REPUBLIC OF CROATIA
MINISTRY OF ENVIRONMENTAL AND NATURE PROTECTION

State Institute for Nature Protection

Priroda Public Institution

UNEP MAP RAC/SPA

MedMPAnet project

# TESTING OF MONITORING PROTOCOL FOR CORALLIGENOUS COMMUNITY 2014 FIELD REPORT

## CASE STUDY - CROATIA

**Published by:** RAC/SPA



**For bibliographic purposes, this volume may be cited as:**

RAC/SPA - UNEP/MAP, 2014. Testing of monitoring protocol for coralligenous community: 2014 Field Report. By Kipson S. Ed. RAC/SPA - MedMPAnet Project, Tunis: 91 p + annexes.

**Cover photo credit:** Sara KALEB.

This document has been elaborated within the framework of the Regional Project for the Development of a Mediterranean Marine and Coastal Protected Areas (MPAs) Network through the boosting of Mediterranean MPAs Creation and Management (MedMPAnet Project).

The MedMPAnet Project is implemented in the framework of the UNEP/MAP-GEF MedPartnership, with the financial support of EC, AECID and FFEM.

*Field work coordination, data collection and analysis, report preparation:*
Silvija Kipson: University of Zagreb, Faculty of Science, Zoology Department, Rooseveltov trg 6, 10000 Zagreb, Croatia, skipson@zg.biol.pmf.hr

***Collection of field data:***

Sara Kaleb: Department of Life Science, University of Trieste, Via L. Giorgieri 10, 34127 Trieste, Italy, sara.kaleb@gmail.com

Petra Rodić, Katja Jelić: State Institute for Nature protection, Trg Mažuranića 5, 10000 Zagreb, Croatia Katja.Jelic@dzzp.hr, petra.rodic@dzzp.hr

Dijana Župan: Učka Nature Park Public Institution, Liganj 42, 51415 Lovran, Croatia, dzupan@pp-ucka.hr

Ante Žuljević: Institute of Oceanography and Fisheries, Šetalište I. Meštrovića 63, 21000 Split, Croatia, zuljevic@izor.hr

Mosor Prvan: Association Sunce, Obala Hrvatskog narodnog preporoda 7, 21000 Split, Croatia, mosor.prvan@sunce-st.org

Maya Sertić: diver, maya.sertic@gmail.com

Ivan Velkovski: diver, velkovski.ivan@hotmail.com

*Contributor:* Patrik Krstinić: Public Institution „Priroda“, Grivica 4, 51000 Rijeka, Croatia, patrik.krstinic@ju-priroda.hr

*Dive officer*: Petronije Tasić

*Video operator*: Lorenzo Lucia

*Taxonomic identification of collected samples*: Maja Novosel (Bryozoa), Tatjana Bakran-Petricioli (Porifera), Sara Kaleb (Rhodophyta) and Petar Kružić (Anthozoa).

# FOREWARD

Development and testing of the coralligenous monitoring protocol has been carried out in the framework of the "MedMPAnet Project – Pilot project Croatia".

The pilot project in Croatia is part of the Regional Project for the Development of a **Med**iterranean **M**arine and Coastal **P**rotected **A**reas (MPAs) **Net**work through the boosting of MPAs creation and management (MedMPAnet) that includes 12 Mediterranean riparian countries.

The objective of the regional project consists in 'enhancing the effective conservation of regionally important coastal and marine biodiversity features, through the creation of an ecologically coherent MPA network in the Mediterranean region', as required by Barcelona Convention's Protocol concerning Specially Protected Areas and Biological Diversity in the Mediterranean (SPA/BD Protocol).

Project objectives in Croatia are to improve MPA management at local level through filling gaps in ecological and fisheries knowledge and better enforcement and monitoring and to assist the Croatian Government in implementing SPA/BD Protocol and developing marine part of Natura 2000 network through inventorying and mapping, as well as further development of national monitoring protocols.

Project partners in Croatia are the Ministry of Environmental and Nature Protection (MENP), the State Institute for Nature Protection (SINP) and the Public Institution "Priroda".

The project in Croatia is coordinated by the Ministry of Environmental and Nature Protection of the Republic of Croatia, whilst the regional project is coordinated by the Regional Activity Centre for Specially Protected Areas (RAC/SPA) based in Tunisia.

Project is funded by the European Commission, Spanish Agency for International Development Cooperation (AECID) and the French Global Environment Facility (FFEM). The MedMPAnet project is part of the MedPartnership GEF full size project "Strategic Partnership for the Mediterranean Sea Large Ecosystem" lead by UNEP/MAP.

# Contents

# Executive summary

This document reports on the additional field activities of a pilot study carried out from June 28th until July 11th 2014 within Primorje-Gorski Kotar County in order to:

1) Test the most recent version of the protocol proposed by the MedMPAnet Working Group for the monitoring of coralligenous outcrops, a habitat endemic to the Mediterranean Sea and included in the priority habitat type “1170 Reefs“ by the EU Habitats Directive

2) Check the applicability of low cost videography in the monitoring program

3) Assess additional coralligenous sites within Primorje-Gorski Kotar County that could qualify as sites of the national monitoring program

4) Contribute to the knowledge of sessile macrobenthos (algae and invertebrates) thriving in coralligenous community found within Primorje-Gorski Kotar County.

According to the proposal, underwater work included photosampling and visual census to collect data for the characterisation of the coralligenous structure and dynamics as well as on potential disturbances such as mass mortalities, mucilaginous algal aggregates, sedimentation and fishing impacts.

In total, 11 sites have been studied, all of them being recently suggested as proposed Natura 2000 sites, except one (Zečevo Islet). In addition, two studied sites where located within Prvić and Grgurov kanal Special Reserve. A total of 8 divers have participated in this field work, with affiliations at the University of Zagreb, University of Trieste, Institute of Oceanography and Fisheries, State Institute for Nature Protection, Učka Nature Park Public Institution and Public Institution "Priroda".

Overall, 330 images of 50 x 50 cm subquadrats have been examined and a total of 93 macrobenthic taxa (i.e. categories of sessile organisms) were identified from photographs: 19 macroalgae, 38 sponges, 10 anthozoans, 1 hydrozoan, 3 polychaetes, 1 bivalve, 10 bryozoans and 11 tunicates (see Appendix 3). Based on photosampling, the highest number

of taxa was recorded at the Cape Šilo at Prvić Island (65 taxa) and the lowest at the Cape Kinkela (46 taxa). Based on collection of physical samples of selected taxonomic groups during this fieldwork as well as results of previous fieldwork and available literature, a total of 206 species of sessile macrobenthos were recorded within Primorje & Gorski Kotar County: 36 macroalgae, 58 sponges, 30 anthozoans and 82 bryozoans. These data provide further insights for the proposed preliminary list of typical species, i.e. species to be considered in the inventory and/or monitoring of the Adriatic coralligenous assemblages.

Regarding potential stressors and gorgonian health status, in comparison with year 2013, 2 populations of *Paramuricea clavata* for which a previous assessment has been made displayed similar degree of injury (Šilo and Sokol), whereas 2 populations, namely Stražica and Tenki displayed considerable increase (20-25%) of affected colonies, putatively due to previously observed incidence of mucilaginous algal aggregates (occurring also in summer 2013). This year no mucilaginous algal aggregates were observed at the time of assessment and again, no invasive species were recorded, but discarded fishing gear remain a constant threat and was recorded at all surveyed sites in medium to high quantity.

As a result of this field work following conclusions and recommendations may be given:

- Increase in photo sampled area to better accommodate the assessment of parameters of structural complexity (cover of basal and intermediate layers) also resulted in a greater number of identified taxa (in comparison to assessment of the same site based on smaller sampled area), while not critically affecting the resolution of photographs in a manner to disable identification of small organisms with important functional role (thus included in the Preliminary list of typical/indicator species to be monitored), such as bioeroding bivalve *Gastrochaena dubia.*

- When the goal is also to characterize a certain coralligenous site for the first time (or to carry out a more comprehensive macrobenthic biodiversity assessment), it is recommended to perform photosampling of a minimum of 3 replicates of 0.5 $m^2$ using 25 x 25 cm subquadrats (as a part of the overall photo sampling effort) to ensure a more reliable identification of organisms (as suggested by Kipson et al. 2011), since certain level of detail (useful for species identification) is lost when 50 x 50 cm subquadrats are used. In addition, voucher specimens should be collected.

- The assessment of erect layer by visual assessment along transects is simple to apply and resulted in a similar evaluation by different observers.

- Videography obtained by GoPro camera fitted with external lightning provides a valuable low-cost tool for documentation of additional information on the dive and the diving site, assessment of coralligenous structural complexity and compilation of more complete species lists.

- Overall, the proposed protocol may be applied within a reasonable time frame when working at depths between 30 and 40 m and in this manner, a team of 4 divers may assess 1 site per dive.

- From newly assessed sites, Cape Stupova excels as a coastal Natura 2000 site within geographical Sector A (see Garrabou *et al.* 2014) due to representatively developed *Paramuricea clavata* assemblage (with the upper depth limit at 32 m, which is shallower than the other 2 sites in the same area) and still well preserved gorgonian population, but also presence of potential and evidenced threats (e.g. discarded fishing gear, mucilaginous algal aggregates, diving). Thus, together with Cape Lonjica it confirms the inclusion among proposed sites for monitoring of coralligenous habitat at the national level.

- From assessed sites that have not been proposed till now as a part of the national monitoring network, including sites of different protection level within 3 different geographical sectors, Zečevo Islet could be considered as one of the rare known sites hosting *Paramuricea clavata* assemblage within geographical sector A but without any protection status.

- To obtain even more comprehensive checklist of macrobenthos (but potentially also of other groups) thriving within coralligenous habitat of the County of Primorje & Gorski Kotar further fieldwork, including collection of physical samples, should be encouraged.

- Due to the considerable amounts of discarded fishing gear observed at every surveyed site, underwater clean-ups by volunteer divers could be considered as both

direct conservation measure and an awareness raising activity. These actions should be performed in a manner not to cause additional damage to organisms.

# 1. Introduction

## *1.1. Coralligenous habitat: development of a monitoring protocol*

Coralligenous assemblages are hotspots of biodiversity in the Mediterranean (harbouring approximately 20% of species) that exhibit great structural complexity, provide habitat for several species of commercial interest and offer a diving attraction (Harmelin & Marinopoulos 1994; Ballesteros 2006). These ecologically, aesthetically and economically valuable bioconstructions are facing major threats (Ballesteros 2006) and are included in the priority habitat type "1170 Reefs" by the EU Habitats Directive (92/43/EEC). To fulfil reporting and monitoring requirements of this Directive, development of the national coralligenous monitoring protocol has been recently initiated in Croatia in the framework of the MedMPAnet project.

The main goals pursued by the proposed protocol are to:

1. Gather community and habitat data for the characterisation of the structure and dynamics of coralligenous habitats
2. Assess stressors affecting the coralligenous habitat such as mass mortalities, mucilaginous algal aggregates, sedimentation, fishing impacts
3. Gather environmental data.

The monitoring envisaged the application of two methodological approaches by divers: photosampling and visual census. Photosampling was based on a validated method (Kipson et al. 2011), while some procedures during visual census were applied for the very first time in the field. To recapitulate, in the first version of the protocol, photosampling was used to determine community composition of macrobenthic species/categories, whereas visual census was used to assess the habitat complexity, gorgonian health status as well as the abundance of macrobioeroders, mucilaginous incidence, sedimentation levels and fishing impacts. The methods proposed were tested during field work in 2013 by most of national experts in order to obtain their opinion on the applicability and potential improvements of

the methods. Their comments during the debriefing and the comparison of data obtained from different assessments by different operators enabled us to determine the applicability and replicability of the proposed methods. Whereas no methodological modifications were envisaged for the assessment of gorgonian health status and fishing impact, the insights obtained during the field trip in 2013 resulted in modification of the assessment of most other parameters. In summary, it was decided that:

- Macrobioeroders (except sea-urchins), cover of basal and intermediate layers and sediment cover should be assessed from photographs (instead of visual assessment along transects in the field)
- Photosampled area should be increased to accommodate the assessment of above mentioned parameters (in addition to the previous ones)
- Categories used for the estimation of cover of mucilaginous aggregates should be simplified.

In view of these results a new monitoring protocol was developed and included in the Monitoring Program for Reefs – Coralligenous Community document (Garrabou *et al.* 2014).

## *1.2. The aim of this report*

The main aim of this document is to report on the additional field activities of a pilot study carried out from June 28$^{th}$ until July 11$^{th}$ 2014 within Primorje-Gorski Kotar County in order to:

1) Test the most recent version of the protocol proposed by the MedMPAnet Working Group for the monitoring of coralligenous outcrops
2) Check the applicability of low cost videography in the monitoring program
3) Assess additional coralligenous sites within Primorje-Gorski Kotar County that could qualify as sites of the national monitoring program

4) Provide a more complete checklist of sessile macrobenthos (algae and the main invertebrate groups) thriving in coralligenous community found within Primorje-Gorski Kotar County.

A synthesis of the main results is given and recommendations are provided.

# 2. Monitoring protocol applied

At each site photosampling was combined with visual census to gather the information on habitat structure and function as well as on the degree of impact of the main disturbances (for more details see Garrabou *et al.* 2014).

## *2.1. Photosampling*

A minimum of three areas of 2,5 $m^2$ (comprised of 10 contiguous photos of 50 x 50 cm quadrats to ensure species identification; Figs. 2.1, 2.2) were photosampled within the same depth range. Photos were taken with Canon D30 digital SLR camera fitted with a 17-55mm lens and housed in Ikelite housing. Lighting was provided by two electronic strobes fitted with diffusers. Such sampling enables further acquisition (through photo analysis) of data on: (i) the presence and abundance of typical (target) species, (ii) the structural complexity based on the cover of species/categories contributing to basal layer (including encrusting organisms, boring sponges, turf, bare rock and sediment) and intermediate layer (massive or bush-like organisms below 15 cm in height) (see below the description for assessment of the third, erect layer), (iii) bioconcretion (through estimation of cover of encrusting calcareous algae and macroinvertebrates contributing to build-up of the coralligenous outcrops) and (iv) bioerosion (through estimation of the cover of boring sponge *Cliona* spp. and enumeration of bioeroding molluscs *Gastrochaena dubia* and *Lithophaga lithophaga* as well as estimation of the effects of bioeroders from their grazing marks). Besides acquisition of data on habitat structure and function, photoquadrats obtained by photosampling furnish information on disturbances through estimates of abundance of invasive species and sediments (already available from the analysis of basal layer, as described above).

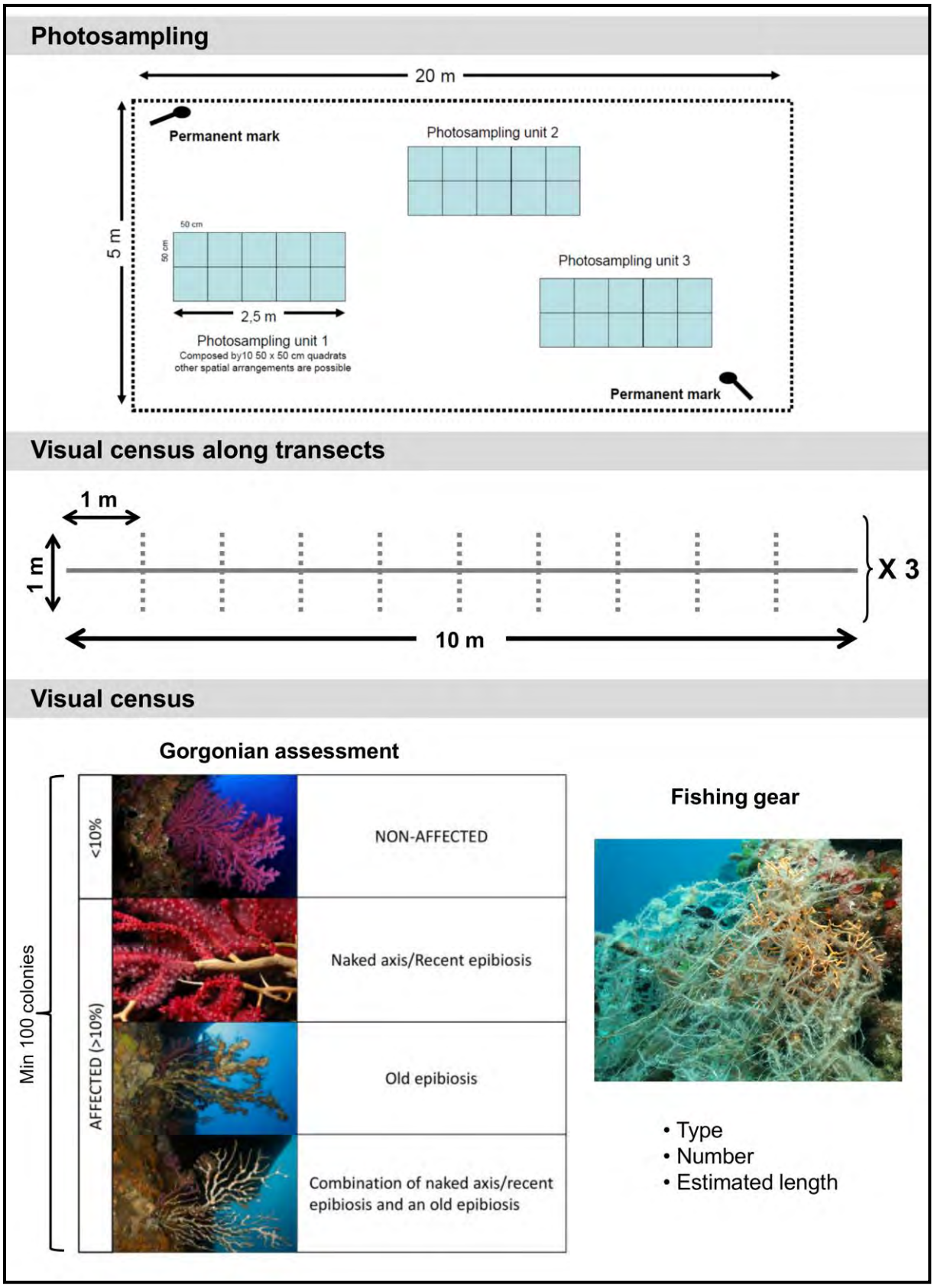



**Fig. 2.1. Sampling scheme of the proposed Croatian coralligenous monitoring protocol.**

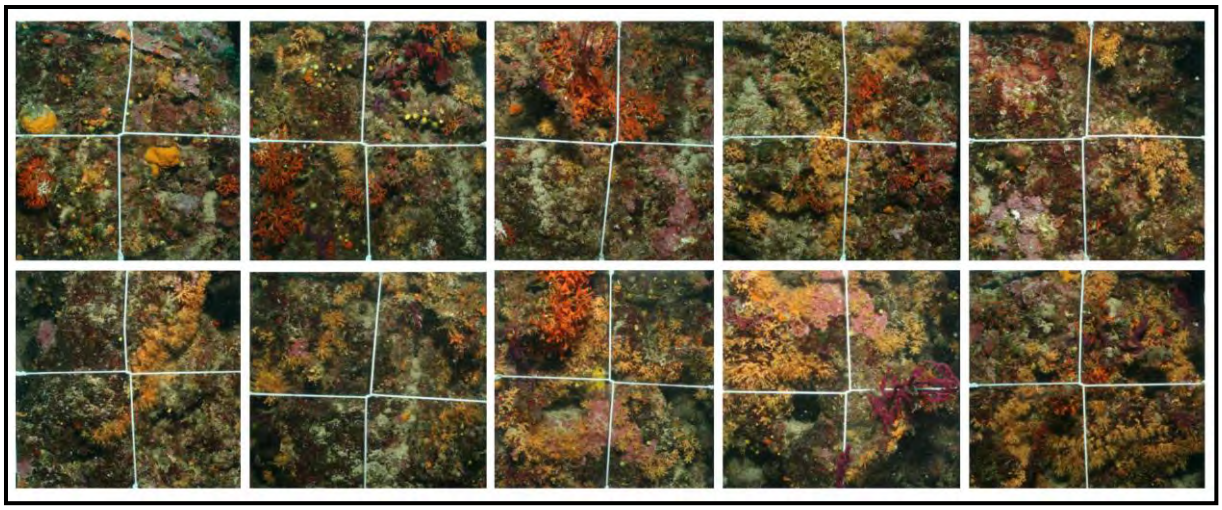


**Fig. 2.2. A replicate used in photosampling: an area of 2.5 $m^2$ obtained by combining 10 contiguous photos of 50 x 50 cm subquadrats. At each study site 3 replicates were sampled. The size of the replicate increased in comparison to the one tested during previous survey (in 2013). This example originates from Cape Sokol at the Krk Island.**

## *2.2. Visual census along the transects*

Visual census along three 10 x 1 m horizontal transects was carried out to assess the third component of degree of structural complexity - the erect layer (by estimating the abundance of arborescent and massive species that can reach heights and/or diameters above 15 cm). To help with the estimates divers used a bar of one meter long and noted species present as well as estimated their density within each 1 $m^2$. In this manner, the diver evaluated the density over the surface that extends 50 cm over and below the bar and afterwards he/she moved to the next $m^2$. To avoid counting of all colonies, the following categories of density were assessed for each quadrat:

| | Category | | | | |
|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 |
| N of colonies/$m^2$ | 0 | 1-2 | 2-10 | 10-20 | > 20 |

The total cover of the erect layer for each transect is obtained by summing up the values of scores for each category determined for each quadrat:

| | Category | | | | |
|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 |
| Score | 0 | 1 | 2 | 3 | 4 |

Finally, the cover of the erect layer is obtained from the total score per transect (i.e. the sum of the scores of ten quadrats). The total score can range from 0 to 40. The estimate of erect layer cover in each transect is determined according to the following categories:

| | Total score value | | | |
|---|---|---|---|---|
| | 0 | 1-10 | 11-20 | > 20 |
| Cover | Null | Low | Medium | High |

Besides estimation of the erect layer, visual census along the same transects allowed for estimation of abundance of macro-bioeroders such as sea urchins *Sphaerechinus granularis* and *Echinus* sp. (by counting total N of individuals of each species in each quadrat along the same transects) as well as estimation of the cover of mucilaginous aggregates. Estimates of the cover of mucilaginous aggregates can be made in each quadrat to cope with the potential heterogeneity, however usually this phenomenon is quite homogenous, at least at the scale of the 10 $m^2$ transects, and it could be easier to provide a single estimate for the whole transect. The following classification was applied:

Category 0 (Null): 0% cover of the transect;

Category 1 (Low): low abundance in the basal-intermediate layers and/or in the erect layer;

Category 2 (Medium): High abundance either in the basal-intermediate layers or in the erect layer;

Category 3 (High): High abundance both in the basal-intermediate layers and in the erect layer.

## *2.3. Visual census not associated to transects*

This method was used to assess degree of impact of disturbances such as fishing and mass mortalities of gorgonian populations. A diver made direct observation on the presence and type of fishing gear at the study site. If fishing net/long line was observed within the coralligenous habitat, its length was also estimated. According to the abundance of recorded fishing gear, following categories were assigned:

| | Total number of fishing gear | | |
|---|---|---|---|
| | 0 | 1-5 | > 5 |
| Category | Low | Medium | High |

To assess conservation status of gorgonian populations (provide estimates on the impacts of mass mortality on gorgonian populations), diver was quantifying the percentage of affected colonies at each study site where gorgonians were present in well developed populations. A colony was considered as affected when the necrosis rate was above 10 % of its total surface. For affected colonies a diver also noted whether the necrosis was recent (presence of denuded axis or axis colonized by pioneering species such as hydrozoans), old (axis covered by long-lived species such as bryozoans, calcareous algae) or displays both types of necrosis (Fig.2.1). At each site a minimum of 100 colonies (of each species present) was examined following a random transect.

## *2.4. Data recording*

Divers' briefing before the underwater work included a short presentation to recapitulate methods that will be used.

Data acquired during visual census and the assessment of gorgonian health were noted in prepared forms (see Appendix 1 and 2). These forms were printed on a special A4 paper that

can be used underwater (Canson, CAD Polyester matté double face 75 µ, Ref 987102). Forms were attached to plastic slates by a duct tape (Fig. 2.3). Depending on the size of the slate, form can be used in A4 format or cut in 2 (for visual census and gorgonian assessment) to fit the smaller slate, in which case it may be attached at both sides of the slate. One slate was provided to each observer. Upon the transcription of the data, pencil tracks may be erased and the same form may be used multiple times. Prior to erasing the data, it is also recommended to take a photo of the slate as a back-up documentation.

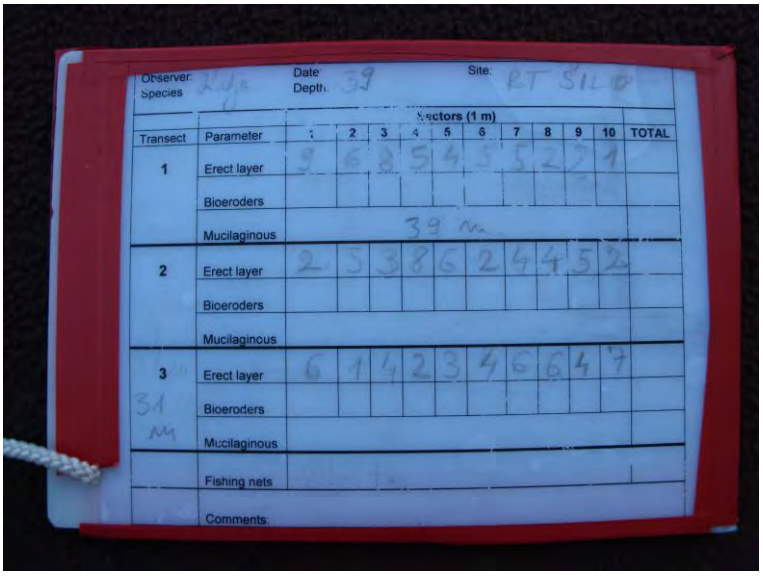



**Fig. 2.3. Example of the new form used for visual census attached to the plastic slate. Photo credit: S. Kipson.**

Besides data gathering by photosampling and visual census, additional documentation of study sites, diving path and coralligenous assemblages was provided by videography (Fig. 2.4, 2.5). This method may facilitate repeated locating of the area where assessment has been carried out and it can also assist in characterisation of the coralligenous habitat, since larger areas may be covered and thus, even greater insight may be gained into morphology of terrain/substrate, species presence/absence and structural complexity.

Additionally, our aim was to test the applicability of a GoPro camera as a low cost option for underwater videography (Fig. 2.4) and to investigate the level of information that could be extracted from such videos. Therefore, marked transects used by divers for visual census were at many sites also recorded with professional video camera as well as with a GoPro

camera (Fig. 2.5). In total, videos with professional camera were recorded at 6 sites, whereas videos with GoPro camera were recorded at 8 sites.

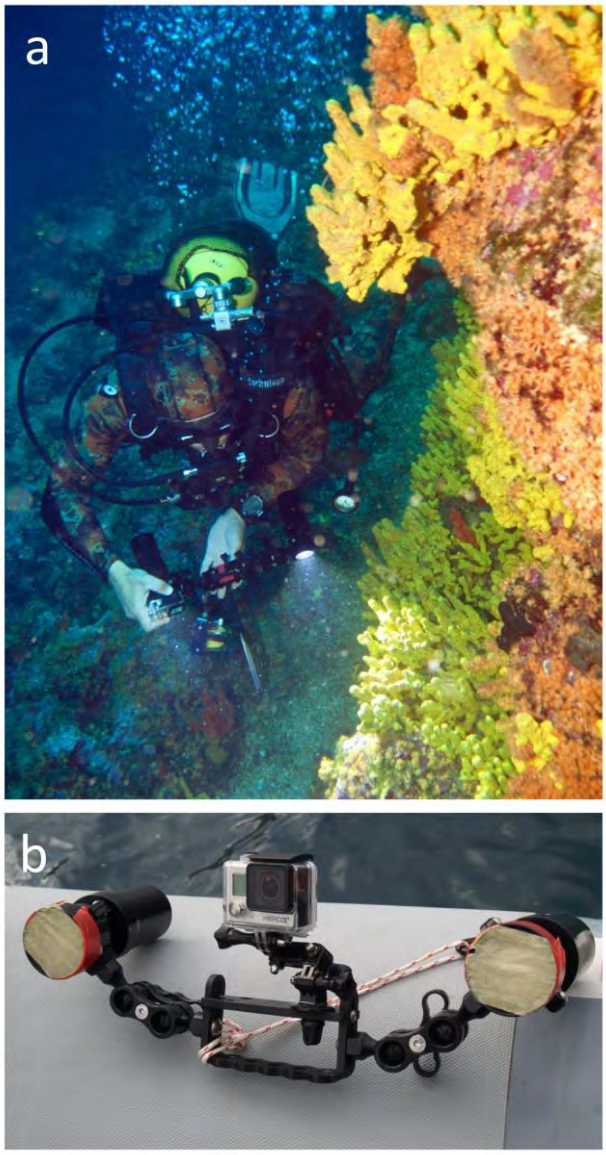



**Fig. 2.4. Video recording by GoPro HERO 3 camera (a), fitted with external lighting (b). Photo credit: (a) S. Kaleb, b) P. Krstinić.**

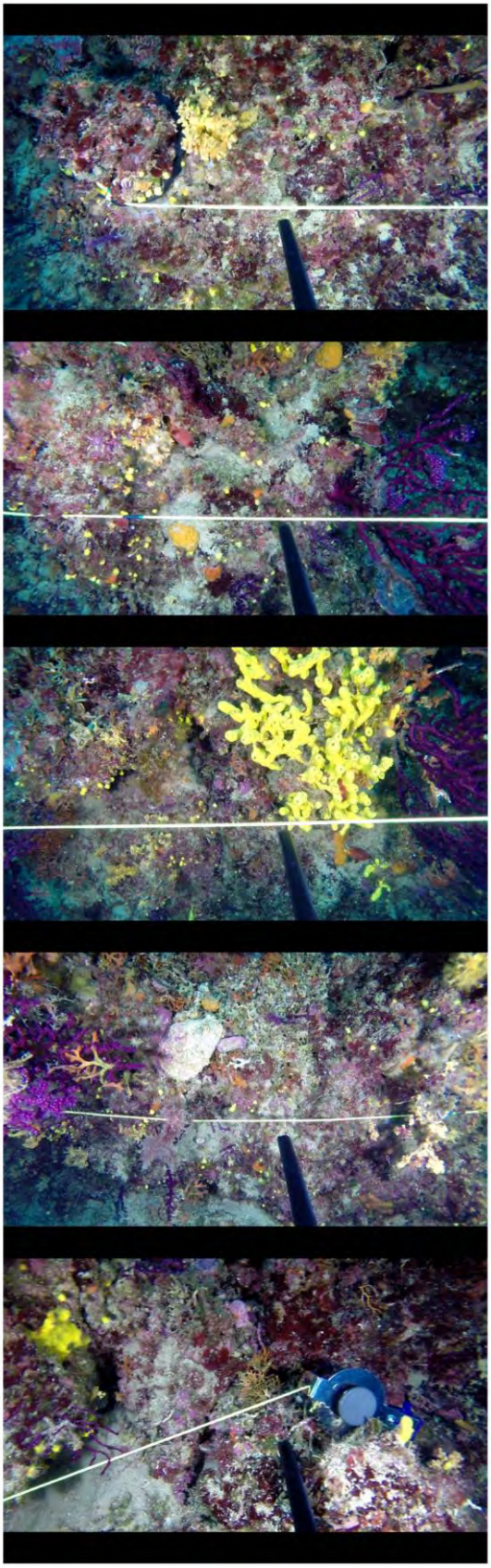


**Fig. 2.5. Parts of the marked video transect recorded with a GoPro camera**

## *2.5. Study sites*

Since the goals of this study were to test the most recent version of the protocol as well as to acquire further insights into coralligenous habitat within Primorje-Gorski Kotar County, we have aimed to reassess some sites, as well as to find additional sites that could serve as good reference sites and be potentially included in the national monitoring program. In total, 11 sites have been studied (Fig. 2.6), out of which 7 were new sites. At these sites coralligenous outcrops were present at two different substrate inclinations, vertical walls (Fig. 2.7c) and cascade-like rocky bottom (slope intercepted by smaller walls; Fig. 2.7d). In addition, we have aimed to assess sites with gorgonian dominated coralligenous communities, since they were selected as facia to be monitored within the national monitoring program. However, at one of the assessed sites (Cape Jablanac, Cres Island) visited for the first time, no gorgonian facies was found.

As envisaged by the protocol, each study site was documented as precisely as possible, by providing GPS coordinates and a photo showing terrestrial view of the site including recognizable landmarks when possible. In addition, the diving path was described with the assistance of photography and videography. All of this information was intended to facilitate the repeated locating of sites and areas where the assessment was carried out. For the description of study sites see Section 4.

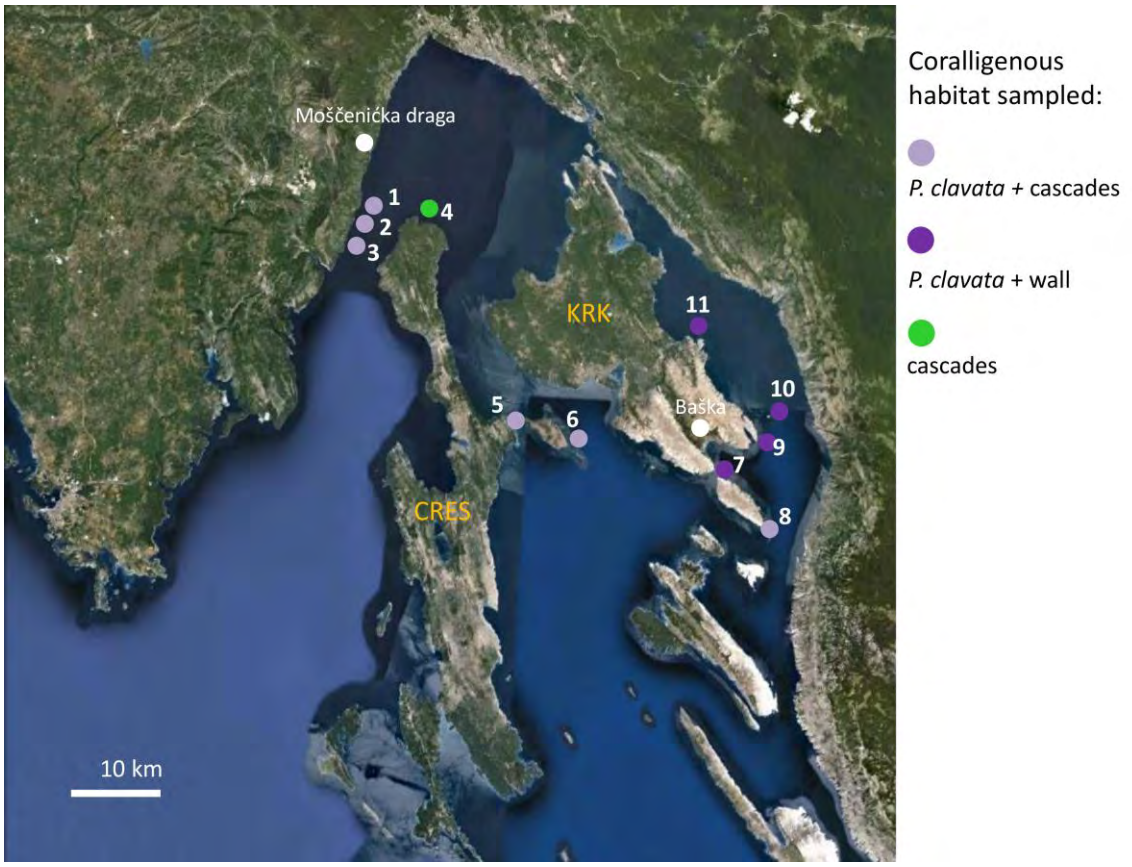



**Fig. 2.6. Study sites of coralligenous habitat within Primorje-Gorski Kotar County (North Adriatic): 1 = Cape Kinkela; 2 = Cape Lonjica; 3 = Cape Stupova; 4 = Cape Jablanac; 5 = Plavnik; 6 =Mali Plavnik; 7 =Cape Stražica; 8 = Cape Šilo; 9 = Cape Sokol; 10 = Zečevo; 11 = Tenki. Characteristics of study sites are summarized in Table 2.1. More detailed maps and the overview of sites that have been assessed for the first time are provided in the Section 4. Map source: Google Earth, Image © 2014 DigitalGlobe.**

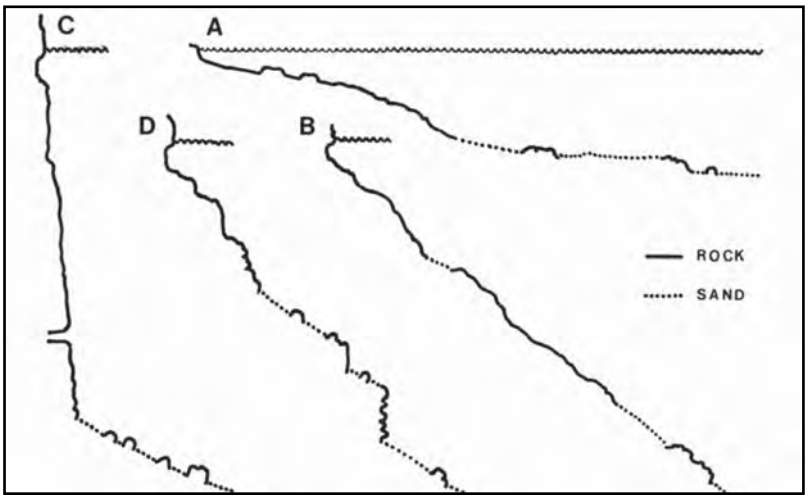



**Fig. 2.7. Slope types: A = gentle inclined slope; B = steep slope; C = vertical cliff and D = slope + walls (adopted from Zavodnik et al. 2005). Coralligenous assemblages assessed within this study were developed on slope types C and D.**

**Table 2.1. Characteristics of study sites within Primorje-Gorski Kotar County (North Adriatic). Cascades imply slopes intercepted by smaller vertical walls.**

| Site N | Location | Site | Abbrev. | Coordinates | | Habitat | Status |
|---|---|---|---|---|---|---|---|
| 1 | Mošćenice | Cape Kinkela | MDKI | 45°11'04.04''N | 14°14'41.63''E | cascades | Natura 2000[1] |
| 2 | Brseč | Cape Lonjica | MDLO | 45°10'10.85''N | 14°14'16.02''E | cascades | Natura 2000 |
| 3 | Brestova | Cape Stupova | MDST | 45°09'01.28''N | 14°13'44.46''E | cascades | Natura 2000 |
| 4 | Cres | Cape Jablanac | JAB | 44°10'31.97''N | 14°19'36.51''E | cascades | Natura 2000 |
| 5 | Plavnik | Plavnik | PLA | 44°58'37.10''N | 14°29'28.51''E | cascades | Natura 2000 |
| 6 | Mali Plavnik | Mali Plavnik | MP | 44°58'31.82''N | 14°32'52.04''E | vertical walls | Natura 2000 |
| 7 | Prvić | Cape Stražica | PRST | 44°56'05.18''N | 14°46'13.65''E | vertical walls | MPA, Natura 2000 |
| 8 | Prvić | Cape Šilo | PRSI | 44°53'02.87"N | 14°50'19.05"E | cascades | MPA, Natura 2000 |
| 9 | Krk | Cape Sokol | KRS | 44°58'14.19''N | 14°49'13.04''E | vertical walls | Natura 2000 |
| 10 | Zečevo | Zečevo | ZEC | 44°59'45.31''N | 14°50'11.71''E | vertical walls | unprotected |
| 11 | Krk | Tenki | KRPT | 45°04'17.88''N | 14°43'17.07''E | vertical walls | Natura 2000 |

[1] Status "Natura 2000" actually means that the sites are proposed as Natura 2000 sites (proposed Sites of Community Importance (pSCI)) to the European Commission. After the evaluation process and subject to approval, these sites will be proclaimed as Natura 2000 (Special Area of Conservation (SAC)) sites.

# 3. Testing of the updated version of the protocol

## *3.1. Photosampling*

**(1) Identification of species/categories (community composition) based on photosampling with increased sampling effort (larger replicates)**

**Main results:** Overall, 330 images of 50 x 50 cm subquadrats have been examined and a total of 93 macrobenthic taxa (i.e. categories of sessile organisms) were identified from photographs: 19 macroalgae, 38 sponges, 10 anthozoans, 1 hydrozoan, 3 polychaetes, 1 bivalve, 10 bryozoans and 11 tunicates (see Appendix 3). Based on photosampling, the highest number of taxa was recorded at the Cape Šilo at Prvić Island (65 taxa) and the lowest at the Cape Kinkela (46 taxa) (Fig. 3.1). Despite of the 3-fold higher sampling effort invested during this survey, i.e. larger area sampled in 2014 (3 replicates of 2,5 $m^2$ with a total of 7,5 $m^2$ per site) than in 2013 (5 replicates of 0,5 $m^2$ with a total of 2,5 $m^2$ per site), the highest species richness recorded was comparable (68 taxa recorded in 2013 at the North coast of Goli Island vs. 65 taxa recorded in 2014 at the Cape Šilo at Prvić Island).

Between 16 and 29 taxa were identified within the first 50 x 50 quadrat (Fig. 3.2). Furthermore, between 36 and 56 taxa were already identified within the first replicate (2,5 $m^2$), which accounts for 74 to 91% of the total number of taxa per site.

Although a similar number of taxa were recorded at most of the sites included in both 2013 and 2014 surveys (despite of the higher sampling effort involved in 2014), this number was always higher in 2014 and in the case of Cape Sokol site it was considerably higher (40 taxa recorded in 2013 vs. 58 taxa recorded in 2014). As already mentioned (see Garrabou & Kipson 2014) this site is characterized by representatively developed plate-like thalli of *Lithophyllum stictaeforme* that were covering a considerable proportions of sampling replicates in 2013 and putatively caused lower recorded taxa richness. Therefore, increased sampling effort in 2014 provided a more objective assessment of this site.

Seventeen of identified taxa were present at all of surveyed sites, whereas 27 taxa were present in 90% of sites (see Appendix 3).

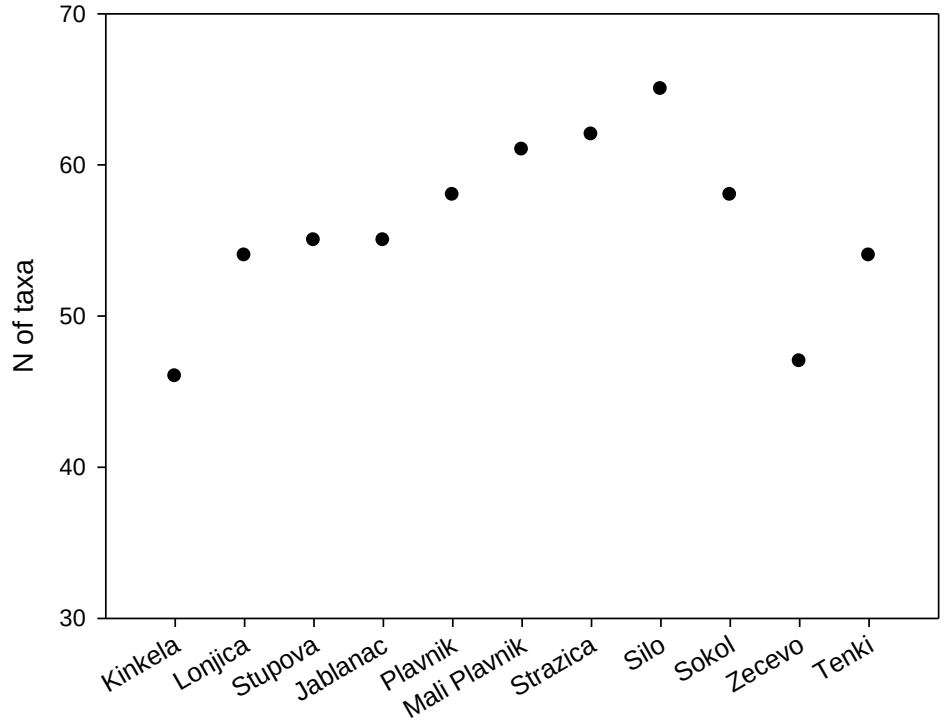



**Fig. 3.1. Species richness of coralligenous assemblages in Primorje-Gorski Kotar County (North-Eastern Adriatic Sea) based on photosampling of three replicates of 2,5 $m^2$.**

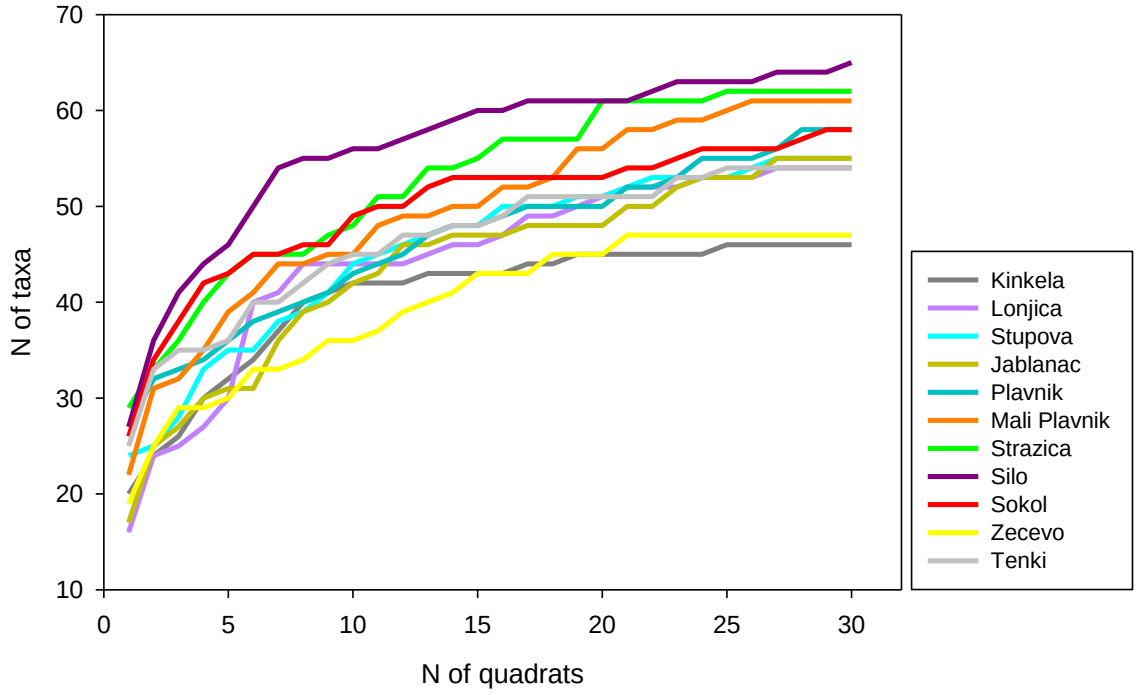



**Fig. 3.2. Number of taxa identified with increasing sampling effort (increased area sampled). The size of quadrat is 50 x 50 cm and 10 contiguous quadrats form a replicate of 2.5 $m^2$.**

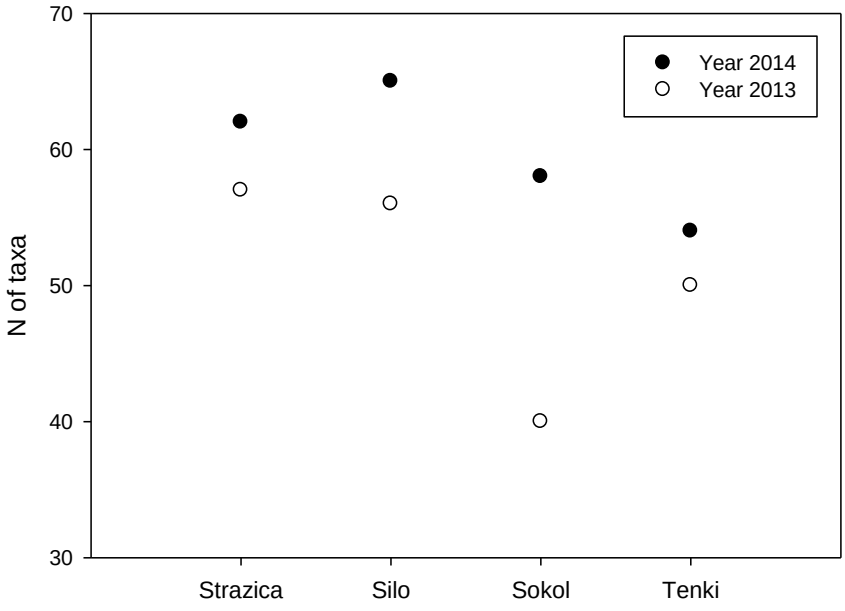



**Fig. 3.3. Species richness based on different sampling effort. Comparison of data acquired from analysis of 5 replicates of 0.5 $m^2$ (in 2013) and 3 replicates of 2.5 $m^2$ (in 2014).**

The most common algal builders were encrusting calcareous red algae *Mesophyllum macroblastum*, *Lithophyllum stictaeforme* and as yet unidentified encrusting Corallinacea, as well as calcifying *Peyssonnelia* species, most commonly *Peyssonnelia rubra.* Encrusting calcareous red algae *Lithothamnion minervae* and *Neogoniolithon mamillosum* were recorded at some sites (Fig. 3.4), but could not be identified in photo replicates. As already emphasized (see Garrabou & Kipson 2014), the accurate identification of these algae to the species level is not possible based on photographs. Identification of all algal species mentioned above was confirmed by collected specimens. The most common animal builders were bushy bryozoans *Myriapora truncata* and *Smittina cervicornis / Adeonella pallasii* as well as a group of orange encrusting bryozoans. Of other important bryozoan builders, *Pentapora fascialis* was recorded at 5 sites, whereas *Schizotheca serratimargo* was noted only at the Cape Jablanac. Other frequent animal builders were serpulid polychaeta and scleractinian corals *Leptopsammia pruvoti, Caryophyllia smithii,* and *Caryophyllia inornata*.

Among agglomerative species sponges *Fasciospongia cavernosa* and bryozoan *Beania* sp. were noted. Furthermore, the main bioeroders were boring sponges *Cliona* sp., and the endolithic bivalve *Gastrochaena dubia*. Especially abundant species were zoantharian *Parazoanthus axinellae,* sponges *Petrosia ficiformis, Hexadella racovitzai,* and *Haliclona (Halicohlona) fulva.*


**Fig. 3.4. Encrusting calcareous red algae *Lithothamnion minervae* and *Neogoniolithon mamillosum* were recorded at several sites, but could not be identified from photo replicates. Their accurate identification requires examination of the physical sample.**

The species most commonly forming the erect layer and contributing to the structural complexity of the outcrops were gorgonians *Paramuricea clavata* and *Eunicella cavolini* as well as sponges *Axinella cannabina*, *Axinella polypoides* and large specimens of *Aplysina cavernicola* (> 15 cm in height). The red gorgonian *Paramuricea clavata* was recorded at 10 study sites, but formed a well-developed population at 7 sites. It was absent from the Cape Jablanac (Cres Island) and it was present in comparably lower abundance (with generally smaller colonies) at the Plavnik Island, Mali Plavnik and Zečevo Islets. The yellow gorgonian *Eunicella cavolini* was present at all study sites, but in sparse densities.

The most common non-calcified red algae were *Peyssonelia* spp., whereas *Flabellia petiolata* and *Palmophyllum crassum* were among the most frequent green algae. From all identified taxa, sponges were the most diverse group, with 18 (at Cape Kinkela) to 26 (at Cape Silo) taxa recorded per site (Figs. 3.5) Among the most common were *Axinella* sp., *Phorbas tenacior*, *Fasciospongia cavernosa*, *Hexadella racovitzai*, *Haliclona (Halicohlona) fulva* and *Aplysina cavernicola*.

In general, for each phyla similar number of taxa were recorded at each study site (Fig. 3.5). For tunicates, 3-fold higher diversity was recorded at Plavnik and Cape Silo in comparison with Zečevo, Cape Sokol and Tenki (Fig. 3.5).

Moreover, in comparison with the survey in 2013 when lower sampling effort was applied, similar number of taxa was recorded for each of the 5 main subsets of taxa (Fig. 3.6). One exception was the Cape Sokol where twice as many sponges were recorded in 2014.

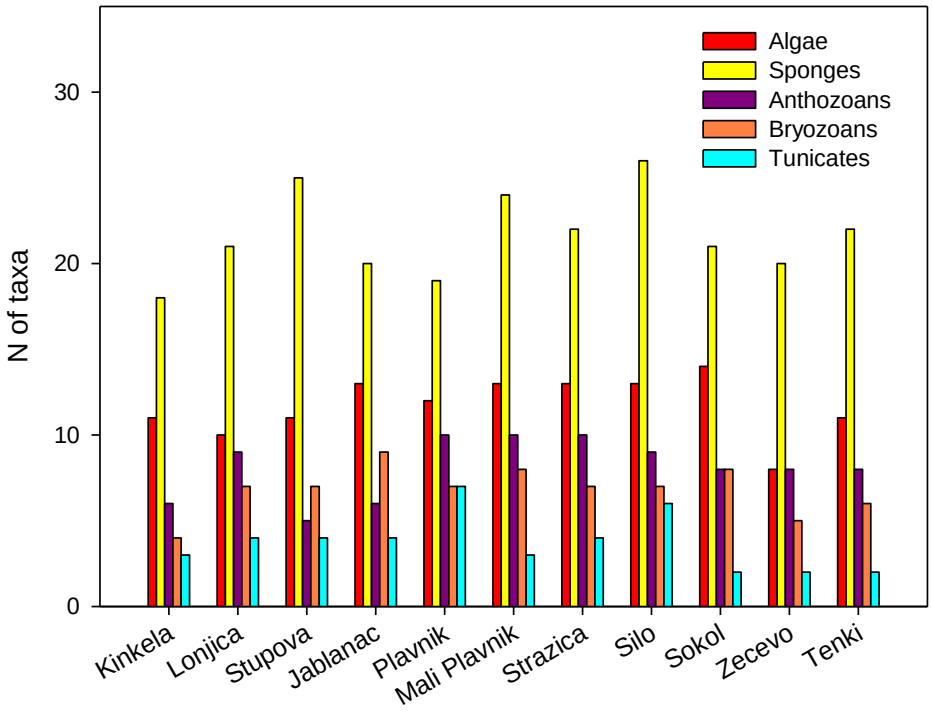



**Fig. 3.5. Taxa richness of the 5 main subsets of taxa in the 30 - 40 m depth range at each of the 11 studied sites (based on photosampling).**

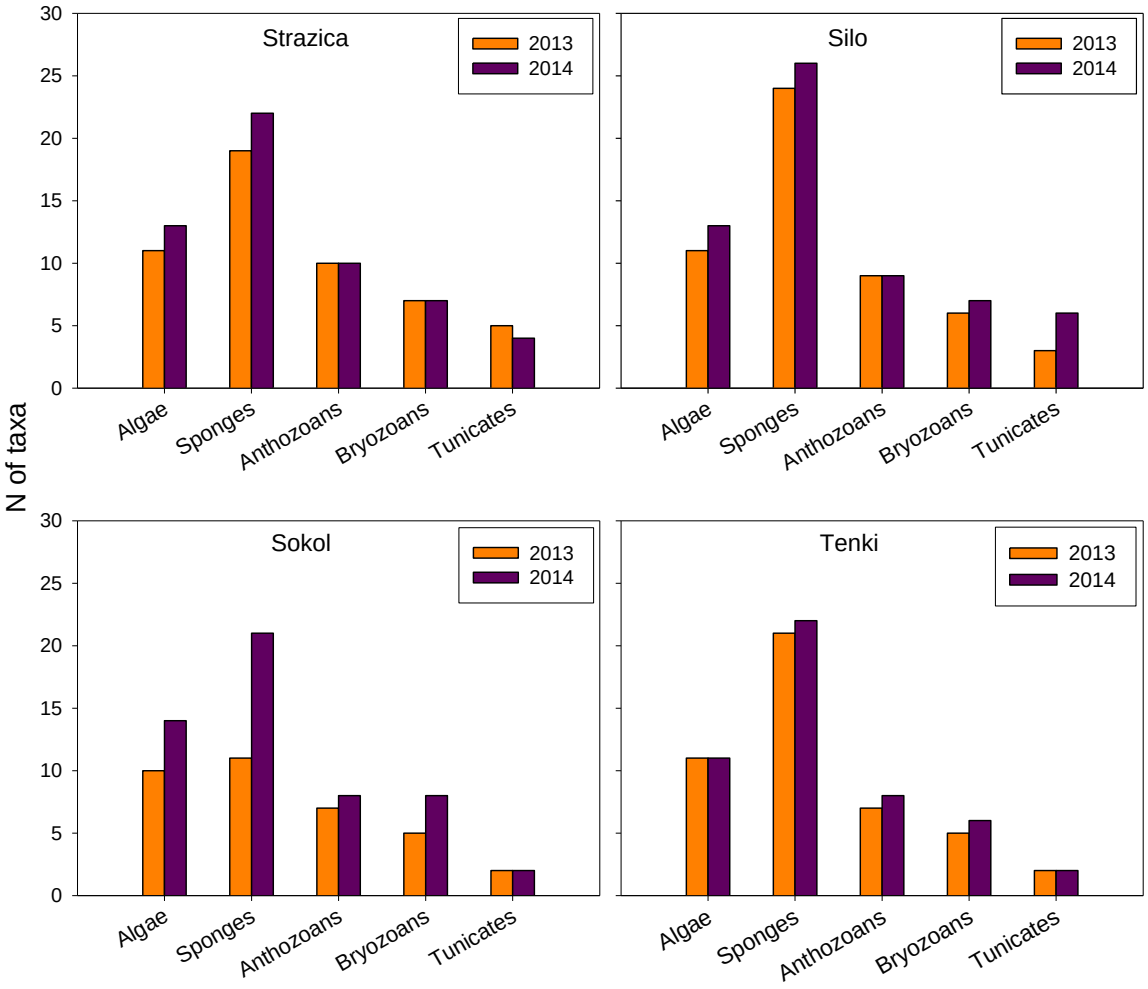



**Fig. 3.6. Comparison of taxa richness by 5 major phyla assessed by different sampling effort (2.5 $m^2$ of total area surveyed in 2013 vs. 7.5 $m^2$ of total area surveyed in 2014).**

Data on species present within the coralligenous habitat acquired during this field trip will provide further support to the proposed preliminary list of typical species, i.e. species to be considered in the inventory and/or monitoring of Adriatic coralligenous assemblages (see Garrabou *et al.* 2014).

**Applicability:** Despite of the increased area to be sampled (in relation to the first version of the protocol), this part of the protocol was implemented without problems. In the depth range from 30 to 40 m, between 12 and 15 min of bottom-time was needed to carry out

photosampling of 3 sets of 10 contiguous photos of 50 x 50 cm (i.e. to take 30 photographs) at each site. Thus, at these considerable depths, sampling can be carried out in a reasonable (no-deco) time frame. As visible from the sites which were assessed by photosampling method in both years (2013 and 2014) but based on different sampling area, increased sampling area led to the compilation of more comprehensive species lists for sites and it enables more objective estimation of basal and intermediate layer (in comparison with visual census of the same parameters used in the first version of the protocol) as part of the assessment of structural complexity. In addition, although a certain level of detail that could be useful in identification of some species was lost by photographing larger area (50 x 50 cm quadrats instead of 25 x 25 cm), resolution was still decent enough to discern some small features such as siphon holes of a boring bivalve *Gastrochaena dubia* that are an important parameter for estimation of bioeroding activity (see Garrabou *et al.* 2014).

**(2) Estimate of the impact of invasive species based on photosampling**

**Main result:** As in the previous survey**,** there were no signs of invasive macroalgae such as *Womersleyella setacea* or *Caulerpa racemosa* within the coralligenous habitat at any of the investigated sites.

## *3.2. Visual census along transects*

**General comment on the application of visual census:** The application of this method to assess the erect layer as a part of structural complexity, macrobioeroders abundance and mucilaginous algal aggregates incidence was regarded as simple and achievable within available time at depth. In order to assess the replicability of the method we used the data obtained by different observers at different sites. In particular, data were collected:

(a) by different observers along the same transect (marked by the rope) (8 sites)

(b) by different observers along random transects (at 3 sites exclusively random transects were made whereas at other 8 sites each observer carried out assessment over 2 marked and 1 random transect)

(c) by different observers along both marked and random transects at different times at the same site

(d) by different observers along marked transects at different sites performing both underwater visual census and video analysis.

**(3) The degree of complexity of coralligenous habitat: estimation of the erect layer**

**Main results:** In general, the estimates of the erect layer as a part of the structural complexity did not differ considerably among the different observers (Figs. 3.7, 3.8, 3.9). This was evident both when the assessment was carried out along marked transects, i.e. when potential differences due to spatial variability found at the site/depth (as it may be the case when random transects are carried out) could be completely avoided (Fig. 3.7), as well as it was evident with random transects (Fig. 3.8). Likewise, assessment carried out at the same site but on different dates was similar (Fig. 9).

In most cases the final score assigned was identical for different observers and it usually indicated a medium complexity (Figs. 3.7, 3.8, 3.9).

**Applicability:** The assessment of erect layer by visual assessment along transects proved to be simple to apply and resulted in similar evaluation by different observers. Therefore its applicability within the proposed monitoring protocol has been confirmed.

**(4) Estimates on the abundance of macro-bioeroders (sea urchins)**

**Main results:** At all the sites sea urchins were rarely observed along transects. In particular, 1 individual of *Sphaerechinus granularis* was recorded along transects at 2 sites.

**(5) Estimate of coverage of mucilaginous aggregates**

**Main results:** During field survey in 2014 no mucilaginous algal aggregates were noted at any of the monitored sites (unlike during the field survey in 2013), therefore we could not test the refined (and simplified) method for the assessment of this parameter.

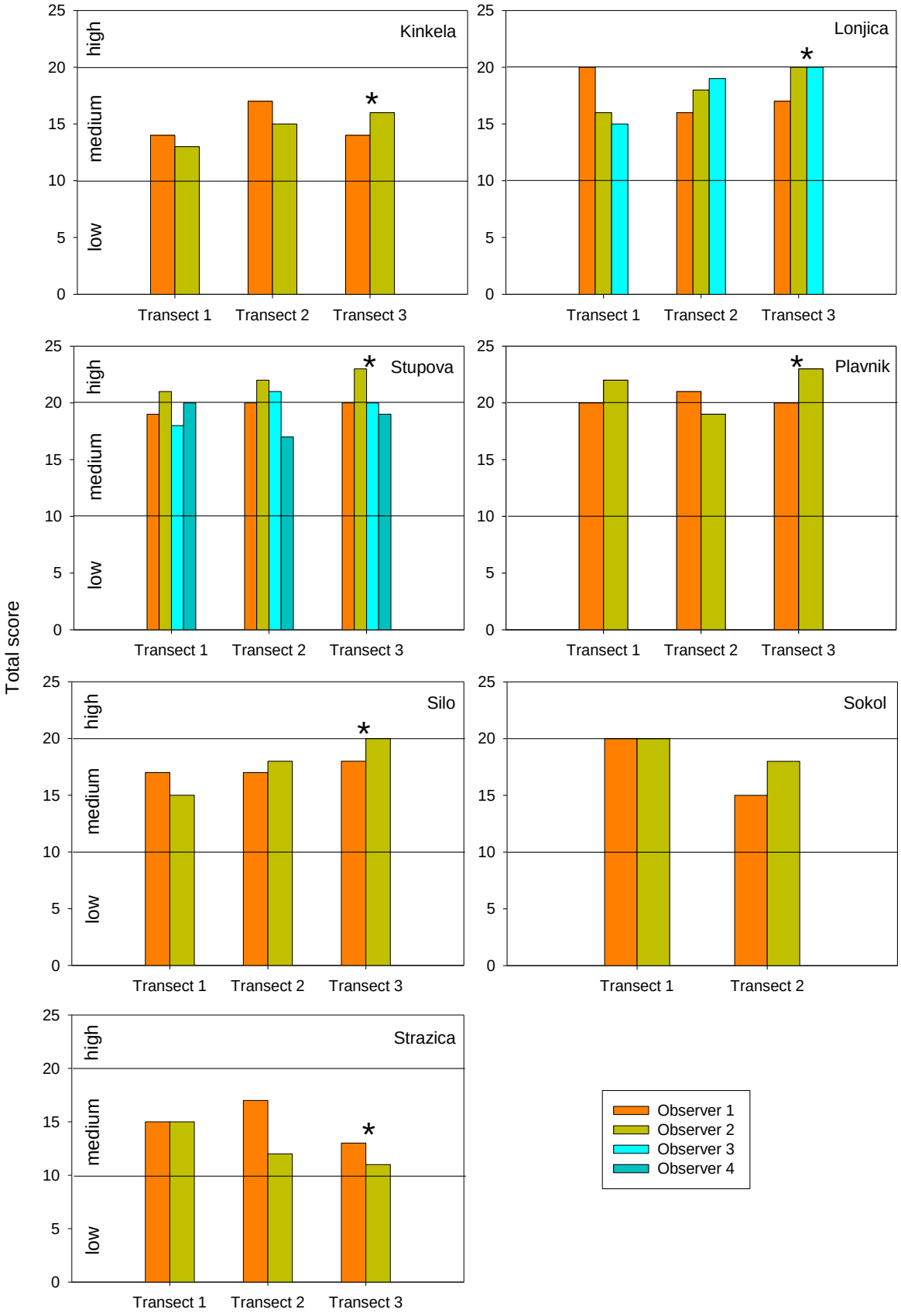



**Fig.3.7. Estimation of the erect layer by different observers along marked (Transect 1 and 2) and random transects (Transect 3) at different sites. * = random transect.**

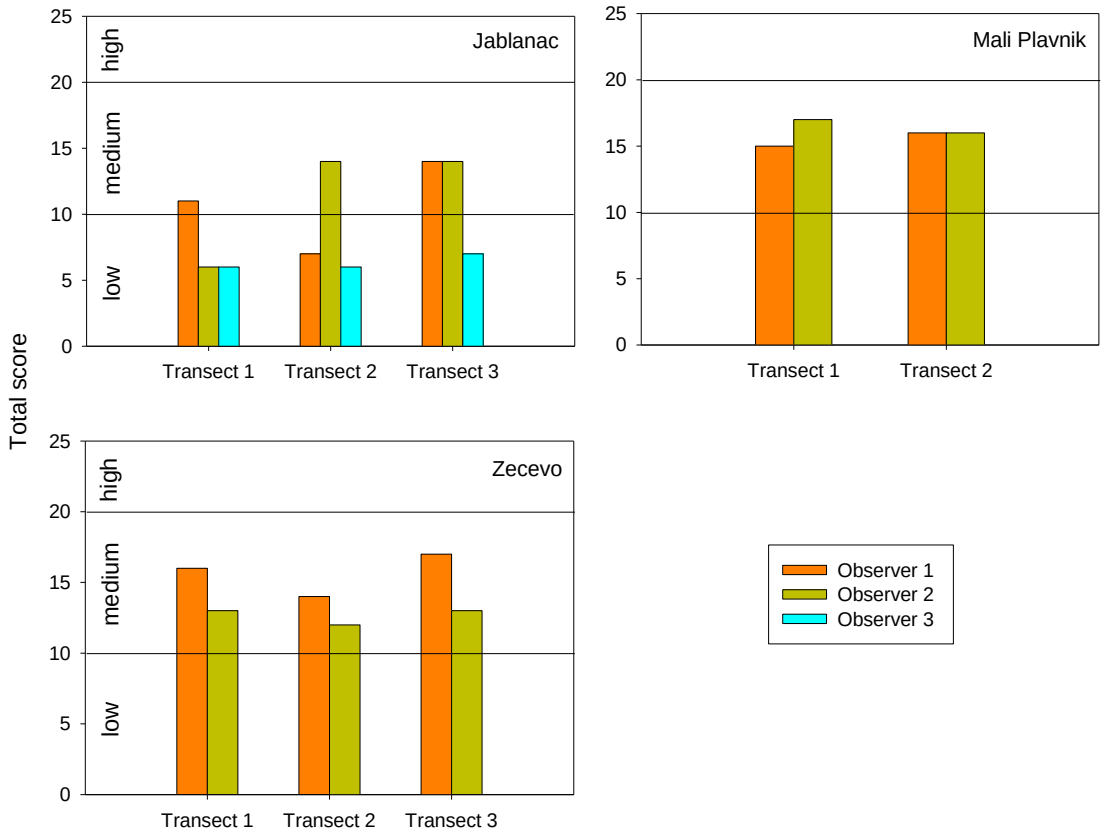



**Fig. 3.8. Estimation of the erect layer by different observers along random transects at different sites.**

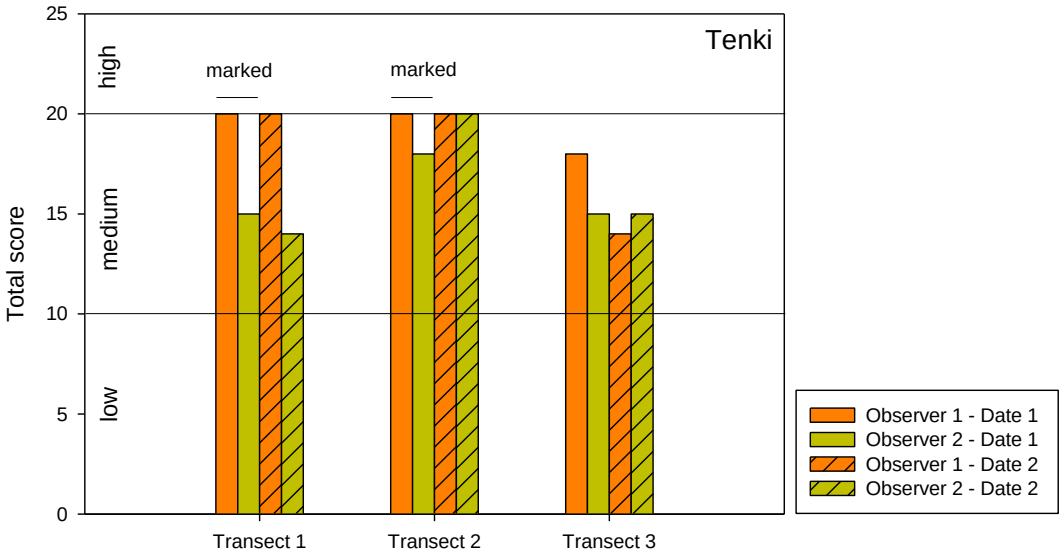



**Fig. 3.9. Estimation of the erect layer by different observers along marked (Transect 1 and 2 at date 1) and random (Transect 1 and 2 at date 2, Transect 3) transects at different times at the same site. At date 2 only random transects were carried out.**

## *3.3. Visual census not associated to transects*

### (7) Assessment of gorgonian health status (mass mortalities)

**Main results:** the red gorgonian *Paramuricea clavata* was examined at 8 sites, 4 of which were also assessed in 2013. In every population 100 colonies were examined except in Plavnik population where 58 colonies were examined, due to generally lower abundance of colonies at that site. At 5 sites out of 8, percentage of affected colonies (with >10% of injured surface) was low (not exceeding 15%). For other sites, 40% of affected *P. clavata* colonies were reported for Capes Stražica and Sokol, whereas the highest level of impact reached 60% of affected colonies at Tenki shallow. Most of the injuries were old. Recent injuries were noted at 2 sites but only in 3% of colonies. At Tenki shallow 13% of colonies displayed both recent and old injuries (Fig. 3.10).

In comparison with the year 2013, 2 populations for which a previous assessment has been made displayed similar degree of injury (Šilo and Sokol), whereas 2 populations, namely Stražica and Tenki displayed considerable increase (20-25%) of affected colonies (Fig. 3.11). As reported previously (see Garrabou & Kipson 2014), during field work in July 2013, mucilaginous algal aggregates were recorded at each sampling site and putatively they may be responsible for the observed increase in affected colonies. Injuries affecting in many cases the basis of the colonies (Fig. 3.12a, b) may reinforce the hypothesis that damage was caused by mucilaginous aggregates, similarly to damages observed in Columbretes Islands, off the Spanish coast (Kersting & Linares 2006). However, in this moment, the causes of increased gorgonian affectation remain unknown. It should also be noted that many colonies, although not showing injured surface and hosting epibiosis, showed signs of broken apical tips (3.12c).

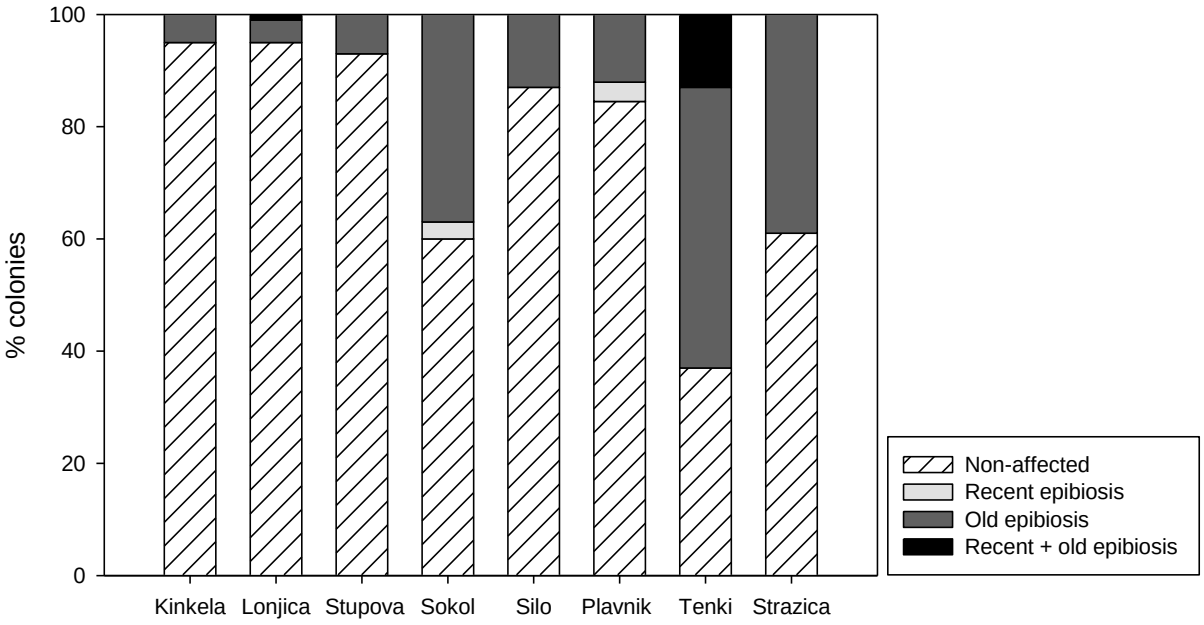



**Fig. 3.10. Health status assessment of the red gorgonian *Paramuricea clavata*. Reported is a percentage of non-affected colonies (with <10% injured surface) and affected colonies (with >10% injured surface). At each site 100 colonies were examined, except at Plavnik site where 58 colonies were examined, due to their lower abundance.**

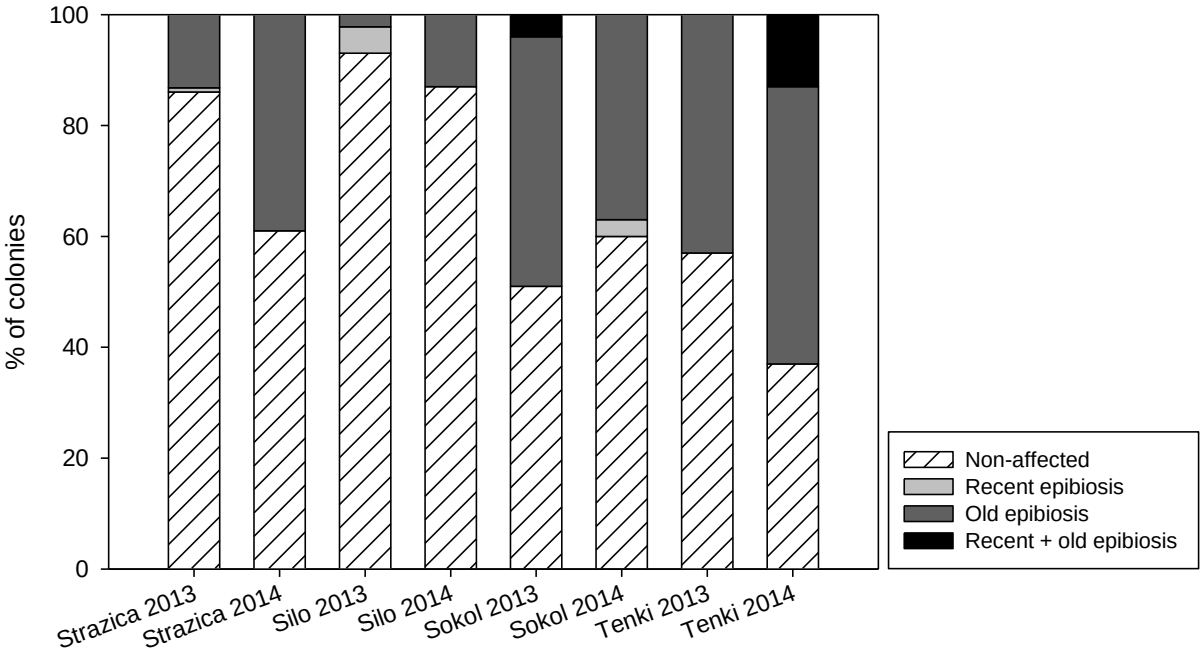



**Fig. 3.11. Comparison of the red gorgonian health status in two consecutive years (2013 and 2014) in 4 surveyed populations.**

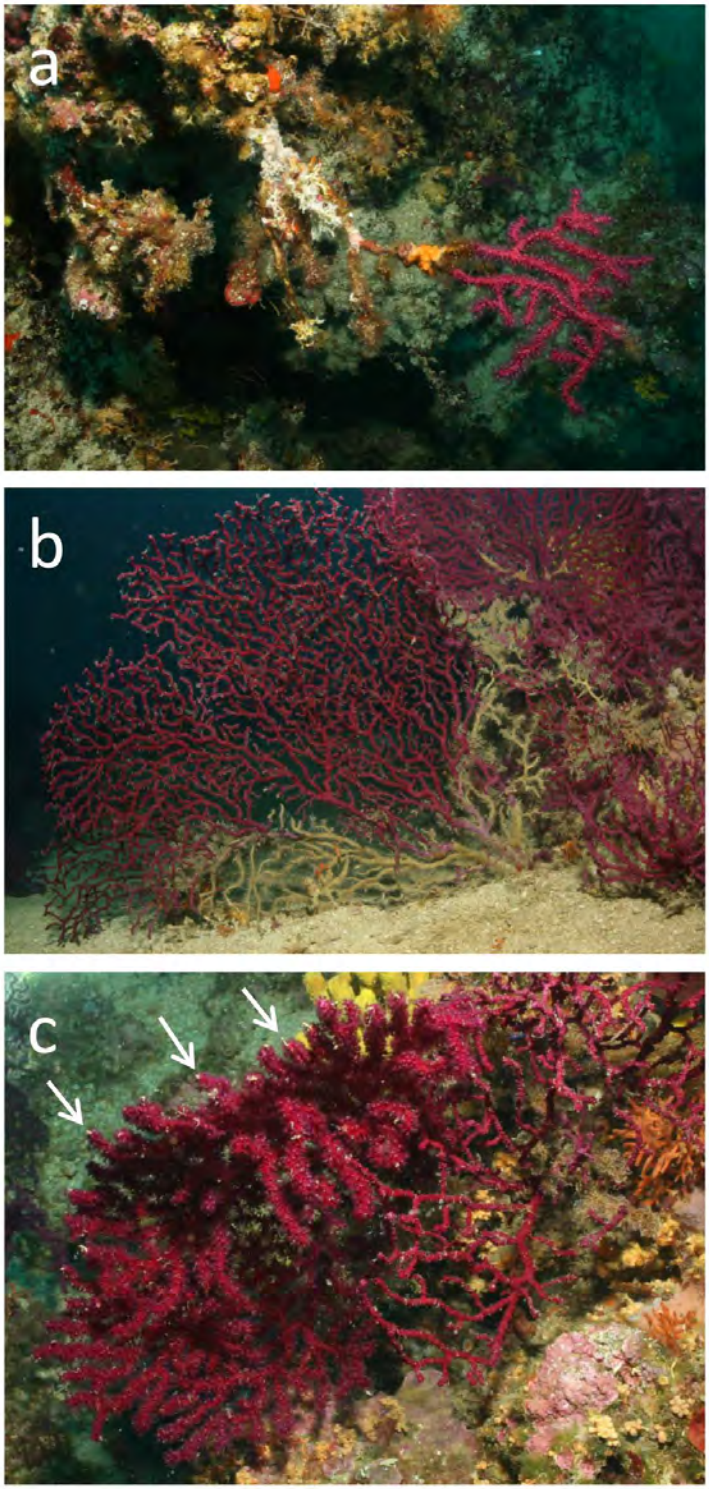



**Fig. 3.12. Illustration of injuries noted for the red gorgonian *Paramuricea clavata* at surveyed sites. a) an old epibiosis in the basal part of the colony; b) more recent epibiosis (< 1 year old) in the basal part of the colony; c) broken apical tips with exposed skeletal axis. Photo credit: A. Žuljević.**

**(8) Estimate on the impacts of fishing**

**Main results:** Discarded fishing gear was recorded at all surveyed sites (e.g. Fig. 3.13). Long-lines were the most common fishing gear encountered but nets and traps, as well as monofilament lines were also observed. At 4 sites high abundance of discarded fishing gear has been estimated (more than 5 pieces), whereas at 7 sites this abundance has been estimated as medium (1-5 pieces; Table 3.1). Longlines were usually 10 m long or longer, whereas nets were between 5 and 10 m long.

**Table 3.1. Enumeration of the observed fishing gear within the coralligenous habitat.**

| | | Fishing gear | | |
|---|---|---|---|---|
| Location | Site | Long-line | Net | Trap |
| Mošćenice | Kinkela | 4 | | |
| Brseč | Lonjica | 3 | 2 | 1 |
| Brestova | Stupova | 4 | | |
| Cres | Jablanac | 1 | 2 | 2 |
| Plavnik | Plavnik | 6 | | |
| Mali Plavnik | Mali Plavnik | 7 | | |
| Prvić | Stražica | 4 | | |
| Prvić | Šilo | 5 | | |
| Krk | Sokol | 3 | | |
| Zečevo | Zečevo | 7 | | |
| Krk | Tenki | 5 | | |

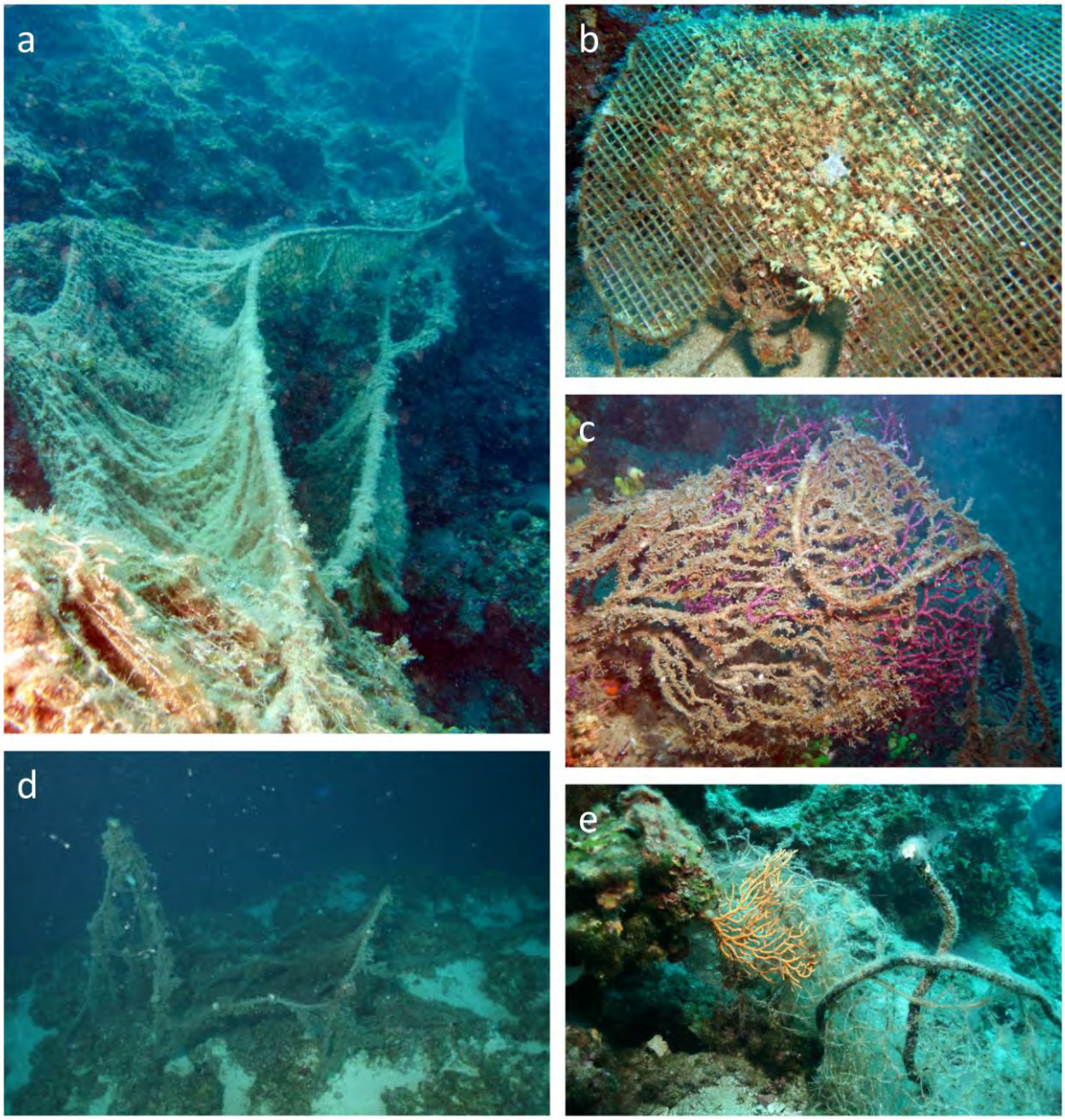



**Fig. 3.13. Discarded fishing gear at surveyed sites: a) net at the Cape Jablanac; b) trap at Lonjica site; c) long-line over the red gorgonian *Paramuricea clavata* at Lonjica site; d) net at Mali Plavnik site; e) monofilament line over the yellow gorgonian *Eunicella cavolini* at Plavnik site. Photo credit: a-c) S. Kaleb; d-e) A. Žuljević.**

# 4. Testing of the applicability of GoPro videography

**Main results:** Based on videos recorded by GoPro camera along 20 m long transects, it was possible to identify 77 to 93% of the total number of taxa recorded from photosamples (Fig. 4.1). Occasionally, even some new taxa, not recorded by photosampling were identified from videos, since a larger area could be covered in this way. However, it should also be noted that it was not possible to observe some small organisms (included in the Preliminary list of typical/indicator species to be monitored) on videos, such as bioeroding bivalve *Gastrochaena dubia*.

Related to the assessment of structural complexity, the estimates of the erect layer carried out along marked transects, both based on direct observation underwater by different observers and based on video analysis, were very similar (Fig. 4.2). In most cases the final score assigned was identical and it usually indicated a medium complexity (Fig. 4.2). The quality and the resolution of videos also imply that an assessment of basal and intermediate layer could be performed in this way, a task that is currently envisaged with the use of photo samples.

**Applicability:** Videography obtained by GoPro camera fitted with external lightning enabled documentation of additional information on the dive and diving site, assessment of the erect layer as a component of overall assessment of coralligenous structural complexity and compilation of more complete species lists (by examination of additional surface).

**Practical notes:** Good quality external torches fitted with diffusers are essential for quality video footage at sampled depths. A GoPro display (LCD BacPac$^{TM}$) is a useful accessory to adjust the distance of the diver from transect/substrate in order to obtain the adequate coverage (i.e. in the case of marked transects 50 cm above and 50 cm below the rope). In addition, for best results, novices need a little experience to optimize the speed of motion while video recording along the transect.

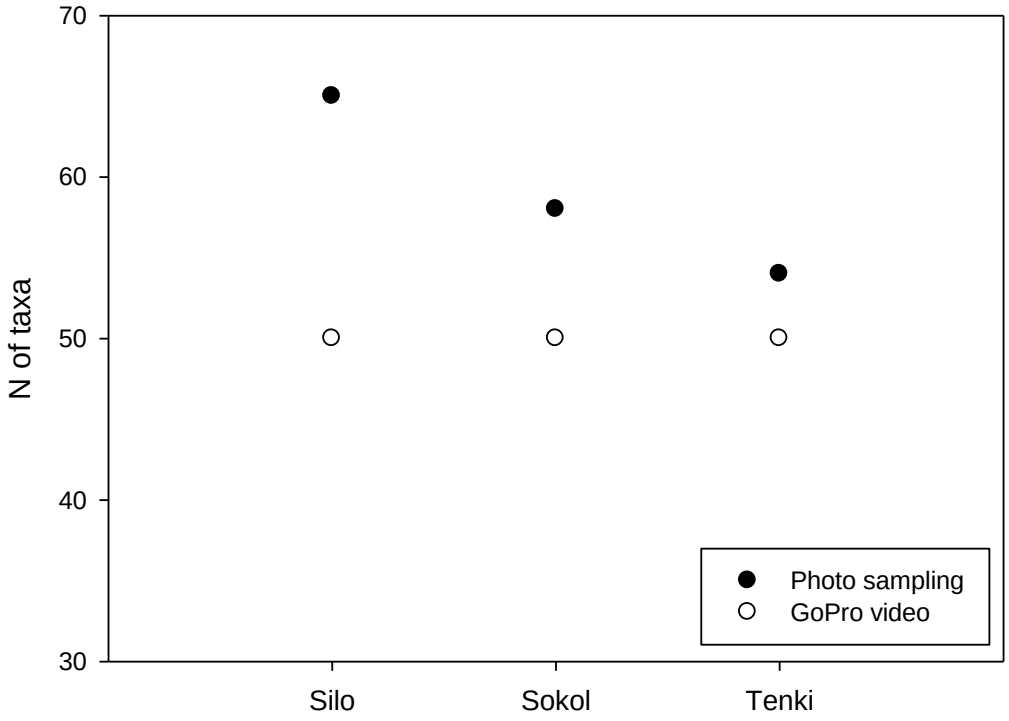



**Fig. 4.1. Species richness based on different sampling effort and different sampling methods. Comparison of data acquired from analysis of 3 photo replicates of 2.5 $m^2$ and a 20 m long video transect recorded by GoPro camera.**

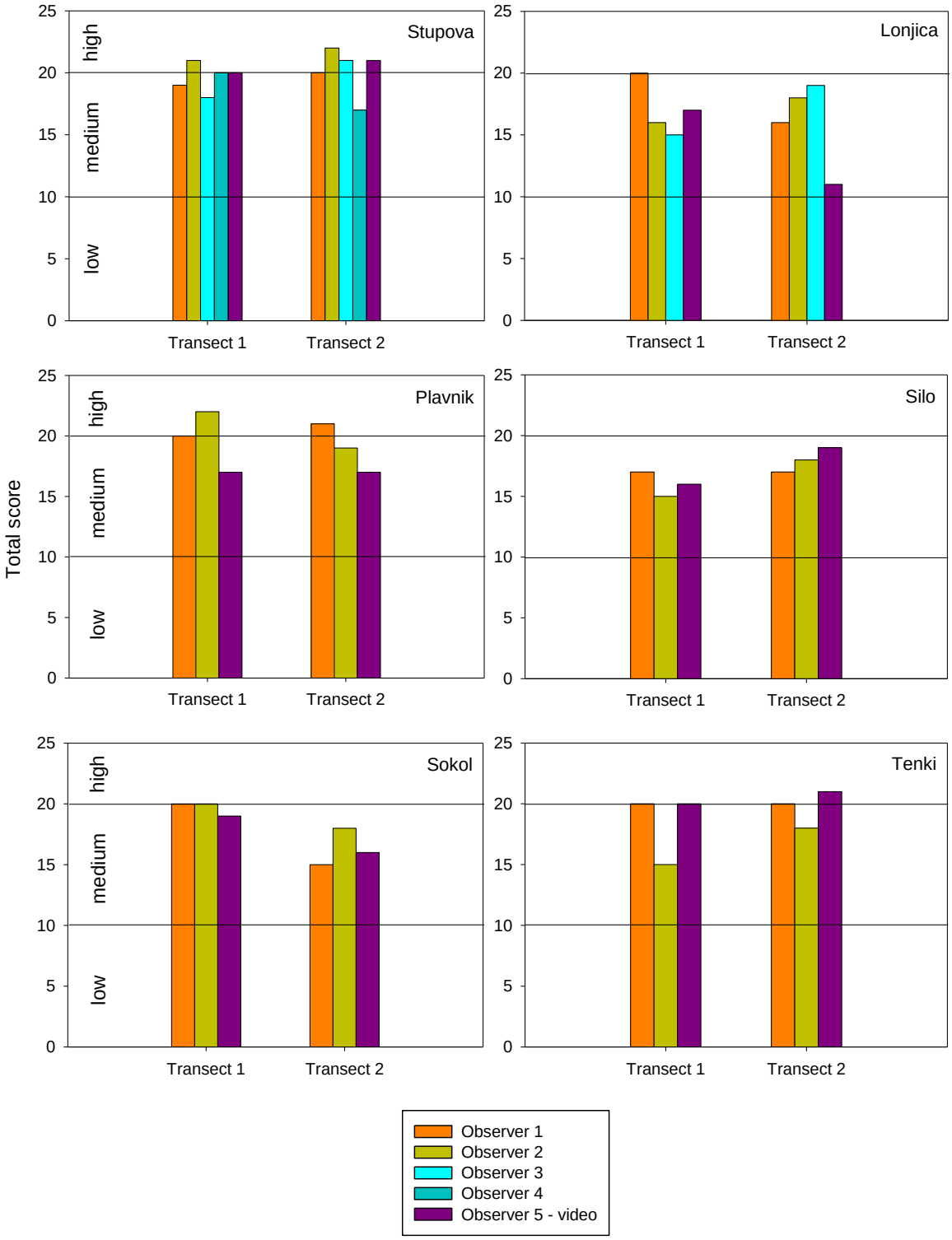



**Fig. 4.2. Estimation of the erect layer by different observers along marked transects at different sites: comparison of the underwater visual census and video analysis.**

# 5. Overview of new study sites

This section provides a description of 7 additional study sites within Primorje-Gorski Kotar County. Four sites, namely Cape Stražica (Prvić), Cape Šilo (Prvić), Cape Sokol (Krk) and Tenki shallow (Krk) have been described previously (see Garrabou & Kipson 2014).

As envisaged by the protocol, each study site was documented as precisely as possible, by providing GPS coordinates and an image showing terrestrial view of the site including recognizable landmarks when possible. In addition, the diving path was described with the assistance of photography and videography. All of this information was intended to facilitate the repeated locating of sites and areas where the assessment was carried out.

Seven new study sites included:

1. Cape Kinkela (Mošćenička Draga)
2. Cape Lonjica (Brseč)
3. Cape Stupova (Brestova)
4. Cape Jablanac (Cres)
5. NW Plavnik
6. Mali Plavnik Islet
7. Zečevo Islet

1 Cape Kinkela

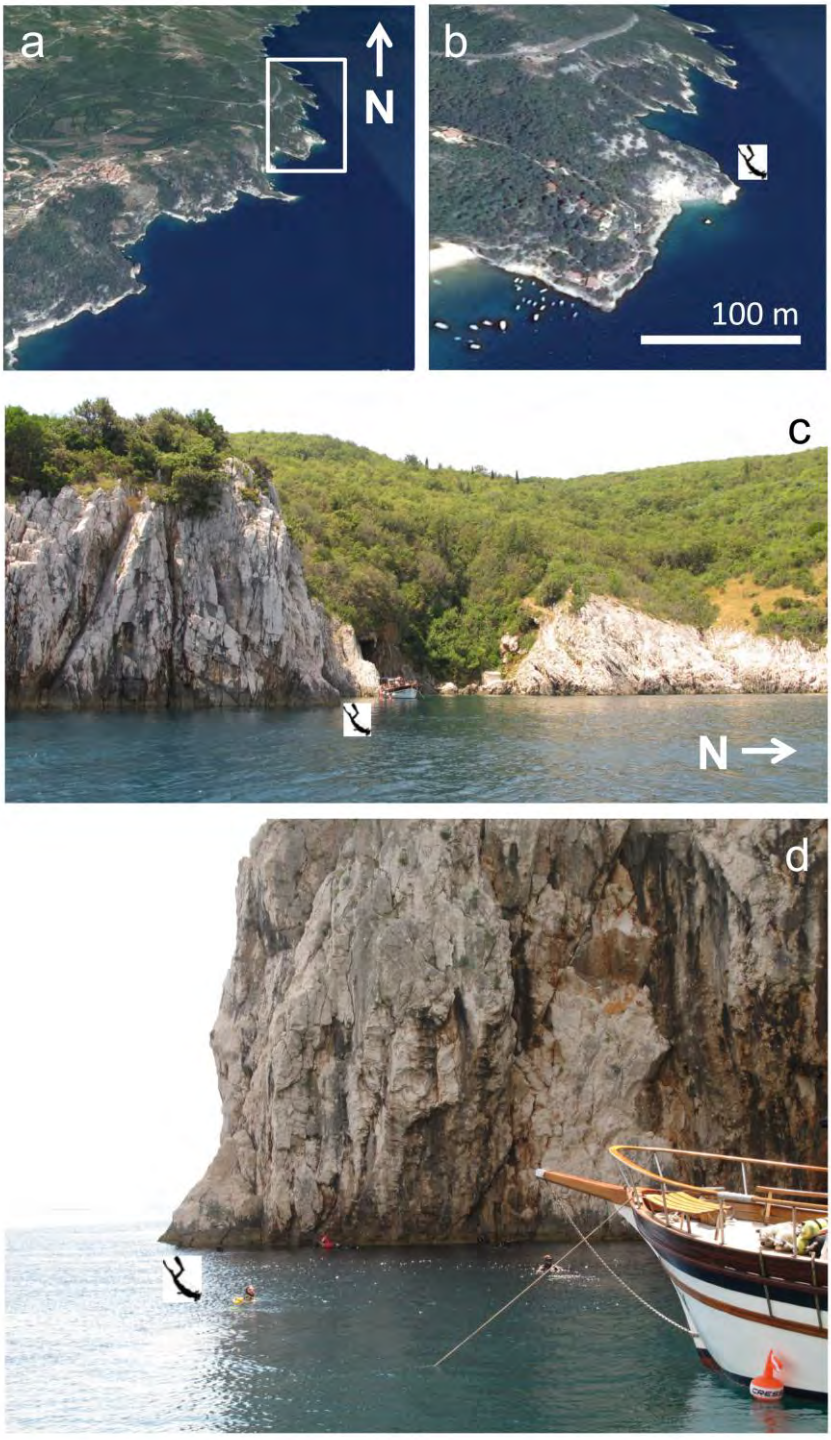



**Fig. 5.1. Cape Kinkela dive site. Designated area of image a) is enlarged on image b); c, d) terrestrial views of the diving site. Source: a, b) Google Earth, Image © 2014 DigitalGlobe.**

GPS: 45°11'04.04''N, 14°14'41.63''E

Date and time of the dive: 29th of June 2014, 12 pm; 3rd of July 2014, 10.30 am

Photos IDs and number of photos: MDKIa1-MDKIc10; 30

Number of transects carried out: 2 marked + 2 random (by 2 observers)

Video transects: 1

Description: This diving site was located at the Cape Kinkela (Fig. 5.1), situated approximately 3 NM south from Mošćenička Draga and represents a popular diving site for local diving centres. Recognizable landmarks are a shed and a semi-cave located on the coast at the right side from the Cape (north from the Cape) (Fig. 5.1c). We have started a dive in the north part of the Cape (Fig. 5.1c). From 5 to 10 m depth the moderately inclined slope and scattered bigger rocks supported the biocenosis of infralittoral algae with abundance of green algae *Codium bursa*, red algae *Sphaerococcus coronopifolius* and sponge *Aplysina aerophoba* (Fig. 5.2a). From 10 to 15 m depth the slope became steeper and the red calcareous algae *Lithothamnion* cf. *crispatum* (Fig. 5.2b), algae *Dictyota* sp. and scattered colonies of the white gorgonian *Eunicella singularis* (Fig. 5.2c) were found. Around 20 m slope turned into a wall dominated by zoantharian *Parazoanthus axinellae*, green filamentous algae and red algae of the genus *Peyssonnelia* (Fig. 5.2d). Below 25 m depth the coralligenous outcrops were developed. The wall stretched down to 33 m depth where it was replaced by a cascade-like rocky bottom, with a slope intercepted by smaller walls (Fig. 5.2e). A *Paramuricea clavata* assemblage was recorded from 35 m depth (Fig. 5.2f). Several colonies of the red gorgonian were also recorded at 28 m depth and a single colony was noted even at 25 m depth. At 43 m depth the rocky bottom was replaced by a detritic bottom.

Photosampling was carried out within *Paramuricea clavata* assemblage at 37 and 38 m depth. At this site each of the two observers carried out visual census along 2 marked transects and 1 random transect at depth between 30 and 37 m, and the video was recorded along 2 marked transects. Furthermore, one operator assessed the red gorgonian health status.

The erect layer of the coralligenous habitat was formed by colonies of the red gorgonian *Paramuricea clavata* (Fig. 5.2f), that were less abundant at this site in comparison to other 2 geographically close sites with similar profile (Capes Lonjica and Stupova). The erect layer was further formed by the yellow gorgonian *Eunicella cavolini* (Fig. 5.2e), large colonies of sponge *Aplysina cavernicola* (> 15 cm high) and the sporadically appearing erect sponge *Axinella cannabina.*

The intermediate layer was formed mainly by smaller specimens of sponge *Aplysina cavernicola*, epibiotic zoantharian *Parazoanthus axinellae*, bushy bryozoan *Myriapora truncata* and *Smittina cervicornis / Adeonella pallasii.*

The basal layer was formed by the red calcareous encrusting algae *Mesophyllum macroblastum* and *Lithophyllum stictaeforme* often growing in representative plate-like thalli (Fig. 5.2e), as well as the calcified and non-calcified algae of the genus *Peyssonnelia* (mainly *Peyssonnelia rubra;* Fig. 5.2e). The encrusting sponge *Hexadella racovitzai* was also abundant in the basal layer.

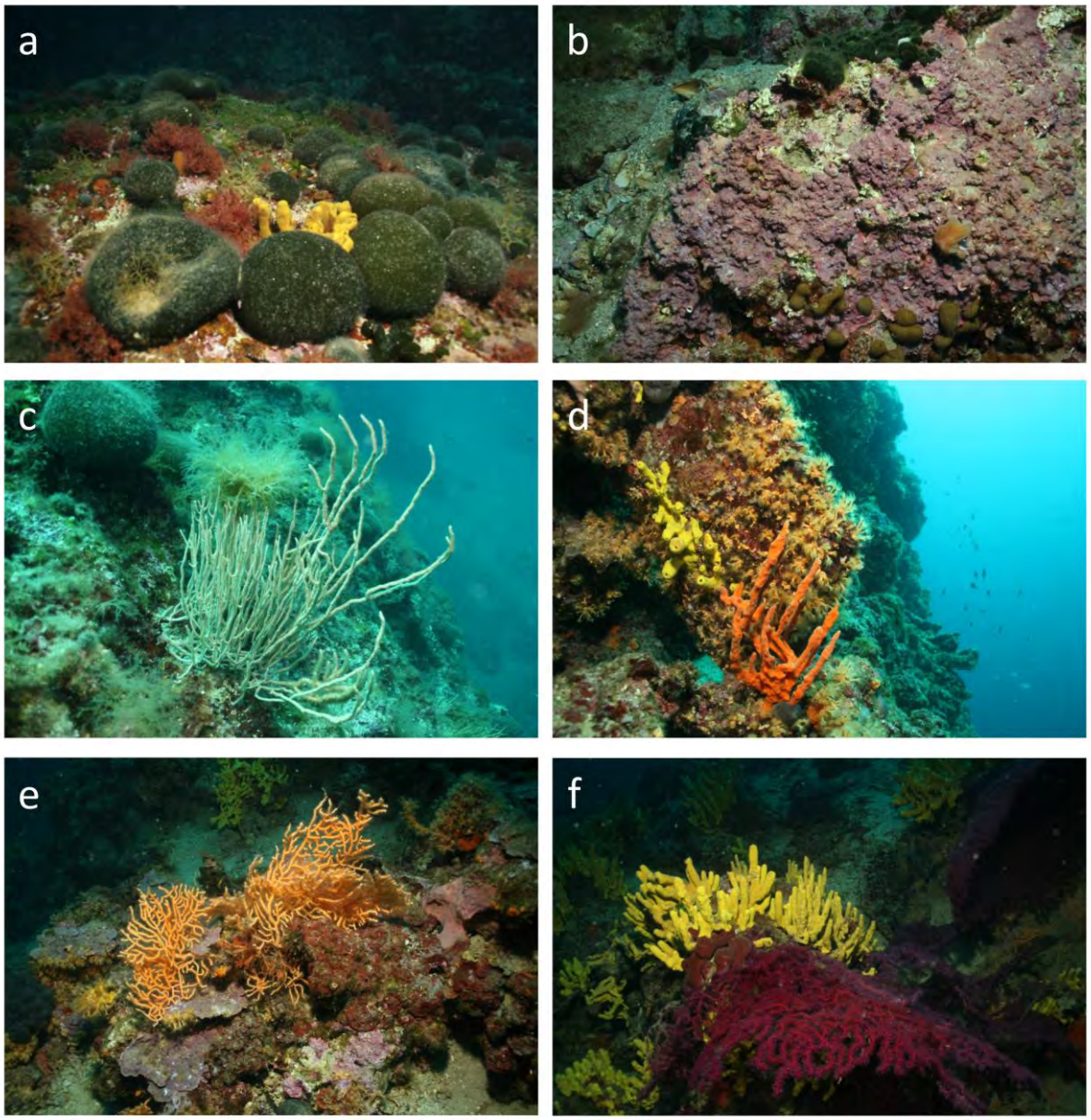



**Fig. 5.2. Cape Kinkela dive path (from a to f). a) from 5 to 10 m depth moderately inclined slope and scattered bigger rocks supported the biocenosis of infralittoral algae with abundance of green algae *Codium bursa*, red algae *Sphaerococcus coronopifolius* and sponge *Aplysina aerophoba*; b) red calcareous algae *Lithothamnion* cf. *crispatum* and sponge *Chondrilla nucula* were noted at 13 m depth; c) steeper slope with scattered colonies of the white gorgonian *Eunicella singularis* at 15 m depth; d) a wall at 20 m depth with abundance of zoantharian *Parazoanthus axinellae*, green filamentous algae, red algae of the genus *Peyssonnelia* and individual colonies of sponge *Axinella cannabina;* e) cascade-like rocky bottom hosting coralligenous outcrops with the red calcareous algae *Lithophyllum stictaeforme* and sporadic colonies of *Eunicella cavolini* at 33 m depth; f) below 35 m depth coralligenous outcrops were dominated by the red gorgonian *Paramuricea clavata*. Photo credit: A. Žuljević.**

Note: During the dive at the southern part of the Cape Kinkela we evidenced a recent illegal harvest of dateshell *Litophaga litophaga* that resulted in considerable damage of the rocky bottom down to 5 m depth (Fig. 5.3) at this site that has been proposed as a Natura 2000 site with habitat type 1170 (Reefs) as a target feature (for further info see http://natura2000.dzzp.hr/natura/).

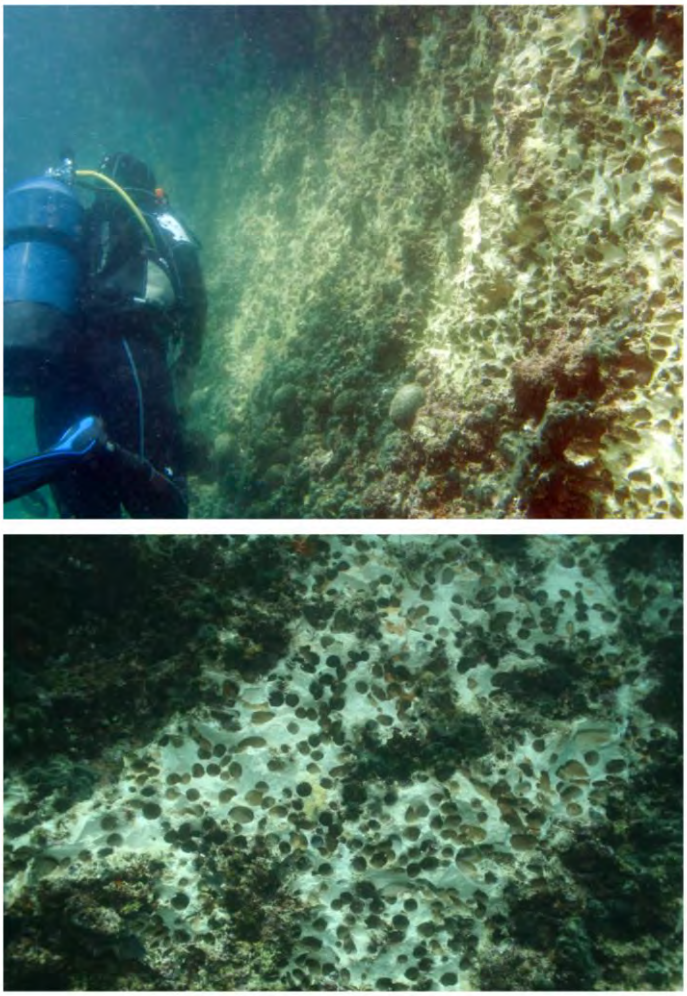


**Fig. 5.3. Cape Kinkela. Rocky bottom (hosting biocenosis of infralittoral algae) damaged by illegal harvest of dateshell *Litophaga litophaga*. Photo credit: S. Kaleb (upper photo) and A. Žuljević (lower photo).**

## 2 Cape Lonjica (Brseč)


**Fig. 5.4. Cape Lonjica dive site. a) Cape Lonjica is located 0.5 NM south from Brseč town; b) terrestrial view of the dive site; c) view of the Brseč town. Source: a) Google Earth, Image © 2014 DigitalGlobe.**

GPS: 45°10'10.85''N, 14°14'16.02''E

Date and time of the dive: 30th of June 2014, 2 pm; 3rd of July 2014, 2 pm

Photos IDs and number of photos: MDLOa1 – MDLOc10; 30

Number of transects carried out: 2 marked + 3 random (by 3 observers)

Video transects: 1

Description: This diving site is located 0.5 NM south from Brseč town (Fig. 5.4) and presents a popular diving site. Underwater, we first dove along a wall (down to 10 m depth) where scattered colonies of the yellow gorgonian were recorded from 9 m depth (Fig. 5.5a). A wall was replaced deeper by a slope intercepted by smaller walls (Fig. 5.5b-d). This bottom hosted a biocenosis of infralittoral algae in which algae *Dictyota* sp., *Codium bursa* and *Codium* sp. were abundant and scattered colonies of the white gorgonian *Eunicella singularis* were found (Fig. 5.5b). From 10 to 17 m alcyonacean *Alcyonium acaule* was also present within the biocenosis of infralittoral algae (Fig. 5.5c). Below 22 m depth species characteristic for the coralligenous were noted. From 37 m depth a *Paramuricea clavata* assemblage was thriving on a cascade-like rocky bottom (Fig. 5.5e-h). Around 48 m depth, the rocky bottom was replaced by a continuous slope of coarse detrital sand.

Photosampling was carried out within the *Paramuricea clavata* assemblage, at depth between 38 and 40 m. At this site each of the 3 observers carried out visual census along 2 marked transects and 1 random transect at 39 and 40 m depth, and the video was recorded along 2 marked transects, both with a professional and GoPro camera. Furthermore, one observer assessed the red gorgonian health status.

The erect layer of the coralligenous habitat was primarily formed by the colonies of the red gorgonian *Paramuricea clavata,* followed by the yellow gorgonian *Eunicella cavolini* (Fig. 5.5e), and large colonies of bushy bryozoan *Pentapora fascialis* (Fig. 5.5g).

The intermediate layer was formed mainly by bushy bryozoans *Myriapora truncata*, *Smittina cervicornis / Adeonella pallasi* and *Pentapora fascialis* (colonies <15 cm in height), smaller specimens of sponge *Aplysina cavernicola*, sponge *Petrosia ficiformis* and zoantharian

*Parazoanthus axinellae*. Above mentioned bryozoans appeared often damaged/overgrown by epibionts in their basal part (e.g. Figs. 5.5f, h) whereas broken apical parts of branches were observed in the red gorgonian *Paramuricea clavata* (Fig. 5.5g).

The basal layer was dominated by the red calcareous algae *Lithophyllum stictaeforme* that developed representative plate-like thalli (Figs. 5.5e,f) and *Mesophyllum macroblastum*, algae of the genus *Peyssonnelia* (mainly *Peyssonnelia rubra* and *P. squamaria*) and the encrusting sponge *Hexadella racovitzai* (Fig. 5.5h).

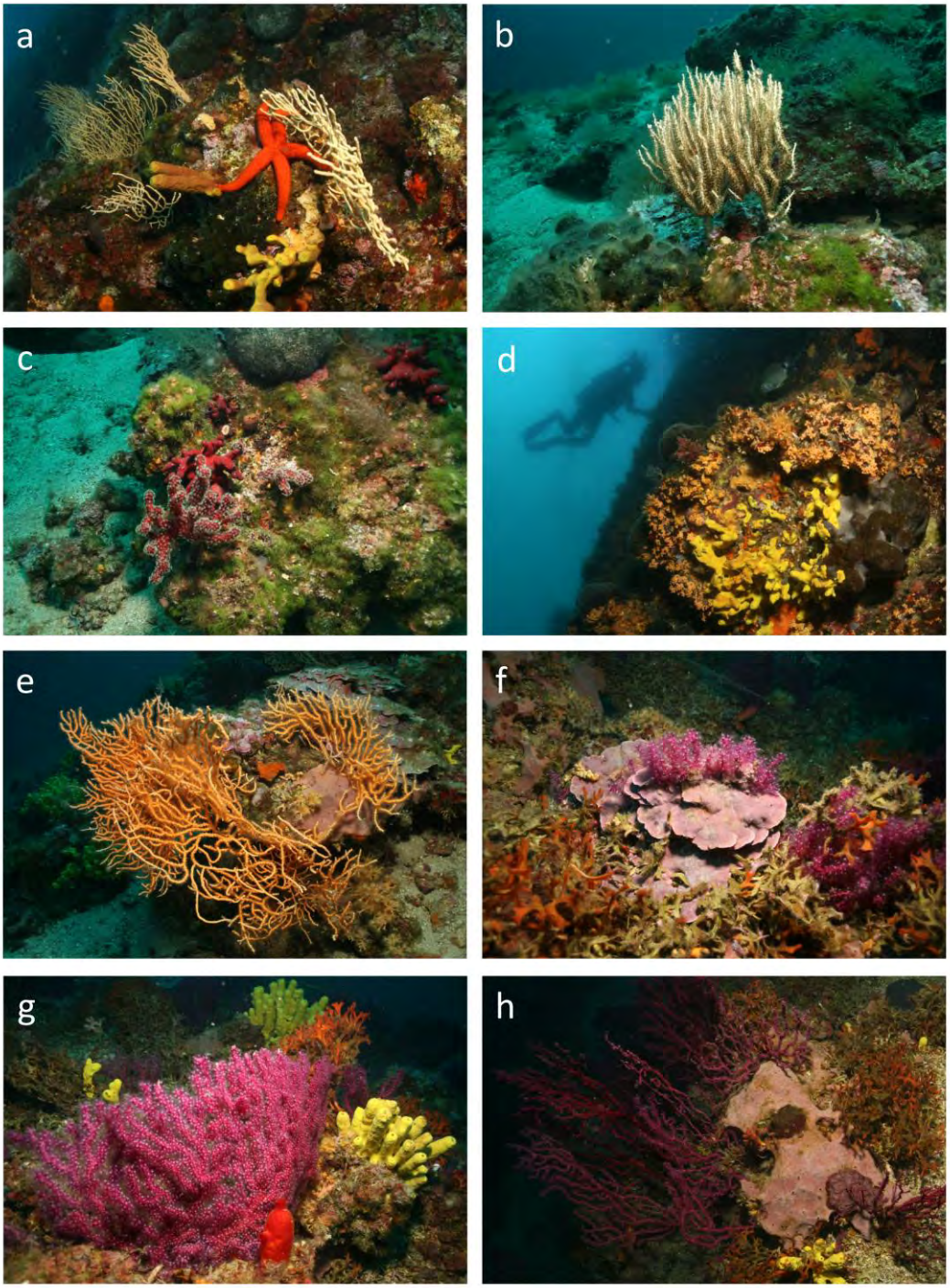



**Fig. 5.5. Cape Lonjica dive path. a) a wall stretched down to 10 m depth where scattered colonies of the yellow gorgonian *Eunicella cavolini* were recorded; b) at 10 m depth moderately inclined slope hosted a biocenosis of infralittoral algae with abundant *Dictyota* sp., *Codium bursa* and *Codium* sp. and scattered colonies of the white gorgonian *Eunicella singularis;* c) from 10 to 17 m alcyonacean *Alcyonium acaule* was also present within the biocenosis of infralittoral algae; d) below 22 m depth species characteristic for the coralligenous were noted on steeper slopes and small walls. From 37 m depth a *Paramuricea clavata* assemblage was thriving on a cascade-like rocky bottom with *Eunicella cavolini* (e) and large colonies of bushy bryozoan *Pentapora fascialis* (f) alongside *P. clavata* (g-h) in the erect layer and red calcareous algae *Lithophyllum stictaeforme* (f) and encrusting sponge *Hexadella racovitzai* as one of the main components of the basal layer (h). Photo credits: A. Žuljević.**

3 Cape Jablanac

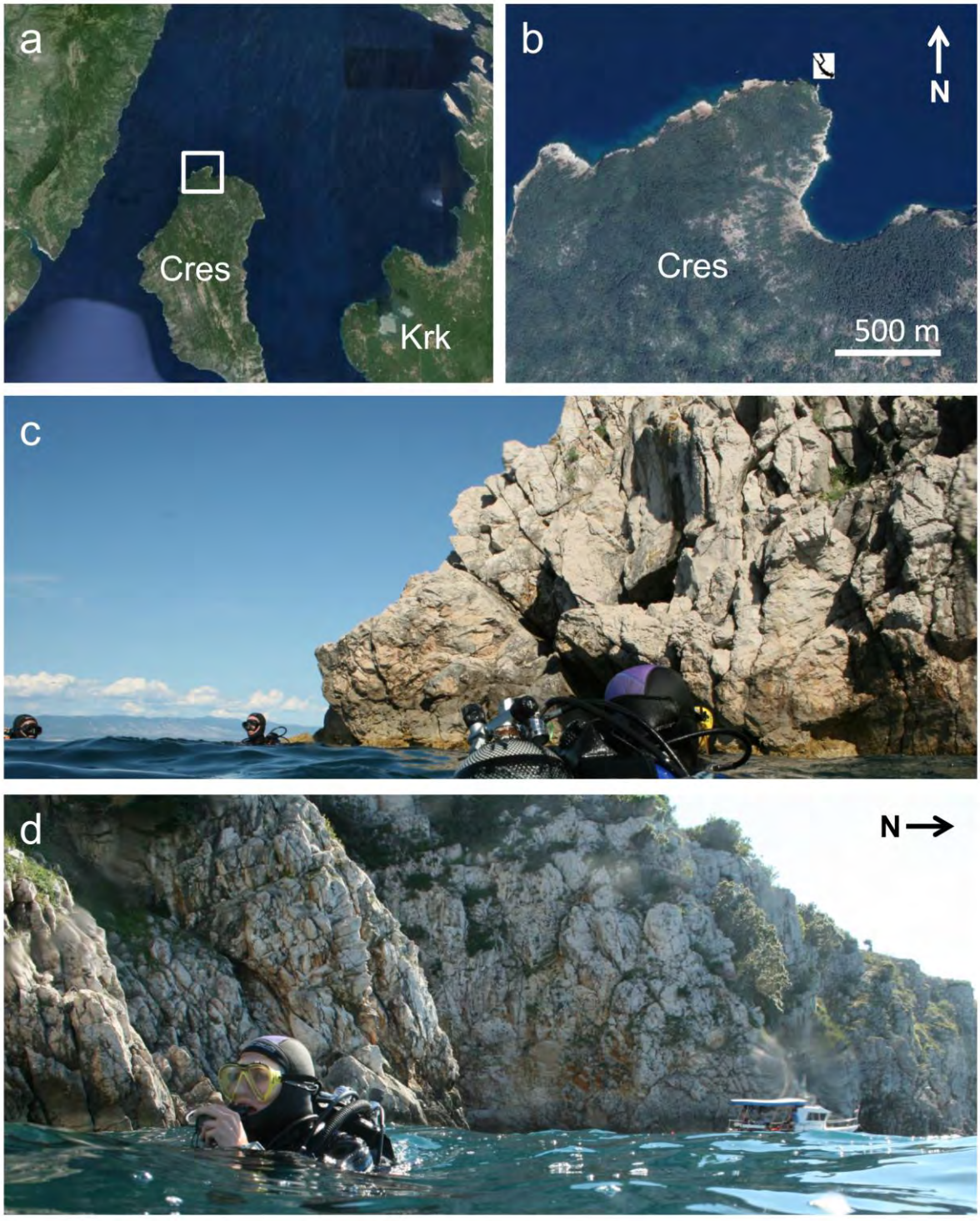



**Fig. 5.6. Cape Jablanac dive site at the Cres Island. Designated area of image a) is enlarged on image b); c) terrestrial view of the dive site; d) the view of the coast stretching northwest from the dive site. Source: a, b) Google Earth, Image © 2014 DigitalGlobe.**

GPS: 44°10'31.97''N, 14°19'36.51''E

Date and time of the dive: 1st of July 2014, 4.30 pm

Photos IDs and number of photos: JABa1 – JABc10; 30

Number of transects carried out: 9 random (by 3 observers)

Video transects: 0

Description: Cape Jablanac is located at the northernmost part of the Cres Island (Fig. 5.6). We started a dive at the tip of the cape. A wall extended down to 10 m (Fig. 5.7a) where it turned into a moderately inclined slope supporting a biocenosis of infralittoral algae with abundance of algae *Codium bursa* and *Laurencia* sp. (Fig. 5.7b). Continuing a dive towards the northeast, a moderately inclined slope became intercepted by rocks and small walls (Fig. 5.7c). Below 23 m depth coralligenous outcrops started to develop on rocks scattered on the detritic bottom (Fig. 5.7d-f). Along the dive, sparse colonies of gorgonian *Eunicella cavolini* were noted from 10 m depth to the maximum depth surveyed - 40 m (Fig. 5.7c, f). A slope with scattered rocks reached around 50 m depth.

Photosampling was carried out within the coralligenous habitat, at depth between 33 and 37 m. Three observers carried out visual census along random transects between 35 and 38 m depth, whereas no video was recorded due to a technical problem. Furthermore, no assessment of gorgonian health status could be performed at this site due to the absence of the red gorgonian *Paramuricea clavata* and scarce abundance of the yellow gorgonian *Eunicella cavolini*.

The erect layer of the coralligenous habitat was formed by large colonies of bushy bryozoan *Pentapora fascialis* and scarce colonies of the yellow gorgonian *Eunicella cavolini.* In general, erect layer was not very well developed at this site, which is indicated also by observers' evaluation that placed this site in the lowest category related to the abundance of organisms that form the erect layer (see Fig. 3.9).

The intermediate layer was formed mainly by sponges *Petrosia ficiformis*, smaller specimens of sponge *Aplysina cavernicola*, epibiotic zoantharian *Parazoanthus axinellae*, green

filamentous algae and *Flabelia petiolata*. In addition, this was the only surveyed site where also a bushy bryozoan *Schizotheca serratimargo* was noted (within photo samples), as the component of the intermediate layer and one of animal builders within the coralligenous habitat.

The basal layer was dominated by the red calcareous algae *Lithophyllum stictaeforme* growing in representative plate-like thalli, calcifying and non-calcifying algae of the genus *Peyssonnelia* (mainly *Peyssonnelia squamaria* and *P. rubra*) and *Mesophyllum macroblastum*. A sponge *Hexadella racovitzai* was among the most abundant encrusting animals.

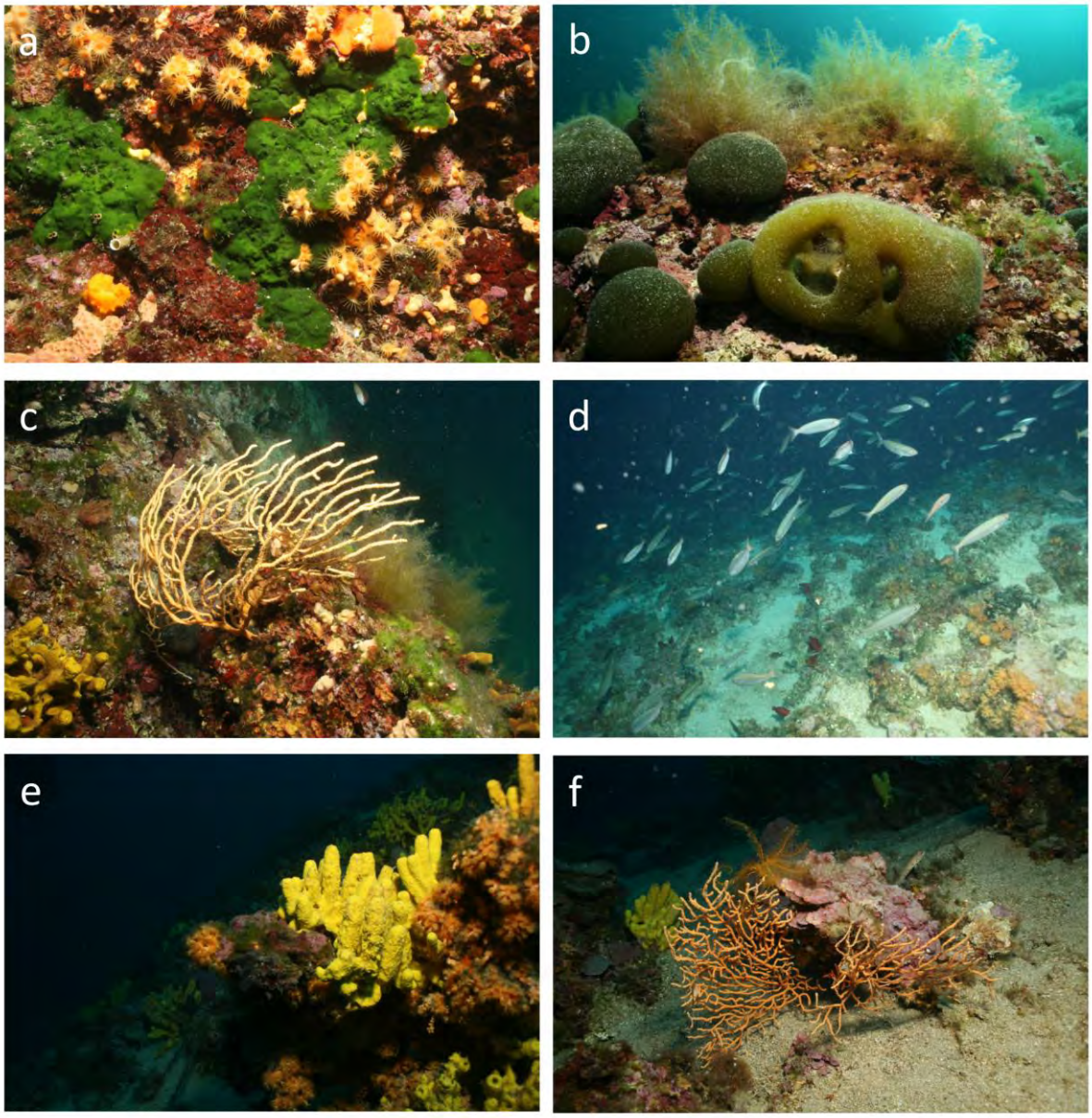
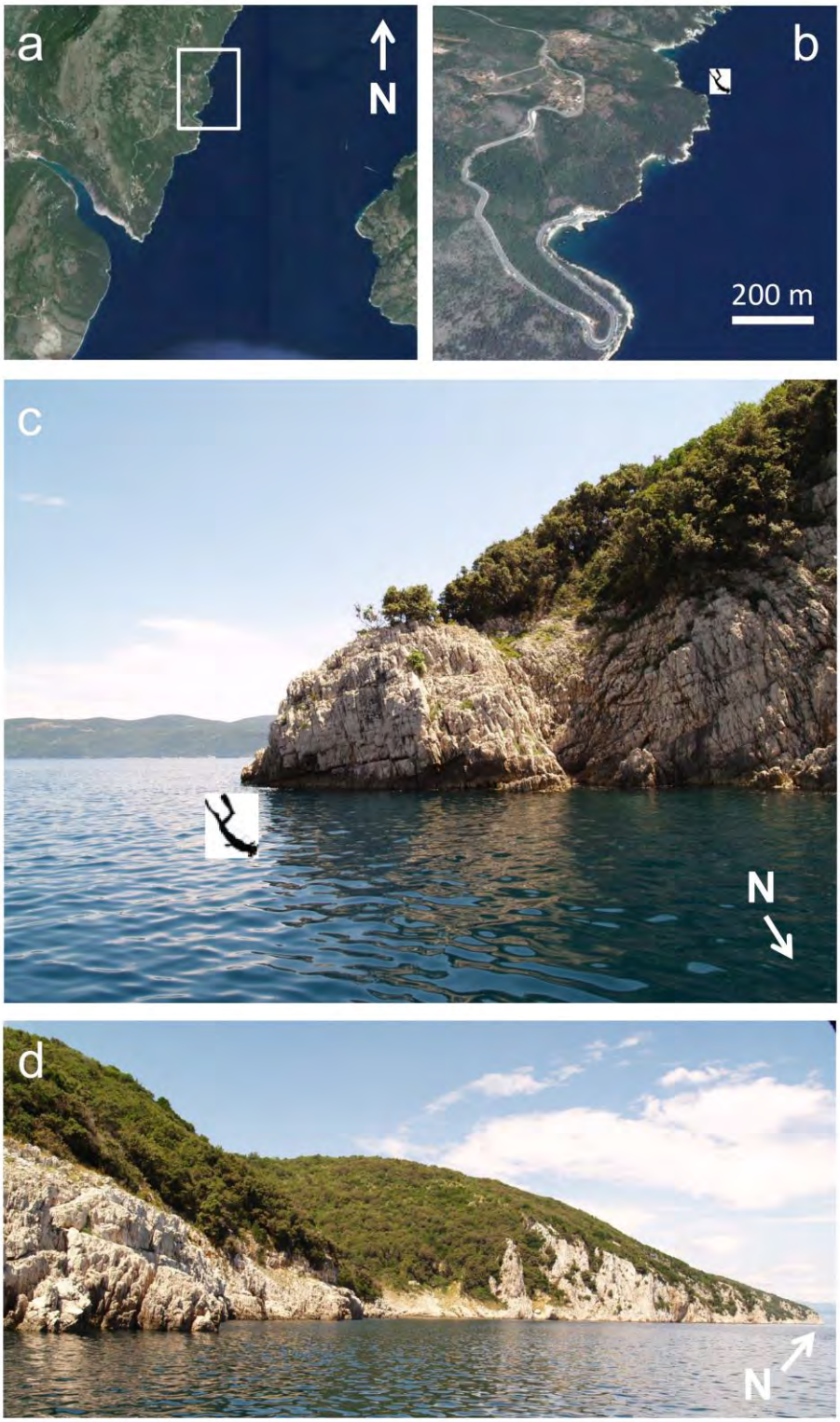



**Fig. 5.7. Cape Jablanac dive path. a)** a wall stretching down to 10 m depth hosted some of species found in more sciaphilic environments such as encrusting green algae *Palmophyllum crassum* and zoantharian *Parazoanthus axinellae*; **b)** moderately inclined slope supporting a biocenosis of infralittoral algae with abundance of algae *Codium bursa* and *Laurencia* sp. **from 10 m depth; c)** sparse colonies of gorgonian *Eunicella cavolini* were noted from 10 m depth at steeper slopes and scattered rocks; **d)** below 23 m depth coralligenous outcrops started to develop on rocks scattered on the detritic bottom; **e) sponge *Aplysina cavernicola and*** zoantharian ***Parazoantus axinellae*** **presented an important component of the intermediate layer; f) the basal layer was dominated by** the red calcareous algae ***Lithophyllum stictaeforme*** **growing in representative plate-like thalli. Photo credit: A. Žuljević.**

4 Cape Stupova




.

**Fig. 5.8. Cape Stupova dive site. Designated area of image a) is enlarged on image b); c) terrestrial view of the Cape Stupova diving site; d) the landscape northwards from the dive site. Source: a, b) Google Earth, Image © 2014 DigitalGlobe.**

GPS: 45°09'01.28''N, 14°13'44.46''E

Time of the dive: 2nd of July 2013, 11 am and 3 pm

Photos IDs and number of photos: MDSTa1 – MDSTc10e8; 30

Number of transects carried out: 2 marked + 4 random (by 4 observers)

Video transects: 1

Description: This diving site is located north from Brestova ferry station (Fig. 5.8). Underwater, a rocky wall stretches down to 7 m. From that depth a moderately inclined slope hosts a biocenosis of infralittoral algae with abundant algae *Dictyota* sp., *Codium bursa* and *Padina pavonica* (Fig. 5.9a). At this site scattered colonies of the yellow gorgonian were recorded from 7 m depth. Below 15 m slope becomes steeper and intercepted by smaller walls (Fig. 5.9b, c). From 25 m depth the coralligenous outcrops with abundant red calcareous algae *Lithophyllum stictaeforme*, zoantharian *Parazoanthus axinellae* and sponge *Aplysina cavernicola* were noted (Fig. 5.9c, d). From 32 m depth a well-developed *Paramuricea clavata* population was thriving on a cascade-like rocky bottom (Fig. 5.9e, f). Around 48 m depth, the rocky bottom was replaced by a slope of coarse detrital sand.

Photosampling was carried out within the *Paramuricea clavata* assemblage, at 34 m depth. At this site each of the 4 observers carried out visual census along 2 marked transects and 1 random transect between 35 and 38 m depth, and the video was recorded along 2 marked transects, both with a professional and a GoPro camera. Furthermore, one observer assessed the red gorgonian health status.

The erect layer of the coralligenous habitat was primarily formed by the colonies of the red gorgonian *Paramuricea clavata,* followed by the yellow gorgonian *Eunicella cavolini* (Fig. 5.9f), and large specimens of sponge *Aplysina cavernicola*.

The intermediate layer was formed mainly by bushy bryozoans *Myriapora truncata* and *Smittina cervicornis / Adeonella pallasi*, zoantharian *Parazoanthus axinellae,* smaller

specimens of sponge *Aplysina cavernicola* and *Petrosia ficiformis.* In addition, massive keratose sponges were abundant at this site.

The basal layer was dominated by the red calcareous algae *Lithophyllum stictaeforme* that developed representative plate-like thalli and *Mesophyllum macroblastum*, algae of the genus *Peyssonnelia* (mainly *Peyssonnelia rubra* and *P. squamaria*) and the encrusting sponge *Hexadella racovitzai* (Fig. 5.9f).

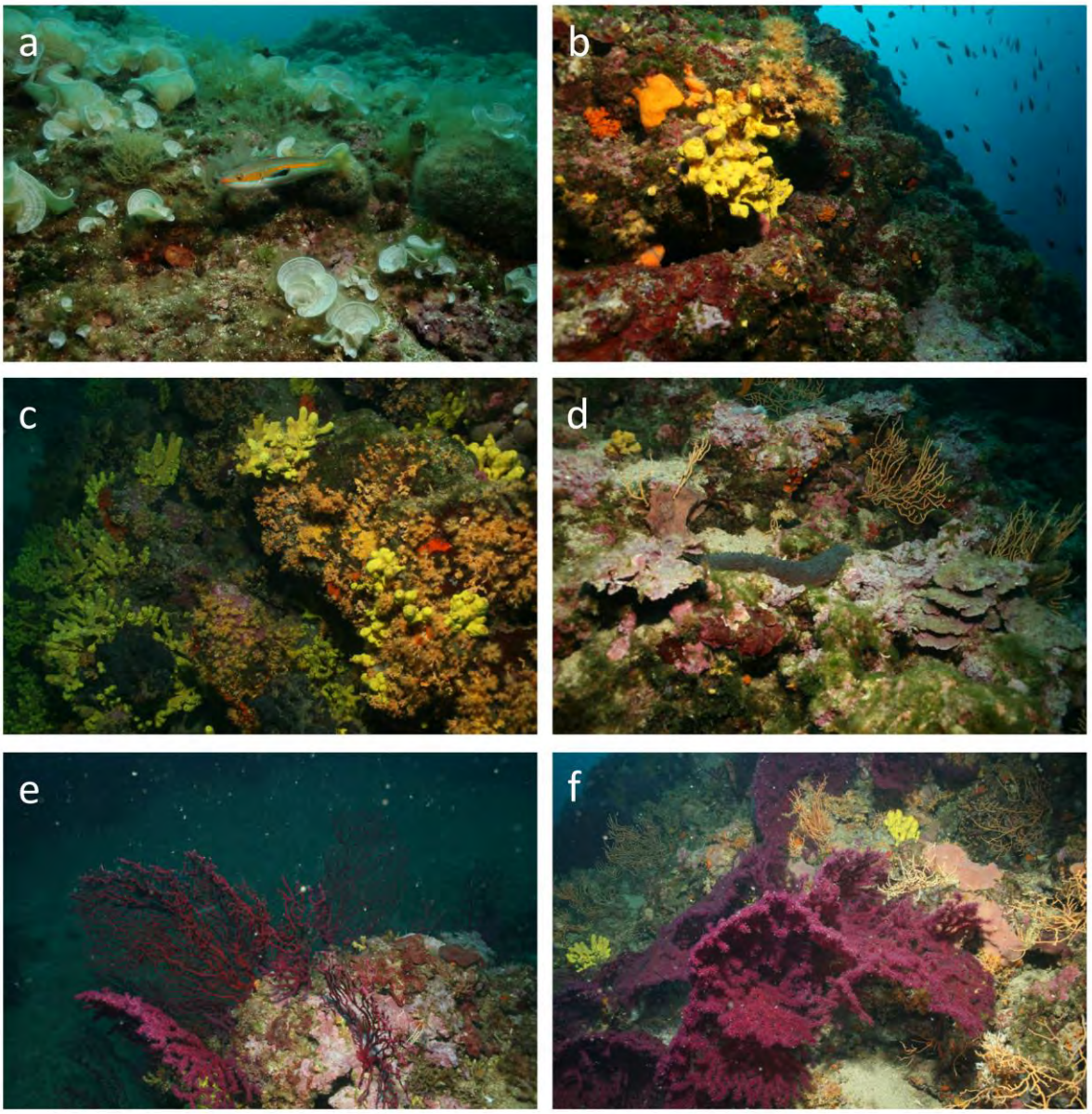



**Fig. 5.9. Cape Stupova dive path. a) from 7 m depth a moderately inclined slope hosts a biocenosis of infralittoral algae with abundant algae *Dictyota* sp., *Codium bursa* and *Padina pavonica*; b) below 15 m slope becomes steeper and it is intercepted by smaller walls; c) from 25 m depth a cascade-like rocky bottom hosts coralligenous outcrops with abundant zoantharian *Parazoanthus axinellae*, sponge *Aplysina cavernicola* and d) the red calcareous algae *Litophyllum stictaeforme* with representatively developed plate-like thalli; e, f) from 32 to 45 m depth *Paramuricea clavata* assemblage is thriving on a cascade-like rocky bottom. Photo credit: A. Žuljević.**

5 Plavnik

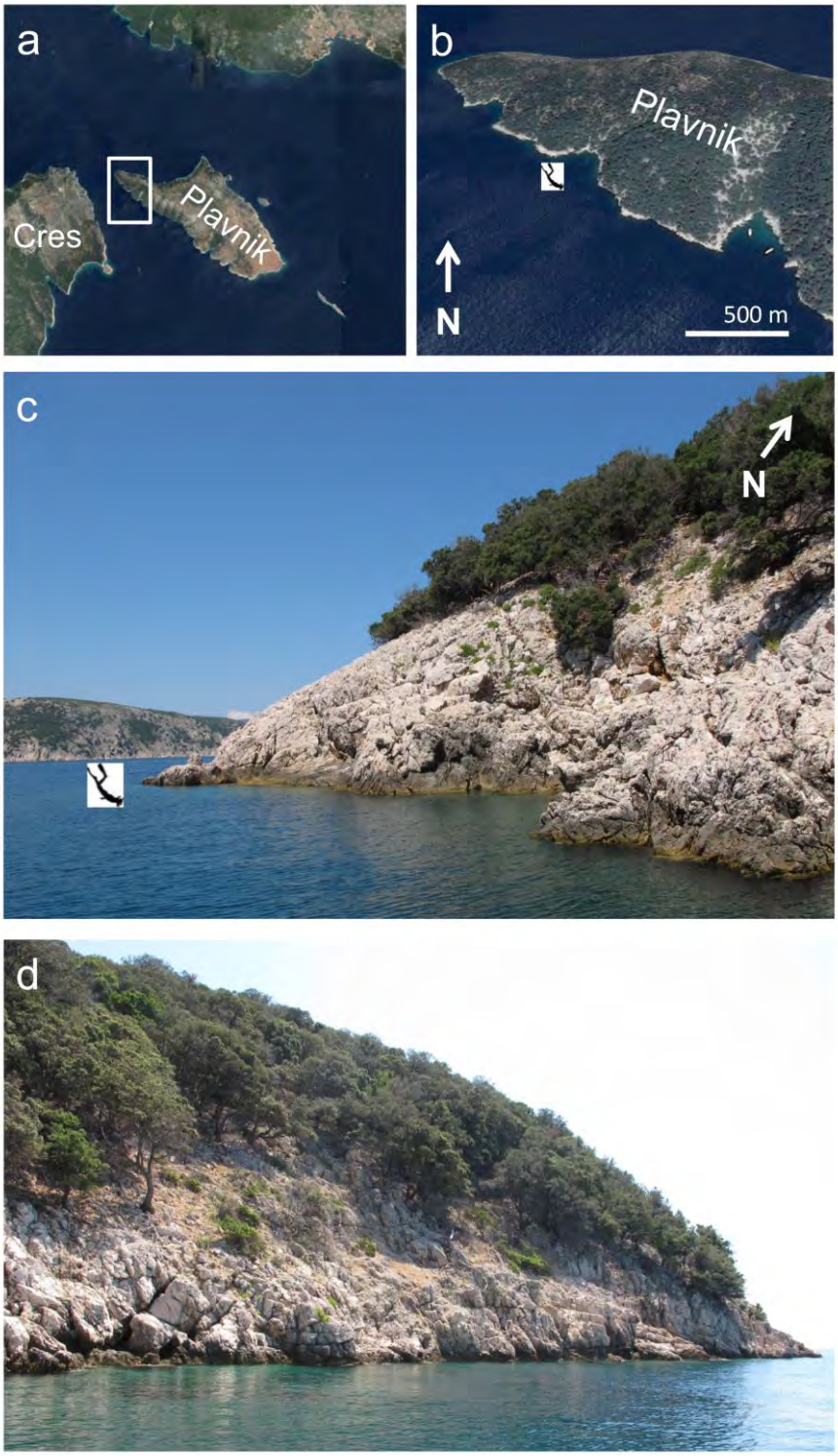



**Fig. 5.10. Plavnik dive site. Designated area of image a) is enlarged on image b); c) terrestrial view of the diving site at the northwestern tip of the second bay from the lighthouse (located at the northern tip of Plavnik Island); d) the view of the southern side of the bay. Source: a, b) Google Earth, Image © 2014 DigitalGlobe.**

GPS: 44°58'37.10''N, 14°29'28.51''E

Date and time of the dive: 6th of July 2014, 11 am

Photos IDs and number of photos: PLAa1-PLAc10; 30

Number of transects carried out: 2 marked + 2 random (by 2 observers)

Video transects: 1

Description: This dive site is located in the western part of the Plavnik Island (Fig. 5.10). We began the immersion at the northwestern tip of the second bay, located 0.4 NM from the lighthouse situated at the northwestern cape of Plavnik Island (Fig. 5.10c). A beadlet anemone *Actinia equina* was abundant below the surface (Fig. 5.11a). The immersion followed towards the west. From 5 to cca 12 m depth moderately inclined slope hosted the biocenosis of infralittoral algae dominated by *Cystoseira* sp. (Fig. 5.11b). Around 15 m depth green algae *Codium bursa* and sponge *Chondrilla nucula* were frequently found within the biocenosis of infralittoral algae (Fig. 5.11c). Below 20 m slope became steeper and it was intercepted by smaller walls. The coralligenous outcrops started to appear at depths below 23 m (Fig. 5.11d, e). A *Paramuricea clavata* assemblage was developed from 27 m (Fig. 5.11f). Around 40 m depth the rocky bottom was replaced by a detritic bottom.

Photosampling was carried out within the *Paramuricea clavata* assemblage, at depth between 32 and 37 m. At this site each of the two observers carried out visual census along 2 marked transects and 1 random transect at depth between 30 and 37 m, and the video transect was recorded both by a professional camera and GoPro camera along 2 marked transects. Furthermore, one operator assessed the red gorgonian health status.

The erect layer of the coralligenous habitat was formed by colonies of the red gorgonian *Paramuricea clavata* that were present in relatively low density. Colonies were mainly small and a lot of them showed signs of broken apical tips, exposing skeletal axis (Fig. 5.11f). There were also a notable number of juveniles. The erect layer was further formed by the yellow gorgonian *Eunicella cavolini* and large colonies of sponge *Aplysina cavernicola* (> 15 cm high).

The intermediate layer was formed mainly by zoantharian *Parazoanthus axinellae* overgrowing sponge *Axinella* sp. or growing directly on the rocky substrate, smaller specimens of sponge *Aplysina cavernicola*, bushy bryozoan *Myriapora truncata* and *Smittina cervicornis / Adeonella pallasii*, and green algae *Flabellia petiolata.* Furthermore, at this site the highest diversity of tunicates was recorded (Figs. 3.5, 5.12).

The basal layer was primarily formed by the red calcareous algae *Mesophyllum macroblastum* and *Litophyllum stictaeforme* growing in representative plate-like thalli (Fig. 5.11e), as well as the calcified and non-calcified algae of the genus *Peyssonnelia* (*Peyssonnelia rubra* and *Peyssonnelia* spp.) and sponge *Hexadella racovitzai*.

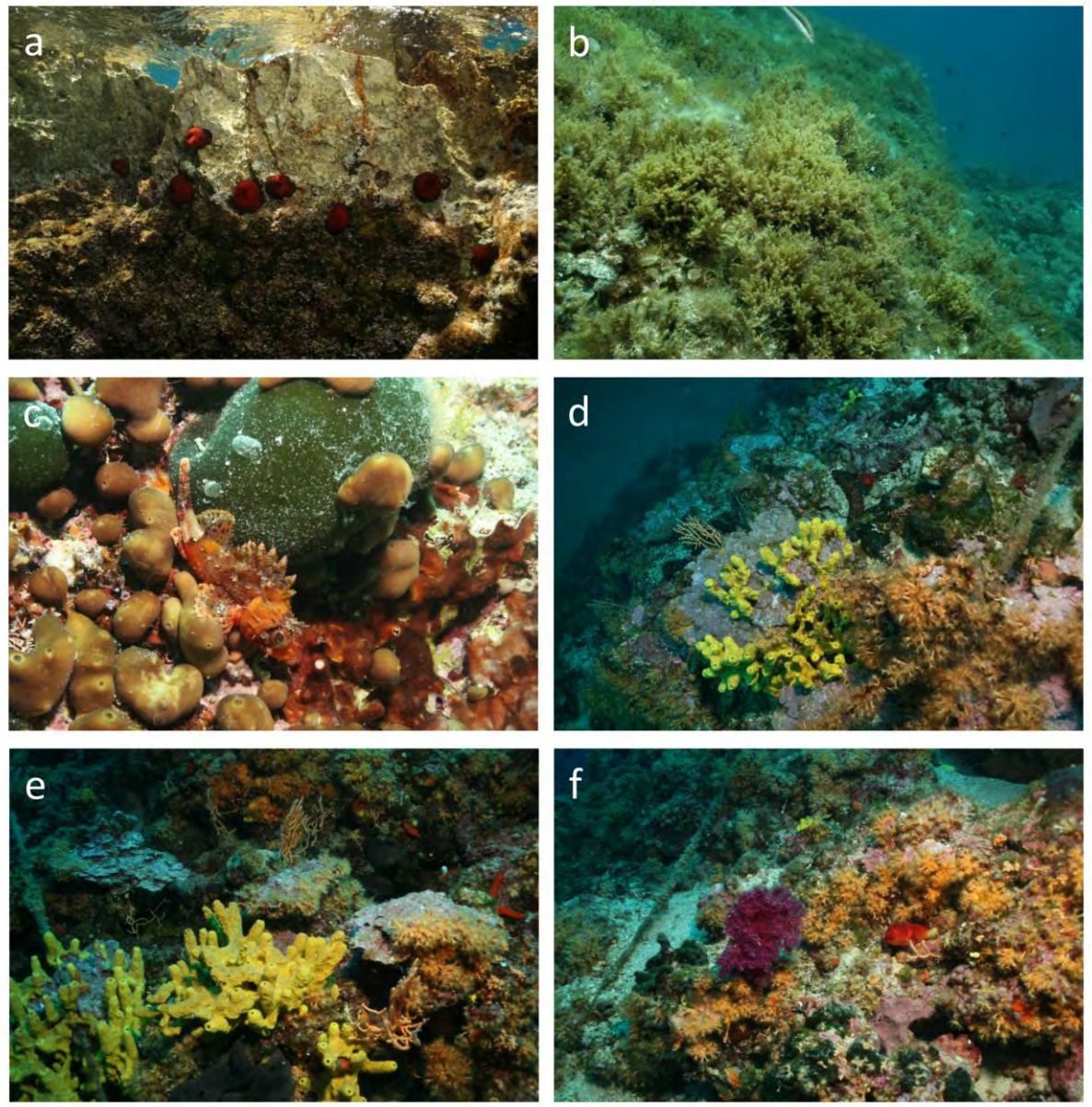



**Fig. 5.11. Plavnik dive path. a) subsurface part of the rock with a beadlet anemone *Actinia equina*; b) between 5 and 12 m depth moderately inclined slope was supporting the biocenosis of infralittoral algae with abundance of *Cystoseira* sp.; c) around 15 m depth green algae *Codium bursa* and sponge *Chondrilla nucula* were frequent within the biocenosis of infralittoral algae; d) the coralligenous outcrops were developed at cascade-like rocky bottom below 23 m depth; e) detail of the coralligenous outcrop with plate-like thalli of the red calcareous algae *Lithophyllum stictaeforme* and abundant sponge *Aplysina cavernicola*; f) the red gorgonian *Paramuricea clavata* was found within the coralligenous habitat below 27 m depth. Photo credit: A. Žuljević.**

**Fig. 5.12. Higher diversity of conspicuous tunicates was observed within coralligenous outcrops at Plavnik in comparison to other surveyed sites.**

6 Mali Plavnik


**Fig. 5.13. Mali Plavnik dive site. Designated area of image a) is enlarged on image b); c) terrestrial view of the diving site; d) view of rocks northwest from the diving site, where the boat was berthed. Source: a, b) Google Earth, Image © 2014 DigitalGlobe.**

GPS: 44°50'59.20''N, 14°49'46.24''E

Date and time of the dive: 6th of July 2014, 4 pm

Photos IDs and number of photos: MPa1-MPc10; 30

Number of transects carried out: 4 random (by 2 observers)

Video transects: 1

Description: Our diving position was located in the southeast part of the Mali Plavnik Island (Fig. 5.13). We dove eastwards from the shore, following a moderately inclined slope hosting a biocenosis of infralittoral algae with abundance of *Laurencia* sp., *Codium bursa* and sponge *Aplysina aerophoba.* From 15 m depth red non-calcareous and calcareous algae such as *Peyssonnelia* spp. (Fig. 5.14a) and *Lithothamnion* cf. *crispatum* were frequent (Fig. 5.14b). From 20 to 25 m depth biocenosis was dominated by more sciaphilic species such as sponge *Aplysina cavernicola*, algae *Flabelia petiolata* and *Peyssonnelia* spp. (Fig 5.14c). Coralligenous habitat was noted below 27 m depth (Fig. 5.14d) and the slope was replaced by a wall around 28 m depth. The red gorgonian *Paramuricea clavata* was noted below 32 m depth (Fig. 5.14e, f). Around 45 m depth the rocky wall was replaced by moderately inclined detritic bottom.

Photosampling was carried out on the wall between 35 and 37 m depth. Visual census was performed along random transects by two observers in the depth range from 33 to 38 m, while the video transect was recorded at 36 m depth. The assessment of the red gorgonian health status was not carried out at this site due to its low abundance.

The basal layer of the coralligenous habitat was dominated by both encrusting and prostrate algae of the genus *Peyssonnelia*, and sponge *Hexadella racovitzai* (Fig.5.14d, e). The intermediate layer was formed by branchy bryozoans *Myriapora truncata* and *Smittina cervicornis* / *Adeonella pallasii,* green algae *Flabellia petiolata*, as well as epibiotic zoantharian *Parazoanthus axinellae* overgrowing other organisms or growing on the bare rock. Smaller colonies of sponge *Aplysina cavernicola* (< 15 cm in height) also contributed to the intermediate layer, whereas larger colonies formed part of the erect layer (Fig. 5.14f).

The erect layer was further formed by sparse colonies of yellow gorgonian *Eunicella cavolini.* In general, the red gorgonian *Paramuricea clavata* was present in low abundance and colonies were relatively small (Fig. 5.14e, f).

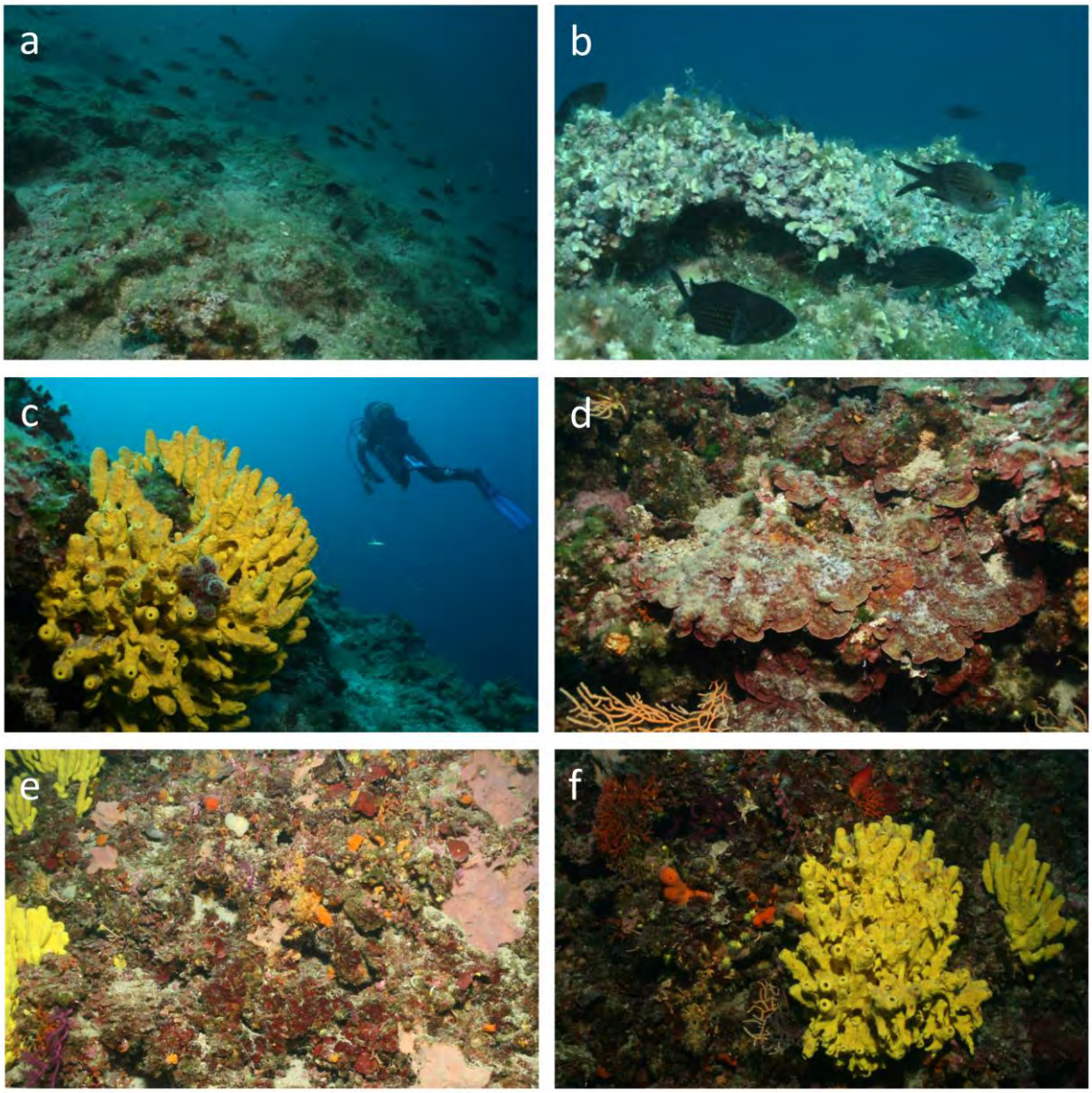



**Fig. 5.14. Mali Plavnik dive path. a) Below 15 m depth a moderately inclined slope was hosting biocenosis of infralittoral algae with abundant non-calcified red algae *Peyssonnelia* spp.; b) around 15 m depth the red calcareous algae *Lithothamnion* cf. *crispatum* was also frequent; c) from 20 to 25 m depth biocenosis was dominated by more sciaphilic species such as sponge *Aplysina cavernicola*, algae *Flabelia petiolata* and *Peyssonnelia* spp.; d) coralligenous habitat was noted below 27 m depth and calcareous red algae *Peyssonnelia* spp. were among the main constituents of its basal layer; e) the encrusting sponge *Hexadella racovitzai* was also abundant in the basal layer; f) the red gorgonian *Paramuricea clavata* was noted below 32 m depth and it was one of the main components of the erect layer together with large colonies of sponge *Aplysina cavernicola*, whereas the intermediate layer was formed by smaller colonies of the same sponge, bushy bryozoan *Smittina cervicornis* / *Adeonella pallasi*, tunicate *Halocynthia papilosa*, etc. Photo credits: A. Žuljević.**

7 Zečevo Islet

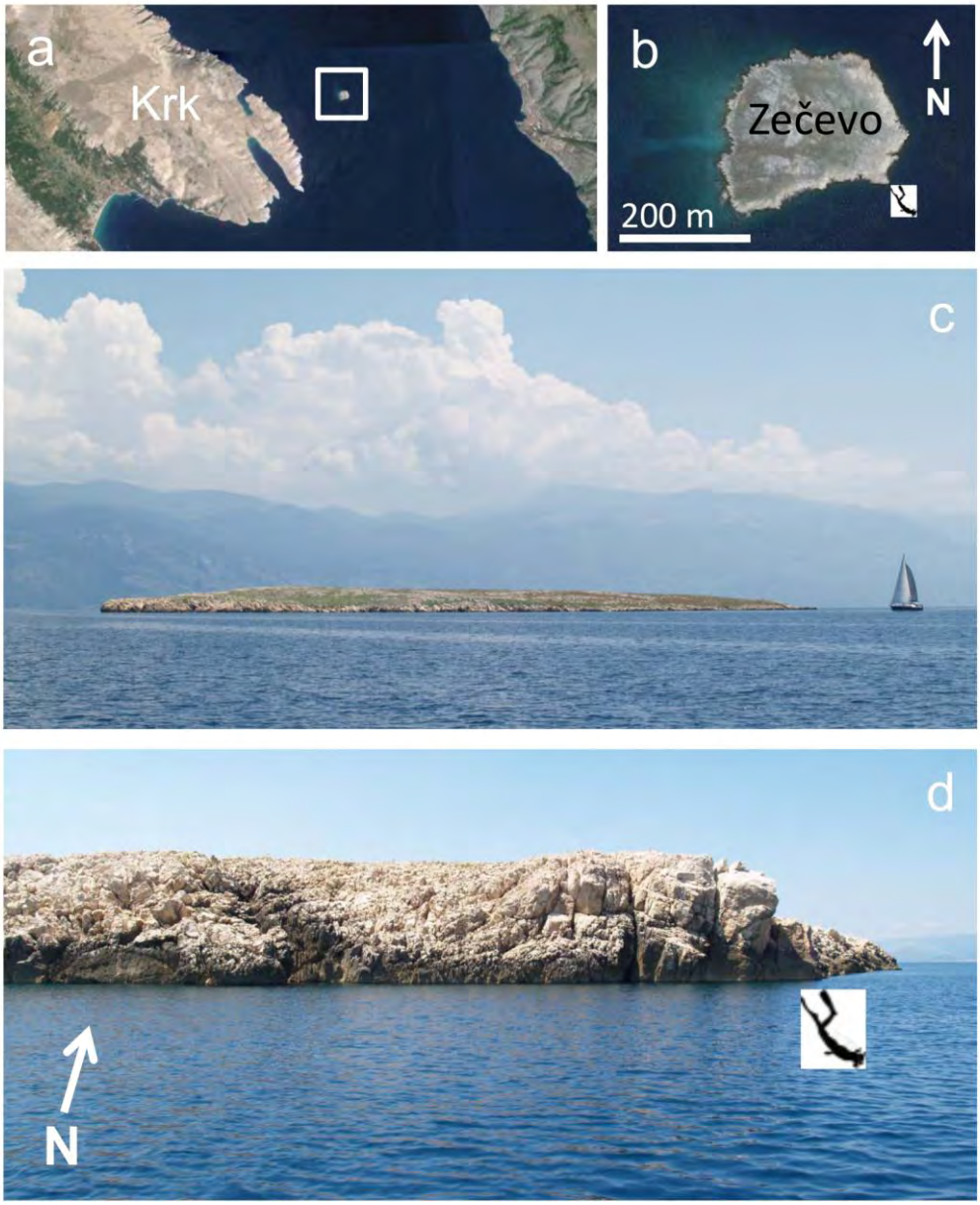



**Fig. 5.15. Zečevo Islet dive site. Designated area of image a) is enlarged on image b); c) Zečevo Islet and the mainland in the background d) terrestrial view of the diving site. Source: a, b) Google Earth, Image © 2014 DigitalGlobe.**

GPS: 44°59'45.31''N, 14°50'11.71''E

Date and time of the dive: 7th of July 2014, 2 pm

Photos IDs and number of photos: ZECa1 – ZECc10; 30

Number of transects carried out: 6 random (by 2 observers)

Video transects: 1

Description: Our diving site was located on the southeast coast of the Zečevo Islet, located 1 NM from the Krk Island and 2.6 NM from the town of Senj on the mainland (Fig. 5.15). Direction of our dive was towards east – southeast. We dove over moderately inclined slope with several scattered boulders that supported the biocenosis of infralittoral algae with abundant *Codium bursa, Cystoseira* sp. and *Dyctiota* sp. (Fig.5.16a). Scattered colonies of soft coral *Alcyonium acaule* were also present in this biocenosis. Around 27 m depth the slope turned into the wall (Fig. 5.16b) that hosted coralligenous outcrops and the first colonies of *Paramuricea clavata* appeared around 28 m. From 32 m depth, a *Paramuricea clavata* assemblage was developed (Fig. 5.16c,d). Around 43 m depth the rocky wall was replaced by a moderately inclined slope of coarse sand rich in detritus.

Photosampling was carried out on the wall between 33 and 35 m depth. Visual census was performed along random transects by two observers in the depth range from 33 to 37 m, while the video transect was recorded at 36 m depth. The assessment of the red gorgonian health status was not carried out at this site.

The erect layer of the coralligenous assemblage was mainly formed by gorgonians *Paramuricea clavata* and *Eunicella cavolini*.

The basal layer was algal dominated and primarily formed by the calcareous red algae *Lithophyllum stictaeforme* and *Mesophyllum macroblastum*, as well as *Peyssonnelia rubra* and *P. squamaria*, followed by the encrusting sponge *Hexadella racovitzai.*

The intermediate layer was formed mainly by sponges *Petrosia ficiformis*, *Agelas oroides*, smaller specimens of sponge *Aplysina cavernicola* and epibiotic zoantharian *Parazoanthus axinellae* overgrowing other organisms or growing on the bare rock.

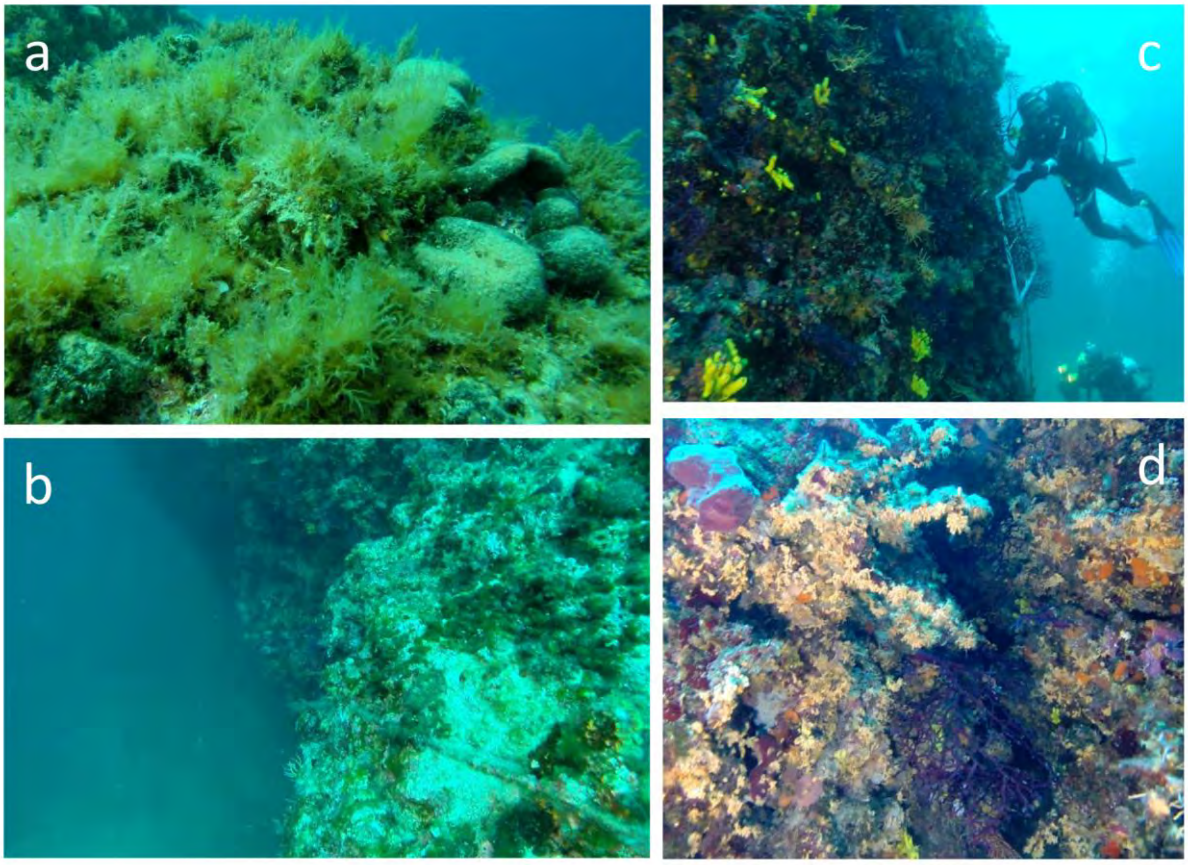



**Fig. 5.16. Islet Zečevo dive path. a) a moderately inclined slope hosting biocenosis of infralittoral algae with abundant *Codium bursa, Cystoseira* sp. and *Dyctiota* sp. at 8 m depth; b) beginning of the wall at 27 m depth; c) *Paramuricea clavata* assemblage thriving on the wall from 32 m depth; d) detail of the coralligenous outcrops at 35 m depth with gorgonian *Paramuricea clavata* in the erect layer, sponge *Petrosia ficiformis* and zoantharian *Parazoanthus axinellae* forming the intermediate layer and red calcareous algae and encrusting sponge *Hexadella racovitzai* forming the basal layer. Photo credit: P. Krstinić.**

# 6. Compilation of checklist of sessile macrobenthos in the coralligenous habitat within Primorje & Gorski Kotar County

During this fieldwork physical samples of certain taxa (Rhodophyta, Porifera, Anthozoa and Bryozoa) were collected and were subsequently determined by the experts. This information was combined with the results of the previous fieldwork and available literature to draft a more complete checklist of sessile macrobenthos thriving within coralligenous habitat in Primorje & Gorski Kotar County. Data compiled from sites is indicated in Table 6.1. The checklist includes a total of 206 species: 36 macroalgae (Table 6.2), 58 sponges (Table 6.3), 30 anthozoans (Table 6.4) and 82 bryozoans (Table 6.5).

In order to obtain a more comprehensive checklist of species thriving within the coralligenous habitat in Primorje & Gorski Kotar County, including also other taxonomic groups, further fieldwork that would include sample collection should be performed.

**Table 6.1. List of the sites within Primorje & Gorski Kotar County considered in the compilation of the checklist of sessile macrobenthos thriving in coralligenous community**

| Code | Site | Location | Source |
|---|---|---|---|
| MDKI | Cape Kinkela | Mošćenice | this report |
| MDLO | Cape Lonjica | Brseč | this report |
| MDST | Cape Stupova | Brestova | this report |
| JAB | Cape Jablanac | Cres | this report |
| CR | Cape Selzine | Cres | Garrabou & Kipson 2014 |
| PLA | Plavnik | Plavnik | this report |
| MP-1 | Mali Plavnik 1 | Plavnik | Garrabou & Kipson 2014 |
| MP-2 | Mali Plavnik 2 | Plavnik | this report |
| PL-1 | Kormati | Kormati (north) | Kružić & Požar-Domac 2006 |
| MC | Ćutin Mali | Cres | Garrabou & Kipson 2014 |
| MC-1 | Ćutin Mali | Cres | Kružić & Požar-Domac 2006 |
| MC-2 | Ćutin Mali | Cres | Kružić & Požar-Domac 2006 |
| LO-1 | Krivica Cove | Mali Lošinj | Kružić & Požar-Domac 2006 |
| GRG | Grgur | Grgur | Garrabou & Kipson 2014 |
| GR-1 | Zadbadnja Cove | Grgur | Kružić & Požar-Domac 2006 |
| GO | North coast of Goli Island | Goli otok | Garrabou & Kipson 2014 |

| Code | Site | Location | Source |
|---|---|---|---|
| GOM | Cape Markonj | Goli otok | Garrabou & Kipson 2014 |
| GO-1 | Galebov Islet | Goli otok | Kružić & Požar-Domac 2006 |
| GO-2 | Cape Senjska Vela | Goli otok | Kružić & Požar-Domac 2006 |
| GO-3 | Macinj | Goli otok | Kružić & Požar-Domac 2006 |
| PRSI | Cape Šilo | Prvić | Garrabou & Kipson 2014 |
| PRS | Cape Samonjin | Prvić | Garrabou & Kipson 2014 |
| PRST | Cape Stražica | Prvić | Garrabou & Kipson 2014 |
| PR-4 | Pećna Cove | Prvić | Kružić & Požar-Domac 2006 |
| PR-5 | Njivica | Prvić | Kružić & Požar-Domac 2006 |
| PR-6 | Kita Cove | Prvić | Kružić & Požar-Domac 2006 |
| PR-7 | Dubac Cove | Prvić | Kružić & Požar-Domac 2006 |
| KRS | Cape Sokol | Krk | Garrabou & Kipson 2014 |
| ZEC | Zečevo | Zečevo | this report |
| KRPT | Tenki | Krk | this report |
| KR-10 | Cape Šilo | Krk | Kružić & Požar-Domac 2006 |
| GRM | Grmac | Sveti Juraj | Novosel et al. 2002 |

**Table 6.2. Checklist of macroalgae recorded within coralligenous habitat in Primorje & Gorski Kotar County. Site codes are provided in Table 6.1.**

| Taxa | MDKI | MDLO | MDST | JAB | CR | MC | PLA | MP-1 | MP-2 | GRG | GO | GOM | PRSI | PRS | PRST | KRS | ZEC | KRPT |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CHLOROPHYTA | | | | | | | | | | | | | | | | | | |
| *Codium coralloides* (Kützing) P.C.Silva / *C. effusum* (Rafinesque) Delle Chiaje | | | | | | | + | | | | | | | | | | | |
| *Flabellia petiolata* (Turra) Nizamuddin 1987 | + | | | + | + | + | + | + | + | + | + | + | + | + | + | + | * | + |
| *Halimeda tuna* (J. Ellis & Solander) J.V. Lamouroux 1816 | | | | + | | | | | | + | | | | | | | | + |
| *Palmophyllum crassum* (Naccari) Rabenhorst 1868 | | | | + | + | + | | + | + | + | + | + | + | + | + | + | | + |
| *Valonia macrophysa* Kützing 1843 | + | | | | + | | + | | + | | | | + | + | + | | | |
| OCHROPHYTA | | | | | | | | | | | | | | | | | | |
| *Dictyopteris* sp. | | | | | + | | | | | + | | | | | | | | |
| RHODOPHYTA | | | | | | | | | | | | | | | | | | |
| *Antithamnionella* sp. | | + | | | | | | | | | | | | | | | | |
| *Antithamnion* sp. | | + | | | | | | | | | | | | | | | | |
| *Botryocladia chiajeana* (Meneghini) Kylin, 1931 | + | + | + | | | + | | | | | | | | | | | | + |
| *Botryocladia microphysa* (Hauck) Kylin, 1931 | + | + | + | | | + | | | | | | | | | | | | |
| *Botryocladia* sp. | | | | + | + | | + | | + | + | + | + | + | | + | + | | + |
| *Cryptonemia lomation* (Bertoloni) J.Agardh, 1851 | | | | | | | | | | | | | | | | | | + |
| *Gastroclonium reflexum* (Chauvin) Kützing, 1849 | | | | | | | | | | | | | | | | | | |
| *Gelidium* sp. | + | | | | | | | | | | | | | | | | | |
| *Grateloupia* sp. | | | | | | | | | | | | | | | | | | |
| *Griffithsia schousboei* Montagne, 1839 | + | | + | | | | | | | | | | | | | | | + |
| *Lithophyllum stictaeforme* (J.E. Areschoug) Hauck, 1877 | + | + | + | + | + | + | + | + | + | + | | | + | + | + | + | + | + |
| *Lithothamnion minervae* Basso, 1995 | | | | + | + | + | | | | | + | + | | | | | | |
| *Lithothamnion philippii* Foslie, 1897 | + | + | | | + | + | + | | | | | | | | | | | + |
| *Lithothamnion sonderi* Hauck, 1883 | | | + | | + | + | + | | | | | | | | | | | + |

| Taxa | MDKI | MDLO | MDST | JAB | CR | MC | PLA | MP-1 | MP-2 | GRG | GO | GOM | PRSI | PRS | PRST | KRS | ZEC | KRPT |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| RHODOPHYTA | | | | | | | | | | | | | | | | | | |
| *Lithothamnion* sp. | + | | + | + | | | | + | | | | | | | | | | + |
| *Mesophyllum macroblastum* (Foslie) Adey, 1970 | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + |
| *Mesophyllum* sp. | + | + | + | | + | | + | | + | | + | | | | | + | | |
| *Neogoniolithon mamillosum* (Hauck) Setchell & L.R.Mason, 1943 | | | | + | + | | | + | | | + | | | | | | | |
| *Peyssonnelia polymorpha* (Zanardini) F.Schmitz, 1879 | + | | | | | | | | | | | | | | | | | + |
| *Peyssonnelia rosa-marina* Boudouresque & Denizot, 1973 | + | + | + | + | | | | | + | + | | | | | | + | | + |
| *Peyssonnelia rubra* (Greville) J. Agardh, 1851 | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + |
| *Peyssonnelia* sp. | + | + | + | + | | + | + | + | + | + | + | + | + | + | + | + | + | + |
| *Peyssonnelia squamaria* (S.G.Gmelin) Decaisne, 1842 | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + |
| *Pneophyllum* sp. | | | | | | + | | | | | | | | | | | | |
| *Radicilingua* sp. | | | + | | | + | | | | | | | | | | | | |
| *Rhodimenia* sp. | | | | | | | | | | | | | | | | | | |
| *Rhodophyllis divaricata* (Stackhouse) Papenfuss, 1950 | | | | | | | | | | | | | | | | | | |
| *Sphaerococcus coronopifolius* Stackhouse, 1797 | | | | | | | | | + | | + | | | | + | + | | |
| *Spongites fruticulosa* Kützing, 1841 | | | | | + | | | | | | | | | | | | | |
| *Titanoderma pustulatum* (J.V.Lamouroux) Nägeli, 1858 | | | | + | | | | + | | | | | | | | | | |

**Table 6.3. Checklist of sponges recorded within coralligenous habitat in Primorje & Gorski Kotar County. Site codes are provided in Table 6.1.**

| | MDKI | MDLO | MDST | JAB | CR | MC | PLA | MP-1 | MP-2 | GRG | GO | GOM | PRSI | PRS | PRST | KRS | ZEC | KRPT | GRM |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PORIFERA | | | | | | | | | | | | | | | | | | | |
| *Aaptos aaptos* (Schmidt, 1864) | | + | | | | | | | | | | | | | | | | | |
| *Acanthella acuta* Schmidt, 1862 | + | + | + | | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + |
| *Acarnus tortilis* Topsent, 1892 | | | | | | | | | | | | | | + | | | | | |
| *Agelas oroides* (Schmidt, 1864) | | | + | | | + | + | + | + | + | + | + | + | + | + | | + | | + |
| *Aplysilla sulfurea* Schulze, 1878 | | | | | | | | | | | | | + | | | | | | |
| *Aplysina cavernicola* (Vacelet, 1959) | + | + | + | + | + | + | + | + | + | | + | | + | + | + | + | + | + | + |
| *Axinella cannabina* (Esper, 1794) | + | | * | | | | + | | | | | | + | + | + | | | | + |
| *Axinella damicornis* (Esper, 1794) | | | | | | | | | | | | | + | + | + | | | | + |
| *Axinella polypoides* Schmidt, 1862 | | * | | | | | | | | | | + | + | | + | + | | | + |
| *Axinella verrucosa* (Esper, 1794) | | | | | | | | | | | | | + | + | + | | | | + |
| *Scalarispongia scalaris* Schmidt, 1862 | | | | | | | | | | | | | + | + | + | | | | + |
| *Chondrosia reniformis* Nardo, 1847 | | | + | | | + | + | | + | * | | | + | + | + | | | + | + |
| *Clathrina* sp. | | | | | | | | | | | + | | + | + | | | | | |
| *Cliona* sp. | | | | | | + | | | | | | | + | | | + | | | + |
| *Cliona schmidti* (Ridley, 1881) | | | | | | | | | | | | | + | + | + | | | | |
| *Crambe crambe* (Schmidt, 1862) | | + | + | + | | | | | | | | | + | + | + | + | | | + |
| *Dercitus plicatus* (Schmidt, 1868) | | | | | | | | | | | | | + | | | | | | |
| *Dictyonella incisa* (Schmidt, 1880) | | | | | | | | | | | | | + | | | | | | |
| *Dysidea avara* (Schmidt, 1862) | | | | | | | | | | | | | + | + | + | | | | + |
| *Dysidea fragilis* (Montague, 1818) | | | | | | | | | | | | | + | + | + | | | | |
| *Dysidea* sp. | | + | + | + | | + | + | + | | * | | + | + | + | + | | + | + | |
| *Erylus discophorus* (Schmidt, 1862) | | | | | | | | | | | | | + | | + | | | | |

| | MDKI | MDLO | MDST | JAB | CR | MC | PLA | MP-1 | MP-2 | GRG | GO | GOM | PRSI | PRS | PRST | KRS | ZEC | KRPT | GRM |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PORIFERA | | | | | | | | | | | | | | | | | | | |
| *Erylus euastrum* (Schmidt, 1868) | | | | | | | | | | | | | | | + | | | | |
| *Eurypon* sp. | | + | | | | | | | | | | | + | | | | | | |
| *Fasciospongia cavernosa* (Schmidt, 1862) | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | |
| *Haliclona (Halichoclona) fulva* (Topsent, 1893) | + | | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | |
| *Halichoclona* (*Reniera*) *mediterranea* Griessinger, 1971 | | | | | | | | | | * | | | + | * | | | | | |
| *Haliclona (Rhizoniera) sarai* (Pulitzer-Finali, 1969) | | + | | | | | | | + | | | | + | | | | | | |
| *Haliclona (Reniera)* sp. 1 | + | | + | | | | | | | | | | | | | | | | |
| *Haliclona (Reniera)* sp. 2 | | | + | | | | | | | | | | | | | | | | |
| *Hemimycale columella* (Bowerbank, 1874) | | + | | | | | | | | | | | + | + | + | | | + | |
| *Hexadella pruvoti* Topsent, 1896 | | | | + | | | | | | | | | | | | | | | |
| *Hexadella racovitzai* Topsent, 1896 | + | + | + | + | | | + | | + | | | | + | | + | + | + | + | + |
| *Sarcotragus foetidus* Schmidt, 1862 | | | | | | | | | | | | | | | | | | | + |
| *Sarcotragus spinosulus* Schmidt, 1862 | | | | | | | | | | | | | + | | + | | | | |
| *Ircinia dendroides* (Schmidt, 1862) | | + | | | | | | | | | | | + | | + | | | | |
| *Ircinia fasciculata* (Pallas, 1862) | | | | | | | | | | | | | + | + | + | | | | + |
| *Ircinia oros* (Schmidt, 1864) | | | | | | | | | | | | | + | | | | | | |
| *Isops intuta* (Topsent, 1892) | | | | | | | | | | | | | | | + | | | | |
| *Myceliospongia araneosa* Vacelet & Perez, 1998 | | + | | | | | | | | | | | | | | | | | |
| *Oscarella lobularis* (Schmidt, 1862) | | | | | | | | | | | | | + | + | + | | | | |
| *Penares helleri* (Schmidt, 1864) | | | | | | | | | | | | | + | | | | | | |
| *Petrosia ficiformis* (Poiret, 1789) | + | + | + | + | + | + | + | + | + | * | + | + | + | + | + | + | + | + | + |
| *Phorbas tenacior* (Topsent, 1925) | | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | | + | |
| *Phorbas topsenti* Vacelet & Perez, 2008 | + | | | | | | | | | | | | | + | | | | | |
| *Phorbas* sp. | | + | | | | | | | | | | | | | | | | | |

| | MDKI | MDLO | MDST | JAB | CR | MC | PLA | MP-1 | MP-2 | GRG | GO | GOM | PRSI | PRS | PRST | KRS | ZEC | KRPT | GRM |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PORIFERA | | | | | | | | | | | | | | | | | | | |
| *Pleraplysilla spinifera* (Schulze, 1879) | | | + | | | | | + | | * | + | + | + | + | + | | | + | |
| *Stylostichon dives* (Topsent, 1891) | | | | | | | | | | | | | + | | | | | | |
| *Raspaciona aculeata* (Johnston, 1842) | | | | | | | | | | | | | + | | + | | | | |
| *Spirastrella cunctatrix* Schmidt, 1868 | | | | | | | | | | | | | + | + | | | | | |
| *Spongia* (*Spongia*) *lamella* (Schulze, 1879) | | | | | | | | | | | | * | | | | | | | + |
| *Spongia officinalis* ssp. *adriatica* Schmidt, 1862 | | | | | | | | | | | | | + | + | | | | | + |
| *Spongia virgultosa* Schmidt, 1868 | | | | | | | | | | | | | + | | | | | | |
| *Stryphnus mucronatus* (Schmidt, 1868) | | | | | | | | | | | | | | | | | | | + |
| *Suberites carnosus* (Johnston, 1842) | + | | | | | | | | | | | | + | | | | | | |
| *Sycon sp.* | | | | | | | | | | | | | + | | + | | | | |
| *Terpios fugax* Duchassaing et Michelotti, 1864 | | | | | | | | | | | | | + | | | | | | |
| *Tethya* sp. | | | + | | | | + | | | * | + | | + | + | | + | | | |

**Table 6.4. Checklist of anthozoans recorded within coralligenous habitat in Primorje & Gorski Kotar County. Site codes are provided in Table 6.1.**

| | MDLO | CR | MC-1 | MC-2 | GO-1 | GO-2 | GO-3 | GR-1 | KR-10 | KRS | LO-1 | PL-1 | PRSI | PRS | PRST | PR-4 | PR-5 | PR-6 | PR-7 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ANTHOZOA | | | | | | | | | | | | | | | | | | | |
| *Alcyonium acaule* Marion, 1878 | + | + | + | + | + | | + | + | | + | + | + | + | + | + | + | | + | + |
| *Alcyonium coralloides* (Pallas, 1766) | + | + | + | | + | + | | + | + | + | | + | + | | + | + | + | + | + |
| *Alcyonium palmatum* Pallas, 1766 | | | | | | + | | | | | | | | | | | | | |
| *Andresia partenopea* (Andrès, 1884) | | | | | | + | | | | | + | | | | | | | | |
| *Caryophyllia cyathus* (Ellis et Solander, 1786) | + | + | | | | | | | | | | | | | + | | | | |
| *Caryophyllia inornata* (Duncan, 1878) | + | + | + | | + | + | + | + | + | + | + | + | + | + | + | | + | + | + |
| *Caryophyllia smithii* Stokes et Broderip, 1828 | + | + | + | + | + | + | + | | + | + | | + | | + | | + | + | | + |
| *Ceratotrochus magnaghii* Cecchini, 1914 | | + | + | | | + | | | + | | | | | + | + | + | | | | |
| *Coenocyathus anthophyllites* Milne Edwards et Haime, 1848 | | | | | | | | | | | | | + | | | | | | |
| *Corynactis viridis* Allman, 1846 | | | | | | | + | | | + | | + | | | + | + | | + | + |
| *Epizoanthus arenaceus* Delle Chiaje, 1823 | | | | + | | | | | + | + | | | + | | | | | | |
| *Epizoanthus paxii* Abel, 1955 | | | | | | | | + | | | | | | | | | | | |
| *Epizoanthus steueri* Pax, 1937 | | + | | | | | | | | | | | | | | | | | |
| *Eunicella cavolini* (Koch, 1887) | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + |
| *Eunicella singularis* (Esper, 1791) | + | + | | | + | + | + | + | | + | + | | + | + | | + | + | + | + |
| *Eunicella verrucosa* (Pallas, 1766) | | | | + | | | | | | | | | | | | | | | |
| *Guynia annulata* Duncan, 1872 | | | | | | | | | + | | + | | + | | + | + | | + | |
| *Hoplangia durothrix* Gosse, 1860 | + | + | + | | + | + | + | + | + | + | | + | + | | + | + | + | + | + |
| *Leptopsammia pruvoti* Lacaze-Duthiers, 1897 | + | + | + | | + | + | + | | + | + | | + | + | + | + | + | + | + | + |
| *Madracis pharensis* (Heller, 1868) | | + | | | | + | + | | + | + | | + | + | + | + | + | + | + | + |
| *Monomyces pygmaea* (Risso, 1826) | | + | | | | | | | | | | | | + | | | | | |
| *Paracyathus pulchellus* (Philippi, 1842) | + | | | | | | | | | | | | + | + | | | | | |

| | MDLO | CR | MC-1 | MC-2 | GO-1 | GO-2 | GO-3 | GR-1 | KR-10 | KRS | LO-1 | PL-1 | PRSI | PRS | PRST | PR-4 | PR-5 | PR-6 | PR-7 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ANTHOZOA | | | | | | | | | | | | | | | | | | | |
| *Paramuricea clavata* (Risso, 1826) | + | + | | + | + | + | + | | + | + | | + | + | | + | + | + | | + |
| *Parazoanthus axinellae* (O. Schmidt, 1862) | + | + | + | + | + | + | | + | + | + | + | + | + | + | + | + | + | + | + |
| *Pennatula rubra* (Ellis, 1764) | | + | | | | | | | | | | | | | | | | | |
| *Phyllangia mouchezi* (Lacaze-Duthiers, 1897) | + | + | + | | | + | + | | + | + | | | | | | + | | | |
| *Polycyathus muellerae* (Abel, 1959) | | + | + | | | | + | | | | | + | + | + | | + | | | |
| *Pteroeides spinosum* (Ellis, 1764) | | | | | + | | | | | | | | | | | | | | |
| *Sarcodictyon roseum* (Philippi, 1842) | | | | | + | | | | | | + | | | + | | + | | | |
| *Thalamophyllia gasti* (Döderlein, 1913) | | | | | | | | | | | | | | + | | | + | | |

**Table 6.5. Checklist of bryozoans recorded within coralligenous habitat in Primorje & Gorski Kotar County. Site codes are provided in Table 6.1.**

| | MDKI | MDLO | MDST | JAB | CR | MC | PLA | MP-1 | MP-2 | GRG | GO | GOM | PRSI | PRS | PRST | KRS | ZEC | KRPT | GRM |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BRYOZOA | | | | | | | | | | | | | | | | | | | |
| *Adeonella pallasii* (Heller, 1867) | | | | | | | | | | | | | + | | + | | | | + |
| *Aetea sica* (Couch, 1844) | + | + | | | | | + | | + | | | | + | | | | | + | |
| *Aetea truncata* (Landsborough, 1852) | + | + | + | | | | + | | + | | | | + | | + | | | | + |
| *Annectocyma* sp. | + | + | + | | | | | | | | | | | | | | | | |
| *Beania magellanica* (Busk, 1852) | + | + | + | + | + | + | + | + | + | + | + | | + | + | + | + | + | + | + |
| *Beania mirabilis* Johnston, 1840 | + | | | | | | | | + | | | | + | | | | | + | + |
| *Beania hirtissima* (Heller, 1867) | + | | | | | | | | | | | | + | | | | | | |
| *Buffonellaria divergens* (Smitt, 1873) | | | | | | | | | | | | | | | | | | | + |
| *Bugula calathus* Norman, 1864 | | | | | | | | | | | | | + | | | | | | + |
| *Bugula fulva* Ryland, 1960 | | + | + | | | | | | | | | | + | | | | | | |
| *Bugula plumosa* (Pallas, 1766) | | | | | | | | | | | | | + | | | | | | |
| *Caberea boryi* (Audouin, 1826) | + | + | | | | | | | | | | | + | | | | | | |
| *Callopora dumerilii* (Audouin, 1826) | | | | | | | | | | | | | + | | | | | + | |
| *Callopora lineata* (Linnaeus, 1767) | | | | | | | | | + | | | | | | | | | | |
| *Cellepora pumicosa* (Pallas, 1766) | | | | | | | | | | | | | + | | | | | | |
| *Celleporina caliciformis* (Lamouroux, 1816) | | | | | | | | | | | | | + | | | | | | + |
| *Celleporina caminata* (Waters, 1879) | + | + | + | | | | + | + | + | | | | + | | | | | | |
| *Celleporina hassallii* (Johnston, 1847) | | | | | | | | | | | | | + | | | | | | |
| *Celleporina lucida* (Hincks, 1880) | | | | | | | | | + | | | | + | | + | | | | |
| *Celleporina tubulosa* (Hincks, 1880) | | | | | | | | | | | | | | | | | | + | |
| *Chorizopora brongniartii* (Audouin, 1826) | + | + | | | | | | | | | | | + | | + | | | | |
| *Collarina balzaci* (Audouin, 1826) | | | | | | | | | | | | | | | + | | | | |

| | MDKI | MDLO | MDST | JAB | CR | MC | PLA | MP-1 | MP-2 | GRG | GO | GOM | PRSI | PRS | PRST | KRS | ZEC | KRPT | GRM |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BRYOZOA | | | | | | | | | | | | | | | | | | | |
| *Copidozoum planum* (Hincks, 1880) | + | + | + | | | | | | | | | | | | | | | | |
| *Crassimarginatella crassimarginata* (Hincks, 1880) | | | | | | | | | | | | | | | + | | | | |
| *Crassimarginatella maderensis* (Waters, 1898) | + | + | + | | | | | | + | | | | | | | | | | |
| *Crisia* sp. | + | + | + | | | | | | | | | | | | | | | | |
| *Diplosolen obelium* (Johnston, 1838) | + | + | + | | | | | | | | | | + | | + | | | + | + |
| *Disporella hispida* (Fleming, 1828) | + | | | | | | | | | | | | + | | | | | | |
| *Disporella* sp. | | | + | | | | | | | | | | | | | | | | |
| *Escharina dutertrei protecta* Zabala, Maluquer & Harmelin, 1993 | | + | | | | | | | | | | | | | | | | | |
| *Escharina vulgaris* (Moll, 1803) | + | | + | | | | | | + | | | | + | | + | | | + | |
| *Escharoides coccinea* (Abildgaard, 1806) | + | | | | | | | | | | | | + | | | | | | |
| *Eurystrotos occulta* (Harmelin, 1976) | | | | | | | | | | | | | + | | | | | | |
| *Fenestrulina malusii* (Audouin, 1826) | + | | + | | | | | | + | | | | | | | | | | |
| *Frondipora verrucosa* (Lamouroux, 1821) | | | + | | | | | | | | | | | | | | | | |
| *Gregarinidra gregaria* (Heller, 1867) | | | | | | | | | | | | | | | + | | | | |
| *Haplopoma impressum* (Audouin, 1826) | | | | | | | | | | | | | + | | | | | | |
| *Hagiosynodos kirchenpaueri* (Heller, 1867) | | + | + | | | | | | | | | | + | | + | | | | |
| *Herentia majae* Berning, Tilbrook & Rosso, 2008 | + | + | + | | | | | | | | | | | | | | | | |
| *Idmidronea atlantica* (Forbes, in Johnston, 1847) | | | | | | | | | | | | | | | + | | | | |
| *Lagenipora lepralioides* (Norman, 1868) | | | + | | | | | | | | | | | | | | | | |
| *Patinella radiata* (Audouin, 1826) | | | | | | | | | | | | | + | | + | | | | |
| *Metroperiella lepralioides* (Calvet, 1903) | | | | | | | | | | | | | + | | | | | | + |
| *Microporella ciliata* (Pallas, 1766) | | + | | | | | | | | | | | | | | | | + | |
| *Microporella umbracula* (Audouin, 1826) | | | | | | | | | | | | | + | | | | | | |

| | MDKI | MDLO | MDST | JAB | CR | MC | PLA | MP-1 | MP-2 | GRG | GO | GOM | PRSI | PRS | PRST | KRS | ZEC | KRPT | GRM |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BRYOZOA | | | | | | | | | | | | | | | | | | | |
| *Mollia circumcincta* (Heller, 1867) | + | + | + | | | | + | | + | | | | + | | | | | + | + |
| *Mollia patellaria* (Moll, 1816) | + | | | | | | + | | + | | | | + | | | | | | + |
| *Myriapora truncata* (Pallas, 1766) | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + |
| *Parasmittina tropica* (Waters, 1909) | | | | | | | | | | | | | + | + | | | | | + |
| *Pentapora fascialis* (Pallas, 1766) | + | + | + | + | + | | | | | | + | | - | + | + | + | | | + |
| *Prenantia cheilostoma* (Manzoni, 1869) | + | | | | | | | | | | | | | | | | | | |
| *Puellina gattyae* (Landsborough, 1852) | | | | | | | | | | | | | + | | | | | | |
| *Puellina hincksi* (Friedl, 1917) | + | + | + | | | | | | + | | | | + | | + | | | + | |
| *Puellina innominata* (Couch, 1844) | + | + | + | | | | | | + | | | | + | | + | | | | + |
| *Puellina pedunculata* Gautier, 1956 | + | + | + | | | | | | | | | | + | | | | | | |
| *Puellina radiata* (Moll, 1803) | | | | | | | | | | | | | | + | + | | | + | + |
| *Reptadeonella violacea* (Johnston, 1847) | | | | | | | | | | | | | | | | | | | + |
| *Reteporella grimaldii* (Jullien, 1903) | + | | | | | | | | | | | | | | | | | | |
| *Reteporella* sp. | | | | | | + | | | | | | | | + | + | | | | |
| *Rhynchozoon* sp. | + | + | + | | | | | | + | | | | | | | | | + | + |
| *Savignyella lafontii* (Audouin, 1826) | | | | | | | | | | | | | | | | | | | + |
| *Schizobrachiella sanguinea* (Norman, 1868) | | | | | | | | | | | | | + | + | | | | | + |
| *Schizomavella cornuta* (Heller, 1867) | + | + | + | | | | + | | + | | | | + | | + | | | + | + |
| *Schizomavella discoidea* (Busk, 1859) | | + | + | | | | | | | | | | | | | | | | |
| *Schizomavella linearis* (Hassall, 1841) | + | + | + | | | | | | + | | | | + | | + | | | + | + |
| *Schizomavella halimedae* (Gautier, 1955) | | | | | | | | | | | | | + | | | | | | |
| *Schizomavella mamillata* (Hincks, 1880) | + | + | + | | | | | | | | | | + | + | | | | | |
| *Schizoporella dunkeri* (Reuss, 1848) | | | | | | | | | | | | | + | + | | | | | |
| *Schizoporella magnifica* (Hincks, 1886) | + | + | + | | | | + | | + | | | | | | | | | | |

| | MDKI | MDLO | MDST | JAB | CR | MC | PLA | MP-1 | MP-2 | GRG | GO | GOM | PRSI | PRS | PRST | KRS | ZEC | KRPT | GRM |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BRYOZOA | | | | | | | | | | | | | | | | | | | |
| *Schizoporella* sp. | | | | | | | | | | | | | | + | | | | | |
| *Schizotheca serratimargo* (Hincks, 1886) | | | | + | | | | | | | | | | | | | | | |
| *Scrupocellaria delilii* (Audouin, 1826) | | | | | | | | | | | | | + | | | | | | |
| *Scrupocellaria scrupea* Busk, 1852 | | | + | | | | | | | | | | + | + | + | | | | |
| *Scrupocellaria scruposa* (Linnaeus, 1758) | | + | | | | | | | | | | | | + | | | | | + |
| *Smittina cervicornis* (Pallas, 1766) | + | + | + | | | | | | | | | | + | + | + | | | + | + |
| *Smittoidea marmorea* (Hincks, 1877) | | + | | | | | | | | | | | + | | | | | | |
| *Smittoidea reticulata* (MacGillivray, 1842) | + | + | | | | | | | | | | | | | | | | | |
| *Synnotum aegyptiacum* (Audouin, 1826) | + | | + | | | | | | | | | | + | | | | | | |
| *Tubulipora liliacea* (Pallas, 1766) | + | + | | | | | | | | | | | + | | | | | | + |
| *Tubulipora* sp. | + | + | | | | | | | | | | | | | + | | | | |
| *Turbicellepora* sp. | | + | + | | | | | | | | | | + | + | + | | | | |
| *Walkeria tuberosa* Heller, 1867 | | | | | | | | | | | | | + | | | | | | |

# 7. Conclusions and recommendations

This Field Report presents the analysis and the results of the field work carried out in 2014 within Primorje-Gorski Kotar County, as part of the MedMPAnet Project. Updated Monitoring Protocol for Coralligenous Community was tested in the field; the applicability of low cost videography was assessed; and additional sites within the Primorje-Gorski Kotar County were also assessed. An updated checklist of sessile macrobenthos thriving within coralligenous habitat in the same county was drafted, which facilitated compilation of a preliminary list of typical/indicator species to be monitored in the Adriatic coralligenous assemblages.

The insights obtained during this field work highlight the following:

- Increase in photo sampled area to better accommodate the assessment of parameters of structural complexity (cover of basal and intermediate layers) also resulted in a greater number of identified taxa (in comparison to assessment of the same site based on smaller sampled area), while not critically affecting the resolution of photographs in a manner to disable identification of small organisms with important functional role (thus included in the Preliminary list of typical/indicator species to be monitored), such as bioeroding bivalve *Gastrochaena dubia.*

- When the goal is also to characterize a certain coralligenous site for the first time (or to carry out a more comprehensive study of macrobenthic biodiversity patterns), it is recommended to perform photosampling of a minimum of 3 replicates of 0.5 $m^2$ using 25 x 25 cm subquadrats (as a part of the overall photo sampling effort) to ensure a more reliable identification of organisms (as suggested by Kipson et al. 2011), since certain level of detail (useful for species identification) is lost when 50 x 50 cm subquadrats are used. In addition, voucher specimens should be collected.

- The assessment of erect layer by visual assessment along transects is simple to apply and resulted in a similar evaluation by different observers.

- Videography obtained by GoPro camera fitted with external lightning provides a valuable low-cost tool for documentation of additional information on the dive and

the diving site, assessment of coralligenous structural complexity and compilation of more complete species lists.

- Overall, the proposed protocol may be applied within a reasonable time frame when working at depths between 30 and 40 m and in this manner, a team of 4 divers may assess 1 site per dive.[2]

- From newly assessed sites, Cape Stupova excels as a coastal Natura 2000 site within geographical Sector A (see Garrabou *et al.* 2014) due to representatively developed *Paramuricea clavata* assemblage (with upper depth limit at 32 m, which is shallower than the other 2 sites in the same area) and still well preserved gorgonian population, but also presence of potential and evidenced threats (e.g. discarded fishing gear, mucilaginous algal aggregates, diving). Thus, together with Cape Lonjica it confirms the inclusion among proposed sites for monitoring of coralligenous habitat at the national level.

- From assessed sites that have not been proposed till now as a part of the national monitoring network, including sites of different protection level within 3 different geographical sectors, Zečevo Islet could be considered as one of the rare known sites hosting *Paramuricea clavata* assemblage within geographical sector A but without any protection status.

- To obtain even more comprehensive checklist of macrobenthos (but potentially also of other groups) thriving within coralligenous habitat of County of Primorje & Gorski Kotar further fieldwork, including collection of physical samples, should be encouraged.

- Due to the considerable amounts of discarded fishing gear observed at every surveyed site, underwater clean-ups by volunteer divers could be considered as both direct conservation measure and an awareness raising activity. These actions should be performed in a manner not to cause additional damage to organisms.

[2] At selected sites where environmental parameters (e.g. seawater temperature) are also monitored (see Garrabou *et al.* 2014) additional dives are required to set up and replace measuring devices (for more info on seawater temperature measurements see www.t-mednet.org).

# 8. References


Ballesteros E (2006) Mediterranean Coralligenous Assemblages: A synthesis of present knowledge. Oceanogr Mar Biol Annu Rev 44:123-195.

Garrabou J, Kipson S (2014) Testing of monitoring protocol for coralligenous community: Field Report, MedMPAnet Project

Garrabou J, Kipson S, Kaleb S, Kružic P, Jaklin A, Žuljević A, Rajković Ž, Rodić P, Jelić K, Župan D (2014): Monitoring Programme for Reefs - Coralligenous Community, MedMPAnet Project

Harmelin JG, Marinopoulos J (1994) Population structure and partial mortality of the gorgonian *Paramuricea clavata* (Risso) in the North-Western Mediterranean (France, Port-Cros Island). Marine Life 4:5–13.

Kipson S, Fourt M, Teixidó N, Cebrian E, Casas E, Ballesteros E, Zabala M, Garrabou J (2011) Rapid biodiversity assessment and monitoring method for high diverse benthic communities: a case study of Mediterranean coralligenous outcrops. PLoS ONE 6 (11) e27103 [doi:10.1371/journal.pone.0027103]

Kersting DK, Linares C (2006) Mortandad de *Paramuricea clavata* asociada a un evento de macroagregados mucilaginosos ("llepó") tras el verano de 2004 en Islas Columbretes. In: Ballesteros M., Palacín C, Turón X. (eds.), Proceedings of XIV Simposio Ibérico de Estudios de Biologia Marina (SIEBM). University of Barcelona (UB), Barcelona:149‑150

Kružić P, Požar-Domac A (2006) Records of Scleractinian corals in Kvarner Region. In: Arko-Pijevac M., Surina, B. (eds.), Natural History researches of the Rijeka region II. Natural History Museum Rijeka, Rijeka:225-236.

Novosel M, Bakran-Petricioli T, Požar-Domac A, Kružić P, Radić I (2002) The benthos of the northern part of the Velebit Channel (Adriatic Sea, Croatia). Nat Croat 11(4):387–409 Novosel M, Požar-Domac A, Pasarić M (2004) Diversity and Distribution of the Bryozoa along Underwater Cliffs in the Adriatic Sea with Special Reference to Thermal Regime. Mar Ecol 25 (2):155–170

## *Appendix 1. Form used for visual census*

| Observer: | | Date: | | | | Site: | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Species: | | Depth: | | | | | | | | | | |
| | | **Sectors (1 m)** | | | | | | | | | | |
| **Transect** | **Parameter** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **TOTAL** |
| **1** | **Erect layer** | | | | | | | | | | | |
| | **Bioeroders** | | | | | | | | | | | |
| | **Mucilaginous** | | | | | | | | | | | |
| **2** | **Erect layer** | | | | | | | | | | | |
| | **Bioeroders** | | | | | | | | | | | |
| | **Mucilaginous** | | | | | | | | | | | |
| **3** | **Erect layer** | | | | | | | | | | | |
| | **Bioeroders** | | | | | | | | | | | |
| | **Mucilaginous** | | | | | | | | | | | |
| | **Fishing nets:** | | | | | | | | | | | |
| | **Comments:** | | | | | | | | | | | |

## *Appendix 2. Form used for rapid assessment of gorgonian health status*

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Observer: | | Date: | | | | Site: | | | |
| Species | | Kind of bottom | | | | | | | |
| Depth survey: | | | | | | | | | |
| NON AFFECTED | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |
| AFFECTED (>10%) | | | | | | | | | |
| a) Naked axis/recent epibiosis | | | | | | | | | |
| b) Old epibosis | | | | | | | | | |
| Combination a) and b) | | | | | | | | | |
| Comments: | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |

## *Appendix 3. Checklist of sessile macrobenthic taxa identified by photosampling within the coralligenous habitat at study sites.*

'+' = presence; '-' = absence. For site abbreviations see Table.2.1.

| Taxa | MDKI | MDLO | MDST | JAB | PLA | MP | PRSI | PRST | KRS | ZEC | KRPT |
|---|---|---|---|---|---|---|---|---|---|---|---|
| CHLOROPHYTA | | | | | | | | | | | |
| *Codium coralloides* (Kützing) P.C.Silva / *C. effusum* (Rafinesque) Delle Chiaje | - | - | - | - | + | - | - | - | - | - | - |
| *Flabellia petiolata* (Turra) Nizamuddin 1987 | + | - | - | + | + | + | + | + | + | - | + |
| Green filamentous algae | + | + | + | + | + | + | + | + | + | + | + |
| *Halimeda tuna* (J. Ellis & Solander) J.V. Lamouroux, 1816 | - | - | - | + | - | - | - | - | - | - | - |
| *Palmophyllum crassum* (Naccari) Rabenhorst, 1868 | - | - | - | + | - | + | + | + | + | - | + |
| *Valonia macrophysa* Kützing, 1843 | + | - | - | - | + | + | + | + | - | - | - |
| RHODOPHYTA | | | | | | | | | | | |
| *Botryocladia* sp. | - | - | - | + | + | + | + | + | + | - | + |
| Branchy red algae | + | + | + | + | + | + | + | - | + | + | + |
| Fleshy red algae | - | + | + | - | - | - | + | + | + | + | + |
| *Lithophyllum stictaeforme* (J.E. Areschoug) Hauck, 1878 | + | + | + | + | + | + | + | + | + | + | - |
| *Mesophyllum macroblastum* (Foslie) Adey, 1970 | + | + | + | + | + | + | + | + | + | + | + |
| *Peyssonnelia rosa-marina* Boudouresque & Denizot,1973 | + | + | + | + | - | - | - | - | - | - | - |
| *Peyssonnelia rubra* (Greville) J. Agardh, 1851 | + | + | + | + | + | + | + | + | + | + | + |
| *Peyssonnelia* sp. | + | + | + | + | + | + | + | + | + | + | + |
| *Peyssonnelia squamaria* F. Schmitz ex J.J.Rodriguez | + | + | + | + | + | + | + | + | + | + | + |
| Red filamentous algae | - | - | - | + | - | - | - | + | - | - | + |
| Unidentified Corallinaceae | + | + | + | - | + | + | + | + | + | - | - |
| *Sphaerococcus coronopifolius* Stackhouse, 1797 | - | - | - | - | - | + | - | + | + | - | - |

| Taxa | MDKI | MDLO | MDST | JAB | PLA | MP | PRSI | PRST | KRS | ZEC | KRPT |
|---|---|---|---|---|---|---|---|---|---|---|---|
| PORIFERA | | | | | | | | | | | |
| *Acanthella acuta* Schmidt, 1862 | + | + | + | - | + | + | + | + | + | + | + |
| *Agelas oroides* (Schmidt, 1864) | - | - | + | - | + | + | - | + | - | + | - |
| *Aplysina cavernicola* (Vacelet, 1959) | + | + | + | + | + | + | + | + | + | + | + |
| *Axinella cannabina* (Esper, 1794) | + | - | - | - | + | - | - | - | - | - | - |
| *Axinella* sp. | + | + | + | + | + | + | + | + | + | + | + |
| Beige encrusting sponge | - | + | + | - | - | - | + | + | + | - | + |
| Bright yellow encrusting sponge | + | + | - | - | - | + | + | + | - | - | - |
| Brownish sponge | - | + | - | - | - | + | - | - | - | - | - |
| *Chondrosia reniformis* Nardo, 1847 | - | - | + | - | + | + | - | - | - | - | + |
| *Clathrina* sp. | - | - | - | - | - | - | - | - | - | - | - |
| *Cliona* sp. | - | - | - | - | - | - | - | - | + | - | - |
| *Crambe crambe* (Schmidt, 1862) */ Spirastrella cunctatrix* Schmidt, 1868 | - | + | + | + | - | - | - | + | + | - | - |
| Cream sponge | - | - | + | - | - | + | + | - | + | - | + |
| *Dysidea* sp. | - | - | + | + | + | - | + | + | - | + | + |
| *Fasciospongia cavernosa* (Schmidt, 1862) | + | + | + | + | + | + | + | - | + | + | + |
| Grey sponge | + | + | + | + | - | + | + | - | + | + | + |
| *Haliclona (Halichoclona) fulva* (Topsent, 1893) | + | - | + | + | + | + | + | + | + | + | + |
| *Haliclona (Rhizoniera) sarai* (Pulitzer-Finali, 1969) | - | - | - | + | + | + | + | + | + | + | + |
| *Hexadella pruvoti* Topsent, 1896 | - | - | - | + | - | - | - | - | - | - | - |
| *Hexadella racovitzai* Topsent, 1896 | + | + | + | + | + | + | + | + | + | + | + |
| *Ircinia* sp. | + | + | - | + | - | - | + | - | - | + | + |
| Keratose sponge | + | + | + | + | - | - | + | + | - | + | + |
| Light orange semi-encrusting sponge | - | + | - | - | - | - | - | - | - | - | - |
| Orange encrusting sponge | + | + | + | + | + | + | + | + | + | + | + |
| Orange massive sponge | - | - | + | - | + | + | + | + | - | + | - |
| *Petrosia ficiformis* (Poiret, 1789) | + | + | + | + | + | + | + | + | + | + | + |
| *Phorbas tenacior* (Topsent, 1925) | - | + | + | + | - | + | + | + | + | - | + |
| Pink sponge (net like) | + | + | - | + | + | + | + | + | + | + | - |

| Taxa | MDKI | MDLO | MDST | JAB | PLA | MP | PRSI | PRST | KRS | ZEC | KRPT |
|---|---|---|---|---|---|---|---|---|---|---|---|
| *Pleraplysilla spinifera* (Schulze, 1879) | - | - | + | - | - | - | - | - | - | - | + |
| Red massive sponge | - | - | - | - | - | - | + | + | - | - | - |
| Red encrusting sponge | - | + | + | + | + | + | + | + | + | + | + |
| Salmon sponge | + | - | - | - | - | - | + | - | + | - | - |
| *Tethya* sp. | - | - | + | - | + | - | + | - | - | - | - |
| Thin orange encrusting sponge | + | + | + | - | - | + | + | + | + | - | + |
| White-greyish massive sponge | + | + | + | - | - | - | - | - | - | - | - |
| White sponge with yellowish crust | - | - | - | - | - | + | - | - | - | - | - |
| White sponge | - | + | + | + | + | + | + | + | + | + | - |
| Yellow encrusting sponge | + | - | - | + | - | + | + | + | + | + | + |
| Yellow sponge | - | - | + | + | + | + | - | - | - | + | + |
| HYDROZOA | | | | | | | | | | | |
| Unidentified Hydrozoa | - | - | - | - | - | - | + | + | + | - | + |
| ANTHOZOA | | | | | | | | | | | |
| *Alcyonium acaule* (Marion, 1878) | - | + | - | + | + | + | + | + | + | - | - |
| *Alcyonium coralloides* (Pallas, 1766) | - | + | - | + | + | + | + | + | - | + | + |
| *Caryophyllia (Caryophyllia) inornata* (Duncan, 1878) | + | + | - | - | + | + | + | + | + | + | + |
| *Caryophyllia (Caryophyllia) smithii* Stokes & Broderip, 1828 | + | + | + | + | + | + | + | + | + | + | + |
| *Cerianthus membranaceus* (Spallanzani, 1784) | - | + | - | - | + | + | - | + | - | - | - |
| *Eunicella cavolini* (Koch, 1887) | + | + | + | + | + | + | + | + | + | + | + |
| *Leptopsammia pruvoti* Lacaze-Duthiers, 1897 | + | + | + | - | + | + | + | + | + | + | + |
| *Paramuricea clavata* (Risso, 1826) | + | + | + | - | + | + | + | + | + | + | + |
| *Parazoanthus axinellae* (Schmidt, 1862) | + | + | + | + | + | + | + | + | + | + | + |
| Unidentified Scleractinian coral | - | - | - | + | + | + | + | + | + | + | + |
| MOLLUSCA | | | | | | | | | | | |
| *Gastrochaena (Rocellaria) dubia* (Pennant, 1777) | + | + | + | + | + | + | + | + | + | + | + |

| Taxa | MDKI | MDLO | MDST | JAB | PLA | MP | PRSI | PRST | KRS | ZEC | KRPT |
|---|---|---|---|---|---|---|---|---|---|---|---|
| POLYCHAETA | | | | | | | | | | | |
| *Filograna* sp. sensu Bianchi, 1981 */ Salmacina dysteri* (Huxley, 1855) | + | - | - | - | - | - | - | + | + | + | + |
| *Protula* sp. | + | + | + | + | + | + | + | + | + | + | + |
| Serpulidae | + | + | + | + | + | + | + | + | + | + | + |
| BRYOZOA | | | | | | | | | | | |
| *Beania magellanica* (Busk, 1852) | - | + | + | + | + | + | + | + | + | + | + |
| Branchy bryozoan | - | + | + | + | + | + | + | + | + | - | + |
| *Celleporina caminata* (Waters, 1879) | - | - | - | - | - | + | - | - | - | - | - |
| *Schizomavella* sp. | + | + | + | + | + | + | + | + | + | + | + |
| Encrusting orange bryozoan | + | + | + | + | + | + | + | + | + | + | + |
| Encrusting beige bryozoan | - | - | - | + | + | + | + | - | + | - | - |
| *Myriapora truncata* (Pallas, 1766) | + | + | + | + | + | + | + | + | + | + | + |
| *Pentapora fascialis* (Pallas, 1766) | - | + | + | + | - | - | - | + | + | - | - |
| *Schizotheca serratimargo* (Hincks, 1886) | - | - | - | + | - | - | - | - | - | - | - |
| *Smittina cervicornis* (Pallas, 1766) */ Adeonella pallasii* (Heller, 1867) | + | + | + | + | + | + | + | + | + | + | + |
| TUNICATA | | | | | | | | | | | |
| *Aplidium* sp. | - | - | - | - | + | - | - | - | - | - | - |
| *Aplidium elegans* (Giard, 1872) | + | + | + | + | + | - | + | + | - | - | - |
| *Didemnum* sp. (dark orange) | - | - | - | - | - | - | - | + | - | - | - |
| Didemnum sp. (orange) | - | - | - | + | - | - | + | - | + | - | - |
| *Didemnum* sp. (white) | - | - | - | - | - | - | + | + | - | - | - |
| *Halocynthia papilosa* (Linnaeus, 1767) | + | + | + | + | + | + | + | + | - | - | + |
| Orange colonial Synascidia | - | + | + | - | + | - | - | - | - | + | - |
| *Polycitor adriaticus* (Drasche, 1883) | - | - | - | - | + | + | - | - | - | - | - |
| *Pycnoclavella* sp. / *Perophora* sp. | + | + | + | + | + | + | + | - | + | + | + |
| *Diplosoma* sp. | - | - | - | - | - | - | + | - | - | - | - |

| Taxa | MDKI | MDLO | MDST | JAB | PLA | MP | PRSI | PRST | KRS | ZEC | KRPT |
|---|---|---|---|---|---|---|---|---|---|---|---|
| White Synascidia | - | - | - | - | + | - | - | - | - | - | - |

**Regional Activity Centre**
**for Specially Protected Areas (RAC/SPA)**

Boulevard du Leader Yasser Arafat
B.P. 337 - 1080 Tunis Cedex - TUNISIA
Tel. : +216 71 206 649 / 485 / 765
Fax : +216 71 206 490
E-mail : car-asp@rac-spa.org
**www.rac-spa.org**