidae	*Mullus* sp.	66	76.10	14.3	0	0.00	0.0
Sparidae	*Pagellus bogaraveo*	1	0.16	1.6	0	0.00	0.0
Centracanthidae	*Centracanthus cirrus*	34	8.20	12.7	1	0.80	2.6
Pomacentridae	*Chromis chromis*	1	0.04	1.6	0	0.00	0.0
Scombridae	*Auxis rochei*	8	0.15	3.2	0	0.00	0.0
	Scomber scombrus	1	2.77	1.6	0	0.00	0.0
	Thunnus alalunga	8	0.09	4.8	0	0.00	0.0
Blennidae	*Parablennius*	1	0.11	1.6	0	0.00	0.0
	Parablennius tentacularis	7	0.14	4.8	0	0.00	0.0
	Scartella cristata	1	0.07	1.6	0	0.00	0.0
Centrolophidae	*Centrolophus niger*	9	1649.60	3.2	0	0.00	0.0
	Schedophilus ovalis	9	11607.30	7.9	0	0.00	0.0
Mugilidae	Mugilidae gn. sp.	2	0.07	3.2	0	0.00	0.0
Balistidae	*Balistes carolinensis*	13	1368.43	11.1	15	523.30	5.1

TABLE 3. – Species representing more than 0.5% of the total catch by type of net and season. The abundance and biomass are expressed as a percentage of the total for each season, and the frequency of occurrence (f) as the number of hauls in which the species was caught in relation to the number of samples analysed in each season.

Season	Experimental net Abundance	%	f	Biomass	%	f	Commercial net Abundance	%	f	Biomass	%	f
Spring	*Trachurus picturatus*	95.4	61.5	*Trachurus picturatus*	83.6	61.5						
	Trachurus trachurus	3.5	38.5	*Centrolopus niger*	6.5	15.3						
	Mullus sp.	0.6	30.8	*Schedophilus ovalis*	5.2	7.7						
				Trachurus trachurus	1.7	38.5						
				Balistes carolinensis	1.6	15.4						
				Polyprion americanus	1.3	7.7						
Summer	*Trachurus picturatus*	89.2	53.6	*Trachurus picturatus*	48.0	53.6	*Naucrates ductor*	48.0	27.3	*Coryphaena hippurus*	46.2	54.5
	Seriola dumerili	4.6	46.4	*Naucrates ductor*	22.7	17.9	*Coryphaena hippurus*	35.9	54.5	*Naucrates ductor*	43.5	27.3
	Naucrates ductor	2.4	17.9	*Seriola dumerili*	12.9	46.4	*Seriola dumerili*	15.3	36.4	*Seriola dumerili*	7.1	36.4
	Trachurus mediterraneus	1.4	21.4	*Schedophilus ovalis*	8.6	10.7	*Polyprion americanus*	0.7	18.2	*Polyprion americanus*	3.3	18.2
	Sardinella aurita	1.1	17.9	*Polyprion americanus*	7.1	35.7						
	Mullus sp.	0.7	17.9									
Autumn	*Naucrates ductor*	61.7	65.0	*Naucrates ductor*	49.3	65.0	*Coryphaena hippurus*	61.7	85.7	*Coryphaena hippurus*	81.5	85.7
	Coryphaena hippurus	22.8	30.0	*Coryphaena hippurus*	47.3	30.0	*Naucrates ductor*	26.7	32.1	*Naucrates ductor*	16.8	32.1
	Centracanthus cirrus	7.1	40.0	*Seriola dumerili*	2.1	20.0	*Trachurus mediterraneus*	4.7	3.6	*Seriola dumerili*	1.4	21.4
	Seriola dumerili	2.9	20.0	*Schedophilus ovalis*	1.1	5.0	*Seriola dumerili*	3.9	21.4			
	Balistes carolinensis	1.9	15.0				*Balistes carolinensis*	2.8	7.1			
	Parablennius tentacularis	1.3	10.0									
	Sardinella aurita	0.6	5.0									
Winter	*Naucrates ductor*	100	100	*Naucrates ductor*	100	100						

number and biomass per haul of the most abundant species caught by both gears.

To test the reliability of the species richness estimates, cumulative curves were constructed as proposed by Blondel (1979). Because normality assumptions were not met, we used the non-parametric Mann-Whitney statistic and the Friedman's test to test differences in mean fish weight and catch

TABLE 4. – Species richness and mean fish weight (±standard error) by season and type of net (EXP: experimental net; COM: commercial net).

Season	Species richness EXP	Species richness COM	Mean fish weight (g) EXP	Mean fish weight (g) COM
Spring	10		28.7 (±21.5)	
Summer	19	4	82.1 (±35.5)	309.4 (±58.2)
Atumun	14	6	264.7 (±63.9)	510.2 (±51.2)
Winter	1		301.5 (±0.1)	

per haul for both gears respectively. Length distributions were compared in pair-wise Kolmogorov-Smirnov two-sample test (Zar, 1996).

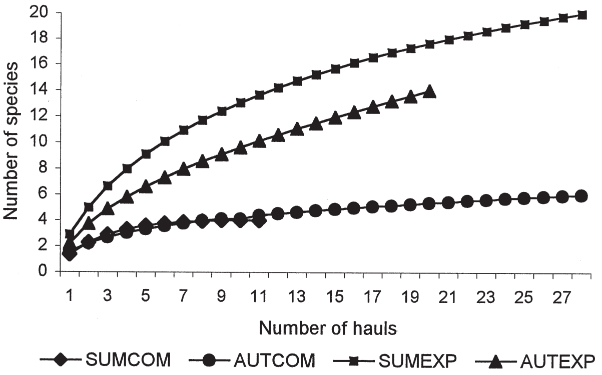

FIG. 2. – Curves of cumulative species richness by gear (COM: commercial net; EXP: experimental net) and season (SUM: summer; AUT: autumn).

RESULTS

From the 63 valid hauls with the experimental net, a total of 11370 fishes weighing 300925 g were caught (Table 1). These individuals belonged to 17 families and 26 species (Table 2). The most frequently caught species were *Trachurus picturatus*, *Naucrates ductor* and *Seriola dumerili*, which appeared in 36, 32 and 27% of the hauls respectively. These species represented 95% of the specimens caught and 67% of the biomass. *Coryphaena hippurus*, *Schedophilus ovalis* and *Polyprion americanus* were also important in terms of biomass, representing 31% of the total catch.

A total of 816 fishes belonging to 7 species and 5 families were collected with the commercial net, resulting in 319610 g of fish in 39 valid hauls (Tables 1 and 2). The most frequently caught species were *C. hippurus*, *N. ductor* and *S. dumerili*, which appeared in 77, 31 and 26% of the hauls respectively. Both in terms of abundance and biomass, *C. hippurus* and *N. ductor* represented more than 85% of the catch.

TABLE 5. – Size ranges of the species captured with experimental and commercial surrounding nets. Mean length (TL: total length; FL: fork length) and standard deviation values (parentheses) are also given.

Species	Experimental net Range (mm)	Experimental net Mean	Experimental net n	Commercial net Range (mm)	Commercial net Mean	Commercial net n
Sardinella aurita	13-22 TL	16 (2.4)	89			
Engraulis encrasicholus	16-29 TL	22 (5.3)	3			
Ceratoscopelus maderensis	11.4 TL	-	1			
Scomberesox saurus	28.2-260 TL	-	2			
Macroramphosus scolopax	48.5-69 TL	53 (7.2)	6			
Polyprion americanus	258-342 TL	295 (25.7)	12	235-370 TL	-	2
Naucrates ductor	7.4-308 FL	230 (43.1)	501	170-295 FL	242 (23.5)	278
Seriola dumerili	43-286 FL	121 (46.6)	172	150-260 FL	193 (20.8)	64
Trachurus sp.	9-16 TL	12 (2.9)	4			
Trachurus mediterraneus	35-98 FL	60 (13.1)	104	35-70 FL	52 (9.4)	25
Trachurus picturatus	40-135 FL	82 (20.2)	4158			
Trachurus trachurus	39-98 FL	64 (11.2)	68			
Coryphaena hippurus	360-570 FL	470 (40.5)	109	210-700 FL	387 (85.7)	395
Mullus sp.	9-60 TL	42 (15.6)	47			
Pagellus bogaraveo	22.5 TL	-	1			
Centracanthus cirrus	6-59.5 TL	18 (15.8)	34	55 TL	-	1
Chromis chromis	12.9 TL	-	1			
Auxis rochei	8-10 TL	9 (0.9)	8			
Scomber scombrus	74 TL	-	1			
Thunnus alalunga	9-15 TL	12 (2.3)	8			
Parablennius sanguinolentus	27 TL	-	1			
Parablennius tentacularis	9.5-19.2 TL	15 (2.7)	7			
Scartella cristata	17.2 TL	-	1			
Centrolophus niger	220-310 TL	262 (27.8)	9			
Schedophilus ovalis	358-499 TL	423 (37.2)	9			
Mugilidae gn. sp.	8.7-19 TL	-	2			
Balistes carolinensis	78-228 TL	147 (43.5)	13	45-144 TL	97 (29.2)	15

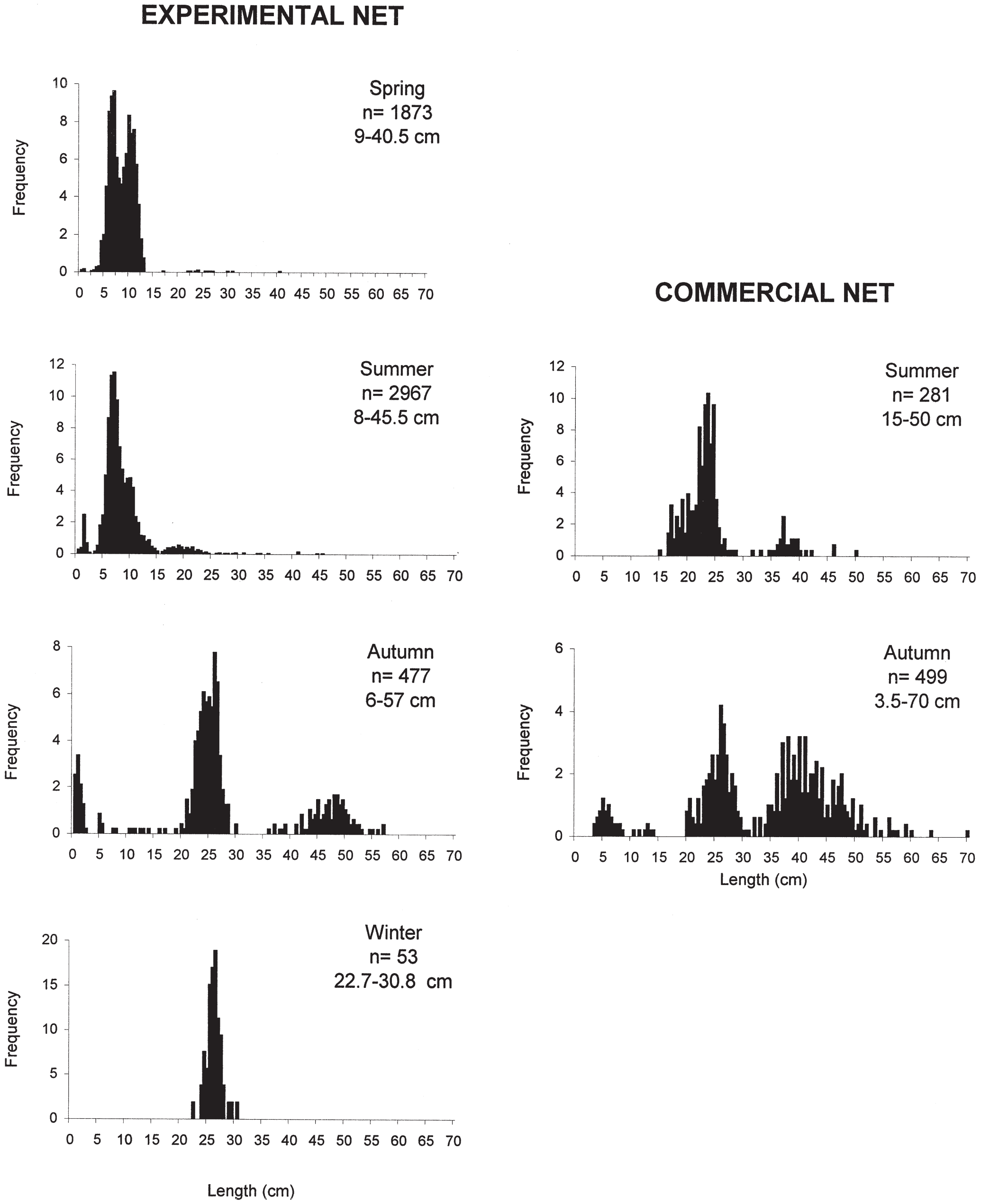

FIG. 3. – Seasonal length frequency distribution of all fishes captured with experimental and commercial nets. Number of specimens measured and length range are shown.

The seasonal specific composition showed differences by gear and season (Table 3). More than 80% of the catch from the experimental net in spring, both in terms of abundance and biomass, consisted of *T. picturatus*. This species was also the most abundant species from summer catches with this gear. Nevertheless, *T. picturatus* was not caught with the commercial net, and *N. ductor*, *C. hippurus* and *S. dumerili* (three species not caught in spring) represented more than 95% of the catch with this gear in summer. By contrast, in this season, *C. hippurus* did not appear in the experimental net catches, and *N. ductor* and *S. dumerili* represented only 7 and 35% in number and biomass respectively. In autumn, *C. hippurus* and *N. ductor* were the most important species caught by both gears, with more than 80% in terms of abundance and biomass.

Species diversity of fish assemblages and average weight caught also varied by gear and season (Table 4). The species richness resulting from the experimental net catches was higher than that from the commercial net. From the curves of cumulative species richness (Fig. 2), it seems

TABLE 6. – Length distribution (FL: fork length) by season for *Naucrates ductor*, *Seriola dumerili* and *Coryphaena hippurus* captured with experimental (EXP) and commercial (COM) nets under fish aggregation devices. Standard deviations are in parentheses.

Species	Season	EXP			COM		
		n	Range (cm FL)	Mean	n	Range (cm FL)	Mean
N. ductor	Summer	154	3.5-24.5	18.6 (4.4)	135	17-26.5	22.6 (1.7)
	Autumn	284	19-30	24.8 (2.4)	143	20-29.5	25.7 (1.8)
	Winter	53	22.5-30.5	26.2 (1.4)			
S. dumerili	Summer	158	4-19.5	11.1 (3.3)	43	15-21	18.2 (1.3)
	Autumn	14	20-28.5	23.3 (2.3)	21	20-26	21.6 (1.4)
C. hippurus	Summer				101	21-50	29.0 (7.2)
	Autumn	109	36-57	47.0 (4.1)	294	25-70	42.0 (6.1)

rather unlikely that additional hauls would increase the number of species collected with the commercial net. However, the mean weight of fish in the experimental net catches was smaller than that from the commercial net (Mann-Whitney test; $p<0.001$).

Similar results were obtained by comparing size caught. Catches from the experimental net ranged between 6 and 570 mm in length, while in the commercial net catches the length range was 35-700 mm (Table 5). The seasonal length frequency distributions by gear (Fig. 3) were significantly different between experimental and commercial net catches, in both summer and autumn (Kolmogorov-Smirnov test; $p<0.001$). The length distribution of the most abundant species caught by both gears (*N. ductor* and *S. dumerili* in summer and autumn, and *C. hippurus* in autumn, Table 6) were also significantly different among gears (Kolmogorov-Smirnov test; $p<0.001$).

Based upon the most abundant species caught by both gears (*N. ductor*, *S. dumerili* and *C. hippurus*), there was no trend between the nets in the number of specimens caught by haul, with values ranging from 1-134 and 1-117 fish/haul from the experimental and the commercial net respectively. There were no signifficant differences in the pooled number of these three species among gears and seasons (Friedman test; $p>0.05$). In summer, the average values were 38±12SE fish/haul from the experimental net and 25±10SE fish/haul from the commercial net, while in autum the average values obtained were 26±8SE and 18±3SE fish/haul respectively (Fig. 4). The values of biomass ranged from $2\text{-}85\cdot10^{3}$ and $460\text{-}25\cdot10^{3}$ g/haul from the experimental and the commercial net respectively. Significant differences in pooled biomass were found among gears in summer, and among seasons in the catch from the experimental net (Friedman test; $p<0.05$). In summer, the average values were $2.5\cdot10^{3}\pm1.1\cdot10^{3}$SE g/haul from the experimental net and $5.6\cdot10^{3}\pm2.3\cdot10^{3}$SE g/haul from the commercial net, while in autumn the average values obtained were $9.8\cdot10^{3}\pm5.2\cdot10^{3}$SE and $9.4\cdot10^{3}\pm1.6\cdot10^{3}$SE g/haul respectively (Fig. 4).

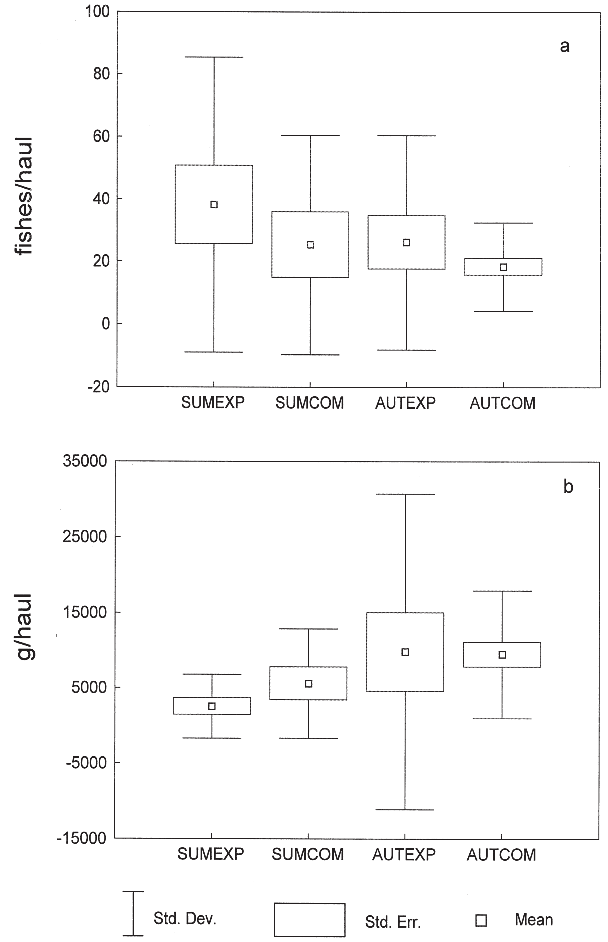

FIG. 4. – Fish abundance (a) and biomass (b) under fish aggregation devices, collected with experimental (EXP) and commercial (COM) net by season (SUM: summer; AUT: autumn). Catch per haul was calculated for the most abundant species captured by both gears: *Naucrates ductor*, *Seriola dumerili* and *Coryphaena hippurus*.

DISCUSSION

The taxonomic and length composition obtained when sampling for pelagic fishes is highly method-dependent. Each sampling method (e.g. towed nets, purse seines, light traps and visual census) has its own set of advantages and disadvantages. All have biases in number, identity and sizes of pelagic fishes collected or observed (e.g. Clarke, 1983; Doherty, 1987; Rountree, 1990; Choat *et al.*, 1993). Although the purse seine net cannot sample deeper than the upper few metres of the water column, it is an effective method for sampling fish fauna associated with flotsam (Kingsford and Choat, 1985), and our results support this conclusion.

In our study, a few families dominated the catch from the two surrounding nets compared and used to sample the fish fauna associated with floating objects, but there were also clear differences between the two types of nets. A high proportion of the species caught in the samples were rare, appearing in only one haul (Table 2), and a strong seasonal variability in the species abundance is shown (Table 3). Not surprisingly given differences in net construction, there were differences in both species composition and the length of fishes in the catches between the two types of nets (Tables 2 and 5). Although of smaller dimensions, the experimental net caught the largest number of families and species, probably due to its purse line closing the bottom of the net, and to the smaller mesh size, which is more effective for catching small fishes. The small mesh size of the codend and the different construction of the main body of the experimental net (from 2 to 65 mm mesh size), allowed capture of a greater size range of fishes (Table 5, Fig. 3). This gear can catch all life stages, such as postflexion larvae (modal length 0.5 and 2 cm), as well as postlarvae and early juveniles between 4 and 14 cm. Larger adults and juveniles from 16 to 28 cm and 36-57 cm were also caught, which were mainly *Naucrates ductor* and *Coryphaena hippurus* respectively. Although small *Trachurus mediterraneus* (3.5 and 7 cm FL) and *Balistes carolinensis* (4.5 and 14 cm TL) were caught in the commercial net, more than 90% of the catches from this gear were adult *N. ductor* and juvenile *Seriola dumerili* and *C. hippurus* (15 and 70 cm FL).

The experimental net revealed a high abundance of small fish under aggregation devices, not only of pelagic species (e.g. genus *Trachurus*, *Sardinella aurita* and *Centracanthus cirrus*) but also of neritic benthic species such as *Mullus* sp. and *Parablennius* spp. The association of early life-history stages of fishes with flotsam has been widely recorded (Rountree, 1990; Safran and Omori, 1990; Kingsford, 1992; Laegdsgaard and Johnson, 1995), although the only available studies on this community in the Mediterranean are from commercial catches (Massutí and Reñones, 1994) and visual censuses (Relini *et al.*, 1994), which did not report clear evidence of this. Moreover, the experimental net was more effective in capturing carangids, such as *Trachurus picturatus*, *Trachurus trachurus* and *T. mediterraneus*, which are species that had been observed under floating objects in previous studies in the area, but which are seldom caught with commercial nets (Massutí and Reñones, 1994). This is probably because the purse line system of the experimental net prevented them from escaping the net by swimming vertically, a behaviour that has been observed in this species. Similarly, the experimental net was better at catching the serranid *Polyprion americanus* and the centrolopids *Schedophilus ovalis* and *Centrolopus niger*, both of which are restricted to the lower layers of the epipelagic zone (Parin, 1970). These species are not well adapted to pelagic life, changing during ontogeny from epipelagic juveniles to mesopelagic (*S. ovalis* and *C. niger*) or benthic (*P. americanus*) adults. They were located at some distance from the FAD, which they apparently use as a substitute substrate or reference point in the uniform offshore environment (Hunter and Mitchell, 1967).

Effectiveness in capturing fish with strong swimming ability concentrated under floating objects (*N. ductor*, *C. hippurus* and *S. dumerili*) was similar for the two nets (Fig. 4). However, mean fish weight for all fishes was greater in the commercial net catches than in the experimental ones (Table 4), suggesting that the commercial net selects larger fish. This might be because the commercial net is adapted to optimize catch of *C. hippurus*, the target species of the fishery. Thus, both fishing gear and technique play important roles in determining the species, and probably the size composition of the catch.

Because the experimental net is effective in capturing small fishes (Table 5), it could be used to capture specimens for studies of the biology of small pelagic fishes. For example, *T. picturatus* was abundant in spring and summer catches, allowing inferences to be made about recruitment patterns, schooling behaviour and growth from modal progression analysis. The samples also contained a size range of other pelagic fishes such as *S. aurita* and *C. cirrus* and the benthic species *Mullus* sp. (commonly exploited with the bottom trawl and purse seine fisheries), which are not caught by these commercial fisheries or by conventional ichthyoplankton nets. Moreover, these small fishes were generally in good condition and could be kept alive and used for experimentation, such as validation of daily ageing. In the same way, fishes that are difficult to capture using other means can be sampled using floating objects (Kingsford, 1993). For example, fishing around these structures with surrounding nets provides a good sample of juvenile stages of *P. americanus*, *C. niger*, *S. ovalis* and *B. carolinensis* (Table 5), which are species with an unknown biology. These are mesopelagic or deep-sea benthic fishes, which were scarce in our study area and difficult to sample due to their avoidance of commercial nets.

In conclusion, this study has shown the effectiveness of surrounding gears for sampling fishes associated with floating objects. The experimental net is an optimal sampling method for pelagic post-larvae and juvenile fishes associated with flotsam, which are difficult to obtain with conventional sampling methods. However, effective sampling with surrounding nets requires favorable sea conditions and operators experienced in this fishing technique.

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