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Crustacean fishery with bottom traps in an area of the southern Tyrrhenian Sea: species composition, abundance and biomass

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Abstract

The north-eastern coast of Sicily is characterized by deep, steep bottoms, not easily exploitable by trawl fishery. In this area few fishermen use bottom traps to catch shrimps and Norway lobsters. Our studies were aimed at identifying the species' composition, abundance and biomass of crustaceans exploitable by bottom traps in this area. Monthly samples over one year were obtained from two lines of 30 baited traps each, at depths between 100 and 500 m. One line was placed in an area usually exploited by this fishery; the other line was used in the unexploited deepest bottoms. Trapped specimens were counted and weighed. ANOVA test, post hoc multiple comparisons and Student's t test were applied on abundance and biomass data, for testing differences between areas, among seasons and species. During 22 fishing days, 23 species characteristic of the bathyal mud assemblage were caught, 8 of which were not considered commercial. Plesionika edwardsii was the most important species, recorded in the whole bathymetric range investigated; Nephrops norvegicus was significantly higher in terms of biomass in the unexploited area. The discard, of slight importance, was mostly represented by the crab Liocarcinus depurator. Spring season yielded the best catches in both areas, showing the highest values for both abundance and biomass

Keywords: Bottom traps; Small scale fishery; Mediterranean; Norway lobster; *Plesionika*; Shrimps.

Introduction

The north-eastern coast of Sicily is characterized by deep steep bottoms, scarcely exploitable by trawl fishery. In this area, the main fishing activity was, until recently, represented by swordfish driftnet fishery; as the European Community legislation clearly forbids such practice, the fleet had to rely on other types of fishing. It became, therefore, necessary to broaden the knowledge of the exploitable resources in those bottoms, which are, to this date, little exploited. Only a few vessels are currently fishing with bottom traps, at a depth of less than 300 m, to catch shrimps (*Plesionika* spp.) and Norway lobsters, *Nephrops norvegicus* (Linnaeus, 1758); this fishery is practised from April to August, which is considered the most productive period. Studies carried out in the Lipari Islands Archipelago (PICCINETTI *et al.*, 1995), in western Sardinia (SECCI *et al.*, 1994) and also in the southern Tyrrhenian Sea (COLLOCA *et al.*, 1998) already showed the high selectivity of bottom traps and encouraging yields, the bulk of the catches consisting of species of high commercial value and with a short life cycle such as *Plesionika* spp.

Our studies were aimed at identifying the species composition, abundance and biomass of crustaceans exploitable by bottom traps and to investigate catch potentiality also at higher depths than those usually exploited by fishermen, in different periods of the year.

Materials and Methods

Description of sites studied

The study area is situated in the Southern Tyrrhenian Sea, off Capo D'Orlando (Fig. 1). The site is characterized by a narrow continental shelf and a very steep slope, with the presence of submarine canyons and valleys (BRAMBATI *et al.*, 1995; TRAMONTANA *et al.*, 1995) which do not allow trawl fishery. Muddy bottoms over 100 m of depth are populated by the characteristic species of the biocoenosis of the bathyal mud (PÉRÈS, 1967, 1985).

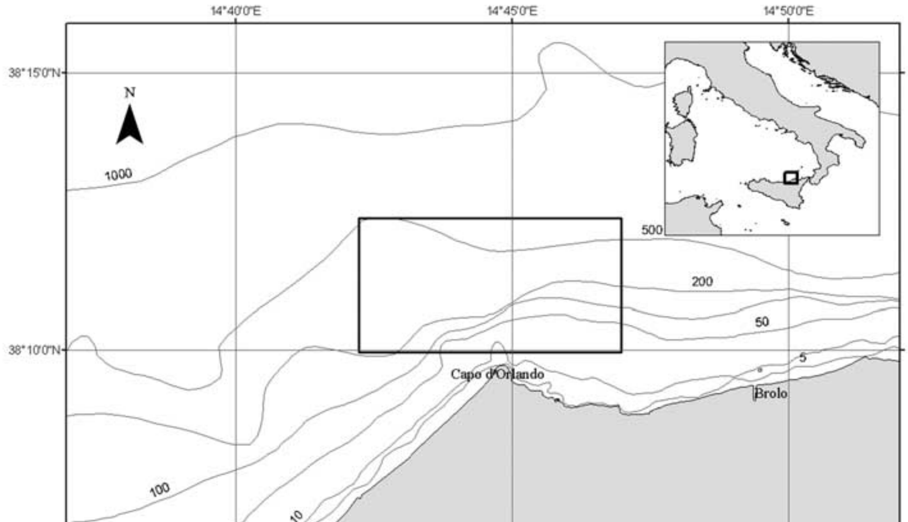

Fig. 1: Study area (rectangle) in the southern Tyrrhenian Sea.

Collection and analysis of data

The survey was carried out with a small scale fishing boat (7.38 GRT, 120 hp) from April 2001 to April 2002. We used 1 m high cylindrical traps of 70 cm base diameter, supported by a vertical wood frame reinforced with iron rings and provided with a 1 cm mesh polypropylene net. A funnel-shaped opening allowed the entrance of animals through each cylinder base. To permit the recovery of trapped animals, a 25 cm diameter circular opening was also created on the cylinder's lateral surface. The bait used consisted of fishes (or pieces), discarded by other fisheries, linked to each other and suspended centrally inside each trap by a nylon line. We set two lines of 30 traps each, connected through a ground line and spaced at about 20 m from each other. One line was placed in an area usually exploited by this fishery (100-300 m, area A), the other line was used in unexploited bottoms (300-500 m, area B), every month over a period of one year. The traps were kept at the bottom for 24 hours and the catches were repeated for five consecutive days, subject to weather conditions. No sampling was carried out during May and September, due to boat maintenance and a fishing ban. Depths were recorded by an echo-sounder at the beginning and at the end of the fishing operations for each trap line. During two fishing days per month, the animals collected were classified to the species level, counted and weighed to the nearest 0.1 g. A further distinction was also made between commercial crustaceans and those usually discarded by fishermen, in order to test the discard incidence in this type of fishing.

Analysis of the sampling data was carried out on the variables' abundance and biomass considered separately, by three-way (species, seasons and areas as factors) and two-way (seasons and areas as factors) analysis of variance (ANOVA). Post hoc multiple comparisons were used for testing differences among seasons and Student's *t* test for testing differences between areas. These tests were applied on log transformed ($\ln(x+1)$) abundance and biomass data, due to the large number of zero values (CARTES & SARDÀ, 1993).

Results

Composition and frequency of occurrence

During 22 fishing days we caught 23 species of crustaceans, which are listed in Table 1 together with their percent frequency of occurrence in both investigated areas. A total of 20 species in area A and 19 species in area B have been recorded. *Goneplax rhomboides* (Linnaeus, 1758), *Macropipus tuberculatus* (Roux, 1830), *Parasquilla ferussaci* (Roux, 1828) and *Plesionika antigai* Zariquiey Alvarez, 1955 were trapped only in area A; *Aegaeon lacazei* (Gourret,1887) *Aristaeomorpha foliacea* (Risso, 1827) and *Pasiphaea multidentata* Esmark, 1866 were caught only in area B. Among discards, we recorded seven species in area A and six in area B, marked by an asterisk in Table 1. *Paromola cuvieri* (Risso, 1816) is not usually sold in local markets, although it is quite appreciated by fishermen themselves. Therefore, we have included it in the list of commercial species.

Abundance

The mean number of individuals per trap, recorded in areas A and B in each season, is reported in Table 2. On the whole, we collected 10,971 and 8,257 individuals in areas A and B, respectively. *Plesionika edwardsii* (Brandt, 1851) was the most abundant species, recorded in the whole bathymetric range investigated; it accounted for 61.5% and 63.3% of the total number of individuals in areas A and B, respectively. *Plesionika narval* (Fabricius, 1787) was also relatively abundant in area A (23.3%), while in area B the second species in importance recorded was *Plesionika gigliolii* (Senna, 1903) (24.4%). The other species accounted for less than 10% of the total number of individuals. The discard was 1.2% and 0.9% in areas A and B, respectively. On the whole, an increasing trend in seasonal crustacean abundance from summer (N_A =

Table 1
List of crustaceans collected in the southern Tyrrhenian Sea by bottom traps and their % frequency of occurrence in the two study areas. The species usually discarded by fishermen are marked with an asterisk.

Species	Area A 100-300 m	Area B 300-500 m
**Aegaeon lacazei* (Gourret, 1887)		4.8
Aristaeomorpha foliacea (Risso, 1827)		4.8
Chlorotocus crassicornis (A. Costa, 1871)	18.2	9.5
**Dardanus arrosor* (Herbst, 1796)	9.1	4.8
**Goneplax rhomboides* (Linnaeus, 1758)	13.6	
**Homola barbata* (Fabricius, 1793)	9.1	4.8
Ligur ensiferus (Risso, 1816)	4.5	9.5
**Liocarcinus depurator* (Linnaeus, 1758)	40.9	14.3
**Macropipus tuberculatus* (Roux, 1830)	4.5	
**Monodaeus couchii* (Chouch, 1851)	36.4	9.5
**Munida rugosa* (Fabricius, 1775)	18.2	4.8
Nephrops norvegicus (Linnaeus, 1758)	54.5	95.2
Parapenaeus longirostris (Lucas, 1846)	90.9	85.7
Parasquilla ferussaci (Roux, 1828)	4.5	
Paromola cuvieri (Risso, 1816)	13.6	28.6
Pasiphaea multidentata Esmark, 1866		4.8
Plesionika antigai Zariquiey Alvarez, 1955	4.5	
Plesionika edwardsii (Brandt, 1851)	100.0	100.0
Plesionika gigliolii (Senna, 1903)	59.1	76.2
Plesionika heterocarpus (A. Costa, 1871)	40.9	33.3
Plesionika martia (A. Milne Edwards, 1883)	4.5	4.8
Plesionika narval (Fabricius, 1787)	81.8	57.1
Processa canaliculata Leach, 1815	9.1	4.8

7.4, NB = 4.4) to spring (N_A = 23.8, N_B = 23.0) was observed.

Biomass

The mean weight per trap (g), recorded in areas A and B in each season, is reported in Table 3. The total weight of crustaceans collected in areas A and B was 51.9 and 53.9 kg, respectively. *P. edwardsii* was the most important species in terms of biomass, accounting for 69.2% and 53.6% of the total biomass in areas A and B, respectively. *P. narval* was the second in importance species in area A (9.3%), while in area B, *N. norvegicus* accounted for 27.1% of the total biomass. The discard was 2.0% and 1.1% in areas A and B, respectively. On the whole, an increasing trend in seasonal crustacean biomass from summer (W_A = 44.8, W_B = 49.1) to spring (W_A = 131.2, W_B = 151.0) was observed.

Statistical analysis

Three-way ANOVA was significant ($p \leq 0.001$) for both variables, abundance ($F_{184,805}$ = 14.41) and biomass ($F_{184,805}$ = 16.46), and showed no between-areas effect, although a significant among-species effect, a significant among-seasons effect and significant joined effects area*species and species*season were found.

Two-way ANOVA, testing areas and seasons effects for abundance, showed significant differences between areas for *N. norvegicus* ($F_{1,35}$ = 13.33, p = 0.0001) and *P. gigliolii* ($F_{1,35}$ = 4.27, p = 0.046), the highest values being recorded in area B. A significant season-effect was recorded for *P. gigliolii* ($F_{3,35}$

Table 2
Mean number of individuals per trap ± SE, for each season in the two study areas. Values for commercial and discarded crustaceans are also reported.

	Area A				Area B			
	Spring	**Summer**	**Autumn**	**Winter**	**Spring**	**Summer**	**Autumn**	**Winter**
A. lacazei								0.04
A. foliacea						0.03		
C. crassicornis	0.03	0.07	0.18 ± 0.03				0.07	0.04
D. arrosor			0.03	0.04			0.03	
G. rhomboides			0.03	0.03				
H. barbata	0.03			0.04			0.03	
L. ensiferus				0.07				0.21 ± 0.12
L. depurator		0.13 ± 0.02	0.67 ± 0.31	0.09 ± 0.04			0.57	0.14 ± 0.02
M. tuberculatus				0.04				
M. couchii		0.03	0.05 ± 0.01	0.09 ± 0.01			0.07	0.15
M. rugosa	0.10 ± 0.04			0.07 ± 0.02	1.37			
N. norvegicus	0.19 ± 0.06	0.03 ± 0.00	0.07 ± 0.02	0.09 ± 0.03	0.41 ± 0.17	0.28 ± 0.09	0.19 ± 0.05	0.29 ± 0.17
P. longirostris	0.40 ± 0.11	0.32 ± 0.10	0.53 ± 0.19	0.27 ± 0.10	0.27 ± 0.06	0.07 ± 0.03	0.31 ± 0.12	0.39 ± 0.08
P. ferussaci			0.03					
P. cuvieri	0.07 ± 0.02			0.03		0.04	0.05 ± 0.01	0.07 ± 0.02
P. multidentata							0.07	
P. antigai			0.03					
P. edwardsii	17.28 ± 6.90	6.20 ± 1.52	8.37 ± 2.20	7.67 ± 2.28	16.01 ± 6.28	3.65 ± 0.81	6.74 ± 3.44	6.51 ± 1.89
P. gigliolii	2.36 ± 0.70		0.79 ± 0.40	3.87 ± 2.64	5.88 ± 1.50	1.55	1.40 ± 0.51	5.84 ± 2.65
P. heterocarpus	0.34		0.89 ± 0.58	0.66 ± 0.22			0.98 ± 0.46	0.29 ± 0.14
P. martia			0.03				0.17	
P. narval	5.19 ± 3.96	1.83 ± 0.85	10.15 ± 6.91	0.78 ± 0.30	2.14 ± 1.57	0.09 ± 0.01	1.57 ± 0.86	1.21 ± 0.66
P. canaliculata			0.20	0.03				0.04
Commercial	0.16 ± 0.05	0.21 ± 0.07	0.24 ± 0.02	0.23 ± 0.06	0.24 ± 0.07	0.23 ± 0.06	0.26 ± 0.20	0.24 ± 0.06
Discarded	0.34 ± 0.12	0.37 ± 0.06	0.42 ± 0.06	0.33 ± 0.30	0.28 ± 0.13	0.31 ± 0.07	0.32 ± 0.04	0.31 ± 0.10

Table 3
Mean weight per trap (g) ± standard error for each season in the two study areas. Commercial and discarded fish values are also reported.

	Area A				Area B			
	spring	summer	fall	winter	spring	summer	fall	winter
A. lacazei								0.07
A. foliacea						0.79		
C. crassicornis	0.03	0.10	0.16±0.03				0.09	0.03
D. arrosor			0.73	1.03			1.34	
G. rhomboides			0.09±0.02	0.07				
H. barbata	0.21			0.03			0.56	
L. ensiferus				0.25				0.74±0.38
L. depurator		0.91±0.09	5.71±2.43	0.92±0.43			5.68	1.62±0.14
M. tuberculatus				0.26				
M. couchii		0.25±0.05	0.39±0.06	0.42±0.05			0.46	0.81
M. rugosa	0.30±0.16			0.34±0.15	8.10			
N. norvegicus	19.07±5.80	2.91±0.89	5.52±0.34	6.75±2.66	35.75±14.44	23.67±8.05	18.34±5.59	20.64±12.46
P. longirostris	3.83±1.15	4.05±0.57	5.14±1.59	2.85±0.98	3.12±0.60	0.94±0.35	3.72±1.28	4.10±0.83
P. ferussaci			0.46					
P. cuvieri	29.72±6.64			13.55		13.27	15.35±1.02	28.90±7.31
P. multidentata								0.86
P. antigai			0.02					
P. edwardsii	92.90±44.10	39.05±8.64	42.30±10.17	38.14±12.87	100.38±34.91	20.94±4.47	31.46±11.05	31.44±11.50
P. gigliolii	2.65±1.50		0.93±0.40	6.43±4.79	9.03±1.96	2.00	2.22±0.72	9.83±4.69
P. heterocarpus	0.60		1.69±1.09	1.44±0.44			2.36±1.23	0.60±0.24
P. martia			0.08					0.23
P. narval	11.80±10.12	3.36±1.42	16.91±11.56	1.64±0.67	4.79±3.60	0.09±0.01	1.79±0.99	2.60±1.45
P. canaliculata			0.50	0.11				0.11
Commercial fish	37.46±10.87	44.94±26.42	60.99±6.48	49.35±53.97	63.94±20.28	56.48±14.21	62.89±33.71	64.07±6.91
Discarded fish	32.32±14.24	38.86±10.25	41.07±3.83	38.44±9.69	17.14±5.15	19.21±5.41	19.80±2.84	19.63±9.31

= 6.155, $p = 0.002$) showing a similar trend in the two areas with the lowest values recorded in summer.

Two-way ANOVA computed for biomass showed significant differences between areas for *N. norvegicus* ($F_{1,18} = 18.1$, $p < 0.0001$) and *P. gigliolii* ($F_{1,18} = 6.139$, $p = 0.018$), the highest values being recorded in area B. A significant season-effect was recorded for the following species: *Liocarcinus depurator* (Linnaeus, 1758) ($F_{3,35} = 2.979$, $p = 0.045$) showing a peak in fall in area A; *Parapenaeus longirostris* (Lucas, 1946) ($F_{3,35} = 3.71$, $p = 0.02$) without a well defined trend in both areas and the lowest values recorded in summer; *P. edwardsii* ($F_{3,35} = 2.886$, $p = 0.049$) with a decreasing trend from spring to winter; *P. gigliolii* ($F_{3,35} = 6.168$, $p = 0.002$) showing a similar trend in the two areas with the lowest values recorded in summer.

Seasonal comparisons between areas for *N. norvegicus* showed significant differences in summer ($t_{10} = -3.48$, $p = 0.01$) and in fall ($t_{10} = -3.433$, $p = 0.006$), with results for area B being always higher than those found for area A.

Discussion

The species collected over the whole period of study are characteristic of the Mediterranean bathyal mud assemblage, according to the literature (PÉRÈS, 1967, 1985; ABELLÒ *et al.*, 1988), and mainly include nekto-benthic and benthic species. Overall, no significant differences were recorded between the areas. The bulk of the catches was represented by species with high commercial value, such as *P. edwardsii* and *N. norvegicus*. *P. edwardsii* attained its maximum abundance and biomass values in spring in both areas. *N. norvegicus* was mostly trapped in the area between 300 and 500 m; moreover, the highest biomass values for this species were recorded in spring. *P. gigliolii* was also mostly caught at greater depths, according to the preferential bathymetric range reported in the literature in different areas of the Mediterranean (MURA, 1995; CARBONELL & ABELLÒ, 1998); the catch of this species was more consistent in spring and in winter. The results obtained in the deepest layer let us suppose its validity as a fishing area; the relatively high biomass values recorded in both areas are in accordance with high faunal productivity reported for submarine canyons, probably related to higher sedimentation rates than those found in surrounding areas (HOUSTON & HAEDRICH, 1984). The increasing trend observed for both abundance and biomass, culminating in spring in both areas, could be related to the intense resuspension during periods of low stratification of the water column; resuspension is, in fact, the main factor responsible for the proliferation of the benthopelagic fauna (ANGEL, 1990 in CARTES *et al.*, 1994). The discard, mainly represented by the crab *L. depurator*, was slight, if compared to the high discard percentages recorded for other fisheries (ALVERSON *et al.*, 1994).

Our results show a much higher variety of species than that recorded in other studies carried out with bottom traps on non-trawlable deep bottoms. In the central Tyrrhenian Sea only six crustacean species were recorded. *P. edwardsii* was always more than 80% of the catch as number of individuals, followed by *P. longirostris* that was constantly present but in low quantity (COLLOCA *et al.*, 1998). Six crustacean species were recorded in the Sardinian seas (SECCI *et al.*, 1994), and five in the Eolian Archipelago (PICCINETTI *et al.*, 1995); in both cases the catches were dominated by *P. edwardsii* showing large yields, higher than those obtained by trawl. Low yields of pandalids trawled in neighbouring areas to our study area (CAMPAGNUOLO *et al.*, 2001, GRECO *et al.*, 2003) confirm that bottom traps consist of a valid gear for the capture of underexploited resources.

Conclusion

The important catch of species of high commercial value, the high selectivity of the gear recorded in the literature, the low number and biomass of discarded species, the light mechanical damages sustained by the organisms and the low impact on the habitat are all factors that encourage this fishery which could represent a valid alternative for small-scale fishery in this area.

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