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Daniela Pessani, Tina Tirelli, Carlo Froglia
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Crustacea Decapoda from Ustica (southern Tyrrhenian Sea): species distribution in different habitats and sampling approach

ABSTRACT

The decapod crustacean fauna of Ustica Island (Sicily, southern Tyrrhenian Sea) has been investigated in summer 2002 with the aid of many different sampling methods: suction device, pushnet, skid trawl, trammel net, traps, underwater observation, interviews. All the substrata occurring around the island from 0 to about -30 m were surveyed: midlittoral rock, infralittoral rock, pebbles, seagrass (*Posidonia oceanica*) bed, sand, detritic bottom, submerged cave. Fifty-seven species were collected in the investigated localities. Abundance and frequency of all species in the samples and in each surveyed biotope are given. The performance of each sampling method has been evaluated, in terms of number of species and individuals, and of species unique to each method. Methods based on direct underwater observation (i.e., visual census) and hand collection provided the largest number of species. Accounts on three remarkable species are given: *Calappa tuerkayana*, *Pachygrapsus transverses*, and *Percnon gibbesi*. This study increases the decapod knowledge of the southern Tyrrhenian sea.

Keywords: decapod fauna, sampling methods, habitat, distribution, Mediterranean.

INTRODUCTION

The decapod crustaceans from Sicily have been the subject of zoological research since the early 19th century. After a half-century gap between the works of Misuri (1914) and those of Torchio (1967), Italian carcinologists started again to work on Sicilian decapods. Yet, the small islands around Sicily have been poorly investigated, although all of them display life-rich marine ecosystems, and many of them host marine reserves which deserve investigations on their biodiversity.

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Ustica is a volcanic island of 9 km^2 located 67 km off north-western Sicily (38°42'N, 13°10' E). Its entire 14 km coastline is protected by a marine reserve that extends up to three miles offshore.

Although the marine biota of Ustica has been the subject of many scientific papers (see e.g., S.I.B.M., 1999), decapod crustaceans have never been dealt with in dedicated papers. The only accounts come from two papers on the island's artisanal fisheries (Arculeo *et al.*, 1996, 2002) and from an unpublished PhD thesis (Catalano, 2000). This study is the first one dedicated to the decapods of the island.

The objectives of this paper are:

to give a list of midlittoral and infralittoral decapods of Ustica;

to give accounts on their distribution in the different biotopes;

to discuss some aspects of the sampling approach adopted.

MATERIAL AND METHODS

Field work

Due to economic constraints and to the necessity of favourable weather conditions, the field work was conducted within a few days in summer of 2002 (except for skid trawl sampling, which was carried out in October the same year). All the main substrata occurring around the island down to about 30 m depth were surveyed. A wide array of sampling methods was used in order to collect the largest possible number of species in the different habitats. Night sampling was also carried out with all methods in an attempt to collect decapods with nocturnal habits.

Sampling localities

The sampling localities were selected around the island in order to cover all the different substrata and to account for the different exposure to the prevailing wind and sea conditions. The following main substrata (Tab. I) were identified with the aid of existing bionomic maps and after pre-survey scuba diving observations: midlittoral rocks, infralittoral rocks, pebbles, *Posidonia oceanica* beds, sand, detritic bottoms and submerged caves. The actual habitat of each decapod species was also recorded (Tab. II). Sampling with each method was carried out along transects perpendicular to the coastline at -1, -5, -15 and -30 m, except where the morphology of the area or other constraints prevented us to do so. Midlittoral sites were also surveyed. A total of 79 samples (Tab. I) were collected in 22 localities (Fig. 1).

Sampling methods

The following sampling methods were adopted:

- suction device driven by an 18 l scuba bottle with regulator, equipped with a 400 μm mesh bag. Used on rocky surfaces with algal canopy. Each sample was collected over a 1 m^2 bottom surface;

- 40x20 cm pushnet with a 400 μm mesh bag (Russo *et al.*, 1985, 1986). Each sample consisted of 100 strokes on a seagrass bed;
- skid trawl net with 8 mm side mesh at the mouth of the bag and 6 mm at the codend. Each sample consisted of a 15-minute tow on a seagrass bed;
- trammel net 500 m long and 1.5 m high, with 20 mm side inner mesh and 72 mm outer mesh. Used on different substrata down to -40 m for about 12-hour soak time from sunset to sunrise;
- traps built with plastic mineral water bottles, similar to those used by Türkay (1982), baited with salted sardine. A set of twenty traps tied together at 3 m intervals was laid in rocky areas and seagrass beds for about 12-hour soak time from sunset to sunrise. Setting and hauling were monitored in scuba diving to avoid loss of material and to identify the biotope actually sampled;
- direct underwater observations and collections in all the habitats surveyed between 0 and 40 m depth. Specimens were either identified *in situ* and recorded on a plastic board or hand-collected and carried to the lab. In some cases samples of biogenic habitat (sponges, seagrass rhizomes, calcareous algal turfs, blocks of encrusting biota and a few specimens of the pen shell, *Pinna nobilis*) were collected in search of cryptic decapods;
- interviews with local fishermen and scuba divers, aimed at collecting records of decapods observed during their activity. In such cases the locality remained generally unknown.

In only three cases our data could be quantitatively evaluated in order to assess the relative species abundance, due to the consistency of the sampling technique used and to the homogeneity of the surveyed habitat: suction device (infralittoral rock), skid trawl (seagrass), pushnet (seagrass).

Samples were sorted immediately after their collection, then frozen, and identified in the lab at a later stage. The systematic arrangement was done according to Martin & Davis (2001), while the nomenclature follows the Italian Fauna checklist (Froglia, 2006).

Sample ID	Date	Sampling method	Depth (m)	Substratum	S	N	d/n
AMed	17/9/2002	trammel net	25	infralittoral rock, seagrass	2	7	n
CCi1	25/6/2002	hand collection	16	sand	3	6	d
CCi2	13/7/2002	hand collection	15-20	infralittoral rock	3	3	d
CFa1	12/9/2002	hand collection	0-1	midlittoral rock and infralittoral fringe	2	2	d
CFa2	12/9/2002	suction device	6	infralittoral rock	10	505	d
CFa3	12/9/2002	trap	10-20	infralittoral rock, detritic bottom, seagrass	7	28	n
Col	11/7/2002	hand collection	0	midlittoral rock	3	66	d
CSM1	22/9/2002	trammel net	25	seagrass	2	2	n
CSM2	13/6/2002	hand collection	0	midlittoral rock	2	6	d
CSM3	25/6/2002	pushnet	28	seagrass	2	9	d
CSM4	25/6/2002	pushnet	15	seagrass	2	17	d
CSM5	25/6/2002	pushnet	5	seagrass	3	90	d
CSM6	11/7/2002	hand collection and air sucker	2	pebbles	12	134	d
CSM7	11/7/2002	pushnet	27-28	seagrass	6	752	d
CSM8	11/7/2002	pushnet	13-15	seagrass	9	2103	d
CSM9	11/7/2002	pushnet	5	seagrass	3	564	d
CSM10	22/10/2002	skid trawl	10-20	seagrass	1	4	d
CSM11	22/10/2002	skid trawl (2 replicates)	10	seagrass	5	11	d
Est1	20/9/2002	trammel net	15-25	infralittoral rock	1	2	n
Est2	21/9/2002	trammel net	11	infralittoral rock, seagrass	1	3	n
GBa1	12/6/2002	suction device	15	infralittoral rock	2	61	d
GBa2	12/6/2002	suction device	7-8	infralittoral rock	3	71	d
GBa3	12/6/2002	suction device	1-3	infralittoral rock	6	366	d

to be continued

GTu	18/9/2002	trammel net	25	infralittoral rock	1	1	n
GVe1	12/7/2002	hand collection	1-4	submerged cave	3	7	d
GVe2	12/7/2002	hand collection	4-8	infralittoral rock	5	61	d
HDi1	11/7/2002	hand collection	15	seagrass	1	1	d
HDi2	11/7/2002	hand collection	30	infralittoral rock	3	3	d
Nor1	17/9/2002	trammel net	25	infralittoral rock, seagrass	1	2	n
Nor2	19/9/2002	trammel net	25	infralittoral rock	4	10	n
OMo1	10/7/2002	hand collection	1-4	infralittoral rock	2	2	d
OMo2	14/7/2002	hand collection, visual census	5-30	infralittoral rock, seagrass	8	107	d
OMo3	12/9/2002	suction device	4-5	infralittoral rock	4	34	d
OMo4	22/10/2002	skid trawl	10-30	detritic bottom	6	19	d
OMo5	22/10/2002	skid trawl (3 samples)	10-30	seagrass	7	45	d
OMo6	22/10/2002	skid trawl	10-20	seagrass	15	278	n
OMo7	22/9/2002	trammel net	40	sand	3	4	n
OMo8	12/9/2002	hand collection	10-15	infralittoral rock	3	8	d
PAr1	12/6/2002	suction device	29	infralittoral rock	2	2	d
PAr10	16/9/2002	trammel net	25	seagrass	2	3	n
PAr2	12/6/2002	suction device	15	infralittoral rock	5	47	d
PAr3	13/6/2002	pushnet	29	seagrass	5	338	d
PAr4	13/6/2002	pushnet	15	seagrass	3	223	d
PAr5	13/6/2002	pushnet	7-8	seagrass	3	81	d
PAr6	25/6/2002	visual census	30	infralittoral rock	1	1	d
PAr7	28/6/2002	hand collection	10-20	infralittoral rock	1	5	d
PAr8	28/6/2002	trap	21	infralittoral rock	1	1	n

to be continued

PAr9	13/9/2002	trammel net	12	seagrass	2	6	n
Pas1	13/9/2002	trammel net	12	infralittoral rock, seagrass	3	11	n
Pas2	14/9/2002	trammel net	25	infralittoral rock, seagrass	3	3	n
Pas3	20/9/2002	trammel net	12	infralittoral rock	2	2	n
PCa1	14/9/2002	suction device	5	infralittoral rock	5	18	d
PCa2	14/9/2002	hand collection	10-25	infralittoral rock	7	20	d
PCa3	14/9/2002	hand collection	0-1	midlittoral rock, infralittoral rock	2	2	d
PCa4	2/10/2002	trammel net	10-12	infralittoral rock, seagrass	2	2	n
PFa1	14/6/2002	hand collection, visual census	21-25	submerged cave	4	204	d
PFa2	14/6/2002	hand collection	15	infralittoral rock	2	16	d
PGa1	12/7/2002	trap	15-25	seagrass	6	60	n
PGa2	13/7/2002	hand collection, visual census	15-30	infralittoral rock, seagrass	5	104	d
PGa3	10/9/2002	trap	30-35	infralittoral rock	5	10	n
PGa4	11/9/2002	trap	10-20	seagrass	10	43	n
PSP1	12/7/2002	hand collection	1	infralittoral rock	2	2	d
PSP2	25/9/2002	trammel net	40	detritic bottom	1	1	n
Ris	18/9/2002	trammel net	25	infralittoral rock	2	3	n
SMe1	15/6/2002	suction device	30	infralittoral rock	4	9	d
SMe2	15/6/2002	suction device	15	infralittoral rock	5	39	d
SMe3	15/6/2002	suction device	5	infralittoral rock	5	45	d
SMe4	24/6/2002	suction device	1	infralittoral rock	3	7	d
SMe5	13/7/2002	hand collection, visual census	5-33	infralittoral rock	2	2	d
SMe6	13/7/2002	trap	12	infralittoral rock	3	5	n
SMe7	13/9/2002	hand collection	10-30	infralittoral rock	4	11	d
SMe8	13/9/2002	suction device	5	infralittoral rock	6	34	d

to be continued

Spa1	13/6/2002	hand collection	0	midlittoral rock	3	46	d
Spa2	13/6/2002	hand collection	0	midlittoral rock	5	81	d
Spa3	13/6/2002	hand collection	0,5	infralittoral rock	1	14	d
Spa4	14/6/2002	hand collection, visual census	5-12	infralittoral rock, seagrass	5	35	n
Sud1	13/9/2002	suction device	18	infralittoral rock, seagrass	7	79	d
Sud2	13/9/2002	suction device	30	infralittoral rock, seagrass	7	32	d
Sud3	13/9/2002	trap	15-35	infralittoral rock, seagrass	4	6	n
unknown	---	---	---	---	4	8	d

Tab. I - List of samples with date, sampling method, depth, substratum, number of species (S) and of individuals (N) and indication of diurnal/nocturnal sampling (d/n). Seagrass is *Posidonia oceanica*

Species	Sample ID	Habitat	N	d/n
STENOPODIDAE				
Stenopus spinosus Risso, 1827	unknown location	sciaphilic rocky bottom	1	d
GNATHOPHYLLIDAE				
Gnathophyllum elegans (Risso, 1816)	GBa3, GVe2, PGa3	photophilic rocky bottom	3	d+n
PALAEMONIDAE				
Brachycarpus biunguiculatus (Lucas, 1846)	OMo6, SMe6	photophilic rocky bottom, seagrass	3	n
Palaemon elegans Rathke, 1837	Spa1, Spa2	littoral pools, vermetid platform	21	d
Palaemon xiphias Risso, 1816	CSM11, CFa2, OMo5, OMo6, PAr5, PGa4	photophilic rocky bottom, seagrass	115	d+n
Periclimenes scriptus (Risso, 1822)	CSM7	seagrass	2	n
Pontonia pinnophylax (Otto, 1821)	OMo2, OMo8	photophilic rocky bottom, seagrass	11	d
ALPHEIDAE				
Alpheus dentipes Guérin-Méneville, 1832	CFa2, CSM5, CSM6, PAr1, PGa4, SMe8, Sud1, Sud2	photophilic and sciaphilic rocky bottom, seagrass, pebbles	10	d+n
Alpheus macrocheles (Hailstone, 1835)	PGa4	seagrass	1	n
Athanas nitescens (Leach, 1814) forma *laevirhyncus* (Risso, 1816)	CFa2, CFa3, CSM7, CSM8, OMo4, OMo6, PAr2	photophilic rocky bottom, seagrass, detritic bottom	11	d+n
HIPPOLYTIDAE				
Hippolyte garciarasoi d'Udekem d'Acoz, 1996	CFa2, CSM7, CSM8, GBa2, GBa3, OMo3, OMo6, PAr2, PAr3, PCa1, SMe2, SMe3, SMe8, Sud1, Sud2	photophilic and sciaphilic rocky bottom, seagrass	123	d+n

to be continued

HIPPOLYTIDAE (segue)				
Hippolyte inermis Leach, 1815	CSM3, CSM8, CSM9, OMo5, OMo6, PAr3	seagrass	30	d+n
Hippolyte leptocerus (Heller, 1863)	CFa2, OMo3, PAr2, SMe3, SMe8, Sud1	photophilic rocky bottom, seagrass	93	d
Lysmata seticaudata (Risso, 1816)	CFa3, OMo6, PGa4	photophilic rocky bottom, seagrass, detritic bottom	16	n
Thoralus cranchii (Leach, 1817)	CFa2, CFa3, CSM8, CSM11, OMo4, OMo5, OMo6, PCa1, SMe8, Sud1, Sud2	photophilic and sciaphilic rocky bottom, seagrass, detritic bottom	136	d+n
PROCESSIDAE				
Processa acutirostris Nouvel & Holthuis, 1957	CSM8, OMo6	seagrass	2	n
Processa macrophthalma Nouvel & Holthuis, 1957	OMo6, PGa3	seagrass	3	n
PANDALIDAE				
Plesionika narval (Fabricius, 1787)	Nor2, PFa1, PGa1, PGa3	photophilic and sciaphilic rocky bottom, seagrass, cave	204	d+n
NEPHROPIDAE				
Homarus gammarus (Linnaeus, 1758)	unknown location	cave	2	d
PALINURIDAE				
Palinurus elephas (Fabricius, 1787)	PAr6, PCa2	photophilic and sciaphilic rocky bottom	2	d
SCYLLARIDAE				
Scyllarides latus (Latreille, 1803)	unknown location		3	d
Scyllarus arctus (Linnaeus, 1758)	OMo5	seagrass	1	d
Scyllarus pygmaeus (Bate, 1888)	OMo6	seagrass	5	n
GALATHEIDAE				
Galathea strigosa (Linnaeus, 1761)	PCa4	photophilic rocky bottom, seagrass	1	n

to be continued

DIOGENIDAE				
Calcinus tubularis (Linnaeus, 1767)	CFa2, CFa3, CSM4, CSM5, CSM6, CSM7, CSM8, CSM9, CSM11, GBa1, GBa2, GBa3, GVe2, OMo2, OMo4, OMo5, Mo6, OMo8, PAr2, PAr3, PAr4, PAr5, Pas3, PCa1, PCa2, PFa2, PGa1, PGa2, PGa4, SMe2, SMe3, SMe4, SMe8, Spa4, Sud1, Sud2	photophilic and sciaphilic rocky bottom, seagrass, detritic bottom, pebbles	1846	d+n
Clibanarius erythropus (Latreille, 1818)	CFa2, Col, CSM6, GBa3, GVe2, OMo3, PGa2, Spa1, Spa2, Spa3 platform	photophilic and sciaphilic rocky bottom, seagrass, pebbles, littoral pools, vermetid 584	d	
Dardanus arrosor (Herbst, 1796)	CSM1, CSM6, GBa3	photophilic rocky bottom, seagrass, pebbles	3	d+n
Dardanus calidus (Risso, 1827)	CCi2, CFa3, CSM6, CSM8, Est1, Est2, GVe1, GVe2, HDi2, Nor2, OMo1, OMo2, PAr3, PAr7 PAr8, PAr9, PAr10, Pas1, Pas2, PFa1, PGa1, PGa2, PGa3, PGa4, Ris, SMe5, SMe6, SMe7, Sud3	photophilic and sciaphilic rocky bottom, seagrass, detritic bottom, pebbles, cave	108	d+n
Diogenes pugilator (Roux, 1829)	CCi1	sand	4	d
Paguristes eremita (Linnaeus, 1767)	CCi1, CSM10, CSM11, HDi2, OMo2, OMo4, Pas3, PCa2, PFa1, SMe1, Sud2	photophilic and sciaphilic rocky bottom, seagrass, detritic bottom, sand, cave	22	d+n
PAGURIDAE				
Cestopagurus timidus (Roux, 1830)	CFa2, CSM3, CSM4, CSM5, CSM7, CSM8, CSM9, GBa1, GBa2, GBa3, GVe1, GVe2, OMo2, OMo4, OMo5, OMo6, PAr2, PAr3,	photophilic and sciaphilic rocky bottom, seagrass, detritic bottom, cave	3496	d+n

to be continued

	PAr4, PAr5, PCa1, PCa2, PFa2, PGa1, PGa2, PGa3, PGa4, SMe1, SMe2, SMe3, SMe4, SMe6, SMe7, SMe8, Spa4, Sud1, Sud2, Sud3			
Pagurus anachoretus Risso, 1827	CCi1, CCi2, CFa3, CSM7, CSM8, OMo6, PAr4, PCa2, PGa1, PGa2, PGa3, PGa4, SMe2, Spa4, Sud3	photophilic and sciaphilic rocky bottom, seagrass, sand, cave	44	d+n
Pagurus cuanensis Bell, 1845	SMe1	sciaphilic rocky bottom	1	d
Pagurus prideaux Leach, 1815	HDi2, OMo7, PSP2	sciaphilic rocky bottom, detritic bottom, sand	3	d+n
DROMIIDAE				
Dromia personata (Linnaeus, 1758)	AMed, CSM6, GTu, GVe1, Nor2, PCa3, PFa1, SMe1, SMe2, SMe7	photophilic and sciaphilic rocky bottom, seagrass, pebbles, midlittoral rock and infralittoral fringe, cave	20	d+n
HOMOLIDAE				
Homola barbata (Fabricius, 1793)	Pas2	photophilic and sciaphilic rocky bottom, seagrass	1	n
CALAPPIDAE				
Calappa granulata (Linnaeus, 1758)	CSM6, OMo7	pebbles, sand	3	d+n
Calappa tuerkayana Pastore, 1995	CSM1, CSM6	seagrass, pebbles (prob. fishery discard)	2	d+n
EPIALTIDAE				
Acanthonyx lunulatus (Risso, 1816)	CFa2, OMo3, SMe4, SMe8, Spa2, Spa4	photophilic rocky bottom, seagrass, vermetid platform	13	d+n

to be continued

INACHIDAE				
Achaeus cranchii Leach, 1817	Sud1	photophilic rocky bottom, seagrass	1	d
Achaeus gracilis (O.G. Costa, 1839)	CSM6, HDi1, OMo6, Sud2	photophilic and sciaphilic rocky bottom, seagrass, pebbles	4	d+n
Inachus thoracicus Roux, 1830	PAr10	seagrass	1	n
MAJIDAE				
Maja crispata (Risso, 1827)	Nor1, Nor2, OMo1, OMo2, OMo5, OMo8, PAr9, Pas1, Pas2, PCa2, PCa4, Ris, SMe7, Spa4	photophilic and sciaphilic rocky bottom, seagrass	23	d+n
Maja squinado (Herbst, 1788)	SMe5, unknown location	photophilic and sciaphilic rocky bottom	3	d
PISIDAE				
Herbstia condyliata (Fabricius, 1787)	CSM6, Sud3	photophilic and sciaphilic rocky bottom, seagrass, pebbles	2	d+n
Lissa chiragra (Fabricius, 1775)	Pas1	photophilic rocky bottom, seagrass	1	n
Pisa tetraodon (Pennant, 1777)	CCi2, OMo2, PCa2	photophilic rocky bottom, seagrass	3	d
PORTUNIDAE				
Liocarcinus corrugatus (Pennant, 1777)	AMed, CFa3, OMo2, PGa1, PGa4	photophilic and sciaphilic rocky bottom, seagrass, detritic bottom	6	d+n
Liocarcinus depurator (Linnaeus, 1758)	OMo7	sand	1	n
PORTUNIDAE (segue)				
Liocarcinus navigator (Herbst, 1794) (=*Liocarcinus arcuatus* (Leach, 1814)	CSM11, OMo6	seagrass	5	d+n

to be continued

ERIPHIIDAE				
Eriphia verrucosa (Forsskål, 1775)	CSM2, CSM6, PSP1, Spa2	photophilic rocky bottom, vermetid platform, midlittoral rock	4	d
PILUMNIDAE				
Pilumnus villosissimus (Rafinesque, 1814)	OMo4	detritic bottom	2	d
XANTHIDAE				
Paractaea monodi Guinot, 1969	PAr1, SMe3	photophilic and sciaphilic rocky bottom	2	d
Xantho poressa (Olivi, 1792)	CSM6	pebbles	32	d
GRAPSIDAE				
Pachygrapsus marmoratus (Fabricius, 1787)	CFa1, Col, CSM2, PCa3, SMe8, Spa1, Spa2	littoral pools, vermetid platform, midlittoral rock and infralittoral fringe	13	d
Pachygrapsus transversus (Gibbes, 1850)	Col	vermetid platform	1	d
PLAGUSIIDAE				
Percnon gibbesi (H. Milne Edwards, 1853)	CFa1, PSP	photophilic rocky bottom, midlittoral rock and infralittoral fringe	2	d

Tab. II - List of the decapod crustaceans of Ustica with sample ID, habitat, number of individuals (N) and indication of diurnal/nocturnal sampling (d/n).

RESULTS

A total of 7,055 individuals belonging to 57 species were collected (Tab. II). The most abundant species were the hermit crabs *Cestopagurus timidus* (n=3,496, 49%), *Calcinus tubularis* (n=1,846, 26%), and *Clibanarius erythropus* (n=584, 8%). *Cestopagurus timidus*, *C. tubularis*, and *Dardanus calidus* (found in thirty-eight, thirty-six and twenty-nine samples, respectively) were the most frequent species. Fourteen species were the rarest and were only found in one sample each. Eighteen species were found in one habitat type only, while all other species lived in more than one habitat. In particular the hermit crabs *C. tubularis*, *C. erythropus*, *D. calidus*, *Paguristes eremita*, *C. timidus*, *Pagurus anachoretus*, and the brachyuran crab *Dromia personata* occupied the highest number of different habitats.

The seagrass beds and the photophilic rocky bottom surveyed with the suction device were the hermit the habitats that provided the largest number of individuals and species (Fig. 2). Mixed habitats like e.g. those sampled with the trammel net were not included in the above calculation.

Eighteen species (32%) were unique to a specific habitat (Fig. 2); again, those collected with the trammel net over a mixed habitat were not included in the calculation.

The sampling method that yielded the largest number of individuals was the pushnet (n=4,177, 59%) followed by the suction device (n=1,347, 19%) (Fig. 3). The largest number of species was given by hand collection (n=26, 46%), followed by skid trawl (n=19, 33%), suction device (n=17, 30%), trammel net and traps (n=16, 28% each) (Fig. 3). Despite the high number of individuals collected, the pushnet yielded few species (n=12, 21%). A number of species was exclusive to each sampling method. Adding up hand collection and visual census, they provided 34 species (60% of the total), 14 of which unique to the method, and 959 individuals (13%) (Fig. 3). The interviews provided three species not detected with any of the other sampling techniques: the European lobster *Homarus gammarus*, the slipper lobster *Scyllarides latus*, and the boxer shrimp *Stenopus spinosus*. They also provided one species that was found only once with the other sampling techniques, the spider crab *Maja squinado*.

The hour of sampling had an influence on the number of species caught: twenty-one species (37%) were found only in the daytime, while twelve species (21%) were collected exclusively at night (Tab. II).

The dominant species in the photophilic rocky bottom surveyed with the suction device were the hermit crabs *C. tubularis* (34%), *C. erythropus* (26%), and *C. timidus* (20%) (Fig. 4). The dominant species in the seagrass beds, as sampled with the skid trawl, were the shrimp *Palaemon xiphias* (33%), the hermit crab *C. tubularis* (28%), and the shrimp *Thoralus cranchii* (18%) (Fig. 5). The seagrass bed samples collected with the pushnet were dominated by the hermit crabs *C. timidus* (73%) and *C. tubularis* (25%) (Fig. 6).

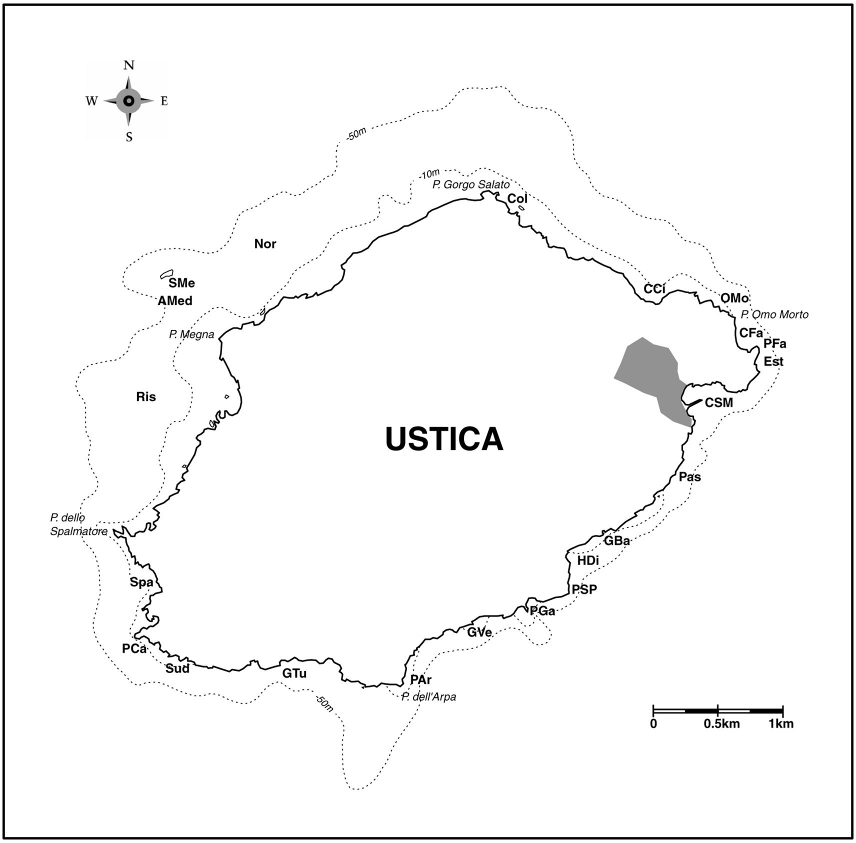

Fig. 1 - Map of Ustica with the sampling localities.

Notes on remarkable species

Calappa tuerkayana Pastore (1995) - Described by Pastore (1995) from the Gulf of Taranto. Holthuis (2001) posed some doubts on the species identity and suggested that it could be a junior synonym of *C. gallus* (Herbst, 1803), a west African species (but see Galil, 1997, about the confusion between *C. gallus* and *C. galloides* Stimpson, 1859). Garcia (2002) found this species in the Baleares Islands in 1983, well before Pastore's description, and considered *C. tuerkayana* a valid species on the basis of its morphological features. Our finding in Ustica is the third Mediterranean record after Garcia and Pastore. We found one specimen in a seagrass bed and another one, dead, on the harbour seabed, probably discarded by a fisherman.

Pachygrapsus transversus (Gibbes, 1850) - This intertidal grapsid crab has a wide distribution and is known from the eastern and western Mediterranean

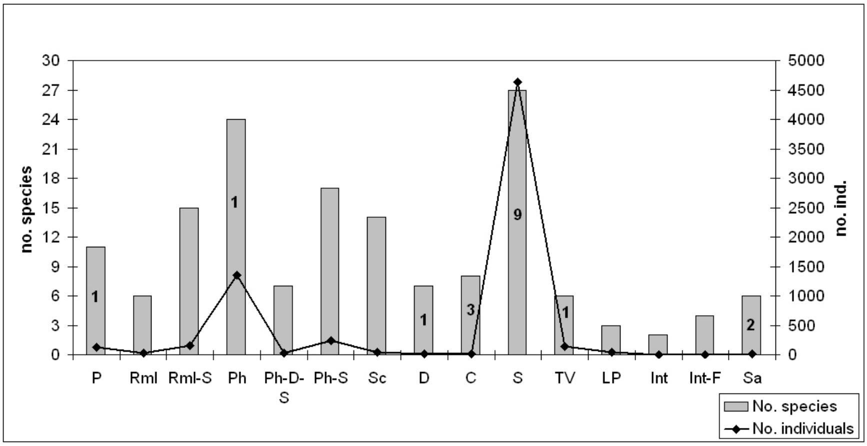

Fig. 2 - Number of species and abundance in each habitat. Figures inside bars indicate the number of species unique to the habitat. P: pebbles; Ph: photophilic rocky bottom; Sc: sciaphilic rocky bottom; D: detritic bottom; C: cave; S: seagrass; VP: vermetid platform; LP: littoral pool; Mid: midlittoral rock; Mid-F: midlittoral rock and fringe; Sa: sand. Seagrass is *Posidonia oceanica*.

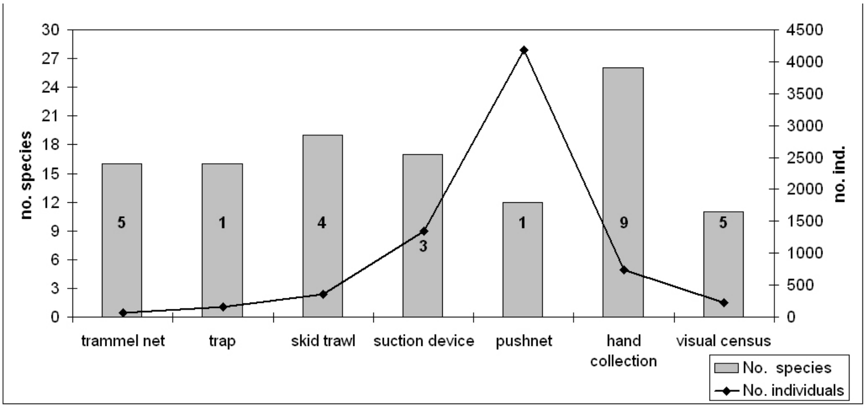

Fig. 3 - Number of species and abundance by sampling method. Figures inside bars indicate the number of species unique to the method.

basin (d'Udekem d'Acoz, 1999). The Ustica specimen, collected in the vermetid platform, was used by Vaccaro & Pipitone (2005) for the first record of this species in Italian waters.

Percnon gibbesi (H. Milne Edwards, 1853) - The first records of this plagusiid crab in the Mediterranean Sea date back to summer 1999 (Yokes & Galil, 2006). From then on it has spread rapidly all over the Mediterranean

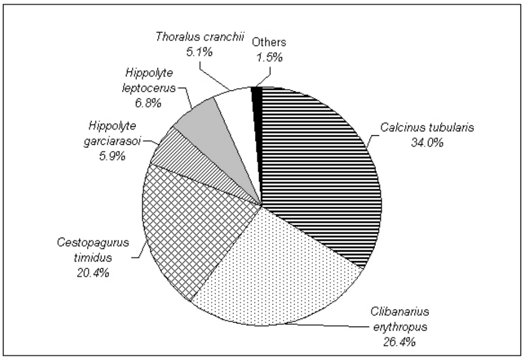

Fig. 4 - Dominance (% no.) of decapods in the photophilic rocky bottom of Ustica, surveyed with the suction device.

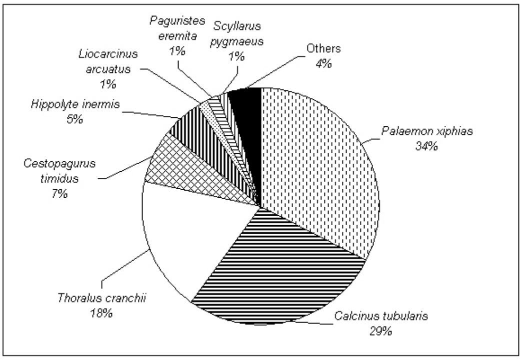

Fig. 5 - Dominance (% no.) of decapods in the seagrass (*Posidonia oceanica*) beds of Ustica, surveyed with the skid trawl.

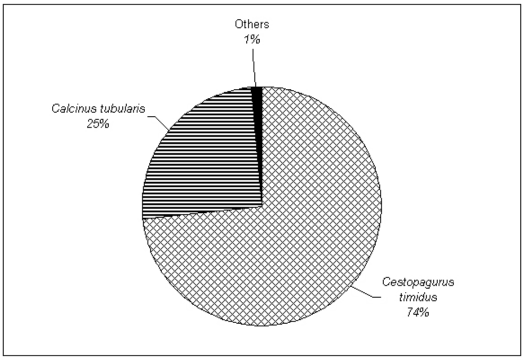

Fig. 6 - Dominance (% no.) of decapods in the seagrass (*Posidonia oceanica*) beds of Ustica, surveyed with the pushnet.

basin following apparently a west to east direction. It has been recently recorded for the first time along the north African shore in Libya (Elkrwe *et al.*, 2008). During this study only two specimens were found, although recent observations suggest that this crab is now more abundant around Ustica (M. Milazzo, pers. comm.).

DISCUSSION

The present study has yielded a number of species in the same range or larger than most other Mediterranean studies based on similar sampling methods and carried out at a similar spatial and temporal scale, e.g.: Relini Orsi *et al.* (1976), Garcia Raso (1988), Grippa (1991), Catalano (2000), Hasan *et al.* (2008). The following species are new to the Sicilian decapod fauna after the review by Pipitone & Arculeo (2003): *Gnathophyllum elegans*, *Pontonia pinnophylax*, *Hippolyte garciarasoi*, *Galathea strigosa*, *Calappa tuerkayana*, and *Pachygrapsus transversus*. The faunistic list given in this paper is clearly not inclusive of all the decapod species occurring around Ustica. Financial constraints prevented us to apply a more intense sampling effort. More specific investigations should be made on substrata, such as soft bottoms and for cryptic species, such as commensal and burrowing decapods. Anyway, all the substrata occurring around the island were surveyed with many different methods, in an effort to collect as many species as possible.

Eighteen species were unique to a single habitat. In a few cases the biotope recorded in Ustica is different from what is reported in the literature (d'Udekem d'Acoz, 1999), as for *Inachus thoracicus*, *Processa marcophthalma*, and *Scyllarus pygmaeus*, collected on a seagrass bed, and *Pilumnus villosissimus*, collected on a detritic bottom.

The sampling effort based on several different methods seemed highly rewarding, in that a number of species unique to each sampling method has been obtained, demonstrating the usefulness and complementarity of the methods employed. Also integrating daytime sampling with night sampling helped to collect more species, due to the nocturnal habits of many decapods (Noël, 2003). It is noteworthy that two widely used methods to sample the vagile zoobenthos with scuba equipment in the Mediterranean, i.e. the pushnet and the suction device, yielded the highest number of individuals, yet not the highest number of species (actually, the lowest number of unique species). In this respect, other direct underwater methods i.e., hand collection and visual census, were much more effective in terms of number of species collected, and proved among the best methods to collect littoral decapod crustaceans (Relini Orsi *et al.*, 1976 ; Garcia Raso, 1988; Grippa, 1991). Even the interviews - a method rarely used to acquire information on the biodiversity of an area (Noël, 2003) - provided three species not detected with any other sampling methods, probably due to their low overall abundance and to their cryptic habits.

The methods used did not allow us to assess quantitatively the surveyed taxa. Only three methods were considered suitable at least to evaluate the dominance (in terms of relative abundance) within the decapod community: the suction device used in the photophilic rocky bottom, and the skid trawl and the pushnet, both used on seagrass beds. Our data clearly suggest that the two latter survey methods gave totally different results, as highlighted by Zupo (1990). Comparisons with data collected in other areas are not easy, due to the exact technique employed with the same sampling gear and to the biotic and abiotic conditions of the sites. For instance Ates *et al.* (2007) found a totally different species composition in the seagrass beds of the Gallipoli Peninsula (Turkey), surveyed with a dredge. Similarly, Falciai (1985-86) and Borg & Schembri (2000) investigated the seagrass beds of Ischia and Malta, respectively, with the pushnet and had very different results from those presented here.

We would stress the importance of faunistic studies in marine protected areas, where they may have at least two possible outcomes, among others: (a) to increase the basic knowledge of the biodiversity and provide baseline data for ecological studies; (b) to allow spatial and temporal monitoring of the effects of protection on the ecosystem. In conclusion, this study gives emphasis to the necessity to use combined sampling techniques in faunistic studies at such a scale, if the detailed distribution of a taxon in all the available substrata is to be investigated.

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RIASSUNTO

La fauna a crostacei decapodi dell'Isola di Ustica (Sicilia, Mar Tirreno meridionale) è stata studiata nell'estate 2002 utilizzando diversi metodi di campionamento: sorbona, retino a mano, gangamo, tremaglio, trappole, osservazioni subacquee e interviste. Sono stati esplorati tutti i substrati presenti attorno all'isola da 0 a circa 30 m di profondità: roccia mesolitorale, roccia infralitorale, ciottoli, praterie di *Posidonia oceanica*, sabbia, fondi detritici, grotte sommerse. Sono state raccolte complessivamente 57 specie nelle località indagate, di cui vengono forniti i dati di abbondanza e frequenza sia in assoluto che nei singoli biotopi. E' stata valutata l'efficienza dei metodi di campionamento adottati, in termini di numero di specie e di individui raccolti e di specie esclusive per ogni metodo. I metodi basati sull'osservazione subacquea diretta (censimento visivo) e sulla raccolta manuale hanno fornito il numero di specie più elevato. Le specie di maggiore interesse sono descritte in dettaglio: *Calappa tuerkayana*, *Pachygrapsus transversus* and *Percnon gibbesi*. Questo studio incrementa le conoscenze sui decapodi del Mar Tirreno meridionale.

Parole chiave: Crostacei Decapodi, campionamento, habitat, distribuzione, Mediterraneo.

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