

ISSN 1330-0520

UDK 597.58:262.3(497.5/1-16)

CRYPTOBENTHIC GOBIES
(PISCES, PERCIFORMES, GOBIIDAE)
AND CLINGFISHES
(PISCES, GOBIESOCIFORMES, GOBIESOCIDAE)
IN THE KVARNER AREA, ADRIATIC SEA

MARCELO KOVAČIĆ

Prirodoslovni muzej Rijeka
51000 Rijeka, Lorenzov prolaz 1, Hrvatska

Kovačić, M.: Cryptobenthic gobies (Pisces, Perciformes, Gobiidae) and clingfishes (Pisces, Gobiesociformes, Gobiesocidae) in the Kvarner area, Adriatic sea, Nat. Croat., Vol. 6, No. 4., 423–435, 1997, Zagreb

During the research period from 1993–1997 SCUBA diving was used to gather information on cryptobenthic gobies and clingfishes. The following cryptobenthic species have been registered of which at least one specimen having been collected. The Gobiidae family: *Chromogobius quadrivittatus*, *Chromogobius zebratus*, *Corcyrogobius liechtensteini*, *Thorogobius ephippiatus*, *Zebrus zebrus*. The Gobiesocidae family: *Gouania wildenowi*, *Lepadogaster candollei*, *Lepadogaster lepadogaster lepadogaster*. Recent findings and data of other authors on fish species found are discussed.

Keywords: Gobiidae, Gobiesocidae, cryptobenthic fishes, Adriatic Sea

Kovačić, M.: Kriptobentoski glavoči (Pisces, Perciformes, Gobiidae) i priljepnjaci (Pisces, Gobiesociformes, Gobiesocidae) u Kvarnerskom području, Jadransko more, Nat. Croat., Vol. 6, No. 4., 423–435, 1997, Zagreb

Istraživanjem ronjenjem autonomnim ronilačkim aparatima u periodu 1993.–1997. sakupljeni su podaci o kriptobentoskim glavočima i priljepnjacima. Tijekom ronjenja zabilježeni su, a od svake vrste i sakupljen barem jedan primjerak, sljedeće kriptobentoske vrste porodice Gobiidae: *Chromogobius quadrivittatus*, *Chromogobius zebratus*, *Corcyrogobius liechtensteini*, *Thorogobius ephippiatus*, *Zebrus zebrus* i obitelji Gobiesocidae: *Gouania wildenowi*, *Lepadogaster candollei*, *Lepadogaster lepadogaster lepadogaster*. Uspoređeni su sadašnji nalazi i prethodno objavljeni podaci drugih autora o pronađenim vrstama riba.

Ključne riječi: Gobiidae, Gobiesocidae, kriptobentoske ribe, Jadransko more

Hrvatski prirodoslovni muzej, Demetrova 1, Zagreb, Croatia

INTRODUCTION

During the past three decades, knowledge on cryptobenthic fish species in the Mediterranean has been augmented thanks to SCUBA diving techniques. Several cryptobenthic fish species have been obtained (AHNELT & PATZNER 1995, BATH 1971, MILLER 1992). New data on other cryptobenthic species have been provided. Earlier, some of the species were known only from the types (AHNELT *et al.* 1994, AHNELT & PATZNER 1996, BATH 1973).

Reports of cryptobenthic fish specimens in the Kvarner area were based mostly on individual findings (AHNELT 1990, MILLER 1971, 1986, 1992, MILLER *et al.* 1973, RIEDL 1966). Cryptic gobies were listed among other gobies by KOVAČIĆ (1994). Ichthyological investigations, including research on benthic fish communities, started at the beginning of this century (JARDAS *et al.* in press). Numerous investigations have been carried out, mostly with bottom trawling, but no cryptobenthic fish species have been collected. Other benthic biological investigations in the Kvarner area have even longer history (ZAVODNIK 1984), and in the recent decades they have also been performed with the use of SCUBA diving (ZAVODNIK *et al.* 1981), however there are no published data on cryptobenthic fishes.

During 89 SCUBA dives in the period from 1993–1997, the fish communities of the inshore benthos in the Kvarner area were investigated. As well as other data, the research also included information on cryptobenthic ichthyofauna.

STUDY AREA, MATERIAL AND METHODS

Study area

The Kvarner area is a part of the northern Adriatic Sea, enclosed between the Istrian peninsula and the mainland (Fig. 1). The area is divided by the large islands of Krk, Rab, Cres and Lošinj and many other small islands. The Kvarner area is a relatively shallow zone, with a medium depth of 50–60 meters, in its western part, and 60–80 meters in its eastern parts. The sea bottom is covered by deposits of gravel and sand in the coastal zone and in deeper parts of mud. The shores are rocky, with rare sand or gravel beaches. At different depths, the bedrock in the inshore sea levels off into the soft sediments. The border between the rocky bottom and the soft sediments can be even deeper than 50 meters at very steep parts of coastal zone of the Kvarner area. In the northern Adriatic sea the average tide measurement varies from 70 cm to 100 cm (PERES & GAMULIN-BRIDA 1973).

Material

Chromogobius zebratus: 1 specimen, sex?, 22,6 + 5,4 mm, PMR P373, Sv. Marko, January 13, 1994; 1 male, 39,9 + 8,6 mm, PMR P362, Sv. Marko, June 9, 1994; 1 male,

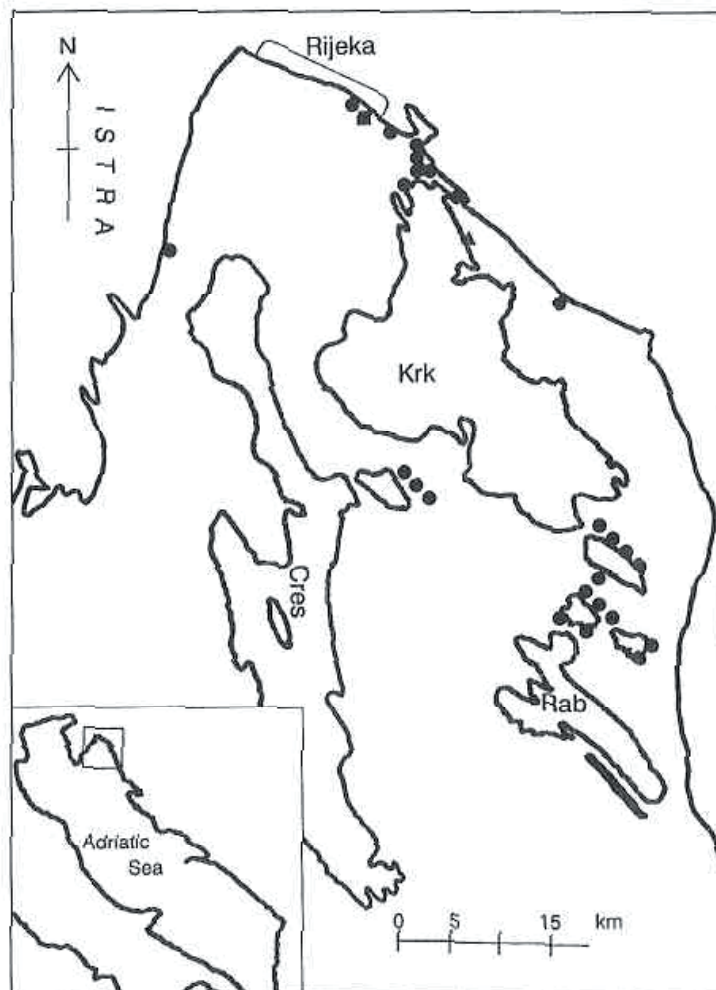


Figure 1. The Kvarner area. At 25 locations (●) cryptobenthic fish species were registered during 35 SCUBA dives. Collecting sites of *Gouania wildenowi* (■) and *Corcyrogobius liechtensteini* (▲).

31,0 + 5,9 mm, PMR P423, Grgur, June 21, 1995. *Chromogobius quadrivittatus*: 1 female, 42,3 + 8,3 mm, PMR P371, Sv. Marko, January 13, 1994; 1 specimen, sex?, 26,6 + 6,1 mm, PMR P472, Oštro, May 29, 1996. *Corcyrogobius liechtensteini*: 1 male, 21,0 + 4,7 mm, PMR P560, Lončarica, Krk, August 4, 1996. *Thorogobius ephippiatus*: 1 male, 52,5 + 10,1 mm, PMR P473, Prvić, June 11, 1996. *Zebrus zebrus*: 1 male, 25,5 + 5,3, PMR P371, Sv. Marko, January 13, 1994; 2 males, 24,8 + 4,9 – 28,8 + 5,8 mm, 2 females, 22,3 + 4,7 – 19,3 + 4,1 mm, PMR P422, Grgur, June 21, 1995; 1 male, 23,2 + 4,5 mm, PMR P426, Goli I., June 21, 1995. *Gouania wildenowi*: 1 specimen, sex?, 28,3 + 3,4 mm, PMR P360, Žurkovo, March 15, 1991. *Lepadogaster candollei*: 1 female, 31,2 + 6,2 mm, 1 specimen, sex?, 30,3 + 6,3, PMR P363, Sv. Marko, June 9, 1994; 1 female, 47,6 + 8,8 mm, PMR P424, Grgur, June 21, 1995. *Lepadogaster lepadogaster lepadogaster*: 2 males, 50,6 + 9,8 – 49,1 + 9,8 mm, 1 specimen, sex?, 35,6 + 7,1 mm, PMR P425, Goli I., June 21, 1995. The specimens are deposited at the Prirodoslovni muzej Rijeka.

Methods

SCUBA diving was used to explore the inshore benthic fish settlements in the Kvarner area was performed by. Specimens were collected and data on fish species observed registered along a transect lying perpendicular to the shoreline. The transects were drawn from the tidal zone to a depth of 20 to 40 meters. In the period from 1993–1997, 89 transects were investigated at 45 locations. Cryptobenthic species were observed in caves, deep holes and crevices in the bedrock and under boulders, rocks and small stones located along the transects. In the investigation only the species of which all or almost all observed specimens found in hidden habitats, are considered to be cryptobenthic species. In order to confirm underwater identification, at least one specimen for every species was collected. The fishes were captured manually, with hand nets. Anaesthetic was used for the examination of small holes and crevices and for the easier netting of specimens. *Corcyrogobius liechtensteini* and *Gouania wildenowi* were collected independently of these investigations by Milvana Arko-Pijevac. The classification of the benthic biocoenosis and algal cover follows PERES & GAMULIN-BRIDA (1973).

RESULTS

During 35 SCUBA dives, eight cryptobenthic species were observed (Fig. 1). Most of the findings were registered under boulders, rocks and small stones. The investigations of crevices and small holes gave poor results, and the only cryptobenthic species found in this habitat was *Corcyrogobius liechtensteini*. Only one species (*Thorogobius ephippiatus*) was observed in caves and in large and deep holes.

The following cryptobenthic species were registered and at least one specimen was collected. The Gobiidae family: *Chromogobius quadrivittatus* (Steindachner, 1863), *Chromogobius zebratus* (Kolombatović, 1891), *Corcyrogobius liechtensteini* (Kolombatović, 1891), *Thorogobius ephippiatus* (Lowe, 1839), *Zebrus zebrus* (Risso, 1826). The Gobioidae family: *Gouania wildenowi* (Risso, 1810), *Lepadogaster candollei* Risso, 1810, *Lepadogaster lepadogaster lepadogaster* (Bonnaterre, 1788).

Some epibenthic species were observed in hidden habitats. Several epibenthic species were found under boulders and stones together with cryptobenthic fishes: *Gobius bucchichi* Steindachner, 1870; *Gobius cruentatus* Gmelin, 1789; *Gobius geniporus* Valenciennes, 1837, *Gobius fallax* Sarato, 1889, *Gobius vittatus* Vinciguerra, 1883, *Parablennius rouxi* (Cocco, 1833). Blennies *Lipophrys canevoui* (Vinciguerra, 1880) and *Parablennius incognitus* (Bath, 1968) were driven out with the use of anaesthetic from bivalve *Lithophaga lithophaga* holes at shallow depths. *Lipophrys nigriceps* (Vinciguerra, 1883); *Parablennius zoonimiri* (Kolombatović, 1892); *Tripterygion delaisi* Cadenat & Blache, 1971; *Tripterygion melanurus minor* Kolombatović, 1892 are abundant in semi-closed (shaded) spaces of overhanging rocks and entrances of caves. Three specimens of *Speleogobius trigloides* Zander & Jelinek, 1976, species was thought to prefer

semiclosed (shaded) and cavern habitat (ZANDER & JELINEK, 1976), were collected at open bottom surfaces (Fig. 2.). The specimens were found at 15 and 25 m depth.



Figure 2. *Speleogobius trigloides*, Prvić island, June 8, 1997.

L. candollei, *Ch. zebratus*, *T. ephippiatus* and *Z. zebrus* were moderately abundant (Fig. 3). *L. lepadogaster* and *Ch. quadrivittatus* were rarely found. *C. liechtensteini* and *G. wildenowi* were not seen during the investigations. They were collected accidentally, and therefore they are the rarest species among the fishes collected.

L. candollei in the Kvarner area was present at a depth of 1–18 m (Fig. 4). It lives on bottoms of variable inclinations, under stones and boulders of different sizes (from less than 10 cm to more than 50 cm). The bottom can be completely covered with stones, but the species can also be found under separate stones and boulders on rocky or sandy bases. The algal cover on stones directly depends on turbulence and wave action and differs in accord with the depth and stone size, and light conditions on the bottom as well. The algal cover varies from a bare stone surface, a cover of small photophylic macroalgae (species like *Acetabularia acetabulum*, *Dictyota dichotoma*, *Dictyota linearis*, *Jania rubens*, *Padina pavonia*), scyaphilic algae (*Hali-medea tuna*, *Peysonnelia* spp., *Pseudolithophyllum expansum*, *Udotea petiolata*) to large photophylic macroalgae (*Cystoseira* spp.). The algal cover of the surrounding bottom surface differs from that of the stones being more abundant only in shallow waters, where the stones are under the influence of wave action. The described *L. candollei* habitats belong to the photophylic algae biocoenosis, but on steep bottoms in deeper ranges, they can be observed to belong to precoralligenous facies of corallinous biocoenosis (PERES & GAMULIN-BRIDA 1973).

Registered specimens of *Ch. zebratus* and *Z. zebrus* have a tolerance to bottom characteristics similar to that of *L. candollei*. They are found under stones and boulders of various sizes, with different bottom inclinations and algal cover. These two

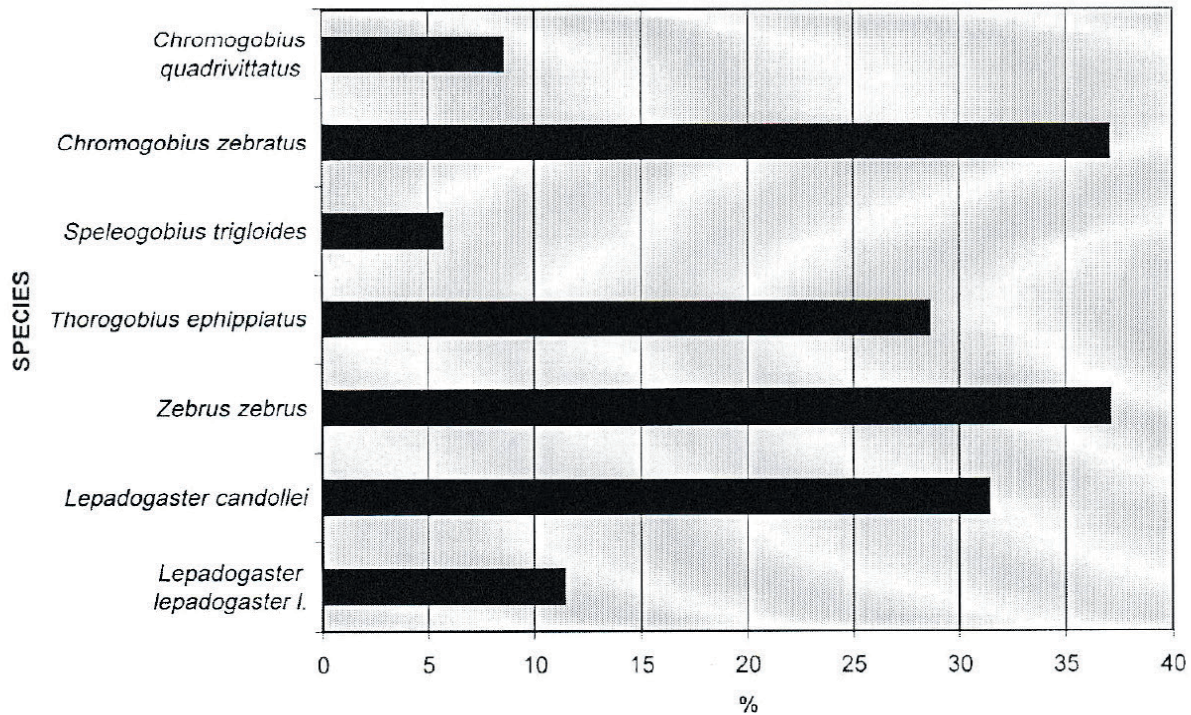


Figure 3. Frequency of occurrence of cryptobenthic fish species in the Kvarner area (number of transects with specific species present is compared to the number of transects with at least one cryptobenthic fish species registered).

species are also present under separate stones and on rocky or sandy bottoms. *Z. zebrus* was not observed deeper than 10 m, but it can be found in waters less than 0,5 m deep (Fig. 4). *Ch. zebratus* was present at a depth of 1–10 m and like *L. candollei*, it was not observed in the very shallow water near the tidal zone. The habitats of the species described belong to the photophylic algae biocoenosis and rarely to the precoralligenous facies of the corallinous biocoenosis on bottoms with steep gradients (PERES & GAMULIN-BRIDA 1973).

T. ephippiatus was found in the Kvarner area in all the caves explored, and in deep crevices and holes. In these spaces the species is regularly situated in small, separated rooms. The specimens were lying on the mud surface, and when disturbed, they escaped into small crevices. *T. ephippiatus* was present at a depth of from 5–32 m (Fig. 4). In the upper part of the depth range it was only found deep in the caves. It was also registered in the lower depth range, at the very beginning of large crevices, almost in open surroundings. In habitats of *T. ephippiatus* live species of fauna typical of dark and semidark caves (*Axinella polyplodes*, *Balanophyllia europea*, *Caryophyllia* spp., *Halocynthia papillosa*, *Parazoanthus axinellae*).

L. l. lepadogaster was found under stones at small depths (1–7 m), but never in very shallow water near the tidal zone (Fig. 4). All findings were gathered on bottoms covered with small stones (size less than 20 cm), without algal cover. These

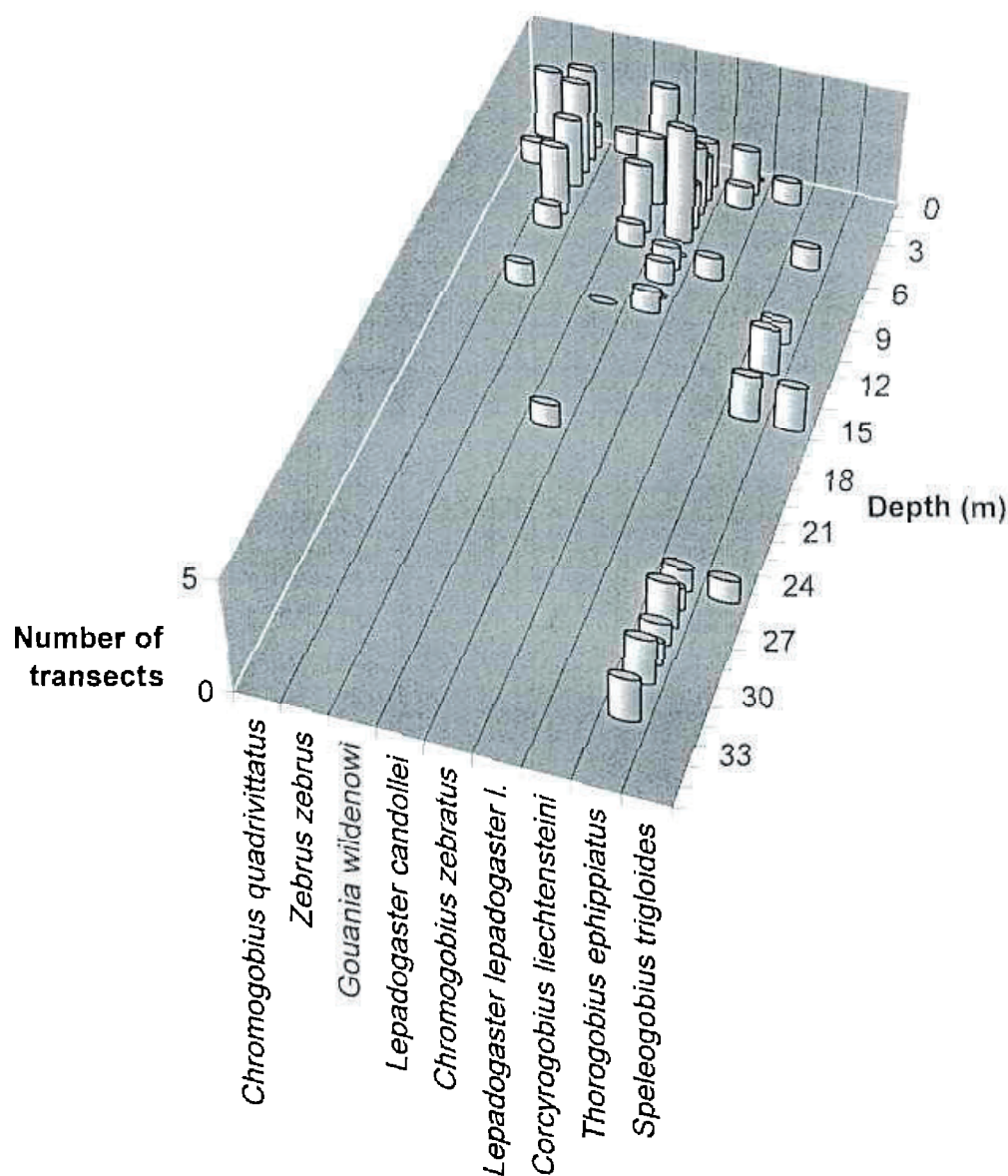


Figure 4. Depth preferences of cryptobenthic fish species registered (number of transects with species present at specific depth).

stony areas are surrounded by a bedrock of a gentle slope, usually covered with small photophylic algae (species *Acetabularia acetabulum*, *Dictyota dichotoma*, *Dictyota linearis*, *Jania rubens*, *Padina pavonia*).

Ch. quadrivittatus was found in very shallow water, immediately under the surface at low tide levels, but only once at a depth of 2 m (Fig. 4). The specimens were hidden under small stones, less than 20 cm in size, in tidal pools always connected with the open water. The habitat of the only specimen found at this depth is similar to that of *L. l. lepadogaster*. The bottoms were bare or very sparsely covered with

algae. The surrounding rocks were inhabited by poorly developed mediolittoral *Fucus virsoides* alga and infralittoral algae of the genus *Cladophora* and *Ceramium*.

G. wildenowi was collected on the gravel beach (gravel size 0,2 – 2 cm). The beach was small, several meters long, surrounded with rocks. Other parts of the nearby coast are rocky, except for two other small gravel beaches. The specimen was found in the gravel immediately under the surface of the sea. Later attempts to collect more specimens on the beach failed.

C. liechtensteini was collected on rocks sparsely covered with small algae at a depth of 1 m (Fig. 4). It was found in a small hole made by the bivalve *Lithophaga lithophaga*. Later examination of similar holes along the transects was unsuccessful. The only species driven out by the use of anaesthetic were the epibenthic blennies *L. canevai* and *P. incognitus*.

DISCUSSION

Recent investigation in the Kvarner area recorded 8 cryptobenthic fish species. Specimens of at least three other cryptobenthic species were observed, but since no positive determination could be done without collected specimens, these species are excluded from the results.

The findings of the investigation do not extend the already known distribution of the registered species in the Mediterranean; the first specimen of *Corcyrogobius liechtensteini* in the northern Adriatic Sea is the exception. Among recently found cryptobenthic species, the following species were reported previously in the area by other authors: *Ch. quadrivittatus*, Mali Lošinj, (MILLER 1971); *Ch. zebratus*, Mali Lošinj, (AHNELT 1990); *T. ephippiatus*, Prvić island, (MILLER *et al.* 1973, RIEDL 1966); *Z. zebrus*, Mali Lošinj, (MILLER 1977). These four gobiid species were also listed by KOVAČIĆ (1994) for the Kvarner area. *Didogobius schlieweni*, described by MILLER (1992) at Unije islands, was not found during the investigation.

Many epibenthic species use shelters in the sea bottom. They seek refuge from danger in soft sediment, under stones or in holes and crevices in the bedrock. Hidden habitats are also used for the reproduction process, as in many gobies. Some infralittoral fishes (species of blennies and threespin blennies) prefer more or less shaded conditions, but can also be found in open sites and on bottom surfaces. The epibenthic species found in hidden habitats on the transects are listed in the results.

During the investigation *Ch. zebratus*, *Z. zebrus* and *L. candollei* were never observed on the open bottom ground, but they were sometimes found under solitary stones and boulders on sand or flat bedrock. That indicates their moving out of the shelters.

Ch. zebratus, *Z. zebrus*, *T. ephippiatus* and *L. candollei* were found relatively often (Fig. 3.), probably because they tolerate different habitats and depths (Fig. 4) in comparison to other collected species. Before these discoveries on the habitat of *Ch.*

zebratus, the species was reported to be living in habitats: intertidal pools (AHNELT 1990, ALBERTO & NIETO 1993, MILLER 1977); fine sand bottom (MERCADER 1994); and small holes in rock (AHNELT & PATZNER 1996). A habitat similar to that of my observations was described in Bouchereau & Tomasini (1990). The lowest registered depth limit of 10 m is greater than in previous data: 0,6 m (AHNELT 1990), 0,7 m (ALBERTO & NIETO 1993), 4 m (MERCADER 1994), 7 m (AHNELT & PATZNER 1996). Most of the data on *Zebrus zebrus* by other authors were obtained from intertidal pools and from depths less than 2 m (AHNELT 1990, MILLER 1977, NIETO & ALBERTO 1992). The only deeper recorded finding was at 9 m (AHNELT & PATZNER 1996). Another difference is that some specimens were registered in intertidal pools among algae (AHNELT 1990) and not only hidden under stones is another difference. Ahnelt & Patzner (1996) reported *Z. zebrus* similar habitats in small holes made by the bivalve *L. lithophaga* similar to those of *C. liechtensteini* collected in the Kvarner area. *T. ephippiatus* in the Kvarner area has a similar sheltered habitat, depth range and behaviour similar to that of the specimens encountered on the Atlantic coast (MILLER 1969, MILLER 1986, MILLER *et al.* 1973), except for the difference in the lower depth limit (5 m) and the differences in the composition of the animal and plant species on the bottom. For *L. candollei* no previous habitat data were found in the literature (BRIGGS 1986, HUREAU 1996, RIEDL 1991).

Species rarely encountered in the Kvarner area *Ch. quadrivittatus* and *L. l. lepadogaster* have specific habitat demands. Previous descriptions of habitat and depth ranges for *Ch. quadrivittatus* are very similar to the recent data registered in the Kvarner area. The species lives among stones, in intertidal pools (AHNELT 1990, AHNELT 1991) and at depth of 1–2 m (GOLANI & BEN TUVIA 1986, MILLER 1971, MILLER 1977). There are no published data on the habitat of *L. l. lepadogaster* (BRIGGS 1986, HUREAU 1996), except for a short remark in RIEDL (1991), which, in general, matches the recent data.

The only habitat of *G. wildenowi* mentioned in the literature (RIEDL 1991) differs from the tidal gravel habitat of the only specimen collected. Riedl states that *G. wildenowi* is not a rare species; it is found among algae and under stones, mostly in the shallow water with large rocks. According to BRIGGS (1986) and HUREAU (1996) there are no other data on the habitat of this species.

C. liechtensteini was found in the Kvarner area at a depth of only 1 m. Until this finding, the known lower depth limit of the species was 5 m (AHNELT *et al.* 1994). The habitats of *C. liechtensteini* mentioned in KOLOMBATOVIĆ (1891) and MILLER (1972) were small holes in big boulders in deeper water, in AHNELT *et al.* (1994) small rock cavities (10–50 cm across) at depths of 5–25 m, and small holes, in AHNELT & PATZNER (1996). The habitats as described are generally similar to those registered in the Kvarner area.

Most of the papers written on hidden fish species in the Mediterranean were based on specimens from old museum collections or on ones occasionally collected. Only in recent years have works on two or more found cryptobenthic fish species

were published as the result of intensive collecting at study sites (AHNELT 1990, AHNELT & PATZNER 1996, BOUCHEREAU & TOMASINI 1990). The most explored types of hidden bottom environments were mediolittoral pools (AHNELT 1990, ALBERTO & NIETO 1993, NIETO & ALBERTO 1992) and holes, crevices and small cavities in the bedrock (AHNELT *et al.* 1994, AHNELT & PATZNER 1995, AHNELT & PATZNER 1996). During the recent investigation on the transects, all the cryptic habitats found were investigated but with different degrees of effort. Mediolittoral pools and large caves (large enough for diver to get in) in the infralittoral were rarely found. Attempts at collecting with the use of anaesthetic in small holes and crevices in the bedrock were unsuccessful, and middle-sized cavities (50–100 cm across) were observed only without the use of anaesthetics. The best result, but with the largest effort, was achieved under boulders, rocks and small stones on the bottom.

Among published works, only the intensively elaborated hidden habitats located at the north coast of Ibiza, Balearic islands (AHNELT *et al.* 1994, AHNELT & PATZNER 1995, AHNELT & PATZNER 1996) are comparable in species composition and abundance with the recent investigation. The absence of some species in the Kvarner area, but found at Ibiza might be the result of their limited geographical distribution (*Didogobius splechnai* AHNELT & PATZNER, 1995; *Gammogobius steinitzi* BATH, 1971), although other species with similar restricted geographical distributions, were found later in other parts of the Mediterranean. Other differences in cryptobenthic fish communities in the two locations might be the result of a different intensity of investigation into similar habitats. During the current research, *Millerigobius macrocephalus* Bath, 1973 was not found and *C. liechtensteini* was found only once, although both species are common at Ibiza and have already been reported in the Adriatic sea. *Ch. zebratus* and *Z. zebrus* seem to be numerous and common in hidden habitats of Mediterranean coasts. No data on species composition and abundance at a habitat of cryptic Mediterranean clingfishes are found in published papers. The abundance of the majority of the cryptobenthic fish species found in the Kvarner area depends on the frequency of the habitat typical of the species, but some species rarely found might be generally scarce and not very numerous even in their preferred habitat. Further investigations on a larger and quantitatively defined bottom surface, together with a better definition of the habitat characteristics, could resolve the question of the rareness of some cryptic fish species.

ACKNOWLEDGMENTS

I am indebted to Milvana Arko Pijevac for help in collecting the specimens and for advice on biocoenological data, and to Dr. Čedomir Benac for advice on the subject of geology.

Received September 1, 1997

REFERENCES

- AHNELT, H., 1990: *Chromogobius quadrivittatus*, *Chromogobius zebratus* und *Zebrus zebrus* (Pisces, Gobiidae): Erstnachweise für Korsika (Frankreich) und Sardinien (Italien). – Ann. Naturhist. Mus. Wien **91B**, 27–41.
- AHNELT, H., 1991: Some rare fishes from the Western Mediterranean Sea. – Ann. Naturhist. Mus. Wien **92B**, 49–58.
- AHNELT, H., P. J. MILLER & R. A. PATZNER, 1994: Systematic and distribution of two rare Mediterranean gobies, *Corcyrogobius liechtensteini* (KOLOMBATOVIĆ, 1891) and *Odondebuenia balearica* (PELLEGRIN & FAGE, 1907) (Teleostei: Gobiidae). – Cybium **18** (2), 169–176.
- AHNELT, H. & R. A. PATZNER, 1995: A new species of *Didogobius* (Teleostei: Gobiidae) from the western Mediterranean. – Cybium **19** (1), 95–102.
- AHNELT, H. & R. A. PATZNER, 1996: Kryptobentische Meergrundeln von den Balearen (Westliches Mittelmeer) mit Anmerkungen zum Unterartstatus von *Chromogobius zebratus levanticus* MILLER, 1971. – Ann. Naturhis. Mus. Wien **98B**, 529–544.
- ALBERTO, L. J. & P. NIETO, 1993: Presence of *Chromogobius zebratus* (Kolombatović, 1891) (Gobiidae) in the Atlantic. Comments on the subspecific characteristics and distribution. – Cybium **17**, 215–221.
- BATH, H., 1971: *Gammogobius steinitzi* n. gen. n. sp. aus dem westlichen Mittelmeer. – Senckenbergiana biol. **52**, 201–210.
- BATH, H., 1973: Wiederbeschreibung der Grundelart *Gobius macrocephalus* Kolombatović aus dem Mittelmeer und Aufstellung einer neuen Gattung *Millerigobius*. – Senckenbergiana biol. **54**, 303–310.
- BOUCHEREAU, J.-L. & J.-A. TOMASINI, 1990: Note sur la presence de *Chromogobius zebratus* (Kolombatović, 1891) and *Millerigobius macrocephalus* (Kolombatović, 1891) (Teleostei: Perciformi: Gobioidi: Gobiidae) sur le cotes de Corse, France. – Bulletin de la Societe Zoologique de France **114** (3), 105–110.
- BRIGGS, J. C., 1986: Gobiessocidae. – In: WHITEHEAD, P. J. P., M.-L. BAUCHOT, J.-C. HUREAU, J. NIELSEN & E. TORTONESE (eds): Fishes of the North-eastern Atlantic and the Mediterranean, 3. 1351–1359. UNESCO. Paris.
- GOLANI, D. & A. BEN TUVIA, 1986: New records of fishes from the Mediterranean coast of Israel including Red Sea immigrants. – Cybium **10** (3), 285–291.
- HUREAU, J. C. (ed), 1996: Fishes of the North-eastern Atlantic and the Mediterranean. CD-ROM. World biodiversity Database, CD-ROM Series. ETI & UNESCO. Amsterdam, Paris.
- JARDAS, I., A. PALLAORO & M. KOVAČIĆ, 1998: Recent ichthyofauna of the Rijeka Bay. – Zbornik radova Znanstvenog savjetovanja Prirodoslovna istraživanja riječkog područja, in press.
- KOLOMBATOVIĆ, G., 1891: Gobies of the marine area of Split (Dalmatia) (in Croatian and Italian). – Godišnje izvješće C.K. Velike realke u Splitu za 1890–91, 1–29.
- KOVAČIĆ, M., 1994: Contribution to the knowledge of gobies, Gobiidae (Pisces, Perciformes) in the Rijeka Bay, Adriatic Sea. – Periodicum biologorum **96** (4), 463–465.
- MERCADER, M., 1994: Premiere capture de *Chromogobius zebratus* (Gobiidae) dans le Mer Catalane. – Cybium **18**, 205–206.
- MILLER, P. J., 1969: Systematics and biology of the leopard spotted goby, *Gobius ephippiatus* (Teleostei: Gobiidae), with description of a new genus and notes on the identity of *Gobius macrolepis* Kolombatović. – J. mar. biol. Ass. U. K. **49**, 831–855.
- MILLER, P. J., 1971: A revision of the Mediterranean gobiid genus *Chromogobius* (Teleostei – Perciformes). – J. Zool. London **164**, 305–334.

- MILLER, P. J., 1972: Generic status and redescription of the Mediterranean fish *Gobius liechtensteini* Kolombatović, 1891 (Teleostei: Gobioidae), and its affinities with certain American and Indo-Pacific gobies. – J. Nat. Hist. 6, 395–407.
- MILLER, P. J., 1977: Gobies from Rhodes and the systematic features of *Zebrus zebrus* (Teleostei: Gobiidae). – Zool. J. Lin. Soc. 60, 339–362.
- MILLER, P. J., 1986: Gobiidae. – In: Whitehead, P. J. P., M.-L. Bauchot, J.-C. Hureau, J. Nielsen & E. Tortonese (eds): Fishes of the North-eastern Atlantic and the Mediterranean, 3. 1019–1085. UNESCO. Paris.
- MILLER, P. J., 1992: A new species of *Didogobius* (Teleostei: Gobiidae) from the Adriatic Sea. J. Nat. Hist. 26, 1413–1419.
- MILLER, P. J., A. L. RICE & A. D. F. JOHNSTONE, 1973: A western Scottish population of the leopard spotted goby, *Thorogobius ephippiatus* (Lowe) (Teleostei: Gobioidae). – Journal of Fish Biology 5, 233–239.
- NIETO, P. & J. L. ALBERTO, 1992: The presence of *Zebrus zebrus* (Risso, 1826) (Gobiidae) on the Atlantic coast of Spain. – Cybium 16, 137–144.
- PERES, J. M. & H. GAMULIN-BRIDA, 1973: Biological Oceanography: Benthos, benthic bionomy of the Adriatic sea (in Croatian). p 493. Školska knjiga. Zagreb.
- RIEDL, R., 1966: Biologie der Meereshohlen. p. 636. Verlag Paul Parey. Hamburg und Berlin.
- RIEDL, R., 1991: Fauna e Flora del Mediterraneo. p 777. Franco Muzzio editore. Padova.
- ZANDER C. D. & H. J. JELINEK, 1976: Zur demersen Fischfauna im Bereich der Grotte von Banjole (Rovinj/YU) mit Beschreibung von *Speleogobius trigloides* n. gen. n. sp. (Gobiidae, Perciformes). – Mitt. Hamburg. Zool. Mus. Inst. 73, 265–280.
- ZAVODNIK, D., A. ŠPAN, N. ZAVODNIK, A. ŠIMUNOVIĆ & B. ANTOLIĆ, 1981: Benthos of the western coast of the island Krk (Rijeka Bay, North Adriatic Sea). – Thalassia Jugosl. 17 (3/4), 285–337.
- ZAVODNIK, N., 1984: Review of investigations on marine benthic algae of Istria and Kvarner (in Croatian). – Pomorski zbornik 22, 349–362.

Sažetak

Kriptobentoski glavoči (Pisces, Perciformes, Gobiidae) i priljepnjaci (Pisces, Gobiesociformes, Gobiesocidae) u Kvarnerskom području, Jadransko more

Marcelo Kovačić

Sastav ribljih zajednica priobalnog bentosa u području Kvarnera istraživan je u periodu 1993.–1997. tijekom 89 ronjenja autonomnim ronilačkim aparatima. Na tim istraživanjima sakupljeni su podaci i o kriptobentoskoj ihtiofauni. Ovo su jedini takvi podaci o ovom području, osim pojedinačnih nalaza stranih autora. U Sredozemnom moru je u posljednja tri desetljeća, zahvaljujući korištenju ronilačke tehnike, otkriveno nekoliko kriptobentoskih vrsta riba, a sakupljeni su primjerci i podaci o ekologiji i biologiji više vrsta poznatih do tada samo na osnovu opisanih tipova. Skrivena staništa na morskom dnu uključuju špilje, duboke duplje i pukotine u stje-

novitoj osnovi te prostore ispod kamenih gromada, kamenja i valutica na morskom dnu. Tijekom ronjenja zabilježene su, a od svake vrste i sakupljen barem po jedan primjerak, sljedeće kriptobentoske vrste porodice Gobiidae: *Chromogobius quadrivittatus*, *Chromogobius zebratus*, *Corcyrogobius liechtensteini*, *Thorogobius ephippiatus*, *Zebrus zebrus* i obitelji Gobiesocidae: *Gouania wildenowi*, *Lepadogaster candollei*, *Lepadogaster lepadogaster*. U špiljama je jedina uočena vrsta bila *T. ephippiatus*. Njen predstavnik je pronađen i u dubokim udubljenjima i pukotinama na dubinama od 12–32 metra. Jedini primjerak vrste *C. liechtensteini* sakupljen je na dubini od 1 metra, na stijeni slabo obrasloj algama, u rupi prstaca. Isto samo jedan primjerak vrste *G. wildenowi* pronađen je na plaži među šljunkom, neposredno ispod donje granice oseke. Rjeđe su nalažene i vrste *L. l. lepadogaster* i *Ch. quadrivittatus*, na ravnim dnima, ravnomjerno pokrivenim valuticama, uz mediolitoralne stijene do 2 metra dubine. Češće su zabilježene, na različitim tipovima dna, vrste *L. candollei* (dubine 1–18 metara), *Ch. zebratus* (dubine 1–10 metara) i *Z. zebrus* (dubine 1–6 metara). Zabilježena staništa pronađenih kriptobentoskih vrsta porodice Gobiidae većinom odgovaraju podacima u literaturi. Prethodno objavljeni podaci o staništu vrsta porodice Gobiesocidae rijetki su i površni. Vidljiva je razlika u sastavu vrsta i njihovoj učestalosti između nalaza u Kvarneru i nalaza drugih autora u drugim dijelovima Sredozemnog mora.