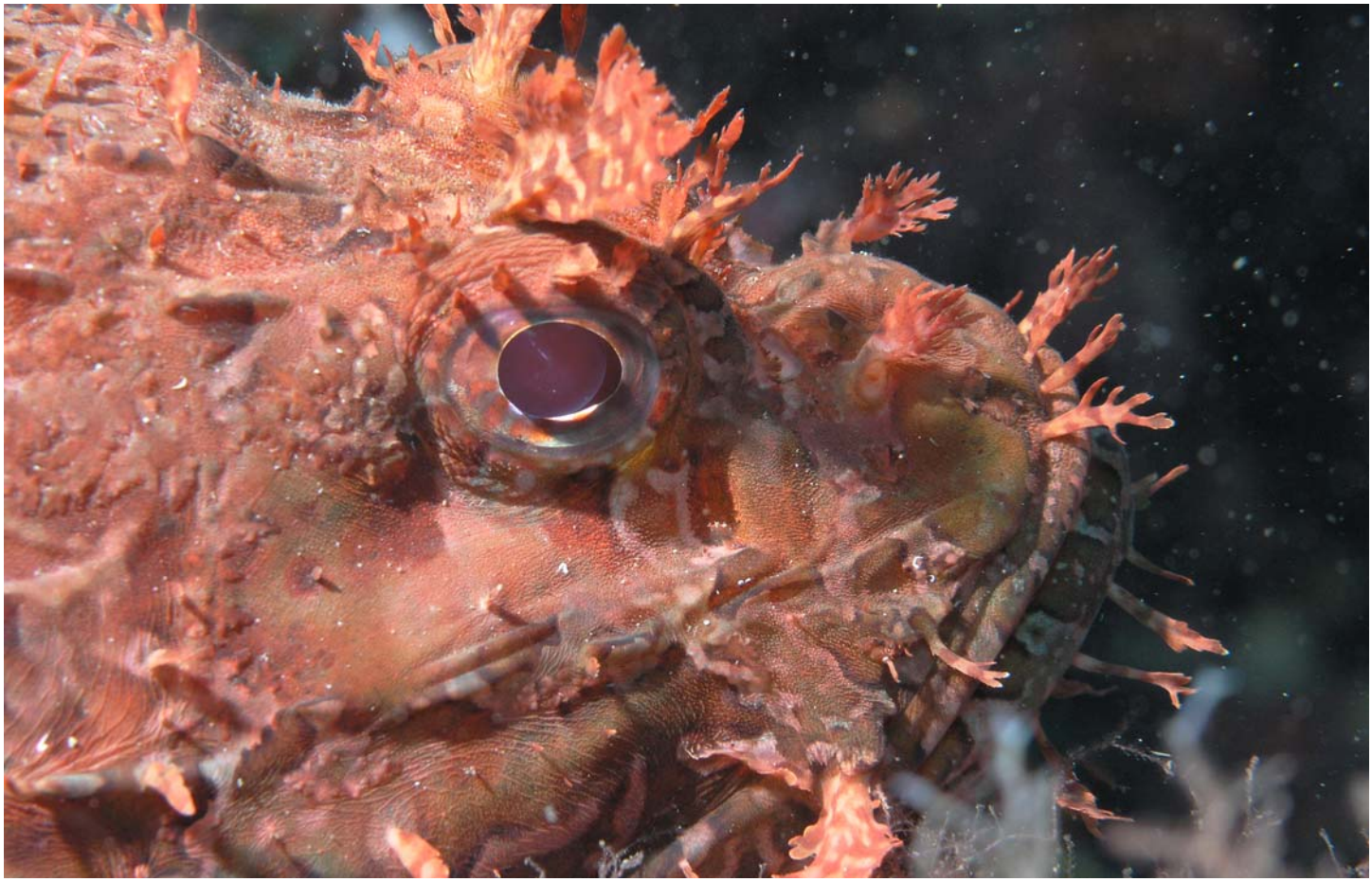
Rostocker Meeresbiologische Beiträge



Zur Fauna des Mittelmeeres

Heft 18

gegründet 1419

Rostocker

Meeresbiologische Beiträge

Fauna des Mittelmeeres

Heft 18

Universität Rostock
Institut für Biowissenschaften
2007

https://doi.org/10.18453/rosdok_id00005362

HERAUSGEBER DIESES HEFTES

Ragnar Kinzelbach
Institut für Biowissenschaften
Allgemeine & Spezielle Zoologie
Universitätsplatz 2
18055 Rostock

HERSTELLUNG DER DRUCKVORLAGE

Patrick Schibat, stud. rer. nat.

CIP-KURZTITELAUFNAHME

Fauna des Mittelmeers / Univ. Rostock,
Inst. f. Biowissenschaften. –
Rostock, 2007. – 143 S. –
(Rostocker Meeresbiologische Beiträge; 18)

ISSN 0943-822X

Universität Rostock, Fachbereich Biowissenschaften, 18051 Rostock

BEZUGSMÖGLICKEITEN:

Universität Rostock
Universitätsbibliothek, Schriftentausch
18051 Rostock

Allgemeine & Spezielle Zoologie (s. o.)

DRUCK:

Universitätsdruckerei Rostock 911-07

Umschlagfoto

Titel: Großer Roter Drachenkopf (*Scorpaena scrofa*), 5.11.2007 in 15m Tiefe, Felslitoral um die Plattform Mar Azul des Club Cala Azul (Ibiza, Spanien). Finder: Dr. Florian Peine, Footograf: Stefan Fischer

Rückseite: Gottesanbeterin (cf *Iris oratoria*), an Hauswand im Club Cala Llenya (Ibiza, Spanien). Finder und Fotograf: Stefan Fischer

Inhalt

Vorwort

Die Kulturen rund um das Mittelmeer sind ein Kernstück europäischer Identität und Bildung. In Wellen, als karolingische, ottonische oder als die „richtige“ Renaissance schlugen Strahlkraft und Leichtigkeit der Mediterraneis bis zum Ostseestrand. Man erinnere sich nur an „unseren“ Ulrich von Hutten (1488-1523), Vorkämpfer für einen deutschen Humanismus, der zwar von Greifswald kommend in der Rostocker Heide erst einmal unter die Räuber fiel, dann jedoch auf die hilfreiche Rostocker Universität und ihre (damals) aufgeschlossene Professorenschaft lateinische Lobeshymen dichtete.

Auch für Biologen im Norden ist das Mittelmeergebiet, zu Land und zu Wasser, Ziel eines unabdingbaren „*tour d'horizon*“, (mindestens) einer den geistigen Horizont erweiternden Bildungsreise, für das Allgemeine und Spezielle. Letzteres, auf das Fach bezogen, veranlasst durch den Reichtum an Endemiten und Relikten an Land und der aus Tethys, Indik und Atlantik zusammengewürfelten, reichen maritimen Biodiversität. Keine Systematische Zoologie ohne Exkursionen ins Mittelmeergebiet.

In Rostock hat dies Tradition. Gleich am Anfang steht ein Experte für orientalische Sprachen und ein Liebhaber von Meeresconchylien, der 1775 unsere Sammlung gegründet hat: Oluf Tychsen (1734-1815), der auch zoologische Fragen mit seiner mediterranen Sprachkultur verband, etwa in der Übersetzung und Kommentierung einer Abhandlung über die Heuschrecken (1787) des Don Ignacio de Asso y del Rio oder in der Übersetzung aus dem Altsyrischen und Bearbeitung des Physiologus Syrus, einer spätantiken Naturgeschichte der Tiere (1795). Im Jahre 1801 schwang er sich sogar zu einem handschriftlichen System der Vögel auf (HRO Mss. Orient. 281,9, 4 Bl. 8o).

- Nur drei weitere Rostocker Mittelmeerforscher seien genannt: Johann Friedrich Link (1767-1851), Universaltalent, reiste mit dem Grafen Johann Centurius v. Hoffmannsegg (Ehrendoktor der Universität Rostock) zum Studium der Natur nach Spanien und Portugal, hinterließ ein Reisewerk und eine unvollendete Flora Portugals.
- Franz Eilhard Schulze (1840-1921), Meereszoologe, der - nach Nord- und Ostsee - von seinem Lehrstuhl in Graz die Fauna der Adria studieren konnte, dort z. B. den Tierstamm der Placozoa entdeckte und später u. a. Gründer des Berliner Naturkundemuseums wurde.
- Ludwig Will (1861-1946), vielseitiger Extraordinarius, der in einer seiner Eigenschaften, nämlich als Meereszoologe, zeitweise jeden Sommer auf Menorca und der Isla del Ayre verbrachte und neben Reptilien auch Meerestiere sammelte und bearbeitete, die heute noch in der Zoologischen Sammlung aufbewahrt werden.

Auch die heute aktiven Wissenschaftler am Lehrstuhl für Allgemeine und Spezielle Zoologie der Universität Rostock haben vom Mittelmeer und der mit ihm befassten „*scientific community*“ in vielfältiger Verflechtung wissenschaftlich Gewinn gezogen. Hervorgehoben seien hier nur die Aktivitäten und Verdienste von Carsten H. G. Müller, der durch ein Jahrzehnt Studierende vor allem nach Ibiza geleitet, ihr Interesse geweckt und ihnen Sachkunde beigebracht hat. Dies unter Einsatz persönlicher Ressourcen und unter Hinanstellung scheinbar wichtigerer Aufgaben. Einige der Resultate werden in diesem Heft der Rostocker Meeresbiologischen Beiträge, auch als Dank an ihn, festgehalten.

Ragnar Kinzelbach
Rostock, 15. November 2007

The avifauna of Ibiza: an updated checklist including comments on abundances and ecology

By Thomas Kellner, Mathias Krech, Axel Schulz & Carsten H. G. Müller

Kellner T., Krech M., Schulz A. & C.H.G Müller (2007): The avifauna of Ibiza: an updated checklist including comments on abundances and ecology. Rostocker Meeresbiologische Beiträge 18: S. 7-29

Abstract. The Balearic Islands Menorca, Mallorca, Ibiza and Formentera are known to be of immense significance for European birds migrating to the South. They are used either as intermediate stops on the route to Africa or as the final winter destination. The Balearic bird communities also incorporate many permanent residents, however. The seasonal dynamics and the specific island situation have fascinated bird watchers for centuries. Continuing this tradition, the authors investigated the avifauna of Ibiza in the course of five excursions, carried out in the spring and fall of the years 1998-2001. Altogether, 110 bird species were identified audiovisually in various habitats around the coasts of Ibiza and the hilly landscape behind the coastline. The authors present a species list with comments on biology and ecology. Zoogeographical remarks are made regarding the spread of the Eurasian Collared Dove (*Streptopelia decaocto*). New data on the feeding ecology of three species are given: Barn Owl (*Tyto alba*), Long-eared Owl (*Asio otus*), and Woodchat Shrike (*Lanius senator*).

Kurzfassung. Die Balearen Menorca, Mallorca, Ibiza and Formentera spielen eine wichtige Rolle für europäische Vögel auf dem Weg zu ihren Winterquartieren. Sie werden als Zwischenstation auf dem Weg nach Afrika genutzt oder zur auch selbst Überwinterung. Daneben gibt es viele Brutvögel. Der jahreszeitliche Wechsel und die Inselsituation haben Vogelbeobachter seit Jahrhunderten fasziniert. Die Autoren folgten dieser Tradition und erstellten im Verlauf von fünf Exkursionen nach Ibiza im Frühjahr und Herbst der Jahre 1998-2001 eine kommentierte Artenliste mit Angaben zur Biologie und Ökologie. Insgesamt 110 Vogelarten wurden audiovisuell in Habitaten an der Küste und im anschließenden Hügelland identifiziert. Zoogeographische Überrlegungen erfolgen zur Ausbreitung der Türkentaube (*Streptopelia decaocto*). Es erfolgen neue Angaben zur Nahrungsökologie von Schleiereule (*Tyto alba*), Waldohreule (*Asio otus*) und Rotkopfwürger (*Lanius senator*).

Key words: Balearic Islands, Ibiza, bird species, checklist, ecology

Introduction

Besides the millions of tourists who visit the Balearic Islands in every year, the four islands Menorca, Mallorca, Ibiza, and Formentera (the latter two also known as the Pityusic Islands) also attract many people interested in exploring their specific fauna and flora. Particular attention has been paid to the bird fauna inhabiting terrestrial, littoral, marine, and sometimes also fresh water areas. According to the review of V. JORDANS (1914, 1933), ornithological observations on the Balearic Islands have a long tradition and date back to the year 1653 when the first reports on the bird fauna

of Mallorca were published. Further classical avifaunistic explorations were conducted several times during the course of the 18th and 19th centuries for all the Balearic Islands. Modern overviews of Balearic avifauna have been provided by V. JORDANS (1914), MESTER (1971), BANNERMAN & BANNERMAN (1983), and CLAVELL I CORBERA (2002). The authors reviewed ornithological observations, even those providing data on the ecology of one single species, carried out during the 20th century. To date, 489 bird species are known to occur in Spain (without the Canary Islands), 436 of which are recorded to have flown over the province Catalunya (DE JUANA ET AL. 2000). 427 bird species have so far been recorded temporarily visiting or permanently living on the Balearic Islands, among them many exotic species (MAYOL 2003).
Numerous bird species set off from their European breeding habitats and migrate towards African territories, where they spend the European winter period. Migrating birds on their way south which usually choose the western course over the Iberian peninsula and/or the short passage over the Western Mediterranean Sea, but are known to visit the Balearic Islands. The structure of pan-balearic bird migration has been well described by many authors, in specific studies as well as in general avifaunistic publications (e. g., GOETHE 1933, MOREAU 1953, MOREAU & MOREAU 1953, BLONDEL & VIELLIARD 1966, JENNING 1972, BAIRLEIN 1985).

Since 1973, when the union of environmental research, or GOB[1] (Grup Balear d´Ornitologia i Defensa de la Naturalesa) was founded, the number of ornithological observations has increased considerably. The GOB has also successfully initiated Balearic ornithological research in the fields of zoogeography, ecology and behaviour and critically evaluated incoming data. Since 1985, GOB activity has resulted in the publication of annual ornithological reports, Anuari Ornitològic de les Balears (e. g. REBASSA ET AL. 1998; GONZÁLEZ ET AL. 2000, 2002; RIERA et al. 2001; SUÁREZ ET AL. 2004, 2005; MARTÍNEZ ET AL. 2006). Most recently, two inventories of the avifauna of certain regions of Ibiza have been published: the “Parc Natural de Ses Salines”, including the salt flats (MARTÍNEZ 2003: 54 species recorded) and the northern part of the island, which is mostly free of anthropogenic influences (PALERM & CARDONA 2004).

Although the established network of GOB-related ornithological activity has produced many useful data on the structure, diversity and dynamics of Balearic bird communities, we believe that there is still space for additional studies, especially because the density of avifaunistic observations for the four Balearic Islands is not always the same. Therefore, we set out to explore the avifauna of Ibiza in five field excursions and some additional experiments on the feeding ecology of certain resident species. The present paper provides a summary of these investigations and tries to contribute to a better understanding of habitat selection and temporal co-existence of breeding and migrating birds on Ibiza.

Materials and methods

Ornithological observations were carried out during five excursions to Ibiza in the years 1998-2001. Observations were made at different times of the year with the aim

[1] http://www.gobmallorca.com

of covering the different succession stages within the bird community caused by transcontinental migrants. Very thorough studies were conducted during March and April 1999, 2000 and 2001. Additional data were obtained from excursions in the fall of the years 1998 (October) and 1999 (November), with reduced personnel, however. Birds were determined either visually with the aid of binoculars and/or by recording the song. Where possible, the number of bird species present in a given habitat was counted visually. With regard to the study area, the main focus of our bird watching activity was the north east of the island, and more precisely a triangle including the town and surroundings of Santa Eulària des Riu, the village Sant Carles de Peralta and the littoral areas of the north eastern coastline., We also checked other localities such as both parts of the salt flats ("regió grossa" and "regió petita") in the south of Ibiza which are located between the airport and Puig des Falcó.

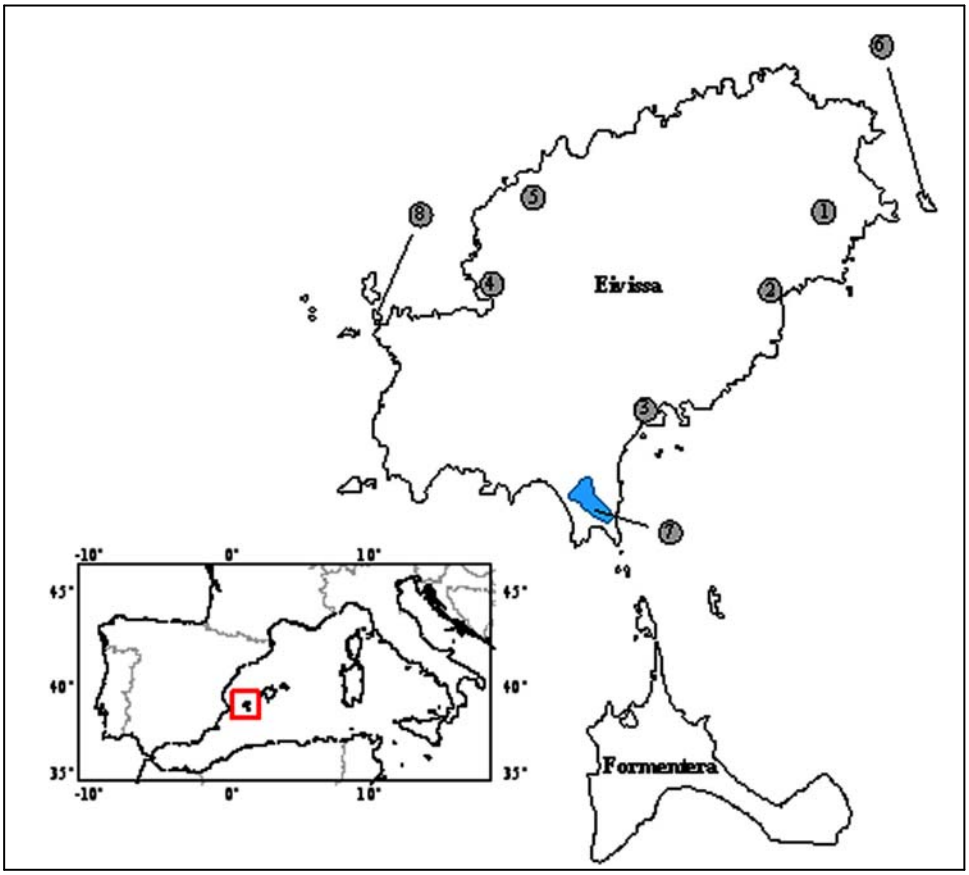


Fig. 1. Map of the Pityusic Islands Ibiza and Formentera and their geographical position within the Western Mediterranean basin (red square in the left figure). The numbered circles inside the map indicate settlements and some bird watching sites. 1 – Sant Carles de Peralta 2 – Santa Eulària des Riu 3 – Eivissa 4 – Sant Antoni de Portmany 5 – Sta. Agnès de Corona 6 – Island of Tagomago 7 – Salt flats 8 – Island of Illa des Bosc.

Efforts were made to include the main terrestrial and marine littoral habitats characterized by a specific geological profile and vegetation, including ruderal locations near villages, urbanisations or big towns, agricultural fields (with red soil, "terra rossa" and often lined by spacious brick walls), pinewood forests (dominated by *Pinus halepensis* and *P. pinea*), degraded bushy areas close to the coast ("Macchie", "Garrigue"; e. g. juniper trees), waste disposal sites (near the Cala

Olivera), golf courses, sandy beaches, rocky shores (including the steep wall formations lining the coast of the north west of Ibiza), small islands situated in the vicinity of Ibiza's coastline, and finally the open sea. Figure 1 provides an overview of all the major urbanisations and villages in Ibiza and, moreover, of all those areas visited for our ornithological observations.

Results and discussion

A total of 110 bird species were recorded for Ibiza while undertaking extensive ornithological observations in March/April 1998-2001 and October/November 1998-1999, including both permanent residents and migratory birds. The species list with remarks on abundances, habitat preferences and status classification is given in the appendix.
Our observations are not always congruent with the results obtained by two comprehensive studies by MARTÍNEZ (2003) and PALERM & CARDONA (2004). For instance, our list for those bird species inhabiting Ibiza's salt flats lacks certain species more recently identified by MARTÍNEZ (2003), including residents such as the Water Rail (*Rallus aquaticus*) or the Pheasant (*Phasianus colchicus*). One reason for this incongruency is clearly the longer time span the authors mentioned had for their observations.
Observations on the distribution of the Eurasian Collared Dove (*Streptopelia decaocto* and data on the feeding ecology of the Barn Owl (*Tyto alba*), Long-eared Owl (*Asio otus*) and the Woodchat Shrike (*Lanius senator*) are discussed in detail.

The population of the Eurasian Collared Dove (*Streptopelia decaocto*) in Ibiza.

In the framework of the excursions 1999-2001, the Eurasian Collared Dove (*Streptopelia decaocto*) was only observed in the eastern part of Ibiza, close to the coastal line. According to our observations, *S. decaocto* occurs in all urbanisations, pinewood forests and agricultural zones situated between the beach Cala Mastella (northeast of Ibizas and Jesús) and north of the capital Eivissa. To date, we have no explanation for the absence of *S. decaocto* from all other parts of the island (Fig. 2). It is well known that the distribution of *S. decaocto* in Europe shows periodical changes which can be best described as oscillations. Accordingly, the first Italian record of *S. decaocto* in Italy in 1944 was due to a westerly expansion of the population in southeast Europe. In the 1970s, there was a further westerly expansion, including to Corsica and southern France. Since 1974, *S. decaocto* is reported to have settled and successfully bred in northwest Spain and in Portugal (HOFSTETTER & STERNER 1994). However, there is no evidence in previous literature for the occurrence of the Eurasian Collared Dove on the Balearic Islands (V. JORDANS 1914, MESTER 1971, MAYOL 1990, HEARL 1996, HEARL & KING 1996). Recently, MAYOL (2003) stated that *S. decaocto* is a breeding resident on the Balearic Islands and has a tendency to extend its range further south and west. Most recently, his view was confirmed by MARTÍNEZ ET AL. (2006) who consider *S. decaocto* to be a permanent breeding resident in Menorca, common in Mallorca but rather rare in Ibiza. Martínez and his co-workers propose a timeline of immigration according to which Mallorca was first reached somewhere in the 1990s, followed by Menorca in 1997, followed Ibiza in 1999, and finally Formentera in 2004. Altogether, the literature hitherto screened contains the following records for *S. decaocto* in Ibiza: 1997 – Cala Llonga, Santa Eulària des Riu and Sant Antoni de Portmany

(REBASSA et al. 1998; 1999) – Can Marines, Santa Eulària des Riu and Sant Antoni de Portmany (GONZÁLEZ ET AL. 2000, 2000) – Sant Joan (RIERA ET AL. 2001, 2001) – Santa Eulària des Riu (GONZÁLEZ ET AL. 2002, 2003) – salt flats (SUÁREZ ET AL. 2004) – Sant Jordi and Can Verger (SUÁREZ ET AL. 2005).

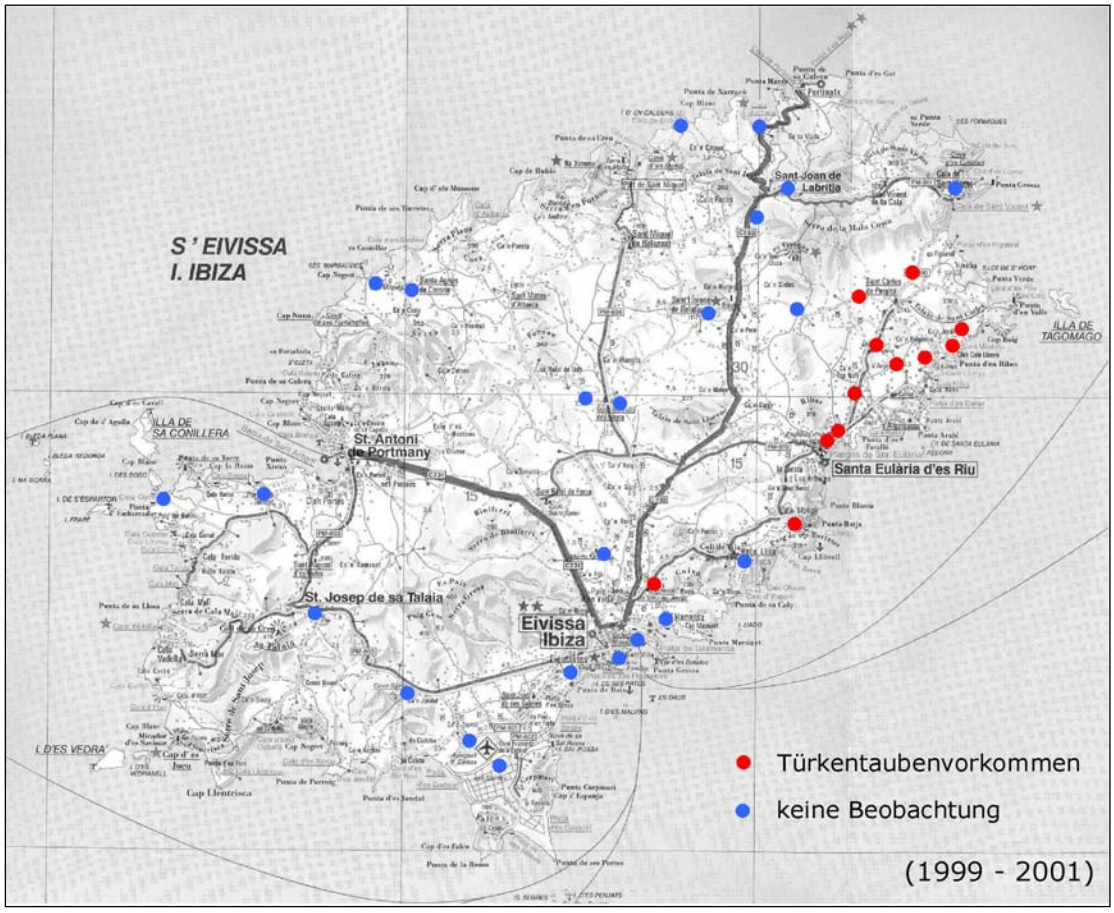


Fig. 2. Distribution of the Eurasian Collared Dove *Streptopelia decaocto* on the island of Ibiza according to our observations between 1999 and 2001 (a red dot indicates the presence of more than one individual).

Based on our recent observations, previous views of the distribution of *S. decaocto* on the island of Ibiza have to be modified. On the one hand, the sharply delimited occurrence along the eastern coast and associated hinterlands fits very well those descriptions given in previous literature (Fig. 2). On the other hand, we are not able to confirm the alleged population near Sant Antoni de Portmany, Sant Joan (both villages located in the western part of Ibiza) and the salt flats in the South.
Therefore we assume that the new population of *S. decaocto* in Ibiza stems from specimens having flown over from Mallorca. Even though it is so far uncertain in which year this immigration took place, the limited presence of the species along the eastern coast of Ibiza and the fact that the island of Mallorca is located north-easterly of Ibiza clearly speaks for this general course of expansion. Formentera was then most likely populated by immigrants having left Ibiza. Our assumption is again confirmed by the timeline of recorded immigration in all Balearic Islands: Ibiza in 1999, Formentera in 2004. The geographical proximity of Formentera, located approximately ten kilometres south of Ibiza (Fig. 1), obviously facilitates the further, southerly expansion of the range of *S. decaocto*.

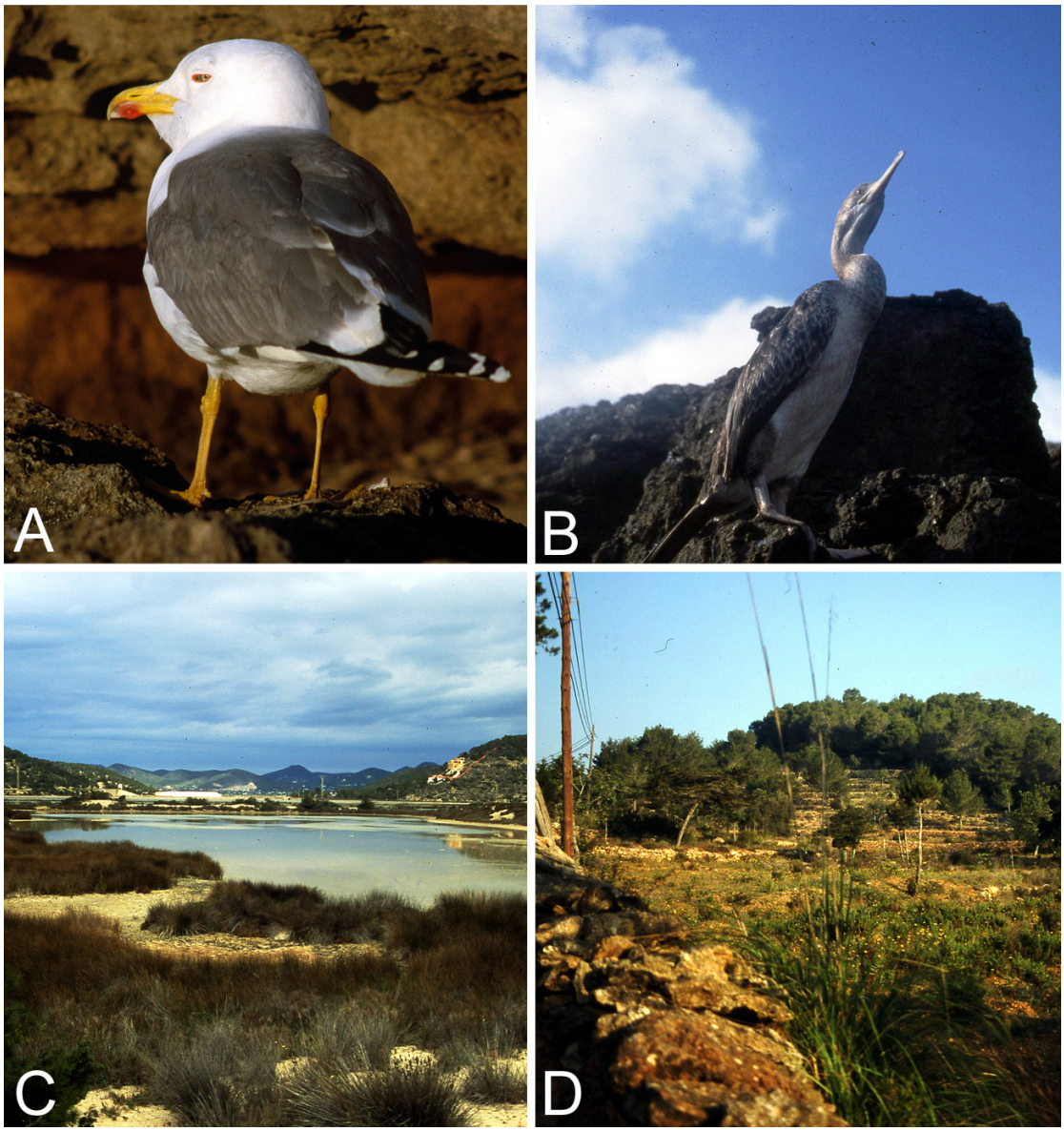


Fig. 3 A-D. A-B. Portraits of two bird species abundant in Ibiza. A. Yellow-legged Gull (*Larus michahellis)*. B. European Shag (*Phalacrocorax aristotelis)*. C-D. Two characteristic habitats in Ibiza investigated with respect to the avifauna. C. View of the smaller part of the salt flats ("régio petita") close to the airport in the South of Ibiza. D. View of a cultivated landscape showing pine trees (e. g. *Pinus halepensis)* and agricultural fields arranged in various terraces. All photographs taken during the excursion in March/April 2000.

The feeding ecology of the Barn Owl (*Tyto alba*). In spring of the years 2001 and 2002, hundreds of *Tyto alba* pellets, each containing the remains of digested prey, were collected in a long disused quarry located southwest of Sant Carles de Peralta (SOMMER ET AL. 2005). A thorough examination showed that 2,767 vertebrate individuals had been eaten by *T. alba* within and around the finding location. Among these vertebrates, mammals were the dominant group (91,8%), followed by other bird species (6,0%) and reptiles (2,2%). Furthermore, SOMMER ET AL. (2005) detected one individual of the Iberian Water Frog (*Rana perezi*) and 12 specimens belonging to different insect taxa (Scarabaeidae und Saltatoria). One important result of this study was the first record of the European free-tailed bat (*Tadarida teniotis*) for Ibiza.

SOMMER et al. (2005) moreover highlighted the unexpected presence of 14 captured specimens of the Pityusic lizzard (*Podarcis pityusensis*) in the prey spectrum of *T. alba*. The finding of *P. pityusensis* in the pellets of *T. alba* is even more surprising as the activity rhythms of the two species do normally not overlap.

The feeding ecology of the Long-eared Owl (*Asio otus*). In spring 2001, hundreds of *Asio otus* pellets were collected by R. Sommer and H. Zoller in a quarry near Sant Miquel de Balansat which has been not in use for many decades. These pellets were analyzed for bones or integumental remains of vertebrates as well as for exoskeletons of insects (Tab. 1). The results of this analysis not only give us interesting insights into the preferences of *A. otus* as a predator but also show the composition of the fauna of small vertebrates. Based on this analysis by Sommer and Zoller (who kindly provided unpublished data), we now know that, among vertebrates, the mouse species *Apodemus sylvaticus* represents the preferred prey organism. Pine forests seem to be the main hunting habitat of the Long-eared Owls examined. It is, however, a remarkable fact that in terms of quantity bird species (63,7%) contribute more to the feeding spectrum of *A. otus* than small mammals (36,4%). The high percentage of birds in the feeding spectrum of *A. otus* is astonishing since it is not well documented in the literature. One necessary condition for this prey spectrum is a high availability of birds in the vicinity of the hiding and breeding places of the Long-eared Owl (GLUTZ VON BLOTZHEIM & BAUER 1994).

Table 1. Results of the prey analysis of Long-eared Owls *Asio otus* from a quarry near Sant Miquel de Balansat (Ibiza, Spain) according to Sommer (hitherto unpublished material, here partly used with kind permission). Bird remains were determined by J. Fiebig and S. Frahnert (Museum für Naturkunde Berlin).

Prey species	Minimum number of individuals n	Total of prey individuals %
Mammalia		
Rattus rattus	1	0,4
Rattus sp.	5	2,1
Apodemus sylvaticus	68	28,1
Mus spretus	9	3,7
Crocidura russula	5	2,1
Total	88	36,4
Aves		
Passer domesticus	38	15,7
Carduelis chloris	22	9,1
Carduelis carduelis	5	2,1
Fringilla coelebs	29	12,0
Serinus serinus	25	10,3
Sylvia sp.	14	5,8
Parus sp.	1	0,4
Fringillidae undet.	1	0,4
Passeriformes undet.	19	7,9
Total	154	63,7
Total number	242	100,0

The feeding ecology of the Woodchat Shrike (*Lanius senator*). In spring 1999, mummified remains of the prey of *Lanius senator* were found speared on the upper tips of the barbed wire separating Ibiza Airport from the "regió grossa", the more extended part of the salt-winning fields and the Ericaceae-dominated vegetation surrounding these salt flats. A detailed examination of the prey remains revealed that *L. senator* seems to prefer specimens of the Pityusic lizard *Podarcis pityusensis* (21 carcasses found along approximately one kilometre of the entire fence line), followed by one specimen each of the common land snail *Helix aspersa*, an unidentified beetle and one bumble-bee. Two years later, in spring 2001, a further examination of the same part of the airport fence line revealed a much lower quantity of speared prey. Only four beetles and two bumble-bees were discovered.
The spectrum and appearance of prey fit well to descriptions given for *L. senator* and its strategies for treating captured animals. However, *L. senator* was never observed actively killing or spearing lizards or insects. With the exception of some species passing by on the islands of Ibiza and Formentera, the Woodchat Shrike is the only *Lanius* species observed which is also generally known to occur in Ibiza and to populate the salt flats in particular. Specimens of *L. senator* living on the other Pityusic Island Formentera preferably feed on *Podarcis pituysensis* and on chicks of the Kentish Plover (*Charadrius alexandrinus* (MESTER 1971). However, the action of capturing and spearing or clamping the prey is thought to be unusual for the Woodchat Shrike. The spectrum of prey organisms widely contains insects of various taxa, only under exceptional circumstances are small vertebrates killed (GLUTZ VON BLOTZHEIM & BAUER 1993).

References

BAIRLEIN F. 1985: Offene Fragen zur Erforschung des Zuges paläarktischer Vogelarten in Afrika. Die Vogelwarte 33: 144-155.

BANNERMAN D.A. & BANNERMAN W.M. 1983: The birds of the Balearics. Publishing House of Christopher Helm, London.

BEAMAN M. 1994: Palearctic birds: a checklist of the birds of Europe, North Africa and Asia north of the foothills of the Himalayas. Harrier Publications, Stonyhurst.

BLONDEL J. & VIEILLARD J. 1966: Sobre migracion y avifauna en Mallorca, primavera 1963. Ardeola 11: 85-94.

CLAVELL I. & CORBERA J. 2002: Catàleg dels ocells dels Països Catalans Catalunya, Paìs Valencià, Illes Balears, Catalunya Nord: Lynx Edicions, Barcelona.

DE JUANA E., GUTIÈRREZ R. & LORENZO J.A. 2000: A list of the birds of Spain. Spanish Rarities Committee. Mimeogr. Report., Barcelona.

GLUTZ VON BLOTZHEIM U.N. & BAUER K.M. 1993: *Lanius senator* Linneaus, 1758 - Rotkopfwürger. In: GLUTZ VON BLOTZHEIM U.N. ed., Handbuch der Vögel Mitteleuropas. Band 13/II. Passeriformes Teil 4: 2. Auflage. Aula-Verlag, Wiesbaden, pp. 1328-1365.

GLUTZ VON BLOTZHEIM U.N. & BAUER K.M. 1994: *Asio otus* Linneaus, 1758 - Waldohreule. In: GLUTZ VON BLOTZHEIM U.N. ed., Handbuch der Vögel Mitteleuropas. Band 9. Columbiformes-Piciformes. 2. Auflage. Aula-Verlag, Wiesbaden, pp. 386-421.

GOETHE F. 1933: Zum Vogelzug auf den Balearen. Mitteilungen über die Vogelwelt 32 10-12: 103-109.

GONZÁLEZ J.M., REBASSA M., LÓPEZ-JURADO C., MARTÍNEZ O. & PALERM J.C. 2000: Registres Ornitològics. Anuari Ornitològic de les Balears 1999 14: 41-122.

GONZÁLEZ J.M., REBASSA M., LÓPEZ-JURADO C., MARTÍNEZ O. & GARCÍA D. & COSTA S. 2002: Registres Ornitològics. Anuari Ornitològic de les Balears 2001 16: 83-171.

HEARL G. 1996: A birdwatching guide to Menorca, Ibiza and Formentera. Arlequin Press, Chelmsford.
HEARL G. & KING J. 1995: A birdwatching guide to Mallorca. Arlequin Press, Chelmsford.
HELBIG A.J. 2005: Anmerkungen zur Systematik und Taxonomie der Artenliste der Vögel Deutschlands. Limicola 19 2: 112-128.
HOFSTETTER F.B. & SCHERNER E.R. 1994: *Streptopelia decaocto* Frivaldszky, 1838 - Türkentaube. In: GLUTZ VON BLOTZHEIM, U.N. ed., Handbuch der Vögel Mitteleuropas. Band 9. Columbiformes-Piciformes. 2. Auflage. Aula-Verlag, Wiesbaden, pp. 98-141.
JENNING W. 1972: Zum Greifvogelzug über Mallorca Balearen: Die Vogelwarte 26 3: 315.
MARTÍNEZ O. 2003: L'avifauna. In: GEN-GOB Eivissa eds., El parc natural de ses salines d'Eivissa i Formentera. El tresor ecològic de les Pitiüses. Genial Edicions Culturals, Ibiza, pp. 40-77.
MARTÍNEZ O., GARCÍA D., COSTA S., LÓPEZ-JURADO C., GONZÁLEZ, J.M., REBASSA M. & PONS A. 2006: Registres Ornitològics 2005. Anuari Ornitològic de les Balears 2005 20: 129-249.
MAYOL J. 1990: The birds of the Balearic Islands. Editorial Moll, Palma de Mallorca.
MAYOL J. 2003: Els Aucells de les Balears. Editorial Moll, Palma de Mallorca.
MESTER H. 1971: Die Vogelwelt der Pityusen. Bonner Zoologische Beiträge 22 1/2: 28-89.
MOREAU R.E. 1953: Migration in the Mediterranean area. The Ibis 95: 329-364.
MOREAU R.E. & MOREAU W. M. 1953: Migrants on the east coast of Spain. The Ibis 95: 372-375.
PALERM J.C. & CARDONA, E. 2004: La fauna. In: GEN-GOB Eivissa eds., Es amunts d'Eivissa. Vida, cultura i paisatge. GEN-GOB Eivissa, Bahia Indústria Gràfica, Ibiza, pp. 60-85.
REBASSA M., SUNYER J., LÓPEZ-JURADO C., GONZÁLEZ J.M., PONS M., MASCARÓ J., MARTÍNEZ O. & PALERM J.C. 1998: Registres Ornitològics. Anuari Ornitològic de les Balears 1997, 12: 133-199.
RIERA J., GONZÁLEZ J.M., LÓPEZ-JURADO C., MARTÍNEZ O. & PALERM J. C 2001: Registres Ornitològics. Anuari Ornitològic de les Balears 2000 15: 51-155.
SOMMER R., ZOLLER H., KOCK D., BÖHME W. & GRIESAU A. 2005: Feeding of the Barn Owl, *Tyto alba* with first record of the European free-tailed bat, *Tadarida teniotis* on the island of Ibiza Spain, Balearics: Folia Zoologica 54 4: 364-370.
SUÁREZ M., GONZÁLEZ J.M., REBASSA M., LÓPEZ-JURADO C., PONS M. & MARTÍNEZ, O. 2004: Registres Ornitològics. Anuari Ornitològic de les Balears 2003 18: 107-211.
SUÁREZ M., GONZÁLEZ J.M., REBASSA M., LÓPEZ-JURADO C., PONS M. & MARTÍNEZ O. 2005: Registres Ornitològics 2004. Anuari Ornitològic de les Balears 2004 19: 127-240.
VON JORDANS A. 1914: Die Vogelfauna Mallorcas mit Berücksichtigung Menorcas und der Pityusen. Dissertation, Universität Bonn.
VON JORDANS A. 1933: Ein weiterer Beitrag zur Kenntnis der Vogelfauna der Balearen und Pityusen. Anzeiger der Ornithologischen Gesellschaft Bayern 2: 223-250.

Acknowledgements

We would like to thank our colleagues Björn Russow and Holger Prietzsch for having accompanied us on the excursions to Ibiza and supported us with their valuable ornithological knowledge. Dr. Robert Sommer (Staatliches Museum für Naturkunde des Freistaates Sachsen, Dresden) kindly helped us by providing hitherto unpublished data on the feeding ecology of the Long-eared Owl (*Asio otus*).

Appendix: Species list with comments

Depending on the number of observations, the frequency of a given species was assigned either to the category single or occasional observations, meaning that the

species seems to be rare in Ibiza, or to the class of abundant species. The latter category too contains both residents permanently populating and possibly breeding in the terrestrial, littoral and/or marine habitats of Ibiza, and migrants temporarily living on the island. If more than one individual of a given species could be found, the authors were usually able to estimate local abundances. Our estimations of the abundances are moreover compared to the official status all observed bird species in Ibiza are supposed to have, based on the latest report by MARTÍNEZ ET AL. (2006). If compared to other resources in the current literature, specific comments and references are added to the list. The English common names are based on the standard work of BEAMAN (1994). The scientific naming of the 110 bird species listed is in accordance with the current rules of zoological nomenclature. The inner structure of the species list corresponds to the system of HELBIG (2005) which reflects the generally accepted hypothesis on phylogenetic interrelationships among recent bird taxa.

Common Shelduck (*Tadorna tadorna*)
Observations: inhabits salt flats, 2-10 individuals encountered in March/April 1999; one individual in March 2000.
Status: rare summer resident. Occasional resident and migrant during winter.

Mallard (*Anas platyrhynchos*)
Observations: inhabits salt flats, with a maximum frequency of eight individuals in March/April 1999; one male and one female seen in March 2000. In addition, one female accompanied by six juveniles was observed in March/April 1999 near Santa Eulària des Riu.
Status: was seen breeding in 1998. rare winter resident and migrant.

Red-breasted Merganser (*Mergus serrator*)
Observation: only one individual could be spotted in March/April 1999 in the Bay of Santa Eulària des Riu.
Status: rare winter resident.

Red-legged Partridge (*Alectoris rufa*)
Observations: species was generally observed at many locations, however only a single record in March/April 1999. Examples: up to a maximum of six individuals at Serra Grossa (March/April 1999), two individuals north-west of the Cala Llenya (November 1999), three times two individuals at Can Jordi (March 2000), plucked feathers of one individual at the Cala Olivera (March 2000).
Status: sedentary and abundant species.

Common Quail (*Coturnix coturnix*)
Observation: one individual was seen on agricultural fields near salt flats in March/April 1999.
Status: sedentary and abundant species.

Greater Flamingo (*Phoenicopterus roseus*)
Observations: populates salt flats in considerable numbers: 22 individuals in October 1998; maximum of 60 individuals in March/April 1999; more than 170 individuals in November 1999; 22 individuals in March 2000.
Status: summer resident apparently non-breeding, abundant winter resident and migrant.

Black-necked Grebe (*Podiceps nigricollis*)
Observations: lives in salt flats, two individuals found in March/April 1999.
Status: very occasional winter resident and migrant.

Cory's Shearwater (*Puffinus diomedea*)
Observations: generally to be considered a common species, more than 15 individuals recorded flying over the waters around the island of Tagomago in March/April 1999.
Status: occurs in moderate numbers during the summer, in contrast only rare resident in winter.

Balearic Shearwater (*Puffinus mauretanicus*)
Observations: more than 25 individuals recorded flying over the waters around the island of Tagomago in March/April 1999.
Status: abundant during the summer, rarely observed winter resident.

Great Cormorant (*Phalacrocorax carbo*)
Observations: a maximum of five individuals observed at the Port of Santa Eulària des Riu in March/April 1999.
Status: rarely observed winter resident.

European Shag (*Phalacrocorax aristotelis*)
Observations: generally, the species turned out to be quite abundant around the coastal waters of Ibiza in March/April 1999, a maximum number of 40 individuals was observed above the waters around the island of Tagomago (also March/April 1999).
Status: sedentary and abundant species.

Cattle Egret (*Bubulcus ibis*)
Observations: only rarely spotted on agricultural fields west of Santa Eulària des Riu: one individual in October 1998 and one individual in November 1999.
Status: considered to be a rarely occurring winter resident and migrant.

Great Egret (*Casmerodius albus*)
Observations: seen in salt flats: three individuals in March/April 1999.
Status: record possibly due to an accidental deviation from the usual flying routes.

Grey Heron (*Ardea cinerea*)
Observations: regular occurrence detected in March/April 1999, species inhabits salt flats: maximum number up to ten specimens in March/April 1999, only one individual seen in March 2000.
Status: winter resident and migrant in moderate numbers.

Little Egret (*Egretta garzetta*)
Observations: inhabits salt flats: maximum number of ten individuals encountered in March/April 1999, another six individuals in March 2000.
Status: known to be a summer resident species which does not reproduce, also present during wintertime as resident and migrant in moderate numbers.

Osprey (*Pandion haliaetus*)
Observations: very occasionally found in salt flats: one individual each in October 1998 and March/April 1999. Additional observations at Sant Carles de Peralta in March/April 1999 (one individual and north of the Cala Olivera in November 1999).
Status: rare winter resident and migrant, extinct as breeding bird.

Eurasien Marsh Harrier (*Circus aeruginosus*)
Observation: seen once in salt flats in March/April 1999.
Status: rare winter resident, migrant in moderate numbers.

Common Kestrel (*Falco tinnunculus*)
Observations: regular presence recorded in general in March/April 1999, one specimen seen flying over a plain near Santa Agnès de Corona in March 2000.
Status: sedentary and abundant species, also winter resident in moderate numbers.

Eleonora's Falcon (*Falco eleonorae*)
Observations: four specimens observed along the northern coastline in October 1998, a maximum of six individuals also seen on steep walls and cliffs around the island of Tagomago in the same year.
Status: abundant summer resident.

Peregrine Falcon (*Falco peregrinus*)
Observations: one individual spotted north of the golf course close to the urbanisation Roca Llisa in March/April 1999, also two individuals observed on steep walls and cliffs around the island of Tagomago; in addition, one individual in November 1999 west of Sant Antoni de Portmany.
Status: sedentary and abundant species, rarely present as winter resident.

Common Crane (*Grus grus*)
Observation: recorded once strutting through salt flats in March 2000 (one individual).
Status: considered rare winter resident and migrant.

Water Rail (*Rallus aquaticus*)
Observation: recorded once strutting through salt flats in March/April 1999 (one individual).
Status: sedentary but very rare species.

Common Moorhen (*Gallinula chloropus*)
Observations: maximum of ten specimens found close to the mouth of the former river of Santa Eulària des Riu in March/April 1999.
Status: sedentary but rare species (also during wintertime).

Common Coot (*Fulica atra*)
Observation: one specimen seen close to the mouth of the former river of Santa Eulària des Riu in November 1999.
Status: considered to be a rare winter resident and migrant.

Stone-curlew (*Burhinus oedicnemus*)
Observations: three individuals spotted at the margins of Can Vicent d'en Pere in March/April 1999, another five individuals in November 1999 and seven individuals in March 2001 at the same location.
Status: sedentary and abundant species, however rare winter resident and migrant.

Black-winged Stilt (*Himantopus himantopus*)
Observations: regularly lives in salt flats, more than 150 individuals encountered in March/April 1999, further 21 individuals in March 2000.
Status: abundant summer resident, occasional migrant.

Grey Plover (*Pluvialis squatarola*)
Observation: one specimen seen strutting through salt flats in November 1999.
Status: rare winter resident and migrant.

Northern Lapwing (*Vanellus vanellus*)
Observations: seven individuals seen walking in the transition zone between airport and salt flats in November 1999.
Status: winter resident and migrant, occurring in moderate numbers.

Little Plover (*Charadrius dubius*)
Observations: inhabits salt flats, one individual each seen on several days in March/April 1999.
Status: rare but then sedentary species, rare migrant.

Ringed Plover (*Charadrius hiaticula*)
Observations: inhabits salt flats: two individuals observed in March/April 1999, further three individuals in November 1999.
Status: rare winter resident and migrant.

Kentish Plover (*Charadrius alexandrinus*)
Observations: inhabits salt flats: 6-9 individuals observed in March/April 1999, another two individuals seen in November 1999 as well as nine individuals in March 2000.
Status: sedentary and abundant species, as a migrant especially abundant during the winter period.

Common Sandpiper (*Actitis hypoleucos*)
Observations: single observations along the entire coast of Ibiza and in salt flats in March/April 1999.
Status: considered a non-breeding summer resident, also very occasional resident and abundant migrant in the winter.

Common Redshank (*Tringa tetanus*)
Observations: two individuals noticed strutting through salt flats in November 1999.
Status: rare winter resident, also migrates in moderate numbers.

Common Greenshank (*Tringa nebularia*)
Observations: occasionally detected strutting through salt flats: each one individual in October 1998 and March 2000, two individuals in November 1999.
Status: rare winter resident and migrant.

Green Sandpiper (*Tringa ochropus*)
Observation: one individual observed strutting through salt flats in March/April 1999.
Status: rare winter resident and migrant.

Wood Sandpiper (*Tringa glareola*)
Observations: 1-3 individuals seen strutting through salt flats in March/April 1999.
Status: migrant in moderate numbers.

Little Stint (*Calidris minuta*)
Observations: populates salt flats, more than 20 individuals seen in November 1999.
Status: winter resident and migrant in moderate numbers.

Dunlin (*Calidris alpine*)
Observations: inhabits salt flats, four individuals observed in November 1999.
Status: exceptional winter resident, but migrates in moderate numbers.

Great Skua (*Stercorarius skua*)
Observations: two individuals watched flying the bird over the Balearic Sea between the islands of Mallorca and Ibiza in March/April 1999 as well as one individual a fair distance from the eastern coastline of Ibiza in March/April 1999.
Status: presence surprising and probably accidental.

Unidentified Gull species (*Larus* sp.)
Observations: about 500 individuals flying above and feeding on a waste disposal site near the Cala Olivera in March 2000.

Black-headed Gull (*Larus ridibundus*)
Observations: occasionally visits salt flats, some observations made in March/April 1999.
Status: abundant winter resident and migrant.

Audouin's Gull (*Larus audouinii*)
Observations: generally regular occurrence (maximum group size about ten individuals) in March/April 1999 and 2000.
Status: sedentary species, occurring in moderate numbers.

Yellow-legged Gull (*Larus michahellis*)
Observations: generally appears abundant with a maximum of 100 individuals seen around the entire coast of Ibiza in March/April 1999 and 2000, possible breeding site discovered on the Island Illa des Bosc in March 2000.
Status: sedentary and abundant species.

Great Black-backed Gull (*Larus marinus*)
Observation: one sole individual observed flying around the island of Tagomago in October 1998.
Status: presence not regular, probably due to an accidental deviation from normal migration routes.

Rock Pigeon (*Columba livia domestica*)
Observation: plucked feathers of one individual of an almost white domestic specimen found near the Cala Olivera in March 2000 (kindly determined by Dr. W.-D. Busching; Naumann-Museum Köthen).
Status: No comments on the status of domestic *Columba livia* on Ibiza. Birds of domestic origin were reported to have bred on Mallorca in 2005. According to MAYOL (2003), individuals escaped from captivity have been observed breeding on Ibiza several times.

Common Wood Pigeon (*Columba palumbus*)
Observation: one individual observed at Sant Miquel de Balansat in March 2001.
Status: sedentary species, occurring in moderate numbers.

Eurasian Collared Dove (*Streptopelia decaocto*)
Observations: regularly seen in the eastern part of Ibiza, particularly frequent between the Cala Mastella and Jesús in March/April 1999, groups up to four individuals watched almost daily near and within the club areas of Can Jordi and Cala Llenya in March/April 2000.
Status: sedentary but seemingly rare species.
Addition: for details on observations, distribution and range expansion see chapter “results and discussion”.

Barn Owl (*Tyto alba*)
Observations: one individual spotted at Santa Eulària des Riu in March/April 1999, also regularly seen westerly of the Club Can Jordi (one individual per day in March 2001).
Status: sedentary species and winter resident in moderate numbers.
Addition: For results of dietary analyses see chapter “results and discussion”.

Eurasian Scops Owl (*Otus scops*)
Observations: according to brief sightings, the species seems to be regularly but singly distributed among the various terrestrial habitats in Ibiza, even though small groups of up to six individuals could be located in the surroundings of Can Vicent d’en Pere (data from March/April 1999).
Status: sedentary and winter resident abundant in number.

Long-eared Owl (*Asio otus*)
Observations: one individual spotted on the steep rocky walls of the urbanisation La Joya (situated between the beaches Cala Llenya and Cala Nova) in November 1999, furthermore two individuals observed in a quarry southeast of Sant Miquel de Balansat in March 2001.
Status: sedentary but rare species.
Addition: for more detailed data on feeding ecology of *Asio otus* see chapter “results and discussion”.

Common Swift (*Apus apus*)
Observations: common bird over the entire territory of Ibiza, with a maximum number of 100 individuals in one location (data from March/April 1999); five individuals seen in salt flats in March 2000.
Status: abundant summer resident and migrant.

Pallid Swift (*Apus pallidus*)
Observations: regularly occurring species, but only going by single observations (data from March/April 1999).
Status: rare summer resident, also migrant in moderate numbers.

Alpine Swift (*Apus melba*)
Observation: one individual observed at Can Fulgencio in March/April 1999.
Status: possibly summer resident, also potential but rarely occurring migrant.

European Bee-eater (*Merops apiaster*)
Observations: five individuals observed at the Club Cala Llenya in March/April 1999, further 35 individuals near Santa Agnès de Corona in the same time period.
Status: summer resident present in moderate numbers, also abundant as migrant.

Hoopoe (*Upupa epops*)
Observations: appeared to occur regularly in various habitats in March/April 1999, especially abundant on freshly ploughed agricultural fields near Santa Agnès de Corona; further single observations made in March/April 2000.
Status: sedentary species, also enters Ibiza as a migrant in abundant numbers.

Eurasien Wryneck (*Jynx torquilla*)
Observations: regular appearance during March/April 1999.
Status: sedentary species, also winter resident and migrant occurring in moderate numbers.

Woodchat Shrike (*Lanius senator*)
Observations: regular appearance during March/April 1999 and March 2000, especially conspicuous close to salt flats, its prey (e.g. the Pityusic lizzard *Podarcis pityusensis*) fixed on the tips of the barbed wire bordering the airport area.
Status: abundant summer resident and migrant.
Addition: for results of diet analyses see chapter “results and discussion”.

Common Raven (*Corvus corax*)
Observations: appeared regularly in all terrestrial habiats investigated (data from March/April 1999), two individuals observed northerly of the Club Can Jordi in April 2000.
Status: sedentary species present in moderate numbers.

Great Tit (*Parus major*)
Observations: a common species in all terrestrial habitats studied (data from March/April 1999); furthermore, up to three individuals were noticed daily around the Club Can Jordi in March/April 2000 as well as each one individual on the agricultural plain near Santa Agnès de Corona and on the waste disposal site near the Cala Olivera in March 2000.
Status: sedentary and abundant species.

Greater Short-toed Lark (*Calandrella brachydactyla*)
Observations: spotted on agricultural fields near salt flats: 25 individuals in March/April 1999.
Status: summer resident and migrant appearing in moderate numbers.

Thekla Lark (*Galerida theklae*)
Observations: regularly seen, in groups of a minimum of three individuals, at salt flats as well as around and within the villages Santa Agnès de Corona, Sant Carles de Peralta and Santa Gertrudis de Fruitera in March/April 1999; further observations made in March 2000 at Port des Torrent (one individual), on the agricultural plain near Santa Agnès de Corona (two individuals) and at Escull de ses Punxes (two individuals).
Status: abundant resident

Sky Lark (*Alauda arvensis*)
Observations: two individuals each noticed in salt flats in March/April 1999 and March 2000, another two individuals observed west of Sant Antoni de Portmany in November 1999.
Status: abundant winter resident and migrant.

Sand Martin (*Riparia riparia*)
Observations: generally occurs regularly, single observations in various habitats in March/April 1999, particularly abundant in salt flats (maximum number of ten individuals in March/April 1999, four individuals in March 2000).
Status: migrant occurring in moderate numbers.

Eurasien Crag Martin (*Ptyonoprogne rupestris*)
Observations: eight individuals seen on the hill of Sa Talaia (almost 500 meters high) and three individuals observed on the steep coastline west of Santa Agnès de Corona in March/April 1999, regularly seen along the eastern coast of Ibiza in November 1999.
Status: sedentary but not common species, also only occasional as winter resident.

Barn Swallow (*Hirundo rustica*)
Observations: generally common species (with a maximum population size of more than 100 individuals at one location in March/April 1999); also observed in salt flats (15 individuals) and around the Club Can Jordi (two individuals in March 2000).
Status: abundant summer resident and migrant.

House Martin (*Delichon urbica*)
Observations: commonly found species (with a maximum population size of 50 individuals in March/April 1999).
Status: abundant summer resident and migrant.

Red-rumped Swallow (*Cecropis daurica*)
Observations: two individuals seen on the agricultural fields at Santa Agnès de Corona in March/April 1999.
Status: migrant rarely reaching Ibiza.
Cetti's Warbler (*Cettia cetti*)
Observations: five specimens noticed along the banks of the mouth of the former river of Santa Eulària in March/April 1999.
Status: sedentary but rarely seen species, appears as winter resident in moderate numbers.

Common Chiffchaff (*Phylloscopus collybita*)
Observations: generally recorded by single observations around the entire territory of Ibiza in March/April 1999, also one individual seen at the Club Cala Llenya in March 2000.
Status: abundant winter resident, also appearing as a migrant in moderate numbers.

Willow Warbler (*Phylloscopus trochilus*)
Observations: regular appearance in March/April 1999, more common in November 1999.
Status: abundant migrant.

Eurasien Reed Warbler (*Acrocephalus scirpaceus*)
Observation: observed at permanently wet places in the town of Eivissa (where *Phragmites* spec. is present): one individual seen in March/April 1999.
Status: abundant summer resident and migrant.

Zitting Cisticola (*Cisticola juncidis*)
Observations: three individuals observed in Santa Eulària des Riu in March/April 1999, also noticed in salt flats (three individuals) and at the Cala Llonga (one individual) during the same study period.
Status: sedentary and abundant species.

Blackcap (*Sylvia atricapilla*)
Observations: generally observed to be regularly distributed among the various terrestrial habitats of Ibiza (data from March/April 1999).
Status: Sedentary but rare species, in contrast abundant resident and migrant during the winter.

Marmora's Warbler (*Sylvia sarda*)
Observations: one individual each noticed around the hill of Sa Talaia in March/April 1999 and at the Cala Olivera in November 1999.
Status: sedentary and abundant species (to be treated as a subspecies *balearica*).

Subalpine Warbler (*Sylvia cantillans*)
Observation: one male specimen spotted at Punta d'Eu Valls in March/April 1999.
Status: migrant appearing in moderate numbers.

Sardinian Warbler (*Sylvia melanocephala*)
Observations: commonly observed in various terrestrial habitats in March/April 1999 and 2000.
Status: sedentary and abundant species.

Firecrest (*Regulus ignicapilla*)
Observations: generally observed to be a common species in various terrestrial habitats in March/April 1999; moreover 1-2 specimens seen almost daily around the Club Can Jordi and one individual at the waste disposal site near the Cala Olivera in March 2000.
Status: sedentary and abundant species.

Winter Wren (*Troglodytes troglodytes*)
Observations: regularly found in March/April 1999, one individual observed at the Club Cala Llenya in March 2000.
Status: sedentary and abundant species.

Ring Ouzel (*Turdus torquatus*)
Observation: one individual spotted north of the golf course Roca Llisa in March/April 1999.
Status: rare winter resident and migrant.

Common Blackbird (*Turdus merula*)
Observations: regular presence, found in various terrestrial habitats in March/April 1999; also seen almost daily at the Club Can Jordi (1-2 individuals) and at Santa Eulària des Riu (one individual) in March/April 2000.
Status: sedentary and abundant species, migrates to Ibiza in moderate numbers.

Song Thrush (*Turdus philomelos*)
Observations: regular presence, found in various terrestrial habitats: single observations in March/April 1999; higher abundances found in November 1999.
Status: abundant winter resident and migrant.

Mistle Thrush (*Turdus viscivorus*)
Observation: one individual spotted at the Club Can Jordi in March 2000.
Status: winter resident, migrates to Ibiza in moderate numbers.

Spotted Flycatcher (*Muscicapa striata*)
Observation: one individual noticed west of the Cala Boix in October 1998.
Status: abundant summer resident and migrant.

Pied Flycatcher (*Ficedula hypoleuca*)
Observations: one individual each spotted west of the Cala Boix in October 1998 and at Serra Grossa in March/April 1999.
Status: abundant migrant.

Blue Rock Thrush (*Monticola solitarius*)
Observations: generally found to be regularly distributed in habitats with sediments covered by rocks in March/April 1999; one male each observed near the Club Cala Lenya, in salt flats and at the Cala Olivera in March 2000.
Status: sedentary and abundant species.

Whinchat (*Saxicola rubetra*)
Observations: one individual each seen west of Santa Eulària des Riu in October 1998 as well as on an agricultural field in the plain of Santa Agnès de Corona in March/April 1999.
Status: abundant migrant.

Stonechat (*Saxicola torquata*)
Observations: regularly observed in March/April 1999; one male and one female specimen each noticed near Santa Agnès de Corona and at Es Port des Torrent in March 2000,
additionally one male inhabiting salt flats in March 2000.

Status: sedentary and abundant species, migrant in moderate numbers.

European Robin (*Erithacus rubecula*)
Observations: commonly detected in March/April 1999, one individual observed in the vicinity of the Club Can Jordi in March 2000.
Status: abundant winter resident and migrant.

Common Nightingale (*Luscinia megarhynchos*)
Observation: one individual found in the upper part of the former river of Santa Eulària in March/April 1999.
Status: summer resident occurring in moderate numbers, abundant in winter as migrant.

Black Redstart (*Phoenicurus ochruros*)
Observations: species rarely found in March/April 1999 but regularly observed in November 1999, one female specimen also found in salt flats in March 2000.
Status: abundant winter resident and migrant.

Common Redstart (*Phoenicurus phoenicurus*)
Observations: species only recorded by single observations in March/April 1999, found to be common in November 1999.
Status: abundant migrant.

Northern Weatear (*Oenanthe oenanthe*)
Observations: in salt flats: two individuals in March/April 1999, one individual in March 2000; two individuals noticed at the plain of Santa Agnès de Corona in March/April 1999.
Status: summer resident present in moderate numbers, also occurring as abundant migrant.

Black-eared Weatear (*Oenanthe hispanica*)
Observations: only one individual observed on an agricultural field at Santa Agnès de Corona in March/April 1999, one individual in the rocky supralittoral zone westerly of the salt flats (Platja des Cavallet) in March 2000.
Status: rare migrant.

House Sparrow (*Passer domesticus*)
Observations: a generally abundant species in March/April 1999, classified as common in March/April 2000; *Passer domesticus* is especially frequent in those areas inhabited by man: possible breeding places in holes of building walls found in Sant Carles de Peralta and Can Gorra in March/April 2000.
Status: sedentary and abundant species.

Eurasien Tree Sparrow (*Passer montanus*)
Observations: only 1-2 individuals seen in and around Can Vicent d'en Pere (data from March/April 1999).
Status: sedentary species occurring in moderate numbers.

Rock Sparrow (*Petronia petronia*)
Observations: 6-7 breeding pairs of *Petronia petronia* observed north-westerly of the Club Cala Llenya, further five individuals seen at Can Vicent d'en Pere (data from March/April 1999).
Status: sedentary and abundant species.

Tawny Pipit (*Anthus campestris*)
Observation: one single specimen observed on an agricultural field close to Santa Agnès de Corona in March/April 1999.
Status: rarely seen summer resident and migrant.

Meadow Pipit (*Anthus pratensis*)
Observations: common species observed in various habitats (data from March/April 1999).
Status: abundant winter resident and migrant.

Rock Pipit (*Anthus petrosus*)
Observation: one individual detected at the beach of the Cala Xarraca in March/April 1999.
Status: presence in Ibiza surprising, possibly caused by an accidental deviation from usual flying courses.

Yellow Wagtail (*Motacilla flava*)
Observations: one individual assigned to *Motacilla flava cinereocapilla* was spotted in salt flats in March/April 1999, further observations in salt flats: two males and one female in March 2000 and more than 50 individuals of *Motacilla flava flava* in March 2001.
Status: summer resident and migrant occurring in moderate numbers.

White Wagtail (*Motacilla alba*)
Observations: investigations speak for a regular presence in Ibiza (studies of March/April 1999); further findings in March 2000: one individual at Escull des ses Punxes, four individuals around Santa Eulària des Riu, one single individual in salt flats.
Status: abundant winter resident and migrant.

Chaffinch (*Fringilla coelebs*)
Observations: regular occurrence in various habitats detected in March/April 1999.
Status: abundant winter resident, also migrant during the winter in moderate numbers.

Hawfinch (*Coccothraustes coccothraustes*)
Observation: one individual seen at Santa Eulària des Riu in March/April 1999.
Status: rare winter resident.

European Serin (*Serinus serinus*)
Observations: abundant during the study periods in March/April 1999 and 2000, together with *Carduelis carduelis* the most abundant species of all investigated birds in March/April 2000.
Status: sedentary and highly abundant species, also very frequent winter resident and migrant.

European Greenfinch (*Carduelis chloris*)
Observations: a common species in various terrestrial habitats in March/April 1999 and 2000, estimated to be one of the most abundant species in Ibiza in March/April 2000 after *Serinus serinus* and *Carduelis carduelis*.
Status: sedentary and abundant species.

European Goldfinch (*Carduelis carduelis*)
Observations: a highly abundant species in various terrestrial habitats in March/April 1999 and 2000, together with *Serinus serinus* ranked as the most abundant species in March/April 2000.
Status: sedentary and highly abundant species, also highly abundant winter resident and migrant.

Eurasian Siskin (*Carduelis spinus*)
Observations: one individual each noticed on the steep walls situated on the northern coastline of Ibiza on October 10, 1998 and at Santa Eulària des Riu in November 1999.
Status: winter resident and migrant occurring in moderate numbers.

Common Linnet (*Carduelis cannabina*)
Observations: generally found to be common in March/April 1999; further occasional findings made in March 2000 at the Port des Torrent (one individual), at the Club Can Jordi (two individuals) and in salt flats (three individuals).
Status: sedentary and abundant species.

Cirl Bunting (*Emberiza cirlus*)
Observation: one breeding pair detected in the vicinity of the Cova Santa in March/April 1999.
Status: sedentary species present in moderate numbers.

Corn Bunting (*Emberiza calandra*)
Observations: regularly found in March/April 1999 (with a maximum of 12 individuals per habitat), another individual seen in salt flats in March 2000.
Status: sedentary species present in moderate numbers.

Authors' addresses:

Thomas Kellner[1*], Mathias Krech[2], Axel Schulz[3] & Carsten H.G. Müller[1,4]

[1] Universität Rostock
Fachbereich Biowissenschaften
Institut für Biodiversitätsforschung
Allgemeine und Spezielle Zoologie
Universitätsplatz 2
18055 Rostock
Germany

[2] Martin-Luther-Universität Halle Wittenberg
Klinik und Poliklinik für Kinder- und Jugendmedizin
Ernst-Grube-Str. 40
06120 Halle a. d. Saale
Germany

[3] Institut für Angewandte Ökologie GmbH (IfaÖ)
Lindenweg 2
18184 Neu Brosterstorf bei Rostock
Germany

[4] Max-Planck-Institut für Chemische Ökologie
Abteilung für Evolutionäre Neuroethologie
Hans-Knöll-Str. 8
07745 Jena
Germany

*corresponding author, e-mail: Varakuschka@web.de

Studies on the ichthyofauna of the coastal waters of Ibiza (Balearic Islands, Spain)

By Stefan Fischer[1]*, Robert A. Patzner[2], Carsten H.G. Müller[1,3] & Helmut M. Winkler[1]

FISCHER ST., PATZNER R. A., MÜLLER C. H.G. & H. M. WINKLER (2007): Studies on the ichthyofauna of the coastal waters of Ibiza (Balearic Islands, Spain). Rostocker Meeresbiologische Beiträge 18: S. 30-62

Abstract. In the framework of several field excursions to the Balearic Island of Ibiza (Western Mediterranean Sea) conducted every spring and autumn between 1998 and 2007, extensive studies were carried out on the structure, diversity and ecology of the coastal ichthyofauna. The ichthyofaunistic observations were made in the months of March, April, September and October in the course of snorkeling and scuba diving in the upper infralittoral of the coastal waters (0 to 40 m depth), including sandy and rocky substrates showing various degrees of exposition to sunlight and wave action, as well as sea grass beds (*Posidonia oceanica*). All in all, we were able to detect 130 species of fish distributed among 43 families. The highest diversity was shown by the Gobiidae (20 species), followed by the Blenniidae with 15, the Labridae with 14 and the Sparidae with 11 species. We also observed some species that are known to be rare in the upper infralittoral, such as *Zeus faber* for example.
Besides providing a standard species list, we also present interesting aut- and synecological data for most taxa recorded. Special attention was paid to associations between different fish species and associations between fishes and invertebrates. In some cases we observed a diminishment in species over the years (e.g. *Parablennius pilicornis* and *Scartella cristata*) which might be related to the general temperature increase in the Western Mediterranean basin, the possible loss of natural feeding resources (probably caused by the spreading of the Lessepsian neophytic alga *Lophocladia lallemandii*) and, subsequently, to dynamic shifts in the blennioid community.

Abstracto. Durante varios muestreos en la Isla Balear de Ibiza (España), cada una realizada en primavera y en otoño del 1998 hasta 2007, estudios extensivos de la estructura, la diversidad y la écología de la ichtiofauna de la región fueron efectuados.
Observaciones ichtiofaunísticas se realizaron en los meses de marzo, abril, septiembre y octubre buceando en las aguas litorales (hasta 40 metros de profundidad). Las observaciones incluyeron sustratos arenosos y rocosos, que mostraron varios grados de exposicíon al sol y oleaje. Además matas de *Posidonia oceanica* fueron muestreadas. En total hemos descubierto 130 especies de peces marinos distribuídos en 43 familias. La mayor diversidad se mostró en Gobiidae con 20 especies, seguido por los Blenniidae con 15 especies, por los Labridae con 14 especies y por los Sparidae con 11 especie. Tambien se observaron algunas especies conocidas como raras en el alto infralitoral, cano por ejemplo *Zeus faber*.
Además de proveer una lista de especies a nivel estandardizado, presentamos datos interesantes aut- y sinecológicos de la mayoría de los peces encontrados. Hemos dado atención especial a las asociaciones de especies de peces, tanto entre ellos como con respecto a las relaciones entre peces e invertebrados. En algunos casos observamos una frecuencia disminuída de especies de peces

(por ejemplo en *Parablennius pilicornis y Scartella cristata*) de las costas de Ibiza en los últimos años. Esos procesos podrían ser causados por una aumenta de temperatura en las aguas occidentales del Mar Mediterráneo. También es posible que hayan desaparecido los recursos de alimentacíon (posiblemente a causa de una extención de un invasor lessepsiano, la alga roja *Lophocladia lallemandii*) resultando en cambios de composición de la fauna de blenniidos.

Key words: Mediterranean Sea, Ibiza, fish, diversity, zoogeography, ecology, associations, *Lophocladia*

Introduction

To date, several studies dealing with the ichthyofauna inhabiting the coastal waters around the so-called Pityusic Islands, Ibiza and Formentera, have been carried out. Some contributions provide a more or less detailed overview of the pelagic and benthic fish fauna (SAN FÉLIX 1997, ARBONA SÁNCHEZ 2003), some papers discuss the species diversity and spatial distribution among a single family (PATZNER 1984, AHNELT & PATZNER 1996, PATZNER 1999a, PATZNER 1999b, HOFRICHTER & PATZNER 2000) and some provide observations on single species (PATZNER 1989, AHNELT ET AL. 1994, AHNELT & PATZNER 1995, HERLER ET AL. 1999, PATZNER 2001, PATZNER 2003).
A third field of ichthyofaunistic research is the colonisation of artificial reefs between Ibiza and Formentera (RENONES ET AL. 1998, MORENO 2002). All in all 405 species are described for the Balearic Islands, comprising 71 (17 %) cosmopolits, 69 (17 %) boreal species, 209 (52 %) centroatlantic species and 56 (14 %) endemic species (MAYOL ET AL. 2000). 55 of these 405 species belong to the Chondrichthyes. The present paper summarizes ten years of ichthyofaunistic field observations made using snorkeling and scuba diving techniques, and provides an update of all fishes ever recorded for the island of Ibiza.
The specific topography of the pityusic shelf elevation and geological dynamics allowed us to separate the island of Ibiza into two principal areas. One main area, the north-western part of the island, is dominated by steep rock walls from the Upper Cretaceous and Lower Tertiary (see description in SPIKER 1935) which tower up to at least 100 m high and, below the water surface line, reach down to a depth of 40 m or more. The southern and eastern parts have a much flatter landscape with a substratum mainly made up by Jurassic rocks (HAANSTRA 1935). The coastal relief is less sloping and appears structurally diversified by many sandy beaches. The sandy sediments extend down to 35 m in depth and are often overlaid by dense and widespread meadows of the sea grass *Posidonia oceanica* (L.) Delile. The greatest expanse of these *Posidonia* beds can be found in the Marine Reserve of Freus d'Eivissa in an area of 13 617 ha (MABILE & PIANTE 2005) in the south of the island between Ibiza and Formentera and also in the area between the Cala Conta and the islands off the coast in the bay of St. Antonio. The surface water along the eastern coast is generally influenced by southerly or easterly currents, whereas the northern and western coast is affected by those currents flowing or circulating southwards out of the Catalonian Sea (see review of HOPKINS 1985). However, the flux regime around Ibiza can be disturbed by seasonal phenomena whereby those currents running southwards between Ibiza and the Iberian Peninsula may dominate the flow pattern from August till January. In contrast, from February until the end of July Atlantic water from the Algerian basin mainly streams into the Balearic Sea via the

so-called Ibiza channel (HERBAUT ET AL. 1997). , The coastal waters of Ibiza are easily reached and populated both by those taxa only producing short-term meroplanctonic larvae or performing parental care and by fish larvae drifting with the holo- and meroplancton from both the north and the south. In theory, the local fish community and diversity may thus be considerably affected by the influence of allochthonous fish species such as alien species from atlanticotropical areas and the Red Sea (Lessepsian Migration). With this in mind, we believe it was time for a critical inventory of the fish fauna of Ibiza.

Material and Methods

Between 1998 and 2007 we conducted annual studies by visual census in the months of March and April, complemented by additional studies in the months of September and October as well as by occasional sightings by two of the authors (R.A.P. and C.H.G.M.) going back to 1980. The main studies took place at six locations around Ibiza (Fig. 1), and a few additional places were investigated at irregular intervals (Cala Nova, Cala Boix, Cala Mastella, Cala Bassa, Cala Tarida).
The observations were made while snorkelling in shallow areas or scuba-diving in deeper regions down to 40 m. In order to also gather nocturnal species or species only active during dusk and dawn, we made several night dives between 10 p.m. and 1 a.m. in the Cala Llenya, where all relevant substrates could be checked for demersal fishes. In order to properly identify taxonomically delicate species (e.g. Gobiidae, Blenniidae, Gobiesocidae) some fishes were caught with hand nets and determined in the lab. Several specimens were fixed in formaldehyde (5 to 10 %) and then transferred into alcohol (70 %). They are stored in the 'Senckenberg Museum' (Frankfurt), in the 'Naturhistorisches Museum' (Vienna) and in the 'Zoologische Staatssammlung' (Munich).
The taxonomy and scientific names of fish were taken from PATZNER & MOOSLEITNER (2003) and FROESE & PAULY (2006).

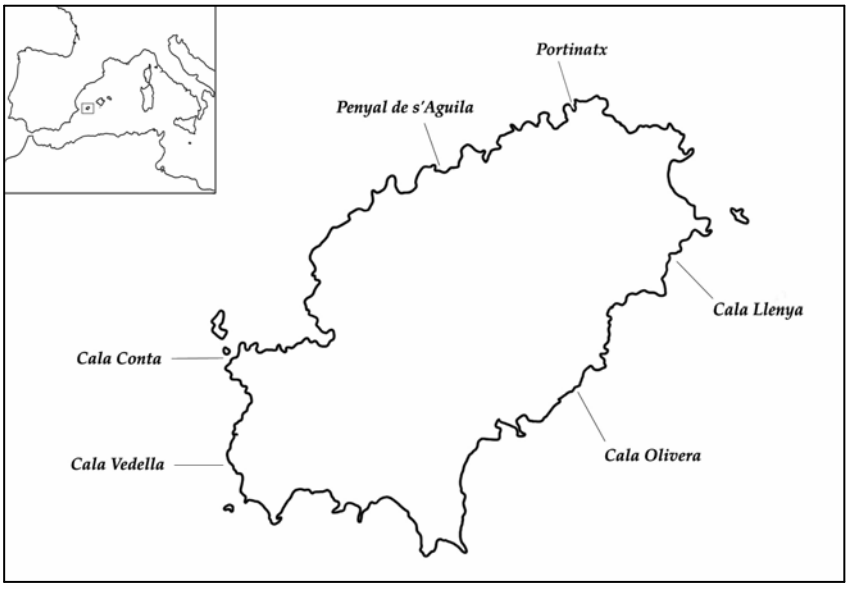


Fig.1 Investigated areas of the island of Ibiza

Results

A total of 130 species, distributed among 43 families, could be identified and thus recorded for the island of Ibiza (Tab. 1). The highest diversity is found in Gobiidae with 20 species, followed by Blenniidae with 15, Labridae with 14 and Sparidae with 11 species.

The ichthyofauna on the sandy bottoms of Ibiza is dominated by 7 species: *Bothus podas podas*, *Trachinus draco*, *Trachinus araneus*, *Uranoscopus scaber*, *Synodus saurus, Mullus surmuletus* and *Lithognathus mormyrus*. A few Sparidae and Labridae may be added to the list as commensal followers of the permanently burrowing *Mullus surmuletus*. Moreover, the pelagic species *Spicara maena* is occasionally seen on shallower sandy bottoms at night.

Table 1. List of recorded species
The habitat preferences are separated into sandy bottom (sb), rocky bottom (rb), rock pools (rp), boulder fields (bf), Posidonia (pos) and pelagic area (pel). The occurrence is described as rare (ra) when species were only detected 1-2 times, less common (lco) when species were observed irregularly and common (co) when species were found each year.

Family	Species	sb	rb	rp	bf	pos	pel
Rajidae	*Raja* cf. *miraletus* Linnaeus, 1758	ra					
	Raja radula Delaroche, 1809	ra					
Dasyatidae	*Dasyatis pastinaca* (Linnaeus, 1758)	ra					
Myliobatidae	*Myliobatis aquila* (Linnaeus, 1758)	ra					ra
Torpedinidae	*Torpedo marmorata* Risso, 1810	lco					
Clupeidae	*Sardina pilchardus* (Walbaum, 1792)						co
Synodontidae	*Synodus saurus* (Linnaeus, 1758)	co					
Muraenidae	*Muraena helena* (Linnaeus, 1758)				co		
Congridae	*Ariosoma balearicum* (Delaroche, 1809)	lco					
	Conger conger (Linnaeus, 1758)		lco				
Belonidae	*Belone belone* Linnaeus, 1761						co
Exocoetidae	*Cheilopogon heterurus* (Rafinesque, 1810)						ra
Syngnathidae	*Hippocampus guttulatus* Cuvier, 1829					ra	
	Syngnathus typhle Linnaeus, 1758					ra	
Gadidae	*Gaidropsarus mediterraneus* Linnaeus, 1758				ra		
	Phycis phycis (Linnaeus, 1766)		ra				

Zeidae	*Zeus faber* Linnaeus, 1758	ra	ra		ra	
Trachipteridae	*Trachipterus trachypterus* (Gmelin, 1789)					ra
Serranidae	*Anthias anthias* (Linnaeus, 1758)		co			
	Epinephelus caninus (Valenciennes, 1843)		ra			
	Epinephelus costae (Steindachner, 1878)		lco			
	Epinephelus marginatus (Linnaeus, 1758)		lco			
	Serranus cabrilla (Linnaeus, 1758)		co			
	Serranus hepatus (Linnaeus, 1758)	ra				
	Serranus scriba (Linnaeus, 1758)		co	co	co	
Moronidae	*Dicentrachus labrax* (Linnaeus, 1758)					ra
	Dicentrarchus punctatus (Bloch, 1792)		ra			
Apogonidae	*Apogon imberbis* (Linnaeus, 1758)		co			
Carangidae	*Seriola dumerili* (Risso, 1810)				lco	
	Trachinotus ovatus (Linnaeus, 1758)					ra
	Trachurus mediterraneus (Steindachner, 1868)					co
	Trachurus trachurus (Linnaeus, 1758)					co
Sciaenidae	*Sciaena umbra* Linnaeus, 1758		lco		lco	
Mullidae	*Mullus surmuletus* Linnaeus, 1758	co				
Sparidae	*Boops boops* (Linnaeus, 1758)					lco
	Diplodus annularis (Linnaeus, 1758)				co	
	Diplodus cervinus cervinus (Lowe, 1838)		lco	lco		
	Diplodus puntazzo (Cetti, 1777)		co	co		
	Diplodus sargus sargus (Linnaeus, 1758)		co	co		
	Diplodus vulgaris (Geoffrey Saint Hilaire, 1817)		co	co		
	Lithognathus mormyrus (Linnaeus, 1758)	co				
	Oblada melanura (Linnaeus, 1758)		co	co	co	
	Sarpa salpa (Linnaeus, 1758)		co	co	co	
	Sparus aurata Linnaeus, 1758			lco		
	Spondyliosoma cantharus (Linnaeus, 1758)					co
Centracanthidae	*Spicara maena* (Linnaeus, 1758)					co
	Spicara smaris (Linnaeus, 1758)					ra
Pomacentridae	*Chromis chromis* (Linnaeus, 1758)					co
Labridae	*Coris julis* (Linnaeus, 1758)		co	co		
	Labrus merula Linnaeus, 1758				lco	
	Labrus viridis Linnaeus, 1758				lco	
	Symphodus cinereus (Bonaterre, 1788)			lco		
	Symphodus doderleini (Jordan, 1891)				lco	
	Symphodus mediterraneus (Jordan, 1891)		co	co		
	Symphodus melanocercus (Risso, 1810)		lco			
	Symphodus melops (Linnaeus, 1758)		co	co		
	Symphodus ocellatus Forskål, 1775		co	co		
	Symphodus roissali (Risso, 1810)		co			
	Symphodus rostratus (Bloch, 1791)				lco	
	Symphodus tinca (Linnaeus, 1758)		co	co		

	Thalassoma pavo (Linnaeus, 1758)		co		co	
	Xyrichthys novacula (Linnaeus, 1758)	co				
Ammodytidae	*Gymnammodytes cicerellus* Rafinesque, 1810	lco				
Trachinidae	*Echiichthys vipera* Cuvier, 1829	ra				
	Trachinus araneus (Cuvier, 1829)	co				
	Trachinus draco Linnaeus, 1758	co				
	Trachinus radiatus Cuvier, 1829	lco				
Uranoscopidae	*Uranoscopus scaber* Linnaeus, 1758	co				
Gobiidae	*Chromogobius zebratus* (Kolombatovic, 1891)				lco	
	Corcyrogobius liechtensteini (Kolombatovic, 1891)		lco		ra	
	Didogobius splechtnai Ahnelt & Patzner, 1995		ra			
	Gammogobius steinitzi Bath, 1971		ra			
	Gobius bucchichi Steindachner, 1870			lco	co	
	Gobius cobitis Pallas, 1811				lco	
	Gobius cruentatus Gmelin, 1789		lco			lco
	Gobius fallax Sarato, 1889	lco				
	Gobius geniporus Valenciennes, 1837	co				
	Gobius niger Linnaeus, 1758		lco			
	Gobius paganellus Linnaeus, 1758			co	co	
	Gobius roulei De Buen, 1928	lco				
	Gobius vittatus Vinciguerra, 1758		lco			
	Gobius xanthocephalus Heymer & Zander, 1992		ra			
	Millerigobius macrocephalus (Kolombatovic,1891)		ra			
	Pomatoschistus bathi Miller, 1928	co				
	Pomatoschistus pictus (Malm, 1865)	co				
	Pomatoschistus sp.	co				
	Thorogobius ephippiatus (Lowe, 1839)		lco			
	Thorogobius macrolepis (Kolombatovic, 1891)		ra			
	Zebrus zebrus (Risso, 1826)		ra	lco		
Callionymidae	*Callionymus pusillus* Delaroche, 1809	lco				
Blenniidae	*Aidablennius sphynx* (Valenciennes, 1836)		co		co	
	Coryphoblennius galerita (Linnaeus, 1758)		co			
	Lipophrys canevae (Vinciguerra, 1880)		co			
	Lipophrys dalmatinus (Steindachner & Kolombatovic, 1883)		ra			
	Lipophrys nigriceps (Vinciguerra, 1883)		lco			
	Parablennius gattorugine (Brünnich, 1768)		co	lco	co	
	Parablennius incognitus (Bath, 1968)		co			
	Parablennius pilicornis (Cuvier,1829)		lco			
	Parablennius rouxi (Cocco, 1833)		lco			
	Parablennius sanguinolentus (Pallas, 1811)		co			
	Parablennius tentacularis (Brünnich, 1768)					ra
	Parablennius zvonimiri (Kolombatovic, 1892)		co			
	Paralipophrys trigloides (Valenciennes, 1836)		co	co		
	Salaria pavo (Risso, 1810)			co		
	Scartella cristata (Linnaeus, 1758)		ra			
Clinidae	*Clinitrachus argentatus* (Risso, 1810)		ra			

Tripterygiidae	*Tripterygion delaisi* Cadenat & Blanche 1971	co				
	Tripterygion melanurus Guichenot, 1845	co				
	Tripterygion tripteronotus (Risso, 1810)	co				
Bythitidae	*Oligopus ater* Risso, 1810	ra				
Carapidae	*Carapus acus* (Brünnich, 1768)	ra				
Sphyraenidae	*Sphyraena viridensis* Cuvier,1829					co
Mugilidae	*Chelon labrosus* (Risso, 1827)					co
	Liza sp.					co
	Oedalechilus labeo (Cuvier, 1829):					co
Atherinidae	*Atherina boyeri* Risso, 1810					co
	Atherina hepsetus (Linnaeus, 1758)					co
Scorpaenidae	*Scorpaena maderensis* Valenciennes, 1833	co	co			
	Scorpaena notata Rafinesque, 1810	lco	lco			
	Scorpaena porcus Linnaeus, 1758	co	co	co		
	Scorpaena scrofa Linnaeus, 1758	lco				
Dactylopteridae	*Dactylopterus volitans* (Linnaeus, 1758)	lco				
Bothidae	*Bothus podas podas* (Delaroche, 1809)	co				
Soleidae	*Solea lascaris* (Risso, 1810)	ra				
Balistidae	*Balistes capriscus* (Gmelin, 1789)	ra				
Molidae	*Mola mola* (Linnaeus, 1758)	ra				ra
Gobiesocidae	*Apletodon incognitus* Hofrichter & Patzner, 1997	lco	co	lco		
	Gouania wildenowi (Risso,1810)		lco			
	Lepadogaster candollii Risso, 1810	co	co			
	Lepadogaster lepadogaster (Bonaterre, 1788)		co			
	Opeatogenys gracilis (Canestrini, 1864)			lco		

Over rocky bottoms and boulder fields the Labridae and Sparidae occur particularly frequently, while the crevices and niches of the boulder fields and sites of large pebbles are occupied by gobies and clingfishes. The shallower regions of the rocky coast, down to 2 meters depth, and the rock pools are dominated primarily by the blennies and the threefin blennies, but the gobies *Gobius bucchichi* and *G. paganellus* are also fairly abundant when *Anemonia viridis* (Forsskål, 1775) or small stones are present. Parameters such as currents, light and natural rock cover determine which blenny species occur (ZANDER 1972a). The rock pools are mainly inhabited by *Salaria pavo*, *Paralipophrys trigloides* and *Coryphoblennius galerita*.
Beside *Chromis chromis*, which are very common in the vicinity of rocks, the main species which could be detected in the pelagic area were shoals of silversides and sardines. Mullets can also be found regularly in front of rocks, whereas needlefishes and barracudas occur more frequently in summer in the open water.

The most typical species for *Posidonia* meadows are the Sparidae *Sarpa salpa* and *Diplodus annularis*. A few Syngnathidae such as *Syngnathus typhle* and *Hippocampus guttulatus* were also seen, whereby the latter was only found once, dead, on the drift line of the beach at Cala Nova. It is difficult in other respects, too, to appoint characteristic species of *Posidonia oceanica*, because many species use *Posidonia* as a nursery area, with the adults then migrating to other habitats (GARCIA-RUBIES & MACPHERSON 1995).

Symbiosis and other associations

Feeding associations (commensalisms) were observed in *Mullus surmuletus* and *Lithognathus mormyrus* on sandy bottoms and in *Symphodus tinca* on rocky bottoms. *M. surmuletus* was usually accompanied by *Coris julis* and *Diplodus vulgaris* (Fig. 2a). In *L. mormyrus* single individuals of other species (*Diplodus vulgaris*, *Bothus podas podas* and sometimes also *Trachinus draco*) followed the group (Fig. 2b).
On sandy bottoms we detected *Bothus podas podas* (Fig. 2c) accompanying *Astropecten platyacanthus* (Philippi, 1837) or *Astropecten aranciacus* (Linnaeus, 1758) and in rocky areas larger species of *Serranus scriba* appeared with *Octopus vulgaris* (Cuvier, 1797). For further comments see 'Discussion'.
Symphodus melanocercus were regularly observed at 'cleaning stations' next to *Posidonia* meadows in the north of the island (Fig. 2d). However, by cleaning adult *Epinephelus marginatus* off Ibiza, this species does not operate cleaning stations but accompanies the large fish constantly. Some other Labridae were observed displaying cleaning behaviour only as juveniles (e.g. *Coris julis* and *Thalassoma pavo*).
Cleaning behaviour was also observed in the shrimp *Lysmata seticaudata* (Risso, 1816), cleaning *Muraena helena*.
In rocky areas *Gobius bucchichi* was always found in the vicinity of *Anemonia viridis* (Fig. 2e). This species usually rests close to the tentacles of the anemone without having any contact to them. When threatened it flees through the tentacles towards the column of the anemone but not between the tentacles close to the mouth of the anemone.
In the pelagic area juveniles of *Trachurus mediterraneus and T. trachurus* were regularly found close to *Cotylorhiza tuberculata* (Macri, 1778), at Portinatx once also to *Pelagia noctiluca* (Forsskål, 1775) (Fig. 2f).
Only once was *Carapus acus* observed, when it left a *Holothuria tubulosa* (Gmelin, 1788) in an aquarium.

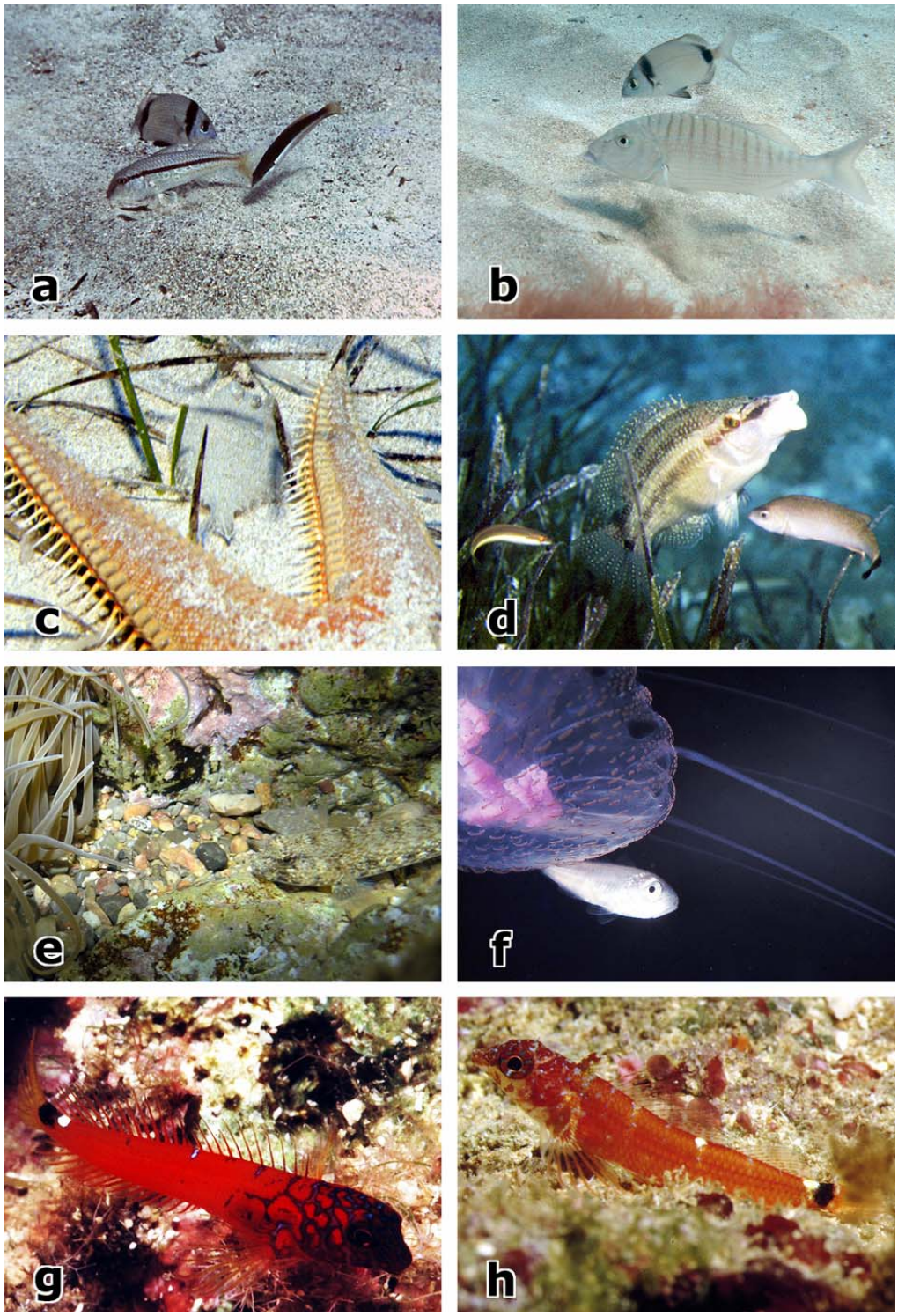


Fig. 2 Associations between fishes and fishes and between fishes and invertebrates around Ibiza. a) feeding association between *Mullus surmulletus* on the one hand and *Diplodus vulgaris and Coris julis* on the other; b) feeding association between *Lithognathus mormyrus* and *D. vulgaris*; c) association between *Bothus podas* and *Astropecten aranciacus*; d) *Symphodus melanocercus* cleaning *Symphodus tinca*; e) *Gobius bucchichi* in typical resting position in front of *Anemonia viridis*; f) *Trachurus* sp. on *Pelagia noctiluca*; g) *Lipophrys nigriceps*; h) *Tripterygion melanurus*, a doubtful mimicry of *L. nigriceps*.

In the following the occurrence of the individual species is described in detail.

Family Rajidae

Raja cf. *miraletus* Linnaeus, 1758
The brown ray normally occurs in areas deeper than 50 m and was only detected once in the Cala Llenya. The juvenile species of about 35 cm in length was caught at 6 m depth on sandy bottoms.

Raja radula Delaroche, 1809
The rough ray was only found once as a juvenile in the Cala Nova. The species was observed in shallow water at a depth of 1 m on sandy bottoms.

Family Myliobatidae

Myliobatis aquila (Linnaeus, 1758)
The common eagle ray was only observed once in the Cala Llenya in March 2007 at a depth of 16m over sandy bottoms.

Family Dasyatidae

Dasyatis pastinaca (Linnaeus 1758)
Juveniles of the common stingray were found on sandy bottoms at a depth of 4 to 5 m at the Cala Nova and at 10 m at Cala Charraca near Portinatx.

Torpedinidae

Torpedo marmorata Risso, 1810
The spotted torpedo was only found a few times on sandy bottoms in the Cala Llenya at depths of 5 to10 m.

Family Clupeidae

Sardina pilchardus (Walbaum, 1792)
The European pilchard was regularly observed in big shoals in protected shallower areas especially at times when stronger swell occurred. The juveniles (and the adults at night) can be found near the water surface. Range of depth: 0 to 20 m.

Family Synodontidae

Synodus saurus (Linnaeus, 1758)
The Atlantic lizardfish is common on sandy bottoms in the south of the Island and was found at a depth of between 2 to 20 m.

Family Muraenidae

Muraena helena (Linnaeus, 1758)
The Mediterranean moray is very common and was regularly found all around the island in rocky areas, boulder fields and at night also in *Posidonia* meadows.

Family Congridae

Ariosoma balearicum (Delaroche, 1809)
This species was only found twice on sandy bottoms: once as a juvenile of about 7 cm in length at the Cala Conta and another time at the Cala Nova. Range of depth: 5 to 10 m. The juvenile species in the Cala Conta was caught during daytime by chance, when sieving sand through a handnet (Fig. 3a).

Conger conger (Linnaeus, 1758)
The conger eel is a common species in rocky areas all around the island, inhabiting crevices and small caves. Range of depth: 3 to 35 m.

Family Belonidae

Belone belone Linnaeus 1758
The garpike was commonly found near the water surface in the open water, where it mostly occurred in small shoals of 5 to 10 individuals.

Family Exocoetidae

Cheilopogon heterurus (Rafinesque, 1810)
Mediterranean flying fish were observed twice at Cala Charraca near Portinatx, twenty years ago.

Family Syngnathidae

Hippocampus guttulatus Cuvier, 1829
The long-snouted seahorse was only found once, dead, on the shore line of the Cala Nova.

Syngnathus typhle Linnaeus, 1758
The broad-nosed pipe-fish has a perfect camouflage. It was detected in a *Posidonia* meadow at the Cala Llenya at a depth of 4 m and between ruptured leaves of *Posidonia* at 5 m depth at Portinatx.

Family Gadidae

Gaidropsarus mediterraneus Linnaeus, 1758

The shore rockling was only caught once in the boulder field in the Cala Llenya in 2002 at a depth of 1 m and twice in rock pools in Portinatx.
Phycis phycis (Linnaeus, 1766)
The forkbeard was observed once in a cave at 15 m depth at Portinatx.

Family Zeidae

Zeus faber Linnaeus, 1758
Two juvenile species of the john dory of about 30 to 40 cm in length were observed during a night dive in the Cala Llenya in autumn 2006 (Fig. 3b). Both species were found over sandy bottoms next to *Posidonia* meadows.

Family Trachipteridae

Trachipterus trachypterus (Gmelin, 1789)
After a storm a larvae of the ribbon fish was found in a bay at Portinatx at a depth of 2 m.

Family Serranidae

Anthias anthias (Linnaeus, 1758)
The swallowtail sea perch is very common at Portinatx and was regularly found on rocky bottoms beyond a depth of 25 m. Occasionally this species was also found at a depth of 15 m.

Epinephelus caninus (Valenciennes, 1843)
The dogtooth grouper was once observed at 40 m depth on a rocky bottoms at Portinatx.

Epinephelus costae (Steindachner, 1878)
The gold blotch grouper was noted in front of a big rock way out in the Cala Llenya at a depth of 12 m and was seen regularly at Portinatx at depths of between 15 and 25 m.

Epinephelus marginatus (Linnaeus, 1758)
Adult dusky groupers were observed out in the open in deeper areas (around 20 m). In autumn many juvenile groupers could be found at depths of up to 5 m, inhabiting caves and crevices in the Cala Llenya and around Portinatx.

Serranus cabrilla (Linnaeus, 1758)
The comber or learned rockfish is also a very common species, occurring mostly at depths of over 3 m on rocky bottoms and above small sandy areas.

Serranus hepatus (Linnaeus, 1758)
Brown combers are rare off Ibiza and there are only two records each for the south of the island (Cala Llenya) and for the northern coast.

Serranus scriba (Linnaeus, 1758)
The painted comber is the most common Serranidae off Ibiza and inhabits rocky bottoms and the edges of *Posidonia* meadows. Range of depth: between 2 and 20 m. Large adults can be found close to *Octopus vulgaris*.

Family Moronidae

Dicentrarchus labrax (Linnaeus, 1758)
The European sea bass was once observed at a depth of 1 m at Portinatx.

Dicentrarchus punctatus (Bloch, 1792)
The spotted sea bass was only detected once in autumn 2006 at the Cala Boix at a depth of 1 m, hunting at a shallow rocky reef on sandy bottoms.

Family Apogonidae

Apogon imberbis (Linnaeus, 1758)
The cardinal fish is very common in shaded areas of crevices, caves and ledges in depths of between 2 and 35 m. It can also be found sporadically in *Posidonia* meadows.

Family Carangidae

Seriola dumerili (Risso, 1810)
The greater amberjack, which occurs at depths of between 4 and 20 m, is not common off Ibiza. However, in September and October large groups of juveniles (20 to 30 cm in length) can regularly be observed around Portinatx.

Trachinotus ovatus (Linnaeus, 1758)
Juveniles of the derbio can be found beneath the water surface, where they occur mainly in the months of summer.

Trachurus mediterraneus (Steindachner, 1868)
The Mediterranean horse mackerel was regularly observed on night dives in the Cala Llenya at a depth of 8 to 16 m. Juveniles were found in association with the jellyfish *Cotylorhiza tuberculata*.

Trachurus trachurus (Linnaeus, 1758)
Juveniles of the Atlantic horse mackerel were regularly observed in association with the jellyfish *Cotylorhiza tuberculata* and most probably once also with *Pelagia noctiluca* (see ‘Discussion’).

Family Sciaenidae

Sciaena umbra Linnaeus, 1758
The brown meagre was observed at the entrances of caves, in *Posidonia* meadows and around rocks near *Posidonia*. Range of depth: between 2 and 15 m.

Family Mullidae

Mullus surmuletus Linnaeus, 1758
The striped red mullet is a very common species, often in a feeding association with labrids and/or sparids (Fig. 2a) on sandy or rocky bottoms at a depth of 1 to 25 m.

Family Sparidae

Boops boops (Linnaeus, 1758)
The bogue can be found over sea grass meadows as well as over rocky bottoms and sandy bottoms at depths of between 2 and 30 m.

Diplodus annularis (Linnaeus, 1758)
Annular seabreams were regularly found on *Posidonia* meadows between 2 and 20 m deep.

Diplodus cervinus cervinus (Lowe, 1838)
The zebra seabream is less common than the other *Diplodus* species and was observed on rocky bottoms as well in boulder fields at a depth of between 2 and 20 m. It was never observed around Portinatx.

Diplodus puntazzo (Cetti, 1777)
The sharp snout seabream is also less common and mainly observed as single individuals in boulder fields and next to *Posidonia* meadows at depths of between 1.5 and 20 m.

Diplodus sargus sargus (Linnaeus, 1758)
The white seabream is a very common seabream occurring over boulder fields and rocky bottoms between 2 and 20 m deep. At night this species can also be detected on the border areas of *Posidonia* meadows.

Diplodus vulgaris (Geoffrey Saint Hilaire, 1817)
The common two-banded seabream is Ibiza's most common Sparidae. It mainly inhabits rocky bottoms covered with algae, and boulder fields, but can also be observed following *Mullus surmuletus* or *Lithognathus mormyrus* over sandy bottoms (Fig. 2a, 2b). Range of depth: between 2 and 20 m.

Lithognathus mormyrus (Linnaeus, 1758)
The striped seabream is common on sandy bottoms around the island at depths of between 2 and 20 m. Due to its feeding habits, it is followed by other species, but unlike with *Mullus surmuletus* it is followed by single individuals, not by shoals (Fig. 2b).

Oblada melanura (Linnaeus, 1758)
The saddled seabream is very common off Ibiza at depths of between 1 and 20 m. Juveniles can be found in large shoals during the summer.

Sarpa salpa (Linnaeus, 1758)
The sarp is a very common fish all around the island. It forms big shoals over *Posidonia* meadows, algae covered rocky bottoms and boulder fields at depths of between 2 and 20 m.

Sparus aurata Linnaeus, 1758
The gilthead seabream was detected irregularly in the boulder fields of Cala Llenya at depths of between 3 and 8 m.

Spondyliosoma cantharus (Linnaeus, 1758)
The black seabream was observed regularly at Portinatx between 10 and 20 m.

Family Centracanthidae

Spicara maena (Linnaeus, 1758)
The blotched picarel was observed in great shoals over *Posidonia* at depths of between 10 and 20 m during the day as well as on sandy bottoms and on the edge of *Posidonia* meadows at night. At Portinatx a huge shoal was observed on every dive for over 20 years at a certain point 35 m in depth.

Spicara smaris (Linnaeus, 1758)
The picarel was seen in small groups at around 10 m at Portinatx.

Family Pomacentridae

Chromis chromis (Linnaeus, 1758)
The damselfish was abundant near large rocks at depths of between 3 and 30 m.

Family Labridae

Coris julis (Linnaeus, 1758)
The rainbow wrasse was found mainly in boulder fields and over rocky bottoms at depths of between 1.5 and 25 m. The species is common all around the island.

Labrus merula Linnaeus, 1758
This shy species is less common than the *Symphodus* species. The brown wrasse occurs individually in *Posidonia* meadows or around rocks near sea grass meadows at depths of between 4 and 20 m.

Labrus viridis Linnaeus, 1758
Like *L. merula*, the green wrasse is very shy and not very common. It inhabits *Posidonia* meadows and algae covered rocky bottoms on the edges of the meadows at depths between 3 and 20 m.

Symphodus cinereus (Bonaterre, 1788)
The grey wrasse is not common around Ibiza and was observed in the boulder field covered with algae in the Cala Llenya and at Portinatx between 1.5 and 5 m.

Symphodus doderleini (Jordan, 1891)
Doederlein's wrasse is not common around Ibiza and was only found a few times in *Posidonia* meadows at the Cala Llenya between 3 and 10 m.

Symphodus mediterraneus (Jordan, 1891)
The axillary wrasse is common in the boulder fields in the Cala Llenya and Portinatx where it could be observed building nests on *Cystoseira* covered rocks in spring and early summer. Range of depth: 0.5 to 20 m.

Symphodus melanocercus (Risso, 1810)
The black-tailed wrasse can regularly be observed cleaning other fishes at depths of between 5 and 20 m, especially around Portinatx. This species operates specific 'cleaning stations', usually at prominent points near *Posidonia* meadows (Fig. 2d).

Symphodus melops (Linnaeus, 1758)
The cockwing wrasse is common all around the Island, occurring on? algae covered rocky bottoms and in boulder fields at depths of between 1 and 20 m. Off Ibiza this species shows several colour variations.

Symphodus ocellatus Forskål, 1775
The eyed wrasse was regularly detected on algae covered rocky bottoms as well as in boulder fields at depths of between 1 and 20 m. In spring and early summer it builds breeding nests.

Symphodus roissali (Risso, 1810)
The five-spotted wrasse is the most common Labridae off Ibiza, inhabiting algae covered rocky bottoms and boulder fields at depths of between 1 and 20 m. This species showed several colour variations off Ibiza.

Symphodus rostratus (Bloch, 1791)
The long-snouted wrasse is less common than other Labridae off Ibiza and was only found a few times in *Posidonia* meadows at depths of between 5 and 10 m. Most individuals were yellow-greenish in color, though some are brownish.

Symphodus tinca (Linnaeus, 1758)
The peacock wrasse can be found all around the island in a feeding association with other labrids above rocky bottoms and in boulder fields at depths of between 1.5 to 20 m.

Thalassoma pavo (Linnaeus, 1758)
The ornate wrasse is very common on rocky bottoms and in boulder fields. Range of depth: 1 to 20 m.

Xyrichthys novacula (Linnaeus, 1758)
The pearly razorfish was detected all around the island on sandy bottoms between 3 and 25 m deep.

Family Ammodytidae

Gymnammodytes cicerellus Rafinesque, 1810
A shoal of juvenile Mediterranean sand eels was observed once in the Cala Llenya over sandy bottom at a depth of 4 meters. Two species were caught with a handnet for proper determination. Another shoal of sand eels was detected in the Cala Conta at a depth of 3 m, but no species could be caught for an accurate identification.

Family Trachinidae

Echiichthys vipera Cuvier, 1829
The lesser weever was only detected once on sandy bottom in the Cala Tarida at a depth of 1 m.

Trachinus araneus (Cuvier, 1829)
The spotted weever is less common than *Trachinus draco* but is found, including in its adult form, in shallow water at about 2 m depth. This species is more aggressive than the other weever fishes and reacts by showing its black dorsal fin when the observer comes too close to it (within a range of about 2 to 3 m).

Trachinus draco Linnaeus, 1758
The greater weever is the most common Trachinidae off the island of Ibiza, inhabiting sandy bottoms between 3 and 20 meters. Observation made by R.A.P.: this species reacts to the electronic flashlight of underwater photography.

Trachinus radiatus Cuvier, 1829
The starry weever is less common than the other weevers, and was only detected twice in the Cala Llenya at a depth of 16 m and once at Portinatx at 20 m on sandy bottoms. It seems to inhabit deeper areas, because it can regularly be found on fish markets.

Family Uranoscopidae

Uranoscopus scaber Linnaeus, 1758
The Atlantic stargazer is common on the southern coast on sandy bottoms at a depth of between 5 and 10 m, but less common in the north of the island. It was never observed in the area of Portinatx.

Family Gobiidae

Chromogobius zebratus (Kolombatovic, 1891)
Kolombatovic's goby is rare around Ibiza. It seems to inhabit boulder fields in water depths from 5 to 12 m.

Corcyrogobius liechtensteini (Kolombatovic, 1891)
In the rocky littoral of northern Ibiza, Liechtenstein's goby is the most common cryptobenthic gobiid fish. It is found frequently at depths of 3 to 25 m mostly in holes made by *Lithophaga lithophaga* (Linnaeus, 1758) or in caves.

Didogobius splechtnai Ahnelt & Patzner, 1995
Splechtna's goby was found only on the northern coast of Ibiza in caves of varying sizes. The depth was usually between 7 and 20 m. The shallowest finding was at 4.5 m in a relatively protected bay, and the deepest 40 m. The animals are usually found at the furthest end of the cave (Fig. 3c).

Gammogobius steinitzi Bath, 1971
Steinitz's goby was also only found in caves at depths of between 7 and 25 m. It settles on the walls and ceilings of deep regions of caves.

Gobius bucchichi Steindachner, 1870
Bucchich's goby was regularly found all around the island in rocky areas, boulder fields and small sandy areas, usually in the vicinity of *Anemonia viridis*. Depth range: between 2 and 20 m.

Gobius cobitis Pallas, 1811
The giant goby was found only a few times in a small cavity with sandy bottom in the Cala Llenya and in boulder fields at Portinatx at a depth of 0.5 to 1.5 m.

Gobius cruentatus Gmelin, 1789
The red-mouthed goby can be detected on rocky bottoms as well as in *Posidonia* meadows and in caves on sandy bottom. Range of depth: between 4 and 20m.

Gobius fallax Sarato, 1889
Sarato´s goby was found several times on sandy bottoms near shelter at Portinatx at depths of between 5 and 7m.

Gobius geniporus Valenciennes, 1837
The slender goby occurs on sandy bottoms at a depth of between 2 and 20 m, frequently near *Posidonia* meadows, and was also detected on sandy bottom in a cave in the Cala Olivera.

Gobius niger Linnaeus, 1758
The black goby was only observed once in the Cala Llenya in a crevice on rocky bottom at a depth of 4 m in spring 2004.

Gobius paganellus Linnaeus, 1758
The rock goby is common in boulder fields in shallow water of 0.5 to 2 m in depth and can sometimes be found in rock pools.

Gobius roulei De Buen, 1928
Roule´s goby was found a few times on sandy bottoms at a depth of 20 m at Cala Olivera as well as at Cala Vedella and near Portinatx at the same depth.

Gobius vittatus Vinciguerra, 1758
The striped goby inhabits secondary hard bottoms below a depth of 15 m and is not common around Ibiza.

Gobius xanthocephalus Heymer & Zander, 1992
The yellow-headed goby was found twice off the northern coast at Portinatx in depths of 25 and 35 meters.

Millerigobius macrocephalus (Kolombatovic, 1891)
The large-headed goby is rare around Ibiza. It was found in small cavities, under sea urchins, and in caves at depths of between 4 and 25 m.

Pomatoschistus bathi Miller, 1928
Bath's goby can be found on sandy bottoms off Ibiza at a depth of 5 to 15 m. In spring it forms shoals of juveniles occurring over *Cymodocea*-meadows.

Pomatoschistus pictus (Malm, 1865)
Like *P. bathi* the picted goby can be observed over sandy bottoms and in shoals over *Cymodocea* in spring at depths of between 5 and 15 m.

Pomatoschistus sp.
Due to problems determining small juvenile *Pomatoschistus* species it can be supposed that other species such as *P. bathi* and *P. pictus* can be found around Ibiza.

Thorogobius ephippiatus (Lowe, 1839)
The leopard-spotted goby was observed at a depth range of between 12 and 45 m resting on the sandy bottom in the rear third of caves. It reacts very shyly to the light of a diving lamp.

Thorogobius macrolepis (Kolombatovic, 1891)
The large-scaled goby was found at depths of between 37 and 45 m at Portinatx in habitats similar to those preferred by *T. ephippiatus*.

Zebrus zebrus (Risso, 1826)
This species is usually found in rock pools in the south and the north of the island. In addition it uses a variety of other habitats at depths from 0.1 to 10 m; hiding under stones, in small cavities, in holes made by *L. lithophaga*, and in association with the sea urchins *Paracentrotus lividus* and *Arbacia lixula*.

Family Callionymidae

Callionymus pusillus Delaroche, 1809
This species is less common on sandy bottoms off Ibiza and was observed at depths of between 1 and 10 m.

Family Blenniidae

Aidablennius sphynx (Valenciennes, 1836)
This is the most common blenny off the island of Ibiza and can be found on flat rocks at depths of 0 to 2 m. This species occurs on bare rocks (or only vegetated by small green algae) as well as on densely vegetated rocks.

Coryphoblennius galerita (Linnaeus, 1758)
Montagu's blenny can be found in the surf zone both below and above the water surface on rocky bottoms and in rock pools. They are most commonly observed outside the water at night.

Lipophrys canevae (Vinciguerra, 1880)
The yellow-cheeked blenny prefers the steep faces of the northern coast, where it inhabits empty *L. lithophaga* holes near the water surface. Range of depth: 0.2 to 1 m.

Lipophrys dalmatinus (Steindachner & Kolombatovic, 1883)
This species is less common around Ibiza and has been detected at Portinatx and in the Cala Vedella between algae on rounded stones in shallow waters from 0 to 1.5 m.

Lipophrys nigriceps (Vinciguerra, 1883)
The specimens occurring around Ibiza are of the subspecies *L. n. portmahonis* Castanos, 1933 (Fig. 2g). They are found in cavities of varying sizes and withdraw into empty *Lithophaga* holes when disturbed. With a few exceptions, this species is only found on the ceiling and the upper parts of the walls of cavities at depths of between 2 and 10 m.

Parablennius gattorugine (Brünnich, 1768)
This is a common species inhabiting rocky bottoms between 2 and 25 m. It is also found in crevices on steep faces in the north of the island as well as in boulder fields and on rocky bottoms in the south.

Parablennius incognitus (Bath, 1968)
The ponti blenny occurred on steep faces as well as on densely vegetated rocks all around the island and inhabits empty *Lithophaga lithophaga* holes. Range of depth: between 0.5 and 2 m.

Parablennius pilicornis (Cuvier, 1829)
The ringneck blenny was found on rocky bottoms covered with algae at depths of 2 to 5 m. Different colour variations were found: (1) cross band colouration (Fig. 3e), (2) longitudinal colouration in juveniles and some females, (3) black colouration only in breeding males, (4) yellow colouration (Fig. 3f) in around 10 % of females (Patzner & Moosleitner 1994b). In recent years the species was found less often than in earlier years and was last detected in 2004 at the Penyal de s`Aguila (see ‘Discussion’).

Parablennius rouxi (Cocco, 1833)
The striped blenny was detected at depths of between 7 and 35 m, mainly at entrances of small cavities on rocky bottoms.

Parablennius sanguinolentus (Pallas, 1811)
The rusty blenny is found both in the north of the island at the Penyal de s´Aguila on flat rocks covered by small green algae and in eutrophic places such as the Cala Llenya at depths of between 0 and 2 m. This species is also very common in the Cala d´Hort.

Parablennius tentacularis (Brünnich, 1768)
The horned blenny was only found once on the edge of *Posidonia* at Portinatx at 30.5 m depth. Normally this species occurs at depths of between 3 and 15 m.

Parablennius zvonimiri (Kolombatovic, 1892)
Zvonimir´s blenny is very common in shaded areas in crevices, caves and under ledges on the steep faces of the northern coast and can be found at depths of up to 5 m.

Paralipophrys trigloides (Valenciennes, 1836)
This blenny can be found in the same places as *Coryphoblennius galerita* and can also be observed outside the water at night.

Salaria pavo (Risso, 1810)
High numbers of peacock blenny individuals can be found in rock pools and were also observed in the salt flats (Salinas) in the south of Ibiza in salt concentrations up to a salinity of 65 (Patzner & Moosleitner, 1994a)!

Scartella cristata (Linnaeus, 1758)
The molly miller inhabits areas beneath the water surface on rocky bottoms (Fig. 3d). Although this species was found both in the north and in the south of the island years ago, it was not recorded after the year 2000 until March 2007 (see 'Discussion'), when we found one individual in an empty *L. lithophaga* hole at a depth of 0.5m in the Cala Llenya. This species was caught with a handnet to avoid a misidentification.

Family Clinidae

Clinitrachus argentatus (Risso, 1810)
The cline was caught a few times in the interstice of *Cystoseira* algae at depths of 0.1 to 1.5 m in the Cala Llenya.

Family Tripterygiidae

Tripterygion delaisi Cadenat & Blanche, 1971
The yellow black-faced triplefin occurs at depths below 3 to 4 m and is found all around the island on rocky bottoms.

Tripterygion melanurus Guichenot, 1845
The pygmy black-faced blenny can be found all around the island inhabiting shaded areas on rocky bottoms mostly underneath ledges (Fig. 2h).

Tripterygion tripteronotos (Risso, 1810)
The red black-faced triplefin is very common in shallow waters 0.2 to 2 m deep on rocky bottoms and is more exposed to the observer than *T. melanurus*.

Family Bythitidae

Oligopus ater Risso, 1810
The black faufre was observed in a deep cavity at Portinatx at a water depth of 12 m. Two juveniles were caught in a small cavity at 25 m depth.

Family Carapidae

Carapus acus (Brünnich, 1768)
The pearl fish was only found once as it left a captured *Holothuria tubulosa* (Gmelin, 1788) in an aquarium at night. It cannot be concluded with certainty whether this species is common or not.

Family Sphyraenidae

Sphyraena viridensis Cuvier, 1829
The yellow mouth barracuda could be observed regularly in little shoals in the open water beneath the water surface, mainly during summer.

Family Mugilidae

Chelon labrosus (Risso, 1827)
The thicklip grey mullet is very common off Ibiza and occurs in shoals, mostly beneath the water surface next to rocks.

Liza sp.
Representatives of this genus (species could not be verified) are regularly seen in small groups of juveniles.

Oedalechilus labeo (Cuvier, 1829)
The boxlip mullet was found regularly at Portinatx at depths of up to 20 m.

Family Atherinidae

Atherina boyeri Risso, 1810
Boyer's sand smelts occur in large shoals and were observed in shallow water (0.5 to 2 m) over *Cymodocea* meadows in the Cala Boix and in a large cave in the Cala Bassa, where this species was very abundant.

Atherina hepsetus (Linnaeus, 1758)
The Mediterranean sand smelt was mainly observed at night, where it can be found near sandy bottoms at a depth of 5 to 15 m.

Family Scorpaenidae

Scorpaena maderensis Valenciennes, 1833
The Madeira rockfish is regularly found on rocky bottoms under ledges and at entrances of caves, mostly in deep water at between 5 and 20 m.

Scorpaena notata Rafinesque, 1810
The small red scorpionfish is uncommon but can be found on rocky bottoms and in sandy areas in the vicinity of rocks or *Posidonia* at depths of between 4 to 20 m.

Scorpaena porcus Linnaeus, 1758
The black scorpionfish is the most common Scorpaenidae off the island of Ibiza and occurs on rocky bottoms, in boulder fields, and also in *Posidonia* meadows. Range of depth: 0.5 to 20 m.

Scorpaena scrofa Linnaeus, 1758
The red scorpionfish inhabits deeper regions and can only be found beyond a depth of 20 m. It occurs on rocky bottoms as well as in sandy areas next to rocks, caves and ledges.

Family Dactylopteridae

Dactylopterus volitans (Linnaeus, 1758)
The flying gurnard is uncommon off Ibiza but was occasionally found on sandy bottoms in the Cala Llenya and at Portinatx at depths of between 10 and 15 m.

Family Bothidae

Bothus podas podas (Delaroche, 1809)
The wide-eyed flounder is the most common flatfish on sandy bottoms off Ibiza and is found at a range of depth between 3 and 30 m. It was observed near sea grass meadows in association with *Astropecten*.

Family Soleidae

Solea lascaris (Risso, 1810)
The sand sole was only found once on a sandy bottom in the Cala Llenya at a depth of 4 to 5 m.

Family Balistidae

Balistes capriscus (Gmelin, 1789)
The grey triggerfish is not very common off Ibiza and was only detected twice over rocky bottoms in spring 2005, once at the Penyal de s´Aguila as a group of 5 adults at 16 m depth and another time as a juvenile of about 20 cm in the boulder field in the Cala Llenya at a depth of 3 m.

Family Molidae

Mola mola (Linnaeus, 1758)
The ocean sunfish was observed several times in the vicinity of Portinatx, at depths ranging from the surface to approximately 40 m (P.A. Reiserer, personal communication to R.A.P.).

Family Gobiesocidae

Apletodon incognitus Hofrichter & Patzner, 1997
This species is common in the pebble banks of the boulder field in the Cala Llenya at depths of 0.5 to 1 m, but it also occurs in *Posidonia* meadows. In the area of Portinatx young specimens were frequently found in association with the sea urchins *Paracentrotus lividus*, *Arbacia lixula*, and *Sphaerechinus granularis.* They were observed at all depths where sea urchins were found, from 0.2 m down to over 20 m.

Gouania wildenowi (Risso, 1810)
The blunt-snouted clingfish was found only in shallow water (0.2 to 0.5 m) in banks of pebbles around Portinatx. The fish lives within the lower, second layer which consists of pebbles with a diameter of between 1 and 2 cm and spends much of its life concealed.

Lepadogaster candollii Risso, 1810
The Connemarra clingfish is very variable in habitat. It was found in boulder fields, in small cavities in sea grass meadows, under sea urchins, and occasionally in caves within a depth range of 0.5 to 20 m.

Lepadogaster lepadogaster (Bonnaterre, 1788)
The shore clingfish was found on banks of pebbles and in boulder fields at a depth range of 0.3 to 5 m. The animals were normally found on the underside of stones with a diameter of more than 5 cm, where they were attached upside down by their sucker disk. The species was checked against *L. purpurea* (Henriques et al. 2002), which was not found.

Opeatogenys gracilis (Canestrini, 1864)
This species was only found attached to leaves in *Posidonia* meadows. Depth range: 2 to 15 m in the Cala Llenya and around Portinatx.

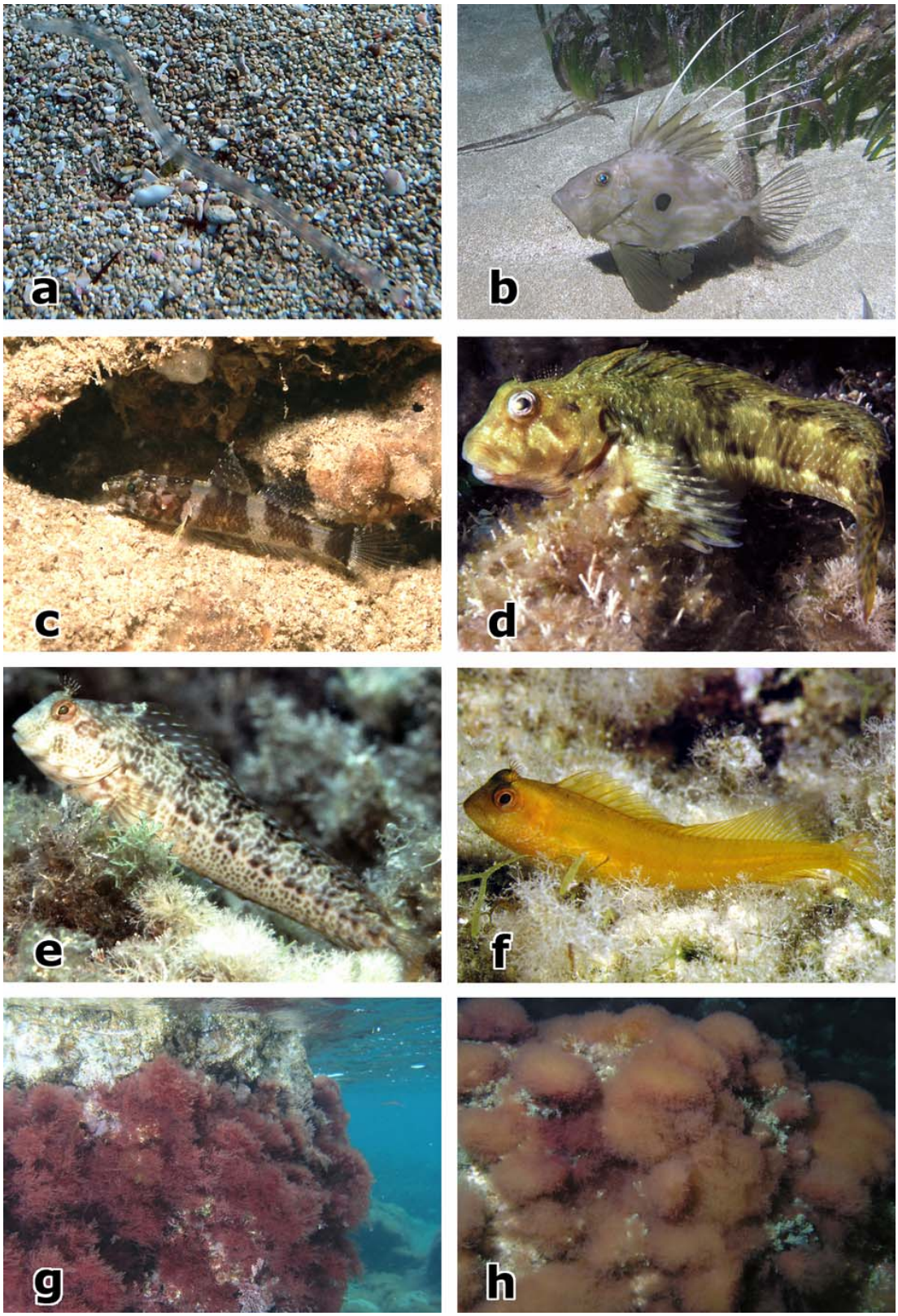


Fig. 3 Fishes and algae around Ibiza. a) juvenile *Ariosoma balearicum* during daytime; b) *Zeus faber* near *Posidinia oceanica*; c) *Didogobius splechtnai* in front of its hole; d) *Scartella cristata,* probably absent from Ibiza since 2000; e) *Parablennius pilicornis* in cross band colouration; f) *P. pilicornis* in yellow colouration; g) *Lophocladia lallemandii* in a shallow area h) *L. lallemandii* at a depth of 20 m at Cala Llenya (note the different colourations).

Discussion

MAYOL ET AL. (2000) described 405 fish species for all the Balearic Islands (Ibiza, Mallorca, Menorca and Formentera). The list also includes off-shore and deep water species which are not in the range of snorkeling or scuba diving. In the present paper the occurrence of 130 fish species is described. Most of these species are benthic (68) or bottom related species (41), with only a few pelagic species (21) recorded. The benthic community is dominated by fishes inhabiting rocky bottoms (47), with Blenniidae and Gobiidae representing more than half of all species. The remainder of the community consists mainly of Scorpaenidae, Gobiesocidae and Tripterygiidae. On sandy bottoms 23 different species occurred, including 6 sit-and-wait predators, hidden in the sand (Trachinidae, Uranoscopidae, Synodontidae), four rays, *Torpedo marmorata, Dasyatis pastinaca* ,*Raja* cf. *miraletus* , *Raja radula* and the eagle ray *Myliobatis aquila*. Like the rays, flatfishes (Bothidae, Solidae) and *Ariosoma balearicum* can also be covered by sand, and the other species inhabit the surface of the sandy bottom (Callionymidae, Dactylopteridae, Mullidae). The bottom related fishes are dominated by 3 families: Labridae, Sparidae and Serranidae. Those species are mainly confined to rocky bottoms and only few of them occur over sand (*Xyrichthyes novacula* and *Lithognathus mormyrus*). Except for a few species, such as the groupers, all three families were abundant both in absolute terms and in number of species. The other fish families which occured (Balistidae, Scianidae, Syngnathidae and Zeidae) were less rich in species and lower in abundance. However, especially cryptic species, such as Syngnathidae in dense *Posidonia* meadows, are not easy to detect by visual census and are often overlooked or underestimated (SMITH 1988). In the pelagic area two main groups can be distinguished: predators such as Sphyraenidae, Moronidae, Carangidae and Belonidae on the one hand, and the planktotroph Atherinidae, Exocoetidae, Centracanthidae and Clupeidae on the other, which are more abundant than the first group and dominate the pelagic area.

Fish species which were not found during the present study. Some species previously described for the island by other authors were not detected by our study. At Portinatx, RIEHL (1978) recorded the pelagic species *Atherina presbyter* (Cuvier, 1817), and in particular benthic species: *Pleuronectes platessa* Linnaeus, 1758, *Raja clavata* Linnaeus, 1758, *Scophthalmus rhombus* (Linnaeus, 1758), *Buglossidium luteum* (Risso, 1810), *Solea solea* (Linnaeus, 1758), *Pomatoschistus microps* (Krøyer, 1838), *P. minutus* (Pallas, 1770) and *Lipophrys pholis* (Linnaeus, 1758). This last species (1978) was declared to be a misidentification (ZANDER pers. comm. in GOLANI ET AL. 2002), but a recent review of the museum material by one of the authors (R.A.P.) confirmed the original determination. See the next chapter for the following other benthic species also reported by Riehl (1978): *Apletodon dentatus* (Facciola, 1887), *Diplecogaster bimaculeatus* (Bonnaterre, 1788), *Ammodytes tobianus* (Linnaeus, 1758) and *Blennius ocellaris* Linnaeus, 1758.
For the marine reserve Freus d'Eivissa, further species are described by Anonymus (2004), all of which are protected and rare species which with one exception appear on the red list for fishes of the Balearic Islands (Mayol ET AL. 2000). In addition, some of those species, such as *Squatina* sp., *Dasyatis centroura* (Mitchill, 1815), *Torpedo torpedo* (Linnaeus, 1758) and *Scyliorhinus stellaris* (Linnaeus, 1758) only occur in deeper areas, or, like *Mustelus* sp., *Sphyrna* sp., and *Prionace glauca* (Linnaeus, 1758), are not detectable using our research techniques. *Umbrina cirrhosa* (Linnaeus, 1758) as well as the Syngnathidae *Hippocampus hippocampus*

(Linnaeus, 1758), *Nerophis ophidion* (Linnaeus, 1758), *Syngnathus abaster* (Risso, 1827) and *Syngnathus acus* (Linnaeus, 1758) are listed in this paper. As already stated, the Syngnathidae in particular are very difficult to detect by visual census because of their perfect camouflage in *Posidonia* meadows. Except for *Syngnathus abaster*, all the Syngnathidae mentioned were also found on the northern coast by RIEHL (1978). ARBONA SAŃCHEZ (2003) also described five further species for the marine reserve in the south of the island. Unfortunately there are no descriptions of the commonness and range of depth of those species. Although species such as *Scyliorhinus canicula* (Linnaeus, 1758) and *Lophius piscatorius* (Linnaeus, 1758) inhabit deeper areas, and *Myctoperca rubra* (Bloch, 1793) appears to be less common, *Pagrus pagrus* (Linnaeus, 1758) and *Chelidonichthys* (=*Trigloporus*) *lastoviza* (Bonnaterre, 1788) also occur in shallower areas.

Possible confusions in literature with other species. Riehl (1978) reported juvenile *Ammodytes tobianus* (Linnaeus, 1758) at Portinatx. This would be the only finding in the Mediterranean Sea. As identification based on juveniles is very uncertain (GOLANI ET AL. 2002) the occurrence of this Atlantic species off Ibiza is doubtful.
In the present study *Blennius ocellaris* was not found in the sea, but it was seen regularly at the fish market at St. Eularia. This supports the idea that this is a deeper water species, living below 30 m (ZANDER 1986). RIEHL's (1978) observation of this species at a water depth of 2 m (no specimen collected) might be a due to confusion with *Parablennius pilicornis*, in which mature males have a very high dorsal fin with a remarkable spot.
Due to the late description of *Apletodon incognitus* by HOFRICHTER & PATZNER (1997) and its similarity to *A. dentatus* and *Diplecogaster bimaculeatus*, the occurrence of these two species off Ibiza can be concluded to be very uncertain.

Symbiosis and other associations. Certain associations between fishes of different species and between fishes and invertebrates in the Mediterranean Sea have been known for several years (e.g. ABEL 1960, THIEL 1970, MOOSLEITNER 1980, MOOSLEITNER 1982, ZANDER 2003).
During our investigations, feeding associations between *Mullus surmuletus*, *Lithognathus mormyrus* (Fig. 2a, 2b) and *Symphodus tinca* were observed. A more detailed investigation – similar to the one by VELTE (2006) - is planned.
PATZNER (1989) observed an association between *Bothus podas podas* and *Astropecten aranciacus* (Fig. 2c) off Ibiza, but we were unable to observe this partnership in recent years because of the disappearance of *A. aranciacus* in this region (MOOSLEITNER & PATZNER 2005).
To our knowledge, no association has previously been described between *Serranus scriba* and *Octopus vulgaris* in the Mediterranean Sea. We found evidence of commensalism (a feeding association), although no direct interactions were observed. A similar relationship between groupers and octopuses has been found in the Red Sea (PATZNER & DEBELIUS 1984) and in the Gulf of California (STRAND 1988).

The behaviour of the only real cleaner fish in the Mediterranean, *Symphodus melanocercus* (Fig. 2d), has been described by several authors (MOOSLEITNER 1980, ZANDER & NIEDER 1997, ZANDER & SÖTJE 2002, PATZNER 2002, PRÖTSCH & PATZNER 2003). A phenomenon which to date has only been observed off Ibiza is that by cleaning adult *Epinephelus marginatus*, *S. melanocercus* does not operate cleaning stations, but accompanies the large fish constantly (PATZNER 2003). It is not known if

this occurs only off Ibiza or also in other parts of the Mediterranean. What is certain is that there are geographical differences in the behaviour of *S. melanocercus* in the Mediterranean Sea (ZANDER & SÖTJE 2002).
The cleaning behaviour of the shrimp *Lysmata seticaudata* in relation to *Muraena helena* was described for the first time at Portinatx (PATZNER 1982) and can be observed regularly.
The association between juveniles of *Trachinus mediterraneus* and *T. trachurus* and the jelly fish *Cotylorhiza tuberculata* is well known in all the Mediterranean area (THIEL 1970). However, a partnership between fishes of this genus and the strongly stinging *Pelagia noctiluca* has not previously been reported. A picture of this association (Fig. 2f) taken by one of the authors (R.A.P.) at Portinatx in around 2 m depth was first published in PATZNER & DEBELIUS (1984); it had been. It most probably shows *T. trachurus*, but this is not quite clear.
The association between *Gobius bucchichi* and the anemone *Anemonia viridis* is a close one in the area around Ibiza (Fig. 2e). It has been shown that is not the case in all the Mediterranean Sea (BRUMMER 1994, VELTE 1994).
The co-occurrence of *Parablennius rouxi* and the similar looking *Gobius vittatus* was also observed off Ibiza, especially around Portinatx. No explanation was found for the existence of mimicry, as suspected by HEYMER & ZANDER (1978). This also applies to the co-occurrence of *Lipophrys nigriceps* and *Tripterygion melanurus* (ZANDER & HEYMER 1976) (Fig. 2g, 2h).
The association between *Carapus acus* and *Holothuria tubulosa* and *Stichopus regalis* (Cuvier, 1817) is well known in the Mediterranean Sea and is most probably a non-parasitic partnership (KLOSS & PFEIFFER 2000).

Decrease in fish species and influence of *Lophocladia* algae. A decrease in the abundance of *Scartella cristata* and *Parablennius pilicornis* has been detected over the course of the last few years. *P. pilicornis* was only rarely found off the northern coast, and *S. cristata* was last found in the year 2000, despite targeted searches for this species. Finally, one specimen was found in the Cala Llenya in March 2007. The thermophile species *S. cristata* showed a northwards migration in the Mediterranean in the 1970s and 80s (CARDONA & ELICES 2001) and was found off the northern Mediterranean Spanish coast in 1988 (Nieder 1988), after being observed in southern Spain as early as 1970 (BATH 1970). Its occurrence in the Balearic Islands was first published by one of the authors (PATZNER 1984) and the species was recorded as not very common. Apart from our own study, there is only one detection of a single specimen for the Balearic Islands, on Menorca in 2001 (CARDONA & ELICES 2001) after 1984. Apart from our own study, it was only detected once/only one specimen was found in the Balearic Islands after 1984, off Menorca in 2001 (CARDONA & ELICES 2001). *P. pilicornis* was also only detected twice off Menorca in the years 1995 and 2000 (CARDONA & ELICES 2000). It seems that neither *S. cristata* nor *P. pilicornis* were very common on the island a priori.
But what caused this decrease in abundance? The occurrence of *S. cristata* in the warmer eastern Mediterranean (DIAMANT ET AL. 1986) and in the Gulf of Mexico and off the coast of Brazil (BATH 1970, ZANDER 1972b) negate the theory that the diminished occurrence of this species is only related to rising water temperatures in the western Mediterranean. Also, the occurrence of the invasive toxic alga *Lophocladia lallemandii* (Montagne) (F. Schmitz), which overgrows rocky bottoms and border areas of *Posidonia* meadows in late summer and autumn, cannot be directly associated with the decrease of *S. cristata*. Even at places in the north of the island where the alga coverage was less dense, the species was detected no more

often in recent years. We are unable at the moment to give probable reasons for the decrease of this species.
Whether or not the red alga has an impact on *S. cristata*, there does seem to be a change in the ichtyofaunistical communities at places of dense coverage (up to 100%). Boudouresque & Verlaque (2002) characterise *Lophocladia lallemandii* as a toxic alga without any predators in the Mediterranean. As in the case of *Caulerpa taxifolia* (M. Vahl) (C. Agardh), the absence of predators enables a rapid spread. The occurrence of this invasive red alga on Ibiza was first described by one of the authors (PATZNER 1998) for the north of the island in 1995. Meanwhile this alga can be found at depths between 0 and 40 m all around the island and also on Formentera, and it shows much denser (up to 100 %) coverage in lentic areas than in areas of frequent disturbance through wave action (Fig. 3g, 3h). The southwest of the island seems to be less covered with *Lophocladia*, which is related to less rocky shores. The impact of *Lophocladia* coverage can be shown by the example of the boulder field at the Cala Llenya. Boulder fields represent a habitat with many macro- and micro-habitats, where many holes and crevices house a lot of invertebrates which represent an important food source for fishes. In addition to the large numbers of invertebrates in the crevices and under stones, the gobies *Gobius bucchichi* and *G. paganellus* were detected in abundance in the spring. In autumn 2006, however, when the whole boulder field with all its crevices was covered by *Lophocladia,* almost no gobies were found. Furthermore, *Anemonia viridis* was not present in autumm at sites where it was very common in spring, and a decrease in agile invertebrates under and between stones was also detected. In the north of the island *Parablennius rouxi* and *Gobius vittatus* as well as several benthic animals were no longer observed in areas of *Lophocladia* (PATZNER 1998).
It would be worth carrying out a comparative study of the infauna of *Lophocladia* and the ‘natural’ infauna of *Cystoseira*, since a change could have a crucial impact on carnivorous species - as indicated by the absence of several benthic animals in the north of the island, among other things. The future will show what impact *Lophocladia* has on the island of Ibiza and whether it induces further changes in the composition of the ichthyofauna. Due to the complex nature of the issue, recording these kinds of change processes is a major research undertaking. The detailed information gathered in this survey lays the foundation for further comparative studies.

Acknowledgements

We would like to thank all the participants in this research for their support and work on this study: Thomas Schiller, Sven Ihnken, Markus Vainer, Tom Reiner, Thomas Lorenz, Volker Hucksdorf, Jörg von Busekist, Malte Dorow and Niko Falk. We would further like to thank Jürgen Nieder for information on *Scartella cristata*. We are grateful to Andreas Müller and Christoph Schubart for translating the abstract into Spanish.

References

ABEL E.F. 1960: Liaison facultative d'un poisson (*Gobius bucchichii* Steindachner) d'une anemone (*Anemonia sulcata* Penn.) en Mediterranee. Vie Milieu 11: 517-531.

AHNELT H., MILLER P.J. & PATZNER R.A. 1994: Systematics and distribution of two rare Mediterranean gobies, *Corcyrogobius liechtensteini* and *Odondebuenia balearica* (Teleostei:Gobiidae). Cybium 18: 169-176.

AHNELT H. & PATZNER R.A. 1995. A new species of *Didogobius* (Teleostei: Gobiidae) from the western Mediterranean. Cybium 19: 95-102.

AHNELT H. & PATZNER R.A. 1996: Kryptobenthische Meergrundeln von den Balearen (Westliches Mittelmeer) mit Anmerkungen zum Unterstatus von *Chromogobius zebratus levanticus* Miller, 1971 (Pisces: Teleostei:Gobiidae). Ann. Naturhist. Mus. Wien 98b: 529-544.

ANONYMOUS 2004: Las reservas marinas en las Islas Baleares, Dirección General de Pesca, Conselleria de Agricultura i Pesca del Govern de les Illes Balears, Mallorca http://web2.caib.es/sac/annexos/cat/ 17931_2.pdf (13.11.2006).

ARBONA SAŃCHEZ P. 2003: El medi mari. In: El Parc Natural de ses Salines d'Eivissa i Formentera. El tresor ecològic de les Pitiüses. Gen-Gob Eivissa, Grup d´estudis de la naturalesa, Genial Edicions Culturals, Eivissa, primera editició 2003.

BATH H. 1970: Vergleichend-morphologische, taxonomische und zoogeographische Untersuchungen an den Schleimfischarten *Blennius cristatus, crinitus* und *nuchifilis* (Pisces: Blennioidea: Blenniidae). Senckenbergiana biol. 51: 287-30.

BOUDOURESQUE C.F. & VERLAQUE M. 2002: Biological pollution in the Mediterranean Sea: invasive versus introduced macrophytes. Mar. Poll. Bull. 44: 32-38.

BRUMMER T. 1994: Vergesellschaftung von Streifengrundel und Wachsrose - nur eine regionale Erscheinung?. DATZ 47: 779-780.

CARDONA L. & ELICES M. 2000: Datos sobre la presencia en el litoral de Menorca (islas Baleares, Mediterráneo Occidental) de *Parablennius pilicornis* (Cuvier, 1829) y *Scorpaena maderensis* (Valenciennes, 1833). Boll. Soc. Hist. Nat. Balears 43: 33-38.

CARDONA L. & ELICES M. 2001: Sobre la possible presencia de *Scartella cristata* (Linnaeus, 1758) (Osteichthyes, Blenniidae) en Menorca (Islas Balears, Mediterráneo Occidental). Boll. Soc. Hist. Nat. Balears 44: 81-85.

DIAMANT A., BEN TUVIA, A., BARANES A. & GOLANI D. 1986: An analysis of rocky coastal eastern Mediterranean fish assemblages and a comparison with an adjacent small artificial reef. J. Exp. Mar. Biol. Ecol. 97: 269-285.

FROESE R. & PAULY D. (eds) 2006. FishBase. World Wide Web electronic publication. www.fishbase.org.

Garcia-Rubies A. & Macpherson E. 1995: Substrate use and temporal pattern of recruitment in juvenile fishes of the Mediterranean littoral. Mar. Biol. 124: 35-42.

GOLANI D., ORSI-RELINI L., MASSUTÍ E. & QUIGNARD J.P. 2002: CIESM Atlas of Exotic Species in the Mediterranean - Vol. 1. Fishes. www.ciesm.org/online/atlas/index.htm.

HAANSTRA U. 1935. Geologie von Ost-Ibiza (Balearen). Phd thesis Rijksuniversiteit Utrecht.

HENRIQUES M., LOURENÇO R., ALMADA F., CALADO G., GONÇALVES D., GUILLEMAUD CANCELA M.L. & ALMADA V.C. 2002: A revision of the status of *Lepadogaster lepadogaster* (Teleostei: Gobiesocidae): sympatric subspecies or a long misunderstood blend of species? Biol. J. Linn. Soc. 76: 327-338

HERBAUT C., MARTEL F. & CRÉPON M. 1997. A sensitivity study of the general circulation of the western Mediterranean Sea. Part II: The response of atmospheric forcing. J. Phys. Oceanogr. 27: 2126-2145.

HERLER J., PATZNER R.A., AHNELT H. & HILGERS H. 1999: Habitat selection and ecology of two speleophilic gobiid fishes (Pisces: Gobiidae) from the western Mediterranean Sea. P.S.Z.N. Mar. Ecol. 20: 49-62.

HEYMER A. & ZANDER C.D. 1978: Morphology and ecology of *Gobius vittatus* and its possible mimicry relationship to *Blennius rouxi* in the Mediterranean. Z. zool. Syst. Evol. 16: 132-143.

HOFRICHTER R. & PATZNER R.A. 1997: A new species of *Apletodon* from the Mediterranean Sea and the eastern Atlantic with notes on the differentiation between *Apletodon* and *Dipledogaster* species, Senckenbergiana biol. 77: 15-22.
HOFRICHTER R. & PATZNER R.A. 2000: Habitat and microhabitat of Mediterranean clingfishes (Teleostei: Gobiesociformes: Gobiesocidae), P.S.Z.N.: Mar. Ecol. 21: 41-53.
HOPKINS T.S. 1985. Chapter 4. Physics of the sea. In: Margalef R. (Ed.). Western Mediterranean: 100-126, Pergamon Press, Oxford.
KLOSS K, & PFEIFFER W. 2000: Zur Biologie des "Eingeweidefisches" *Carapus acus* (Brunnich, 1768) (Carapidae, Teleostei), mit Hinweisen auf eine nicht-parasitische Ernährung. Rev. Siusse Zool. 107: 335-349.
MABILE S. & PIANTE C. 2005: Répertoire global des aires marines protégées en Méditerranée Fondation WWF-France. Paris, France xii + 132 pp http://www.wwf.fr/content/download/484/2234/version/2/file/ RepertoireAMP.pdf (13.11.2006)
MASSUTI E., MOREY G., MORANTA J. & RIERA F. 2001: Presència de *Sphyraena viridensis* (Pisces, Sphyraenidae) a les Illes Balears. Boll. Soc. Hist. Nat. Balears, 44: 97-101.
MAYOL J., GRAU A., RIERA F. & OLIVER J. 2000: Llista Vermella dels Peixos de les Balears, Documents tecnics de Conservacio. II epoca num.7, Govern de les Illes Balears, Palma: pp 126. http:// dgcapea.caib.es/pe/publicacions.es.htm (13.11.2006).
MOOSLEITNER H. 1980: Putzerfische und -garnelen im Mittelmeer. Zool. Anz. Jena 205: 219-240.
MOOSLEITNER H. 1982: Fressgemeinschaften auf Sandböden im Mittelmeer, Zool. Anz. Jena 209: 269-282.
MOOSLEITNER H. & PATZNER R.A. 2005: Das Verschwinden des Roten Kammseesternes (*Astropecten aranciacus*) BUFUS-Info digital, Univ. Salzburg 34 http://bufus.sbg.ac.at/info/Info34/Info34-1.htm.
MORENO I. 2002: Effects of substrate on the artificial reef fish assemblage in Santa Eulalia Bay (Ibiza, western Mediterranean), ICES J. mar. Sci. 59: 144-149.
NIEDER J. 1988: Zum Vorkommen von *Scartella cristata* (L.) und *Parablennius pilicornis* (Cuv.) (Teleostei, Blenniidae) an der nordspanischen Mittelmeerküste. Zool. Anz. Jena 220: 144-150.
NIEDER J. 1997: Seasonal variation in feeding patterns and food niche overlap in the Mediterranean Blennies *Scartella cristata*, *Parablennius pilicornis* and *Lipophrys trigloides* (Pisces: Blenniidae). P.S.Z.N.: Mar. Ecol. 18: 227-237.
PATZNER R.A. 1982: *Lysmata seticaudata* (Decapoda, Crustacea) als Putzergarnele im Mittelmeer. Helgol. Meeresunters. 35: 227-230.
PATZNER R.A. 1984: Die Blenniiden von Ibiza (Balearen) und ihre Verbreitung im West-Mittelmeer (Pisces: Teleostii: Blennioidea), Senckenbergiana biol. 65: 179-203.
PATZNER R.A. 1989: Wenn der Seestern mit dem Plattfisch… Eine Fressgemeinschaft am Sandboden des Mittelmeeres. Aquarium heute 1: 27-28.
PATZNER R.A. 1998: The invasion of *Lophocladia* (Rhodomelaceae, Lophotalieae) at the northern coast of Ibiza (western Mediterranean Sea). Boll. Soc. Hist. Nat. Balears 41: 75-80.
PATZNER R.A. 1999a: Habitat utilization and depth distribution of small cryptobenthic fishes (Blenniidae, Gobiesocidae, Gobiidae, Tripterygiidae) in Ibiza (western Mediterranean Sea). Environ. Biol. Fish. 55: 207-214.
PATZNER R.A. 1999b: Sea urchins as hiding-place for juvenile benthic teleosts (Gobiidae and Gobiesocidae) in the Mediterranean Sea. Cybium 23: 93-97.
PATZNER R.A. 2001: Gehörnter Schleimfisch. Endlich auf Ibiza nachgewiesen. DATZ 54: 33.
PATZNER R.A. 2002: *Symphodus melanocercus*, ein Putzer im Mittelmeer. DATZ 55 (9): 62-64.
PATZNER R.A. 2003: Das Verhalten von *Symphodus melanocercus* (Labridae) beim Putzen von adulten *Epinephelus marginatus* (Serranidae). Z. Fischk. 6: 107-108.
PATZNER R.A. & DEBELIUS H. 1984: Partnerschaft im Meer. E. Pfriem Verlag, Wuppertal.

PATZNER R.A. & MOOSLEITNER H. 1994a: Die Schleimfische des Mittelmeeres Teil 2: Arten des obersten Wasserbereiches. Das Aquarium 302/5: 30-36.
PATZNER R.A. & MOOSLEITNER H. 1994b: Die Schleimfische des Mittelmeeres. Teil 4: Arten des tieferen Wassers. Das Aquarium 302/11: 30-36.
PATZNER R.A. & MOOSLEITNER H. 2003: Checkliste deutscher Populärnamen und wissenschaftlicher Namen der Fische im Mittelmeer. Z. Fischk. 6: 49-71.
PRÖTSCH M. & PATZNER R.A. 2003: Zum Verhalten des Schwarzschwanz-Lippfisches (*Symphodus melanocercus*) und dessen Interaktion mit Putzkunden. Z. Fischk. 6: 9-15.
RENONES O., MORATA J., COLL J. & MORENO I. 1998: Fish assemblages of an artificial reef in *Posidonia oceanica* (L.) Delile, 1813 meadow off the southern Balearic Islands (western Mediterranean). Bol. Inst. Esp. Oceanogr. 14: 57-68.
RIEHL R. 1978: Zur Fischfauna von Ibiza, Balearen. Senckenbergiana biol. 59: 173-182.
SAN FELIX M. 1997: Guia submarina d´Eivissa i Formentera. Ed. Mediterrànea – Eivissa.
SMITH M.P.L. 1988: Effects of observer swimming speed on sample counts of temperate rocky reef fish assemblages. Mar. Ecol. Prog. Ser. 43: 223-231.
SPIKER E.T.N. 1935. Geologie von West-Ibiza (Balearen). Phd thesis, Rijksuniversiteit Utrecht.
STRAND S. 1988: Following behaviour: Interspecific foraging associations among Gulf of California reef fishes. Copeia 1988: 351-357.
THIEL M.E. 1970: Das Zusammenleben von Jung- und Kleinfischen mit Rhizostomeen (Scyphomedusae). Ber. Dt. Wiss. Komm. Meeresforsch. 21: 444-473.
VELTE F. 1994: Ein Anemonenfisch im Mittelmeer - die Streifengrundel. DATZ 47: 300-302.
VELTE F. 2006: Freiwasserbeobachtungen bei Kreta zur Fressgemeinschaft zwischen der Streifenbarbe (*Mullus surmuletus*) und anderen Fischen. Verh. Ges. Ichthyol. 5: 117-127.
ZANDER C.D. 1972a: Beiträge zur Ökologie und Biologie von Blenniidae (Pisces) des Mittelmeeres. Helgol. wiss. Meeresunters. 23: 193-231.
ZANDER C.D. 1972b: Zur Verbreitungsgeschichte der Gattung *Blennius* (Blennioidei, Pisces). Mitt. Hamburg. Zool. Mus. Inst. 68: 213-230.
ZANDER C.D. 1986: Blenniidae. In: Fishes of the north-eastern Atlantic and the Mediterranean: pp. 1096-1112. (Whitehead P.J.P. Bauchot M.-L., Hureau J.-C., Nielsen J. & e. Tortonese, eds.). UNESCO, Paris.
ZANDER C.D. & Heymer A. 1976: Morphologische und ökologische Untersuchungen an den speleophilen Schleimfischartigen *Tripterygion melanurus* und *T. minor*. Z. zool. Syst. Evol. 14: 41-59.
ZANDER C.D. & Nieder J. 1997: Interspecific associations in Mediterranean fishes: feeding communities, cleaning symbioses and cleaner mimics. Vie Milieu 47: 203-212.
ZANDER C.D. & SÖTJE I. 2002: Seasonal and geographical differences in cleaner fish activity in the Mediterranean Sea. Helgol. Mar. Res. 55: 232-241.
ZANDER C.D. 2003: Eine Fressgemeinschaft von Fischen an Hartböden des Mittelmeeres. Z. Fischk. 6: 99-105.

Authors' addresses:

Stefan Fischer[1]*, Robert A. Patzner[2], Carsten H.G. Müller[1,3], Helmut M. Winkler[1]

[1] Universität Rostock
Allgemeine & Spezielle Zoologie
Universitätsplatz 2
18051 Rostock
Germany

[2] Universität Salzburg
Fachbereich Organismische Biologie
Hellbrunnerstraße 34
Salzburg
Austria

[3] Max-Planck-Institut für chemische Ökologie
Abteilung für Evolutionäre Neuroethologie
Hans-Knöll-Straße
07745 Jena
Germany

*corresponding author; E-mail: stefan.fischer@uni-rostock.de

Commercial fishery and fish species composition in the coastal waters of Libya

By Esmaile Shakman & Ragnar Kinzelbach

SHAKMAN E. & KINZELBACH R. (2007): Commercial fishery and fish species composition in coastal waters of Libya. Rostocker Meeresbiologische Beiträge 18: S. 63-78.

Abstract. This study was carried out along the Libyan coast from February 2005 to March 2006. A total of 1,511 fishing boats of four types were observed: 64.26% were “flouka”, 24.09% “mator”, 6.88% “lampara” and 4.77% “batah”. Most of them were concentrated in the western region (58.64%). The most common fishing gear used in the coastal area is the trammel net, which is used by flouka, mator and batah. Depending on the fishing season, the fish size and the target fish species, other fishing gear is also used occasionally. In this study forty two fish species of commercial value were found in the eastern region, twenty one in the Gulf of Sirt region and twenty eight in the western region. The percentage of native fish species was 61.90% of the total number of fish species in the eastern region, while in the Gulf of Sirt region and the western region the percentages were 54.55% and 71.43% respectively. The exotic herbivorous fish species Siganus rivulatus and Siganus luridus were found in greater abundance than the native herbivores *Sparisoma cretense* and *Sarpa salpa*. Their abundance varied in the different regions. S. rivulatus was abundant in the eastern part of Libya while S. luridus was more abundant in the Gulf of Sirt and the western region of Libya. The reason for this is probably that S. rivulatus is euyecous and adapts well to most habitats, since it was found in different herbivorous habitats (rock with algae, sand with algae and grass with algae), whilst the stenecous S. luridus was found in one specific habitat (rock with algae). Furthermore there might be competition between the Indo-Pacific herbivorous fish S. rivulatus and the native fish S. salpa; S. rivulatus and S. luridus may have benefited from low competition pressure, due to the low level of diversity and abundance of native herbivorous fish species.

Kurzfassung. Eine Untersuchung über die Fischerei an der Küste Libyens wurde von Februar 2005 bis März 2006 durchgeführt. Insgesamt wurden 1.511 Fischerboote in vier Typen angetroffen: 64.26% „flouka“, 24.09% „mator“, 6.88% „lampara“ und 4.77% „batah“. Sie werden kurz beschrieben. Die meisten, 58,64% waren im Westen des Landes konzentriert.
Das wichtigste Fanggeschirr der Küstenfischerei ist das Spiegel netz eingesetzt mit flouka, mator und batah. Abhängig von Jahreszeit, Größe und Art der erwarteten Fische wird nur gelegentlich auch anderes Gerät eingesetzt. In dieser Untersuchung wurden 42 Arten von wirtschaftlicher Bedeutung in der Ost-Region gefunden, 21 in der Region der Syrte und 28 in der West-Region. Der Anteil einheimischer Fische betrug 61.90% der Gesamtartenzahl in der Ost-Region, in der Syrte 54.55%, in der West-Region 71.43%. Die eingewanderten Pflanzen fressenden Arten Siganus rivulatus und Siganus luridus wurden häufiger gefischt als die einheimischen Herbivoren Sparisoma cretense und Sarpa salpa. Ihre Abundanz schwankte regional. S. rivulatus überwog in der Ost-Region, während S. luridus häufiger in der Syrte und im Westen war. Die Ursache ist wahrscheinlich die Euryökie von S. rivulatus: Er wurde in verschiedenen

Pflanzen produzierenden Habitaten angetroffen (Fels oder Sand mit Algen, Seegras mit Algen). Der stenöke S. luridus kam nur in einem spezifischen Habitat, Fels mit Algen, vor. Hinzu kommt möglicherweise eine Konkurrenz zwischen dem indopazifischen Herbivoren *S. rivulatus* und der autochthonen Art S. salpa. Beide Einwanderer, S. rivulatus und S. luridus, haben wahrscheinlich von einer geringen Konkurrenz durch die nur in geringer Diversität und Abundanz vorhandenen einheimischen Pflanzenfressern profitiert.

Key words: Coastal area, exotic fish, fishing vessels, herbivorous fish, Libya, species composition, trammel net.

Introduction

The Mediterranean Sea is an almost closed marine basin between Europe, Asia and Africa. It is connected with the Atlantic Ocean by the Straits of Gibraltar, which are fifteen kilometers wide and have an average depth of 290 m to a maximum 950 m. In addition to this natural connection, it has been connected to the Red Sea by the Suez Canal since 1869. The Suez Canal is one hundred and twenty meters wide and twelve meters deep. The number of fish species recorded for the Northeast Atlantic and the Mediterranean Sea totals about 1,255 (UNESCO 1984, 1985, 1986), a total of 540 fish species was listed for the Mediterranean Sea, including 362 shore dwellers, 62 of them endemic (Tortonese, 1963). It is unreasonable to assume that the whole Mediterranean Sea has the same species composition, due to the evident regional speciation in this sea (WHITEHEAD *ET AL*. 1984-1986).

A number of studies have been conducted in Libyan waters. The first was by VINCIGUERRA in 1881 who recorded seventeen species when reporting on the ichthyofauna of Libya. The number of species known increased rapidly in the early 20th century (NINNI 1914, VINCIGUERRA 1922, TORTONESE 1939). More detailed studies were conducted in the second half of the 20th century, ALDEBERT & PICHOT (1973), for instance, concentrated on some flat fishes, DUCLERC (1973) on Scorpaenidae. Some other surveys resulted in check lists: in the western part in 1972, for example, sixty two species were listed (GORGY 1972). A total of 131 fish species were registered by SOGREAH (1977). Also in 1977, 39 cartilaginous fish species and 185 osteichthyes species were listed (CONTRANSIMEX 1977). ZUPANOVIC & EL-BUNI (1982), using demersal fishing gear, reported that Libyan waters are potentially moderately productive in fish. They also stated that the Libyan fish fauna was mainly was related to the fauna of the eastern part of the Mediterranean Sea, the Levant Basin. In the eastern part of Libya (Benghazi region) a list of bony fishes came up with a total of 201 species belonging to seventy one families and fifteen orders (HASSAN & SILINI 1999). In 1993 a survey of the fishing fleet was carried out along the Libyan coast (LAMBOUEF & REYNOLDS 1994). Recently an investigation of artisanal fisheries was conducted along the Libyan coast (LAMBOUEF 2000).

Many exotic species have migrated into the Mediterranean through the Suez Canal and the Straits of Gibraltar from the Indo-Pacific and Atlantic Oceans (POR 1978, 1990). This represents a continued and unique phenomenon that allows direct observation of introductions and colonization in a marine environment. The estimated number of exotic species in the Mediterranean Sea is about 1,000, including at least 93 exotic fish species as of 2002 (GOLANI *ET AL*. 2002). Up to now 64 of them have penetrated the Mediterranean Sea through the Suez Canal

(Lessepsian migration) (GOLANI *ET AL*. 2004, GOLANI & SONIN 2006, BILECENOGLU & KAYA 2006). Some of them have become major components of the composition of the eastern and central Mediterranean ichthyofauna communities and have also gained economic importance in the fisheries of these regions (BILECENOGLU & TASKAVAK 2002, BARICHE *ET AL*. 2004, SHAKMAN & KINZELBACH 2007).The fact that many species successfully establish themselves in the new environment indicates that the dietary requirements of many migrant species reflect the non-selective nature of their feeding habits. This adaptation is of great importance for any migrant in its new environment; the ecological process occasioned by spatial and temporal overlap in the use of resources is considered an important force in organizing fish communities; competition can lead to adaptations which may include habitat selection and/or resource allocation or extinction (MADL 2001). The herbivores *S. salpa* (Linnaeus 1758) (Sparidae) and *S. cretense* (Linnaeus 1758) (Scaridae) are the only native herbivorous fish species in the Mediterranean Sea (BAUCHOT & HUREAU 1986, QUIGNARD & PRAS 1986). *S. cretense* feeds on seaweeds and small benthic invertebrates, while *S. salpa* is almost exclusively herbivorous. Two exotic herbivorous fish species *S. luridus* Rüppell, 1828 and *S. rivulatus* Forsskål, 1775 (Siganidae) were added to the ichthyofauna of the Mediterranean Sea after the opening of the Suez Canal in 1869 (STEINITZ 1927, BEN-TUVIA 1964), and they were recorded on the Libyan coast in 1970 (STIRN 1970).

Most published surveys were performed by trawling. The present study was an attempt to concentrate on the coastal area with the aims of: (a) identifying the most important fishing gear and fishing craft in this area (b) investigating the ichthyofauna collected by this fishing gear (trammel net) along the Libyan coast, (c) comparing the abundance of exotic and native fish species, especially herbivorous fish species, and finally (d) contributing to the general knowledge about species composition in this area.

Materials and methods

This study was conducted from February 2005 to March 2006; the survey was performed along the Libyan coast in an area extending from Farwah in the western part of Libya up to the Al Bardiyah Gulf on the Libyan border with Egypt (Fig. 1). The aim of this survey was to find out the number of boats, the type of boat and type of fishing gear used in the coastal area. Seventy six active landing sites were visited; the latitude and longitude of the region, the number of boats, and the types of fishing gear were recorded for each region. Important information about fishing vessels and fishing gear was collected from local fishermen and fishermen's unions.
For fish species composition, the study was carried out from March 2005 to March 2006. The study area was divided into three main regions according to topography and environment (eastern region, Gulf of Sirt, western region), two sites were selected in the eastern region (Tubruk, Benghazi), one site in the Gulf of Sirt (Musrata) and two sites were selected in the western region (Tripoli, Zwara); these were considered to be the most active catching sites and were investigated monthly, Al-Bardiyah in the eastern region and Farwah in the western region were also selected in the border areas and were investigated seasonally (Fig. 1). A total of 130 samples were collected from the Libyan coast, 53 samples from the eastern region, 52 samples from western region and 25 samples from the Gulf of Sirt region using the trammel nets (inner mesh 26 mm, outer mesh 120 mm) used by fishing vessels

of the type “flouka” (Fig.2). In order to standardize sampling bases and fishing effort, two fishing boats of the same size and two sets of fishing gear were considered from each sampling site. Each sample collected was washed in fresh water and sorted, then identified and classified according to WHITEHEAD *ET AL.* (1984-1986) for the native fish species and GOLANI et al. (2002) for the exotic fish species. The individual numbers of each fish species were counted and the estimated weights for each species were recorded. Information was collected about the length of fishing gear, the depth, the type of habitats, the catch, the first observation for newcomers, the season and the Libyan names of fish.

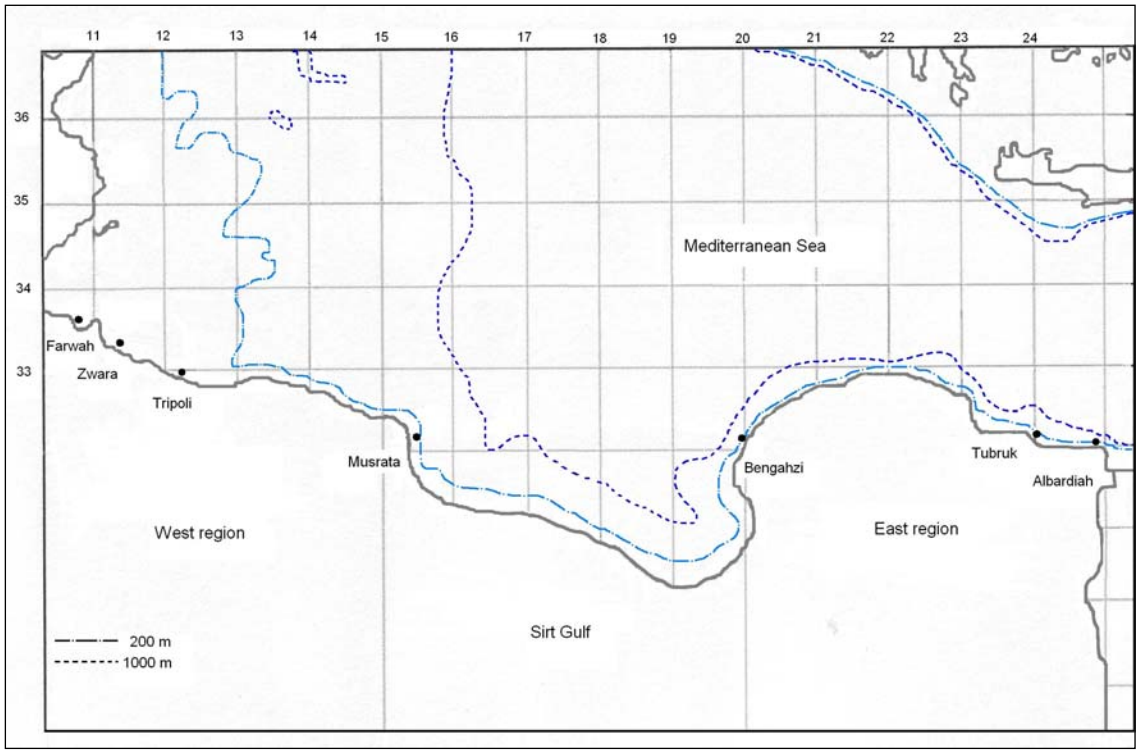


Fig. 1. Map of the Libyan coast, showing the study area

Fig. 2. The fishing vessels used along the Libyan coast: 1 Mator, 2 Batah, 3 Lampara, 4 Flouka.

Results

Fishing vessels

The number of boats counted by this study was 1,511; of them 64.26% were “flouka”, 24.09% were “mator”, 6.88% were “lampara” and 4.77% were “batah” (Fig.3). Most of them were concentrated in the western part of the Libyan coast (Tab.1). In the coastal area the fishing vessel used most was the flouka. Lampara, used to catch small pelagic fish, were concentrated in the western part, with a few in the Gulf of Sirt, especially in Musrata. Batah, on the other hand, were concentrated in the shallow waters of the western region (Farwah site), with only a small number of them found in the eastern region (Attimimi and Ainghazala sites) (Fig. 4).

Table 1. The number and percentage of fishing vessels along the Libyan coast

Region	East region	Middle region	West region	Total
Number	308	317	886	1511
Percentage	20.38%	20.98%	58.64%	100

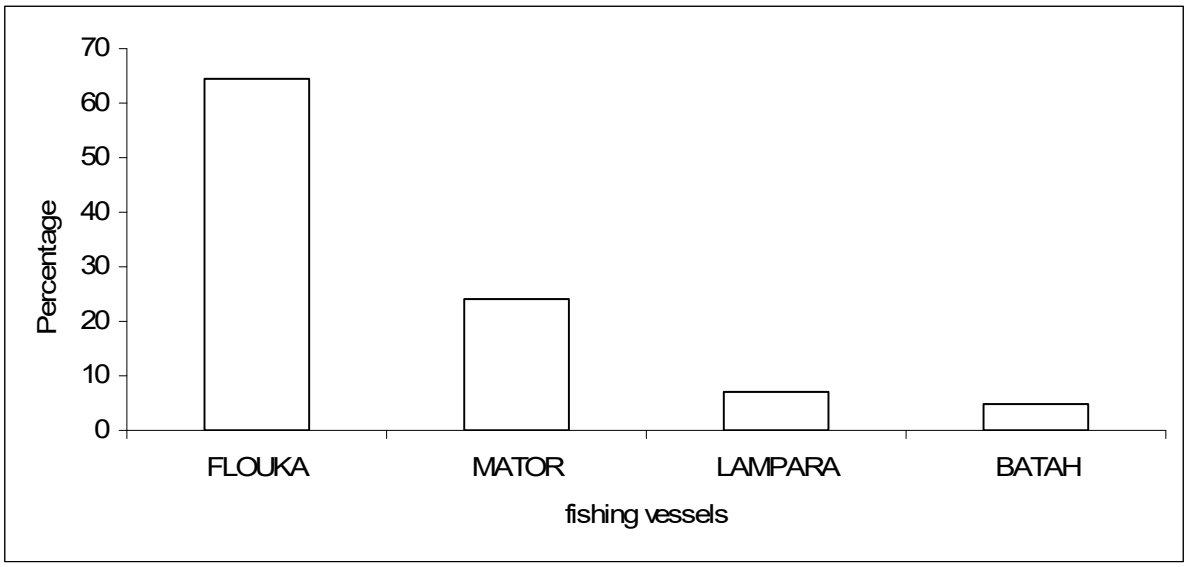


Fig. 3. The percentage of fishing vessels.

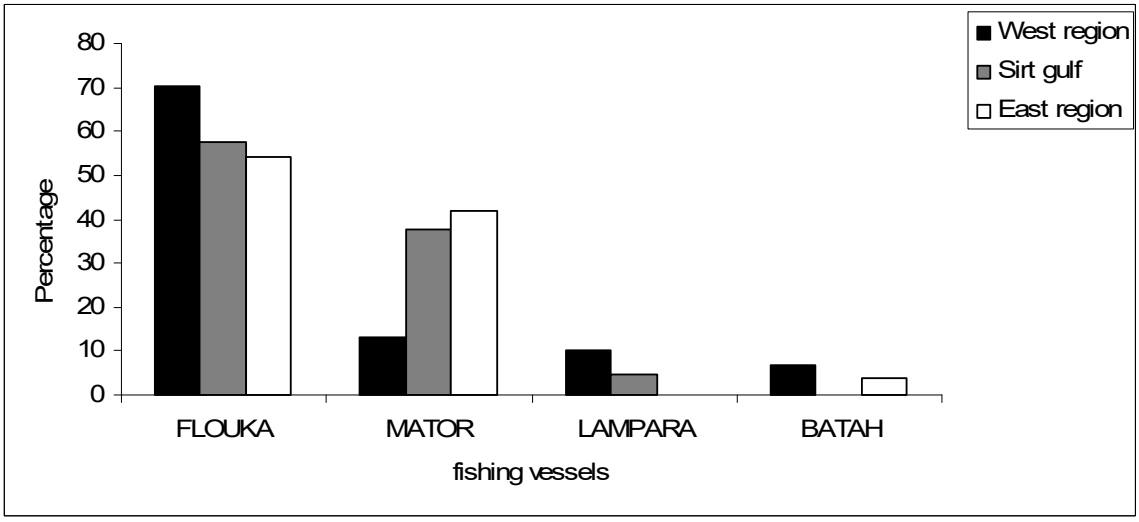


Fig. 4. The percentage of fishing vessels in the coastal area and their distribution along the coast of Libya.

The most commonly used fishing gear in the coastal area were trammel nets. These nets are used by flouka at depths of one to fifty meters, and are used by mator at more than thirty meters. They are also used by batah at depths of up to 5 meters (Fig. 5). Flouka also use other fishing gear such as long line, gill nets etc., depending on the season and size of the target fish species caught along the Libyan coast (Fig. 6).

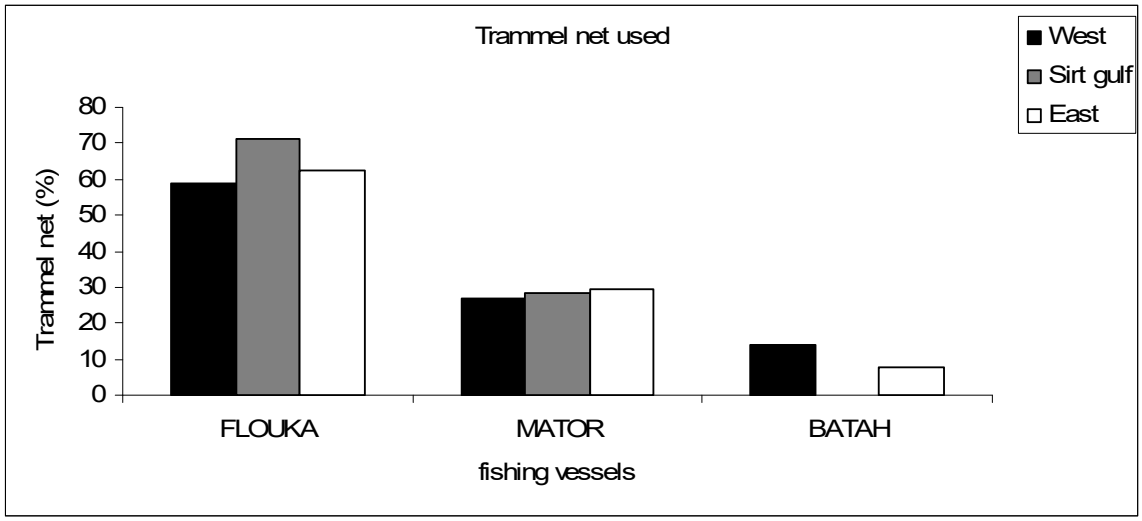


Fig. 5. The percentage of fishing vessels that used the trammel net.

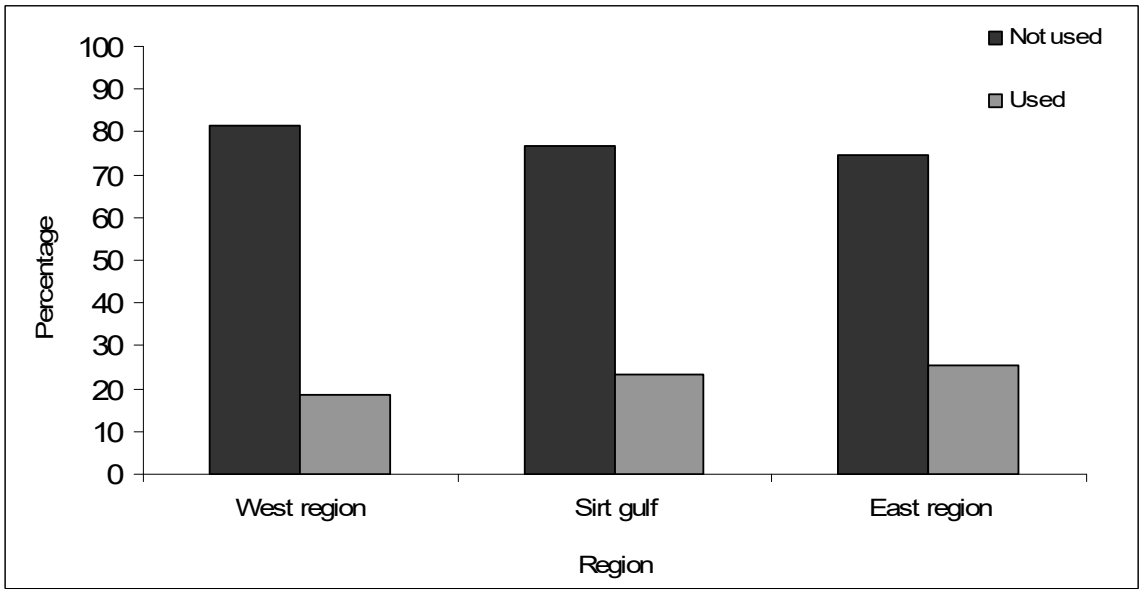


Fig. 6. The percentage of flouka that used and did not use the trammel net along the coast of Libya.

Species composition

In this study, the highest fish species diversity in the coastal area was in the eastern region (45.65%), while in the Gulf of Sirt and western regions the figure was 23.91% and 30.43% respectively (Fig. 7). The percentage of native fish species was higher than exotic fish species in the eastern region (61.90%), in the Gulf of Sirt region the percentage of native fish species was 54.55%, while 71.43% of fish were native fish species in the western region (Fig. 8).

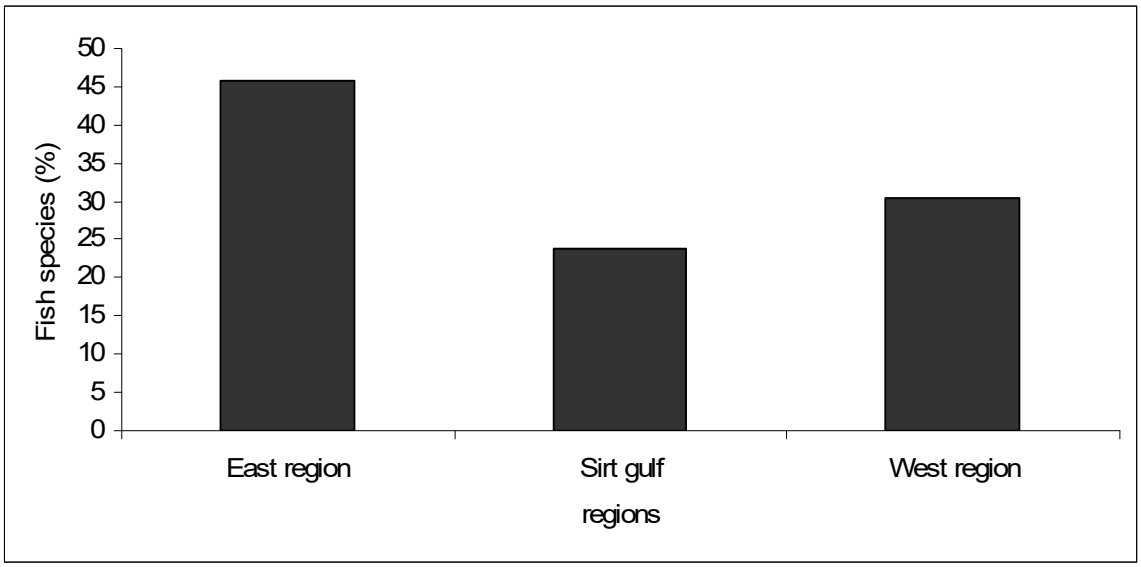


Fig. 7. The number percentage of fish species.

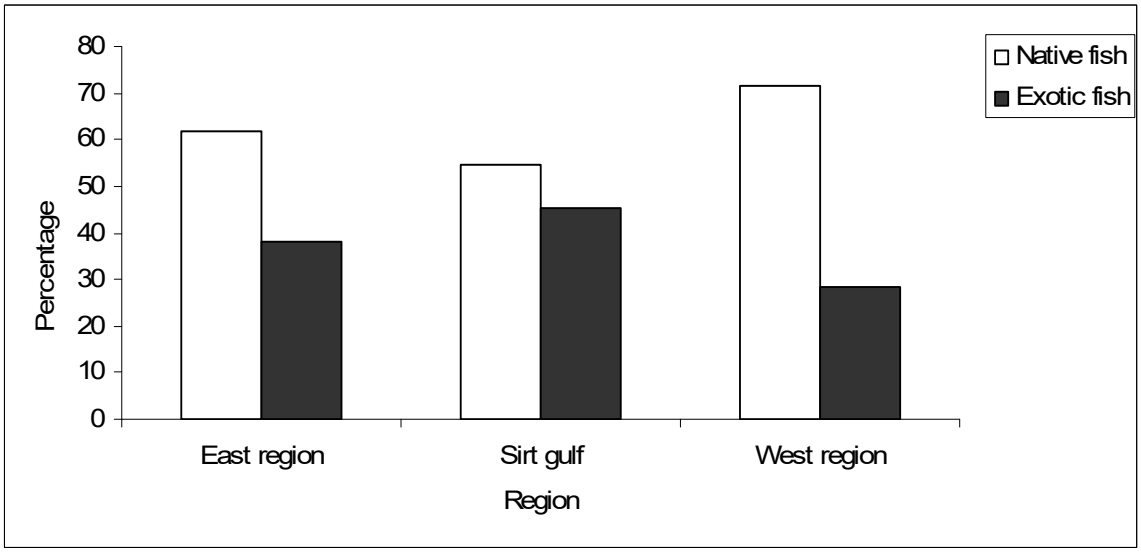


Fig. 8. The relation between the number of exotic fish species and the number of native fish species.

In the eastern region of the Libyan coast, forty two fish species were found (Tab. 2). The highest percentage for native species was Annular Seabream *D. annularis* (Sparidae) at 7.74% of the catch and the lowest percentage was Shi Drum *Ubbrina cirrosa* (Sciaenidae) at 0.10% of the total catch; the highest percentage for exotic fish species was Marbled Spine-foot *S. rivulatus* (Siganidae) at 41.20% and the lowest percentage was Blue-spotted Cornetfish *F. commersonii* (Fistularidae) at 0.02% and Spotback Herring *Herklotsichthys punctatus* (Clupeidae) at 0.02% of the total catch.

Table 2. The species composition and number percentage collected from the coastal waters of the eastern part of Libya (* Cephalopod).

Libyan name	Common name	Scientific name	family	N%	W%
Kahlla	Saddledbream	*Oblada melanura*	Sparidae	0.67	1.15
Treellya	Striped red mullet	*Mullus surmuletus*	Mullidae	3.01	4.31
Garagous mausham	Banded seabream	*Diplodus vulgaris*	Sparidae	1.48	1.37
Garagous	white sea bream	*Diplodus sargus*	Sparidae	4.16	4.79
Brakash	Painted comber	*Serranus scriba*	Serranidae	0.30	0.22
Sbarus	Annular seabream	*Diplodus annularis*	Sparidae	7.74	4.29
Shkorfo	Scorpionfish	*Scorpaena* spp	Scorpaenidae	2.12	1.90
Buri	Box lip mullet	*Oedalechilus labeo*	Mugilidae	3.18	5.10
Mankos	Striped sea bream	*Lithoganthus mormyrus*	Sparidae	2.71	2.59
Zemrina	Mediterranean moray	*Muraena helena*	Muraenidae	0.27	0.38
Ghazla	Parrotfish	*Sparisoma cretense*	Scaridae	6.31	11.1
Abokather	Ballan wrasse	*Labrus bergylata*	Labridae	1.31	1.93
Dout	Dusky grouper	*Epinephelus guaza*	Serranidae	0.81	1.62
Morjan	Common sea bream	*Pagrus pagrus*	Sparidae	0.89	0.84
Baghllah	Shi drum	*Ubbrina cirrosa*	Sciaenidae	0.10	0.41
Grab	Brown meagre	*Sciaena umbra*	Sciaenidae	0.76	1.21
Pullem	Stargazer	*Uranoscopus scaber*	Uranoscopidae	0.27	0.39
Halof	Grey trigger fish	*Balistes carolinensis*	Balistidae	0.30	0.40
Homrayah	Common dentex	*Dentex dentex*	Sparidae	0.22	0.11
Dendashie	Common dentex	*Dentex dentex*	Sparidae	0.30	0.33
Shelpa	Salema	*Sarpa salpa*	Sparidae	1.11	0.97
Tannut	Black seabream	*Spondyliosoma cantharus*	Sparidae	0.22	0.39
Mdas	Common Sole	*Solea spp*	Soleidae	0.15	0.09
Mugalzl	Barracuda	*Sphyraena spp*	Sphyraenidae	0.12	0.23
Strelia	Leerfish	*Lichia amia*	Carangidae	0.02	0.29
Sardine	Madeiran Sardinella	*Sardinella maderensis*	Clupeidae	5.05	6.18
Moshta	obtuse barracuda	*Sphyraena obtusata*	Sphyraenidae	1.33	2.61
Moshta	red barracuda	*Sphyraena pinguis*	Sphyraenidae	4.29	5.60
Sridna	Spotback herring	*Herklotsichthys punctatus*	Clupeidae	0.02	0.01
Makarona	Brushtooth lizardfish	*Saurida undosquamis*	Synodontidae	0.54	0.66
Abo- meshfa	Halfbeak	*Hemiramphus far*	Hemiramphidae	1.77	0.75
Gaeta	Cornetfish	*Fistularia commersonii*	Fistularidae	0.02	0.09
Namousa	Silverside fish	*Atherinomorus lacunosus*	Atherinidae	0.42	0.06
Saurou Asfar	Shrimp scad	*Alepes djedaba*	Carangidae	0.89	0.56
Treellya Khadra	Goatfish	*Upeneus pori*	Mullidae	0.05	0.04
Sparus Masrry	Porgie	*Crenidens crenidens*	Sparidae	0.05	0.03
Gasaetlla	Sweeper fish	*Pempheris vanicolensis*	Pempheridae	0.05	0.02
Buri	Roving grey mullet	*Liza carinata*	Mugilidae	0.05	0.05
Balameta Yamania	Spanish Mackerel	*Scomberomorus commerson*	Scombridae	0.30	4.41
Halofboresha,	Filefish	*Stephanolepis diaspros*	Monacanthidae	0.25	0.13
Batata Khahlla	Dusky spine-foot	*Siganus luridus*	Siganidae	3.57	3.36
Batata beda	Marbled spine-foot	*Siganus rivulatus*	Siganidae	41.2 0	25.8
* Garneat	Common octopus	*Octopus* spp	Octopodidae	0.17	0.70
* Sepei	Cuttlefish	*Sepia offlcinalis*	Sepiidae	1.45	2.51

Twenty one fish species were found in the Gulf of Sirt region of the Libyan coast (Tab. 3). The highest percentage for native fish species was Annular Seabream *D. annularis* (Sparidae) at 17.11 % of the total catch and the lowest percentage was Saddled Bream *Oblada melanura* (Sparidae) at 4.56% of total catch; the highest percentage for exotic fish species was Dusky Spine-foot *S. luridus* (Siganidae) at 36.82% and the lowest percentage was Blue-spotted Cornetfish *F. commersonii* (Fistularidae) at 0.07% of the total catch.

Table 3. The species composition and number percentage collected from the coastal waters? of the middle part of Libya (* Cephalopod).

Libyan name	**Common name**	**Scientific name**	**family**	**N%**	**W%**
Treellya	Striped red mullet	*Mullus surmuletus*	Mullidae	2.88	3.24
shkorfo	scorpionfish	*Scorpaena* sp	Scorpaenidae	9.26	5.47
Kahlla	Saddledbream	*Oblada melanura*	Sparidae	4.56	4.32
Sbarus	Annular seabream	*Diplodus annularis*	Sparidae	17.1	10.1
Grab	Brown meagre	*Sciaena umbra*	Sciaenidae	1.26	3.31
Garagous	white sea bream	*Diplodus sargus*	Sparidae	3.86	3.02
Shelpa	Salema	*Sarpa salpa*	Sparidae	2.31	2.00
Dout	Dusky grouper	*Epinephelus guaza*	Serranidae	0.98	2.06
Ghazla	Parrotfish	*Sparisoma cretense*	Scaridae	2.88	4.63
Abokathear	Ballan wrasse	*Labrus bergylate*	Labridae	4.42	8.05
Mankos	Striped sea bream	*Lithoganthus mormyrus*	Sparidae	3.65	2.06
Moshta	obtuse barracuda	*Sphyraena obtusata*	Sphyraenidae	0.35	0.50
Moshta	red barracuda	*Sphyraena pinguis*	Sphyraenidae	1.54	1.54
Makarona	Brushtooth lizardfish	*Saurida undosquamis*	Synodontidae	0.14	0.15
Gaeta	Cornetfish	*Fistularia commersonii*	Fistularidae	0.07	0.11
Namousa	Silverside fish	*Atherinomorus lacunosus*	Atherinidae	0.21	0.09
Saurou Asfar	Shrimp scad	*Alepes djedaba*	Carangidae	0.28	0.36
Balameta	Spanish Mackerel	*Scomberomorus commerson*	Scombridae	0.49	5.44
Yamania					
Halof boresha	Filefish	*Stephanolepis diaspros*	Monacanthidae	0.21	0.20
Batata Khahlla	Dusky spine-foot	*Siganus luridus*	Siganidae	36.8	37.2
Batata beda	Marbled spine-foot	*Siganus rivulatus*	Siganidae	5.19	5.31
* Sepia	Cuttlefish	*Sepia offlcinalis*	Sepiidae	1.54	0.91

Twenty eight fish species were found in the western region of Libya (Tab. 4). The highest percentage for native fish species was Annular Seabream *Diplodus annularis* (Sparidae) at 10.74% of the catch, and the lowest was Red Sea Bream *Pagellus bogaraveo* (Sparidae) at 0.16% of the total catch; the highest percentage for exotic fish species was Dusky Spine-foot *S. luridus* (Siganidae) at 40.06% of the catch, and the lowest was Blue-spotted Cornetfish *Fistularia commersonii* (Fistulariidae) at 0.03% of total catch.

Table 4. The species composition and number percentage collected from the coastal waters of the western part of Libya (* Cephalopod).

Libyan name	Common name	Scientific name	family	N%	W%
Treellya	Striped red mullet	*Mullus surmuletus*	Mullidae	3.25	2.57
Shkorfo	scorpionfish	*Scorpaena* spp	Scorpaenida	7.03	7.08
Dendashie	common dentex	*Dentex dentex*	Sparidae	0.20	0.67
Sbarus	Annular seabream	*Diplodus annularis*	Sparidae	10.7	6.23
Grab	Brown meagre	*Sciaena umbra*	Sciaenidae	3.97	4.11
Morgan abo ain	Large-eyed dentex	*Dentex macrophthalmus*	Sparidae	1.07	0.83
Kahlla	Saddledbream	*Oblada melanura*	Sparidae	1.37	1.56
Tanot	Black sea bream	*Spondyliosoma cantharus*	Sparidae	0.81	1.70
Garagous	white sea bream	*Diplodus sargus*	Sparidae	4.88	3.68
Garagose mausham	Banded seabream	*Diplodus vulgaris*	Sparidae	2.34	0.53
Abokathear	Ballan wrasse	*Labrus bergylate*	Labridae	5.43	5.25
Djaja	Tub gurnard	*Trigla lucerna*	Triglidae	0.98	1.47
Dout	Dusky grouper	*Epinephelus guaza*	Serranidae	1.11	2.16
Brakash	Painted comber	*Serranus scriba*	Serranidae	0.33	0.25
Ghazla	Parrotfish	*Sparisoma cretense*	Scaridae	2.73	3.98
Mankos	Striped sea bream	*Lithoganthus mormyrus*	Sparidae	1.69	1.64
Shelpa	Salema	*Sarpa salpa*	Sparidae	3.12	0.48
Morjan	Commonsea bream	*Pagrus pagrus*	Sparidae	2.60	0.28
Hamreia	Red sea bream	*Pagellus bogaraveo*	Sparidae	0.16	0.18
Strelia	Leerfish	*Lichia amia*	Carangidae	0.10	0.15
Moshta	obtuse barracuda	*Sphyraena obtusata*	Sphyraenidae	0.10	0.16
Moshta	red barracuda	*Sphyraena pinguis*	Sphyraenidae	0.16	0.18
Gaeta	Bluespotted	*Fistularia commersonii*	Fistularidae	0.03	0.06
SaurouAsfar	Shrimp scad	*Alepes djedaba*	Carangidae	0.16	0.37
Balameta	Spanish	*Scomberomorus*	Scombridae		
Yamania	Mackerel	*commerson*		0.49	3.91
Halofboresha	Filefish	*Stephanolepis diaspros*	Monacanthidae	0.13	0.15
Batata Khahlla	Dusky spine-foot	*Siganus luridus*	Siganidae	40.1	45.3
Batata beda	Marbled spine-foot	*Siganus rivulatus*	Siganidae	4.52	4.47
* Sepia	Cuttlefish	*Sepia offlcinalis*	Sepiidae	0.42	0.64

Herbivorous fish species

S. rivulatus was most abundant in the eastern region of the Libyan coast (more than *S. luridus* and the native fish species *S. salpa* and *S. cretense*). In the Gulf of Sirt region the exotic herbivore *S. luridus* was more abundant than *S. rivulatus* and the native fish species *S. salpa* and *S. cretense*; in the western region the highest percentage was for *S. luridus*, which was more abundant than *S. rivulatus* and the native *S. salpa* and *S. cretense* (Fig.9).

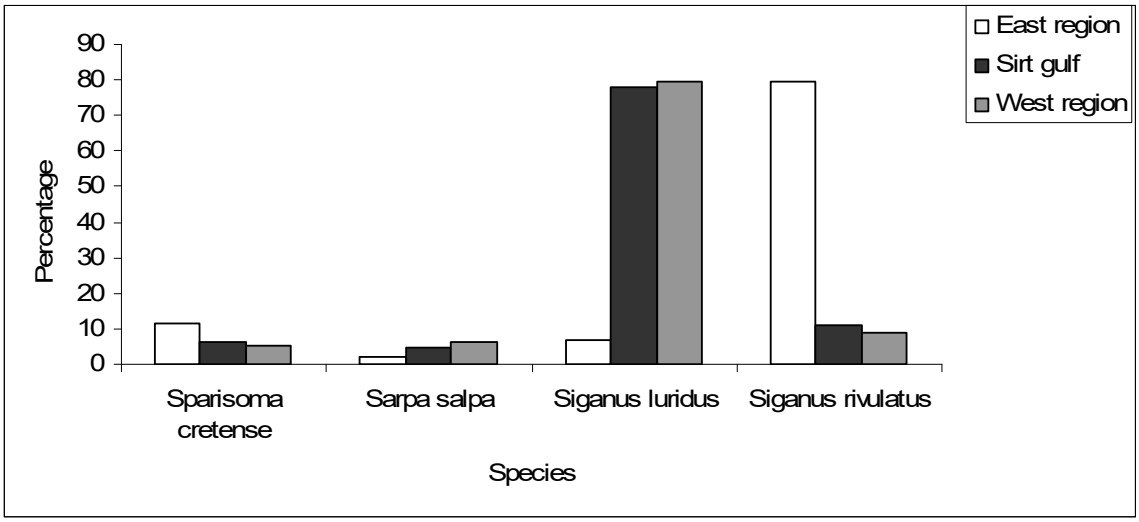


Fig. 9. The relation between herbivorous fish species and native fish species in the main regions.

Discussion

The ichthyocoenosis of the Mediterranean Sea consists primarily of Atlanto-Mediterranean species (62%) from the adjacent Atlantic biogeographic provinces beyond the Straits of Gibraltar (Lusitanian Sea). Many Mediterranean species are endemic (20%) while others are cosmopolitan or circumtropical (13%) or Indo-Pacific (5%). These proportions differ for different major taxonomic groups and also for different parts of the Mediterranean Sea, but the pattern remains essentially the same (Ketchum, 1983).

At the time of this study, a total of 1,511 boats were being used in the coastal area of Libya. The percentages of different fishing craft were: 64.26% flouka, 24.09% mator, 6.88% lampara and 4.77% batah (Fig.3). Most of them were concentrated in the western part of Libya (58.64%) (Tab. 1, the main fishing area in Libya). The lampara was found predominantly in the western part, with a few exceptions in the Gulf of Sirt. The lampara is used to catch small pelagic fish species (Sardine, Mackerel etc.). The flouka and the mator were found right along the Libyan coast, while the batah, which is used in shallow water (Fig. 5) was found in the Farwah Lagoon, with a few boats of this type in the Attimimi and Ainghazala regions. The flouka was used in regions where the water was between one and fifty meters deep, while the mator was used for depths of more than thirty meters; the batah was used in depths of up to 5 meters.

In 2000 the country's entire fishing fleet numbered 1,866 boats; of these 1,266 boats were operated along the Libyan coast. Around 55% of the total number of boats was found in the western region, while 23% and 22% were found in the Gulf of Sirt region and in the eastern part of Libya respectively. The results of this study are almost identical to the framework survey of 135 landing sites in 2000, in which 61% of the fleet were flouka, 28% were mator, 7% were lampara used to catch small pelagic fish, while the batah represented only a small fraction of the total number of boats (4%) (LAMBOEUF *ET AL.* 2000). However, two major differences distinguish this study from the one conducted in 2000, namely: a) in the present study only 76 active sites were considered because some of the landing sites investigated in the year 2000 were only temporary, b) in the year 2000 all the craft were counted (operational

(68%), non-operational (8%), under repair (22%) and unknown (2%)) whereas in this study only operational craft were counted.
As mentioned earlier, the percentage of exotic fish species relative to native fish species decreases from east to west along the Libyan coast. This means that there is a correlation between early arrival and greater abundance which can be explained (a) because the longer a species is in the Mediterranean, the greater the opportunity to build up its population, or (b) by the greater research effort, which was much less intense in the past (GOLANI 2002). This also means that there are many Lessepsian fish species included in the Libyan ichthyofauna which are of commercial value (SHAKMAN & KINZELBACH 2007). The exotic fish species are still spreading in the various parts of the Mediterranean Sea (GOLANI *ET AL.* 2002, GOLANI *ET AL.* 2004), and some of these species have become established, become commercially important, and become regular catch species in many different parts of the Mediterranean Sea (EL-SAYED 1994, TORCU & MATER 2000, PAPACONSTANTINOU 1990, BARICHE *ET AL.* 2004, SHAKMAN & KINZELBACH 2007). There is a difference in the distribution of native and exotic fish species along the Libyan coast, with the diversity of fish species in the eastern region being high in comparison with the middle and the western parts of Libya. The most abundant native fish species along the Libyan coast was Annular Seabream *Diplodus annularis* (Sparidae), which made up 7.74% of the total in the eastern part, 17.11% in the middle region and 10.74% in the western part; the least abundant were the two Indo-Pacific fish species Spotback Herring *Herklotsichthys punctatus* (Clupeidae) at 0.02% and Blue-spotted Cornetfish *Fistularia commersonii* (Fistulariidae) at 0.02% in the eastern part, and the Blue-spotted Cornetfish *F. commersonii* (Fistulariidae) at 0.07% in the middle region and 0.03% in the western part of Libya. In the present study, the results do not mean that these fish species are only established in this area, for the simple reason that different fish species are caught using different types of fishing gear, whereas this study only investigates the trammel nets used throughout the year along the Libyan coast. It is illogical to assume that the whole body of the Mediterranean Sea has the same species composition; regional speciation is evident in the Mediterranean Sea (WHITEHEAD *ET AL.* 1984-1986). Many surveys have been carried out along the Libyan coast in order to study species composition in different parts of Libya. In 1972 sixty two fish species were listed (GORGY *ET AL.* 1972). Some other surveys concentrated on trawler fishing and found 131 fish species (SOGREAH 1977), while 185 bony fish are listed by CONTRANSIMEX (1977). The highest diversity of fish species was found in a specific area of the Benghazi region (201 species). This figure was based on the catch captured by different types of commercial fishing gear (Hassan & Silini 1999).
The low diversity of herbivorous fish in the Mediterranean Sea includes only two herbivorous fish *S. salpa* (L., 1758) (Sparidae) and *S. cretense* (L., 1758) (Scaridae) (BAUCHOT & HUREAU 1986, QUIGNARD & PRAS 1986). In the present study the most abundant herbivorous fish were the Indo-Pacific fish species *S. rivulatus* and *S. luridus*, which are more numerous than the native fish species *S. cretense* and *S. salpa* along the Libyan coast. The concentration of these Indo-Pacific fish species varied along the coast, with *S. rivulatus* being concentrated in the eastern part of the Libyan coast, while *S. luridus* was concentrated in the middle region and western part of Libya (Fig.9). It might be that there is competition between Indo-Pacific herbivorous fish species and native herbivorous fish species. On the other hand *S. rivulatus* was more abundant (79.47%) than *S. luridus* (6.89%) and the herbivorous native fish species *S. salpa* (2.14%) and *S. cretense* (11.50%) in the eastern region, and when this result is compared with results from the eastern Mediterranean

(Lebanon coast), the abundance of these species is quite similar: *S. rivulatus* was the most abundant at 72 % and *S. luridus* numbered 8 %, with the native species *S. cretense* at 20 % and the least abundant *S. salpa* (<1 %) (BARICHE *ET AL.* 2004). Similar relative abundances were reported from the eastern Mediterranean (84% Siganids, 11% Scarids and 5% Sparids) (DIAMANT *ET AL.* 1986). In the Gulf of Aqaba (Red Sea), the dominant herbivores were the Acanthuridae (63%) and the Scaridae (35%) (BOUCHON-NAVARO & HARMELIN-VIVIEN 1981). *S. rivulatus* has an ability to adapt to most habitats, as it was found in different herbivorous habitats (rock with algae, sand with algae and grass with algae), whereas *S. luridus* was found in one specific habitat (rock with algae). It might be that *S. rivulatus* has benefited from a reduction of competition pressure due to the low diversity and abundance of native herbivorous fish species. GEORGE & ATHANASSIOU (1967) suggested that as *S. salpa* and *S. rivulatus* present similarities in body shape and habits, they might be in close competition for the same resources. Furthermore, this indicates that the population of the native fish species *S. salpa* has declined dramatically in the last seventy years (BARICHE *ET AL.* 2004). To conclude, the main fishing vessel used in the coastal area was the flouka, the most commonly used fishing gear in the coastal area were trammel nets, the fish species diversity in the coastal area was higher in the eastern part of Libya than in the middle and western parts, the abundance of exotic herbivorous fish species was higher than that of native herbivorous fish species with different concentrations on the coast, *S. rivulatus* is more abundant and has the ability to adapt to different habitats while *S. luridus* was found in one specific habitat.

Acknowledgments

We would like to express our thanks to the fishermen and fishermen's union for their collaboration, and we would also to thank the staff and administration of the Marine Biology Research Center (MBRC) - Libya and Environment General Authority (EGA) branch Benghazi - Libya for their cooperation, Our thanks to Mr. Khaled Tayeb for his help in the survey and also our thanks to Mr. Mike Smart, Gloucester GL2 OJH, United Kingdom, for the linguistic revision of the text, this article forms part of a PhD Thesis.

References

ALDEBERT Y. & PICHOT, P. 1973: Observations sur les Heterosomes de Mediterrannee oriental/ secteur Tuniso-Libyen/ CIESM Journees Ichthyol. 57-60, Rome.

AL-HASSAN L.A.J. & EL-SILINI O.A. 1999: Check-list of bony fishes collected from the Mediterranean coast of Benghazi, Libya. Revista de Biologia Marina y Oceanografia 34: 291-301.

BARICHE M., LETOURNEUR Y. & VIVIEN M.H. 2004: Temporal fluctuations and settlement patterns of native and Lessepsian herbivorous fishes on the Lebanese coast (eastern Mediterranean). Environmental Biology of fishes 70: 81-90.

BAUCHOUT M.L. & HUREAU J.C. 1986: Sparidae. In fishes of the north-eastern Atlantic and the Mediterranean (ed. P. J. P. WHITEHEAD *ET AL.),* pp. 883-907. Paris: UNESCO.

BILECENOGLU M. & KAYA M. 2006: A new alien fish in the Mediterranean Sea - *Platax teira* (Forsskål, 1775) (Osteichthyes: Ephippidae). Aquatic invasion 1 (2): 80-83.

BILECENOGLU M., & TASKAVAK E. 2002: Characterization of Lessepsian migrant fish at Turkish sea. In: Bayram Öztürk and Nuri Basusta (eds). Workshop on Lessepsian migration, 20-21 July 2002 Gökceada- Turkey: 87-91.

BOUCHON-NAVARO Y. & HARMELIN-VIVIEN, M. 1981: Quantitative distribution of herbivorous reef fishes in the Gulf of Aqaba (Red Sea). Marine Biology 63: 79-86.
CONTRANSIMEX C. 1977: Final report concerning the results of the fisheries oceanographic survey, carried out by the Romanian researcher teams on board “Delta Dunarii” and “Gilort” in the eastern territorial waters of the Libyan Arab Republic between Ras Azzaz and Ras Karkura, II: 173-563.
DIAMANT A., BEN-TUVIA, A., BARANES, A. & GOLANI, D. 1986: An analysis of rocky coastal eastern mediterranean fish assemblages and a comparison with an adjacent small artificial reef. J. Exp.Mar. Biol. Ecol. 97: 269-285.
DUCLERC J. 1973: Les Scorpaenides de L’Est Tunisien et de Libye. Journées Ichthyol. : 73-74, Rome, C.I.E.S.M.
EL-SAYED R.S. 1994: Check-list of Egyptian Mediterranean fishes. National Institute of Oceanography and Fisheries, 77 + IX pp., Alexandria, Egypt.
GOLANI D., ORSI-RELINI L., MASSUTI E. & QUIGNARD J.P. 2002: CIESM Atlas of Exotic species in the Mediterranean. In: Briand F (ed). Fishes. Vol.1, CIESM publishers, Monaco. 256 pp.
GOLANI D., ORSI-RELINI L., MASSUTI E. & QUIGNARD J.P. 2004: Dynamics of fish invasions in the Mediterranean: update of the CIESM Fish Atlas. Rapports de la Commission Internationale pour l´ Exploration Scientifique de la Mer Méditerranée 37: 367.
GOLANI D. & SONIN, O. 2006: The Japanese threadfin bream *Nemipterus japonicus*, a new Indo-Pacific fish in the Mediterranean Sea. Journal of Fish Biology 68: 940-943.
GEORGE C.J. & ATHANASSIOU, V. 1967: A two year study of the fishes appearing in the seine fishery of St George Bay, Lebanon. Ann. Mus. Civ. Storia Nat. Genova 76: 237-294.
GORGY S.A, MUGAHID, A & ALI, R. 1972: Survey of the Libyan territorial waters and the adjacent international waters in the central Mediterranean. Communication presentée au 23e Congrès-Assemblée Pleniere CIESM., Athens 3-11 (4), 72 J.
KETCHUM B.H. 1983: Ecosystems of the world 26 Estuaries and Enclosed Seas. Amsterdam, Oxford, New York: Elsevier Scientific Publishing Company.
LAMBOEUF M. 2000: Artisanal fisheries in Libya, census of fishing vessels and inventory of artisanal fishery metiers. FAO-COPEMED-MBRC, 42 pp.
LAMBOEUF M., & REYNOLDS J.E. 1994: The fishing fleet of Libya: preliminary results of the 1993 frame survey. TBN No. 16.
MADL P. 2001: Essay about the phenomenon of Lessepsian Migration. Marine Biology I. http : www.sbg.ac.at/ipk/avstudio/pierofun/lm/lesseps.htm. Cited 12 Apr. 2006.
NINNI E. 1914: Min. Colonie Uff. Marina Roma (in Tortonese, 1939).
QUIGNARD J.P. & PRAS A. 1986: Scaridae In fishes of the northern-eastern Atlantic and the Mediterranean, (ed. P. J. P. Whitehead et al.) pp. 943-944. Paris: UNESCO.
PAPACONSTANTINOU C. 1990: The spreading of Lessepsian fish migrants into the Aegean Sea (Greece). Scientia Marina. 54 (4): 313-316.
POR F.D. 1978: Lessepsian migration. The influx of Red Sea Biota into the Mediterranean by way of the Suez Canal. Berlin: Springer Verlag. p. 228.
POR F.D. 1990: Lessepsian migration. An appraisal and new data. Bulletin of the institute of Oceanography Monaco 7: 1-10.
SHAKMAN E.A. & KINZELBACH R. 2007: Distribution and characterization of Lessepsian migrant fish along the coast of Libya. Acta Ichthyologica et Piscatoria 37 (1): 7-15.
SOGREAH E. 1977: Trawl fishing ground survey off the Tripolitanian coast. Final Report. Part V: 1-44, and final report: Introduction and General Conclusions: 1-30.
STEINITZ W. 1927: Beiträge zur Kenntnis der Küstenfauna Palästinas. I. Pubblicazioni della Stazione Zoologica di Napoli 8 (3-4): 311-353.
STIRN J. 1970: Some note on western trends of Lessepsian migration. Journées Ichthyologiques, Rome, 30 nov- 1dec 1970, CIESM, Monaco 187-190.
TORCU H. & MATER S. 2000: Lessepsian fishes spreading along the coasts of Mediterranean and the Southern Aegean Sea of Turkey. Turkish Journal of Zoology 24: 139-148.
TORTONESE E. 1939: Appunti di ittiologica Libica: Pescidi Tripoli. Annali Museo Libico Storia Naturale 1: 359-375.

TORTONESE E. 1963: Elenco riveduto dei Leptocardi, Ciclostomi, Pesci Cartalaginei e ossei del Mare Mediterraneo. Annali. Mus. Civ. Stor. Nat. Giacomo Doria, 74: 156-185.
UNITED NATION EDUCATIONAL, SCIENTIFIC, AND CULTURAL ORGANIZATION (UNESCO) 1984, 1985, 1986. Fishes of the North eastern Atlantic and the Mediterranean. 3 vols. Paris.
VINCIGUERRA D. 1881: Risoltati ittiologici delle crociere del" Violante" Annali Museo Civico Storia Naturale, Genova 18: 465-590.
VINCIGUERRA D. 1922: Ittiologici delle Libya. Bolletino Museo Zoologia Anatomia Comparata Torini 36 (745).
WHITEHEAD P.J.P., BAUCHOT M.L., HUREAU J.C., NIELSEN J. & TORTONESE E. (eds) 1984-1986: Fishes of the north-eastern Atlantic and the Mediterranean. Vols. I-III, 1473 pp., UNESCO, Paris.
ZUPANOVIC S. & EL-BUNI A.A. 1982: A contribution to demersal fish studies off the Libyan coast. Bulletin of the Marine Research Centre, Tripoli, Libya 3: 78-122.

Authors' addresses:

Esmaile Shakman
Prof. Dr. Ragnar Kinzelbach

Universität Rostock
Allgemeine & Spezielle Zoologie
Universitätsplatz 2
D-18055 Rostock
Germany

E-Mail: shugmanism@yahoo.com

First record of the Sweeper fish, *Pempheris vanicolensis* Cuvier, 1821, on the eastern Libyan coast (Osteichthyes, Pempheridae)

By Esmaile Shakman & Ragnar Kinzelbach

SHAKMAN E. & R. KINZELBACH (2007): First record of the Sweeper fish, *Pempheris vanicolensis* Cuvier, 1821, on the eastern Libyan coast. Rostocker Meeresbiologische Beiträge 18: S. 79-81

Abstract. The Sweeper fish, *Pempheris vanicolensis* Cuvier, 1821, which is considered to belong to the Lessepsian marine fish species in the Mediterranean Sea, was found for the first time on the eastern part of the Libyan coast (Benghazi).

Kurzfassung. Der Sweeper *Pempheris vanicolensis* Cuvier, 1821, family Pempheridae, ein Vertreter der Lesseps'schen Arten im Mittelmeer, wurde erstmals im östlichen Teiul der Küste Libyens, Bezirk Bengasi, nachgewiersen.

Key words Sweeper fish, *Pempheris vanicolensis*, Lessepsian migration, exotic fish species, Libya.

Libya has a long coast of around 2,000 km whose topography varies greatly and which is exposed to a variety of environmental factors. When the Suez Canal opened, marine organisms invaded the Mediterranean Sea (POR 1978). This "Lessepsian migration" of Indo-pacific organisms into the Mediterranean is still going on; ninety alien fish species had been identified as of March 2002, 64 species of them Lessepsian migrants (GOLANI *ET AL.* 2004, GOLANI & SONIN 2006, BILECENOĞLU & KAYA 2006). Temperature and salinity are the two main biotic factors that influence the distribution of marine organisms over large zoogeographical areas. They also often have a decisive influence on the ecological distribution of species in various habitats of an area (BEN-TUVIA 1978).
One of the species that has penetrated the Mediterranean Sea is Sweeper fish. It was first recorded in Lebanon in 1979 (MOUNEIMNÉ 1979). In the eastern Mediterranean Sea, it was recently found in the Gulf of Gabès in Tunisia (BRADAI ET AL. 2004). It was therefore no surprise to find this species in Libyan waters too during a thorough and ongoing investigation into exotic fish.

One specimen of *Pempheris vanicolensis* (Fig. 1) was collected from the eastern region of the Libyan coast (Benghazi) by trammel net on rocky seafloor. The temperature was 22°C, the depth 4m. The specimen was washed with fresh water immediately after identification. It was preserved for one month in a mixed solution of ethanol and formaldehyde and was subsequently kept in formaldehyde (5 %).

Fig. 1. Sweeper fish *Pempheris vanicolensis* Cuvier, 1821.

Determination and scientific name: *Pempheris vanicolensis* (Cuvier, 1831), family Pempheridae, with the vernacular name Sweeper. In Libya it is known as “gasaetlla” or “samak deal”.

Characters: TL 148.89 mm, Bw. 50.97 mm, HL. 33.45 mm., D.F.L. 22.71., A.F.L. 64.12., ED. 17.55 mm. D: V+9, A: III + 37, P: I + 16, VL: 1 + 5, P: 16, LL: 53. Tl/BW: 2.95., TL/HL: 4.45., BW/HL: 1.51., HL/ED: 1.91.

Standard abbreviations. Meristic: **D**: dorsal fin, **A**: Anal fin, **P**: Pelvic fin, **V**: Ventral fin. Morphometric **T**: Total length, **Fl**: Fork length, **S**: Standard length, **BW**: Body width, **DFL**: Dorsal fin length, **ANL**: Anal fin length, **Hl**: Head length, **Edi**: Eye diameter.

The body is laterally compressed, the belly is triangular and the eyes are large. The body is silverish blue in colour, with a touch of brownish pink. The fins are of intense red-brown, the tip of the dorsal fin and the base of the anal fin are black.

The sweeper is one of the Indo-Pacific fish species that invaded the Mediterranean Sea through the Suez Canal. It was first recorded in Lebanon in 1979 (MOUNEIMNÉ 1979), and subsequently along many other coasts in the eastern and central Mediterranean Sea (GOLANI & DIAMANT 1991, GÜCÜ *ET AL.* 1994, TORCU & MATER 2000, HATICE *ET AL.* 2001, BRADAI *ET AL.* 2004). GOLANI (2002) predicted that the many potential rock habitat, site-related species from the Red Sea would not or would only rarely succeed in reaching those habitats in the Mediterranean, since they would need to cross the Suez Canal, the northern Gulf of Suez and the south-eastern Mediterranean, all of which lack a continuous rock habitat. The sweeper proves that given time, it will cross the gaps.

References

BEN-TUVIA A. 1978. Immigration of fishes through the Suez canal. Bull. Fishery. 76: 249-255.

BRADAI M.N., QUIGNARD J.P., BOUAIN A., JARBOUI O., OUANNES-GHORBEL A., BEN ABDALLAHL. ZAOUALI J. & BEN-SALEM S., 2004: Ichtyofaune autochtone et exotique des côtes Tunisinnes: recensement et biogeography. Cybium. 28 (4): 315-328.

CATALANO E. & ZAVA B. 1993. Sulla presenza di *Stephanolepis diaspros* Fr. Brunn. Nelle Acque Italiane (Osteichthyes, Monacanthidae). Supplemento alle Ricerche di Biologia della selvaggina, 21: 379-382.

GOLANI D. & DIAMANT A. 1991. Biology of the Sweeper *P. vanicolensis* Cuvier and Valenciennes, a lessepsian migrant in the eastern mediterranean with a comparison of original Red sea population. J. fish Biol. 38: 819-820.

GOLANI D., ORSI-RELINI L., MASSUTI E. & QUIGNARD J.-P. 2002. CIESM Atlas of Exotic species in the mediterrean. Vol. 1. In: Briand F. (ed.), Fishes. CIESM publishers, Monaco.

GÜCÜ A., BINGEL F. & AVSAR D. 1994. Distribution and occurrence of Red sea fishes at the Turkish coast-Northern Cilician Basin. Acta Adriatica. . 34 (1/2): 103-113.

HATICE T., ZELIHA, A. & AKIF, I. 2001. An investigation on fishes of the Turkish Republic of Northern Cyprus. Turk. J. vet. Anim. Sci. 25. 155-159.

MOUNEIMNE N. 1979. Poissons nouveaux pour les cotes libanaises Cybium, 6: 105-110.

PAPACONSTANTINOU C. 1987. Distribution of the Lessepsian fish migrants in the Aegean Sea. Biologia Gallo-hellenica, 13: 15-20.

POR F.D. 1978. Lessepsian migration. Ecological studies 23: 228 pp., Berlin, New York (Springer Verlag)

STEININTZ W. 1927. Beiträge zur Kenntnis der Küstenfauna Palästinas. I. Pubblicazioni della Stazione Zoologica di Napoli, 8 (3-4): 311-353.

TORCU H. & MATER S. 2000. Lessepsian fishes spreading along the coasts of the Mediterranean and the southern Aegean Sea of Turkey. Doga-Tr. J. Zool. 24 (2): 139-148.

TORTONESE E. 1967. Un pesce plettognato nuovo per I Mari Italiani: *Stephanolepis diaspros* Fraser Brunner. Doriana, Suppl. Degli Annali del Museo Civico di storia Naturale “G. Doria”, 4 (181): 1-4.

Authors’ addresses

Esmaile Shakman
Prof. Dr. Ragnar Kinzelbach

Universität Rostock
Allgemeine & Spezielle Zoologie
Universitätsplatz 2
D-18055 Rostock
Germany

Email: shugmanism@yahoo.com.

First record of the Tropical Halfbeak *Hyporhamphus affinis* (Günther, 1866) in Tunesia (Teleostei: Hemirhamphidae)

By Ragnar Kinzelbach

R. KINZELBACH (2007): Erstnachweis des eingewanderten Tropischen Halbschnäblers *Hyporhamphus affinis* (Günther, 1866) in Tunesien (Teleostei: Hemirhamphidae). Rostocker Meeresbiologische Beiträge 18: S. 82-83

Kurzfassung. Der Tropische Halbschnäbler *Hyporhamphus affinis* (Günther 1866), Familie Hemirhamphidae, ein Vertreter der Lesseps'schen Arten im Mittelmeer, wurde, weit ab vom ersten Fundort im Libanon 1964, erstmals in Tunesien nachgewiesen.

Abstract. The Halfbeak fish, *Hyporhamphus affinis* (Günther 1866), which is considered to belong to the Lessepsian marine fish species in the Mediterranean Sea, was found for the first time in Tunisia, far away from the first record in Lebanon in 1964.

Key words: Tropical Halfbeak fish, *Hyporhamphus affinis*, Lessepsian migration, exotic fish species, Tunisia.

Two halfbeak species (Hemirhamphidae) have so far made their way into the Mediterranean as Lessepsian migrants. *Hemiramphus far* (Forskål, 1775) is now found in many places in the eastern basin of the Mediterranean, (SHAKMAN & KINZELBACH 2006 2007), whereas *Hyporhamphus affinis* (Günther, 1866) has only reliably been identified in Lebanon's coastal waters (GEORGE *ET AL.* 1964). It was also reported to have been found in Turkey, but this is unconfirmed.

On 9 September 2007 a withered 23 cm long specimen of *Hyporhamphus affinis* was found in the stone packing around the harbour basin at Houmed es-Suq (Humtsouk), Jerba, Tunisia. It had probably been caught with a fishing rod in the harbour, which reaches depths of 3m, and thrown back in disappointment. The water temperature near the surface was 22°C. The specimen was kept in a dry place, then transferred to ethanol (70%) and deposited in the Rostock University collection (ZSRO Os 610). It was identified on the basis of GOLANI *ET AL.* (2002).

References

GEORGE C. J., ATHANASSIOU V. A. & BOULOS I.,1964. The fishes of the coastal waters of Lebanon. Miscellaneous papers in the Natural Sciences, The American University of Beirut **4**: 1-24.

GOLANI D., ORSI-RELINI L., MASSUTI E. & QUIGNARD J.-P. 2002. CIESM Atlas of Exotic species in the Mediterrean. Vol. 1. Fishes. CIESM publishers, Monaco.

SHAKMAN E. & KINZELBACH R. 2006. The Halfbeak Fish, *Hemiramphus far* (Forskål, 1775) in the coastal waters of Libya. Zoology in the Middle East **39**: 111-112, Heidelberg.

SHAKMAN E. & KINZELBACH R. 2007. Distribution and characterization of Lessepsian migrant fishes along the coast of Libya. Acta Ichthyologica et Piscatoria **37** (1): 7-15.

Anschrift des Verfassers

Prof. Dr. Ragnar Kinzelbach
Fachbereich Biowissenschaften
Institut für Biodiversitätsforschung
Allgemeine und Spezielle Zoologie
Universitätsplatz 2
18055 Rostock
Germany

Email: Ragnar.kinzelbach@uni-rostock.de

Recent Cephalopods of the German Oceanographic Museum and the Zoological Collection Rostock

By Jan Strauß & Götz Bodo Reinicke

STRAUß J. & G. B. REINICKE (2007): Recent Cephalopods of the German Oceanographic Museum and the Zoological Collection Rostock. Rostocker Meeresbiologische Beiträge 18: S. 84-95

Abstract. The malacological collections of the German Oceanographic Museum (GOM) in Stralsund and the Zoological Museum of the University Rostock (ZSRO) keep Cephalopod specimens from all over the world. The inventory and taxonomic revision presented in this study provides an overview of the cephalopod samples present in both collections. The total of 252 specimen records (GOM: 193, ZSRO: 59) represent 51 different species, mainly from northern Atlantic, Mediterranean and western Pacific locations. Special reference is made to species collected from the North Sea.

Kurzfassung. In den wissenschaftlichen Mollusken-Sammlungen des Deutschen Meeresmuseums (DMM) in Stralsund und der Zoologischen Sammlung Rostock (ZSRO) werden Cephalopoden-Exemplare aus allen Teilen des Weltmeeres aufbewahrt. Die vorliegende Inventur und taxonomische Revision gibt einen Überblick über das vorhandene Sammlungsmaterial. Unter insgesamt 252 Sammlungspositionen (DMM: 193, ZSRO: 59) liegen Belege von 51 verschiedenen Arten vorwiegend aus dem nördlichen Atlantik, dem Mittelmeer und dem westlichen Pazifik vor. Sammlungsobjekte aus der Nordsee werden gesondert diskutiert.

Key words: Mollusca, Cephalopoda, malacological collection, species catalogue, North Sea

Introduction

The malacological collections of the German Oceanographic Museum (GOM) and Zoological Museum of the University of Rostock (ZSRO) differ in their histories. Compared to the ZSRO, the collection of the GOM has a relatively short history, beginning with the establishment of the museum in 1951 by Professor O. DIBBELT. One of the principle duties of the GOM, which developed against the social and political backdrop of the German Democratic Republic, was to design and display attractive exhibitions for the public. Scientific emphasis was placed on ornithology and marine mammal research. Contributions to the pool of exhibits and collection lots were provided by associate institutions (e. g. VEB Hochseefischerei Rostock) and friends of the museum. Since German reunification, key aspects of the collection have been systematically extended, focus on its original areas of emphasis has been deepened, and new areas of focus have come into play.
In contrast, the ZSRO looks back on a 232 year history which began when the museum was established in 1775 by Professor O. G. TYCHSEN. After relocation of the collection from Bützow to Rostock, the exhibits were stored at today's zoological museum in historical glass cabinets dating from 1880, where they have been on display right up to the present day, first only to students, but now also to the public.

The ZSRO collection provides type and collection specimen references for research purposes, as well as for the education of students. The collection focuses on aquatic animals, molluscs, birds and insects. Most recent acquisitions include polychete worms from A. BICK, insects, scorpions and freshwater bivalves from R. KINZELBACH, and fishes, especially sturgeons, from H. WINKLER. Today, the ZSRO collection consists of approximately 100,000 items or series (R. KINZELBACH, personal communication).
Molluscs have been a focus area of both collections since the beginning, and especially of the ZSRO which dates back to the era of "naturalia cabinets" and conserves the type species series of F. LINK (1806). The malacological departments of GOM and ZSRO therefore intend to compile representative collections of voucher specimens and to establish reference collections of molluscs especially for the Mecklenburg-Western Pomerania and Baltic Sea regions. The GOM malacological collection aims to completely represent the species inventory of German coastal and sea areas including the North and Baltic Sea (HOPPE 1992). It is (with a few exceptions) limited to marine molluscs, but includes brackish regions of marginal seas and coasts as well. As with the ZSRO, other focus regions include the Mediterranean and the Red Sea.
The GOM systematic collection aims at the best possible representation of species and documentation of the mollusc fauna of selected regions over relatively long time scales. Since cephalopods are purely marine animals which are only vagrants in the Baltic and do not generate reproductive stocks, special emphasis in this study was placed on voucher specimens of North Sea cephalopod fauna. A revision and inventory of the GOM's collection stocks was last conducted in the early 1990s, and a successive inventory of the ZSRO has been being conducted since 1995. No systematic review had been carried out prior to this inventory.
In order to consider and register new cephalopod material and lost collection lots in both institutions, a revision and digitization of the cephalopod material was conducted in the course of a zoological student internship in 2005.

The cephalopod fauna of the North Sea

The North Sea is an epicontinental sea with an average water depth of 93 m (OTT 1996), but mostly depth ranges of 40-50m. It is delimited towards the northern Atlantic by an imaginary line between Scotland and Norway (62°N, 5°W) and in the western approach to the English Channel (5°W) as well as by coastlines of adjoining coastal states (WALDAY & KROGLUND 2002). Due to the low water depth of the continental shelf basin, the limited diversity of the bottom relief and the predominantly sandy sediment, only three cephalopod life-forms occur. STEIMER (1993) defines them as: (1) nekto-benthic forms which are regular residents of the North Sea on their spawning and foraging migrations, such as the Loligonid family and *Sepia officinalis*; (2) purely benthic forms such as *Eledone cirrhosa* and *Bathypolypus arcticus*, which permanently inhabit the area, and (3) oegopsid high-pelagic forms (oceanic squids) such as *Onychoteuthis banksi*, which sporadically stray into the North Sea because of currents or while hunting swarms of fishes.
Despite the limited diversity of habitats, the North Sea does not represent a uniform zoogeographical region but can be divided into a northern and southern component (JAECKEL 1958). As a result of topographical conditions, Nordic forms predominate because of the wider passage way they have compared to the English Channel

(VOSS 1973, JAECKEL 1958). Furthermore, the composition of the cephalopod fauna of the North Sea is permanently subject to large fluctuations (STEIMER 1993).
According to STEIMER (1993), 32 cephalopod species have been recorded in the geographic range of the North Sea and the adjacent waters Skagerrak, Kattegat and Belt Sea. These species are highlighted in table 1 (see below). 16 of these are classified as immigrants at regular intervals or permanent inhabitants and *Alloteuthis subulata* shows the greatest abundance in the southern North Sea (STEIMER 1993). To continue the list of permanent North Sea residents, nekto-benthic species include *Loligo forbesii*, *Loligo vulgaris*, *Todaropsis eblanae* and *Todarodes sagittatus*. The benthic species recorded are *Sepia officinalis*, *Rossia macrosoma*, *Rossia glaucopis*, *Sepietta oweniana*, *Sepietta neglecta*, *Sepiola atlantica*, *Sepiola aurantiaca*, *Sepiola pfefferi*, *Octopus vulgaris*, *Eledone cirrhosa* and *Bathypolypus arcticus*. Except for the Sepiolids *Sepietta neglecta* and *Sepiola aurantiaca*, these species are frequently found in the North Sea (STEIMER 1993).

Material and Methods

Inventory and taxonomic revision. Existing items from the collections as well as supplementary details and information were digitized in spring and summer 2005. New items were inventoried into the catalogues. Missing item information was tracked down in catalogues and inventory books, which keep record of additional collection data and acknowledge collectors, donors etc. Unregistered items for which complete collection data could be retrieved and items in good condition were newly catalogued.
The taxonomic revision was based on the information provided in the cephalopod section of the Integrated Taxonomic Information System (www.itis.gov, last revised 1999), as well as relevant technical literature (see below). Upon data entry, the species name of each item was checked for taxonomic validity and updated where necessary. Invalid species names or synonyms were recorded in the database.
Information about cephalopod specimens from the North Sea was acquired separately and was supplemented by further literature.

Species identification and set-up of the collection. The correctness of species identification was checked during the revision and registration of items, on the basis of macroscopically observable diagnostic features. Undetermined specimens were analysed in detail and identified. During the identification process, species – mainly conserved with ethanol (70%) – were rinsed in tap water and examined in water filled dissecting dishes using a stereomicroscope. Identification of species was conducted referring to keys by NESIS (1987), ROPER ET AL. (1984), and JEREB & ROPER (2005) as well as the Tree of Life Web Project (YOUNG ET AL. 1996) and the database Cephbase (WOOD & DAY 2006) available via internet. Preparations were carried out where necessary. Cephalopod specimens were preserved in ethanol (70%) and displayed in the collections.

Results

The cephalopod collection of the GOM holds 193 specimen records, the ZSRO collection 59. 46 of the GOM's specimens and 21 of ZSRO's are representatives of the approximately 786 living cephalopod species currently recognized, as listed in

the Current Classification of Recent Cephalopoda from May 2001. Combining the results from both collections, a total of 51 extant cephalopod species are represented. As yet, there are no type specimens in either cephalopod collection.
Highlights of the collections are two glass models of the cephalopod species *Ancistroteuthis lichtensteini* (Ferussac, 1835) and *Octopus vulgaris* Cuvier, 1797 at the ZSRO made by the world famous Saxonian glassblowing company BLASCHKA, as well as a male specimen of the giant squid *Architeuthis dux* Steenstrup, 1857 from New Zealand, which is displayed in the GOM exhibition (see Figs. 1,2).

Fig. 1, 2. 1a-b. BLASCHKA models in ZSRO. 2. Exponate of *Architeuthis dux* in German Oceanogrphic Museum Stralsund.

The GOM's cephalopod records mainly comprise specimens from the Atlantic Ocean and the Mediterranean (collectors include L. & R. ENZENROß), which make up about 50% of the collection stock. The North Sea is represented by just two specimen

records (*Alloteuthis media*, *Alloteuthis subulata*) (Fig. 3). The cephalopod fauna of the Eastern Pacific is represented by specimens from the South Eastern Asian waters (collector: U. PIATKOWSKI).
At the ZSRO, four specimen records from the North Sea are present (*Loligo vulgaris*, 2 *Alloteuthis subulata*, *Sepia officinalis*). It is noteworthy that of these, one specimen record of *Alloteuthis subulata* was collected on the Darss peninsula (Mecklenburg Bight), which indicates that *A. subulata* is able to invade relatively deep into brackish regions of the Baltic Sea with occasional saltwater inflow from the North Sea.
For most parts of the collection stock, however, details about sampling locations are largely unknown (Fig. 4).

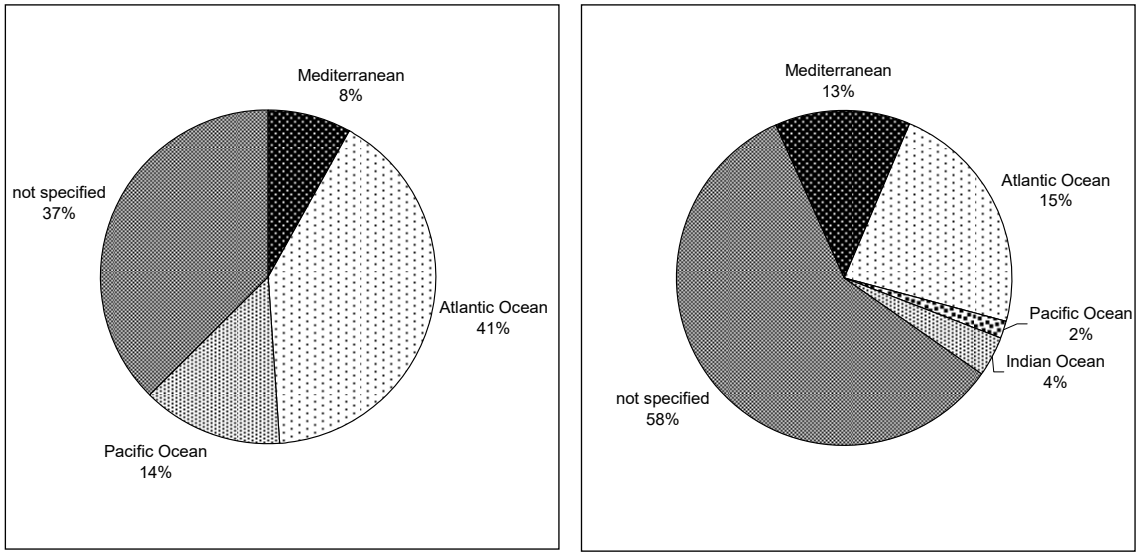


Fig. 3, 4: Proportions of Cephalopod items in both collections arranged according to sea area: Fig. 3 (left): GOM, Fig. 4 (right): ZSRO.

Most collection items with unknown locations originate from the Northern Atlantic Ocean (GOM) and from the Mediterranean and Atlantic Ocean regions (ZSRO). Figure 5 indicates the origin of the cephalopod specimens in both collections sorted by sea area.

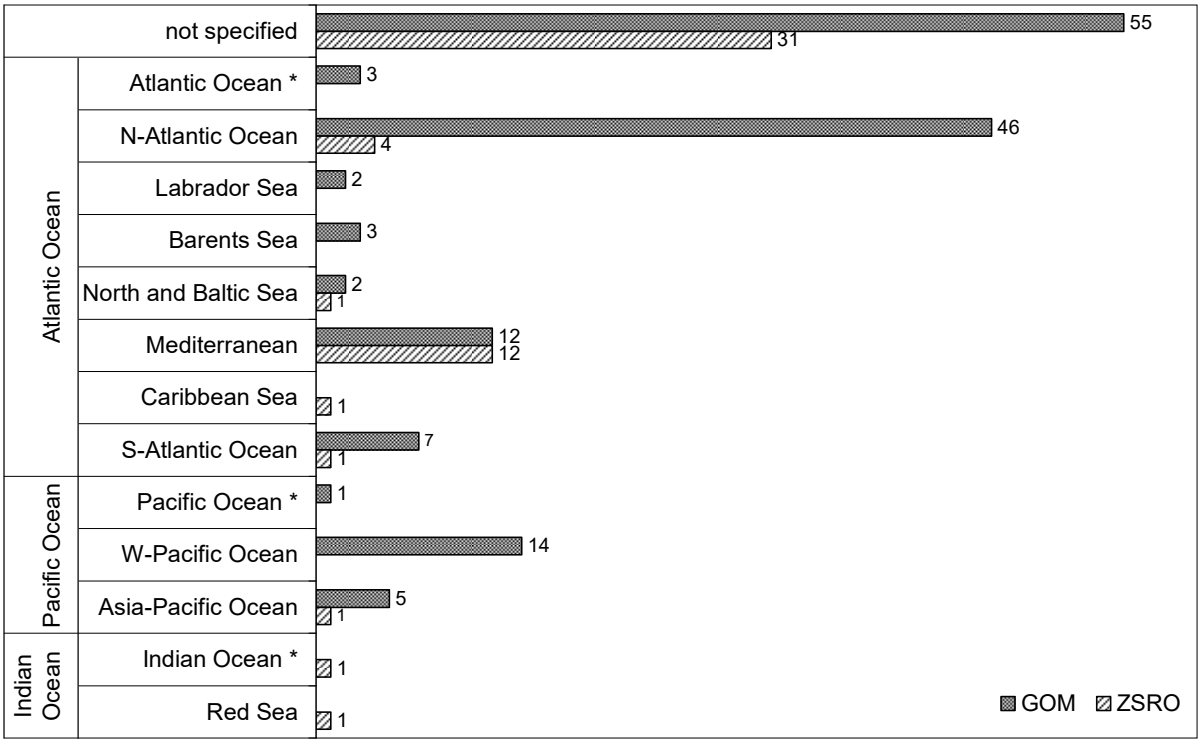


Fig. 5. Geographic origin of Cephalopod samples in the collections of the GOM and the ZSRO, arranged according to sea area. Counts refer to number of collection items. Asterisks (*) denote samples of which the origin is unknown in more detail.

Table 1 gives an overview of the cephalopod species of both collections. The list includes the species retrieved or identified during the revision of the cephalopod collections in 2005, and gives the number of collection items for each species. The latter are itemised by collection regions using FAO main fishing areas (FAO's Handbook of Fishery Statistics). The geographical classification of the areas is reviewed in table 2. For items which could not be classified according to these regions due to lack of information, collection locations are stated separately. Specimens which could not be reliably identified to species level are summarized in the attributed genus.

Tab. 1. Catalogue of cephalopod species at GOM and ZSRO. Data in parentheses refer to numbers of FAO Fishing Areas. Abbreviation n. s. is used where finding sites are not specified. Asterisks (*) denote cephalopod species which are reported for the North Sea (according to STEIMER 1993).

Cephalopoda CUVIER 1797 **Taxa arranged by families**	**GOM**		**ZSRO**	
	number of specimens	**Number (area)**	**number of specimens**	**Number (area)**
Nautilidae				
Nautilus pompilius Linné, 1758			8	8 (n. s.)
Nautilus sp.	1	1 (n. s.)	1	1 (n. s.)
Spirulidae				
Spirula spirula Linné, 1758	1	1 (n. s.)	1	1 (51)
Sepiidae				
Sepia officinalis Linné, 1758 *	28	4 (27); 4 (34); 3 (37); 1 (51); 16 (n. s.)	10	1 (27); 3 (37); 6 (n. s.)
Sepia bertheloti Orbigny, 1835			1	1 (34)
Sepia elegans Blainville, 1827 *	1	1 (37)	2	2 (37)
Sepia orbignyana Ferussac, 1826 *	1	1 (37)		
Sepia sp.	10	1 (51); 9 (n. s.)	2	1 (37); 1 (47)
Sepiolidae				
Sepiola rondeleti Leach, 1834	1	1 (n. s.)	3	2 (37); 1 (n. s.)
Sepiola sp.	1	1 (37)		
Rondeletiola minor (Naef, 1912)			1	1 (37)
Sepietta oweniana Orbigny, 1839 *	1	1 (27)		
Sepietta neglecta Naef, 1916 *	1	1 (n. s.)		
Rossia moelleri Steenstrup, 1856	1	1 (21)		
Austrorossia mastigophora Chun, 1915	1	1 (51)		
Loliginidae				
Loligo vulgaris vulgaris Lamarck, 1796 *	6	1 (21); 1 (34); 1 (37); 3 (n. s.)	3	1 (27); 2 (n. s.)
Loligo vulgaris reynaudi Orbigny, 1939 *	1	1 (47)		
Loligo (Alloteuthis) media Linné, 1758 *	1	1 (27)	1	1 (37)
Loligo (Alloteuthis) subulata Lamarck, 1798 *	3	3 (27)	2	2 (27)
Loligo opalescens Berry, 1911	1	1 (77)		
Loligo pealeii Lesueur, 1821	1	1 (21)		
Sepioteuthis lessoniana Ferussac, 1830	1	1 (71)		
Uroteuthis bartschi Rehder, 1945	2	1 (71); 1 (n. s.)		
Uroteuthis (Photololigo) chinensis (Gray, 1849)	1	1 (71)		
Uroteuthis (Photololigo) duvauceli (Orbigny, 1835)	1	1 (71)		
Loligo forbesii Steenstrup, 1856 *	2	2 (n. s.)		
Loligo sp.	1	1 (n. s.)	2	2 (21)
Architeuthidae				
Architeuthis dux Steenstrup, 1857 *	1	1 (81)		

Cranchiidae				
*Taonius pavo (*Lesueur, 1821)	2	2 (27)		
Enoploteuthidae				
Abralia multihamata Sasaki, 1929	1	1 (71)		
Gonatidae				
Gonatus steenstrupi Kristensen, 1981	1	1 (27)		
Histioteuthidae				
Histioteuthis eltaninae Voss, 1969	3	3 (51)		
Ommastrephidae				
Illex illecebrosus (Lesueur, 1821) *	2	1 (21); 1 (n. s.)	1	1 (27)
Illex argentinus (Castellanos, 1960)	1	1 (41)		
Illex coindetii (Verany, 1839) *	7	3 (34); 1 (37); 3 (n. s.)	1	1 (37)
Illex sp.	6	2 (21); 1 (41); 3 (n. s.)		
Todarodes sagittatus (Lamarck, 1798) *	8	2 (27); 1 (47); 1 (51); 2 (S-Atlantic); 1 (34); 1 (n. s.)	1	1 (n. s.)
Todarodes angolensis Adam, 1962	3	3(51)		
Todarodes sp.	2	2 (k. A.)		
Todaropsis eblanae (Ball, 1841) *	2	1 (27); 1 (uncertain)	1	1 (n. s.)
Nototodarus sloanii (Gray, 1849)	1	1 (n. s.)		
Ommastrephes bartramii (Lesueur, 1821) *	2	2 (n. s.)		
Sthenoteuthis oualaniensis (Lesson, 1830)	1	1 (51)		
Onychoteuthidae				
Onychoteuthis banksii (Leach, 1817) *	1	1 (n. s.)	1	1 (n. s.)
Onychoteuthis sp.			1	1 (n. s.)
Ancistroteuthis lichtensteini (Ferussac, 1835)			1	1 (glass model)
Thysanoteuthidae				
Thysanoteuthis rhombus Troschel, 1857	2	2 (n. s.)		
Argonautidae				
Argonauta argo Linné, 1758	3	1 (61); 2 (n. s.)	3	1 (31); 1 (37); 1 (n. s.)
Argonauta hians Lightfoot, 1786			1	1 (n. s.)
Argonauta sp.	1	1 (n. s.)		
Octopodidae				
Octopus vulgaris Cuvier, 1797 *	31	1 (27); 19 (34); 4 (37); 2 (aquarium); 5 (n. s.)	2	1 (glass model); 1 (n. s.)
Octopus defilippi (Verany, 1851)	1	1 (n. s.)		
Octopus macropus Risso, 1826	1	1 (uncertain)		
Octopus tehuelchus Orbigny, 1834	1	(41)		

Octopus sp.	19	3 (21); 1 (37); 15 (n. s.)	1	1 (37)
Eledone moschata (Lamarck, 1798)	5	1 (37); 4 (n. s.)	6	3 (37); 3 (n. s.)
Eledone cirrhosa (Lamarck, 1798) *	1	1 (n. s.)	1	1 (n. s.)
Eledone thysanophora Voss, 1962	3	3 (51)		
Eledone sp.	3	3 (n. s.)		
Pareledone sp.	1	1 (Antarctica)		
Graneledone verrucosa (Verrill, 1881) *	1	1 (27)		
Bathypolypus arcticus (Prosch, 1847) *	3	2 (27); 1 (n. s.)		
Ocythoidae				
Ocythoe tuberculata Rafinesque, 1814	4	4 (n. s.)		
Total number of specimen records	**193**		**59**	
Number of species	**46**		**21**	

Tab. 2. FAO's Major Fishing Areas for statistical purposes.

Number	Area	Abbreviation
18	Arctic Sea	ARC
21	Atlantic, Northwest	WNA
27	Atlantic, Northeast	ENA
31	Atlantic, Western Central	WCA
34	Atlantic, Eastern Central	ECA
37	Mediterranean and Black Sea	MED
41	Atlantic, Southwest	WSA
47	Atlantic, Southeast	EDA
48	Atlantic, Antarctic	ANC
51	Indian Ocean, Western	WIO
57	Indian Ocean, Eastern	EIO
58	Indian Ocean, Antarcic and Southern	ANE
61	Pacific, Northwest	WNP
67	Pacific, Northeast	ENP
71	Pacific, Western Central	WCP
77	Pacific, Eastern Central	ECP
81	Pacific, Southwest	WSP
87	Pacific, Southeast	ESP
88	Pacific, Antarctic	ANW

Discussion

The cephalopod collections of the GOM and the ZSRO are small scale collections with 193 (GOM) and 59 (ZSRO) collection items respectively. Both collections are mainly composed of industrial fishery catches and sporadic by-catches, single findings during field trips and expeditions, as well as market-purchased collections and donations by individuals. Besides their role as voucher samples, reference specimens and for research, the collections are used to educate students and the interested public (ZSRO), as well as occasionally as a pool of exhibits for the museum's exhibitions. In accordance with the different intentions of the institutions,

these roles have varying levels of importance, which explains the difference in scope of the two malacological collections.

As stated above, highlights of the collections are glass models made by BLASCHKA (ZSRO), as well as a 6 m long male specimen of the giant squid *Architeuthis dux* Steenstrup, 1857 (GOM), which are both displayed in the public exhibitions of the museums. In addition, another interesting find was made in the GOM collection, where an old sealed container from the Comparative Anatomical Collection of the Royal Institute for Anatomy Greifswald holds eleven individuals identified to be *Uroteuthis bartschi*. Rehder described this species for the first time in 1945 and according to ROPER ET AL. (1984), it occurs in the Asia-Pacific region. However, efforts to pinpoint the collection site of this sample have not yet been successful and should be continued. This specimen is inventoried under the catalogue number IIE-13046 at the GOM.
The collection locations of many items could not be retrieved by comparing them with sample acquisition registers either. Thus, for a certain proportion of the cephalopod material, exact collection sites remain unknown, so that this part of the collection is not suitable for use in studies of comparative biology or biogeographic patterns.
Regarding the representativeness of the North Sea cephalopod collections, it can be stated that 17 of 32 species reported by STEIMER (1993) and JAECKEL (1958) are represented in the collections of the GOM and the ZSRO. With reference to STEIMER's classification (1993), 16 of these species are permanent inhabitants or regular immigrants on spawning and foraging migrations. With regard to the GOM's objective of complete representation of cephalopod species from the North Sea and Baltic Sea regions (HOPPE 1992), it can be summarized that 15 confirmed North Sea species are not yet available in either collection. If only the 16 species which, according to STEIMER (1993), are permanent inhabitants of the North Sea are considered, there are five species missing in the collections to date: (1) *Rossia macrosoma* (Chiaie, 1830), (2) *Rossia glaucopis* Loven, 1845, (3) *Sepiola atlantica* Orbigny, 1839, (4) *Sepiola aurantiaca* Jatta, 1896 and (5) *Sepiola pfefferi* Grimpe, 1921. These species at least should be included to provide a complete collection of cephalopod species native to the North Sea and adjacent waters in Mecklenburg-Western Pomerania.

Acknowledgements

The authors would like to thank the following colleagues and institutions for supporting this study: The German Oceanographic Museum provided lab space and equipment for digitizing specimen records. At the Zoological Collection Rostock Professor Dr R. KINZELBACH supported the study with advice and helpful discussions.
J. S. would especially like to thank his GOM colleagues for their warm hospitality, especially for providing free lodging during the internship. In addition, J. S. would like to thank Monika Wilhelm for revising the English version of the manuscript.

References

HOPPE E. 1992: Weichtiere in Ausstellung und Sammlung des Meeresmuseums. Meer und Museum 8: 8-18.

JAECKEL S.G.A. 1958: Cephalopoden. In: A. Remane, ed. Die Tierwelt der Nord- und Ostsee. Kiel. Vol. 3 (part IX), pp. 479-723.

JEREB P. & ROPER C.F.E. (eds) 2005: Cephalopods of the world. An annotated and illustrated catalogue of species known to date. Volume 1. Chambered nautiluses and sepioids (Nautilidae, Sepiidae, Sepilidae, Sepiadariidae, Idiosepiidae and Spirulidae). FAO Species Catalogue for Fishery Purposes. No.4, Vol.1. Rome: FAO. 262 pp. 9 colour plates.

NESIS K.N. 1987: Cephalopods of the World: squid, cuttlefish, octopuses and their allies. 351 pp., Neptune City U.S.A.: T.F.A. Publications.

OTT J. 1996: Meereskunde. Einführung in die Geographie und Biologie der Ozeane. 2nd ed. 424 pp., Stuttgart (Ulmer).

REHDER H.A. 1945: A new Genus and Species of Squids from the Philippines. Proceedings of the Biological Society of Washington 58, 21-26.

ROPER C.F.E., SWEENEY M.J., & NAUEN, C.E. 1984: Cephalopods of the world. An annotated an illustrated catalogue of species of interest to fisheries. FAO Fisheries Synopsis (125) Vol.3, 277 pp. - Available from: ftp://ftp.fao.org/docrep/fao/009/ac479e/ac479e00.pdf [Accessed 16 November 2006].

Smithsonian National Museum of Natural History (NMNH) 2001: Current Classification of Recent Cephalopoda [online]. Available from: http://www.mnh.si.edu/cephs/newclass.pdf [Accessed 15 November 2006].

STEIMER S. 1993: Zur Biologie der Cephalopodenfauna der südlichen Nordsee. Thesis (Diploma Dissertation), University of Kiel, 70 pp.

VOSS G.L. 1973: Cephalopod resources of the world. FAO Circular, 149, 75 pp.

WALDAY M. & KROGLUND T. 2002: Seas around Europe. The North Sea - bottom trawling and oil/gas exploitation. [online]. European Environment Agency. Available from: http://reports.eea.europa.eu/report_2002_0524_154909/en/NorthSea.pdf [Accessed 15 November 2006].

WOOD J. B. & DAY C. L. 2006: CephBase. A database-driven web site on all living cephalopods (octopus, squid, cuttlefish and nautilus) [online]. Available from: www.cephbase.utmb.edu [Accessed 15 November 2006].

YOUNG R.E., VECCHIONE M. & MANGOLD K.M. 1996: Cephalopoda Cuvier 1797. Octopods, squids, nautiluses, etc. [online]. The Tree of Life Web Project. Available from: http://tolweb.org/Cephalopoda [Accessed 15 November 2006].

FAO Coordinating Working Party on Atlantic Fishery Statistics (CWP) 1990: Handbook of fishery statistics. Rome: FAO.

Integrated Taxonomic Information System. Online database. Cephalopod section (1999) [online]. Available from: www.itis.gov [Accessed 15 November 2006].

Map of Major Fishing Areas [online]. Available from: http://www.fao.org/figis/servlet/static?dom=root&xml=geography/fao_fishing_area.xml [Accessed 15 November 2006].

[online] Available from: ftp://ftp.fao.org/docrep/fao/009/a0150e/a0150e00.pdf [Accessed 16 November 2006]

Authors` adresses

Jan Strauß[1] & Götz B. Reinicke[2]

[1] c/o Universität Rostock,
Institut für Biowissenschaften
Allgemeine &Spezielle Zoologie
Universitätsplatz 2
18055 Rostock
Germany
E-Mail: Jan.Strauss@uni-rostock.de

[2] Deutsches Meeresmuseum
Museum für Meereskunde und Fischerei - Aquarium
Katharinenberg 14-20
18439 Stralsund
Germany
E-Mail: Goetz.Reinicke@meeresmuseum.de

Muscheln aus flachen Küstengewässern von Ibiza, Spanien (Mollusca: Bivalvia)

Von Lisa Schüler

SCHÜLER L. (2007): Mussels from shallow coastal waters of Ibiza, Spain (Mollusca: Bivalvia). Rostocker Meeresbiologische Beiträge 18: S. 96-104

Kurzfassung. Insgesamt konnten auf Ibiza bisher 94 Arten von Muscheln identifiziert werden, 37 davon wurden zudem lebend gefunden. Die meisten gefundenen Arten sind häufig, weit verbreitet und abundant. Eine für das Gebiet neue Art konnte in mehreren Jahren nachgewiesen werden *Myoforceps aristata*, die bisher nur an der Südküste des Mittelmeers verbreitet sein soll (REPETTO *ET AL*. 2005).
Die Muschelgemeinschaften der Sedimentböden sind diverser als die der Hartböden. Dennoch sind Hartbodenbewohner zunächst leichter lebend zu finden als im Sediment vergrabene Arten. Der grobe Sandboden der *Posidonia*-Wiesen ist reich an Schillmaterial und lebenden, meist juvenilen Muscheln.

Abstract. The Bivalvia species diversity in the shallow coastal waters of Ibiza was analysed during field courses in zoology of the University of Rostock. Altogerther 94 bivalvia species were identified, 37 of them were also found alive. Most of the determined species are common and have a wide distribution. Regularly can be found: *Arca noae, Barbatia barbata, Musculus costulatus, Modiolus barbatus, Mytilaster solidus, Lissopecten hyalinus, Chlamys varia, Crassadoma multistriata, Spondylus gaederopus, Lima lima, Limaria tuberculata, Limaria hians, Lucinella divaricata, Loripes lacteus, Ctena decussata, Chama gryphoides, Glans trapezia, Cardita calyculata, Parvicardium exiguum scriptum, Spisula subtruncata, Capsella variegata, Donax venustus, Donax trunculus, Chamelea gallina, Venus casina, Dosinia lupinus*, and *Irus irus*.
One species, *Myoforceps aristata*, is new for the waters around the Balearic Islands. Its distribution was up to now limited to the south coast of the Mediterranean (REPETTO *ET AL*. 2005).
Sedimentary soils are richer in species than hard substrate. In contrast to that, bivalvia that live on rocks and stones are often easier to find than such living buried in sand. Sand or gravel bottoms of *Posidonia*-meadows contain a lot of shell valves and living, mostly juvenile mussels.

Key words: Mediterranean Sea, Ibiza, Bivalvia, species list

Einleitung

Bivalvia sind ausschließlich wasserlebende Weichtiere, die einen reduzierten Kopf, einen meist muskulösen Fuß und eine zweiklappige Schale aufweisen. Sie sind im Meer, in Brack- und Süßwasser zu finden, überwiegend in Flachwasserbereichen. Muscheln sind fast ausschließlich Filtrierer (mit Ausnahme der Teredinidae). Sie leben eingegraben im Sediment, sind z. T. mit Byssus an Hartsubstrat befestigt oder mit einer Schalenklappe festgewachsen, einige Arten bohren in Gestein oder Holz, wenige können schwimmen mit Hilfe ihrer Schalenklappen. Etwa 20.000 Arten sind

beschrieben. Im Mittelmeer kommen etwa 450 Arten vor, einschließlich der neu eingewanderten Arten.
Die Artenvielfalt der Muscheln in den Küstengewässern vor Ibiza wurde mittels mehrerer Methoden gesammelt, bestimmt und anhand der Literaturdaten zur Ökologie und Verbreitung der Arten diskutiert. Nach REPETTO *ET AL.* (2005) ist das Vorkommen von etwa 346 Arten in den Gewässern um die Balearen zu erwarten.

Material und Methoden

In den Jahren 1997 bis 1999 (Material gesammelt von Carsten H. G. Müller, Universität Rostock) und 2003 bis 2007 wurden im Rahmen des Zoologischen Feldpraktikums der Universität Rostock in verschiedenen Buchten der Insel Ibiza nach Muschelschalen bzw. lebenden Tieren gesucht. Hierfür wurde zunächst der Spülsaum nach Schill abgesucht, weiterhin wurden schnorchelnd und tauchend lebende Tiere gesammelt. Bei Tauchgängen in Wassertiefen von 1,5-20 m wurden Sediment- bzw. Gesteinsproben entnommen, die unter dem Auflichtmikroskop nach Muscheln untersucht wurden. Lebende Tiere wurden in Ethanol (70%) abgetötet und fixiert. Die Bestimmung erfolgte anhand der Schalenmorphologie. Verwendet wurde ein Auflichtmikroskop, mit bis zu 100facher Vergrößerung.

Ergebnisse

Insgesamt konnten 94 Arten identifiziert werden. Einige sind in sehr vielen Untersuchungsjahren gefunden worden, wie *Arca noae*, *Musculus costulatus*, *Loripes lacteus*, *Cardita calyculata*, *Glans trapezia*, *Spisula subtruncata*, *Tellina donacina*, *Donax venustus*, *Chamelea gallina* und *Dosinia lupinus*. Von den 94 Arten konnten 37 auch lebend nachgewiesen werden. Die meisten wurden nur an jeweils einem Standort gefunden, andere dagegen wie *Barbatia barbata* und *Musculus costulatus* kommen in mehreren Buchten vor.

Diskussion

Lebend gefundene Tiere sind meist Hartsubstratbewohner, die mit Byssusfäden festgeheftet oder mit einer Schale an den Felsen zementiert sind (Arcidae, Mytilidae, *Spondylus gaederopus*) und daher im Blockfelsgrund von Tauchern und Schnorchlern leicht entdeckt werden können. Auch mobile Tiere (*Limaria hians*) können, wenn sie schwimmen, schnorchelnd gefunden werden. Ebenso sind große und auffällige Arten wie *Pinna* häufig lebend zu sehen.
In Gesteinsproben, v. a. bewachsenen, ist regelmäßig *Musculus costulatus* anzutreffen, und in der Penyal de s'Aguila *Myoforceps aristatus*. Im groben Sediment in der Nähe der Seegraswiesen, das reich an Schillmaterial ist, wurden ebenfalls viele Arten lebend gefunden, hierbei vor allem juvenile Stadien (*Tellina donacina*, Lucinidae gen. spp., *Chamelea gallina*, *Donax venustus*, *Dosinia lupinus*) oder kleinwüchsige Arten (*Gouldia minima*, *Tellina pygmaea*, *Kellia suborbicularis*, *Neolepton sulcatum*, *Galeomma turtoni*).
Ein Vergleich der einzelnen Buchten auf ihre Diversität ist nicht sinnvoll, weil sie nicht vergleichbar oft und genau untersucht wurden. Auch ähneln sich die Buchten in ihren Habitaten. Sandboden, *Posidonia*-Wiese und Blockfelsgrund ist stets vorhanden, wenn auch in unterschiedlicher Ausprägung. Einzig die Penyal de s'Aguila unterscheidet sich deutlich, da hier nur Hartsubstrat vorhanden ist. Die Cala

Llenya wurde regelmäßig beprobt, daher findet sich hier auch die größte registrierte Artenvielfalt.
Beim Vergleich des bevorzugten Bodentyps nach der Literatur mit dem tatsächlichen Fundort der lebenden Tiere, sieht man, dass die Daten meist übereinstimmen. Das bedeutet, dass entweder die Toleranz der Organismen größer ist als angegeben (z. B. in Hinsicht auf die Korngröße des Sediments), die Tiere verdriftet wurden oder juvenile Exemplare gefunden wurden, die noch einen anderen Lebensraum besitzen. Es lässt sich jedoch klar erkennen, dass auf Sedimentböden eine reichere Muschelfauna auftritt als auf als reinem Hartboden. Von den lebend gefundenen Arten sind neun reine Hartbodenbewohner, 26 dagegen reine Sedimentbewohner.
Die meisten der gefundenen Arten sind regelmäßig und in relativ hoher Abundanz anzutreffen (Tab. 2). Andere dagegen wurden nur in Einzelfällen gefunden (u. a. *Nuculana pella*, *Gregariella semigranata*, *Kellia suborbicularis*, *Neolepton sulcatum*, *Limatula* cf. *subovata*, *Timoclea ovata*, *Clausinella fasciata brongniarti*, *Abra alba*, *Solecurtis strigilatus*, etc.). Dies lässt nicht immer einen Rückschluss auf die Häufigkeit der jeweiligen Art zu. *Nuculana pella* beispielsweise bevorzugt eher Weich- als Sandboden; *Kellia* und *Neolepton* sind vermutlich wegen ihrer geringen Größe (1 mm) oft übersehen worden. *Limatula*-Arten bevorzugen größere Tiefen als die untersuchten.

Häufige, in den Küstengewässern Ibizas regelmäßig anzutreffende, abundante Arten sind:
Arca noae, Barbatia barbata, Musculus costulatus, Modiolus barbatus, Mytilaster solidus, Lissopecten hyalinus, Chlamys varia, Crassadoma multistriata, Spondylus gaederopus, Lima lima, Limaria tuberculata, Limaria hians, Lucinella divaricata, Loripes lacteus, Ctena decussata, Chama gryphoides, Glans trapezia, Cardita calyculata, Parvicardium exiguum scriptum, Spisula subtruncata, Capsella variegata, Donax venustus, Donax trunculus, Chamelea gallina, Venus casina, Dosinia lupinus sowie *Irus irus*.

Der Artstatus von *Parvicardium scriptum* und *Clausinella brongniarti* ist bisher nicht eindeutig geklärt, deshalb werden sie hier als Unterart von *Parvicardium exiguum* bzw. *Clausinella fasciata* aufgeführt.
Die Bestimmung konnte meist eindeutig erfolgen bis auf Einzelfunde, von denen nur eine Schalenklappe gefunden wurde wie *Limatula* cf. *subovata*, *Arca* cf. *tetragona* etc.
Das Fehlen von *Timoclea ovata* in den ersten Jahren ist nicht zu erklären, da dies eine häufige Art ist, die alle Arten von Böden ab 4 m Wassertiefe bewohnt (POPPE & GOTO 1993).
Die meisten hier bestimmten Arten kommen im ganzen Mittelmeer vor. Auf das westliche Mittelmeer beschränkt sind *Ervilia castanea, Phaxas pellucidus, Lajonkairia substriata* und *Gregariella semigranata*.
Neu für das Gebiet der Balearen ist *Myoforceps aristata*. Ihre Verbreitung beschränkt sich nach REPETTO *ET AL*. 2005 bisher auf die Südküste des Mittelmeeres.

Danksagung

Ich bedanke mich bei allen Ibiza-Exkursanten der Jahre 2003-2007, die lebende Muscheln oder schillhaltige Sedimente aufgesammelt und der Zoologischen Sammlung der Universität Rostock übergeben haben. Besonders zu danken habe ich in diesem Zusammenhang: Martin Schwentner, Juliane Pasold, Dipl. Biol. Stefan

Fischer, Dr. Florian Peine, Dr. Carsten H. G. Müller (alle Universität Rostock), Dipl. Biol. Andy Sombke (MPI für Chemische Ökologie, Jena) und Dr. Kristina Kusche (Universität Münster). Frau Dipl. Biol. Hanna Damm half bei der Aufarbeitung der Schillsedimente und bei der Aussortierung des für die vorliegende Untersuchung relevanten Materials. Herr Dr. Carsten H. G. Müller hat darüber hinaus eine umfangreiche malakologische Aufsammlung mit zahlreichen bereits bestimmten Muschelarten von der Insel Ibiza zur Verfügung gestellt (eingeliedert in die ZSRO), die im Rahmen dieser Studie revidiert wurde.

Literatur

NORDSIECK F. 1969: Die europäischen Meeresmuscheln. (Bivalvia). Gustav Fischer Verlag, Stuttgart.

REPETTO G., ORLANDO F. & ARDUINO G. 2005: Conchiglie del Mediterraneo. Amici del Museo "Federico Eusebio", Alba, 392 p.

COSTELLO M.J., EMBLOW C.S. & WHITE R. (Hrsg.), 2001: European Register of Marine Species. A check-list of the marine species in Europe and a bibliography of guides to their identification. Publications Scientifiques du M.N.H.N., Paris.

KILIAS R. 1997: Marine Muscheln und Schnecken. Ulmer Verlag, Stuttgart.

POPPE G. & GOTO Y. 1993: European Seashells. Volume II (Scaphopoda, Bivalvia, Cephalopoda). Verlag Christa Hemmen, Wiesbaden.

RIEDL R. 1963: Fauna und Flora der Adria. Verlag Paul Parey, Hamburg.

RODRÍGUEZ R. & SÁNCHEZ J. 1997: Moluscos Bivalvos de Canarias. Ediciones del cabildo insular de Gran Canaria, Las Palmas.

TEBBLE N. 1966: British bivalve seashells. A handbook for identification. Trustees of the British Museum, London.

Author's address:

Lisa Schüler
Universität Rostock
Institut für Biowissenschaften
c/o Allgemeine & Spezielle Zoologie
Universitätsplatz 2
18055 Rostock
Germany

Anhang

Tab. 1. Fundortnummern und Beschreibung der beprobten Buchten auf Ibiza.

1	Cala Llenya	nordöstlich gelegen, breit, viele verschiedene Habitate: Blockfelsgrund, Sandboden mit ausgedehnten *Posidonia*-Wiesen, kleinere Geröllfelder
2	Playa Portinatx	im Norden gelegen, schmal und relativ flach, weist viel Sandboden auf, aber auch kleinere felsige Bereiche sowie *Posidonia*-Wiesen
3	Cala Vadella	im Südosten, größtenteils sandig mit *Posidonia*-Wiesen, am Rand Blockfelsgrund
4	Penyal de s'Aguila	im Norden, ausschließlich Felsküste und typische Hartbodengesellschaft
5	Cala Tarida	im Südwesten, sehr breit, sandig mit wenigen Blockfelsen am Rand
6	Cala Azur	der Cala Llenya benachbart, klein, ausschließlich mit Blockfelsgrund
7	La Joya	gegenüber der Cala Llenya, größtenteils felsig
8	Cala Olivera	östlich gelegen, ähnlich der Playa Portinatx

Tab. 2. Artenliste gesamt. (Für Fundorte vgl. Tab. 1)

Art	**Autor**	**Familie**	**Jahre**
Nuculana pella	(Linné, 1767)	Nuculanidae	2006
Arca noae	Linne, 1758	Arcidae	1997-99, 2004, 2005, 2006, 2007
Arca cf. *tetragona*	Poli, 1795	Arcidae	2004
Barbatia barbata	(Linné, 1758)	Arcidae	1997-99, 2003, 2004, 2006, 2007
Striarca lactea	(Linné, 1758)	Noetiidae	1997-99, 2004, 2006, 2007
Glycymeris violacescens	(Lamarck, 1819)	Glycymeridae	1997-99, 2006, 2007
Glycymeris glycymeris	(Linné, 1758)	Glycymeridae	1997-99
Modiolus barbatus	(Linné, 1758)	Mytilidae	1997-99, 2004, 2006, 2007
Lithophaga lithophaga	(Linné, 1758)	Mytilidae	1997-99, 2007
Myoforceps aristatus	(Dillwyn, 1817)	Mytilidae	2005, 2006, 2007
Musculus costulatus	(Risso, 1826)	Mytilidae	2003, 2004, 2005, 2006, 2007
Mytilus galloprovincialis	Lamarck, 1819	Mytilidae	2005, 2006, 2007
Mytilaster solidus	Monterosato, 1872	Mytilidae	2003, 2004, 2006, 2007
Gregariella semigranata	(Reeve, 1858)	Mytilidae	2007
Pecten jacobaeus	(Linné, 1758)	Pectinidae	1997-99, 2006
Aequipecten opercularis	(Linné, 1758)	Pectinidae	1997-99, 2006
Lissopecten hyalinus	(Poli, 1795)	Pectinidae	1997-99, 2004, 2006, 2007
Chlamys flexuosa	(Poli, 1795)	Pectinidae	1997-99, 2006
Chlamys glabra	(Linné, 1758)	Pectinidae	1997-99, 2006
Chlamys varia	(Linné, 1758)	Pectinidae	1997-99, 2004, 2006, 2007
Crassadoma multistriata	(Poli, 1795)	Pectinidae	1997-99, 2004, 2006, 2007
Spondylus gaederopus	Linné, 1758	Spondylidae	1997-99, 2004, 2006, 2007
Lima lima	(Linné, 1758)	Limidae	1997-99, 2004, 2006, 2007
Limaria tuberculata	(Wood S., 1839)	Limidae	1997-99, 2004, 2006, 2007
Limaria hians	(Gmelin, 1791)	Limidae	2004, 2005, 2006, 2007
Limatula cf. *subovata*	(Jeffreys, 1876)	Limidae	2004
Anomia ephippium	Linné, 1758	Anomiidae	1997-99, 2006, 2007

Ostrea edulis	Linné, 1758	Ostreidae	1997-99, 2006, 2007
Neopycnodonte cochlear	(Poli, 1795)	Gryphidae	2006
Pinna nobilis	Linné, 1758	Pinnidae	1997-99, 2006, 2007
Pinna rudis	Linné, 1758	Pinnidae	1997-99
Lucinella divaricata	(Linné, 1758)	Lucinidae	2004, 2005, 2006, 2007
Anodontia fragilis	(Philippi, 1836)	Lucinidae	2004, 2006, 2007
Ctena decussata	(Costa O.G., 1829)	Lucinidae	1997-99, 2004, 2006, 2007
Loripes lacteus	(Linné, 1758)	Lucinidae	1997-99, 2004, 2005, 2006, 2007
Diplodonta apicalis	Philippi, 1836	Ungulinidae	2004, 2006
Chama gryphoides	Linné, 1758	Chamidae	1997-99, 2004, 2006, 2007
Pseudochama gryphina	(Lamarck, 1819)	Chamidae	1997-99, 2004, 2006
Galeomma turtoni	Sowerby G.B.I in Turton, 1825	Galeommatidae	2004
Kellia suborbicularis	*(Montagu, 1803)*	Kelliidae	2004
Neolepton sulcatum	(Jeffreys, 1859)	Neoleptonidae	2004
Venericardia antiquata	(Linné, 1758)	Carditidae	2004, 2006, 2007
Glans trapezia	(Linné, 1767)	Carditidae	1997-99, 2003, 2004, 2005, 2006, 2007
Cardita calyculata	(Linné, 1758)	Carditidae	1997-99, 2004, 2005, 2006, 2007
Acanthocardia tuberculata	(Linné, 1758)	Cardiidae	1997-99, 2006, 2007
Acanthocardia cf. echinata	(Linné, 1758)	Cardiidae	2004
Laevicardium crassum	(Gmelin, 1791)	Cardiidae	1997-99, 2006, 2007
Cerastoderma glaucum	(Poiret, 1789)	Cardiidae	1997-99
Cerastoderma edule	(Linné, 1758)	Cardiidae	1997-99
Parvicardium exiguum scriptum	(Bucquoi et al.,1892)	Cardiidae	2003, 2004, 2006, 2007
Parvicardium minimum	(Philippi, 1836)	Cardiidae	2004
Plagiocardium papillosum	(Poli, 1795)	Cardiidae	2004, 2007
Spisula subtruncata	(da Costa, 1778)	Mactridae	1997-99, 2004, 2005, 2006, 2007
Mactra stultorum	(Linné, 1758)	Mactridae	1997-99, 2006, 2007
Donacilla cornea	(Poli, 1795)	Mesodesmatidae	2007
Ensis ensis	(Linné, 1758)	Pharidae	1997-99

Phaxas pellucidus	(Pennant, 1777)	Pharidae	2005
Tellina pulchella	Lamarck, 1818	Tellinidae	2006
Tellina incarnata	Linné, 1758	Tellinidae	1997-99, 2006, 2007
Tellina donacina	Linné, 1758	Tellinidae	1997-99, 2004, 2005, 2006, 2007
Tellina planata	Linné, 1758	Tellinidae	1997-99, 2004, 2006
Tellina fabula	Gmelin, 1791	Tellinidae	2006
Tellina pygmaea	Lovén, 1846	Tellinidae	2004
Tellina nitida	Poli, 1791	Tellinidae	2004
Arcopagia balaustina	(Linné, 1758)	Tellinidae	2004, 2006, 2007
Gastrana fragilis	(Linné, 1758)	Tellinidae	1997-99, 2006, 2007
Capsella variegata	(Gmelin, 1791)	Donacidae	1997-99, 2004, 2006, 2007
Donax trunculus	Linné, 1758	Donacidae	1997-99, 2004, 2006, 2007
Donax venustus	Poli, 1795	Donacidae	1997-99, 2004, 2005, 2006, 2007
Gari costulata	(Turton, 1822)	Psammobiidae	2004, 2007
Gari fervensis	(Gmelin, 1791)	Psammobiidae	2006, 2007
Gari depressa	(Pennant, 1777)	Psammobiidae	1997-99, 2007
Ervilia castanea	(Montagu, 1803)	Semelidae	2004, 2007
Abra alba	(Wood W., 1802)	Semelidae	2006
Solecurtus strigilatus	(Linné, 1758)	Solecurtidae	1997-99
Gouldia minima	(Montagu, 1803)	Veneridae	2004, 2006, 2007
Timoclea ovata	(Pennant, 1777)	Veneridae	2007
Callista chione	(Linné, 1758)	Veneridae	1997-99, 2006, 2007
Clausinella fasciata brongniarti	(da Costa, 1778)	Veneridae	2007
Chamelea gallina	(Linné, 1758)	Veneridae	1997-99, 2004, 2005, 2006, 2007
Venus verrucosa	Linné, 1758	Veneridae	1997-99, 2006, 2007
Venus casina	Linné, 1758	Veneridae	1997-99, 2004, 2006, 2007
Dosinia lupinus	(Linné, 1758)	Veneridae	1997-99, 2004, 2005, 2006, 2007
Dosinia exoleta	(Linné, 1758)	Veneridae	2007
Paphia aurea	(Gmelin, 1791)	Veneridae	1997-99, 2006, 2007

Paphia rhomboides	(Pennant, 1777)	Veneridae	1997-99, 2007
Tapes decussata	(Linné, 1758)	Veneridae	1997-99
Irus irus	(Linné, 1758)	Veneridae	1997-99, 2004, 2006, 2007
Lajonkairia substriata	(Montagu, 1808)	Petricolidae	2004, 2005, 2007
Sphenia binghami	Turton, 1822	Myidae	2004, 2007
Corbula gibba	(Olivi, 1792)	Corbulidae	2004, 2006, 2007
Hiatella arctica	(Linne, 1767)	Hiatellidae	2004, 2006
Hiatella cf. *rugosa*	(Linne, 1767)	Hiatellidae	2004
Thracia distorta	(Montagu, 1803)	Thraciidae	2004
Thracia cf. pubescens	(Pulteney, 1799)	Thraciidae	2004

Tab. 3. Funde von lebenden Tieren. (Für Fundorte vgl. Tab. 1.)

Art	**Substrat**	**Substrat (Literaturdaten)**	**Fundort**
Nuculana pella	Sandboden	Weichboden	3
Arca noae	Hartboden, Posidonia	auf Hartsubstrat	4, 1
Barbatia barbata	Posidonia, Sandboden	auf Hartsubstrat	1, 3, 7
Striarca lactea	Posidonia	zwischen Algen, unter Steinen	1
Mytilaster cf. solidus	Sandboden, Posidonia, rock pool	auf Hartsubstrat oder in Algen	1,4
Musculus costulatus	Posidonia, Hartboden	zwischen Algen, unter Steinen	1,4, 7
Mytilus galloprovincialis	Hartboden	auf Hartsubstrat	4
Myoforceps aristatus	Hartboden	bohrt in Kalkalgen oder Schalen	4,7
Lithophaga lithophaga	Hartsubstrat	bohrt in Hartsubstrat	5, 7
Lissopecten hyalinus	Posidonia	versteckt in Posidonia, Korallen, Schwämmen	1
Pinna nobilis	Sandboden	Sandboden, Weichboden	3
Spondylus gaederopus	Hartboden	auf Hartsubstrat	1
Limaria hians	Blockfelsgrund, Sandboden	Sandboden, manchmal in Posidonia	1
Ctena decussata	Sandboden, Posidonia	Sandboden, Weichboden, in Algen	1
Loripes lacteus	Sandboden	Sandboden, Weichboden, Kies	1

Lucinella divaricata	Sandboden	Feinsand, Weichboden	1
Diplodonta apicalis	Sandboden, Posidonia	Sandboden, Weichboden	1
Venericardia antiquata	Sandboden, Posidonia	Sandboden	2
Glans trapezia	Sandboden, Posidonia	auf Hartsubstrat	1
Cardita calyculata	Sandboden, Hartboden	auf Hartsubstrat, unter Steinen	1, 4
Chama gryphoides	Hartsubstrat	auf Hartsubstrat	7
Parvicardium exiguum scriptum	Posidonia	Sandboden, Weichboden, Kies	1
Plagiocardium papillosum	Posidonia	Grobsand und Kies	1
Acanthocardia tuberculata	Sandboden	Sandboden, Weichboden, Kies	1, 3
Spisula subtruncata	Sandboden	Sandboden, Weichboden	8
Phaxas pellucidus	Sandboden	Sandboden, Weichboden, Kies	8
Arcopagia balaustina	Sandboden, Posidonia	Sandboden, Weichboden, Kies	2
Tellina donacina	Sandboden, Posidonia	Sandboden, Weichboden, Kies	1,8
Tellina fabula	Sandboden	Feinsand	3
Tellina pygmaea	Sandboden, Posidonia	Grobsand und Kies	1
Tellina cf. *planata*	Sandboden, Posidonia	Feinsand	1
Capsella variegata	Sandboden, Posidonia	Sandboden	1
Donax venustus	Sandboden, Posidonia	Sandboden	1
Donax trunculus	Sandboden, Posidonia	Sandboden	1
Gouldia minima	Sandboden, Posidonia	Sandboden, Weichboden, Kies	1
Chamelea gallina	Sandboden, Posidonia	Sandboden, Weichboden	1
Dosinia lupinus	Sandboden	Sand, Grobsand	1,3
Irus irus	Sandboden	in Höhlen und Spalten, Laminaria-Wurzeln	1
Lajonkairia substriata	Sandboden	bohrend in Hartsubstrat	1
Corbula gibba	Sandboden, Posidonia	Sandboden, Weichboden, Kies	1
Hiatella arctica	Hartboden	auf Hartsubstrat, in kleinen Höhlen	4
Hiatella cf. *rugosa*	Blockfelsgrund	in kleinen Höhlen, Bohrlöchern	1

Käferschnecken aus flachen Küstengewässern von Ibiza, Spanien (Mollusca: Polyplacophora)

Von Lisa Schüler

SCHÜLER L. (2007): Chitons from shallow coastal waters of Ibiza, Spain (Mollusca: Polyplacophora). Rostocker Meeresbiologische Beiträge: 18 S. 105-111

Kurzfassung. Insgesamt konnten in den Küstengewässern Ibizas zwölf Arten von Polyplacophora nachgewiesen werden, sieben davon lebend gefunden, elf in Form von isolierten Schalenplatten. Die häufigsten Arten sind *Acanthochitona crinita, Acanthochitona fascicularis, Chiton olivaceus, Lepidopleurus cajetanus* und *Ischnochiton rissoi.* Im oberen Meso- und im Supralitoral kann *Lepidochitona corrugata* regelmäßig und in großer Zahl angetroffen werden. Auf Ibiza lebt ein Drittel der aus dem Mittelmeer bekannten Arten der Polyplacophora. Zwei Arten konnten neu für das Gebiet bestimmt werden, *Lepidochitona furtiva* und *Lepidochitona canariensis.* Letztere, bekannt von den Kanmaren und Madeira, war bisher nur ein Mal im Mittelmeer in Marokko nachgewiesen worden.

Abstract. The Polyplacophora species diversity in the shallow coastal waters of Ibiza was analysed during field courses in zoology of the University of Rostock. Altogether twelve species were identified, this means more than one third of species that live in the Mediterranean. Thus, Ibiza has a quite rich fauna of Polyplacophora. The most frequent species in the bays investigated are *Acanthochitona crinita, Acanthochitona fascicularis, Chiton olivaceus, Lepidopleurus cajetanus,* and *Ischnochiton rissoi*. *Lepidochitona corrugata* was found regularly and in bhigh numbers the upper meso- and supralittoral. Expected were 18 species in the coastal waters of the Balearic Islands. Some of them were not recorded. The reasons are discussed. Two additional species were identified clearly by their typical characters, which had not been recorded for the Balearic Islands before, *Lepidochitona furtiva* and *Lepidochitona canariensis*. The second is distributed around the Canary Islands and Madeira, and there is only one earlier record from the Mediterranean in Morocco (Dell'Angelo ET AL. 1999).

Key words: Mediterranean Sea, Ibiza, Polyplacophora, species list

Einleitung

Käferschnecken (Polyplacophora) sind ausschließlich maritime Weichtiere mit unverkennbarem Körperbau. Auf dem Rücken tragen sie acht, sich dachziegelartig überdeckende Schalenplatten, die beweglich miteinander verbunden sind. Sie werden umgeben vom Gürtel, der neben Kalkstacheln auch Sinnesorgane trägt. Sie sind in fast allen Meeren zu finden, bevorzugt in flachen Küstengewässern mit Hartsubstrat, auf dem sie sich mit ihrem breiten Kriechfuß anheften. Sie ernähren sich von pflanzlichem oder tierischem Aufwuchs. Etwa 850 Arten sind beschrieben.
Im Mittelmeer kommen 31 Arten vor. Mitgezählt sind Arten, die den Schwerpunkt ihrer Verbreitung im Atlantik haben, jedoch in der Nähe der Straße von Gibraltar gefunden werden, also möglicherweise ins Mittelmeer einwandern, sowie ein

Neozoon aus dem Roten Meer, *Chiton (Ischnochiton) hululensis* (E. A. Smith in Gardiner, 1903).
Ziel der Untersuchung war die Erfassung, Bestimmung und Interpretation der Artenvielfalt der Polyplacophora in den Küstengewässern vor Ibiza. Nach den Verbreitungskarten von DELL'ANGELO & SMRIGLIO (2001) und REPETTO ET AL. (2005) ist ein Vorkommen der von 18 Arten in den Gewässern um die Balearen zu erwarten (Tab. 1).

Tab. 1. Die Käferschnecken der Balearen nach der Literatur.

Leptochitonidae:
Lepidopleurus cajetanus (Poli, 1791)
Leptochiton algesirensis (Capellini, 1859)
Leptochiton asellus (Gmelin, 1791)
Leptochiton cancellatus (Sowerby G. B. II, 1840)
Leptochiton geronensis Kaas & Van Belle, 1985
Leptochiton africanus (Nierstrasz, 1906)

Ischnochitonidae:
Ischnochiton rissoi (Payraudeau, 1826)
Ischnochiton vanbellei Kaas, 1985
***Callochiton calcatus* Dell'Angelo & Palazzi, 1994**
Callochiton septemvalvis (Montagu, 1803)
***Lepidochitona corrugata* (Reeve, 1848) = *Lepidochitona caprearum* (Scacchi, 1836)**
Lepidochitona cinerea (Linné, 1767)
Lepidochitona monterosatoi Kaas & Van Belle, 1981

Chitonidae:
Chiton corallinus (Risso, 1826)
Chiton olivaceus Spengler, 1797
Chiton phaseolinus Monterosato, 1879

Acanthochitonidae:

***Acanthochitona fascicularis* (Linné, 1767)**

***Acanthochitona crinita* (Pennant, 1777)**

Material und Methoden

In den Jahren 2004 bis 2007 wurden im Rahmen eines Zoologischen Feldpraktikums der Universität Rostock jeweils im Frühjahr mehrere Buchten der Insel Ibiza faunistisch untersucht. Im Jahre 2004 kam ein Stechrohr zur Entnahme von Sedimentproben aus 1,5 bis 20 m Tiefe zum Einsatz. Sie wurden in Ethanol (70%) fixiert und konnten später nach Tieren oder Schillmaterial durchsucht werden.
In den Jahren 2004 bis 2006 wurden Zufallsfunde von lebenden Polyplacophora (Schnorcheln oder Tauchen im Flachwasser) fixiert und aufbewahrt. Im März 2007 erfolgten gezielt Probenahmen in Flachwasser bis 6 m Tiefe. Das Substrat wurde dort nach lebenden Tieren abgesucht, die mit einem Messer vom Untergrund gelöst, in Ethanol (70%) getötet und fixiert wurden. Mit einem feinmaschigem Kescher wurden Sedimentproben vom Rand einer *Posidonia*-Wiese entnommen, aus denen

dann wie schon 2004 Schillmaterial gewonnen werden konnte. Zusätzlich wurden Gesteinsproben mit Algenbewuchs entnommen und nach lebenden Polyplacophora abgesucht.
Auch der Spülsaum wurde nach Schillmaterial abgesucht. Unter dem Auflichtmikroskop wurden isolierten Schalenplatten zur Bestimmung aussortiert. Meist handelte es sich um kleine Stücke von 1-6 mm Breite.
Die Bestimmung erfolgte bei Schillmaterial anhand der Struktur der einzelnen Schalenplatten (Tegmentum, Articulamentum, Apophysen, Insertionsplatten), wobei meist die erste, letzte und eine mittlere Platte vorliegen muss. Beim fixierten Tier wird die Struktur des Tegmentums und der verkalkten Gürtelelemente als Bestimmungsmerkmal benutzt. Dafür wurde ein Auflichtmikroskop mit bis zu 100facher Vergrößerung verwendet.
Als Sammelmethode eignet sich besonders die Untersuchung von grobsandigem Sediment von Stellen, an denen sich Schill akkumulieren kann. Lebende Tiere sind durch ihre verborgene Lebensweise (in Höhlen, unter Steinen oder farblich getarnt) oft nur schwer zu entdecken. Die Bestimmung anhand der isolierten Schalenplatten ist effektiver, sofern genug Material vorhanden ist.

Zur Identifikation von *Lepidochiton algesirensis*

Von dieser Art wurde nur eine mittlere Schalenplatte gefunden. Anhand der fehlenden Insertionsplatten kann sie leicht zur Gruppe der Leptochitonidae zugeordnet werden. Anhand der Größe der Schalenplatte (ca. 4 mm) kann die Größe des Tiers auf ca. 10 mm geschätzt werden. Somit kommen nur drei Arten in Frage: *L. asellus*, *algesirensis* und *africanus*. *Lepidopleurus cajetanus* kann durch ihre äußerst markante Skulptur ausgeschlossen werden. Somit muss die Skulptur der lateralen und mittleren Felder der mittleren Schalenplatte verglichen werden. Sie besteht aus winzigen Körnchen, die zu zarten senkrechten Reihen verschmelzen. Die Anzahl der Reihen ist bestimmungsrelevant. *Lepidochiton africanus* kann ausgeschlossen werden, da sie nur ca. die Hälfte dieser Körnchenreihen besitzt sowie eine dunklere Färbung des Tegmentums. *Leidochiton asellus* und *algerisensis* ähneln sich stark. In Folge des nur mittelmäßigen Erhaltungszustands der Schale, die Skulptur ist etwas abgerieben, ist die Bestimmung nicht ganz eindeutig. *Leptochiton algesirensis* hat ein regelmäßigeres Aussehen und etwas weniger Körnchenreihen als *Lepidochiton asellus* und die Schale ist runder und weniger gekielt (nach DELL'ANGELO & SMRIGLIO 2001).

Untersuchte Standorte

Die Sedimentproben von 2004 wurden in der Playa Portinatx in 7 m Tiefe und in der Cala Llenya in anderthalb, 9, 15 und 20 m Tiefe entnommen. Das Sediment bestand hier aus Sand mit einem großen Anteil an organischen Resten, die sich in den sogenannten Bombentrichtern der *Posidonia*-Wiesen ansammeln. Zufallsfunde lebender Tiere stammen aus der Penyal de s'Aguila, Cala Llenya und Cala Olivera.
Im Jahr 2007 wurden gezielt mehrere Standorte und Habitate beprobt: Sediment wurde in der Cala Llenya in 2-6 m Tiefe beprobt. Rock pools und oberes Meso- bzw. Supralitoral wurden in der Cala Llenya, Cala Tarida, Cala Azur und Penyal de s'Aguila untersucht; Gesteinsproben aus 1-2 m Tiefe wurden aus der Cala Tarida und La Joya entnommen, der Spülsaum in der Cala Vadella und Cala Llenya

ausgelesen. Ergiebig war auch Sediment, das sich in einem im Vergleich zum Meeresspiegel hoch gelegenen und ca. 80 cm tiefen rock pool in der Penyal de s'Aguila angesammelt hatte.

Tab. 2. Fundortnummern und Beschreibung der beprobten Buchten auf Ibiza.

1	Cala Llenya	nordöstlich gelegen, breit, viele verschiedene Habitate: Blockfelsgrund, Sandboden mit ausgedehnten *Posidonia*-Wiesen, kleinere Geröllfelder
2	Playa Portinatx	im Norden gelegen, schmal und relativ flach, weist viel Sandboden auf, aber auch kleinere felsige Bereiche sowie *Posidonia*-Wiesen
3	Cala Vadella	im Südosten, größtenteils sandig mit *Posidonia*-Wiesen, am Rand Blockfelsgrund
4	Penyal de s'Aguila	im Norden, ausschließlich Felsküste und typische Hartbodengesellschaft
5	Cala Tarida	im Südwesten, sehr breit, sandig mit wenigen Blockfelsen am Rand
6	Cala Azur	der Cala Llenya benachbart, klein, ausschließlich mit Blockfelsgrund
7	La Joya	gegenüber der Cala Llenya, größtenteils felsig
8	Cala Olivera	östlich gelegen, ähnlich der Playa Portinatx

Ergebnisse

Die meisten Funde stammen aus den Sedimentproben der Jahre 2004 und 2007. Aus dem Schill konnten elf Arten identifiziert werden, sieben davon wurden zusätzlich lebend gefunden. *Lepidochitona canariensis* wurde nur lebend gefunden. Insgesamt ergibt sich also eine Artenzahl von zwölf.
Bei folgenden vier Arten handelt es sich um Einzelfunde: *Leptochiton* cf. *algerisensis*, *Lepidochitona canariensis*, *Lepidochitona furtiva* und *Chiton phaseolinus*. Bis auf die erstgenannte Art konnten jedoch alle eindeutig zugeordnet werden.
Zwei Arten, *Lepidochitona furtiva* und *L. canariensis*, sind nicht in der Liste der zu erwartenden Arten enthalten (Tab. 1), also neu für das Gebiet der Balearen.

Tab. 3. Artenliste insgesamt. (Für Fundorte vgl. Tab. 2.)

Art	**Autor**	**Fundort**	**Tiefe in m**	**Jahr**
Lepidopleurus cajetanus	(Poli, 1791)	1, 4	5 - 20 m	2004, 2005, 2006, 2007
Leptochiton cf. *algesirensis*	(Capellini, 1859)	1	20 m	2004
Ischnochiton rissoi	(Payraudeau, 1826)	1, 2, 3, 8	1,5 - 20 m	2004, 2005, 2006, 2007
Callochiton septemvalvis	(Montagu, 1803)	1, 2, 4	1,5 - 20 m	2004, 2007
Lepidochitona monterosatoi	Kaas & Van Belle, 1981	1, 4	20 m	2004, 2007
Lepidochitona corrugata	(Reeve, 1848)	1, 5, 6	0 - 20 m	2004, 2007
Lepidochitona canariensis	(Thiele, 1909)	4	Flachwasser	2004
Lepidochitona furtiva	(Monterosato, 1879)	1	20 m	2004

Chiton olivaceus	Spengler, 1797	1, 2, 4	1,5 - 20 m	2004, 2006, 2007
Chiton phaseolinus	Monterosato, 1879	4	Flachwasser	2007
Acanthochitona crinita	(Pennant, 1777)	1, 4, 5, 7	1 - 20 m	2004, 2007
Acanthochitona fascicularis	(Linné, 1767)	1, 2, 3, 4	1,5 - 20 m	2004, 2005, 2007

Tab. 4. Artenliste nach Lebendfunden. (Für Fundorte vgl. Tab. 2.)

Art	**Fundort**	**Tiefe**	**Substrat**	**Jahr**
Lepidopleurus cajetanus	1	2 m	Hartsubstrat	2006
Ischnochiton rissoi	1, 2, 8	2 m, 5 m, 20 m	Sandboden; Hartsubstrat	2005, 2006, 2007
Lepidochitona corrugata	1, 5, 6	Meso-, Supralitoral	Hartsubstrat; rock pool	2007
Lepidochitona canariensis	4	Flachwasser	Hartsubstrat	2004
Chiton olivaceus	1, 4	1 m	Hartsubstrat; unter Stein	2004, 2006
Acanthochitona crinita	4, 5, 7	1 m	Hartsubstrat	2004, 2007
Acanthochitona fascicularis	1	1 m	Hartsubstrat	2007

Die Schalenplatten aller Arten außer von *Lepidochitona canariensis* finden sich in den Sedimentproben wieder. Lebend war in den rock pools und im oberen Meso- und Supralitoral ausschließlich *Lepidochitona corrugata* zu finden, diese Art jedoch sehr abundant. Auf den Gesteinsproben dominierte *Acanthochitona crinita* (meist juvenil), weiterhin wurden hier *Chiton olivaceus* und *Lepidochitona canariensis* gefunden. Zufallsfunde, d. h. lebende Tiere, die beim Tauchen oder Schnorcheln auf dem Substrat oder unter Steinen gefunden wurden, waren *Ischnochiton rissoi*, *Acanthochitona fascicularis*, *Chiton olivaceus* und *Lepidopleurus cajetanus*.
Im Spülsaum waren Platten von *Acanthochitona fascicularis*, *Chiton olivaceus* und *Lepidopleurus cajetanus* vorhanden.
Im Sediment des hochgelegenem rock pools der Penyal de s'Aguila fanden sich allein acht Arten, darunter auch seltenere wie *Lepidochitona monterosatoi* und *Chiton phaseolinus*, obwohl von diesem Sediment nur wenig Material untersucht wurde.

Diskussion

Die Reichhaltigkeit der Sedimentproben an Schalenmaterial unterschiedlicher Arten erklärt sich durch Akkumulation und Sortierung durch Wellenbewegung. Dadurch werden auch lebend schwer zu entdeckende kleine Arten (viele werden nur 5-8 mm lang), Schalen juveniler Tiere sowie Arten mit versteckter Lebensweise hier gefunden. Bei den Zufallsfunden handelt es sich dagegen überwiegend um größere

Arten bzw. adulte Individuen (15-30 mm lang). Es kann angenommen werden, dass die beim Schnorcheln gefundenen Arten zu den häufigen gehören.
Auch am Spülsaum ist die Wahrscheinlichkeit, Schalen seltener Arten angespült zu finden, recht gering.
Offensichtlich ist, dass die an vielen Standorten gefundenen Arten wie *Ischnochiton rissoi* und die beiden *Acanthochitona*-Arten zu den häufigeren gehören.
Die Einzelfunde dagegen stammen vermutlich von im Gebiet seltenen Arten; die vier genannten bevorzugen nämlich durchaus die untersuchten flachen Küstenbereiche. Beachtenswert ist an dieser Stelle der Fund von selteneren Arten im Sediment eines rock-pools aus der Penyal de s'Aguila, da dieses nur durch sehr hohen Wellengang an diese über 10 m hoch gelegene Stelle gelangen kann. Es ist davon auszugehen, dass die hier gefundenen Arten lokal, also in dieser Bucht, häufig vorkommen.
Die Spritzwasserzone und das obere Mesolitoral werden von *Lepidochitona corrugata* dominiert und in hoher Abundanz besiedelt; dies entspricht den Angaben der Literatur (DELL'ANGELO & SMRIGLIO 2001). Diese Art kann, auch nach eigenen Beobachtungen, einige Zeit außerhalb des Wassers überleben und findet sich im gleichen Habitat wie *Melarhaphe neritoides* (Linnaeus, 1758) bzw. etwas darunter zusammen mit *Osilinus turbinatus* (Born, 1780) (DELL'ANGELO & SMRIGLIO 2001). Allerdings können auch andere Arten, z. B. *Lepidochitona cinerea* und *Lepidopleurus cajetanus*, kurzfristiges Trockenfallen ertragen und daher in diesem Habitat erwartet werden.

Die einzelnen Buchten können hinsichtlich der Diversität nicht verglichen werden, weil über die Jahre keine Probenahme gleichmäßig an allen Standorten erfolgte. Es wurden möglichst verschiedene Buchten untersucht, da eine Gleichverteilung der Individuen einer Art nicht immer gegeben ist, es gibt bei vielen Arten lokale Häufung des Vorkommens. Dass in der Cala Llenya elf der zwölf Arten gefunden wurden, kann sowohl in der häufigen Beprobung als auch in der Diversität der Habitate in dieser Bucht begründet sein.

Von den zu erwartenden 18 Arten (Tab. 1) sind folgende acht nicht gefunden worden: *Leptochiton asellus, Leptochiton cancellatus, Leptochiton geronensis, Leptochiton africanus, Ischnochiton vanbellei, Callochiton calcatus, Lepidochitona cinerea* und *Chiton corallinus*.

Das Fehlen von *Leptochiton asellus* könnte dadurch erklärt werden, dass die Art Tiefen von 30-100 m bevorzugt sowie Hartsubstrat auf Schlammböden. *Leptochiton geronensis* ist ebenfalls eine in der Tiefe von 100-250 m vorkommende Art, assoziiert mit Kalkrotalgen. Ähnliches gilt für *Ischnochiton vanbellei*. *Leptochiton africanus* ist typisch für Weichböden in 25-150 m Tiefe mit einem hohen Anteil an organischer Substanz. Ähnliches gilt für *Callochiton calcatus*, die jedoch auch felsigen Boden bewohnt (DELL'ANGELO & SMRIGLIO 2001). Da diese genannten Habitate nicht beprobt wurden, ist das Fehlen der zugehörigen Arten nicht verwunderlich.

Chiton corallinus bevorzugt Tiefen von 15-100 m auf Coralligène, hätte also durchaus gefunden werden können. Für die ebenfalls zu erwartenden Arten *Leptochiton cancellatus* und *Lepidochitona cinerea* gilt, dass ihr Fehlen in einer geringen Häufigkeit begründet sein könnte oder durch die lediglich stichprobenartigen Untersuchungen bedingt ist.

Für das Gebiet neu sind zwei Arten:
Lepidochitona furtiva kommt im gesamten Westteil des Mittelmeers vor mit Ausnahme der spanischen Küste (REPETTO *ET AL.* 2005). Es ist möglich dass sie dennoch dort vorkommt, jedoch weniger häufig ist und nur zufällig noch nicht nachgewiesen wurde. Sie bevorzugt *Posidonia*-Wiesen in 1-40 m Tiefe, findet somit auch hier ein günstiges Habitat. Ihre Identifikation ist eindeutig durch die glatte Struktur des Tegmentums.
Bei *Lepidochitona canariensis*, die auf den Kanaren und Madeira verbreitet ist, gab es bisher nur einen Nachweis im Mittelmeer, in Marokko (DELL'ANGELO ET AL. 1999). Ihre Identifikation ist ebenfalls eindeutig. Sie ähnelt *Lepidochitona cinerea*, hat jedoch anders geformte Granula auf der Oberseite und einen deutlich stärker ausgeprägten Apex.

Danksagung

Im Zusammenhang mit der Materialaquise danke ich zahlreichen Kollegen, die mich während der Ibiza-Exkursionen direkt oder indirekt mit Polyplacophoren versorgt haben. In diesem Zusammenhang seien folgende Personen genannt: Andrej Fuchs, Christoph Wittek, Dipl. Biol. Stefan Fischer, Dr. Florian Peine, Dr. Carsten H. G. Müller (alle Universität Rostock) und Dr. Kristina Kusche (Universität Münster). Frau Dipl. Biol. Hanna Damm half bei der Aufarbeitung der Schillsedimente und bei der Aussortierung des für die vorliegende Untersuchung relevanten Materials.

Literatur

DELL' ANGELO B. & SMRIGLIO C. 2001: Living chitons from the Mediterranean Sea. Edizioni Evolver S.r.l., Roma.

REPETTO G., ORLANDO F. & ARDUINO G. 2005: Conchiglie del Mediterraneo. Amici del Museo "Federico Eusebio", Alba, 392 p.

COSTELLO M.J., EMBLOW C.S. & WHITE R. (eds) 2001: European Register of Marine Species. A check-list of the marine species in Europe and a bibliography of guides to their identification. Publications Scientifiques du M.N.H.N., Paris.

Author's address:

Lisa Schüler
c/o Universität Rostock
Allgemeine & Spezielle Zoologie
Institut für Biowissenschaften
Universitätsplatz 2
18055 Rostock
Germany

Insights into the Crustacea Decapoda of the Adriatic Sea. Observations from four sampling locations along the Croatian coast

By Carsten H. G. Müller & Christoph D. Schubart

MÜLLER C. H. G. & SCHUBART Ch. D. (2007): Insights into the Crustacea Decapoda of the Adriatic Sea. Observations from four sampling locations along the Croatian coast. Rostocker Meeresbiologische Beiträge 18: 112-130

Abstract. An annotated species list is provided on the basis of seven sampling surveys of decapod crustaceans carried out on various supra-, medio- and infralittoral substrates (sandy bottoms, rocky shores, seagrass beds of *Posidonia oceanica*) at four locations on the Adriatic Sea: Rovinj (in 1968), Slanik Bay (in 2001) and Pula (in 2004, 2005) on the Istrian Peninsula and the island of Šipan (in 2001, 2003, 2005) in the direct vicinity of Dubrovnik. All in all, 72 taxa were collected using shore sampling and snorkeling and scuba-diving techniques. The list of species collected is a good reflection of the spectrum of infralittoral Decapoda expected to be common along northern and southern Adriatic coastlines in the months of July and August. With a total number of 28 taxa (= 39%), the Brachyura represented the dominant group, followed by the Anomala with 20 species (= 28%) and the Caridea with (17 species = 24%). The majority of decapod crustaceans were captured on rocky substrates (51 taxa = 71%). Our present results provide an overview of typical infralittoral inhabitants within the studied areas. No Adriatic endemics and only one originally East Asian neozoan could be detected. No Lessepsian or Atlanto-tropical immigrants were encountered. Most decapod species collected have a wide distributionary range, including the whole Mediterranean Sea, or are constitutents of the Atlantic-boreal fauna in general. Besides confirming the occurrence of species reported by previous authors, we present new insights into the morphology, ecology, distribution and behaviour of some species. These are discussed in comparison to conspecific populations from other parts of the Mediterranean Sea.

Kurzfassung. Eine kommentierte Artenliste von dekapoden Crustacea wird vorgelegt, entstanden durch Besammlung verschiedener Substrate des Supra-, Meso- and Infralittorals (Sand, Fels, *Posidonia*-Wiesen) an vier Plätzen des Adriatischen Meeres: Rovinj (1968), Slanik Bay (2001) und Pula auf Istrien (2004, 2005) und der Insel Šipan bei Dubrovnik (2001, 2003, 2005). Insgesamt wurden 72 Taxa nachgewiesen. Die Artenliste gibt das zu erwartende Spektrum der infralittoralen Decapoda wieder. Mit insgesamt 28 Taxa (= 39%), sind die Brachyura die dominierende Gruppe, gefolgt von den Anomala mit 20 Arten (= 28%) and den Caridea mit 17 Arten (= 24%). Die meisten Dekapoden wurden auf Felssubstrat gefunden (51 Taxa = 71%). Die Aufsammlung bietet einen Überblick über die typischen infralitoralen Bewohner im Untersuchungsgebiet. Keine adriatischen Endemiten und nur ein ursprünglich ostasiatisches Neozoon wurden nachgewiesen. Damit werden frühere Befunde bestätigt. Neue Mitteilungen betreffen Morphologie, Ökologie, Verbreitung und Verhalten für einige der vorgestellten Arten. Sie werden im Vergleich mit mediterranem Material von anderen Fundorten diskutiert.

Key words: Crustacea, Decapoda, shallow water habitats, Adriatic Sea, zoogeography, ecology, biocoenoses

Introduction

The Adriatic Sea is limited to the north by the lagoonary channel system around Venice and Trieste, while in the south it ends at the Strait of Otranto where the Adriatic Sea is connected to the Ionian Sea. Because of the high density of research facilities along its coastline, such as the classical marine biological institutes and museums in Venice, Rovinj and Dubrovnik, the Adriatic Sea is one of the best investigated biogeographic regions in the Mediterranean Sea. Many carcinologists have contributed to a long tradition of research, most of them especially interested in the Decapoda. The first documented insights into Adriatic decapod fauna were presented at the beginning of the 16th century by GIOVIO (syn.: JOVIUS), whose first documented observations were made in 1524. ŠTEVČIĆ (1993) defined three distinct periods of significant carcinological research activity in the Adriatic Sea: the "post-Linnean-period" (1763-1846), the "Sinonimia-moderna-period" (1847-1968), and the "current-period" (1969-present). 124 species of the approximately 240 decapod species so far reported to inhabit the Adriatic Sea (see listings by PESTA 1918, RIEDL 1968, MANNING & ŠTEVČIĆ 1985, ŠTEVČIĆ 1990, 1991, 1995, 1998, 2002; D'UDECEM D'ACOZ 1999) were recorded in the "Sinonimia-moderna-period". In the so-called "current period", 51 species have been newly recorded for the Adriatic decapod community (ŠTEVČIĆ 1991, 1995, 1998, 2002, KIRINČIĆ 2003, 2006, SCHUBART 2003). Eleven species were newly recorded in the 1990s alone which is equivalent to an average rate of one to two species descriptions every year (ŠTEVČIĆ 2002). Several species are known to be endemic to the Adriatic Sea, which may underscore the independent faunistic role of this "Randmeer" in relation to western (Atlantic-Lusitanic) or eastern (Levante Basin, Red Sea) faunal elements and its importance for biogeography (cf. TÜRKAY 1989).

The enormous progress in knowledge can surely be traced back to the no less than 70 contributions published in the relatively short period of almost 40 years (see ŠTEVČIĆ 1993, 2002). One possible explanation for the considerable increase of scientific activity during the "current period" may be a continuously growing interest in zoocoenotic questions. Obviously, a further reason lies in the necessity of documenting changes in the composition of Adriatic decapod fauna. Faunal and floral communities, more precisely in our case the infralittoral macrozoobenthos, must not be seen as static units. They are exposed to dynamic changes either caused by long-term climate shifts or produced by anthropogenic impacts. The marine macrozoobenthos, for instance, is influenced by the immigration or human-mediated import of allochthonous species from other biogeographical regions. Both processes are playing an increasingly important role in ecological research projects in the Mediterranean Sea. Many neobiota, among them many Decapoda, gained entry to Mediterranean littoral habitats in previous decades and established stable populations, partly by tending to invade neighbouring regions. A current and spectacular example is the Mediterranean spreading of the atlantico-tropical flat crab *Percnon gibbesi* (H. Milne Edwards, 1853), a highly mobile member of the Plagusiidae, which was recorded almost simultaneously on various islands in the western Mediterranean in the new millenium (e.g., Pelagie Islands (Isola di Pantelleria, Linosa): RELINI ET AL. 2000, PUCCIO ET AL. 2003, 2006, Balearic Islands: GARCIA & REVIRIEGO 2000, MÜLLER 2001, Sicily: PIPITONE ET AL. 2001, Greece: THESSALOU-LEGAKI ET AL. 2006, Turkey: YOKES & GALIL 2006). In total, six neozoic decapod species - the swimming crabs *Callinectes danae* Smith, 1869, *Callinectes*

sapidus Rathbun, 1896 and *Dyspanopeus sayi* (Smith, 1869), the brackish water-inhabiting panopeid crab *Rhithropanopeus harrisii* (Gould, 1841), the sea spider *Maja goltziana* d'Oliveira, 1888 and the penaeid shrimp *Penaeus japonicus* Bate, 1888 have been newly observed in the Adriatic Sea (D'UDECEM D'ACOZ 1999, ŠTEVČIĆ 2002). The first four of the species listed are known to stem from the northwest Atlantic, whereas *M. goltziana* comes from the tropical East Altlantic (see note of PALLAORO & DULČIĆ 2004). *P. japonicus* is originally an Indopacific species and should most probably be considered an escapee from local Adriatic aquacultures (see discussion in ŠTEVČIĆ 2002).
It should be taken into account that the frequency and intensity of investigations into macrozoobenthic organisms has become much higher in the northern part of the Adriatic Sea, but that changes are most likely to occur first in the southern Adriatic Sea. We therefore believe that it will be useful to partially fill this gap by providing new observations concerning the community of Crustacea Decapoda populating various infralittoral substrates in the coastal waters around the island of Szipan, which have hitherto remained uninvestigated despited being located in the close vicinity of Dubrovnik in southern Croatia. We compared our collection of decapod crustaceans from Šipan/Jakljan with those collections that were carried out in three localities around Istria (northern Croatia). Going on the suggestions of ŠTEVČIĆ (2002), we particularly focused on hitherto neglected microhabitats such as seagrass beds of *Posidonia oceanica*, *Cymodocea nodosa* or *Zostera* spec. and primary hard bottoms of the upper infralittoral and mediolittoral zones respectively.

Materials and methods

During seven field trips to northern and southern sites of the Croatian coast in the years 1968, 2001, 2003, 2004, and 2005, various decapod crustaceans were collected through snorkelling and diving on sandy, muddy and rocky supra-, medio- and infralittoral bottoms down to 40 metres depth, according to the ecological zoning given by PÉRÈS (1967) and MARINOPOULOS (1988). The infralittoral zones investigated included habitats such as fields of rocky boulders (with or without macroalgae coverage), steep walls, seagrass beds, sac-shaped caves and grottoes. Samples were taken both during the day and at night, either by hand or by using hand nets. Sediments were sieved underwater with hand nets of a mesh size of approximately 1 mm. Those decapods associated with macroalgae such the canopy algae of the genus *Cystoseira* or encrusting algae of the genera *Jania* and *Peyssonnelia* were obtained by cutting various algae from their rocky substrate, transferring them into small plastic tanks and carefully searching the thallous network for decapods attached to it.
Sampling in the north of the Adriatic Sea was concentrated on the Istrian Peninsula. In the framework of a field excursion of the University of Mainz to Rovinj in 1968 (organised by Prof. H. RISLER) decapod crustaceans were collected in shallow waters within the Limski-Channel (north of Rovinj) and around Dvije Sectrice, a group of small islands south of Rovinj, or dredged near Banjole on silty or muddy sediments around 35 metres depth. More recently, further sampling was carried out in Uvala Slanik, a small bay between Umag and Novigrad (13°32'26"E-45°22'54"N) in late Augst 2001 and along the coast of Pula, situated at the southwestern tip of the Istrian Peninsula (see Fig. 1) between 27th of August and 2nd of September 2004 and between 29th of August and 3rd of September 2005. In the latter, case, samples were taken along the coast of the Bay of Valsaline as well as along the western coastal

line of the peninsula northwards from the campsite of Valovine. The coast is lined by belts of rocky boulders or steep, massive walls that can extend down to ten metres depth and display deep cavities (sac cave type). In the bay of Valsaline, sandy areas are present below two metres depth. These roughly sorted sandy sediments are often interrupted by fields of rocky boulders partly overgrown by various degradation stages of *Cystoseira amentacea* var. *spicata* Ercegovic, 1952. In addition, we collected decapods at Marina Veruda, an elongated shallow bay quite isolated from the open sea and characterized by dense meadows of *Zostera* spec., which grow on a muddy sediment. *Posidonia* beds were not present in any of the investigated areas.

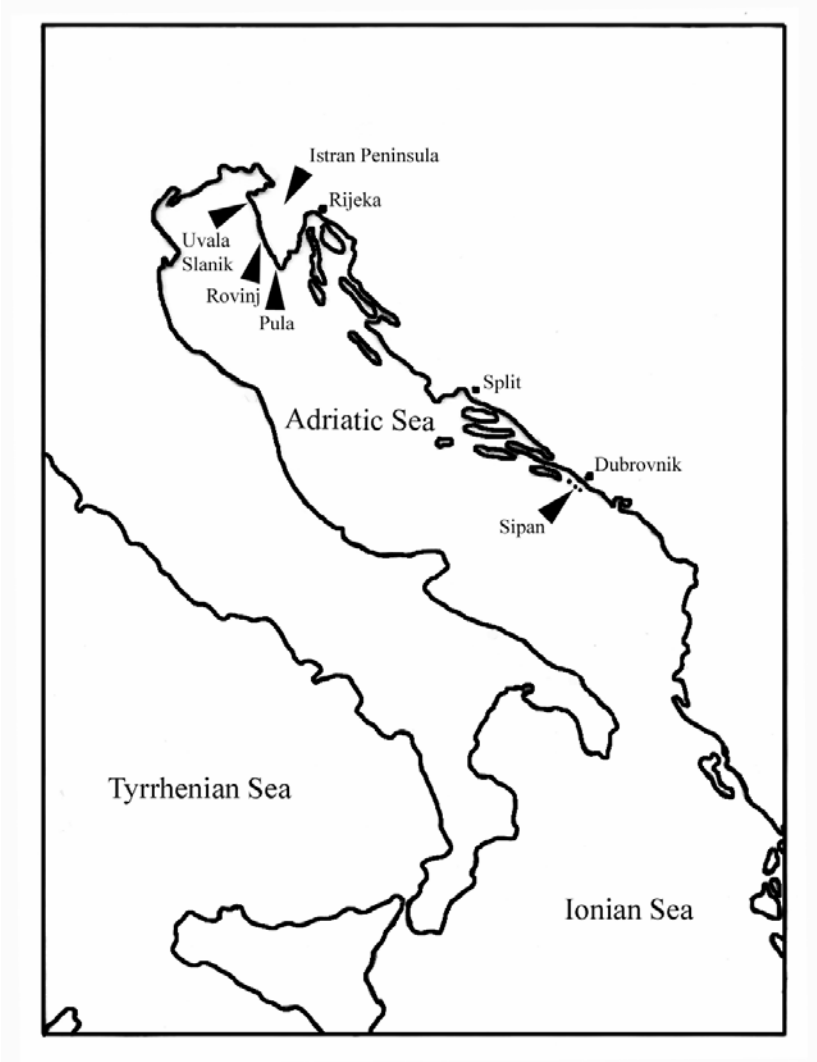


Figure 1. Map of the Adriatic Sea and surrounding Mediterranean waters showing the sampling areas at Rovinj, Uvala Slanik, Pula (all situated on the Istrian Peninsula) and the island of Šipan (Dalmatian coast). The sampling locations are marked by black arrows.

With the aim of comparing decapod communities from the northern Adriatic Sea to those from the southern Dalmatian Coast we set out on two further excursions to the islands of Šipan and Jakljan, which belong to the so-called Elaphite Islands (Fig. 1). Šipan and Jakljan are only a few hundred metres away from the Croatian mainland and several kilometres northwest of Dubrovnik. The infralittoral regions around Šipan and Jakljan display a similar diversity of habitats. During three field trips (1st-14th of

October 2001, 10th-22nd of Mai 2003, 17th-29th of September 2005) four different sampling locations were investigated, either regularly or only once: (i) the inner coastline of the Bay of Sipanska Luka (northern coast of Šipan), (ii) the outer coastline of the Bay of Sipanska Luka (northwestern tip of Šipan), (iii) the northwestern tip of Jakljan (neighbouring island to Šipan in the north), and (iv) the Bay of Sudurac (southern tip of Šipan). The first three habitats were inspected every third day only in 2001, whereas in the Bay of Sudurac decapods were caught every day during all three excursions (2001, 2003, 2005). Infralittoral habitats studied around the coasts of Šipan and Jakljan comprised rocky substrates of different vertical extensions and various degrees of exposure to sunlight and wave action (moderately sloped and steep walls, boulder fields, rough gravel sediments, artificial objects such as quay walls), submarine caves, deep crevices, secondary hard bottoms (e. g. submarine household equipment disposal sites), phytal grounds (boulders overgrown by macroalgae such as *Cystoseira* spec.), sandy or muddy sediments (muddy sediments especially observed in the highly eutrophic Bay of Sipanska Luka below eight metres depth, where anoxity was detected under a thin floccuent layer), scattered *Posidonia* and/or *Cymodocea* meadows (with leaves strongly affected by epibiontic coats, leaves not longer than 30 cm), and widely expanded detritus grounds below 25 metres depth assigned to coralligène fields of the "Nulliporen-facies" type (*sensu* HEß 2002).

In determining the decapod crustaceans collected we used the traditional monographs of PESTA (1918), ZARIQUIEY ALVAREZ (1968), INGLE (1980, 1993) and RIEDL (1968, 1983). Those taxa known to be difficult with respect to taxonomy were identified with the aid of specialised keys (e.g. *Hippolyte*: D'UDECEM D'ACOZ 1996, *Pilumnus*: KOUKOURAS & TÜRKAY 1996, *Periclimenes*: GRIPPA & D'UDECEM D'ACOZ 1996, *Anapagurus*: GARCÍA-GÓMEZ 1994). All collected specimens were fixed and conserved in 70% alcohol, and deposited in the Zoological Collection of the Institute for Biosciences of the University of Rostock or at the Senckenberg Museum Frankfurt (SMF).

Results

The present carcinological study of the infralittoral decapod fauna in the coastal waters of Rovinj, Pula and Šipan yielded the presence of 72 taxa (including 71 determined and one unidentifiable species) comprising penaeid and caridean shrimps, brachyuran crabs, hermit crabs, porcellain crabs, squat lobsters, slipper lobsters and true lobsters. The majority of these 72 taxa (71% = 51 taxa) were collected on various rocky grounds of the supra-, meso- and sublittoral, with at least 13% (nine species) preferring the epiphytic layer on compact rocky shores with steep inclinations or boulder fields. These species are referred to herein as phytal inhabitants. Usually, decapods were observed hidden under rock boulders or crammed into rocky crevices. According to our observations, there are only few troglophilic species in the infralittoral zones along/around Rovinj, Pula and Šipan (e.g. *Palaemon serratus* (Pennant, 1777)). Only four species (approx. 6% of the total number of species) were caught in seagrass beds such as those of the Neptune seagrass *Posidonia oceanica* (Linnaeus) Delile (e.g. *Dardanus calidus* (Risso, 1827)) or *Zostera* spec. (e.g. *Carcinus aestuarii* Nardo, 1847). Almost 19% (= 14 species) were found buried in or lying/moving on sandy habitats (including the sand-filled erosion crater within beds of *P. oceanica*), and of these two species were found on

silty sand or muddy grounds at depth levels of one metre (*Upogebia pusilla* (Petagna, 1792, *Callianassa tyrrhena* (Petagna, 1792)) or below 20 metres (*Pagurus exacavatus* (Herbst, 1791)). Six decapod species (= 8%) were found in temporary or permanent association with other invertebrates such as sponges (e.g. *Paguristes eremita* (Linnaeus, 1767) with *Suberites domuncula* (Olivi, 1792), cnidarians (e.g. true symbiosis between *Dardanus calidus* and *Calliactis parasitica* (Couch, 1842)) and bivalves (*Pinnotheres pisum* (Linnaeus, 1767) living in the mantle cave of *Pinna nobilis* Linnaeus, 1758). The species collected either had a permanently cryptic lifestyle (e. g. representatives of the brachyuran genus *Xantho*, *Calappa granulata* (Linnaeus, 1758)), or were observed engaging in diurnal activities in the field. However, some strictly nocturnal decapod species were also recorded (e. g. *D. calidus*, *Galathea strigosa* (Linnaeus, 1761), *Herbstia condyliata* (J. C. Fabricius, 1787), *Lysmata seticaudata* (Risso, 1816). A detailed list of all taxa collected and determined with remarks on their ecology and frequency is given in Table 1.
Brachyuran crabs were the group with the highest number of 28 taxa (= 39%), followed by the Anomala with 20 species (= 28%), among which pagurid and diogenid hermit crabs (13 species) represent the dominant group. Pleocyemate shrimps, the Caridea, were another highly diverse group (17 species = 24%). Other taxa, such as the Dendrobranchiata, Palinuridea, Nephropidea, and Thalassinidea were only recorded once or twice.
Our material does not contain Lessepsian migrants or invaders from the tropical Atlantic Sea. However, it includes the first record of the varunid species *Hemigrapsus sanguineus* (de Haan, 1835) in the Mediterranean Sea (see SCHUBART 2003). This originally East Asian species had already been recorded as an invasive species along the North American and European Atlantic coastlines (summarized in SCHUBART 2003). Otherwise, the decapods collected normally occur widely in the entire Mediterranean Sea (e.g. *Pachygrapsus marmoratus* (J. C. Fabricius, 1787)) or belong to Altlantic-boreal faunal elements which are particularly abundant in the western Mediterranean Sea (e.g. *Homarus gammarus* (Linnaeus, 1758)). Specific Adriatic endemics were not recorded.

Discussion

The 72 taxa of Crustacea Decapoda collected represents 30% of the total number of 241 taxa so far recorded for the entire Adriatic Sea (ŠTEVČIĆ 1990, 1996, 2002; D'UDECEM D'ACOZ 1999). At first sight, these 72 taxa may be dismissed as a rather disappointing outcome. For instance, only 34 decapod species were found in the waters around Rovinj, whereas ŠTEVČIĆ (1971, 1985, 1991, 1995) counted almost 120 species in the same area. However, our main focus lay on those decapods inhabiting infralittoral substrates not deeper than 40 metres. Therefore, deeper substrates such as the circalittoral soft bottoms in the open northern Adriatic Sea, for instance, remained unexamined. Except at the Isle of Banjole near Rovinj in 1968, we did not have the opportunity to use heavy dredges to gather data from those decapod groups known to exclusively populate deeper sandy and muddy sediments: Processidae, Upogebiidae, Callianassidae, Thiidae, Goneplacidae and some Paguridae of the genus *Anapagurus*. We also only covered a short period of the year, even within the summer season. A more comprehensive overview of the decapod fauna would surely have required a wider sampling schedule. With these methodical limitations in mind, the present study may be considered a contribution to our knowledge of the structure of more common decapod crustacean communities

living on infralittoral hard bottoms, sandy grounds and seagrass beds along the Croatian coast in late summer. It may moreover function as a useful checklist for students or colleagues exploring similar habitats and using comparable sampling methods.

In general, the lifestyle of many infralittoral decapods found along the coasts of Rovinj, Pula and Šipan coincides with that which has been reported from similar habitats on other Mediterranean coasts. Good examples in this category are common, euryoecious species such as the hermit *Clibanarius erythropus* (Latreille, 1818), the grapsid crab *Pachygrapsus marmoratus* (J. C. Fabricius, 1787) and the rockpool and shallow water shrimp *Palaemon elegans* Rathke, 1837). In contrast, we also found decapod crustaceans which differed considerably from other Mediterranean populations with regard to their frequency, habitat selection and behaviour. For example, our survey revealed a reduced diversity of the squat lobster genus *Galathea* at all sampling locations. This genus is, however, known as species-rich and abundant on various infralittoral substrates in the Mediterranean Sea (see D'UDECEM D'ACOZ 1999) and even in the Adriatic Sea (Števčić 1990).
Further surprising observations made in the areas studied concern both the species and the zoocoenotic level. Some interesting examples of these unexpected findings are discussed in the following chapters. Our comments on taxonomy and ecology are naturally not final: many conclusions need to be proven by further studies at the same sampling site or by comparison with other Adriatic regions displaying similar substrate conditions.

Unusual habitat selection of *Pagurus prideauxi* Leach, 1815. ŠTEVČIĆ (1990) has already reported that Adriatic individuals of *Paguristes prideauxi* occur from 10 to 100 metres in depth. In comparison with our own observations on the vertical distribution of *P. prideauxi* in the western Mediterranean, e.g. in the coastal waters of Ibiza (observations on detritus grounds below 40 metres in depth), it appears that the upper limit of the vertical distribution is shifted towards much shallower bottoms in the Adriatic Sea. The finding of an adult individual of *P. prideauxi* under a boulder at one metre in depth in the coastal waters of Šipan even exceeds the bathymetric range given by ŠTEVČIĆ (1990) considerably. Also, in the coastal waters of Pula numerous individuals of *P. prideauxi* were observed above the upper depth limit proposed by ŠTEVČIĆ (1990), appearing at 7-8 metres depth. Our record of *P. prideauxi* in the very shallow waters of Šipan may be explained by an extensive migration of the macrozoobenthos (inhabiting *Posidonia* beds, sandy or hard bottom substrates) from the predominantly anoxic sediments below ten metres depth to upper infralittoral zones. The anoxia of the sediment may be caused by the particular tube-like topography of the Bay of Sipanska Luka which seems to reduce dynamics of incoming water currents and therefore prevent the necessary water exchange between overlying water columns. When pollution is also taken into account (household remains thrown into the Bay, sewage water from kitchens and toilets), it is not surprising that species from both high and deeper infralitoral facies were often observed together in high densities in the shallowest waters of Šipan. Thus it appears that these decapod zoocoenoses and the putative species richness in the uppermost infralittoral are an artificial result of strong hydrodynamic and anthropogenic influences.

The genus *Paguristes* Dana, 1851: habitat segragation useable for separation of species? Two representatives of the genus *Paguristes* were found in the areas

studied, *Paguristes streaensis* Pastore, 1984 and *Paguristes eremita* (Linnaeus, 1767). While *P. eremita* is known to have established stable populations on various infralittoral substrates (but mostly sandy sediments) from 2 to 50 metres depth and to be common in the Adriatic Sea (ŠTEVČIĆ 1990) (see also chapter below), current knowledge about the presence of *P. streaensis* along the Adriatic coasts is still sketchy. Pastore (1984) described the species for the Ionian Sea; the only record from the Adriatic was provided by ABED-NAVANDI & DWORSCHAK (1998).
Individuals of *P. streaensis* observed in the shallowest waters of Sipanska Luka (a tube-like bay, 1-3 metres depth) clearly showed morphological and colouration features typical for the given species, including the apically rounded rostrum, the antennal acicle inner proximal margin with two acute processes confined to the basal part, and the specific coloration of the cephalothorax and its appendages (see INGLE 1993). However, our individuals of *P. streaensis* displayed a differing corneal and eye stalk coloration from the holotype (bright yellow instead of greenish blue) and a greater variability in terms of the arrangement of setae covering the 1^{st}-3^{rd} peraeopods. One explanation for phenotypical incongruencies among specimens of *P. streaensis* belonging to the population of Šipan and those specimens from La Strea (Ionian Sea) might be the existence of a hitherto undescribed species of *Paguristes* with a distribution limited to the eastern Adriatic Sea, with eyes of a whitish-yellow colour and eye peduncles which are yellow in appearance. According to previous authors, the description of new species within the genus may be necessary (INGLE 1993, PASTORE in D'UDECEM D'ACOZ 1999).
To date, the three Mediterranean species of the genus *Paguristes* (*P. eremita*, *P. streaensis*, *P. syrtensis*) are still separated on the basis of colour features, according to the description of PASTORE (1984). There are only few morphological characters to distinguish the three species from each other. The lack of solid characters have led to some authors questioning the status of *P. streaensis* as a valid species (e. g. D'UDECEM D'ACOZ 1999). We propose that in addition to morphology and phenotypes, the choice of different habitats in the uppermost and deeper infralittoral (*P. streaensis*: sandy sediments at 1-3 metres depth moderately exposed to wave action, *P. eremita*: fine sandy, muddy sediments or secondary hard bottoms (coralligène) below 30 metres depth) may provide additional support to separate the two Adriatic species. *P. eremita* and *P. streaensis* were never found together in the same habitat. If there is a significant ecological separation between the species, one could postulate that a sympatric speciation has taken place in the genus *Paguristes*.

Species previously thought to be rare:

***Gnathophyllum elegans* (Leach, 1815).** The spotted shrimp *Gnathophyllum elegans* was observed in relative high abundances inhabiting boulder fields at various depth levels around the island of Šipan. Even though it showed up at both nothern and southern sampling locations in the Adriatic Sea, *G. elegans* was considered a very rare species overall in Adriatic waters, living on detritic bottoms below 30 metres depth (HOLTHUIS 1949, ŠTEVČIĆ 1990, D'UDECEM D'ACOZ 1999). We found this species to be common in the Adriatic Sea (Tab. 1). The seemingly false impression of the real population density of *G. elegans* may be put down to local patchiness, the extraordinarily cryptic behaviour of the species, or the generally lower density of carcinological observations in the southern Adriatic sea (ŠTEVČIĆ 2002).

***Calcinus tubularis* (Linnaeus, 1767).** To date, there have been only a few records of the colourful hermit crab *Calcinus tubularis* in southern Adriatic waters (VASO 1993, ŠTEVČIĆ 1995). Furthermore, *C. tubularis* was considered a "very rare" species (ŠTEVČIĆ 1995). However, we detected *C. tubularis* in remarkable abundances in the upper infralittoral zone (Tab. 1) around Šipan and would therefore agree more with the latest statement of ŠTEVČIĆ (2002) who estimated *C. tubularis* to be "relatively common" in southern Adriatic areas.
The ecology of *C. tubularis* is perhaps even more interesting than its apparent spreading northwards along the Dalmatian coast in past decades. In Šipan, we regularly found either solitary juvenile individuals of *C. tubularis* or larger group clusters under rocks below depths of approximately three metres. The clustering behaviour of *C. tubularis* is well studied and has been recorded in populations living in the Tyrrhenian, Aegean and Levantian Sea (KINZELBACH 1990, GHERARDI 1990). In Šipan, we observed an unusual ecological separation between syntopic populations of *C. tubularis* and *Clibanarius erythropus* (Latreille, 1818), another subsocial, grazing hermit crab that prefers similar habitat structures and an almost identical variety of snail shell types (e. g. *Bittium* sp., *Cerithium* sp., *Osilinus* sp., *Stramonita* sp.). The occurrence of *C. tubularis* in the shallowest boulder fields corresponds to KINZELBACH (1990) on the ecological model which predicts that *C. tubularis* is expelled from the uppermost infralittoral (waterline/eulittoral down to three metres depth) to deeper-lying rocky grounds (below three metres depth) by its space and shell competitor *C. erythropus* in the colder western Mediterranean Sea, whereas in the warmer regions of the eastern Mediterranean Sea this process should be reversed. The distribution pattern across the rocky shores of Šipan is then characteristic for colder temperated waters, although a few hundred kilometres further south, within the Ionian Sea, the situation is different. This would once again underline the isolated role of the Adriatic Sea. Interestingly, we found no evidence of sessile individuals in studied habitats around Šipan as described by many authors (FENIZIA 1933, KINZELBACH 1990, GÖTHEL 1992). We believe that, again contradicting the ecological and ethological experiences gathered with regard to the same species in other parts of the Mediterranean Sea, the absence of sessile *C. tubularis* speaks for a locally faciliated shell supply in the rocky shores of Šipan, thus preventing the hermit crab community from suffering from the main population-limiting factor, the normally limited shell resources.

The problem of intermediates in the genus *Pilumnus* Leach, 1815. Besides the three easily determinable species *Pilumnus spinifer* H. Milne Edwards, 1843, *Pilumnus hirtellus* (Linnaeus, 1761) and *Pilumnus villosissimus* (Rafinesque, 1814), we found living individuals and exuviae which could not firmly be assigned to any of these species of *Pilumnus,* but which clearly belong to the genus. These individuals show intermediate morphological characteristics. The possession of one acute spine on the distal margin of the carpus of the pereiopods suggests they should be assigned to *P. villosissimus*, whereas the structure and density of hair coverage on carapace surface more resembles that observed in *P. spinifer*. While individuals of *P. spinifer* seem to prefer deeper secondary hard bottoms, *P. villosissimus* and the intermediates described above were observed under large boulders from grounds lying between depths of five and ten metres. Similar intermediates of *Pilumnus* were collected in the shallow waters of the Balearic Island Ibiza. In other, non-Adriatic regions of the Mediterranean Sea, including the coastal waters of the Northern Sporades (see TÜRKAY ET AL. 1987), such intermediates of *Pilumnus* species were

not reported, even though all species known for the Mediterranean Sea were documented in those areas investigated. However, based on the present findings, it seems necessary to revise the genus *Pilumnus* at least with respect to the Mediterranean species of the genus as postulated by D'UDECEM D'ACOZ (1999) some years ago and currently being tested using morphometric and genetic methods (SCHUBART ET AL., in prep).

The *Cystoseira amentacea*-paguroid-*Gobius* assemblage: a new facies? In the Bay of Valsaline (Pula), we observed a bizarre hard bottom community comprising an extended field of polymorphic, often contigious boulders (closely attached by sponges of the genus *Ircinia* as well as of the species *Aplysina aerophoba* (Schmidt, 1862), dispersed funnels filled with unsorted sandy sediments of high organic content, the brown algae species *Cystoseira amentacea* var*. spicata* (Ercegovic) Giaccone, appearing in a highly degenerated condition with its thallous strand heavily overgrown by (syn-)ascidians (e. g., *Phallusia mammilata* (Cuvier, 1815) and demospongial sponges (e. g., *Ircinia* sp.), the gobiid *Gobius cruentatus* (Gmelin, 1789) and masses of hermit crabs, mainly the striped hermit *Pagurus anachoretus* Risso, 1827, *Paguristes eremita*, *Anapagurus breviaculeatus* Fenizia, 1937 but occasionally also *Pagurus prideauxi* (see also chapter above). This phytal community is found below seven metres and may extend to a depth of ten metres. Even if not studied in every detail (e. g., smaller macrofauna, entire meiofauna, seasonal aspects), the species community described herein appears to be unique and has no obvious equivalent in those infralittoral benthic communities found in any other areas studied (including non-Adriatic coasts of the Mediterranean Sea), on the basis of the thorough review of HEß (2002). Furthermore, none of the species listed occurred in such high numbers in other areas investigated during the present study. The abundance of *P. anachoretus* especially was much higher than in any other habitat ever searched before by the authors. Also the presumed preference of *P. anachoretus* for large rocks with steep, shadowed margins seems to be absent when it is part of the "*Cystoseira amentacea*-paguroid-*Gobius* assemblage". We recommend further investigations into the peculiar structure of this community to verify its potential function as an independent zoocoenosis.

Acknowledgements

We would like to thank Prof. Dr. Ragnar Kinzelbach (Universität Rostock) who provided us with a hitherto unpublished decapod species list obtained from carcinological collections at Rovinj in August 1968. Further thanks go to Carsten Dietz (Universität Rostock) as well as students of the Universität Regensburg who helped us to collect various decapod crustaceans during our field trips to Šipan and Pula.

References

GARCIA LL. & REVIRIEGO B. 2000: Presencia del cranc subtropical *Percnon gibbesi* (H. Milne Edwards, 1853) (Crustacea, Decapoda, Grapsidae) a les Illes Balears. Primera cita a la Mediterrania occidental. Bol. Soc. Hist. Nat. Balears 43: 81-89.

GHERARDI F. 1990: Competition and coexistence in two Mediterranean hermit crabs, *Calcinus ornatus* (Roux) and *Clibanarius erythropus* (Latreille) (Decapoda, Anomura). J. Exp. Mar. Biol. Ecol. 143: 221-238.

GIOVIO (JOVIUS) P. 1524. De Romanis piscibus libellus. Unknown publisher, Rome.

GRIPPA G.B & D'UDECEM D'ACOZ C. 1996: The genus *Periclimenes* Costa, 1844 in the Mediterranean Sea and the Northeastern Atlantic Ocean: review of the species and description of *Periclimenes sagittifer aegylios* subsp. nov. (Crustacea, Decapoda, Decapoda, Pontoniinae). Atti Soc. It. Sci. Nat. Museo Civ. Stor. Nat. Milano 135: 401-412.

HEß M. 2002: 6. Lebensräume und Lebensgemeinschaften – Die Sedimentböden. In: Hofrichter R (ed.). Das Mittelmeer – Fauna, Flora, Ökologie – I. Allgemeiner Teil: 384-403, Spektrum Akademischer Verlag, Heidelberg Berlin, 607 p.

INGLE R.W. 1980: British crabs. Publications of the British Museum of Natural History, Oxford University Press, London, 222 p.

INGLE R.W. 1993: Hermit crabs of the Northeastern Atlantic Ocean and Mediterranean Sea. Chapman & Hill, London, 495 p.

KIRINČIĆ M. 2003: *Brachycarpus biunguiculatus* (Lucas, 1846): a new species of shrimp for the Adriatic Sea (Decapoda, Caridea). Crustaceana 76: 891-894.

KIRINČIĆ M. 2006: First record of *Hippolyte prideauxiana* Leach, 1817 (Crustacea, Decapoda, Caridea) in the Adriatic Sea. Acta Adriat. 47: 85-88.

KOUKOURAS A. & TÜRKAY M. 1996: A new species of *Periclimenes* from the Aegean Sea (Crustacea: Decapoda: Palaemonidae). Senckenbergiana biol. 76: 135-142.

MANNING R.B. & ŠTEVČIĆ Z. 1985: Decapod fauna of Piran gulf. Quadern. Laboratoria Technologia di Pesca 3: 285-304.

MARINOPOULOS J. 1988 : Etude des peuplements infralittoraux de substrat rocheux de la région de Marseille et des facteurs abiotiques (lumière, hydrodynamique) les influencant. Thesis, University Aix-Marseille II, 317 p.

MÜLLER C.H.G. 2001 : Erstnachweis der Flachkrabbe *Percnon gibbesi* (Crustacea: Decapoda: Grapsidae) für die Balearischen Inseln. Senckenbergiana Marit. 31: 83-89.

PALLAORO A. & DULČIĆ J. 2004: On the occurrence of the spider crab *Maja goltziana* (Crustacea: Majidae) an alien species in the Adriatic Sea. J. Mar. Biol. Ass. UK 84: 1007-1008.

PÉRÈZ J.M. 1967: The Mediterranean benthos. Oceanogr. Mar. Biol. (An. Rev.) 5: 449-533.

PESTA O. 1918. Die Decapodenfauna der Adria. Versuch einer Monographie. Verlag Franz Deuticke, Leipzig Wien, 500 p.

PIPITONE C., BADALAMENTI F. & SPARROW A. 2001. Contribution to the knowledge of *Percnon gibbesi* (Decapoda, Grapsidae), an exotic species spreading rapidly in Sicilian waters. Crustaceana 74: 1009-1017.

PICCIO V., RELINI M. & AZZURRO E. 2003: Osservazioni sulla riproduzione di *Percnon gibbesi* (H. Milne Edwards, 1853) a Linosa. Biol. Mar. Mediter. 10: 267-272.

PUCCIO V., RELINI M., AZZURRO E. & RELINI O. 2006: Feeding habits of *Percnon gibbesi* (H. Milne Edwards, 1853) in the Sicily Straits. Hydrobiologia 557: 79-84.

RELINI M., ORSI L., PUCCIO V & AZZURRO E. 2000: The exotic crab *Percnon gibbesi* (H. Milne Edwards, 1853) in the Central Mediterranean. Sci. Mar. 64: 337-340.

RIEDL R. 1868: Fauna und Flora der Adria. Paul Parey, Hamburg Berlin, 521 p.

RIEDL R. 1983: Fauna und Flora des Mittelmeeres. Paul Parey, Hamburg Berlin, 836 p.

SCHUBART C.D. 2003. The East Asian shore crab *Hemigrapsus sanguineus* (Brachyura: Varunidae) in the Mediterranean Sea, an independent introduction. Scientia Marina 67(2): 195-200.

ŠTEVČIĆ Z. 1971: Beitrag zur Revision der Decapodenfauna von Rovinj. Thalassia jugoslavica 7: 525-531.

ŠTEVČIĆ Z. 1985: New and rarely reported species of decapod Crustacea from the Adriatic Sea. Rapports Comm. International Mer Méditer. 29: 313-314.
ŠTEVČIĆ Z. 1990: Checklist of the Adriatic decapod Crustacea. Acta Adriatica 31: 183-274.
ŠTEVČIĆ Z. 1991: Decapod fauna of seagrass beds in the Rovinj area. Acta Adriatica 32: 637-653.
ŠTEVČIĆ Z. 1993: History of investigations of the Adriatic decapod Crustacea. Bios 1: 151-160.
ŠTEVČIĆ Z. 1995: Contributions to the faunistic list of adriatic decapod Crustacea Natura Croatica 4: 113-115.
ŠTEVČIĆ Z. 1998: Morski deseteronožni raci kvarnerske regije (Marine decapod Crustacea of the Kvarner region). In: Arko-Pijevac M, Kovačić M & Crnković D (eds.), Prirodoslovna istraživanja riječkog područja 1: 647-660.
ŠTEVČIĆ Z. 2002: New observations on the Adriatic decapod fauna (years 1990-2000). Crustaceana 75: 643-647.
THESSALOU-LEGAKI M, ZENETOS A., KAMBOUROGLU U., CORSINI-FOKA M., KOURAKLIS P., DOUNAS C. AND NICOLAIDOU A. 2006: The establishment of the invasive crab *Percnon gibbesi* (H. Milne Edwards, 1853) (Crustacea: Decapoda: Grapsidae) in Greek waters. Aquatic Invasions 1: 133-136.
TÜRKAY M. 1989: Subtropische und tropische Faunenelemente in der Fauna des Östlichen Mittelmeeres. Natur und Museum 119: 183-189.
D'UDECEM D'ACOZ C. 1996: The genus *Hippolyte* Leach, 1814 (Crustacea, Decapoda, Caridea, Hippolytidae) in the eas Atlantic Ocean and the Mediterranean Sea, with a checklist of all species in the genus. Zoologische Verhandelingen (Leiden) 303: 1-133.
D'UDECEM D'ACOZ C. 1999: Inventaire et distributions des Crustacés Décapodes de l'Atlantique nord-oriental, de la Méditerranée et des eaux continentales adjacentes au nord de 25°N. Collections Patrimoines Naturelles (Institut d'Écologie te de Gestion de la Biodiversité, Paris) 40: 383 p.
YOKES B. & GALIL B.S. 2006: Touchdown – First record of *Percnon gibbesi* (H. Milne Edwards, 1853) (Crustacea: Decapoda: Grapsidae) from the Levantine coast. Aquatic Invasions 1: 130-132.
ZARIQUIEY ALVAREZ R. 1968: Crustáceos Decápodos Ibéricos. Investigación Pesquera, Barcelona, 510 p.

Author's addresses

Carsten H. G. Müller[1,2]* & Christoph D. Schubart[3]

[1] Universität Rostock
Institut für Biowissenschaften
Allgemeine & Spezielle Zoologie
Universitätsplatz 2
18051 Rostock
Germany

[2] Max-Planck-Institut für Chemische Ökologie
Abteilung für Evolutionäre Neuroethologie
Hans-Knöll-Str. 8
07745 Jena
Germany

[3] Universität Regensburg
Fakultät für Biologie I
Institut für Zoologie
93040 Regensburg
Germany

*corresponding author; E-mail: carsten.mueller@uni-rostock.de

Tab. 1. Species list of Crustacea Decapoda collected in coastal waters of Rovinj, U. Slanik, Pula and Šipan, including details about the year and depth of sampling as well as the substrate type. Furthermore, observations on the frequency of each species are provided: 1 = rare (species spotted one to five times), 2 = common (species spotted six to 20 times), 3 = very common (species spotted more than 20 times). In some cases, details on the sampling depth for certain species caught during the Rovinj excursion of 1968 are missing due to incomplete reports (see question marks). The systematic classification of the species to the various decapod orders and families is based on the system used by d'Udecem d'Acoz (1999). Abbreviations: *ex* exuvial rest, *inl* infralittoral zone (till 20 m depth), *juv* juvenile specimen, *msl* meso(eu-) littoral zone, *Pu* Pula, *Pu** collection from lagoonary channel system of Marina Veruda, *Ro* Rovinj, *spec* specimen, *spl* supralittoral zone, *subl* lower sublittoral zone (below 20 m depth), *Sz* island of Šipan, *Uv* Uvala Slanik.

Taxa	Location	Year	Habitat preferences	Depth (m)	Frequency
Dendrobranchiata					
Sicyoniidae					
Sicyonia carinata (Brünnich, 1768)	Ro	1968	inl	?	?
Caridea					
Gnathophyllidae					
Gnathophyllum elegans (Risso, 1816)	Sz	2001	inl, under rocks	2 to 15	2
Paleamonidae					
Palaemon elegans Rathke, 1837	Ro, Sz	1968, 2001	inl, spl, rock pools, phytal	0 to 1	3
Palaemon serratus (Pennant, 1777)	Sz, Pu	2001-05	msl, inl, caves	1 to 3	2
Palaemon adspersus Rathke, 1837	Ro	1968	phytal	?	?
Periclimenes amesthysteus (Risso, 1827)	Sz	2001	inl, between rocks, associated	2	1
			with *Anemonia sulcata*		
Periclimenes aegylios Grippa & d'Udecem d'Acoz, 1996	Pu	2004	inl, between rocks, associated	3 to 15	1
			with *Anemonia sulcata*		
Typton spongicola O.G. Costa, 1844	Ro	1968	inl	?	?

Alpheidae					
Alpheus dentipes Guérin, 1832	Ro, Pu	1968, 2004, 2005	inl, under rocks	5 to 20	2
Alpheus macrocheles (Hailstone, 1835)	Sz	2001	inl, under rocks	3 to 20	2
Athanas nitescens (Leach, 1814)	Ro, Sz, Pu	1968 and	inl, subl, under rocks,	2 to 30	3
		2001-2005	sandy sediment		
Hippolytidae					
Hippolyte inermis Leach, 1814	Ro, Sz, Pu	1968, 2001-2005	inl, in *Posidonia*-beds	3 to 25	1 to 2
Hippolyte sapphica d'Udecem d'Acoz, 1993	Pu	2004, 2005	inl, phytal (*Cystoseira*, *Posidonia*)	2 to 5	2
Hippolyte prideauxiana Leach, 1817	Ro	1968	inl, phytal	below 5	?
Hippolyte cf. *garciarasoi* d'Udecem d'Acoz, 1996	Sz	2004	inl, phytal (*Cystoseira*)	0 to 2	3
Lysmata seticaudata (Risso, 1816)	Sz, Pu	2001-2005	msl, inl, under rocks,	0 to 15	2
			in caves and crevices		
Spirontocaris cranchi Leach, 1816	Ro	1968	inl	below 10	?
Crangonidae					
Philocheras bispinosus (Hailstone, 1835)	Sz	2001	subl, sandy bottom	35	2
Palinuridea					
Palinuridae					
Palinurus elephas (J.C. Fabricius, 1787)	Sz	2001	subl, cave entry	35	1
Scyllaridae					
Scyllarus arctus (Linnaeus, 1758)	Sz, Pu	2001-2005	inl, subl, rocky ground, caves	15 to 35	1 to 2
Nephropidea					
Nephropidae					
Homarus gammarus (Linnaeus, 1758)	Sz	2001	subl, coralligène	35	1 (ex)

Nephrops norvegicus (Linnaeus, 1758)	Ro	1968	inl	below 30?	?
Thalassinidea					
Upogebiidae					
Upogebia pusilla (Petagna, 1792)	Pu*	2004, 2005	msl, muddy ground	0 to 1	3
Callianassidae					
Callianassa tyrrhena (Petagna, 1792)	Pu*	2004	msl, muddy ground	0 to 1	3
Anomala					
Galatheidae					
Galathea squamifera Leach, 1814	Ro, Sz, Pu	1968, 2001-2005	inl, between and under rocks	3 to 15	3
Galathea strigosa (Linnaeus, 1761)	Pu	2004-2005	inl, rocky grounds	10 to 15	2
Galathea intermedia Lilljeborg, 1851	Ro, Sz	1968, 2001	inl, subl, under rocks	10 to 40	1
Porcellanidae					
Porcellana platycheles (Pennant, 1777)	Ro, Sz, Pu	1968, 2001-2005	msl, inl, under rocks	1 to 10	2 to 3
Pisidia bluteli (Risso, 1816)	Sz, Pu	2001-2005	msl, inl, under rocks	1 to 20	3
Pisidia longicornis (Linnaeus, 1767)	Ro	1968	inl, under rocks	below 1	?
Pisidia longimana (Risso, 1816)	Ro	1968	inl, under rocks	below 1	?
Diogenidae					
Calcinus tubularis (Linnaeus, 1767)	Sz	2001	inl, rocky grounds, phytal	3 to 20	2
Clibanarius erythropus (Latreille, 1818)	Ro, Sz, Pu	1968, 2001-2005	spl, msl, rocky grounds, rock pools	0 to 2	3
Dardanus calidus (Risso, 1827)	Sz, Pu	2001, 2005	inl, rocky grounds, *Posidonia*-beds	3 to 20	2
Diogenes pugilator (P. Roux, 1829)	Ro, Sz, Pu	1968, 2001-2005	inl, sandy bottoms	2 to 10	3
Paguristes eremita (Linnaeus, 1767)	Ro, Sz, Pu	1968, 2001-2005	inl, subl, sandy bottoms	10 to 40	2
			sometimes with *Suberites domuncula*		

Paguristes streaensis Pastore, 1984	Sz, Sl?	2001, 2004	inl, fine sandy funnels, muddy grounds	1 to 5	2
Paguridae					
Pagurus prideauxi Leach, 1815	Sz, Pu	2001-2005	msl, inl, subl, under rocks,	1 to 40	1 to 2
			sandy bottoms, with *Adamsia palliata*		
Pagurus cuanensis Bell, 1845	Sz	2001	inl, rocky grounds, phytal	5 to 20	1
Pagurus anachoretus Risso, 1827	Ro, Sz, Pu	1968, 2001-2005	msl, inl, subl, rocky grounds,	1 to 30	2 to 3
			sandy bottoms		
Pagurus chevreuxi (Bouvier, 1896)	Sz, Pu	2001-2005	inl, under rocks	3 to 10	2
Cestopagurus timidus (P. Roux, 1830)	Sz, Pu	2001-2005	inl, under rocks, *Posidonia*-beds	2 to 20	2
Anapagurus breviaculeatus Fenizia, 1937	Pu	2004, 2005	inl, sandy bottoms at the margins	10 to 25	3
			of *Posidonia*-beds		
Pagurus exacavatus (Herbst, 1791)	Ro	1968	inl, sandy and muddy bottoms	below 20	?
Brachyura					
Dromiidae					
Dromia personata (Linnaeus, 1758)	Ro, Sz, Pu	1968, 2001-2005	inl, under and between rocks,	2 to 10	1
			carries *Suberites domuncula*		
Majoidea					
Majidae					
Eurynome aspera (Pennant, 1777)	Ro	1968	inl	?	?
Macropodia rostrata (Linnaeus, 1761)	Sz	2001	inl, phytal, attached to algous thalli	10	1 (juv)
Inachus phalangium (J. C. Fabricius, 1775)	Pu	2004, 2005	inl, rocky grounds, associated	5 to 15	2
			with *Anemonia sulcata*		
Inachus thoracicus P. Roux, 1830	Ro, Sz	1968, 2001	subl, transition zone between	20 to 40	1
			sandy and rocky substrate		
Acanthonyx lunulatus (Risso, 1816)	Ro, Sz, Pu	1968, 2001-2005	msl, phytal, attached to algous thalli	0 to 2	3
Pisa tetraodon (Pennant, 1777)	Sz	2001	inl, phytal, rocky grounds	10 to 20	2

Pisa nodipes (Leach, 1815)	Ro	1968	inl, rocky grounds	?	?
Herbstia condyliata (J. C. Fabricius, 1787)	Sz, Pu	2001, 2005	inl, under and between rocks	1 to 10	1
Maja crispata Risso, 1827	Ro, Sz, Pu, Sl	1968, 2001-2005	msl, inl, subl, phytal, primary and secondary hard substrates	1 to 30	2
Maja squinado (Herbst, 1788)	Ro	1968	inl, rocky grounds	?	?
Dorripoidea					
Dorripidae					
Ethusa mascarone (Herbst, 1785)	Ro, Sz	1968, 2001	inl, phytal, attached to algous thalli	5 to 20	1
Leucosioidea					
Leucosiidae					
Ebalia cranchii Leach, 1817	Sz	2001	subl, under rocks	35	1
Ilia nucleus (Linnaeus, 1758)	Pu	2005	inl, mixed sandy and rocky bottoms	5 to 15	2
Calappoidea					
Calappidae					
Calappa granulata (Linnaeus, 1758)	Sz	2001	subl, sandy ground	30	1 (ex)
Portunoidea					
Portunidae					
Carcinus aestuarii Nardo, 1847	Ro, Pu*, Sl	1968, 2004, 2005	msl, muddy sand, *Zostera*-beds	0 to 2	3
Parthenopoidea					
Parthenopidae					
Parthenope massena (P. Roux, 1830)	Ro, Sz	1968, 2001	inl, subl, sandy ground	10 to 35	1
Xanthoidea					
Xanthidae					
Xantho poressa (Olivi, 1792)	Sz, Pu, Sl	2001-2005	msl, inl, under rocks	1 to 20	1 to 3

Xantho hydrophilus (Herbst, 1790)	Ro, Sz, Pu	1968, 2001-2005	msl, inl, under rocks	1 to 15	2
Xantho pilipes A. Milne-Edwards, 1867	Pu	2004, 2005	inl	10 to 20	1
Eriphiidae					
Eriphia verrucosa (Forskal, 1775)	Ro, Sz, Pu, Sl	1968, 2001-2005	msl, rocky crevices and small holes	0 to 2	2
Pilumnidae					
Pilumnus spinifer (H. Milne-Edwards, 1843)	Sz, Pu	2001, 2004	inl, subl, rocky ground	5 to 35	1 to 2
Pilumnus villosissimus (Rafinesque, 1814)	Sz, Pu	2001-2005	inl, rocky grounds, sometimes	5 to 10	2
			associated with *Anemonia sulcata*		
Pilumnus hirtellus (Linnaeus, 1761)	Ro, Pu	1968, 2004, 2005	inl, rocky ground	10 to 20	1
Pilumnus sp.	Sz	2001	inl, rocky grund	5 to 10	1 (1 indiv.)
Grapsoidea					
Grapsidae					
Pachygrapsus marmoratus (J. C. Fabricius, 1787)	Ro, Sz, Pu, Sl	1968, 2001-2005	spl, msl, rocky substrates, rock pools,	0 to 1	3
			phytal (under macrophytes)		
Varunidae					
Hemigrapsus sanguineus (de Haan, 1835)	Sl	2001	spl, rocky littoral	0	1
Pinnotheroidea					
Pinnotheridae					
Pinnotheres pisum (Linnaeus, 1767)	Ro	1968	inl, in various Bivalvia	?	?

Orthoptera and Mantodea of Istria and the Croatian Island Šipan

By Andy Sombke & Mathias Schlegel

SOMBKE A. & SCHLEGEL M. (2007): Orthoptera and Mantodea of Istria and the Croatian Island Šipan. Rostocker Meeresbiologische Beiträge 18: S. 131-137

Abstract. In 12 localities in Croatia studied in the years 2001 to 2002 and 2004 to 2006 a total of 36 Orthoptera species and 3 species of Mantodea were found. The most frequently encountered Orthoptera species were *Pezotettix giornae*, *Aiolopus strepens*, *Acrida ungarica*, *Tylopsis liliifolia*, *Calliptamus italicus* and *Oedipoda caerulescens*. Rare species include *Locusta migratoria*, *Phaneroptera falcata*, *Sepiana sepium* and *Tettigonia viridissima*. No differences between the north and the south of the Croatian coastline were found with regard to common species. Comments on the distribution and biology of some species are also given.

Kurzfassung. An 12 Plätzen in Kroatien, die in den Jahren 2002-2003 und 2004-2006 untersucht wurden, wurden zusammen 36 Arten von Orthoptera und 3 Arten von Mantodea aufgefunden. Die am häufigsten angetroffenen Orthoptera waren *Pezotettix giornae*, *Aiolopus strepens*, *Acrida ungarica*, *Tylopsis liliifolia*, *Calliptamus italicus* und *Oedipoda caerulescens*. Seltenere Arten waren *Locusta migratoria*, *Phaneroptera falcata*, *Sepiana sepium* und *Tettigonia viridissima*. Es wurden keine Unterschiede zwischen dem Norden und Süden der kroatischen Küstenlandes im Vorkommen der Gruppe der häufigen Arten gefunden. Zu ausgewählten Arten werden Verbreitung und Bioloigiue kommentiert.

Keywords: Orthoptera, Mantodea, croatia, faunistics

Introduction

Istria is the biggest peninsula in the Adriatic Sea. It is located between the Gulf of Trieste and the Bay of Kvarner. The Istrian peninsula has a surface area of 3,476 square kilometres. It can be divided in three completely different areas according to geological and geomorphic structure. The hilly northern and north-eastern part, due to its scarce vegetation and nude karst surfaces, is also known as White Istria. South-west from White Istria stretches an area that is considerably richer morphologically, containing lower flysch mountainous tracts consisting of impermeable marl, clay, and sandstone, which is why this part is called Grey Istria. Limestone terrace along the coastline, covered with red earth, form an area called Red Istria. One third of the Istrian peninsula is covered with woods. Along the coast and on the islands pine woods, macchia and garrigue (PRAVDIN 1964) prevail, interspersed by holm oak and strawberry tree.
The elafite island Šipan covers a surface of 16.5 square kilometres and is located north west of Dubrovnik. It is characterised by a coastal mountain range which encircles an inner plain. The mountains are usually tree covered, while the inner plain is extensively used for agriculture and cattle breeding. The climate of the Istrian coastline (Red Istria) and the island Šipan is basically Mediterranean. There are not many new papers dealing with Orthopteroidea in Istria (KRAUSS 1878, INGRISCH 1977) and the Croatian coastline near Dubrovnik (ADAMOVIC 1964, KARAMANN 1961).

Material and methods

This study covers seven localities in Istria and five on Šipan. The excursions started in the year 2001, in the period from August through October. The same season was selected for the other excursions to Šipan, Pula and Vrsar (2002, 2004, 2005, 2006), because the chances of finding adult individuals was higher during that period. The time dedicated to active collection varied from site to site. In the main, xerothermic habitats were selected; wet or waterlogged meadows were not investigated.
The material was primarily collected using a standard insect net. The animals were located acoustically, and where possible, the surrounding vegetation was checked. The insects were fixed using 70% benzinealcohol and identified in the laboratory using identification keys (HARZ 1969, 1975, SCHMIDT & LILGE 1996, SZIJJ 2004). Information on distribution was taken from HARZ (1969, 1975), SCHMIDT & LILGE (1996) and ADAMOVIC (1964).

Short description of the study plots

This study covers 12 sites on the Croatian coastline. Climate conditions were relatively similar.

1) **Šipan (Habitat I)** – Coastal sun-exposed dry slope - dominated by sparsely covered rocks, the vegetation seldom grows over 1 m in height and usually consists of grasses and dry bushes.

2) **Šipan (Habitat II)** – Coastal meadow - east of the Šipanska Luka Bay. Short growing grasses and several trees and palms, because of the proximity to the coastal shore line, a constant wind dominated the locality.

3) **Šipan (Habitat III)** – Heterogeneous agricultural fallow area south of Šipanska Luka surrounded by farmland and olive trees, characterised by heterogeneous grasslands and bushes which grow up to 70-80 cm.

4) **Šipan (Habitat IV)** – Agriculturally unused meadow - grassland located on the inner plateau of the island, adjacent areas are used for agriculture, viniculture and cattle breeding, grass-dominated pasture which grows up to 40 cm enriched by a few bushes.

5) **Šipan (Habitat V)** – Cattle pasture - several hundred meters north of Habitat IV, grasses usually do not grow above 5 cm.

6) **Vrsar (Habitat I)** – Campsite near shoreline (Porto Sole) - dominated by short growing grasses, bushes are rare, on a southward inclined slope and highly sun exposed, in this habitat human activities have a strong influence on the vegetation.

7) **Vrsar (Habitat II)** – Agricultural fallow with areas of unused meadow – surrounded with holm oaklets and blackberry bushes (Garrigue), grassland up to 20 – 30 cm, the adjacent areas are used for agriculture, (200 m north of Porto Sole).

8) **Vrsar (Habitat III)** – Hill with arid vegetation - the first investigation area lies on a dry slope which is covered by rocks, the second area lies on top of the hill in front of a hedged field, the slope is surrounded by olive trees and bushes, near the fence short grasses, bushes or no vegetation dominates the area, (1.5 km south of Vrsar).

9) **Vrsar (Habitat IV)** – Unused meadow with bushes (Garrigue) - the vegetation consists of dry grasses which grow up to 40 cm, bushes and many short growing thistles, this area is close to a few electricity pylons and lies on a cycle track to Limski Fjord, (3 km east of Porto Sole).

10) **Vrsar (Habitat V)** – Pine wood surrounded by meadow - a pine wood with a lot of hedges, brushwood and brakes, the adjacent area is an unused meadow with short grasses up to 10 cm, this plot lies on the same cycle track as Habitat IV, (4 km east of Porto Sole).

11) **Pula (P)** – situated on the southern tip of the peninsula. Areas surrounding the marine school Valsaline.

12) **Limski Kanal (Lim)** – the channel-like bay known as the Limski Kanal is 6 km long and lies between Rovinj and Vrsar, the site of investigation was at the end of this bay, high growing dry grasses up to 50 cm with groups of bushes (Macchia) and small intensively farmed surfaces dominated this location.

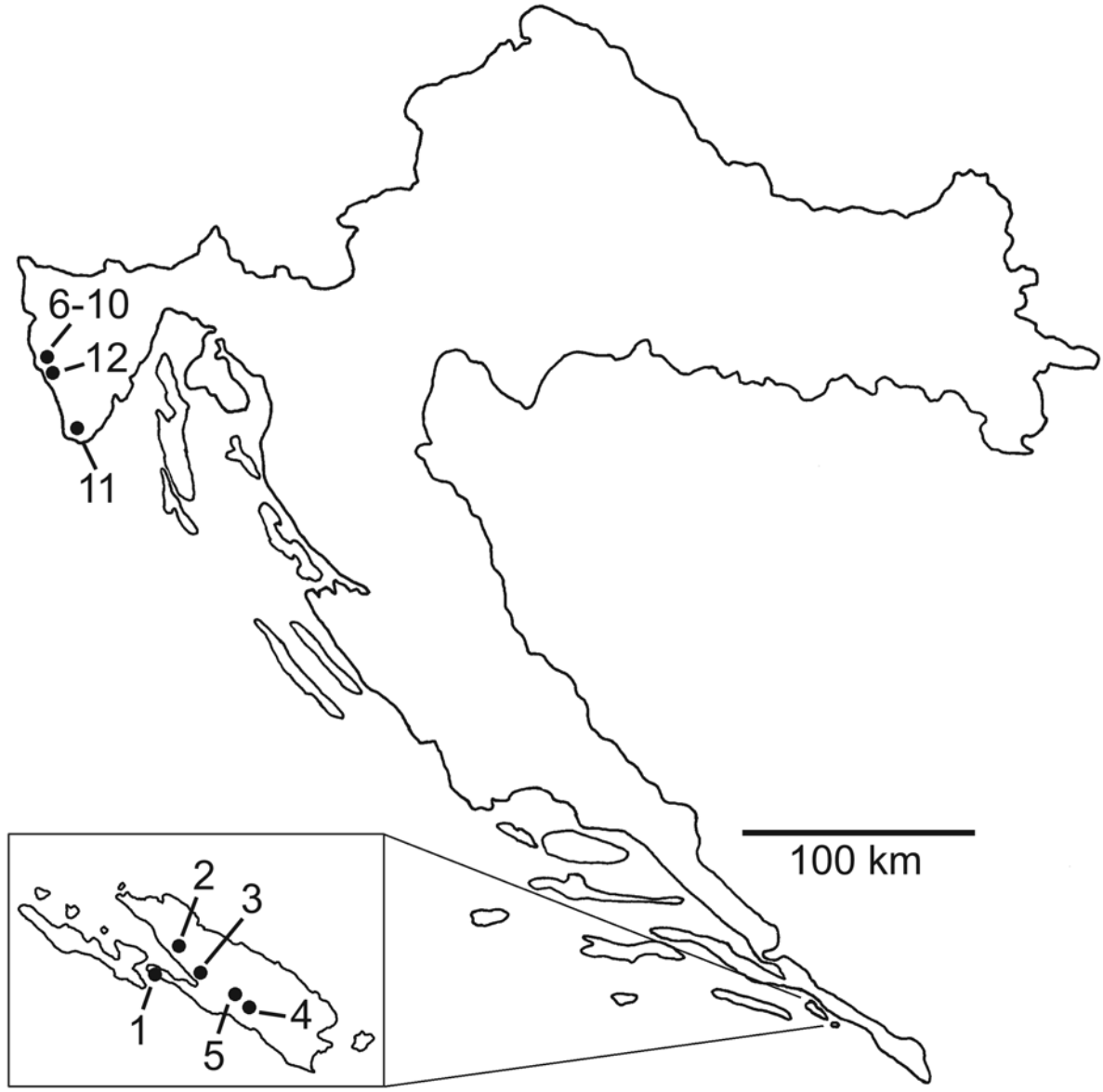


Fig. 1. Map of Croatia. 1-5 (Habitats on Šipan), 6-10 (Habitats at Vrsar), 11 (Pula), 12 (Limski Kanal).

Results

During this study we identified a total of 36 Orthoptera species and 3 mantids (Tab. 1).

The most frequent Orthoptera species in the studied localities were *Pezotettix giornae*, *Oedipoda caerulescens*, *Aiolopus strepens*, *Calliptamus italicus* and the palae-arctic, xero-thermophilous species *Oedipoda caerulescens*. The rare species included *Locusta migratoria*, *Phaneroptera falcata*, *Sepiana sepium* and *Tettigonia viridissima*.

The most frequent Mantodea species were *Mantis religiosa* and *Ameles decolor*. The latter species prefers dry meadows, areas with sparse plant coverage, small bushes up to 30 cm and sun exposed places. *Mantis religiosa* was found, especially in the region of Vrsar, only in areas with higher growing grasses.

Comparing the results, no major differences between the north and the south of the Croatian coastline could be found with regard to the common species.

Tab. 1. Orthoptera and Mantodea of selected localities on Šipan, Vrsar, Pula and Limski Kanal (Croatia) with habitat (see methods).

Locality and Habitat	**S I**	**S II**	**S III**	**S IV**	**S V**	**S**	**Vr I**	**Vr II**	**Vr III**	**Vr IV**	**Vr V**	**P**	**Lim**
ENSIFERA													
Phaneroptera nana nana						X							
Phaneroptera falcata							X						
Meconema meridionalis						X							
Decticus albifrons								X					X
Platycleis affinis		X	X	X	X	X							
Platycleis intermedia						X		X					
Tettigonia viridissima				X									
Tylopsis lillifolia			X			X		X		X		X	X
Rhacocleis germanica		X	X			X		X			X		X
Yersinella raymondi							X		X			X	
Eupholidoptera chabrieri schmidti							X					X	X
Sepiana sepium											X		
Conocephalus discolor													X
Acheta domesticus							X						
Gryllomorpha dalmatina						X							
Pseudomogoplistes squamiger								X					
Mogoplistes brunneus						X							
CAELIFERA													
Anacridium aegypticum	X			X		X						X	
Locusta migratoria			X										
Calliptamus italicus	X	X	X			X			X	X	X		X
Pezotettix giornae		X				X		X		X	X	X	X
Acrida ungarica			X	X	X	X	X	X	X				
Acrotylus patruelis			X	X		X							
Acrotylus insubricus						X							
Aiolopus thalassinus					X	X						X	

Aiolopus strepens						X		X	X	X			X
Oedipoda caerulescens	X	X	X	X	X	X		X	X			X	X
Oedipoda germanica									X			X	
Euchorthippus declivus								X		X			X
Chorthippus parallelus												X	
Chorthippus brunneus	X	X				X		X				X	
Chorthippus dorsatus												X	
Chorthippus biguttulus		X										X	
Chorthippus vagans										X			
Omocestus rufipes										X			X
Omocestus haemorrhoidalis		X	X			X							
MANTODEA													
Mantis religiosa		X	X			X		X					X
Ameles decolor									X	X	X	X	
Empusa fasciata								X					

Discussion

Šipan. In coastal habitats *Calliptamus italicus*, very common throughout the Mediterranean (HARZ 1957), was found either sporadically or frequently but was not recorded on the inner plain. In contrast, *Oedipoda caerulescens* was found in all habitats. It is assessed to be palaearctic and xerothermophil, preferring sandy, sparsely vegetated environments and for this reason a typical indicator for arid habitats (HARZ 1957). In the more sheltered areas of habitats III, IV and V *Acrida ungarica* was dominant. *A. ungarica* prefers xerotherm vegetation growing on sandy grounds as well as rocky and loamy steppes. It usually avoids cultivated areas and was not found in coastal surroundings. Large numbers of juvenile Acridinae were noticed in Habitats IV and V in the inner part of Šipan. They were not specified any further. In all habitats (except Habitat I) Ensifera were found in bushes and higher grasses. The most common species was *Platycleis affinis*.
Locusta migratoria cinerascens was recorded once in Habitat III. According to information given by inhabitants a major locust plague took place in 1999. The migratory locust exists permanently in its solitary phase in the Ulcinj District, Montenegro, Yugoslavia (ADAMOVIC 1964). Thus, the single individual in Habitat III may be part of a permanent stable population.
In addition, *Tyliopsis liliifolia* was found in Habitat III. Adults were detected in 50 cm high grasses. *T. liliifolia* is very common throughout the Mediterranean (HARZ 1969). With localisation in Habitat II and III xerothermophil *Acrolytus patruelis* (Oedipodinae) was always found in relative proximity to the seashore. Not on the inner plain of the island (SCHMIDT & LILGE 1996).
Recording species diversity allows statements to be made on the status quo of chosen areas and disregards natural and human changes. However, these changes have to be considered because many species, including some rare ones, colonise new territories. Due to the dynamics of pioneer vegetation societies, changes in species composition have to be expected. For this reason it is necessary to carry out annual and long-term observations of faunal changes in order to obtain more substantial information (KRIEGBAUM 1989). The taxa identified are not representative of the number of taxa which actually exist in the area (KARAMANN 1961, ADAMOVIC 1964). Investigations into Orthopteroidea in the Dubrovnik region revealed a total of approximately 55 species. The short period of time available for sampling, a relatively

low number of investigated habitats, the absence of freshwater habitats and most importantly the season of the year (October) are reasons for the comparatively low number of taxa found.

Istria. The most frequent Orthoptera species in Istria were *Pezotettix giornae*, *Decticus albifrons*, *Aiolopus strepens*, *Tylopsis liliifolia, Calliptamus italicus* and the palaearctic, xero-thermophilous species *Oedipoda caerulescens*.
The two latter species usually occurred together in similar habitats, at the sides of paths in the proximity of shrubs in dry, sun-exposed locations with little to no vegetation. These seem to be the crucial habitat components (BROSE 1997) for their occurrence.
Pezotettix giornae was very frequently represented in habitats II, IV and V, but it did not reach the status of a plague. This species actually reproduces massively in Slovenia some years (INGRISCH & KÖHLER 1998). However *Euchorthippus declivus*, which sometimes also reaches plague status, was rare. Other rare species were *Phaneroptera falcata* and *Sepiana sepium*. The latter species was a single find in a pinewood with a lot of hedges, brushwood and brakes (Habitat V). *Eupholidoptera chabrieri schmidti*, *Phaneroptera falcata* and *Yersinella raymondi* were found in Habitat I only in bushes and hedges around the buildings of the campsite. Because of anthropogenic influences in that area the grasses are short and the plant communities not particularly diverse. We found a low number of species in that location.
Conocephalus discolor is more common in southern Europe (HARZ 1969) than the short-winged species *Conocephalus dorsalis*. We found *C. discolor* near the coast at the end of the Limski Kanal, in the absence of wet meadows or waterlogged areas. This corresponds to information given by KLEUKERS ET AL. (1996) that *C. discolor* also colonizes dry (urban) wasteland, edges of fields and ruderal grassland vegetation. The grasses must be dense and not too short. Higher growing, tall grasses are a habitat factor which plays a big role for a lot of other species such as *Tylopsis liliifolia*, *Pezotettix giornae* and *Mantis religiosa*.
The investigated areas are important for agriculture and very suitable for Mediterranean farm crops such as grape vines, olives and aromatic herbs. These human activities and especially in Istria the influences of tourism are the main reasons for changes in the structure of the vegetation and in the Orthoptera species diversity. Thus the main threat to many Mediterranean ecosystems and their endemic species, which in part are limited to small circulation areas, also lies in the radical development of always new areas for tourism. As in Central Europe, factors such as changes in land and forest use can also endanger plants and animals.

Acknowledgements
We would like to thank Prof. J. Heinze, Dr. C. Schubart (both University of Regensburg) and Dr. C.H.G. Müller (University of Rostock) for material from Pula and Dr. S. Adler (University of Rostock) for additional material from Šipan.

References

ADAMOVIC Z.R. 1964: Orthopteroides collected in Dubrovnik District, Jugoslavia. Bull. Mus. Hist. Nat. 19: 155-88.
BROSE U. 1997: Untersuchungen zur Ökologie von *Calliptamus italicus* Linnaeus, 1758 unter Berücksichtigung von Habitatpräferenzen, Populationsaufbau und

Ausbreitungsverhalten. Articulata 12: 19-33.
HARZ K. 1957: Die Geradflügler Mitteleuropas. Gustav Fischer), Jena, 495 pp.
HARZ K. 1969: Die Orthopteren Europas The Orthoptera of Europe. Vol. I. - The Hague, Dr. W. Junk B. V., 749 pp.
HARZ K. 1975: Die Orthopteren Europas The Orthoptera of Europe. Vol. II. - The Hague, Dr. W. Junk B. V., 939 pp.
INGRISCH S. 1977: Bemerkenswerte Orthopterenfunde aus Nordgriechenland und aus Istrien. Nachrbl. bayer. Entomol. 30: 87-91.
INGRISCH S. & KÖHLER G. 1998: Die Heuschrecken Mitteleuropas. Magdeburg, 460 pp. (Westarp Wiss.).
KARAMANN M. 1961: Beitrag zur Kenntnis der Orthopteren Jugoslawiens. Fragm. Balcan. 4: 37-48.
KRAUSS H.A. 1878: Die Orthopteren-Fauna Istriens. Sitzungsberichte der Kaiserlichen Akademie der Wissenschaften zu Wien, Mathematisch-Naturwissenschaftliche Klasse, Abteilung 1 78: 451–544, pls 1–6.
KLEUKERS R.M.J.C., DECLEER K., HAES E.C.M., KOLSHORN P. & THOMAS, B. 1996: The recent expansion of *Conocephalus discolor* Thunberg Orthoptera: Tettigoniidae in western Europe. Entomologist's Gazette 47: 37–49.
KRIEGBAUM H. 1989: Heuschreckenpopulationen als mögliche Indikatoren bei der Prüfung anthropogener Umwelteinflüsse. Articulata 4: 11–20.
PRAVDIN F.N. 1964: Regularities of the vertical distribution of orthopteroid insects. Orthopteroidea in the Adriatic Part of the Balkan Peninsula. Entomologiceskoe obozrenie Akad. Moskva 43: 258-267.
SCHMIDT G.H. & LILGE R. 1996: Geographische Verbreitung der Oedipodinae Orthopteroidea, Caelifera, Acrididae in Europa und Randgebieten. Verlag Dr. Kovač, 149 pp.
SZIJJ J. 2004: Die Springschrecken Europas. Hohenwarsleben, 110 pp. (Westarp Wiss.).

Authors` addresses:

Andy Sombke[1,2]*, Mathias Schlegel[1]

[1] Universität Rostock
Institut für Biowissenschaften
Allgemeine & Spezielle Zoologie
Universitätsplatz 2
D -18055 Rostock

[2] Max-Planck-Institut für Chemische Ökologie
Abteilung für Evolutionäre Neuroethologie
Hans-Knöll-Str. 8
07745 Jena
Germany

*corresponding author; E-mail: asombke@ice.mpg.de