

A survey of the benthic flora in the National Marine Park of Zakynthos (Greece)

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Abstract

We studied the composition of the benthic marine macroflora in Laganas Bay (National Marine Park of Zakynthos, Ionian Sea, Greece). Seasonal samples were collected by SCUBA-diving from April 2001 to February 2003. A total of 182 taxa at specific and infraspecific rank of macroalgae was found, 146 of which are new records to Zakynthos Island and 12 to the Greek coasts. The vegetation of most of the rocky substrata is characterized by species of the canopy-forming genus *Cystoseira*, while that of soft bottoms is characterized by large meadows of *Posidonia oceanica*. Two other phanerogams (*Cymodocea nodosa* and the lessepsian immigrant *Halophila stipulacea*) also occur on soft bottoms, the former developing dense meadows, while the latter occurs in only a restricted area. The invasive green alga *Caulerpa racemosa* var. *cylindracea* was of frequent occurrence on hard and soft substrata.

Keywords: macroalgae; national park; Zakynthos Island; Greece.

Introduction

During the last three decades, there have been significant studies on the benthic marine macroalgal flora and algal communities of the Greek coasts and particularly of the Aegean Sea (Coppejans 1974, Tsekos and Haritonidis 1974, Panayotidis 1979, Tsekos et al. 1982, Haritonidis et al. 1986, Athanasiadis 1987, Nikolaidis 1987, Nikolaidis and Haritonidis 1990, Lazaridou 1994, Sartoni and De Biasi 1999, Tsirika 2000).

In contrast, limited information is available on the benthic marine flora of the Greek west coasts and even less on the Greek Islands of the Ionian Sea. A study of the marine macroflora of the Peloponnese region was conducted by Giaccone (1968a). Further studies dealing with the marine macroalgae of the Greek west coasts were undertaken by Haritonidis and Tsekos (1976) and Diapoulis and Haritonidis (1987). Only two floristic surveys of the benthic marine flora of the Ionian Islands have been published. Tsekos and Haritonidis (1977) gave information on selected sites in the whole island complex,

while Schnetter and Schnetter (1981) focused only on Kefalonia Island.

Zakynthos belongs to the Ionian Islands complex, which is situated in western Greece. Laganas Bay is a shallow marine embayment in the southern part of Zakynthos and is a very popular tourist resort. Laganas Bay, including Marathonissi and Pelouzo Islands (two small, uninhabited islands), represents the major part of the National Marine Park of Zakynthos, one of the most important nesting places of the loggerhead turtle *Caretta caretta* (Linnaeus) in the Mediterranean Sea. In December 1999, the President of the Greek Republic established the National Marine Park of Zakynthos, its main objectives being preservation of the natural environment and conservation of the ecological balance of marine and coastal areas of the Bay of Laganas and of the Strophadia Islands. The area is characterized by a variety of marine habitat types listed in Annex I (list of habitats to be protected by means of a network of sites) of the Council Directive 92/43/EEC on the conservation of natural habitats and of wild fauna and flora (Tsirika et al. 2001).

The only survey of the benthic macroalgae in Zakynthos Island was conducted by Tsekos and Haritonidis (1977). This survey included three sites, one of which is located in Laganas Bay.

Taking into consideration the significance of biodiversity knowledge in a marine protected area, as well as the lack of data on the National Marine Park of Zakynthos, the aim of the present survey is to record the benthic marine macroflora in Laganas Bay, providing species lists for macroalgae and marine phanerogams collected from hard and soft substrata.

Materials and methods

The current study took place in Laganas Bay (southern Zakynthos). The marine area of the National Marine Park of Zakynthos includes: the internal area of Laganas Bay (divided into three discrete protected zones A, B and C), the external marine area and Strophadia Islands, southeast of Zakynthos Island. Eight characteristic sites (Figure 1) were chosen for seasonal sampling on hard substrata in the sublittoral zone at a depth range of 2–12 m. Four of the selected sites (5, 6, 7 and 8) are located in protected zone A of the National Park, two (sites 3 and 4) in the protected zone B and two other sites (sites 1 and 2) in the borderland of the Park. Another site, Agios Sostis harbor (Site 9: 37°42'52"N and 020°51'53"E), was chosen for the study of marine macroflora composition (Figure 1).

Sites 1 and 2 are located at the southwestern part of Laganas Bay close to Keri (37°39'09"N and 020°50'49"E) and Marathia (37°39'25"N and 020°51'28"E), respectively.



Figure 1 Map of Zakynthos Island indicating the sampling sites.

The area is characterized by the presence of a hard substratum consisting of large horizontal reefs. Samples were collected at a depth range of 6–12 m in site 1 and 4–6 m in site 2. Site 3 is located at the southwestern part of Marathonissi Island (37°41'00"N and 020°52'21"E). Reefs ending on a soft bottom covered by *Posidonia oceanica* (L.) Delile characterize this region and samples were collected at a depth range of 5–6 m. Site 4 is located on the northwestern part of Marathonissi Island (37°41'16"N and 020°51'59"E). This site is characterized by the absence of consolidated hard substrata, while dense populations of macroalgae grow on small rocks and in the gaps within *P. oceanica* meadows. Samples were collected at a depth range of 3–5 m. Sites 5 (37°42'24"N and 020°56'50"E) and 6 (37°42'15"N and 020°57'08"E) are located at the northern and eastern part of Pelouzo Island, respectively. Site 5 is characterized by the absence of typical hard substrata, while in site 6 there are typical reefs. Samples were collected at a depth range of 2–4 m and 3–8 m, respectively.

Sites 7 (37°43'41"N and 020°56'00"E) and 8 (37°43'28"N and 020°56'23"E) are located at the eastern part of Laganas Bay and samples were collected at a depth range of 3–7 m and 3–5 m, respectively.

In order to study the benthic macroalgae in the selected sites, seasonal samples were collected by SCUBA-diving, from sampling areas of 625 cm² by means of a hammer and chisel. Additional sampling was randomly done in order to collect as many species as possible. Samples collected were preserved in seawater-formalin (5%) solution for the identification of the species in the laboratory.

Apart from the marine macroalgae, the presence and expansion of marine phanerogams colonizing soft substrata were observed by SCUBA-diving.

Results and discussion

The majority of the underwater landscape in Laganas Bay consists of soft substrata, either unvegetated or occupied by marine phanerogams. The dominant community is that with *Posidonia oceanica*, which forms dense meadows in the central part of the gulf (between Marathonissi and Pelouzo Islands) as well as in the southwestern and southeastern regions. The main part of the northern, northwestern and northeastern regions consists of unvegetated sandbeds. In various areas of the Bay and mostly in the western region, meadows of *Cymodocea nodosa* (Ucria) Ascherson, sometimes mixed with tufts of *P. oceanica*, exist. The hard substratum is restricted to areas close to the coasts, mainly in the eastern part of the gulf, but also in the western part. In the northern central region of the gulf, reefs are present almost exclusively close to Agios Sostis harbor. The mosaic of reefs and *P. oceanica* meadows found mainly in the western part of Laganas Bay is of great significance (Pergent *et al.* 2003).

Another marine phanerogam observed in the area studied is *Halophila stipulacea* (Forsskål) Ascherson. *H. stipulacea* is a tropical subtidal seagrass introduced into the Mediterranean Sea, probably from the Red Sea through the Suez Canal (Lipkin 1975). This species has been recorded in various areas along the Greek coasts (Haritonidis and Diapoulis 1990). In the Ionian Islands only floating leaves were observed in Paxi Islands (no fixed whole plants), and the exact place of origin could not be determined (Tsekos and Haritonidis 1977). In Laganas Bay, *H. stipulacea* forms a restricted dense meadow in Ag. Sostis harbor (Site 9). The presence of this species at this site as well as its absence from the

rest of the area studied could indicate its transportation from another region, possibly *via* shipping.

In the area studied a total of 182 macroalgal taxa at specific and infraspecific level was identified (Table 1). The red algae dominate with 120 representatives, whereas the brown and green algae have 30 and 32 representatives, respectively. One hundred and forty-six of the species identified are new to Zakynthos Island, 52 to the Ionian Islands, 36 to the Greek coasts of the Ionian Sea and 12 to the Greek coasts in general (Table 1). These 12 species have been recorded previously from other regions of the Mediterranean Sea and their absence from the Greek coasts could be attributed to the limited number of surveys in the latter area. *Botryocladia chiajeana* (Meneghini) Kylin and *Botryocladia microphysa* (Hauck) Kylin, for example, have been found in several localities in the Mediterranean Sea (Turna et al. 2000). *Ceramium strobiliforme* G.W. Lawson et D.M. John has been recorded from the Italian coasts (Cormaci et al. 1992, Furnari et al. 1999). *Laurencia* species recorded here from Greek coasts for the first time have been recorded from other Mediterranean areas previously (Furnari et al. 2001). Among the species new to Greece, the brown alga *Discosporangium mesarthrocarpum* (Meneghini) Hauck is of great importance. It is very abundant as an epiphyte on *Cystoseira* species. This species is widely distributed only in the western Mediterranean Sea (Ribera et al. 1992).

Comparing the number of species found in Laganas Bay during the current study with those of other eastern Mediterranean areas, the benthic marine macroflora of the National Marine Park of Zakynthos seems rather rich. For example, the species recorded in the North Aegean Sea are: 121 species in the Thermaikos Gulf (Haritonidis 1978), 70 in Chalkidiki (Tsekos et al. 1982), 180 in the Lesvos and Thasos Islands (Haritonidis and Tsekos 1974), 110 in the North Sporades Islands (Nikolaidis and Haritonidis 1990) and 289 in Sithonia (Athanasiadis 1987). The numbers of species recorded from the south Aegean Sea are: 168 species throughout the area (Giaccone 1968a,b,c,d), 89 from Milos and Sikinos Islands (Coppejans 1974), 144 from Rhodos Island (Diannelidis et al. 1977), 190 from Milos Island (Lazaridou 1994) and 83 from the same island (Sartoni and De Biasi 1999). In the Ionian Sea, Schnetter and Schnetter (1981) mentioned 265 species in Kefalonia Island and Tsekos and Haritonidis (1977) found 163 species from various localities of the Ionian Islands. In other studies carried out in the eastern Mediterranean Sea, 179 and 288 species were recorded from the Turkish (Güven and Ötzig 1971) and Syrian (Mayhoub 1976) coasts, respectively. All of the above numbers seem remarkably low when compared with surveys in the western Mediterranean Sea. Verlaque (1987) recorded 510 species from Corsica, Giaccone et al. (1985) found 677 species from Sicily and Cormaci et al. (1997) recorded 223 species from the Maltese Islands. A general opinion exists that species diversity and biomass of the Mediterranean biota decline from west to east (Ketchum 1983), as a result of dissimilarities in abiotic parameters and paleoclimatic and hydrologic events (Lüning 1990). According to Giaccone and Di Martino (2000), the profound differences that exist both in the

floristic contingent and in the distribution patterns of plants between the western and eastern basin of the Mediterranean Sea, may be explained by paleoclimatic data reconstructed through the cycles of Milankovich and the Sapropel crises.

Tsekos and Haritonidis (1977) identified 69 species of macroalgae in three sites in Zakynthos Island. In one of the above sites, which was located in Laganas Bay (Keri), 31 species of macroalgae were observed. The impoverished flora may be explained by the lack of appropriate substrata in this site, as well as by the limited depth where the sampling took place.

Due to the fact that sampling took place in relatively shallow waters (2–12 m depth) during the current study, it is almost certain that the benthic marine flora of Laganas Bay exceeds the 182 species collected. Comparing floristic assemblages collected in the 8 sites with hard substrata, no remarkable differences in composition and species distribution along the bathymetric gradient were observed, with the exception of Pelouzo Island's sites (5 and 6) which show the lowest number of species. The genus *Cystoseira* characterizes most of the rocky underwater landscape in the region studied, with a remarkable frequency of *C. spinosa* Sauvageau, a species that has recently disappeared from different areas of the eastern Mediterranean Sea (Marino et al. 1999, Cormaci and Furnari 1999).

Among the 182 species of macroalgae and the three species of marine phanerogams found in Laganas Bay, six have probably been introduced to the Mediterranean Sea (Boudouresque and Verlaque 2002): the red algae *Lophocladia lallemandii* (Montagne) F. Schmitz, the *Falkenbergia* (tetrasporophyte) stage of *Asparagopsis armata* Harvey and *Womersleyella setacea* (Hollenberg) R.E. Norris, the brown alga *Colpomenia peregrina* Sauvageau, the green alga *Caulerpa racemosa* (Forsskål) J. Agardh var. *cylindracea* (Sonder) Verlaque, Huisman et Boudouresque and the phanerogam *Halophila stipulacea*. Boudouresque and Verlaque (2002), on the basis of several bibliographic references, considered five of the above species (all except *C. peregrina*) as invasive organisms in the Mediterranean Sea. *W. setacea* in both the Aegean Sea (Athanasiadis 1997) and the Ionian Sea (personal unpublished data), *C. racemosa* (Panayotidis and Montesanto 1994) and *H. stipulacea* (Haritonidis and Diapoulis 1990) can be considered as invasives.

Asparagopsis armata (the tetrasporophyte) and *Lophocladia lallemandii* formed populations of low density on *Cystoseira* and other macroalgal species. *Womersleyella setacea* occurred in turfs in low abundance on the substrata with other red algae, in contrast to the dense turfs that this red alga forms in other regions of the Greek coasts. *Caulerpa racemosa* var. *cylindracea* may be considered as invasive in Laganas Bay. This 'invasive variety' of *C. racemosa* (as stated by Verlaque et al. 2003) was first recorded in Laganas Bay by Panayotidis and Montesanto (1994, as *C. racemosa*). *C. racemosa* var. *cylindracea* was present in all of the selected sites, from 2 to 40 m depth, settling on several kinds of substrata (bare rocks, benthic fauna, encrusting algae, turf species and erect algae). The species expansion was much more significant at greater depths. The presence of this species

Table 1 List of species.

	S1	S2	S3	S4	S5	S6	S7	S8
	Rhodophyceae							
I					+			+
	<i>Acrochaetium mediterraneum</i> (Levring) Boudouresque							
W							+	
	<i>Acrochaetium microscopicum</i> (Nägeli ex Kützing) Nägeli							
W							+	+
	<i>Acrochaetium secundatum</i> (Lyngbye) Nägeli							
Z	+	+	+				+	+
	<i>Acrodiscus vidovichii</i> (Meneghini) Zanardini							
Z		+	+	+				+
	<i>Alsidium helminthochorton</i> (Schwendemann) Kützing							
Z	+							
	<i>Amphiroa rigida</i> J.V. Lamouroux							
Z			+	+				
	<i>Anotrichium barbatum</i> (C. Agardh) Nägeli							
Z	+	+				+		
	<i>Anotrichium tenue</i> (C. Agardh) Nägeli							
							+	
	<i>Antithamnion cruciatum</i> (C. Agardh) Nägeli							
W		+	+					+
	<i>Antithamnion piliferum</i> Cormaci et G. Furnari							
W		+						
	<i>Apoglossum ruscifolium</i> (Turner) J. Agardh							
Z	+	+	+	+	+	+	+	+
	<i>Boergesenella fruticulosa</i> (Wulfen) Kylin							
W	+			+				
	<i>Botryocladia boergesenii</i> J. Feldmann							
Z			+					
	<i>Botryocladia botryoides</i> (Wulfen) J. Feldmann							
G	+		+	+				
	<i>Botryocladia chiajeana</i> (Meneghini) Kylin							
G			+					
	<i>Botryocladia microphysa</i> (Hauck) Kylin							
W				+				
	<i>Brongniartella byssoides</i> (Goodenough et Woodward) F. Schmitz							
		+	+	+				+
	<i>Callithamnion corymbosum</i> (J.E. Smith) Lyngbye							
I		+						
	<i>Ceramium cimbricum</i> H.E. Petersen (H.E. Petersen) G. Furnari et Serio							
Z	+	+	+	+	+	+	+	+
	<i>Ceramium codii</i> (H. Richards) Mazoyer							
Z	+							
	<i>Ceramium comptum</i> Börgesen							
			+	+	+	+	+	+
	<i>Ceramium diaphanum</i> (Lightfoot) Roth							
Z	+	+	+	+	+	+	+	+
	<i>Ceramium flaccidum</i> (Harvey ex Kützing) Ardissonne							
G	+	+	+	+	+		+	+
	<i>Ceramium strobiliforme</i> G.W. Lawson et D.M. John							
Z	+	+	+	+	+		+	+
	<i>Ceramium tenerrimum</i> (G. Martens) Okamura							
Z	+	+	+	+		+	+	+
	<i>Champia parvula</i> (C. Agardh) Harvey							
Z				+				
	<i>Chondria capillaris</i> (Hudson) M.J. Wynne							
Z			+	+		+	+	
	<i>Chondria dasyphylla</i> (Woodward) C. Agardh							
W			+	+			+	
	<i>Chondria mairei</i> Feldmann-Mazoyer							
Z	+			+			+	
	<i>Chondria scintillans</i> Feldmann-Mazoyer							
Z					+			
	<i>Chondrophycus thuyoides</i> (Kützing) G. Furnari							
W	+			+	+		+	+
	<i>Choreonema thuretii</i> (Bornet) F. Schmitz							
Z	+	+	+	+	+	+	+	+
	<i>Chroodactylon ornatum</i> (C. Agardh) Basson							
Z	+	+	+	+	+	+	+	+
	<i>Chylocladia verticillata</i> (Lightfoot) Bliding							
Z	+	+					+	
	<i>Crouania attenuata</i> (C. Agardh) J. Agardh							
Z			+			+		
	<i>Cryptonemia lomation</i> (A. Bertoloni) J. Agardh							
Z	+	+	+	+	+		+	
	<i>Dasya corymbifera</i> J. Agardh							
Z			+	+		+		
	<i>Dasya hutchinsiae</i> Harvey							
Z	+	+			+	+		
	<i>Dasya ocellata</i> (Grateloup) Harvey							
I	+		+	+	+	+	+	+
	<i>Dasya rigidula</i> (Kützing) Ardissonne							
Z	+	+	+	+	+	+	+	+
	<i>Dipterosiphonia rigens</i> (Schousboe ex C. Agardh) Falkenberg							
I			+	+	+			
	<i>Erythrocladia irregularis</i> Rosevinge							
Z	+	+	+	+	+	+	+	+
	<i>Erythrotrichia carnea</i> (Dillwyn) J. Agardh							
Z	+	+	+	+				
	<i>Eupogodon planus</i> (C. Agardh) Kützing							
I	+	+	+	+	+	+	+	+
	<i>Falkenbergia rufolanosa</i> (Harvey) Schmitz' life-history phase of <i>Asparagopsis armata</i> Harvey							
W	+	+	+	+		+		
	<i>Feldmannophycus rayssiae</i> (J. Feldmann et G. Feldmann-Mazoyer) H. Augier et Boudouresque							
W	+							
	<i>Gelidiella antipae</i> Celan							
Z	+		+					+
	<i>Gelidium bipectinatum</i> G. Furnari							
	+							
	<i>Gelidium pusillum</i> (Stackhouse) Le Jolis							
Z			+					
	<i>Gelidium spinosum</i> (S.G. Gmelin) P.C. Silva							
W			+	+				
	<i>Gulsonia nodulosa</i> (Ercegovic) J. Feldmann et G. Feldmann							
Z				+				
	<i>Gymnothamnion elegans</i> (Schousboe ex C. Agardh) J. Agardh							
Z	+	+	+	+	+	+	+	+
	<i>Haliptilon virgatum</i> (Zanardini) Garbary et H.W. Johansen							
							+	
	<i>Halopitys incurva</i> (Hudson) Batters							
Z							+	
	<i>Halydictyon mirabile</i> Zanardini							
	+	+	+	+	+	+	+	+
	<i>Herposiphonia secunda</i> (C. Agardh) Ambronn							
	+	+	+	+			+	+
	<i>Herposiphonia tenella</i> (C. Agardh) Ambronn							
Z	+	+	+	+	+	+	+	+
	<i>Heterosiphonia crispella</i> (C. Agardh) M.J. Wynne							
G					+			
	<i>Hydrolithon cruciatum</i> (Bressan) Y.M. Chamberlain*							

(Table 1 continued)

		S1	S2	S3	S4	S5	S6	S7	S8
W	<i>Hydrolithon farinosum</i> (J.V. Lamouroux) Penrose et Y.M. Chamberlain var. <i>chalicodictyum</i> (W.R. Taylor) Serio			+					
	<i>Hydrolithon farinosum</i> (J.V. Lamouroux) Penrose et Y.M. Chamberlain var. <i>farinosum</i>	+	+	+	+	+	+	+	+
Z	<i>Hypoglossum hypoglossoides</i> (Stackhouse) Collins et Harvey	+							
W	<i>Jania adhaerens</i> J.V. Lamouroux				+			+	+
	<i>Jania longifurca</i> Zanardini	+				+		+	+
Z	<i>Jania rubens</i> (Linnaeus) J.V. Lamouroux var. <i>corniculata</i> (Linnaeus) Yendo	+		+	+		+	+	+
	<i>Jania rubens</i> (Linnaeus) J.V. Lamouroux var. <i>rubens</i>	+	+	+	+	+	+	+	+
G	<i>Laurencia caduciramulosa</i> Masuda et Kawaguchi	+		+		+			
G	<i>Laurencia</i> cf. <i>majuscula</i> (Harvey) A.H.S. Lucas	+		+					
G	<i>Laurencia chondrioides</i> Børgesen	+	+	+	+		+	+	+
G	<i>Laurencia intricata</i> J.V. Lamouroux	+		+	+	+	+	+	
W	<i>Laurencia microcladia</i> Kützing	+	+	+	+		+	+	+
G	<i>Laurencia minuta</i> Vandermeulen, Garbary et Guiry subsp. <i>scammaccae</i> G. Furnari et Cormaci	+			+		+		
Z	<i>Laurencia obtusa</i> (Hudson) J.V. Lamouroux			+				+	
Z	<i>Lejolisia mediterranea</i> Bornet		+	+	+	+		+	+
W	<i>Lithophyllum dentatum</i> (Kützing) Foslie		+						
	<i>Lithophyllum incrustans</i> Philippi	+	+	+	+			+	+
I	<i>Lithophyllum stictaeforme</i> (Areschoug) Hauck	+	+						
Z	<i>Lithothamnion corallioides</i> (P. et H. Crouan) P. et H. Crouan				+	+		+	
Z	<i>Lomentaria chylocradiella</i> Funk			+					
G	<i>Lomentaria clavaeformis</i> Ercegovic	+		+					
Z	<i>Lophocladia lallemandii</i> (Montagne) F. Schmitz	+	+	+	+	+	+	+	+
I	<i>Lophosiphonia cristata</i> Falkenberg		+	+	+	+			+
Z	<i>Lophosiphonia obscura</i> (C. Agardh) Falkenberg	+	+	+	+	+	+	+	+
Z	<i>Lophosiphonia reptabunda</i> (Suhr) Kylin	+		+	+				
I	<i>Melobesia membranacea</i> (Esper) J.V. Lamouroux	+	+	+	+	+	+	+	+
Z	<i>Meredithia microphylla</i> (J. Agardh) J. Agardh	+		+	+			+	
Z	<i>Mesophyllum philippii</i> (Foslie) Adey		+		+				
Z	<i>Monosporus pedicellatus</i> (J.E. Smith) Solier			+					
Z	<i>Myriogramme minuta</i> Kylin	+		+					
Z	<i>Neurocaulon foliosum</i> (Meneghini) Zanardini							+	
W	<i>Nitophyllum micropunctatum</i> Funk		+		+				
Z	<i>Nitophyllum punctatum</i> (Stackhouse) Greville	+							
Z	<i>Osmundaria volubilis</i> (Linnaeus) R.E. Norris		+						
Z	<i>Peyssonnelia bornetii</i> Boudouresque et Denizot	+							
I	<i>Peyssonnelia harveyana</i> P. et H. Crouan ex J. Agardh							+	
Z	<i>Peyssonnelia polymorpha</i> (Zanardini) F. Schmitz	+							
Z	<i>Peyssonnelia rubra</i> (Greville) J. Agardh	+	+	+		+			
Z	<i>Peyssonnelia squamaria</i> (S.G. Gmelin) Decaisne		+	+					
	<i>Phymatolithon lenormandii</i> (Areschoug) W.H. Adey		+					+	
Z	<i>Pneophyllum fragile</i> Kützing	+	+	+	+	+	+	+	+
W	<i>Polysiphonia atlantica</i> Kapraun et J.N. Norris	+	+	+	+	+	+	+	+
Z	<i>Polysiphonia breviarticulata</i> (C. Agardh) Zanardini				+	+		+	
Z	<i>Polysiphonia denudata</i> (Dillwyn) Greville ex Harvey		+	+			+		
Z	<i>Polysiphonia fucooides</i> (Hudson) Greville	+		+	+				
	<i>Polysiphonia furcellata</i> (C. Agardh) Harvey			+					
I	<i>Polysiphonia scopulorum</i> Harvey	+	+	+	+	+	+	+	+
Z	<i>Polysiphonia sertularioides</i> (Grateloup) J. Agardh	+		+	+			+	+
Z	<i>Rhodymenia ardissoni</i> J. Feldmann			+					
Z	<i>Rytiphlaea tinctoria</i> (Clemente) C. Agardh	+	+	+	+	+	+	+	+
Z	<i>Schizymenia dubyi</i> (Chauvin ex Duby) J. Agardh				+				
Z	<i>Spermothamnion repens</i> (Dillwyn) Rosenvinge		+	+	+	+		+	+
	<i>Spyridia filamentosa</i> (Wulfen) Harvey	+				+			
Z	<i>Stylonema alsidii</i> (Zanardini) K.M. Drew	+	+	+	+	+	+	+	+
I	<i>Stylonema cornu-cervi</i> Reinsch				+				
Z	<i>Taenioma nanum</i> (Kützing) Papenfuss	+	+	+	+		+	+	+
Z	<i>Titanoderma cystoseirae</i> (Hauck) Woelkerling, Y.M. Chamberlain et P.C. Silva	+	+		+	+	+		
Z	<i>Tricleocarpa fragilis</i> (Linnaeus) Huisman et R.A. Townsend				+				
W	<i>Womersleyella setacea</i> (Hollenberg) R.E. Norris	+	+		+	+			+
	<i>Wrangelia penicillata</i> (C. Agardh) C. Agardh	+	+	+	+	+	+	+	+
Z	<i>Wurdemannia miniata</i> (Sprengel) Feldmann et Hamel						+		

(Table 1 continued)

		S1	S2	S3	S4	S5	S6	S7	S8
	Phaeophyceae								
Z	<i>Acinetospora crinita</i> (Carmichael) Sauvageau	+	+	+		+			
Z	' <i>Aglaozonia melanoidea</i> Sauvageau' life-history phase of <i>Cutleria adpersa</i> (Mertens ex Roth) De Notaris					+			
Z	' <i>Aglaozonia parvula</i> (Greville) Zanardini' life-history phase of <i>Cutleria multifida</i> (J.E. Smith) Greville	+						+	+
W	<i>Colpomenia peregrina</i> Sauvageau		+						
Z	<i>Cystoseira amentacea</i> (C. Agardh) Bory	+	+	+	+	+	+	+	+
W	<i>Cystoseira barbatula</i> Kützing	+				+		+	+
I	<i>Cystoseira elegans</i> Sauvageau	+	+	+	+	+	+	+	+
	<i>Cystoseira foeniculacea</i> (Linnaeus) Greville		+		+	+	+	+	+
	<i>Cystoseira spinosa</i> Sauvageau	+		+	+		+	+	+
	<i>Dictyopteris polypodioides</i> (A.P. De Candolle) J.V. Lamouroux		+	+	+	+			+
	<i>Dictyota dichotoma</i> (Hudson) J.V. Lamouroux var. <i>dichotoma</i>		+	+	+	+	+	+	+
Z	<i>Dictyota dichotoma</i> (Hudson) J.V. Lamouroux var. <i>intricata</i> (C. Agardh) Greville	+	+		+	+	+	+	+
Z	<i>Dictyota fasciola</i> (Roth) J.V. Lamouroux var. <i>fasciola</i>	+							
Z	<i>Dictyota fasciola</i> (Roth) J.V. Lamouroux var. <i>repens</i> (J. Agardh) Ardissonne		+	+	+		+	+	+
	<i>Dictyota linearis</i> (C. Agardh) Greville	+	+	+	+	+	+	+	+
I	<i>Dictyota mediterranea</i> (Schiffner) G. Furnari	+	+	+	+	+	+	+	+
G	<i>Discosporangium mesarthrocarpum</i> (Meneghini) Hauck	+	+	+	+	+	+	+	+
	<i>Ectocarpus siliculosus</i> (Dillwyn) Lyngbye				+				
G	<i>Elachista neglecta</i> Kuckuck <i>nom. illeg.</i>							+	
Z	<i>Feldmannia caespitula</i> (J. Agardh) Knoepffler-Péguy				+			+	
	<i>Feldmannia irregularis</i> (Kützing) Hamel	+							
Z	<i>Lobophora variegata</i> (J.V. Lamouroux) Womersley ex E.C. Oliveira	+						+	
	<i>Padina pavonica</i> (Linnaeus) J.V. Lamouroux	+	+		+	+	+	+	+
Z	<i>Sargassum vulgare</i> C. Agardh <i>nom. illeg.</i>								+
Z	<i>Sphacelaria cirrosa</i> (Roth) C. Agardh	+	+	+	+	+	+	+	+
W	<i>Sphacelaria fusca</i> (Hudson) S.F. Gray				+			+	+
Z	<i>Sphacelaria plumula</i> Zanardini			+	+	+			
Z	<i>Sphacelaria rigidula</i> Kützing		+		+	+		+	+
	<i>Sphacelaria tribuloides</i> Meneghini								+
	<i>Stypocaulon scoparium</i> (Linnaeus) Kützing		+		+	+	+	+	
	Chlorophyceae								
	<i>Acetabularia acetabulum</i> (Linnaeus) P.C. Silva				+				
I	<i>Acrochaete viridis</i> (Reinke) Nielsen	+							
Z	<i>Anadyomene stellata</i> (Wulfen) C. Agardh	+	+		+	+	+	+	
	<i>Caulerpa prolifera</i> (Forsskål) J.V. Lamouroux				+				
	<i>Caulerpa racemosa</i> (Forsskål) J. Agardh var. <i>cylindracea</i> (Sonder) Verlaque, Huisman et Boudouresque	+	+	+	+	+	+	+	+
I	<i>Chaetomorpha aerea</i> (Dillwyn) Kützing	+		+					
	<i>Chaetomorpha linum</i> (O.F. Muller) Kützing		+						+
Z	<i>Chaetomorpha mediterranea</i> (Kützing) Kützing	+			+				+
	<i>Cladophora albida</i> (Nees) Kützing				+	+			
I	<i>Cladophora coelothrix</i> Kützing			+	+			+	
	<i>Cladophora dalmatica</i> Kützing	+	+	+	+	+	+	+	+
Z	<i>Cladophora echinus</i> (Biasoletto) Kützing	+	+	+	+	+	+	+	+
Z	<i>Cladophora hutchinsiae</i> (Dillwyn) Kützing				+				
	<i>Cladophora laetevirens</i> (Dillwyn) Kützing		+		+		+		
Z	<i>Cladophora pellucida</i> (Hudson) Kützing	+					+		+
	<i>Cladophora prolifera</i> (Roth) Kützing	+	+	+	+	+		+	+
	<i>Cladophora sericea</i> (Hudson) Kützing							+	
Z	<i>Cladophora socialis</i> Kützing	+			+		+	+	
Z	<i>Cladophoropsis modonensis</i> (Kützing) Reinbold				+		+	+	
Z	<i>Codium adhaerens</i> C. Agardh				+				
	<i>Dasycladus vermicularis</i> (Scopoli) Krasser	+	+		+	+		+	+
Z	<i>Derbessia tenuissima</i> (Moris et De Notaris) P. et H. Crouan	+			+			+	
	<i>Flabellia petiolata</i> (Turra) Nizamuddin		+	+	+	+		+	+
Z	<i>Halimeda tuna</i> (Ellis et Solander) J.V. Lamouroux		+	+				+	+
W	<i>Microdictyon tenuius</i> Decaisne ex J.E. Gray								
Z	<i>Pedobesia simplex</i> (Meneghini ex Kützing) M.J. Wynne et Leliaert							+	
W	<i>Penicillus capitatus</i> Lamarck							+	
Z	<i>Phaeophila dendroides</i> (P. et H. Crouan) Batters				+	+			

(Table 1 continued)

		S1	S2	S3	S4	S5	S6	S7	S8
W	<i>Pringsheimiella scutata</i> (Reinke) Höhnelt ex Marchewianka							+	
Z	<i>Pseudochlorodesmis furcellata</i> (Zanardini) Børgesen		+	+	+		+	+	+
Z	<i>Valonia macrophysa</i> Kützinger			+	+	+	+	+	+
Z	<i>Valonia utricularis</i> (Roth) C. Agardh	+	+	+	+	+	+	+	+

Species recorded for the first time in Greece, on Greek coasts of the Ionian Sea, in the Ionian Islands and in Zakynthos Island are marked with G, W, I and Z, respectively. * According to Penrose (1996), *Hydrolithon cruciatum* (Bressan) Y.M. Chamberlain would be a heterotypic synonym of *Hydrolithon farinosum* (J.V. Lamouroux) Penrose et Y.M. Chamberlain.

was of great importance on soft substrata as well. It formed dense populations within *Posidonia oceanica* stands and especially near the limits of the meadows [the presence of the native species *C. prolifera* (Forsskål) Lamouroux was also important there], in the gaps in the meadows and it was present in the stand of *Halophila stipulacea* in Ag. Sostis harbor.

Conclusions

Evaluation of biodiversity in a marine protected area is of great importance for protection and conservation of natural habitats. The current study represents a first attempt to record the benthic macroflora in the National Marine Park of Zakynthos. The newly recorded species to Zakynthos Island demonstrate inadequate knowledge and the need of further surveys, necessary for sustainable management of the area.

The main characteristics of the benthic flora in Laganas Bay are:

- The high frequency of *Posidonia oceanica* meadows. The maintenance of the beds is of great importance for the conservation of the sandy nesting beaches for the sea turtle *Caretta caretta*.
- The dominance of *Cystoseira* species, forming dense populations and supporting a rich associated flora on hard substrata.
- The expansion of the green alga *Caulerpa racemosa* var. *cylindracea* leading to its characterization as 'invasive' in the area studied. Its possible effects on the native biocommunities need further investigation.

Acknowledgements

We wish to thank Dr. G. Skoufas for his kind assistance in the field work. Moreover, we are grateful to the organization of the National Marine Park of Zakynthos for providing essential help during our stay on Zakynthos Island. Finally, we are indebted to Mrs. E. Palantza for revising the English text and to the anonymous reviewers for their valuable comments. This work is part of the PhD Thesis by A. Tsirika and it is supported by the Operational Programme "Education and Initial Vocational Training" of the Hellenic Ministry of National Education and Religious Affairs.

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Received 23 June, 2004; accepted 9 December, 2004