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# A VISUAL CENSUS OF THE COASTAL FISH ASSEMBLAGE AT KOSTRENA (THE KVARNER AREA, CROATIA)

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## ABSTRACT

*The modified stationary visual census technique (point method or circular point method) was used to provide a preliminary description of fish assemblages at the locality of Kostrena (the Kvarner area, Croatia). A high number (52) of fish species was recorded. The results also showed strong influence of substrate composition and bottom depth on the fish community, at least on fish species composition. Samples grouped in cluster analysis in five habitat types based on similarity of bottom and depth characteristics. The community parameters between groups were significantly different.*

**Key words:** fish assemblages, Adriatic Sea, visual census

## VISUAL CENSUS DELLA COMUNITÀ ITTICA LITORALE DI KOSTRENA (AREA QUARNERINA, CROAZIA)

*SINTESI*

*L'articolo riporta una descrizione preliminare delle comunità ittiche di Kostrena (area Quarnerina, Croazia), ottenuta con la tecnica del visual census, con l'utilizzo di un sistema fisso di osservazione. L'autore ha registrato un numero elevato di specie ittiche (52). I risultati indicano una forte influenza della composizione del substrato e della profondità dell'acqua sulla comunità ittica, almeno per quanto riguarda la natura delle specie. I campioni sono stati raggruppati in cinque tipi di habitat in base alle somiglianze delle caratteristiche di substrato e profondità, con l'uso della cluster analysis. I parametri di comunità differiscono significativamente tra i vari gruppi.*

**Parole chiave:** comunità ittiche, mare Adriatico, visual census

## INTRODUCTION

The marine area of the Kostrena municipality has been proposed for protection as a submarine park by the Primorsko-Goranska County. In order to prepare a proposal for the protection program, a thorough investigation of the geology and biology of sublittoral sea bottom of the Kostrena municipality was conducted. The Kostrena is recreational area with well preserved beaches and coastal zone, but situated in the northern part of the Rijeka Bay, which is heavily polluted by domestic and industrial waste (Fig. 1). According to Jardas *et al.* (1998), there are no published data on coastal fish assemblage at Kostrena.

The main aim of the ichthyological investigation was to provide a preliminary description of fish assemblages at the locality of Kostrena; consequently, the visual census method was chosen as the one best suited to this aim.

## MATERIAL AND METHODS

The geomorphological, sedimentological, biocenological and ichthyological researches were carried out at four locations (KO1, KO2, KO3, KO4) (Fig. 1) in the summer of 1999, from July to August. Modified stationary visual census technique (Bohnsack & Bannerot, 1986, also named point method by Bortone *et al.*, 1989 or circular point method by Francour, 1997) was applied. The point method advantages were listed in Bohnsack & Bannerot (1986). However, the main reasons for point method in this research were steep bottom, habitat changes along with depth and habitat patchiness (heterogeneity). At the four locations (KO1, KO2, KO3, KO4) (Fig. 1), visual fish censuses were performed at the depths of 0, 2.5, 5, 7.5, 10, 15, 20, 25, 30, 35 and 40 m during morning hours. Bottom characteristics at different depth points were recorded, and bottom type classified as soft bottom (sand, muddy sand with <1/6 of surface consisting of cobbles, boulders and bedrock), mixed bottom and rocky bottom (cobbles, boulders and bedrock with <1/6 of surface covered with sand). The phytal cover was not taken into consideration. However, the algal cover at all four locations was poorly developed and erected macroalgae or seagrass were not present. The largest depths were not reached at KO1 (40 m) and KO4 positions (30 m, 35 m, 40 m). Altogether, a total of 40 point counts were carried out (KO1: 10, KO2: 11, KO3: 11, KO4: 8). Diver rotated at a point making a full circle (360°) during 5 minutes and counted the fishes occurring in his visual field within a defined area. Hyperbenthic and benthopelagic fishes were counted within a circular area of 4 m radius (50 $m^2$), and epibenthic fishes within a circular area of 1.8 m radius (10 $m^2$). Counting areas smaller than usual (Bohnsack & Bannerot, 1986, Bortone *et al.*, 1989; Francour, 1996) were chosen because of the high relief, which covered the visual field, especially for small ephibenthic species. A marked line was used to estimate the radius. All chosen depths were taken as a centre of the counting area, except at 0 m where this point was in fact the edge of the counting area. Fishes were counted according to the abundance scale based on a basic geometric progression factor of 2 (1, 2-5, 6-10, 11-30, 31-50, 51-100, >100). According to Bohnsack & Bannerot (1986), the density of fishes, expressed as the number of individuals per 10 $m^2$, was considered an index and not an absolute datum.

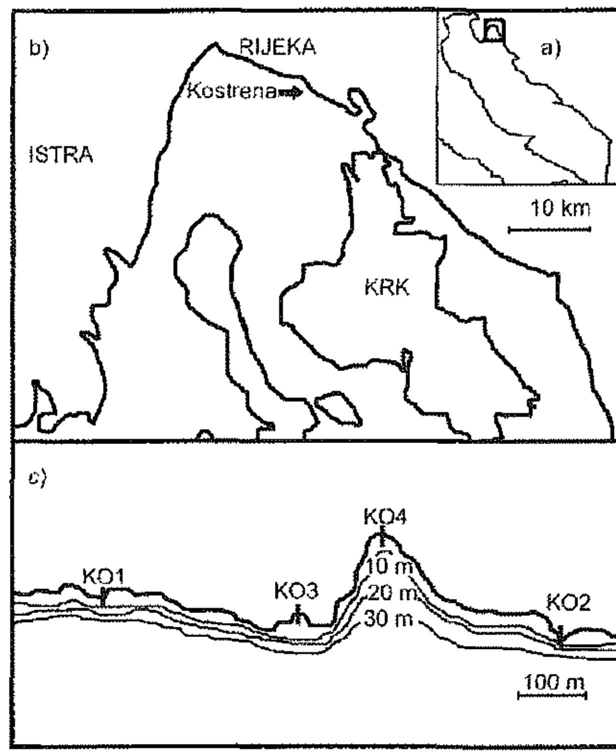


***Fig. 1: Sampling area: a) the Adriatic Sea, b) the Kvarner area, c) the Kostrena coast with investigated KO1-KO4 locations.***
***Sl. 1: Vzorčišče: a) Jadransko morje, b) Kvarner, c) kostrensko obrežje z raziskanimi lokacijami KO1-KO4.***

Qualitative affinities between samples were studied by means of the Jaccard similarity index (Krebs, 1989), using the centroid method for hierarchial classification analysis. Abundance data were compiled for each group of samples from cluster analysis, and the following community parameters were calculated: mean species number, mean individuals number and species diversity (the Shannon-Wiener diversity index H' according to Krebs, 1989). The significance of the differences of community parameters among groups was tested statistically using the non-parametric Kruskal-Wallis test.

***Tab. 1:** List of recorded fish species with quantitative data: a)-f), pooled samples based on cluster analysis, bottom and depth characteristics explained in text; mean±s.d., mean abundance with standard deviation; F%, frequency of occurrence. Underlined species are those observed out of the counting points during SCUBA divings.*
***Tab. 1:** Seznam zabeleženih ribjih vrst s kvanitativnimi podatki: a)-f), podatki, zbrani na osnovi grozdičaste analize, pridnene in globinske značilnosti pojasnjene v besedilu; sred.±s.d., srednja gostota s standardno deviacijo; F%, frekvenca pojavljanja. Podrčrtane vrste so zunaj števnih točk opazili potapljači.*

| | a) & b) | | c) | | d) | | e) | | f) | |
|---|---|---|---|---|---|---|---|---|---|---|
| Species | mean±s.d. | F% | mean±s.d. | F% | mean±s.d. | F% | mean±s.d. | F% | mean±s.d. | F% |
| *Aidablennius sphynx* (Valenciennes, 1836) | 0.13±0.35 | 12.5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Atherina* sp. | 2.5±7.07 | 12.5 | 2.22±6.67 | 11.1 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Boops boops* (Linnaeus, 1758) | 0 | 0 | 3.28±6.79 | 33.3 | 5.45±7.85 | 45.5 | 5±9.26 | 25 | 0 | 0 |
| *Buenia affinis* Iljin, 1930 | 0 | 0 | 0 | 0 | 0 | 0 | 0.25±0.46 | 25 | 0 | 0 |
| *Chromis chromis* (Linnaeus, 1758) | 0.4±0.7 | 25 | 2.02±2.55 | 77.8 | 2.25±3.24 | 45.5 | 0 | 0 | 0 | 0 |
| *Coris julis* (Linnaeus, 1758) | 1.16±1.3 | 75 | 1.28±1.16 | 88.9 | 0.47±0.61 | 63.6 | 0.13±0.1 | 62.5 | 0 | 0 |
| *Diplodus annularis* (Linnaeus, 1758) | 0 | 0 | 0.09±0.11 | 44.4 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Diplodus puntazzo* (Cetti, 1777) | 0 | 0 | 0.02±0.07 | 11.1 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Diplodus sargus sargus* (Linnaeus, 1758) | 0.08±0.10 | 37.5 | 0.02±0.07 | 11.1 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Diplodus vulgaris* (E. Geoffroy Saint-Hilaire, 1817) | 0.03±0.07 | 12.5 | 0.12±0.23 | 33.3 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Gobius bucchichi* (Steindachner, 1870) | 1.38±1.38 | 75 | 0.22±0.44 | 22.2 | 0 | 0 | 0.13±0.35 | 12.5 | 0 | 0 |
| *Gobius cobitis* Pallas, 1811 | 0.25±0.46 | 25 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Gobius cruentatus* Gmelin, 1789 | 0 | 0 | 0.33±0.5 | 33.3 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Gobius geniporus* Valenciennes, 1837 | 0 | 0 | 0.11±0.33 | 11.1 | 0.09±0.31 | 9.1 | 0.13±0.35 | 12.5 | 0 | 0 |
| *Gobius roulei* De Buen, 1928 | 0 | 0 | 0 | 0 | 0.18±0.41 | 18.2 | 2±1.65 | 75 | 1.63±1.25 | 100 |
| *Gobius vittatus* Vinciguerra, 1883 | 0 | 0 | 1.56±0.37 | 100 | 1.81±1.37 | 90.1 | 0 | 0 | 0 | 0 |
| *Gobius xanthocephalus* Zander & Heymer, 1992 | 0 | 0 | 0.33±0.5 | 33.3 | 0.18±0.41 | 18.2 | 0 | 0 | 0 | 0 |
| *Labrus bimaculatus* Linnaeus, 1758 | 0 | 0 | 0 | 0 | 0.09±0.30 | 9.1 | 0 | 0 | 0 | 0 |
| *Lipophrys canevai* (Vinciquerra, 1880) | 0.25±0.46 | 25 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Oblada melanura* (Linnaeus, 1758) | 3.51±6.79 | 75 | 1.1±1.29 | 77.8 | 0.06±0.21 | 9.1 | 0 | 0 | 0 | 0 |
| *Parablennius gattorugine* (Brunnich, 1788) | 0 | 0 | 0 | 0 | 0.09±0.3 | 9.1 | 0 | 0 | 0 | 0 |
| *Parablennius incognitus* (Bath, 1968) | 0.38±0.52 | 37.5 | 0.11±0.33 | 11.1 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Parablennius rouxi* (Cocco, 1833) | 0.25±0.46 | 25 | 1.56±1.1 | 100 | 1.27±1.17 | 81.8 | 0.13±0.35 | 12.5 | 0 | 0 |
| *Parablennius sanguinolentus* (Pallas, 1811) | 0.38±0.52 | 37.5 | 0.11±0.33 | 11.1 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Parablennius tentacularis* (Brunnich, 1788) | 0 | 0 | 0 | 0 | 0 | 0 | 0.13±0.35 | 12.5 | 0 | 0 |
| *Parablennius zvonimiri* (Kolombatović, 1892) | 0.63±0.52 | 62.5 | 0 | 0 | 0.09±0.31 | 9.1 | 0 | 0 | 0 | 0 |
| *Sarpa salpa* (Linnaeus, 1758) | 0.18±0.32 | 25 | 0.8±1.39 | 33.3 | 0.06±0.21 | 9.1 | 0 | 0 | 0 | 0 |
| *Scorpaena porcus* Linnaeus, 1758 | 0 | 0 | 0 | 0 | 0.18±0.41 | 18.2 | 0 | 0 | 0 | 0 |
| *Serranus hepatus* (Linnaeus, 1758) | 0 | 0 | 0.09±0.11 | 44.4 | 0.15±0.09 | 72.7 | 0.13±0.1 | 62.5 | 0 | 0 |
| *Serranus scriba* (Linnaeus, 1758) | 0.05±0.09 | 25 | 0.04±0.09 | 22.2 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Speleogobius trigloides* Zander & Jelinek, 1976 | 0 | 0 | 0 | 0 | 0.59±1.07 | 36.4 | 0 | 0 | 0 | 0 |
| *Spicara maena* (Linnaeus, 1758) | 0 | 0 | 0 | 0 | 0.36±1.21 | 9.1 | 0 | 0 | 0 | 0 |
| *Spicara smaris* (Linnaeus, 1758) | 0 | 0 | 1.88±3.48 | 44.4 | 0.35±0.65 | 27.3 | 0 | 0 | 0 | 0 |
| *Spondyliosoma cantharus* (Linnaeus, 1758) | 0 | 0 | 0.02±0.07 | 11.1 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Symphodus (Crenilabrus) cinereus* (Bonaterre, 1788) | 0 | 0 | 0 | 0 | 0 | 0 | 0.03±0.07 | 12.5 | 0 | 0 |
| *Symphodus (Crenilabrus) mediterraneus* (Linnaeus, 1758) | 0 | 0 | 0 | 0 | 0.04±0.08 | 18.2 | 0 | 0 | 0 | 0 |
| *Symphodus (Crenilabrus) ocellatus* (Forskal, 1775) | 0.03±0.07 | 12.5 | 0.09±0.11 | 44.4 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Symphodus (Crenilabrus) tinca* (Linnaeus, 1758) | 0.03±0.07 | 12.5 | 0.16±0.09 | 77.8 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Thorogobius ephippiatus* (Lowe, 1839) | 0 | 0 | 0 | 0 | 0.36±0.5 | 36.4 | 0 | 0 | 0 | 0 |
| *Thorogobius macrolepis* (Kolombatović, 1891) | 0 | 0 | 0.11±0.33 | 11.1 | 0.96±0.96 | 72.7 | 0.13±0.35 | 12.5 | 0 | 0 |
| *Tripterygion delaisi* Cadenat & Blache, 1971 | 0 | 0 | 0.22±0.44 | 22.2 | 0.36±0.5 | 36.4 | 0 | 0 | 0 | 0 |
| *Tripterygion tripteronotus* (Risso, 1810) | 0.38±0.52 | 37.5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| <u>*Chromogobius quadrivittatus* (Steindachner, 1863)</u> | | | | | | | | | | |
| <u>*Dicentrarchus labrax* (Linnaeus, 1758)</u> | | | | | | | | | | |
| <u>*Gobius paganellus* Linnaeus, 1758</u> | | | | | | | | | | |
| <u>*Lepadogaster candoleii* Risso, 1810</u> | | | | | | | | | | |
| <u>*Lepadogaster lepadogaster lepadogaster* (Bonnaterre, 1788)</u> | | | | | | | | | | |
| <u>*Lipophrys dalmatinus* (Steindachner & Kolombatović, 1883)</u> | | | | | | | | | | |
| <u>*Lipophrys nigriceps* (Vinciguerra, 1883)</u> | | | | | | | | | | |
| <u>*Scorpaena notata* Rafinesque, 1810</u> | | | | | | | | | | |
| <u>*Tripterygion melanurus minor* Kolombatović, 1982</u> | | | | | | | | | | |
| <u>*Zebrus zebrus* (Risso, 1810)</u> | | | | | | | | | | |
| Number of point counts | 8 | | 9 | | 11 | | 8 | | 4 | |
| Mean number of species | 6.5±2.6 | | 9.88±2.22 | | 7.45±1.86 | | 3.25±1.67 | | 1 | |
| Mean number of individuals | 11.95±10.02 | | 19.04±8.61 | | 15.47±10.55 | | 8.15±8.67 | | 1.63+1.25 | |
| Species diversity | 1.91±0.4 | | 2.33±0.70 | | 2.3±0.51 | | 1.22±0.71 | | / | |
| Total number of species | 19 | | 26 | | 22 | | 11 | | 1 | |

Mann-Whitney U-test was used for multiple comparisons (Sokal & Rohlf, 1995). Cluster analysis and tests of significance were carried out by the SPSS 9.0 program. The Shannon-Wiener diversity index was calculated by the use of Ecological methodology 5.2 program (C. J. Krebs, 2000: Programs for Ecological Methodology, 2nd ed.).

## RESULTS

A total of 52 fish species were recorded, 42 were censused during point counts, while others were randomly observed during the same SCUBA divings (Tab. 1). The dominant families in terms of species number were Gobiidae (14 species) and Blenniidae (10 species). Hierarchical classification analysis among the Kostrena samples showed grouping of samples based on similar bottom and depth characteristics (Fig. 2). Six main clusters belonged to five habitat types with the following depth and substrata characteristics: a) and b) rocky bottom 0-2.5 m depth, c) rocky and mixed bottom at 5-10 m depth (except for the counting point R15KO3), d) rocky and mixed bottom at 15-30 m depth (except for the counting point R10KO3), e) sandy bottom at 5-20 m depth and mixed bottom at 30-35 m depth, and f) sandy bottom at 25-40 m depth (Fig. 2). Poorly inhabited sandy bottom at 25-40 m depth clearly differed in quantitative characteristics of fish assemblages from all other habitats (Tab. 1). The community parameters between the four remaining groups were significantly different (Kruskal-Wallis = 20.52 in species richness, 11.43 in abundance and 9.1 in species diversity, all $P<0.05$). Habitats differ significantly in species richness except for

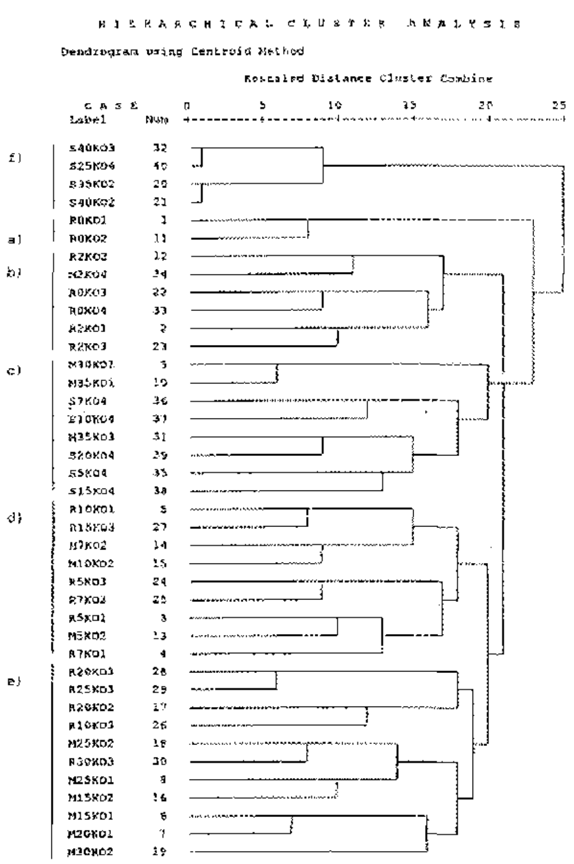


***Fig. 2: Cluster analysis between visual census samples. Similarity index of Jaccard and centroid method for hierarchical classification analysis. R: rocky bottom, M: mixed bottom, S: sandy bottom; 0-40: depth (m); KO1-KO4: locations.***
***Sl. 2: Grozdičasta analiza med vzorci vizualnega štetja. Jaccardov indeks podobnosti in centroidna metoda za analizo hierarhične razvrstitve. R: kamnito dno, M: mešano dno, S: peščeno dno; 0-40: globina (m); KO1-KO4: lokalitete.***

| Mean species number / *Srednje št. vrst* | ab | c | d |
|---|---|---|---|
| e | * | * | * |
| d | | * | |
| c | * | | |
| **Mean individuals number / *Srednje št. osebkov*** | **ab** | **c** | **d** |
| e | * | * | * |
| d | | | |
| c | | | |
| **Species diversity / *Diverziteta vrst*** | **ab** | **c** | **d** |
| e | | * | * |
| d | | | |
| c | | | |

***Fig. 3: Results of Mann-Whitney U-test for multiple comparisons of mean fish species number, mean individuals number and species diversity between pooled samples based on cluster analysis (a-e). The bottom and depth characteristics explained in text.***
**** - denotes significant difference (P<0.05) between two groups of samples.***
***Sl. 3: Rezultati Mann-Whitneyevega U-testa za večkratne primerjave srednjega števila ribjih vrst, srednjega števila osebkov in diverziteto vrst med vzorci, zbrani na osnovi grozdičaste analize (a-e). Pridnene in globinske značilnosti so pojasnjene v besedilu.***
**** - ponazarja pomembno razliko (P<0.05) med dvema skupinama vzorcev.***

habitats ab) and d) (Mann-Whitney U-test, Fig. 3). Fish density was significantly lower only in habitat e) compared to all other tested habitats. The habitat e) also showed significant differences from habitats c) and d) in species diversity (Mann-Whitney U-test, Fig. 3). The most common and abundant ephibenthic fish species during the visual census at Kostrena were: *Gobius bucchichi* in shallow water, *Gobius vittatus* and *Parablennius rouxi* on the rocky bottom of ≥5 m depth, with *Thorogobius macrolepis* of ≥15 m depth as well (Tab. 1), and *Gobius roulei* on the sandy bottom. Among hyperbenthic and benthopelagic species, *Atherina* sp., *Coris julis* and *Oblada melanura* were the most common and most abundant fishes in shallow infralittoral, while *Boops boops* and *Chromis chromis* were the most common and most abundant fishes in deeper infralittoral. The high density of these two groups overlapped between 5-10 m depth (Tab. 1).

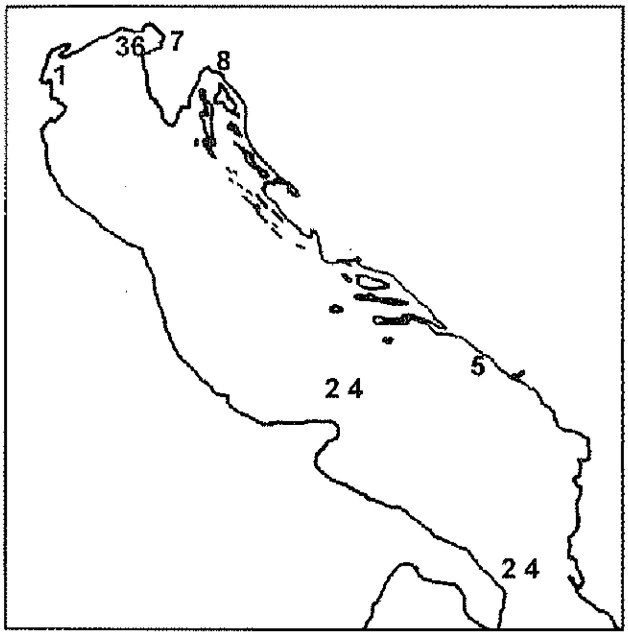


***Fig. 4: Available data on visual census of fish assemblages in the Adriatic Sea: 1 - Marconato** et al., **1996; 2 - Fasola** et al., **1997; 3 - De Girolamo** et al., **1998; 4 - Guidetti, 2000; 5 - Guidetti & Bussotti, 2000; 6 - Castellarin** et al., **2001; 7 - Lipej & Orlando Bonaca,** in prep.; **8 - the present research.***

***Sl. 4: Razpoložljivi podatki o vizualnem štetju ribjih združb v Jadranskem morju: 1 - Marconato** et al., **1996; 2 - Fasola** et al., **1997; 3 - De Girolamo** et al., **1998; 4 - Guidetti, 2000; 5 - Guidetti & Bussotti, 2000; 6 - Castellarin** et al., **2001; 7 - Lipej & Orlando Bonaca,** in prep.; **8 – pričujoče raziskave.***

## DISCUSSION

The present visual count of fishes is one of only a few performed visual counts of fish assemblages in the Adriatic Sea (Marconato *et al.*, 1996; Fasola *et al.*, 1997; De Girolamo *et al.*, 1998; Guidetti, 2000; Guidetti & Bussotti, 2000; Castellarin *et al.*, 2001; Lipej & Orlando Bonaca, *in preparation*)(Fig. 4). The present preliminary observation on the fish community was conducted on too small sample to provide an estimate of the absolute abundance of fish species at the Kostrena locality. However, it is a good qualitative description of fish assemblages and clearly shows the most numerous fish species in the habitats during the summer when the visual counts were carried out. It is difficult to compare the most numerous fish species with other published visual census results in the same zoogeographic area (the northern Adriatic). Marconato *et al.* (1996) and De Girolamo *et al.* (1998) did not give any details on fish species abundance. Castellarin *et al.* (2001) performed visual counts only in shallow water (<5 m depth). The most numerous fishes in their results during summer months were hyperbenthic and benthopelagic *Atherina* spp. and *O. melanura*, but also several other species not recorded, or at least not common at Kostrena (*Mugil cephalus, Sparus aurata, Sciaena umbra, Sarpa salpa*). *Coris julis*, abundant in shallow waters at Kostrena, were not mentioned in their list. *Gobius cruentatus* were similarly abundant as *G. bucchichi* among epibenthic species. The present data with 40 point counts show a surprisingly high number of fish species, compared to other published results of visual counts in the Mediterranean, often conducted on much larger samples, and combined with other sampling techniques (Francour *et al.*, 1995, 332 counts and 38 fish species; Harmelin-Vivien *et al.*, 1996 with 1081 visual counts and 48 fish species; Vacchi *et al.*, 1998 with 129 visual counts and 48 fish species). Only a few researches recorded larger species richness by SCUBA diving (Harmelin *et al.*, 1995; Mazzoldi & De Girolamo, 1997; La Mesa & Vacchi, 1999; Lipej & Orlando Bonaca, *in preparation*). The noted species richness during the present research was caused by a high number of found Blenniid and Gobiid species, reached in the visual counts of Mediterranean fish assemblages only by Mazzoldi & De Girolamo (1997), Castellarin *et al.* (2001) and Lipej & Orlando Bonaca (*in preparation*). It is more likely that the small epibenthic fishes, especially gobies, are underestimated in the Mediterranean visual censuses in general, than that the fish assemblages at Kostrena are especially rich in gobiid fauna. Several species of presently found gobiids are still known only from a few published records: *Buenia affinis, G. roulei, Speleogobius trigloides, T. macrolepis* (Kovačić, 1995, 1997, 2002; Ahnelt & Kovačić, 1997). *Speleogobius trigloides* was discovered and described from cave habitat (Zander & Jelinek, 1976). However, later findings were at open bottom surfaces (Kovačić, 1997; Fesser, 1980; this work). The papers publishing comparisons of visual census data from different infralittoral habitats or depths in the Mediterranean are rare. Guidetti (2000) compared fish assemblages at rocky bottoms, *Posidonia* meadows and bare sands. He came to similar results as the present study of higher species richness and fish density on rocky reef habitats than on bare sandy bottoms. Other papers compared visual census data between different seagrass meadows (Bussotti & Guidetti, 1999), bottoms with presence or absence of *Caulerpa* (Francour *et al.*, 1995; Harmelin-Vivien *et al.*, 1996), or rocky bottoms with or without erect macroalgal cover (Guidetti & Bussotti, 2000). Several papers with visual census data from two or three defined depths in the Mediterranean have been published (Francour, 1994; Francour *et al.*, 1995; Mazzoldi & De Girolamo, 1997; Vacchi *et al.*, 1998; La Mesa & Vacchi, 1999). However, due to the purpose of these papers, little attention was paid to comparisons of species composition and the community parameters among different depths. La Mesa & Vacchi (1999) observed that community parameters increased significantly with depth from shallow (3-5 m), intermediate (10-15) m to the deep transect (25-30 m), while the present research points out a significantly higher richness of species at medium infralittoral depths.

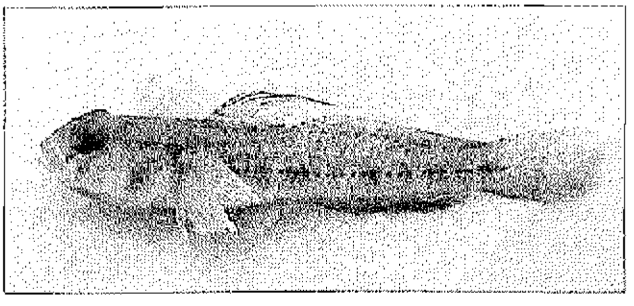

***Fig. 5: Gobius roulei. (Photo/Foto: M. Kovačić)***

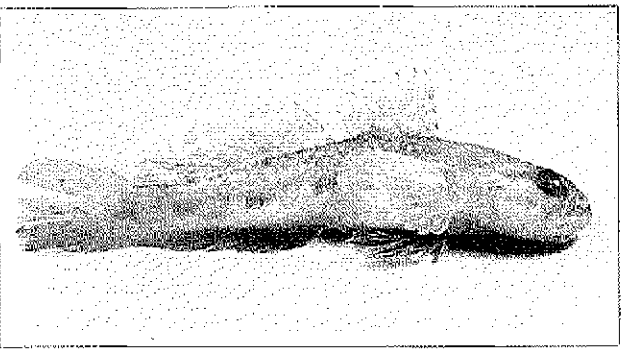

***Fig. 6: Thorogobius macrolepis. (Photo/Foto: M. Kovačić)***

## CONCLUSIONS

The results of the preliminary observation of the fish community, especially the high number of fish species, justify the proposal to establish a protected area at the Kostrena locality. The results also showed strong influence of substrate composition and bottom depth on the fish community, at least on fish species composition. The absence of large species of rocky habitat (*Labrus* spp., *Sciaena umbra*, *Scorpaena scrofa*) in the studied area could have been caused by the anthropogenic factors on the fish community (overfishing and disturbance). However, the influence of the methodology of visual counts with defined and, for large fishes, relatively small, surface can not be excluded. The future use of the random visual census technique or the total count visual census technique could resolve this dilemma. The majority of numerously found epibenthic gobiids are connected with the availability of cracks and crevices, whereas poorly presented hyperbenthic wrasses (fam. Labridae) prefer dense cover of erected macroalgae or seagrass.

## ACKNOWLEDGEMENTS

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# VIZUALNO ŠTETJE PRIOBALNIH RIBJIH ZDRUŽB V KOSTRENI (KVARNER, HRVAŠKA)

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*POVZETEK*

*Za predhodni opis ribjih združb na štirih lokalitetah v Kostreni (Kvarner, Hrvaška) v poletnih mesecih (juliju in avgustu) leta 1999 je bila uporabljena metoda vizualnega štetja rib, in sicer modificirana stacionarna tehnika štetja (točkovna ali krožna točkovna metoda). Rezultati predhodnega opazovanja ribjih združb opravičujejo načrt ustanovitve zaščitenega območja na tej lokaliteti. Pričujoči podatki kažejo na presenetljivo visoko število ribjih vrst v primerjavi z drugimi objavljenimi rezultati vizualnih štetij v Sredozemlju, ki so bila pogosto opravljena na neprimerno večjih vzrocih in kombinirana z drugimi tehnikami vzorčenja. Zabeleženih je bilo 52 ribjih vrst, 42 med točkovnim štetjem, druge pa naključno med potopi, ki jih je opravila skupinica potapljačev. Na morskem dnu, bogatem s špranjami in drugimi ribjimi zavetišči, a brez gostega pokrova makroalg ali morske trave, so bile zabeležene mnoge male efibentoške vrste (družini Gobiidae in Blenniidae). Rezultati pričajo tudi o močnem vplivu sestave matične podlage in globine dna na ribjo skupnost – ali vsaj na sestavo ribjih vrst. Po tako imenovani grozdičasti analizi so bili primerki razvrščeni v pet habitatnih tipov, temelječih na podobnostih v značilnostih dna in globine. Parametri združb med posameznimi skupinami so se močno razlikovali.*

**Ključne besede:** ribje združbe, Jadransko morje, vizualno štetje

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