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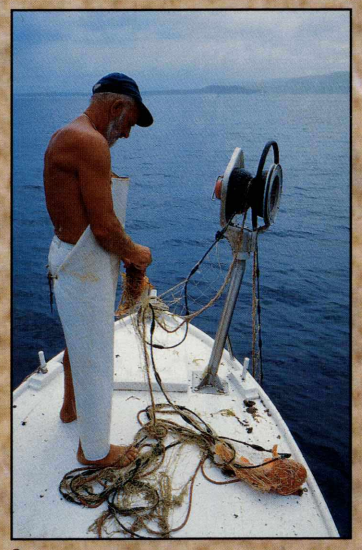

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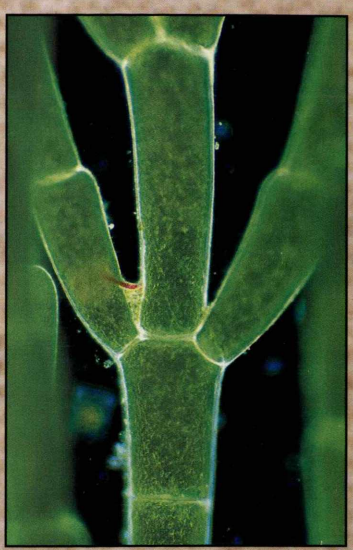

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BIOLOGIA ED ECOLOGIA MARINA

MARINE BIOLOGY AND ECOLOGY

original scientific paper

UDC 597(Jadransko morje)

HISTORICAL AND CONTEMPORARY PRESENCE OF THE GREAT WHITE SHARK, *CARCHARODON CARCHARIAS* (LINNAEUS, 1758), IN THE NORTHERN AND CENTRAL ADRIATIC SEA

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ABSTRACT

Data concerning the presence of Carcharodon carcharias *(Linnaeus, 1758) in the Northern and Central Adriatic Sea, as recorded in the Italian Great White Shark Data Bank, is presented herewith. A total of 79 cases, corresponding to about 83 specimens, are presented, complete with all biological details collected. Moreover, a brief analysis of the data is given.*

Key words: Great white shark, *Carcharodon carcharias*, Adriatic Sea

PRESENZA STORICA E ATTUALE DELLO SQUALO BIANCO, *CARCHARODON CARCHARIAS* (LINNAEUS, 1758), NELL'ALTO E MEDIO ADRIATICO

SINTESI

Vengono esposti i dati in merito alla presenza di Carcharodon carcharias *(Linnaeus, 1758) nell'Alto e Medio Mare Adriatico registrati nella Banca Dati Italiana Squalo Bianco. E' riportato un totale di 79 casi, corrispondenti a circa 83 esemplari, completo di tutti i dettagli che è stato possible rilevare. I dati vengono quindi brevemente analizzati.*

Parole chiave: Squalo bianco, *Carcharodon carcharias*, Mare Adriatico

INTRODUCTION

Although the great white shark, *Carcharodon carcharias* (Linnaeus, 1758) (Fig. 1), has never been the subject of specific studies in the Adriatic Sea, its presence in these waters has been known for a long time, being recorded on many occasions by several authors. As a result of a program of data collection called the *"Italian Great White Shark Data Bank" ("Banca Dati Italiana Squalo Bianco")* and instigated in 1996, substantial information about historical and recent records of this species from the Adriatic Sea have been collected. These data are reported here in full.

MATERIALS AND METHODS

The search for data on white sharks from the Adriatic was effected by bibliographical research, location and study of materials preserved in natural history museums, collaborations with other researchers, coast guards, and private citizens. For every case, whenever possible, the following data were collected: date and location of the

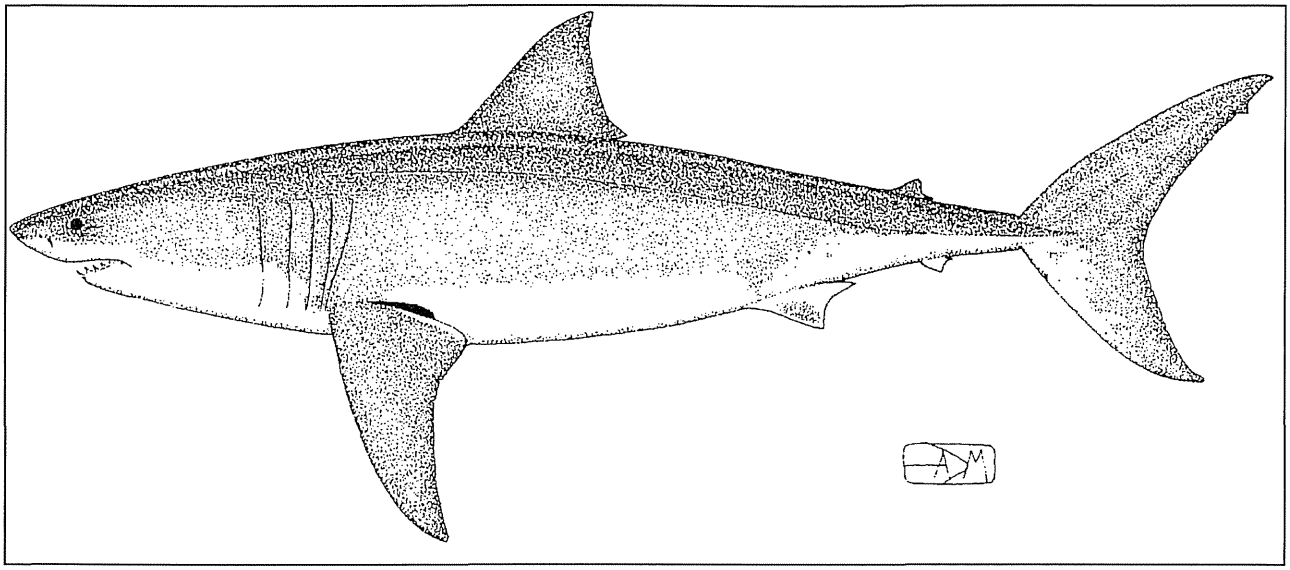

Fig. 1: Great white shark** Carcharodon carcharias **(Linnaeus, 1758). Drawing by Alessandro De Maddalena.
Sl. 1: Beli morski volk** Carcharodon carcharias **(Linné, 1758). Risba: Alessandro De Maddalena.

record, total length (TL) in cm, mass (P) in kg and sex (S) of the specimen, type of record (sighting, capture, attack on human or boat), register number in the International Shark Attack File (ISAF), depth of the sea at record location, distance from the coast, weather, information about specimens preserved in museums and catalogue number (cat. no.) in the collections, as well as any additional details.

RESULTS

326 records of *Carcharodon carcharias* in the Mediterranean Sea have been collected in the Italian Great White Shark Data Bank. Of these, a total of 79 cases (77 of which are deemed reliable) are referred to the Adriatic Sea (including Italy, Slovenia, Croatia, and unknown Country), corresponding to about 83 specimens (81 reliable) (Tab. 1). Only the large region encompassing Sicily, Egadi, Pantelleria, Pelagie, Malta and Tunisia has a larger number of records (105 specimens in total) as far as the Mediterranean is concerned.

With the exception of a few cases in which neither exact location nor Country is indicated - consequently they are indicated as occurring in the "Adriatic Sea" - the records are geographically well clustered in two zones: in the Eastern and Western Adriatic (Fig. 2). The lack of data from the Southern Adriatic supports a statement made by Bini (1967), who reported the great white shark as very rare in this zone.

The Eastern Adriatic

The high number of cases of great white sharks recorded from the Eastern Adriatic during the 19th century and in the first half of the 20th century indicate that a population - perhaps of substantial size - must be present in the northern part of this zone, particularly in the Gulf of Trieste and in the Kvarner. The presence of this population in the Northeastern Adriatic may be causally

Fig. 2: Record location of great white sharks in the Adriatic Sea.
Sl. 2: Lokacije belih morskih volkov, zabeleženih v Jadranskem morju.

Tab. 1: Data on great white sharks registered in the Adriatic Sea.
Tab. 1: Podatki o belih morskih volkovih, zabeleženih v Jadranu.

DATE	LOCATION	TL (cm)	P (kg)	S	REMARKS	REFERENCES
1827	Adriatic Sea ITALY				Capture; jaws preserved in the Museo di Anatomia Comparata of Bologna (cat. no. AC P 114).	M. Zuffa *(pers. comm.)*, De Maddalena (2000)
Beginning of February 1839	Civitanova ITALY	600 ca. (602)	1814		Capture or stranding; skeleton preserved in the Museo di Anatomia Comparata, Rome (cat. no. 111-95).	Bonaparte (1839), Metaxà (1839), Vinciguerra (1885-1892), Condorelli & Perrando (1909), De Maddalena (1998-1999-)
September 14th 1868	Jablanac, CROATIA				Capture. Preserved in the Croatian Museum Zagreb.	Brusina (1888)
December 16th 1868	Sv. Gjuraj, Near Senj CROATIA	460			Capture. Preserved in the Croatian Museum Zagreb.	Brusina (1888)
April 1872 - July 1882	Eastern North Adriatic Sea	from146 to 530			21 specimens captured. Surely some of these individuals are reported further.	Marchesetti (1884)
April 16th 1872	Preluka harbour CROATIA	490			Capture	Brusina (1888)
April 19th 1872	Grado ITALY	300			Capture, 4 miles offshore	Brusina (1888)
May 12th 1872	Opuzen CROATIA	95			Capture, 10 miles offshore	Brusina (1888)
May 12th 1872	Konao (Mljet) CROATIA	237			Capture	Brusina (1888)
June 8th 1872	Preluka harbour CROATIA	131			Capture	Brusina (1888)
June 16th 1872	Dugi Otok CROATIA	146			Capture	Brusina (1888)
July 25th 1872	Cavtat CROATIA	260			Capture	Brusina (1888)
August 8th 1872	Rab CROATIA	130			Capture	Brusina (1888)
1873	Trieste ITALY	460		M	Capture	Doderlein (1881), Graeffe (1886)
May 5th 1877	Ustrine (Cres) CROATIA	460			Capture	Brusina (1888)
May 8th 1877	Sv. Martin (Cres) CROATIA	413			Capture	Brusina (1888)
May 12th 1877	Adriatic Sea ITALY				Capture	Perugia (1881), Ninni (1912)
May 12th 1877	Adriatic Sea ITALY				Capture	Perugia (1881), Ninni (1912)
June 17th 1878	Osor -Cres- CROATIA	371			Capture	Perugia (1881), Brusina (1888), Ninni (1912)
May 21st 1879	Sv. Martin Cres CROATIA	382			Capture	Brusina (1888)

DATE	LOCATION	TL (cm)	P (kg)	S	REMARKS	REFERENCES
June 1879	Kvarner CROATIA				Capture. Maybe in fact one of the two following cases.	Graeffe (1886), Tortonese (1956), Fergusson (1996)
June 17th 1879	Adriatic Sea				Capture	Perugia (1881), Ninni (1912)
July 23rd 1879	Split CROATIA	402 or 445			Capture	Perugia (1881), Brusina (1888), Ninni (1912)
September 21st 1879	Ustrine -Cres- CROATIA	530			Capture	Perugia (1881), Faber (1883), Brusina (1888), Ninni (1912)
November 5th 1879	Grado ITALY	250			Capture	Perugia (1881), Ninni (1912)
1880	Golfo di Trieste ITALY	460			Capture	Ninni (1912), Fergusson (1996), Mojetta *et al.* (1997)
April 22nd 1881	Rab CROATIA	380			Capture	Brusina (1888)
October 16th 1881	Rab CROATIA	405			Capture	Brusina (1888)
April 13th 1882	Sv. Martin (Cres) CROATIA	529			Capture	Brusina (1888)
June 13th 1883	Vrboska (Hvar) CROATIA	300			Capture	Brusina (1888)
September 26th 1883	Rab CROATIA	396			Capture	Brusina (1888)
September 14th 1885	Santa Croce di Trieste ITALIA	400			Capture	Brusina (1888)
March 3rd 1886	Korčula CROATIA	560			Capture	Brusina (1888)
September 2nd 1887	Krk CROATIA	470			Capture	Brusina (1888)
1902	Trieste ITALY	375		M	Capture; preserved taxidermied in the Museo di Storia Naturale of Venezia (cat. no. 2039).	Mizzan (1994), De Maddalena (2000)
May 29th 1906	Kvarner CROATIA	522		F	Capture; preserved taxidermied in the Museo di Storia Naturale of Trieste (without cat. no.).	De Maddalena (2000)
January 1908	Medola CROATIA				Possible great white shark attack on Milena Scambelli.	M. Zuffa *(pers. comm.)*, Anonymous (1908)
May 19th 1908	Stadival CROATIA	170			Captured by Simeone Armanini and Simeone Franceschini.	M. Zuffa *(pers. comm.)*
June 1908	Golfo di Trieste ITALY		1400		Captured by Stelio Candela.	Arrassich (1994)
October 1909	Kraljevica CROATIA	550 ?			Capture	A. Mojetta *(pers. comm.)*, Mojetta *et al.* (1997)
1927	Rovinj CROATIA	600 ca.	1000		Capture. Stomach contained inedible objects.	De Maddalena (1999)

DATE	LOCATION	TL (cm)	P (kg)	S	REMARKS	REFERENCES
August 21st 1934	Susak CROATIA				Unprovoked fatal attack on swimmer Agnes Novak. ISAF no. 370.	Giudici & Fino (1989)
August 23rd and 30th 1934	Rijeka CROATIA	600 ca. >700			At least 2 specimens sighted.	Giudici & Fino (1989)
August 30th 1934	Rijeka CROATIA	600			Doubtful unprovoked fatal attack on swimmer Zorica Princ (or Prinz?). ISAF no. 974.	Fergusson (1996)
September 2nd 1934	Kralijevica CROATIA	>700	>2000		Capture	Giudici & Fino (1989)
September 7th 1934	Moschiena CROATIA	500 ca.	800 ca.		Capture; pursuing school of tunas.	Giudici & Fino (1989)
September 7th 1934	Martinschizza CROATIA	>600 ca.			Sightings; eating a small board of cork.	Giudici & Fino (1989)
August 24th 1938	Koper SLOVENIA	500 ca.			Sighted by Nicola Lubrano.	State Archives of Trieste
1940 ca.	Koper SLOVENIA				Attack on boat.	M. Zuffa *(pers. comm.)*
September 24th 1961	Opatija CROATIA				Unprovoked fatal attack on swimmer Sabit Plan. ISAF no. 946.	Anonymous (1961), Giudici & Fino (1989), Fergusson (1996)
July 7th 1963	Riccione ITALY	450 ?			Unprovoked nonfatal attack on diver Manfred Gregor. ISAF no. 1220.	Ellis (1983), Fergusson (1996), Mojetta *et al.* (1997)
October 22nd 1963	Izola SLOVENIA	600	1100		Capture. Stomach contained 1 dolphin.	Lipej (1993-1994)
August 16th 1966	Dalmatia CROATIA				Fatal attack.	A. Mojetta *(pers. comm.)*
1970	Novigrad CROATIA				Unprovoked attack on diver Jurinčić.	A. Mojetta *(pers. comm.)*
September 1971	Ika CROATIA				Fatal attack on Stanislav Klepna.	Gilioli (1989)
1971	Opatija CROATIA				Unprovoked fatal attack on a swimmer. ISAF no. 1640.	Fergusson (1996)
August 10th 1974	Omiš CROATIA	500 ca.			Fatal attack on Rolf Schneider.	M. Zuffa *(pers. comm.)*
June 7th 1978	Golfo di Venezia ITALY	500 ca.			Sighted by Luigi Alberotanza and Luigi Cavaleri; regurgitated a bottlenose dolphin.	L. Alberotanza *(pers. comm.)*, L. Cavaleri *(pers. comm.)*, Beltrame (1983), Albertarelli (1990), Fergusson (1996)
A few days later	Caorle ITALY				Sighting	L. Alberotanza *(pers. comm.)*
End of September 1986	Western Adriatic Sea (Rimini, Pesaro) ITALY	600 ca.?		F	Repeated sightings and a possible nonfatal attack on a boat.	Anonymous (1986), Gilioli (1989), Giudici & Fino (1989), Marini (1989), Martelli (1989), Fergusson (1996)
August-September 1987	Pesaro ITALY	>600			Sighting	Cardellini (1987), Mojetta *et al.* (1997)

DATE	LOCATION	TL (cm)	P (kg)	S	REMARKS	REFERENCES
May 1988	Numana ITALY	450 ca.			Sighted by Fausto Fioretti.	M. Marconi *(pers. comm.)*
September 9th 1988	Porto Barricata ITALY	>550			Sighting or possible attack on a boat.	A. Mojetta *(pers. comm.)*, Mojetta *et al.* (1997)
September 1989	Pesaro ITALY	>500			Sighting	Fergusson (1996)
December 17th 1991	Ancona ITALY	210	180		Capture	Fergusson (1996)
Mid-March 1992	Termoli ITALY	230	200 ca.	F	4 or 5 juveniles captured.	Anonymous (1992), Fergusson (1996)
August 1993	Šibenik CROATIA	500		F	Capture	Fergusson (1996)
August 1993	Lošinj CROATIA				Repeated sightings by fishermen.	Fergusson (1996)
September 4th 1998	Dubrovnik CROATIA				Sighted offshore.	De Sabata *et al.* (1999)
August 2nd 1998	Mljet CROATIA				Sighting	De Sabata *et al.* (1999)
August 27th 1998	Senigallia ITALY	500-600 ca.	1200 ca.		Sighted by Stefano Catalani; feeding on a thresher shark carcass.	Imarisio (1998), Montefiori (1998)
September 26th 1999	Giulianova ITALY	600 ca.			Sighted by Elvio Mazzagufo; feeding on tuna carcass.	Graziosi (1999)
?	Foce del Po ITALY				Sighting	M. Zuffa *(pers. comm.)*
?	Adriatic Sea				Capture. Set of jaws preserved in the Museo di Storia Naturale of Trieste (without cat. no.).	De Maddalena (2000)
Before 1881	Golfo di Venezia ITALY	490			Capture	Doderlein (1881), Carus (1893), Fergusson (1996)
Before September 1891	Adriatic Sea	1005	4000		Capture	Anonymous (1891), Ellis & McCosker (1991)
Before 1969	Adriatic Sea				Capture; stomach contained inedible objects.	Lineaweaver III & Backus (1969), Gianturco (1978)
Before 1992	Northern Adriatic Sea ITALY				2 specimens captured.	Anonymous (1992)

linked to the fact that there were once several commercial fisheries dedicated to catching tunas in this region. The fisheries were established in response to the massive and well-known quantity of tunas that passed along this part of the Adriatic. It is well known that tunas are among the favoured prey for great white sharks. Moreover, the long Croatian coast - consisting of several islands, straits and small bays - seems to be a habitat congenial to this species.

Between the years 1872 and 1905, the Imperial Maritime Austrian Government issued three circulars offering a reward of up to 500 florins for every great white shark captured. These circulars also mentioned other shark species, but primarily referred to *Carcharodon carcharias*. At the State Archives of Trieste, the orders of payment for these rewards are available but, unfortunately, in most cases the species for which they were issued is not listed. To obtain the monetary reward, fishermen must present their captured specimens to the Museo di Storia Naturale of Trieste to verify the species identification. From April 1872 to July 1882, 21 shark specimens were presented to the Museo di Storia Naturale of Trieste; the size of these specimens ranged from 1.46 to 5.3 metres, of which 7 (33.33%) were over 4

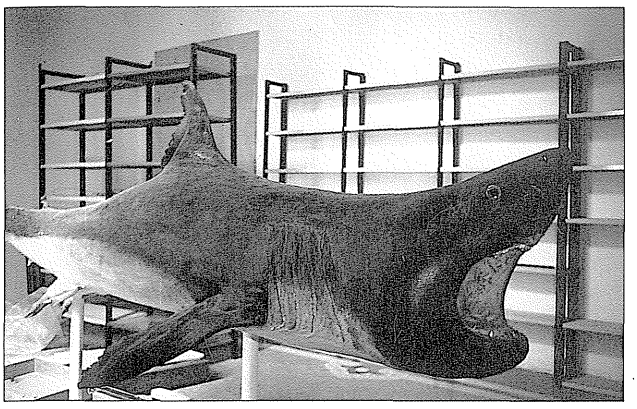

Fig. 3: 3.75 m specimen preserved in the Museo di Storia Naturale of Venezia (cat. no. 2039), caught off Trieste (Italy) in 1902. (Photo: A. De Maddalena)
Sl. 3: 3,75 m dolgi primerek belega morskega volka v beneškem prirodoslovnem muzeju (kat. št. 2039), ujet leta 1902 v bližini Trsta. (Foto: A. De Maddalena)

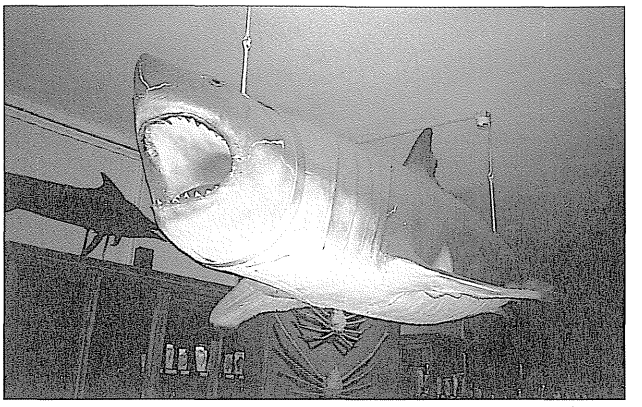

Fig. 4: 5.22 m specimen preserved in the Museo di Storia Naturale of Trieste (without cat. no.), caught in Kvarner (Croatia) on May 29th 1906. (Photo: A. De Maddalena)
Sl. 4: 5,22 m dolgi primerek v tržaškem prirodoslovnem muzeju (brez kat. št.), ujet 29. maja 1906 v Kvarnerju. (Foto: A. De Maddalena)

meters in length (Marchesetti, 1884). Among these 21 specimens are 11 captures recorded over the same period from the waters of Trieste, Grado (Italy), Osor, Kvarner, Split, Ustrine (Croatia) and other unspecified locations (Doderlein, 1881; Graeffe, 1886; Perugia, 1881; Faber, 1883; Ninni, 1912; Tortonese, 1956; Fergusson, 1996; Mojetta *et al.*, 1997). Moreover, Brusina (1888) reports 24 specimens, ranging from 1.3 to 5.6 meters in length, caught between September 1868 and September 1887 in the Eastern Adriatic; it is certain that some of these individuals are the same as those reported by Marchesetti (1884). This measure apparently produced the desired result, since from 1887 to 1902 no other records of large sharks from the Eastern Adriatic are known.

But from 1902, a number of the shark capture records were made again. These include several sightings of large sharks as well as attacks on humans and even boats. According to Boulenger (1939), *"there does not pass a bathing season, especially on the Liburnian and Dalmatian coasts, without an attack on a bold swimmer by one of these tigers of the sea"*. In the museums of Venezia and Trieste there are two large taxidermied great white shark specimens captured in the Eastern Adriatic during the early years of the 20th century. The specimen in the Museo di Storia Naturale of Venezia (cat. no. 2039; Fig. 3) is a 3.75 m TL male caught off Trieste (Italy) in 1902 (Mizzan, 1994; De Maddalena, 2000), while that in the Museo di Storia Naturale of Trieste (without cat. no.; Fig. 4) is a 5.22 m TL female caught in Kvarner (Croatia) on May 29th 1906 and is the largest taxidermied *C. carcharias* preserved in Italy (De Maddalena, 2000).

In January 1908, some sharks approached a boat full of young women near Medola (Croatia). Perhaps one of the sharks attacked the boat, because Milena Scambelli fell suddenly into the sea. A shark bit her leg, lacerating it. Ms. Scambelli was rescued and taken to hospital, but did not survive (M. Zuffa, *pers. comm.*; Anonymous, 1908). Whatever precipitated the attack, the identity of the causal species must remain highly uncertain. It seems very strange that a witness specified that the sharks, "jumped around the boat". In fact, *C. carcharias* can breach entirely out of water, but does so relatively rarely.

On May 19th 1908, there was another capture of a shark in the Eastern Adriatic. The shark was caught near Stadival (Croatia) by fishermen Simeone Armanini and Simeone Franceschini. At the time it was identified as a shortfin mako *(Isurus oxyrinchus),* but subsequent examination of the available evidence suggests that it was probably a young *C. carcharias* (M. Zuffa, *pers. comm.).* The differences in the teeth of these two members of the Lamnidae family are less obvious in very young specimens and can sometimes generate some confusion. A short time after this capture of a small great white shark, in June 1908, Stelio Candela caught a large specimen weighing 1,400 kg in the Gulf of Trieste. A conclusive photographic evidence has been preserved about this incident (Arrassich, 1994). Another, 5.5 m long great white shark was caught in October of the following year in Kraljevica (Croatia) (A. Mojetta, *pers. comm.*; Mojetta *et al.*, 1997).

In Rovinj (Croatia), nine fishing boats captured, in 1927, a large specimen of great white shark, about 6 m long and weighing some 1,000 kg. Its stomach contained several inedible objects.

During the summer of 1934, there were a series of records of great white sharks in Croatian waters. On August 21st 1934, the island of Susak witnessed an attack

Fig. 5: 6 m specimen caught in the waters off Izola (Slovenia) on October 22nd 1963. (L. Lipej's archive)
Sl. 5: Šestmetrski beli morski volk, ujet 22. oktobra 1963 v bližini Izole. (Arhiv L. Lipeja)

on a young woman, Agnes Novak, who was swimming near a tuna catching station. There was an anti-shark net, but Agnes entered the water outside this net. Eye-witnesses from a fishing boat heard the woman scream and they saw a large great white shark biting Agnes's abdomen and dragging her underwater (Giudici & Fino, 1989). This fatal attack is no. 370 in the ISAF.

In the days that followed the attack on Agnes Novak, there were many sightings of sharks. The possibility cannot be excluded that one or more of these sharks could have been responsible for the attack on Novak. Sightings of at least two sharks occurred on August 23rd and 30th near Rijeka. On August 23, a large shark - estimated to be about 6 m long - was seen by some soldiers to be swimming near a torpedo-factory. Possibly the same shark was sighted later that afternoon by some fishermen, where it was seen swimming towards the shore off Diga Cagno. On August 30th, two large sharks were reported between Punta Baro and Diga Cagno. An hour later a shark - estimated to be more than 7 meters long - was swimming towards Labin channel, when it was encountered by some fishermen (Giudici & Fino, 1989).

A few days later, on September 2, an enormous shark - reportedly measuring 7 m in length and weighing 2 t - was caught at Kraljevica. Examination of its stomach contents did not indicate that it had been responsible for the attack on Novak (Giudici & Fino, 1989). A few days later yet another capture of a great white shark occurred: it was almost 5 m long and weighed 800 kg. The shark became trapped in a tuna net (Moščenićka Draga) while pursuing a school of tuna. On the same day, only a few hours after this capture, a shark longer than 6 m was seen near Martinščica and, an hour later, probably the same shark was sighted near a fishing boat eating a small board of cork (Giudici & Fino, 1989).

This series of well-documented records ends with a very doubtful incident. ISAF case no. 974 concerns a fatal attack on a swimmer, named Zorica Princ (or Prinz?), that occurred on August 30th near Rijeka, by a 6 m *C. carcharias*. Although Fergusson (1996) included it in his list of the Mediterranean great white shark attacks, the veracity of this incident must be regarded as questionable, because there is a strong possibility that it was merely a fabrication organised by a local newspaper.

At the State Archives of Trieste, I found a note attesting the following event: at 3 o'clock in the morning of August 24th 1938, a large shark of undisclosed species but measuring about 5 m TL carried away, in the Koper waters (Slovenia), a mile off the Ospizio Marino, the net of the fishing boat "S. Giovanni" belonging to Nicola Lubrano. On the basis of the shark's behaviour and its sheer size, it seems reasonable to infer that it was probably a *C. carcharias*. Again in the Koper waters, an attack on a boat occurred around 1940, as a result of which a fragment of a tooth of the shark remained embedded in the wood of the hull (M. Zuffa, *pers. comm.*).

From that moment, the records of great white sharks in the Eastern Adriatic become quite rare. The following incident occurred at Opatija, 21 years after the boat attack in the Koper waters, the record dated September 24th 1961. In the early afternoon of that day, student Sabit Plan was attacked by a large shark, which was subsequently identified as *C. carcharias* by Fergusson (1996). The young man was 100 m offshore when attacked. A boat was deployed to rescue him, but he had lost an arm and both legs so that - by the time it reached him - he was already dead (Anonymous, 1961; Giudici & Fino, 1989). This case is no. 946 in the ISAF.

On October 22nd 1963, a large shark measuring 6 m TL was caught near Izola (Slovenia) (Figs. 5 and 6). It approached a fishing boat while fishermen were turning in their nets and was killed with 23 rifle shots. According to the local newspapers, its stomach contained a dolphin, weighing about 200 kg (L. Lipej, *pers. comm.;* Lipej, 1993-1994). The source reports photographic evidence of this capture. A series of five attacks occurred in the Croatian waters between 1966 and 1974 (Dalmatia, August 16th 1966; Novigrad, 1970; Ika, Sepember 1971; Opatija, 1971; Omiš, August 10th 1974). Afterward, for many years, there were no other records of great white sharks in the Eastern Adriatic. More recently, four cases occurred in the Croatian waters. In August 1993, there

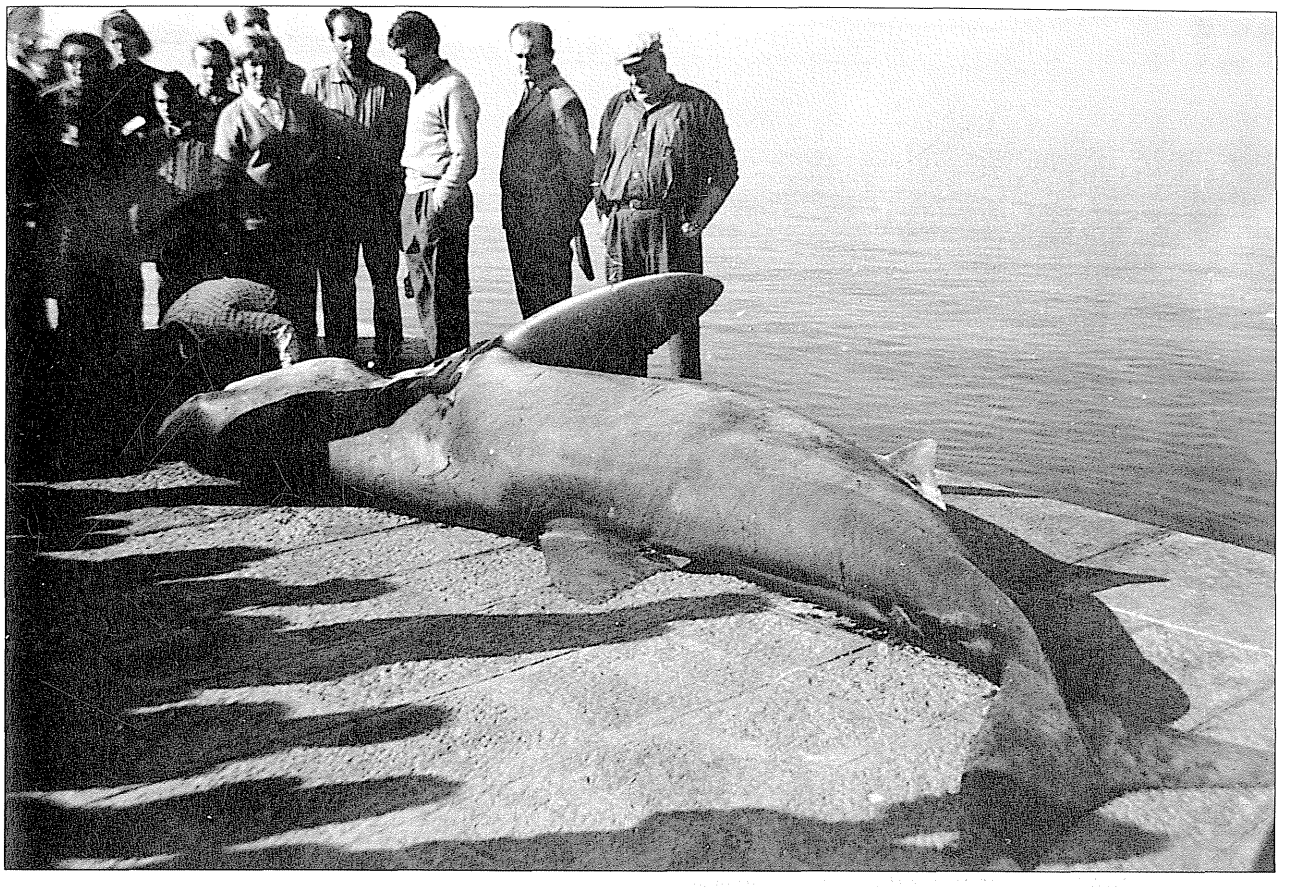

Fig. 6: 6 m specimen caught in the waters off Izola (Slovenia) on October 22nd 1963. (L. Lipej's archive)
Sl. 6: Šestmetrski beli morski volk, ujet 22. oktobra 1963 v bližini Izole. (Arhiv L. Lipeja)

was a capture of a 5-m specimen at Šibenik, followed by some sightings by fishermen at Lošinj (Fergusson, 1996; Mojetta *et al.*, 1997). In the summer of 1998, there was a sighting of a great white shark at Dubrovnik (on September 4th), and another at Mljet on August 2nd (De Sabata *et al.*, 1999).

The Western Adriatic

Records of great white sharks from the Western Adriatic have never been as frequent as those from along the eastern coast. This may be because the greater uniformity of the eastern coast of Italy does not favour this species approaching the shore. Historical evidence for the presence of *C. carcharias* on this side of the Adriatic is provided by a set of jaws preserved in the Museo di Anatomia Comparata of Bologna (cat. no. AC P 114; Fig. 7) from a specimen caught in 1827 at an unknown locality in the Western Adriatic which, upon capture, was exhibited at the Bologna fish market (M. Zuffa, *pers. comm.*; De Maddalena, 2000).

Early in February 1839, a very large great white shark was captured or stranded (the various sources differ on this point) in Civitanova, reported to be over 6 m long and weighing 1,814 kg. Shipped to Rome, the specimen was preserved at the University (Bonaparte, 1839; Metaxà, 1839; Vinciguerra, 1885-1892; Condorelli & Perrando, 1909). Not long ago, in the Museo Civico di Zoologia of Rome, the skin of this large shark was again preserved, but it has since then been lost or destroyed. The Museo di Anatomia Comparata of Rome keeps the cranium, jaws and the vertebral column of this large shark. From an analysis of the largest vertebra, I calculated a TL of 6.02 m, making this the largest verified specimen preserved in an Italian museum (De Maddalena, 1998-1999). Among the undated cases, but probably referable to the 19th century, is a 4.9 m specimen caught in Golfo di Venezia some time before 1881 (Doderlein, 1881; Carus, 1893; Fergusson, 1996).

The following documented case occurred much later than the Golfo di Venezia specimen. On July 7th 1963 (and not in 1961 as erroneously reported in Ellis, 1983), in Riccione, spearfishing diver Manfred Gregor was the victim of an unprovoked non-fatal attack by a *C. carcharias* about 4.5 m long (Fergusson, 1996; Mojetta *et al.*, 1997). This incident constitutes case no. 1220 of the ISAF.

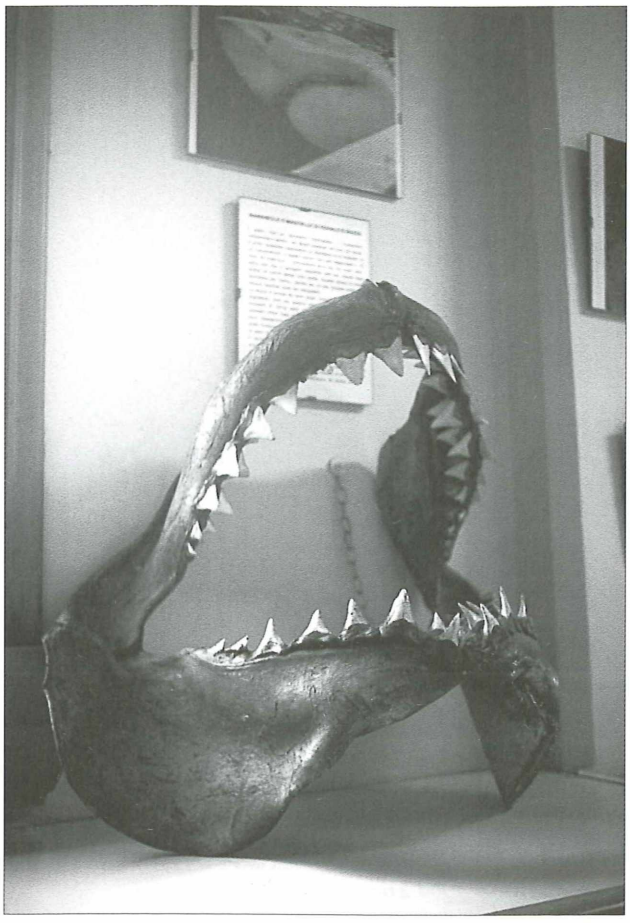

Fig. 7: Set of jaws preserved in the Museo di Anatomia Comparata of Bologna (cat. no. AC P 114), from a specimen caught in 1827 in the Adriatic. (Photo: A. De Maddalena)
Sl. 7: Čeljust belega morskega volka, ujetega leta 1827 v Jadranu, v zbirki bolonjskega muzeja komparativne anatomije. (Foto: A. De Maddalena)

A well documented case occurred on June 7th 1978 in the Golfo di Venezia. Luigi Alberotanza and Luigi Cavaleri, two researchers of the Centro Nazionale delle Ricerche (C.N.R.), were on the research platform "Acqua alta", located 13 km off Lido, in waters 16 m deep. They were returning from a dive to clean the legs of the platform when they saw two dark fins on the surface. Imagining it was a shark, they waited in hopes of seeing it better. Alberotanza tried to attract it by throwing a large steak in the water. Suddenly, the fins disappeared. Some moments later, while the men headed inside the platform to take off their wetsuits, the platform was shaken by a powerful bump. The men saw clearly a great white shark swimming close to the platform. They estimated the shark's length based on the known distance between the legs of the platform: it was about 5 m long. Luigi Cavaleri took even some photos of the shark. The shark disappeared, but the remains of a bottlenose dolphin, *Tursiops truncatus* (Montagu, 1821), were found near the platform. Examination of the dolphin remains indicated that they were regurgitated by the shark, perhaps following its collision with the platform (L. Alberotanza, *pers. comm.*; Luigi Cavaleri, *pers. comm.*; Beltrame, 1983; Albertarelli, 1990). In Fergusson (1996) this incident is erroneously dated and located as happening in July 1977 in the Venice Lagoon. Possibly the same specimen was sighted a few days later, near Caorle (L. Alberotanza, *pers. comm.).*

Late in September 1986, between Rimini and Pesaro, several sightings of a large great white shark occurred (Gilioli, 1989; Giudici & Fino, 1989; Marini, 1989; Martelli, 1989; Fergusson, 1996). This specimen was described as being about 6 m long, but some estimates ranged as much as 8-9 m. It may also be the same individual that had attacked the fishermen's boat and - possibly the same incident - snatched from the hand of a fisherman a whole crate of pilchards (Anonymous, 1986). This shark was first sighted on September 20th by the captain of the hydrofoil covering the Rimini-Yugoslavia route. On September 23rd, the shark was sighted off Rimini near the oil-platform "Antonella". On another occasion, it was seen 13 miles off Pesaro, near the oil-platform "Basil". It seems that Roberto Bartomioli photographed and Marco Benelli filmed this shark but, to my knowledge, the pictures of this animal were never reproduced. Many anglers tried to capture the shark: Gabriele Bartoletti and Stefano Dragoni, on two separate occasions, succeeded in getting the shark swallow the bait, but they could not catch it. Several eyewitnesses described the shark as having a white coloration; perhaps they mistook a pale grey for white or possibly it was an albino specimen. Dubbed "Willy" by the fishermen of Rimini, this shark was resighted and recognized (based on characteristics unknown to me) during the period from 1986 to 1989. It seems that the shark was seen near Pesaro between August and September 1986, and resighted during the same period of the following year (Cardellini, 1987; Mojetta *et al.*, 1997). In September 1989, there was a sighting, near Pesaro, of a large shark, estimated to be 5 m long and supported by photographic evidence (Fergusson, 1996). In the opinion of Notarbartolo di Sciara (1986), "Willy" was a basking shark, *Cetorhinus maximus* (Gunnerus, 1765), but this seems highly improbable, considering that the species was recognized as *C. carcharias* by many eyewitnesses. Moreover, if the reported attack on a fishing boat actually occurred, this hypothesis can be excluded.

Not far from Pesaro, in May 1988, 28 miles offshore 100° from Numana, Fausto Fioretti sighted from his boat a great white shark that he estimated to be 4.5 m long, in water 85-90 m deep. This occurred during a fishing tournament, so possibly the shark was attracted by the activity (M. Marconi, *pers. comm.*). Fioretti took some photos of this shark (Fig. 8).

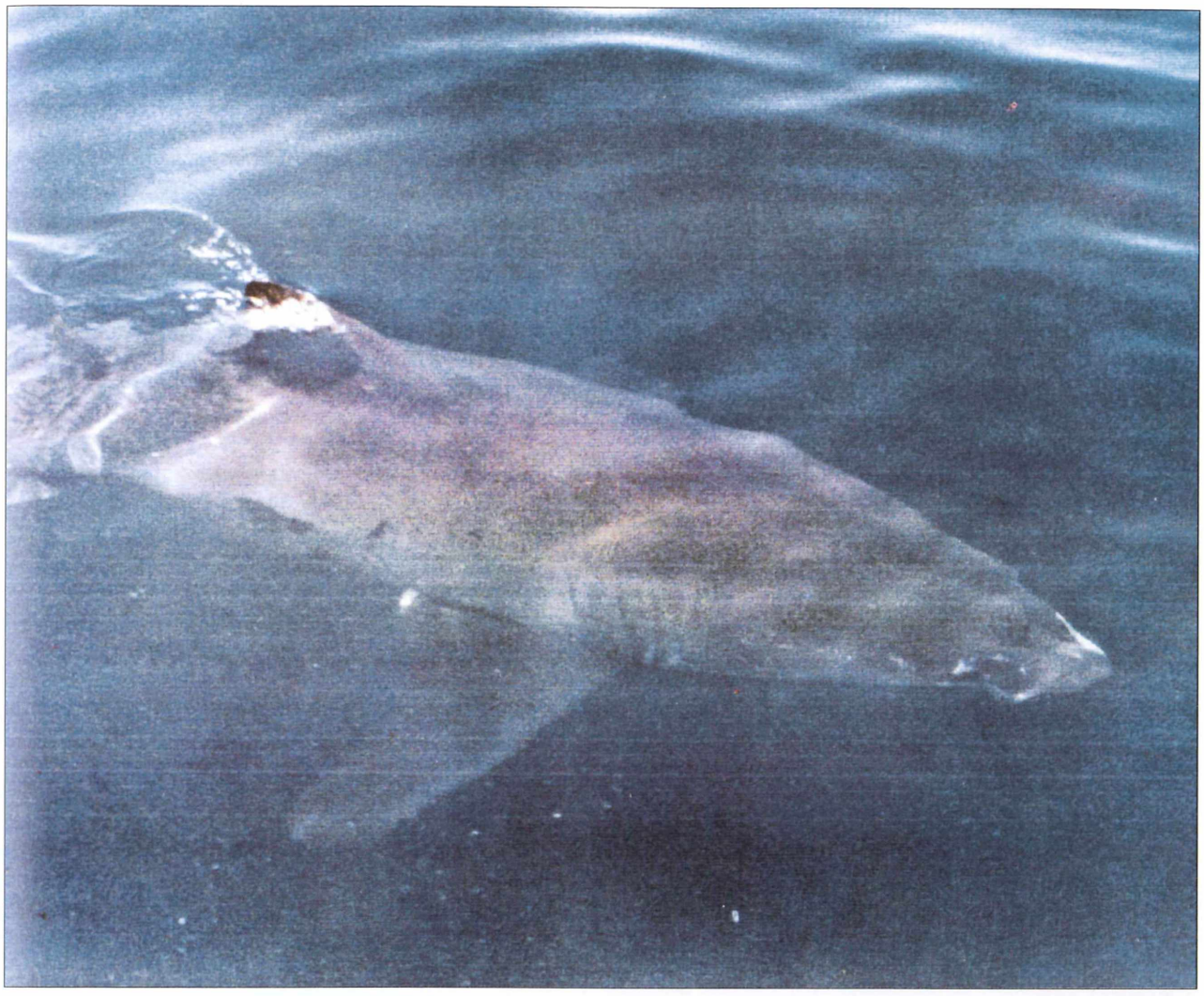

Fig. 8: Specimen sighted off the shore of Numana (Italy) in May 1988, estimated to be about 4.5 m long. (Photo: Fausto Fioretti)
Sl. 8: Primerek, dolg približno 4,5 m, opažen maja leta 1988 v bližini Numane (Italija). (Foto: Fausto Fioretti)

In 1988, there was a documented record, dated September 9, of an encounter that occurred near Porto Barricata, but it is not clear whether it was a simple sighting or an attack on a boat (A. Mojetta, *pers. comm.*; Mojetta *et al.*, 1997).

Over the years 1991-1992, captures of some young specimens were recorded, unfortunately with very few details. One specimen, captured in Ancona on December 17th 1991, was 2.1 m long (Fergusson, 1996), and 4 or 5 young specimens - of which one was a female measuring 2.3 m and weighing about 200 kg - were captured in Termoli, in Mid-March 1992 (Anonymous, 1992; Fergusson, 1996).

A very well documented case, one which Italian mass-media gave great publicity, occurred in 1998, on August 27th at 3 p.m., some 22 miles off Senigallia, in waters 72 m deep. A great white shark specimen, estimated 5-6 m long, came alongside the boat of Stefano Catalani. The angler had caught a thresher shark, *Alopias vulpinus* (Bonnaterre, 1788), which was subsequently fixed to the side of the hull. The shark circled the boat for about ten minutes, then bit the sack containing the bait and finally took a piece of the thresher shark carcass. Frightened, Catalani surrendered the carcass, but the great white shark remained close to the boat. After having filmed the shark for about half an hour, Catalani decided to leave (Imarisio, 1998; Montefiori, 1998).

Another recent well documented case involves an encounter offshore from Giulianova. It was September 1999, and the angler Elvio Mazzagufo was fishing for tunas in waters 250 m deep. A *C. carcharias*, estimated

to be 6 m long, approached the boat and started to eat one of the hooked tunas. When the tuna was hauled on to the boat, the shark bit the vessel's hull. Contrary to that reported by the press, no such attack occurred. The shark was even photographed (Fig. 9) (Graziosi, 1999).

Lastly, it must be mentioned that a sighting of a great white shark occurred on an unknown date near the mouth of the Po that is verified by photographic evidence (M. Zuffa, *pers. comm.).*

In addition to the records described above, in the interests of completeness, it is of some interest to report that in some Italian natural history museums there are additional specimens of which the capture location is unknown, but for which is easy to hypothesise that in some cases they may be from the Adriatic. Among these could be the 7 specimens preserved in the museums of Venezia, Padova, Modena, Ferrara, Reggio-Emilia, which are mostly referable to the 19th century (De Maddalena, 2000).

DISCUSSION

During the 19th century and the first half of the 20th , a population of great white shark perhaps of considerable size was present in the Eastern North Adriatic Sea in Kvarner (Croatia) and in the Gulf of Trieste (Italy), but has with the passing of time decreased significantly. Surely it must be the hunting of this species that has contributed to this decrease, although a more important factor may be an impoverishment - caused by an excessive exploitation by fisheries - of the species on which *C. carcharias* preys. Another possible factor could be the increasing pollution caused by human activities suffered by the Adriatic. In my opinion, the great white shark must be at this time considered sporadic in the Northern and Central Adriatic.

For 69 specimens (85.18% of all reliable specimens recorded), the months of encounters are indicated. Most great white shark specimens (51 or 73.91%) have been reported from May to September, with a peak in August-September (28 or 40.58%). Obviously it must be taken into account that in the summer months, due to the increasing frequentation of Adriatic coasts by humans, there are more possibilities of encounters between men and sharks. But, strangely, only 3 specimens have been recorded from the region during the month of July.

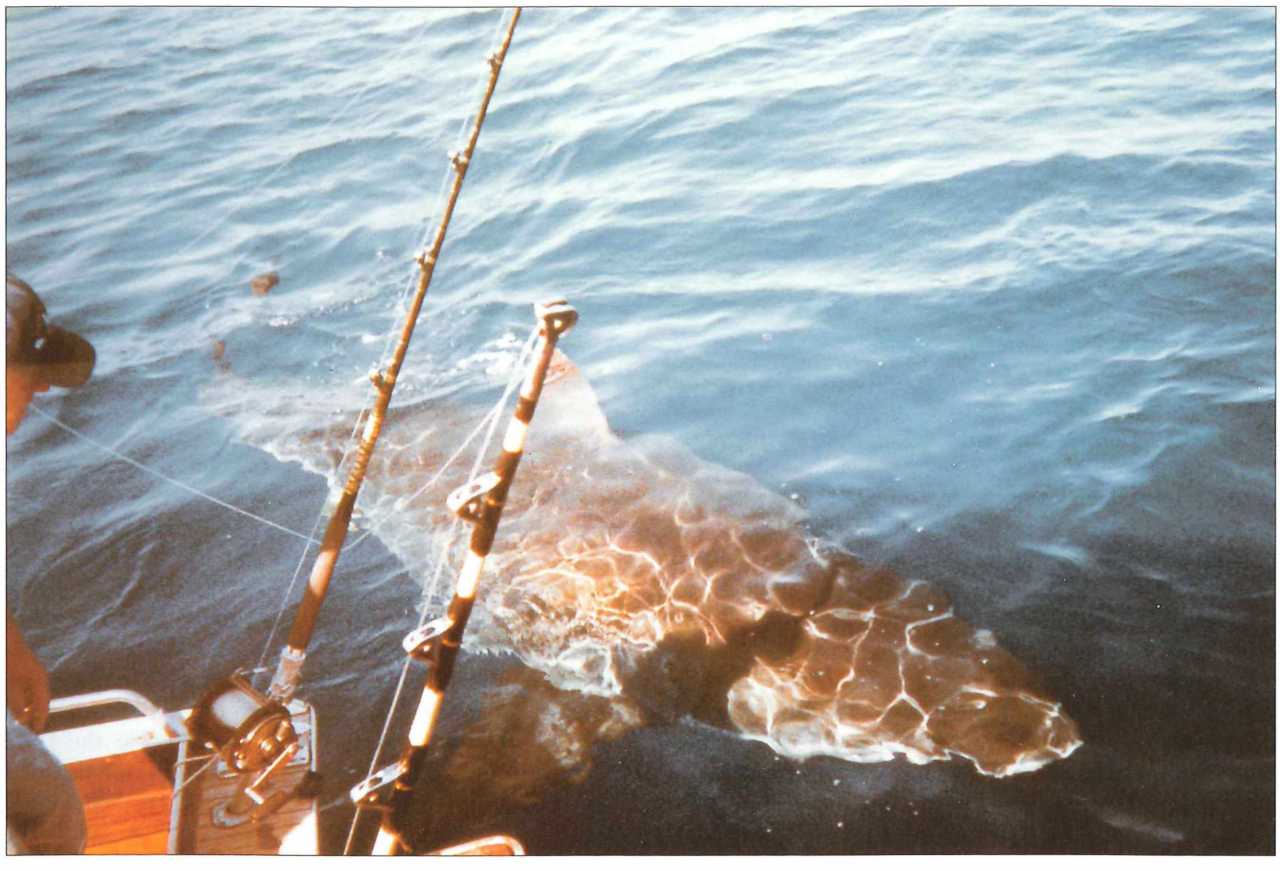

Fig. 9: Specimen sighted off the shore of Giulianova (Italy) on September 26th 1999, estimated to be about 6 m long. (Photo: Elvio Mazzagufo)
Sl. 9: Primerek, dolg kakih 6 m, opažen 26. septembra 1999 v bližini Giulianove (Italija). (Foto: Elvio Mazzagufo)

On the matter of size, there are some interesting cases of very large great white shark specimens reported from the Adriatic, particularly of the enormous 1,005 cm TL great white shark caught before 1891 in an unspecified location (Anonymous, 1891; Ellis & McCosker, 1991), and other 11 specimens 6-7 m in length. Of the latter, in some cases length was merely estimated at the time of sighting, but in others the sharks were probably even measured. Unfortunately, there is no way of verifying or refuting the reported lengths of very large sharks like these, because it is unknown how these measurements were taken. The only verified case is that of the 6.02 m specimen caught near Civitanova in 1839 (De Maddalena, 1998-1999). Moreover in Lipej (1993-1994) it was possible to examine a photo of the 6 m TL specimen caught in Izola in 1963 (Figs. 5 and 6); the shark's length can be compared to the dimensions of the humans photographed next it. There is also a photograph of the specimen, estimated to be 6 m long, sighted in September 1999 off Giulianova (Graziosi, 1999); unfortunately there are no objects visible near the shark that could be used to confirm its length (Fig. 9). There are 11 records of young specimens of great white sharks under 3 m in length, from the Adriatic. The smallest of these, caught in May 1872 off Opuzen, measured 95 cm (Brusina, 1888).

The number of cases in which great white shark stomach contents were reported, or in which the shark was observed during predation, are few. There are 2 cases of predation on dolphins (in 1 case the species was *Tursiops truncatus*; in the other, the species is not mentioned), 1 case of a specimen observed pursuing a school of tunas, and another of a shark feeding on a dead tuna (species not mentioned), 1 case of a great white shark feeding on a dead thresher, *Alopias vulpinus*, and 3 cases of sharks that had eaten inedible items (in 1 case, the kinds of objects is not mentioned, in another it was a small board of cork, and in another the items were a raincoat, 2 or 3 coats, and an automobile number-plate). In the Adriatic, the great white shark probably has the same diet as observed in the rest of the Mediterranean - and similar that noticed elsewhere in the world - being based on cetaceans, tunas, marine turtles, sharks, and swordfishes (Fergusson, 1996; De Maddalena, 1999).

Regarding the attacks on humans in the Adriatic, there are 9 reliable records (excluding 4 doubtful cases): 7 along the Croatian coast, 1 in Slovenian waters, and 1 in Italian waters. The attacks occurred against swimmers (3), divers doing underwater spearfishing (2), and a boat (1). The number of fatal attacks from the Adriatic is 6, of which none was reported as provoked. All attacks occurred in the 20th century, the most recent of which is dated 1974.

CONCLUSIONS

It is very important to continue collecting new and historical data on the occurrence of great white sharks in the Adriatic. This will, in time, permit filling the gaps in our knowledge of this species in general, and in the Adriatic in particular.

Everyone who wishes to communicate to the author records of great white sharks not represented in this work, from Adriatic and, more generally, from the Mediterranean Sea, can contact him at the address listed in the byline of this work. Whenever possible, please report the following: date, time, location of the encounter, depth of the sea, distance from the coast, weather, activity of observer at the time of the encounter, total length (in a straight line from the tip of the snout to the tip of the upper lobe of caudal fin), mass, sex, stomach contents and behaviour of the specimen, presence of other species in the immediate area, comments, photographs, names of all eyewitnesses, your name and contact address. It is very important, if at all possible, to retain teeth, vertebrae, samples of skin, and any embryos. Please also specify whether or not you authorize the publication of your data and pictures.

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ZGODOVINSKA IN NEDAVNA POJAVLJANJA BELEGA MORSKEGA VOLKA *CARCHARODON CARCHARIAS* (LINNÉ, 1758) V SEVERNEM IN SREDNJEM JADRANU

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POVZETEK

V 19. stoletju in v prvi polovici 20. stoletja se je v Kvarnerju (Hrvaška) in Tržaškem zalivu pojavljala populacija belih morskih volkov precejšnje velikosti, ki pa se je sčasoma občutno zmanjšala. Ta upad lahko brez dvoma pripišemo lovu na to vrsto, še bolj pa ribiški industriji in njenemu pretiranemu izkoriščanju vrst, s katerimi se beli morski volk hrani. Nadaljnji možni dejavnik bi lahko bilo naraščajoče onesnaževanje zaradi vseh mogočih človekovih dejavnosti na Jadranu. Sicer pa avtor članka meni, da je treba na belega morskega volka gledati kot na sporadično vrsto v severnem in srednjem Jadranu.

Za 69 osebkov (85,18% vseh zanesljivo opaženih) so podani meseci, v katerih so bili zabeleženi. Največ (51 ali 73,91%) jih je bilo opaženih med majem in septembrom, z vrhuncem v avgustu in septembru (28 ali 40,58%). Seveda pa je treba upoštevati dejstvo, da je v poletnih mesecih, ko je na jadranskih obalah precej več obiskovalcev kot sicer, možnosti za srečanje z morskimi psi neprimerno večje. Pa vendar so bili v mesecu juliju v tem območju zabeleženi samo trije beli morski volkovi.

O pojavljanju zelo velikih belih morskih volkov obstaja nekaj zelo zanimivih poročil, posebno o orjaškem 1005 cm dolgem osebku, ujetem pred letom 1891 na nespecificirani lokaciji (Anonymous, 1891; Ellis & McCosker, 1991), in še 11 osebkih, dolgih od 6 do 7 m. Kar zadeva slednje, je bila dolžina nekaterih izmed njih ocenjena v času, ko so bili opaženi, medtem ko so bili drugi verjetno celo izmerjeni. Žal pa ni načina, da bi preverili ali zavrnili podatke o dolžinah teh zelo velikih morskih volkov, saj ni znano, kako so bile meritve opravljene. Edini preverjeni primer je 602 cm dolgi osebek, ujet leta 1839 blizu Civitanove (De Maddalena, 1998-1999). Kar zadeva podatke L. Lipeja (1993-1994), pa si je mogoče natančno ogledati fotografijo 6-metrskega osebka, ujetega leta 1963 v Izoli (Sl. 5 in 6); dolžino tega volka lahko namreč primerjamo z dimenzijo ljudi, fotografiranih ob njem. Obstaja tudi fotografija osebka, opaženega oktobra 1999 v bližini Giulianove (Graziosi, 1999); dolg naj bi bil 6 m, vendar pa v bližini tega volka niso vidni nobeni predmeti, ki bi jih lahko uporabili za potrditev njegove dolžine (Sl. 9). Iz Jadrana obstaja 5 zapisov o mladih osebkih, krajših od 3 metrov; najmanjši med njimi, ujet maja 1872 blizu Opuzna, je meril 95 cm (Brusina, 1888).

Število primerov, v katerih so poročali o vsebini volčjih želodcev ali pa je bil volk opazovan med plenjenjem, so zelo redki. Obstajata 2 primera, ko sta morska volka uplenila delfina (v enem primeru veliko pliskavko, v drugem pa vrsta ni omenjena), potem imamo 1 primer, ko je morski volk zasledoval jato tun, 1 primer, ko se je osebek hranil z mrtvo tuno (vrsta tune ni omenjena), 1 primer, ko se je beli morski volk hranil z morsko lisico Alopias vulpinus, *in 3 primere, ko so morski volkovi trgali neužitne predmete (v 1 primeru predmet ni omenjen, v drugem je šlo za plutovinasto tablo, v tretjem pa za dežni plašč, dva ali 3 zimske plašče in avtomobilsko registrsko tablico). V Jadranu se veliki morski volk najbrž prehranjuje bolj ali manj enako kot njegovi vrstniki drugod v Sredozemlju - in tudi drugod po svetu - in sicer predvsem s kiti, tunami, morskimi želvami, morskimi psi in mečaricami (Fergusson, 1996; De Maddalena, 1999; De Maddalena, 2000).*

Kar zadeva napade na ljudi v Jadranskem morju, imamo 9 zanesljivih poročil (neupoštevaje 4 dvomljive primere): 7 iz hrvaškega obalnega morja, 1 iz slovenskega in 1 iz italijanskega. V 3 primerih so beli morski volkovi napadli kopalce, v 2 podvodne ribiče in v 1 primeru čoln z ljudmi. Šest napadov v Jadranskem morju je bilo pogubnih, pa čeprav poročila govorijo, da ti niso bili izzvani. Vsi so se zgodili v 20. stoletju, zadnji leta 1974.

Ključne besede: beli morski volk, *Carcharodon carcharias*, Jadransko morje

REFERENCES

Albertarelli, M. (1990): Spaventatevi ma con calma. Natura Oggi, 8, Agosto 1990. Milano, De Agostini-Rizzoli Periodici, 30-41.

Anonymous (1891): Great white shark in the Mediterranean. Mediterranean Naturalist, 1(4). 76.

Anonymous (1908): Fanciulla straziata da un pescecane. La Domenica del Corriere, 2 Agosto. Milano, Corriere della Sera.

Anonymous (1961): Uno squalo ha divorato un giovane studente che faceva il bagno ad Abbazia (Opatija). Il Piccolo, 26 Novembre. Trieste.

Anonymous (1986): Strappa le sardine dalle mani dei pescatori Willy, Squalo bianco gigante in Adriatico. Corriere della Sera, 22 Settembre. Milano, RCS.

Anonymous (1992): Raro Squalo bianco pescato in Adriatico. Corriere della Sera, 19 Marzo. Milano, RCS.

Arrassich, F. (1994): Trieste in cento cartoline. Roma, Edizioni La Cartolina.

Beltrame, M. (1983): Lo squalo in casa nostra. Natura Oggi 3, Luglio 1983. Milano, De Agostini-Rizzoli Periodici, 52-61.

Bini, G. (1967): Atlante dei Pesci delle coste Italiane - vol. 1 - Leptocardi, Ciclostomi, Selaci. Roma, Mondo Sommerso.

Bonaparte, C. (1839): Iconografia della Fauna Italica per le quattro Classi degli Animali Vertebrati - Tomo III. Pesci. Roma, Tipografia Salviucci.

Brusina, S. (1888): Morski psi Sredozemnoga i Crljenog mora. Glasnik hrvatskoga naravoslovnoga družtva. Zagreb. pp. 167-230.

Canestrini, G. (1874): Fauna d'Italia - Parte Terza - Pesci. Milano, Vallardi.

Cardellini, S. (1987): Si è rifatto vivo Willy lo squalo bianco della riviera. Resto del Carlino, 25 Agosto.

Carus, J. V. (1893): Prodromus faunae mediterraneae II. Plagiostomi - Selachoidei. Stuttgart.

Condorelli, M. & G. G. Perrando (1909): Notizie sul *Carcharodon carcharias* L., catturato nelle acque di Augusta e considerazioni medico-legali sui resti umani trovati nel tubo digerente. Bollettino della Società Zoologica Italiana, 1909. Roma, Società Zoologica Italiana, 164-183.

De Maddalena, A. (1998 -1999): Il più grande esemplare Italiano di squalo bianco, *Carcharodon carcharias* (Linnaeus, 1758) individuato nei reperti conservati presso il Museo di Anatomia Comparata dell'Università "La Sapienza" di Roma. Museologia Scientifica, 15(2). Firenze, Associazione Nazionale Musei Scientifici, 195-198.

De Maddalena, A. (1999): Records of the Great White Shark in the Mediterranean Sea. Milano, private publication.

De Maddalena, A. (2000): Reperti di Squalo Bianco, *Carcharodon carcharias* (Linnaeus, 1758), conservati nei Musei Italiani. Annali del Museo Civico di Storia Naturale "G. Doria". Genova, Museo di Storia Naturale "G. Doria". In press.

De Sabata, E., Meloni, M., Miliani, M. & S. Nava (1999): Bianchi di casa nostra. Pesca in Mare, 3. Firenze, EDAI, 92-99.

Doderlein, P. (1881): Manuale Ittiologico del Mediterraneo. Parti 1-2. Palermo.

Ellis, R. (1983): The book of Sharks. London, Robert Hale.

Ellis, R. & J. E. McCosker (1991): Great White Shark. Stanford, Stanford University Press.

Faber, G. L. (1883): Fisheries of the Adriatic and the Fish of thereof. London, Bernard Quaritch.

Fergusson, I. K. (1996): Distribution and Autecology of the White Shark in the Eastern North Atlantic Ocean and the Mediterranean Sea. In Klimley, A. P. & Ainley, D. G. (eds.): Great White Sharks: The Biology of *Carcharodon carcharias*. San Diego, Academic Press, 321-345.

Gianturco, C. (1978): Lo Squalo. Torino, Società Editrice Internazionale.

Gilioli, S. (1989): Caccia al killer. Sette, 7. Milano, RCS, 50-61.

Giudici, A. & F. Fino (1989): Squali del Mediterraneo. Roma, Atlantis.

Graeffe, E. (1886): *Carcharodon rondeleti*, in Uebersicht der Seethierfauna des Golfes von Triest, etc. Arb. Zool. Inst. Univ. Wien, Zool. St. Trieste, 7. 446.

Graziosi, G. (1999): Squalo bianco attacca pescherecccio. *Corriere della Sera*, 27 Settembre. Milano, RCS, 19.

Imarisio, M. (1998): Non date la caccia allo squalo. Corriere della Sera, 30 Agosto. Milano, RCS, 16.

Lawley, R. (1881): Studi comparativi sui Pesci fossili coi viventi dei Generi *Carcharodon*, *Oxyrhina* e *Galeocerdo*. Pisa, Nistri.

Lineaweaver III, T. H. & R. H. Backus (1969): The Natural History of Sharks. London, André Deutsch Ltd.

Lipej, L. (1993-1994): Še o izolskem belem morskem volku. Proteus, 56. 208-209.

Marchesetti, C. (1884): La pesca lungo le coste Orientali dell'Adria. Atti del Museo Civico di Storia Naturale di Trieste, 1884. Trieste, Museo Civico di Storia Naturale di Trieste.

Marini, F. (1989): Pochi secondi lunghi un'eternità. Pesca in mare, 4. Firenze, EDAI, 78-79.

Martelli, F. (1989): Caccia alla morte bianca. Pesca in mare, 4. Firenze, EDAI, 80-83.

Metaxà, L. (1839): Smisurato pesce del peso di 4000 libre. Annali della Società Medico-Chirurgica Metaxà, 1839. Società Medico-Chirurgica Metaxà, 35-38.

ZGODOVINSKA IN NEDAVNA POJAVLJANJA BELEGA MORSKEGA VOLKA *CARCHARODON CARCHARIAS* (LINNÉ, 1758) V SEVERNEM IN SREDNJEM JADRANU

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POVZETEK

V 19. stoletju in v prvi polovici 20. stoletja se je v Kvarnerju (Hrvaška) in Tržaškem zalivu pojavljala populacija belih morskih volkov precejšnje velikosti, ki pa se je sčasoma občutno zmanjšala. Ta upad lahko brez dvoma pripišemo lovu na to vrsto, še bolj pa ribiški industriji in njenemu pretiranemu izkoriščanju vrst, s katerimi se beli morski volk hrani. Nadaljnji možni dejavnik bi lahko bilo naraščajoče onesnaževanje zaradi vseh mogočih človekovih dejavnosti na Jadranu. Sicer pa avtor članka meni, da je treba na belega morskega volka gledati kot na sporadično vrsto v severnem in srednjem Jadranu.

Za 69 osebkov (85,18% vseh zanesljivo opaženih) so podani meseci, v katerih so bili zabeleženi. Največ (51 ali 73,91%) jih je bilo opaženih med majem in septembrom, z vrhuncem v avgustu in septembru (28 ali 40,58%). Seveda pa je treba upoštevati dejstvo, da je v poletnih mesecih, ko je na jadranskih obalah precej več obiskovalcev kot sicer, možnosti za srečanje z morskimi psi neprimerno večje. Pa vendar so bili v mesecu juliju v tem območju zabeleženi samo trije beli morski volkovi.

O pojavljanju zelo velikih belih morskih volkov obstaja nekaj zelo zanimivih poročil, posebno o orjaškem 1005 cm dolgem osebku, ujetem pred letom 1891 na nespecificirani lokaciji (Anonymous, 1891; Ellis & McCosker, 1991), in še 11 osebkih, dolgih od 6 do 7 m. Kar zadeva slednje, je bila dolžina nekaterih izmed njih ocenjena v času, ko so bili opaženi, medtem ko so bili drugi verjetno celo izmerjeni. Žal pa ni načina, da bi preverili ali zavrnili podatke o dolžinah teh zelo velikih morskih volkov, saj ni znano, kako so bile meritve opravljene. Edini preverjeni primer je 602 cm dolgi osebek, ujet leta 1839 blizu Civitanove (De Maddalena, 1998-1999). Kar zadeva podatke L. Lipeja (1993-1994), pa si je mogoče natančno ogledati fotografijo 6-metrskega osebka, ujetega leta 1963 v Izoli (Sl. 5 in 6); dolžino tega volka lahko namreč primerjamo z dimenzijo ljudi, fotografiranih ob njem. Obstaja tudi fotografija osebka, opaženega oktobra 1999 v bližini Giulianove (Graziosi, 1999); dolg naj bi bil 6 m, vendar pa v bližini tega volka niso vidni nobeni predmeti, ki bi jih lahko uporabili za potrditev njegove dolžine (Sl. 9). Iz Jadrana obstaja 5 zapisov o mladih osebkih, krajših od 3 metrov; najmanjši med njimi, ujet maja 1872 blizu Opuzna, je meril 95 cm (Brusina, 1888).

Število primerov, v katerih so poročali o vsebini volčjih želodcev ali pa je bil volk opazovan med plenjenjem, so zelo redki. Obstajata 2 primera, ko sta morska volka uplenila delfina (v enem primeru veliko pliskavko, v drugem pa vrsta ni omenjena), potem imamo 1 primer, ko je morski volk zasledoval jato tun, 1 primer, ko se je osebek hranil z mrtvo tuno (vrsta tune ni omenjena), 1 primer, ko se je beli morski volk hranil z morsko lisico Alopias vulpinus, *in 3 primere, ko so morski volkovi trgali neužitne predmete (v 1 primeru predmet ni omenjen, v drugem je šlo za plutovinasto tablo, v tretjem pa za dežni plašč, dva ali 3 zimske plašče in avtomobilsko registrsko tablico). V Jadranu se veliki morski volk najbrž prehranjuje bolj ali manj enako kot njegovi vrstniki drugod v Sredozemlju - in tudi drugod po svetu - in sicer predvsem s kiti, tunami, morskimi želvami, morskimi psi in mečaricami (Fergusson, 1996; De Maddalena, 1999; De Maddalena, 2000).*

Kar zadeva napade na ljudi v Jadranskem morju, imamo 9 zanesljivih poročil (neupoštevaje 4 dvomljive primere): 7 iz hrvaškega obalnega morja, 1 iz slovenskega in 1 iz italijanskega. V 3 primerih so beli morski volkovi napadli kopalce, v 2 podvodne ribiče in v 1 primeru čoln z ljudmi. Šest napadov v Jadranskem morju je bilo pogubnih, pa čeprav poročila govorijo, da ti niso bili izzvani. Vsi so se zgodili v 20. stoletju, zadnji leta 1974.

Ključne besede: beli morski volk, *Carcharodon carcharias*, Jadransko morje

REFERENCES

Albertarelli, M. (1990): Spaventatevi ma con calma. Natura Oggi, 8, Agosto 1990. Milano, De Agostini-Rizzoli Periodici, 30-41.

Anonymous (1891): Great white shark in the Mediterranean. Mediterranean Naturalist, 1(4). 76.

Anonymous (1908): Fanciulla straziata da un pescecane. La Domenica del Corriere, 2 Agosto. Milano, Corriere della Sera.

Anonymous (1961): Uno squalo ha divorato un giovane studente che faceva il bagno ad Abbazia (Opatija). Il Piccolo, 26 Novembre. Trieste.

Anonymous (1986): Strappa le sardine dalle mani dei pescatori Willy, Squalo bianco gigante in Adriatico. Corriere della Sera, 22 Settembre. Milano, RCS.

Anonymous (1992): Raro Squalo bianco pescato in Adriatico. Corriere della Sera, 19 Marzo. Milano, RCS.

Arrassich, F. (1994): Trieste in cento cartoline. Roma, Edizioni La Cartolina.

Beltrame, M. (1983): Lo squalo in casa nostra. Natura Oggi 3, Luglio 1983. Milano, De Agostini-Rizzoli Periodici, 52-61.

Bini, G. (1967): Atlante dei Pesci delle coste Italiane - vol. 1 - Leptocardi, Ciclostomi, Selaci. Roma, Mondo Sommerso.

Bonaparte, C. (1839): Iconografia della Fauna Italica per le quattro Classi degli Animali Vertebrati - Tomo III. Pesci. Roma, Tipografia Salviucci.

Brusina, S. (1888): Morski psi Sredozemnoga i Crljenog mora. Glasnik hrvatskoga naravoslovnoga družtva. Zagreb. pp. 167-230.

Canestrini, G. (1874): Fauna d'Italia - Parte Terza - Pesci. Milano, Vallardi.

Cardellini, S. (1987): Si è rifatto vivo Willy lo squalo bianco della riviera. Resto del Carlino, 25 Agosto.

Carus, J. V. (1893): Prodromus faunae mediterraneae II. Plagiostomi - Selachoidei. Stuttgart.

Condorelli, M. & G. G. Perrando (1909): Notizie sul *Carcharodon carcharias* L., catturato nelle acque di Augusta e considerazioni medico-legali sui resti umani trovati nel tubo digerente. Bollettino della Società Zoologica Italiana, 1909. Roma, Società Zoologica Italiana, 164-183.

De Maddalena, A. (1998 -1999): Il più grande esemplare Italiano di squalo bianco, *Carcharodon carcharias* (Linnaeus, 1758) individuato nei reperti conservati presso il Museo di Anatomia Comparata dell'Università "La Sapienza" di Roma. Museologia Scientifica, 15(2). Firenze, Associazione Nazionale Musei Scientifici, 195-198.

De Maddalena, A. (1999): Records of the Great White Shark in the Mediterranean Sea. Milano, private publication.

De Maddalena, A. (2000): Reperti di Squalo Bianco, *Carcharodon carcharias* (Linnaeus, 1758), conservati nei Musei Italiani. Annali del Museo Civico di Storia Naturale "G. Doria". Genova, Museo di Storia Naturale "G. Doria". In press.

De Sabata, E., Meloni, M., Miliani, M. & S. Nava (1999): Bianchi di casa nostra. Pesca in Mare, 3. Firenze, EDAI, 92-99.

Doderlein, P. (1881): Manuale Ittiologico del Mediterraneo. Parti 1-2. Palermo.

Ellis, R. (1983): The book of Sharks. London, Robert Hale.

Ellis, R. & J. E. McCosker (1991): Great White Shark. Stanford, Stanford University Press.

Faber, G. L. (1883): Fisheries of the Adriatic and the Fish of thereof. London, Bernard Quaritch.

Fergusson, I. K. (1996): Distribution and Autecology of the White Shark in the Eastern North Atlantic Ocean and the Mediterranean Sea. In Klimley, A. P. & Ainley, D. G. (eds.): Great White Sharks: The Biology of *Carcharodon carcharias*. San Diego, Academic Press, 321-345.

Gianturco, C. (1978): Lo Squalo. Torino, Società Editrice Internazionale.

Gilioli, S. (1989): Caccia al killer. Sette, 7. Milano, RCS, 50-61.

Giudici, A. & F. Fino (1989): Squali del Mediterraneo. Roma, Atlantis.

Graeffe, E. (1886): *Carcharodon rondeleti*, in Uebersicht der Seethierfauna des Golfes von Triest, etc. Arb. Zool. Inst. Univ. Wien, Zool. St. Trieste, 7. 446.

Graziosi, G. (1999): Squalo bianco attacca pescherecccio. *Corriere della Sera*, 27 Settembre. Milano, RCS, 19.

Imarisio, M. (1998): Non date la caccia allo squalo. Corriere della Sera, 30 Agosto. Milano, RCS, 16.

Lawley, R. (1881): Studi comparativi sui Pesci fossili coi viventi dei Generi *Carcharodon*, *Oxyrhina* e *Galeocerdo*. Pisa, Nistri.

Lineaweaver III, T. H. & R. H. Backus (1969): The Natural History of Sharks. London, André Deutsch Ltd.

Lipej, L. (1993-1994): Še o izolskem belem morskem volku. Proteus, 56. 208-209.

Marchesetti, C. (1884): La pesca lungo le coste Orientali dell'Adria. Atti del Museo Civico di Storia Naturale di Trieste, 1884. Trieste, Museo Civico di Storia Naturale di Trieste.

Marini, F. (1989): Pochi secondi lunghi un'eternità. Pesca in mare, 4. Firenze, EDAI, 78-79.

Martelli, F. (1989): Caccia alla morte bianca. Pesca in mare, 4. Firenze, EDAI, 80-83.

Metaxà, L. (1839): Smisurato pesce del peso di 4000 libre. Annali della Società Medico-Chirurgica Metaxà, 1839. Società Medico-Chirurgica Metaxà, 35-38.

Mizzan, L. (1994): I Leptocardi, Ciclostomi e Selaci delle collezioni del Museo Civico di Storia Naturale di Venezia - 1) Leptocardia, Agnatha, Gnathostomata - Chondrichthyes (esclusi Rajiformes). Bollettino del Museo Civico di Storia Naturale di Venezia, 45. Venezia, Museo Civico di Storia Naturale "Fontego dei Turchi", 123-137.

Mojetta, A., Storai, T. & M. Zuffa (1997): Segnalazioni di squalo bianco (*Carcharodon carcharias*) in acque italiane. Quaderni della Civica Stazione Idrobiologica di Milano, 22. Milano, Civica Stazione Idrobiologica, 23-38.

Montefiori, S. (1998): Squalo all'attacco, paura nelle Marche. Corriere della Sera, 29 Agosto. Milano, RCS, 14.

Ninni, E. (1912): Catalogo dei Pesci del Mare Adriatico. Venezia, Bertotti.

Notarbartolo di Sciara, G. (1986): Sullo Squalo bianco al largo della costa marchigiana. Aqua, 8. Milano, Edizioni del Cormorano, 6.

Perugia, A. (1881): Elenco dei Pesci dell'Adriatico. Milano, Hoepli.

Tortonese, E. (1956): Fauna d'Italia vol. II - Leptocardia, Ciclostomata, Selachii. Bologna, Calderini.

Vinciguerra, D. (1885-1892): Guida del Museo di Zoologia della R. Università di Roma - Fauna locale - Specie animali della provincia di Roma esistenti nella nuova collezione. Parte III - Pesci. Roma, Istituto di Zoologia della Reale Università di Roma.

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OCCURRENCE OF BLUEFISH, *POMATOMUS SALTATOR* (LINNAEUS, 1766), AND BUTTERFISH, *STROMATEUS FIATOLA* (LINNAEUS, 1758), JUVENILES IN THE EASTERN CENTRAL ADRIATIC

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ABSTRACT

The bluefish, Pomatomus saltator, *and butterfish,* Stromateus fiatola, *juveniles were caught near Cape Čiovo (island of Čiovo, eastern central Adriatic) and near Stončica station (island of Vis, eastern central Adriatic) in September 1999, respectively. There are no previous records of the bluefish and butterfish juveniles in the eastern Adriatic, although several studies and investigations on fish juvenile stages were carried out between 1975 and 1998 in the eastern Adriatic. The main morphometric and meristic data are given.*

Key words: *Pomatomus saltator, Stromateus fiatola,* juveniles, eastern Adriatic, first occurrence

RITROVAMENTO DI STADI GIOVANILI DI PESCE SERRA, *POMATOMUS SALTATOR,* (LINNAEUS, 1766) E DI FIETO, *STROMATEUS FIATOLA* (LINNAEUS, 1758), NELL'ADRIATICO CENTRO-ORIENTALE

SINTESI

Stadi giovanili di pesce serra, Pomatomus saltator, *e di fieto,* Stromateus fiatola, *sono stati catturati nelle vicinanze di capo Čiovo (isola di Čiovo, Adriatico centro-orientale) e della stazione di Stončica (isola di Vis, Adriatico centro-orientale) a settembre del 1999. Sebbene tra il 1975 ed il 1998 siano stati condotti numerosi studi sugli stadi giovanili di pesci nell'Adriatico orientale, non risulta alcuna segnalazione precedente del ritrovamento di stadi giovanili di pesce serra e di fieto nell'Adriatico orientale. Nell'articolo vengono riportati i dati morfometrici e meristici.*

Parole chiave: *Pomatomus saltator, Stromateus fiatola,* stadi giovanili, Adriatico orientale, primo ritrovamento

INTRODUCTION

The bluefish, *Pomatomus saltator* (Linnaeus, 1766), is a pelagic species living in shoals (chiefly when young) along the continental shelf from 0 to 200 m. It is common in the eastern Atlantic from Portugal, Madeira, the Canaries, southward along African coasts to South Africa, also in the Mediterranean and the Black Sea (elsewhere, subcosmopolitan in tropical and subtropical seas) (Tortonese, 1986). This species is fairly rare in the Adriatic Sea (Jardas, 1996).

The butterfish, *Stromateus fiatola* Linnaeus, 1758, occurs near the bottom over continental shelves from 12 to 50 m in depth. It occurs at the Atlantic coasts from the Bay of Biscay (rare) southward to Cape Town, and in the Mediterranean (not Adriatic) (Haedrich, 1986). Jardas (1996) reported about its presence in the Adriatic Sea (fairly rare).

There is no published information on biology and ecology of both species in the Adriatic. The aim of this paper is to provide first data on the occurrence of juveniles of the bluefish and butterfish in the eastern Adriatic and their morphometric and meristic characteristics.

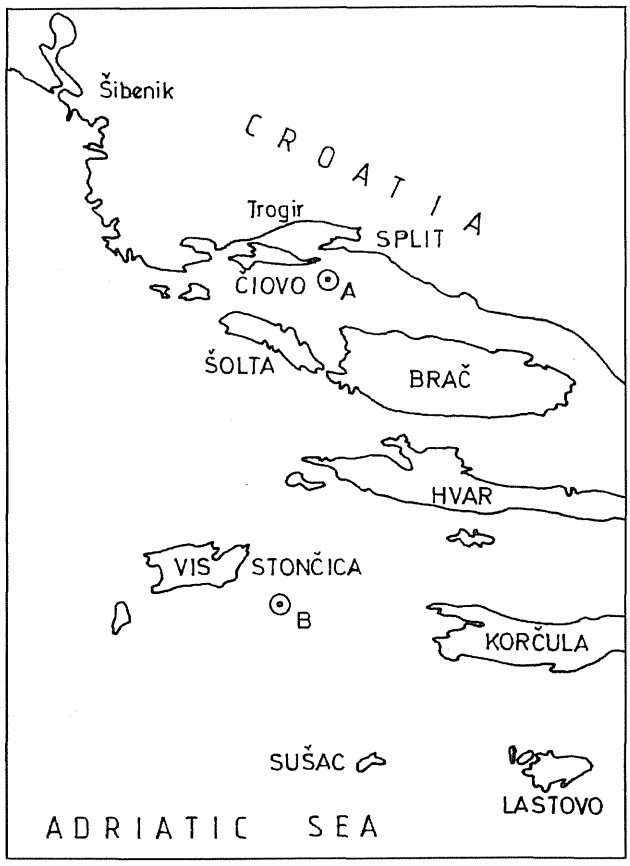

Fig. 1: Sites where juveniles of** Pomatomus saltator **and** Stromateus fiatola **were found (A - Cape Čiovo, island of Čiovo; B - Cape Stončica, island of Vis).
Sl. 1: Lokacije, na katerih so bile ujete mladice** Pomatomus saltator **in** Stromateus fiatola **(A - rt Čiovo, otok Čiovo; B - rt Stončica, otok Vis).

MATERIAL AND METHODS

The bluefish juvenile was caught (29.09.1998) near Cape Čiovo (island of Čiovo, eastern central Adriatic) at the depth between 15 and 20 m on sandy-muddy bottom covered by *Posidonia oceanica* (Fig. 1). The butterfish juvenile was caught by bottom trammel set (23.09.1998) near Stončica station (island of Vis, eastern central Adriatic) at the depth of 20 m on rocky-sandy-muddy bottom (Fig. 1).

The specimens were identified according to Šoljan (1975). They are deposited in the Ichthyological Collection of the Institute of Oceanography and Fisheries in Split, Croatia.

The specimens were preserved in 4% buffered formaldehyde immediately after capture, subsequently measured to the nearest 0.01 mm, and weighed to the nearest 0.01 g. Reduction in length caused by preservation depends on initial lengths of the specimens and duration of storage. Meristic characteristics considered were dorsal, anal, pectoral, ventral, caudal fins, and number of scales in the longitudinal line and dentes.

RESULTS AND DISCUSSION

Juveniles of the bluefish have elongate compressed body and large head (Fig. 2). Mouth terminal, lower jaw is slightly prominent. Pectoral fin is short, not reaching to origin of soft dorsal fin. Colour is silvery, greenish-grey on back and there is a longer black spot at the base of pectoral fin.

Juveniles of the butterfish have deep compressed body. Eyes and mouth small, dorsal fin single and long based, longer than the similar anal fin. Anterior rays longer than those, which follow, but fins not falcate. Pectoral fins broad and wing-like, but not prolonged, while pelvic fins are absent. Colour is generally bluish on the back, with dark vertical bars, and whitish on the sides and below, overall with a silver cart.

Studies on larval and juvenile stages of fish are of particular importance to population dynamics, especially to recruitment and biological models incorporating environmental parameters (Houde, 1986; Myers & Cadigan, 1993). The bluefish and butterfish are fairly rare species in the Adriatic Sea (Jardas, 1996; Pallaoro & Jardas, 1996). Graeffe (1888) reported about the presence of both species at Trieste fish market and their occurrence together with jellyfish *Rhizostoma pulmo* L. From that time only several specimens of the bluefish have been caught until now in the eastern Adriatic, the first one near Dubrovnik in June 1887, and the second near Split (without data on date of capture) registered by J. Kolombatović (Langhoffer, 1903). Further records were made near Vranjic (Split area) on June 16 in 1938, and in Tarska Cove - Novigrad (Istra peninsula) on December 6 in 1991.

The first record of the butterfish was made near Rijeka on July 16th in 1896 (Langhoffer, 1903). Other records were in the Neretva Channel on November 20 in 1944 (Onofri, 1997), in Trpanj area (Pelješac peninsula) on February 2 in 1996 (Pallaoro & Jardas, 1996), in Dubrovnik area (without data on date of capture) (Mušin, 1989) and in Vis Channel (without data on date of capture) (Onofri, 1983).

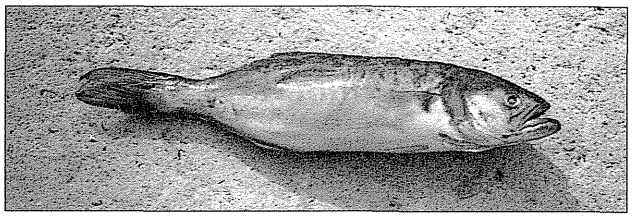

***Fig. 2: Juvenile specimen of the bluefish** Pomatomus saltator.*
***Sl. 2: Mladica skakavke** Pomatomus saltator.*

In table 1 the main morphometric and meristic data of both species are presented.

Tab. 1. Morphometric (in mm) and meristic data of the bluefish and butterfish juveniles in the eastern Adriatic.
Tab. 1. Morfometrični (v mm) in meristični podatki o mladicah skakavke in fige v vzhodnem Jadranu.

Species	*Pomatomus saltator*	*Stromateus fiatola*
Weight (W) (g)	250.3	44.30
Morphometric characters (cm)		
Total length (TL)	30.20	16.30
Standard length (SL)	25.60	12.62
Head length (C)	6.56	2.99
Predorsal length (LPD)	8.83	3.62
Preanal length (LPA)	15.14	5.31
Prepectoral length (LPP)	7.23	3.24
Preventral length (LPV)	7.86	3.42
First dorsal fin length (LD1)	3.60	7.42
Second dorsal fin length (LD2)	6.98	-
Anal fin length (A)	6.40	5.01
Pectoral fin length (LP)	4.33	2.88
Ventral fin length (LV)	2.95	0.22
Caudal fin length (LC)	6.15	3.76
Maximal body height (Tmax)	6.59	6.45
Minimal body height (Tmin)	2.08	0.97
Eye diameter (O)	1.08	0.59
Interorbital length (Io)	1.71	1.29
Preorbital length (Po)	1.66	0.85
Postorbital length (Olo)	3.97	1.65
Meristic characters		
First dorsal fin (D1)	VII	VI / 44
Second dorsal fin (D2)	25	-
Anal fin (A)	III / 24	III / 34
Pectoral fins (P)	16	23
Ventral fins (V)	I / 5 + 5 / I	3
Caudal fin (C)	III + 16 + III	IV + 16 + IV
Linea lateralis (LI)	102	-
Dentes sup.	15	-
Dentes inf.	18	-

There are no previous records of the bluefish and butterfish juveniles in the eastern Adriatic, although several studies and investigations on fish juvenile stages were carried out between 1975 and 1998 in the eastern Adriatic.

The meristic characteristics of the bluefish juveniles (Tab. 1) slightly differ from data by Tortonese (1986), *i.e.* D1 VII-VIII, D2 I+2-28, A II+23-27, while the characteristics of butterfish differ from data by Haedrich (1986), *i.e.* D 42-50, A 33-38, P 21-25.

Theses September records show that both species probably spawn in the middle Adriatic or even more to the south, especially when we take into consideration that the bluefish spawns in spring and summer (Tortonese, 1986). There are no data about reproduction of the butterfish in the Mediterranean, but this record could suggest that it is probably in the summer period, which is in agreement with the findings for Adriatic (Jardas, 1996). We suppose that both specimens are about one year old according to the spawning season. Spawning of the bluefish was limited to the warmest months, from July to September along the Catalan coast, when the surface temperature was about 25°C, suggesting an inshore spawning (Sabatés & Martin, 1993). Until quite recently, there were no reliable data on bluefish spawning in the Black Sea, but Gordina & Klimova (1996) showed that bluefish spawned throughout the Black Sea from June to September at temperatures from 20° to 26°C. Sabatés and Martin (1993) stated that the northern limit of the geographic distribution of bluefish in the Mediterranean is the Catalan coast, but the findings of bluefish specimens in the Tar Cove (Mirna estuary-northern Adriatic) could not support this statement. It should be emphasised that in 1998 the eastern Adriatic was characterised by some interesting records of thermophilic species more northerly, for example, species *Ruvettus pretiosus* (Bettoso & Dulčić, 1999) in the Gulf of Trieste. An unusual occurrence of such rarely found fish could be related to the changes in climate and/or oceanographical conditions (Quigley, 1985; Dulčić *et al.*, 1999). The penetration and occurrence of both species might be connected with some special climatological and oceanographical conditions and input of intermedian waters (50-100 m) in the central Adriatic, which influenced the increase in salinity and temperature. Pallaoro (1988) also stated that the Adriatic ingressions caused more rare species to appear in the central Adriatic region in the 1986-87 period. As quoted by Harmelin (1991), some species with southern affinities (*Seriola dumerili, Diplodus cervinus, Balistes carolinensis, Epinephelus alexandrinus*) are being found more commonly along the northwestern Mediterranean coasts. Juveniles of these species were observed at relatively high latitudes, such as Calvi and Barcelona. Changes in the physical properties of the water and natural fluctuations in space and time are perhaps responsible for the mentioned occurrences (Saldanha, 1992). The status of the bluefish and butterfish needs to be evaluated on a continuous basis because it is becoming increasingly apparent that uncommon species, and particularly those on the edge of their distribution, can be essential indicators of environmental change (Swabby & Potts, 1990).

POJAVLJANJE MLADIC SKAKAVKE *POMATOMUS SALTATOR* (LINNÉ, 1766) IN FIGE *STROMATEUS FIATOLA* (LINNÉ, 1766) V VZHODNEM SREDNJEM JADRANU

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POVZETEK

Septembra 1999 so bile v bližini rta Čiovo (otok Čiovo, vzhodni srednji Jadran) ujete mladice skakavke Pomatomus saltator, *v bližini postaje Stončice (otok Vis, vzhodni srednji Jadran) pa mladice fige* Stromateus fiatola. *Iz vzhodnega Jadrana doslej še ni bilo zapisov o pojavljanju mladic teh ribjih vrst, čeprav je bilo med letoma 1975 in 1998 v vzhodnem Jadranu opravljenih že več študij in raziskav o razvojnih stadijih mladic. Delo vsebuje tudi poglavitne morfometrične in meristične podatke.*

Ključne besede: *Pomatomus saltator, Stromateus fiatola,* mladice, vzhodni Jadran, prvo pojavljanje

REFERENCES

Bettoso, N. & J. Dulčič (1999): First record of the oilfish *Ruvettus pretiosus* (Pisces: Gempylidae) in northern Adriatic Sea. J. Mar. Biol. Ass. U.K., 79, 1145-1146.

Dulčić, J., B. Grbec & L. Lipej (1999): Information on the Adriatic ichthyofauna - effect of water warming. Acta Adriat., 40(2), 33-44.

Gordina, A. D. & T. N. Klimova (1996): On bluefish (*Pomatomus saltatrix* L.) spawning in the Black Sea. Mar. Fres. Wat. Res., 47(2), 315-318.

Graeffe, E. (1888): Übersicht der Seethierfauna des Golfes von Triest nebst Notizen uber Vorkommen, Lebensweise, Erscheinungs-und Fortpflanzungszeit de einzelnen Arten. Pisces (Fische), 1-26.

Haedrich, R. L. (1986): Stromateidae. *In:* Whitehead, P.J.P., M.-L. Bauchot, J.-C. Hureau, J. Nielsen & E. Tortonese (*eds.*): Fishes of the north-eastern Atlantic and the Mediterranen. UNESCO, Paris, 565 pp.

Harmelin, J. G. (1991): Statut du corb (*Sciaena umbra*) en Méditerranée. *In:* Boudorescque, C. F., M. Avon & V. Gravez (*eds.*): Les Especes Marines a Proteger en Méditerranée. GIS Posidonie Publ. Marseille, France, 291-227.

Houde, E. D. (1986): Potential for growth, duration of early life stages and regulation of recruitment in marine fish. Int. Count. Explor. Sea ICES CM, 1986/I, 28 pp.

Jardas, I. (1996): Jadranska ihtiofauna. Školska knjiga, Zagreb, 533 pp.

Langhoffer, A. (1903): Popis riba narodnog zooloških muzeja u Zagrebu do konca godine 1900. Glasnik hrvatskog naravoslovnog društva, XV – prva polovina. Vlasništvo i naklada društva, Oton Kučera (*ed.*)

Mušin, D. (1989): Ichthyological collection (Cyclostomata, Selachii, Osteichthyes) of the Natural History Museum of the Biological Institute, Dubrovnik. Matice srpske za prirodne nauke, 76, 137-168.

Myers, R. A. & N. G. Cadigan (1993): Density dependent juvenile mortality in marine demersal fish. Can. J. Fish. Aquat. Sci., 50, 1576-1590.

Onofri, I. (1983): Ribe (Pisces) prirodoslovnog muzeja u Splitu. Matice srpske za prirodne nauke, 64, 23-50.

Onofri, I. (1997): On rare fish species in the Adriatic Sea. *In:* Finka, B., S. Jukić, S. Kaštela, M. Maras, I. Petricioli & T. Vodopija (*eds.*): Zbornik radova znanstvenog skupa "Tisuću godina prvog spomena ribarstva u Hrvata". Razred za filološke znanosti HAZU, Zagreb, 531-541 (*in Croat.*)

Pallaoro, A. (1988): O mogućnostima pojave nekih rijetkih vrsta riba na srednjejadranskom području u vezi sa jadranskom ingresijom 1986/87 godine. Morsko ribarstvo, 3, 82-87.

Pallaoro, A. & I. Jardas (1996): Ichthyological collection of the Institute of Oceanography and Fisheries in Split (Croatia). Nat. Croat., 3, 177-219.

Quigley, D. T. G. (1985): Specimens of trigger fish *Balistes carolinensis* Gmelin, 1789 (*B. capriscus* Gmelin) from Achill Island, Co. Mayo, and a review of the Irish records. Ir. Nat. J., 21(11), 474-476.

Sabatés, A. & P. Martin (1993): Spawning and distribution of bluefish *Pomatomus saltatrix* (L.) in the northwestern Mediterranean. J. Fish. Biol., 43: 109-118.

Saldanha, L. (1992): Marine fishes, habitats and conservation. Neth. J. Zool., 42(2-3), 190-199.

Swabby, S. E. & G. W. Potts (1990): Rare British marine fishes - identification and conservation. J. Fish. Biol., 37, 133-143.

Šoljan, T. (1975): I pesci dell'Adriatico. Officine grafiche di Verona, 522 pp.

Tortonese, E. (1986): Pomatomidae. *In:* Whitehead, P. J. P., M.-L. Bauchot, J.-C. Hureau, J. Nielsen & E. Tortonese (*eds.*): Fishes of the north-eastern Atlantic and the Mediterranen. UNESCO, Paris, 812-813.

review article

UDC 574

MEIOBENTHIC HARPACTICOIDA (COPEPODA) FROM THE SOUTHERN PART OF THE GULF OF TRIESTE (NORTHERN ADRIATIC) I. LIST OF TAXA

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ABSTRACT

The article presents an integral systematic review of free - living nonparasitic meiobenthic harpacticoid copepods, arranged on the basis of the extensive material gathered during all the past investigation into this group in the area of the southern part of the Gulf of Trieste between 1970 and 2000. The emphasis is on the alphabetical and systematic survey, which includes a total of 130 species, and on morphological-taxonomic features presented with the taxonomic sketches of 62 species.

Key words: Harpacticoida, Copepoda, Gulf of Trieste, list of taxa

ARPACTICOIDI (COPEPODA: HARPACTICOIDA) MEIOBENTONICI DELLA PARTE MERIDIONALE DEL GOLFO DI TRIESTE (NORD ADRIATICO) I. ELENCO DELLE SPECIE

SINTESI

L'articolo presenta una revisione sistematica integrale di copepodi arpacticoidi meiobentonici, non-parassiti e conducenti vita libera, ottenuta grazie a un ampio numero di ricerche su questo gruppo, effettuate nella parte meridionale del Golfo di Trieste tra il 1970 ed il 2000. L'autore ha messo in evidenza sia la revisione alfabetica e sistematica, che comprende 130 specie, sia le caratteristiche morfo-tassonomiche, schematizzate per 62 specie.

Parole chiave: Harpacticoida, Copepoda, Golfo di Trieste, elenco delle specie

INTRODUCTION

The present contribution is an attempt at the very first integral systematic review of meiobenthic, non-parasitic, free-living species of harpacticoids of the southern part of the Gulf of Trieste, which predominantly belong to the territorial waters of the Republic of Slovenia. The emphasis is on the list of species and on the morphological-taxonomic characteristics of the more common species of this second most important group of meiofauna, while the biocenotic and ecological aspects of the so far made investigations in respect of the harpacticoids of this part of the Gulf are presented in a separate article (Vrišer, 2000).

The aim of this contribution is to present a refined and fairly rounded up list of species supported with the author's so far unpublished morphological-taxonomic sketches (Figs. 1-9). As such it should be a basic aid to all future investigators of harpacticoids in our as well as a wider area.

METHODS

All samplings were carried out with the gravity core (Meischner & Rumohr, 1974) with the 10 cm^2 aperture, some 5-10 cm deep into the sediment, mostly in three replicates; the meiofauna was extracted with the shaking-supernatant technique of Wieser (1960) and sieved through 0.125 mm and 0.050 mm sieves. During the determination of species and the revision of nomenclature we relied mainly on the basic taxonomic literature (Lang, 1948; Bodin, 1979) and on various taxonomic periodic sources, of which only a restricted selection is referred to in this article.

ECOLOGICAL CHARACTERISTICS OF THE AREA

All the samplings of harpacticoids carried out so far in the southern part of the Gulf of Trieste covered the entire depth range of these waters: from 1-15 m during the study of copepods of coastal profiles to the investigations of the open waters of the Gulf (19-25 m, and exceptionally 30 m depths). The coastal harpacticoids (1-15 m in the Bays of Koper, Strunjan and Piran) were studied comparatively during the summer and winter months, while the fauna of the deeper open waters was investigated only during the summer. Thermal conditions of the entire area oscillated between 9-21°C, average salinity was 37.5 PSU, oxygen content from 55 to 96% saturation and only exceptionally below 40% (at the time of hypoxic crises).

The harpacticoids dealt with during the two coastal ecological studies (Marcotte, 1974; Vrišer, 1986) were only at two of their shallowest sampling localities (in the Koper and Piran Bays at depths ranging from 1-5 m) under the strong influence of organic pollution of urban origin, while the remaining Copepoda fauna that is dealt with by this article belonged to a clean, unpolluted environment. The substrate of the investigated area is in view of its geological structure clayey silt (with 10-20% of clay), which on the coast turns into silty clays (with up to 25% of clay), while in direction of the open sea it turns into fine sand (Ogorelec *et al.*, 1991).

THE EXTENT OF RESEARCH INTO HARPACTICOIDS OF THE SOUTHERN PART OF THE GULF OF TRIESTE

The first "pathfinding" investigations in the area were carried out by Marcotte during 1971-1972 within the framework of a comparative summer-winter study of the impacts of pollution on meiofauna of the coastal belt of the Piran Bay. From the depth transects of five localities ranging between 1 and 15 m, this research brought forth 53 harpacticoid species, 10 of which were not fully determined (Marcotte, 1973, 1974; Marcotte & Coull, 1974).

Some meiofaunal samples were taken by the two Bulgarian copepodologists at 15 m near Piran in August 1971. In the published results of this study 25 species are treated (Marinov & Apostolov, 1981a, b).

On the basis of Marcotte's studies the author of this article carried out, in 1978-1979, a more extensive comparative summer-winter (February - August) ecological study of meiofauna (between 1 and 15 m) of the Piran and Strunjan Bays and in the polluted part of the Koper Bay. These investigations (Vrišer, 1982, 1983, 1986) have rendered 62 harpacticoid species, 25 of which were eventually determined by Trajan Petkovski, the Macedonian expert for this group, and the rest by the author himself, 28 of them fully and 9 only partially. Morphological sketches of this material are fully presented in this article (Figs. 1-10).

An extensive research into meiofauna of the entire area of Slovenian waters was carried out in August 1985 at 31 stations at depths ranging from 19 - 25 m (Vrišer, 1992). A survey of the entire collected material (almost 16000 harpacticoid individuals) has from this source rendered a total of 71 species. 34 of these have not been fully determined as yet.

Within the framework of research into seasonal and long-term changes in meiofauna occurring in the environment frequently affected by hypoxia, a total of 42 harpacticoid species were determined between 1992 and 1995 at the research station in the centre of the Gulf of Trieste (Vrišer, 1996, 1997), while the experiment on recolonization of artificially defaunated sediment during 1993-1995 at the experimental station off Piran (21 m) brought forth 32 harpacticoid species (Vrišer & Vukovič, 1999).

In this article, a full list of all until now registered harpacticoid species of the research area is presented for the very first time. It has been made on the basis of all studies carried out to date and covers a total of **130 species**, in 35 of which only their genus has been determined. The number of species greatly surpasses the original expectations as well as estimates by some copepodologists (*e.g.* B.M. Marcotte, B.C. Coull & M. Specchi, *pers. comm.*) about the possible species diversity of this group in our waters.

I believe that the actual number of harpacticoid species of the investigated area, *i.e.* in nature, is most probably not much greater than 150, although some of the present-day species determinations might well be refuted by future investigations.

Considering the number of species, the harpacticoid fauna of the Gulf of Trieste can be assessed as a medium diverse area, if compared with the studies of spatially much larger areas in the Mediterranean: 340 species on the entire Cote d'Azur (Chappuis, 1953), 164 in the Eastern Mediterranean, 140 along the Israeli coast, 121 in the Black Sea (Por, 1964), 250 along the Catalonian coast (Soyer, 1970), *etc.*

In spite of the exceptional abundance of specimens

from the research carried out so far, the determination of the greater part of the incompletely determined species has been rendered difficult due to the fact that only a few individuals have been found together, although quite often at more than just a single locality. In spite of a series of difficulties *(e.g.* a high share of juvenile individuals, unfavourable sex structure, injured individuals, ecological variability of taxonomic features, *etc.),* this still enabled to make a distinction among separate species, but certainly not their positive determination. Solution of such individual problems - some of the species may even be new to science - is extremely time-consuming, for a renewed search for these species demands specific repeated samplings which, however, are not necessary successful at all times. These problems thus remain a goal and the subject of the future research.

In spite of the many studies carried out in the past, the knowledge of the Adriatic harpacticoids is today still rather modest. The extent of research into this group in the Slovene waters is a considerable exception, for in the Mediterranean, too, it is very difficult to find a comparable small area, where so much harpacticoid research has been carried out to date.

LIST OF TAXA

The list includes all till now registered and identified harpacticoid species of the Slovene part of the Gulf of Trieste. For utterly practical reasons, particularly in order to make the search easier, the species are arranged in alphabetical order. Separate incompletely determined species are marked *Genus sp.* and numbered.

The letter (M) by the consecutive number before the names of genus and species indicates that the species under the same number is also presented with a sketch of the morphological-taxonomic features (see the following chapter: morphological characteristics and taxonomic features of species).

1. (M) *Acrenhydrosoma perplexum* (T. Scott, 1899)
2. (M) *Ameira parvula* (Claus, 1866)
3. *Ameira sp.*1
4. *Ameira sp.*2
5. *Amonardia similis* (Claus, 1866)
6. (M) *Amphiascoides debilis* (Giesbrecht, 1881)
7. *Amphiascoides proxima* (T. Scott, 1914)
8. (M) *Amphiascoides sp.*1
9. *Amphiascopsis thalestroides* (Sars, 1911)
10. *Amphiascopsis cinctus* (Claus, 1927)
11. (M) *Amphiascopsis sp.*1
12. *Amphiascopsis sp.*2
13. *Amphiascopsis sp.*3
14. *Amphiascus caudaespinosus* Brian, 1927
15. *Amphiascus congener* Sars, 1909
16. *Amphiascus minutus* Claus, 1863
17. (M) *Amphiascus varians* Norman & T.Scott, 1905
18. *Amphiascus sp.*1
19. (M) *Asellopsis sp.*1
20. *Bradya (Bradya) typica* Boeck, 1872
21. (M) *Bulbamphiascus imus* (Brady, 1872)
22. (M) *Bulbamphiascus inermis* (Sewell, 1940)
23. *Bulbamphiascus minutus* (Dinet, 1971)
24. *Bulbamphiascus sp.*2
25. *Brianola stebleri* (Monard, 1926)
26. (M) *Canuella furcigera* Sars, 1903
27. (M) *Canuella perplexa* T. & A. Scott, 1893
28. *Canuella* sp.1
29. (M) *Cletodes pusillus* Sars, 1920
30. (M) *Cletodes limicola* Brady, 1872
31. *Cletodes longicaudatus* Boeck, 1872
32. *Cletodes tenuipes* Brady, 1896
33. (M) *D'Arcythompsonia scotti* Gurney, 1920
34. *D'Arcythompsonia sp*1
35. *Dactylopodella flava* (Claus, 1866)
36. (M) *Dactylopodia tisboides* (Claus, 1863)
37. *Danielssenia perezi* Monard, 1935
38. (M) *Diagoniceps menaiensis* Geddes, 1968d
39. *Diarthrodes minutus* (Claus, 1863)
40. (M) *Diosaccus tenuicornis* (Claus, 1863)
41. *Diosaccus sp.*1
42. (M) *Ectinosoma normani* T. & A. Scott, 1894a
43. (M) *Ectinosoma obtusum* Sars, 1920
44. (M) *Ectinosoma dentatum* Steuer, 1940
45. *Ectinosoma melaniceps* Boeck, 1864
46. *Ectinosoma sp.*1
47. *Ectinosoma sp.*2
48. (M) *Enhydrosoma buchholtzi* (Boeck, 1872)
49. (M) *Enhydrosoma caeni* Raibaut, 1965
50. *Enhydrosoma longifurcatum* Sars, 1909
51. (M) *Enhydrosoma sordidum* Monard, 1926b
52. (M) *Enhydrosoma propinquum* (Brady, 1880)
53. *Enhydrosoma tunisensis* Monard, 1935a
54. (M) *Enhydrosomella staufferi* Monard, 1935a
55. (M) *Esola longicauda* Edwards, 1891
56. *Eurycletodes (Oligocletodes) latus* (T. Scott, 1892)
57. (M) *Eurycletodes (Oligocletodes) sp.*1
58. (M) *Euterpina acutifrons* (Dana, 1848)
59. *Halectinosoma angulifrons* (Sars, 1919)
60. *Harpacticus obscurus* T. Scott, 1895b
61. *Harpacticus tenellus* Sars, 1920
62. (M) *Harpacticus sp.*1
63. (M) *Harpacticus sp.*2
64. *Harpacticus sp.*3
65. *Harpacticus sp.*4
66. *Harpacticus sp.*5
67. *Haloschizopera bulbifera* (Sars, 1911)
68. *Haloschizopera junodi* (Monard, 1935b)
69. (M) *Haloschizopera pontarchis* Por, 1959
70. *Haloschizopera sp.*1
71. (M) *Hemimesochra nixe* Por, 1964
72. *Hemimesochra sp.*1

73. *Heterolaophonte quinquispinosa* Sewell, 1924
74. (M) *Heterolaophonte stroemi paraminuta* Noodt, 1955d
75. (M) *Heterolaophonte sp.*1
76. (M) *Heteropsyllus curticaudatus* T. Scott, 1894a
77. *Heteropsyllus sp.*1
78. (M) *Horsiella sp.*1
79. *Itunella muelleri* (Gagern, 1922)
80. *Laophonte longicaudata* Boeck, 1864
81. (M) *Laophonte sima* Gurney, 1927
82. (M) *Laophonte inornata* A. Scott, 1902
83. (M) *Laophonte cornuta* Philippi, 1840
84. *Laophonte sp.*1
85. *Laophonte sp.*2
86. *Laophonte sp.*3
87. *Laophonte sp.*4
88. (M) *Laophontopsis lamellifera* (Claus, 1863)
89. (M) *Longipedia coronata* Claus, 1863
90. *Longipedia pontica* Kritczagin, 1877
91. (M) *Mesochra sp.*1
92. *Mesopsyllus atargatis* Por, 1960
93. (M) *Microsetella norvegica* (Boeck, 1864)
94. *Nitocra divaricata* (Chappuis, 1923)
95. (M) *Nitocra fragilis* Sars, 1905b
96. (M) *Normanella mucronata* Sars, 1909
97. (M) *Paradactylopodia brevicornis* Claus, 1866
98. *Paradanielssenia kunzi* Soyer, 1970b
99. (M) *Paralaophonte congenera* var. *mediterranea* Sars, 1908c
100. *Paralaophonte brevirostris* (Claus, 1863)
101. *Paralaophonte sp.*1
102. (M) *Paramphiascella coulli* Marcotte, 1974
103. *Paramphiascella sp.*1
104. (M) *Parathalestris sp.*1
105. *Phyllopodopsyllus pauli* Crisafi, 1959
106. (M) *Phyllopodopsyllus sp.*1
107. (M) *Pontocletodes ponticus* Apostolov, 1980
108. (M) *Proameira sp.*1
109. (M) *Pseudobradya sp.*1
110. (M) *Rhynchothalestris rufocincta* (Brady, 1880a)
111. *Robertgurneya rostrata* (Gurney, 1927d)
112. *Robertgurneya ecaudata* (Monard, 1936)
113. (M) *Robertsonia knoxi* (Thompson & A. Scott, 1903)
114. *Robertsonia propinqua* (T. Scott, 1893c)
115. (M) *Stenhelia (Delavalia) normani* T. Scott, 1905b
116. (M) *Stenhelia (Delavalia) minuta* A. Scott, 1902
117. *Stenhelia (Delavalia) adriatica* Marinov & Apostolov, 1981
118. *Stenhelia (Delavalia) intermedia* Marinov & Apostolov, 1981
119. *Stenhelia (Delavalia) reflexa* Brady & Robertson, 1880a
120. *Stenhelia (Delavalia) sp.*1
121. *Stenhelia (Delavalia) sp.*2
122. (M) *Stylicletodes longicaudatus* (Brady & Robertson, 1880a)
123. (M) *Thalestris rufoviolascens* Claus, 1866
124. (M) *Tisbe lancii* Marcotte, 1974
125. *Tisbe gracilis* T. Scott, 1895b
126. *Tisbe clodiensis* Bataglia & Fava, 1968
127. *Tisbe reluctans* Volkmann-Rocco, 1968
128. (M) *Typhlamphiascus confusus* (T. Scott, 1902)
129. (M) *Typhlamphiascus sp.*1
130. *Zosime atlantica* Bodin, 1968c

SYSTEMATIC SURVEY

The survey includes 130 systematically arranged harpacticoid species from the collective list. For the spatial reasons the species are presented only with their consecutive numbers from the alphabetical list of species.

Fam. LONGIPEDIIDAE Sars, Lang
- Gen. *Longipedia* Claus, 1863 *(89, 90)*

CANUELLIDAE Lang
- *Canuella* T. & A.Scott, 1893 *(26, 27)*
- *Brianola* Monard, 1926 *(25)*

ECTINOSOMATIDAE Sars, Olofsson
- *Ectinosoma* Boeck, 1864 *(42, 43, 44, 45, 46, 47)*
- *Halectinosoma* Lang, 1948, 1965b *(59)*
- *Bradya* Boeck, 1672 *(20)*
- *Microsetella* Brady & Robertson, 1873 *(93)*
- *Pseudobradya* Sars, 1904 *(109)*

D'ARCYTHOMPSONIDAE Lang
- *D'Arcythompsonia* T. Scott *(33, 34)*
- *Horsiella* Gurney *(78)*

TACHIDIIDAE Sars, Lang
- *Euterpina* Norman, 1903 *(58)*
- *Danielssenia* Boeck, 1872 *(37)*
- *Paradanielssenia* Soyer, 1970b *(98)*

HARPACTICIDAE Sars
- *Harpacticus* Milne-Edwards, 1840 *(60, 61, 62, 63, 64, 65, 66)*

TISBIDAE Stebbing, Lang
- *Tisbe* Lilljeborg, 1853 *(124, 125, 126, 127)*
- *Zosime* Boeck, 1872 *(130)*

THALESTRIDAE Sars, Lang
- *Thalestris* Claus, 1863 *(123)*
- *Parathalestris* Brady & Robertson, 1873 *(104)*
- *Rhynchothalestris* Sars, 1905 *(110)*
- *Diarthrodes* Thomson, 1872 *(39)*
- *Dactylopodia* Lang, 1948 *(36)*
- *Paradactylopodia* Lang, 1948 *(97)*
- *Dactylopodella* Sars, 1905 *(35)*

DIOSACCIDAE Sars
- *Stenhelia* Boeck, 1864 *(115, 116, 117, 118, 119, 120, 121)*
- *Diosaccus* Boeck, 1872 *(40, 41)*
- *Robertsonia* Brady, 1880 *(113, 114)*

Amphiascus Sars, 1905 *(14, 15, 16, 17, 18)*
Amphiascopsis Gurney, 1927 *(9, 10, 11, 12, 13)*
Amonardia Lang, 1948 *(5)*
Bulbamphiascus Lang, 1948 *(21, 22, 23, 24)*
Robertgurneya Lang, 1948 *(111, 112)*
Typhlamphiascus Lang, 1948 *(128, 129)*
Amphiascoides Nicholls, 1941a, 1941b *(6, 7, 8)*
Paramphiascella Lang, 1948 *(102, 103)*
Haloschizopera Lang, 1948 *(67, 68, 69, 70)*
AMEIRIDAE Monard, Lang
Ameira Boeck, 1864 *(2, 3, 4)*
Proameira Lang, 1948 *(108)*
Nitocra Boeck, 1864 *(94, 95)*
TETRAGONICIPITIDAE Lang
Phyllopodopsyllus T. Scott, 1906 *(105, 106)*
Diagoniceps Willey, 1930 *(38)*
CANTHOCAMPTIDAE Sars, Monard, Lang
Mesochra Boeck, 1864 *(91)*
Itunella Brady, 1896 *(79)*
CLETODIDAE T. Scott
Cletodes Brady 1872 *(31, 32)*
Enhydrosoma Boeck, 1872 *(48, 49, 50, 51, 52, 53)*
Heteropsyllus T. Scott *(76, 77)*
Eurycletodes Sars, 1909 *(56, 57)*
Hemimesochra Sars, 1920 *(71, 72)*
Pontocletodes Apostolov, 1980 *(107)*
Stylicletodes Lang, 1936 *(122)*
Enhydrosomella Monard, 1935 *(54)*
Acrenhydrosoma Lang, 1948 *(1)*
Mesopsyllus Por, 1960b *(92)*
LAOPHONTIDAE T. Scott
Laophonte Philippi, 1840 *(80, 81, 82, 83, 84, 85, 86, 87)*
Heterolaophonte Lang, 1948 *(73, 74, 75)*
Paralaophonte Lang, 1948 *(99, 100, 101)*
Asellopsis Brady & Robertson, 1873 *(19)*
Esola Edwards, 1891 *(55)*
Laophontopsis Sars, 1908 *(88)*
Normanella Brady, 1880 *(96)*

MORPHOLOGICAL CHARACTERISTICS AND TAXONOMIC FEATURES OF SPECIES

Figure 1 schematically presents ventral and lateral appearance of the body of a harpacticoid copepod with diagnostic characters.

Figures 2-9 show taxonomically significant morphological details of the body and the extremities of 62 harpacticoid species from the research area, while figure 10 displays external appearance of the 12 more common species.

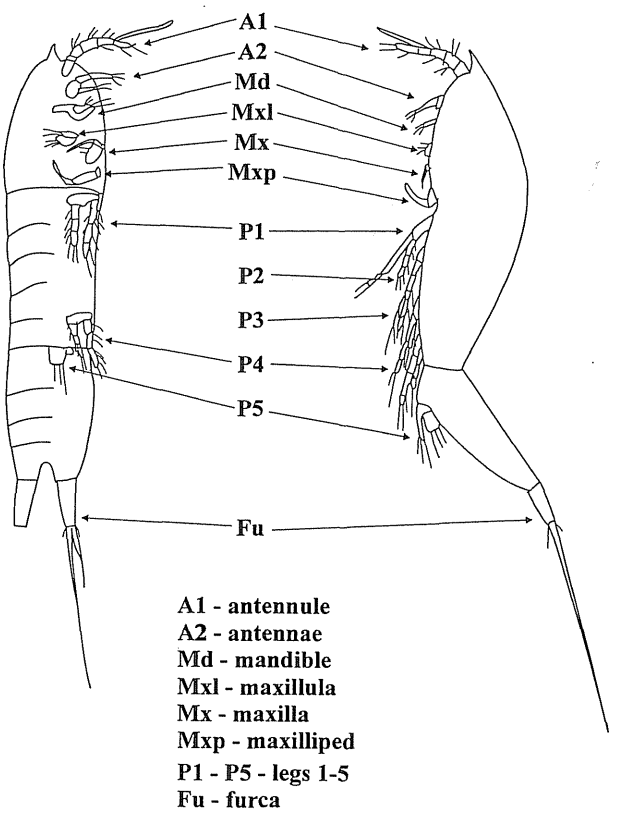


Fig. 1: Ventral and lateral views of a harpacticoid copepod with body parts (diagnostic characters) labelled.
Sl. 1: Ventralni in lateralni videz telesa harpaktikoidnega kopepoda z oznakami določevalnih znakov.

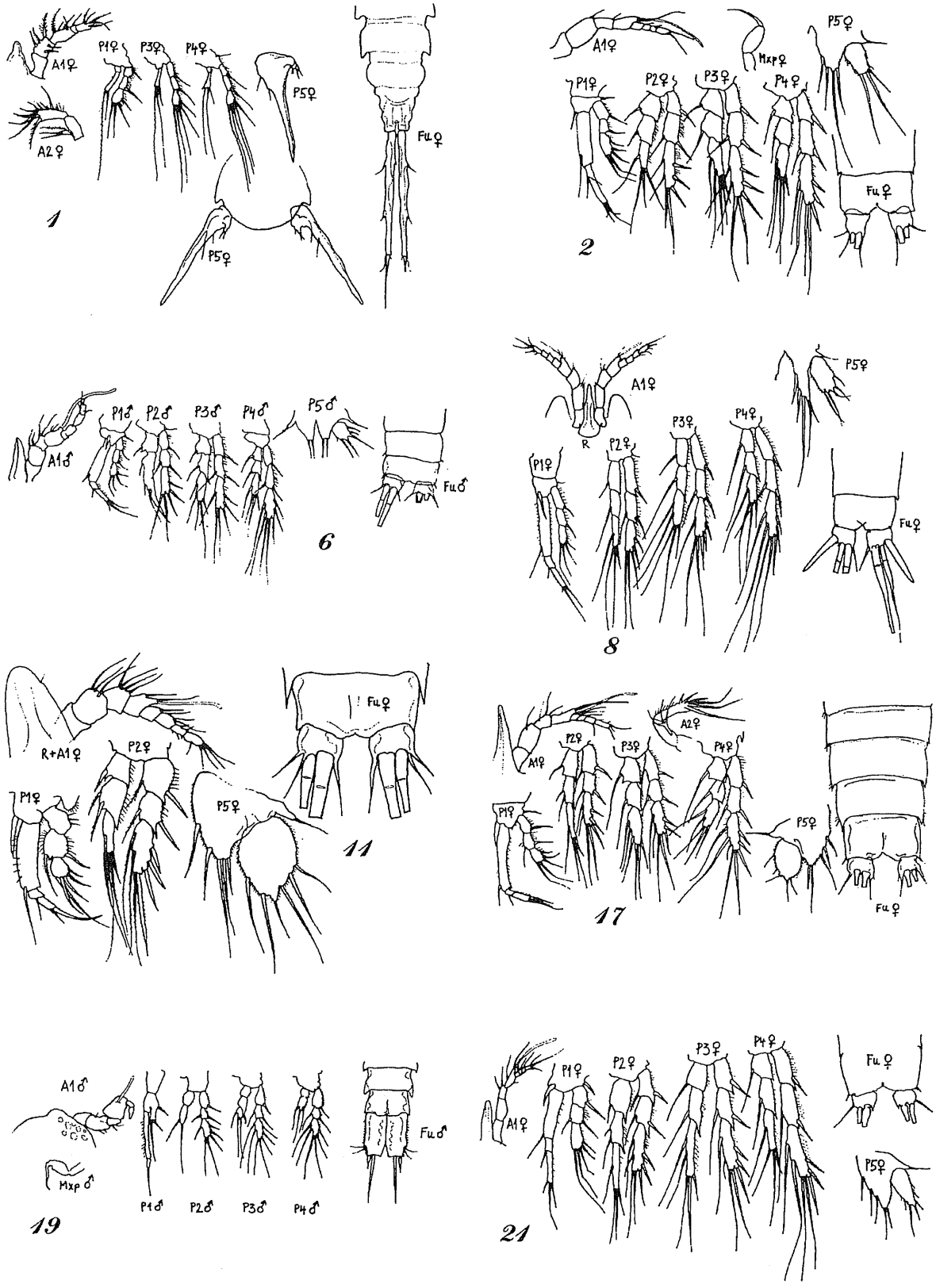


Fig./Sl. 2: 1. Acrenhydrosoma perplexum, 2. Ameira parvula, 6. Amphiascoides debilis, 8. Amphiascoides sp.1, 11. Amphiascopsis sp.1, 17. Amphiascus varians, 19. Asellopsis sp.1, 21. Bulbamphiascus imus.

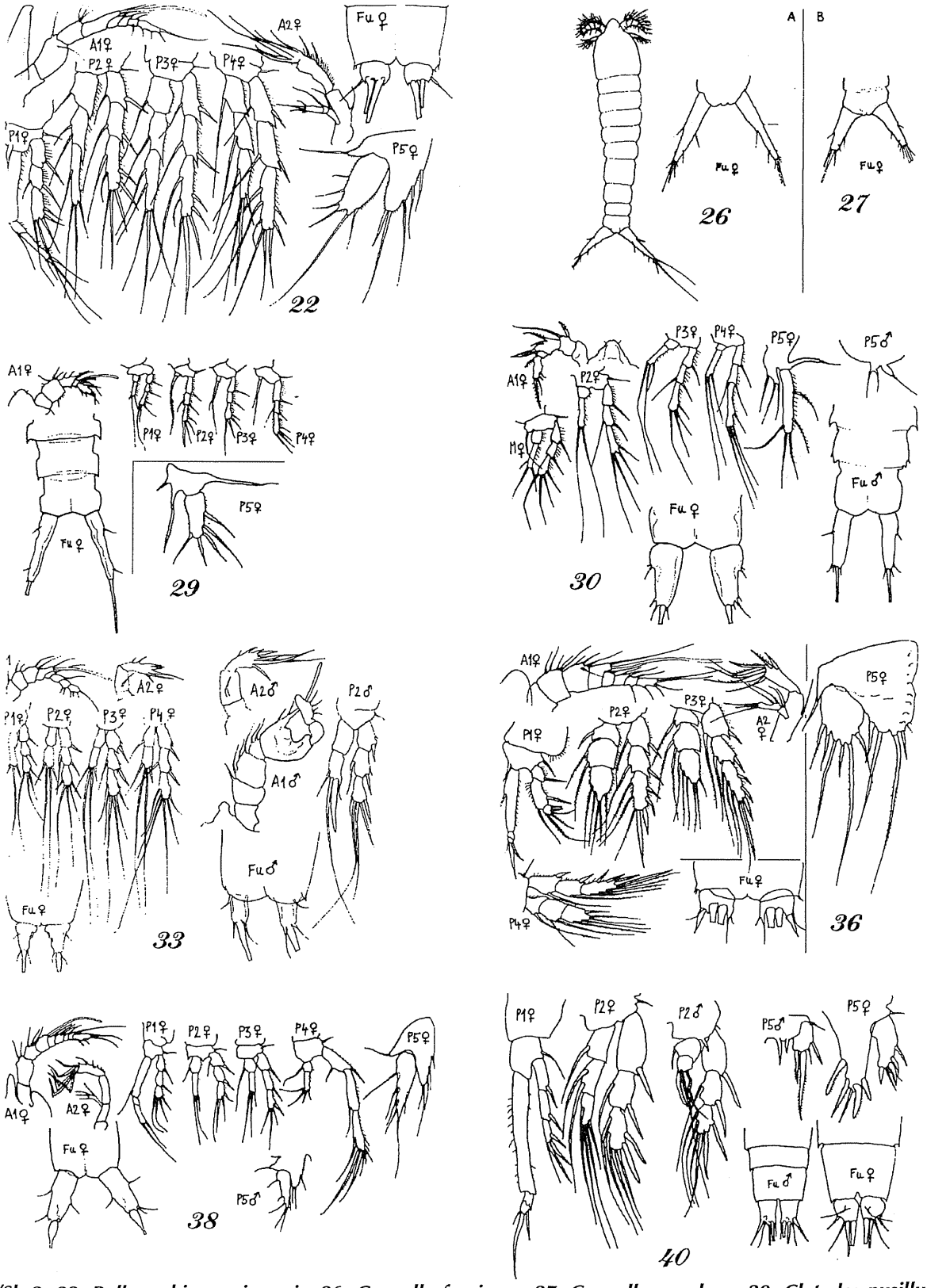


Fig./Sl. 3: 22. Bulbamphiascus inermis, 26. Canuella furcigera, 27. Canuella perplexa, 29. Cletodes pusillus, 30. Cletodes limicola, 33. D'Arcythompsonia scotti, 36. Dactylopodia tisboides, 38. Diagoniceps menaiensis, 40. Diosaccus tenuicornis.

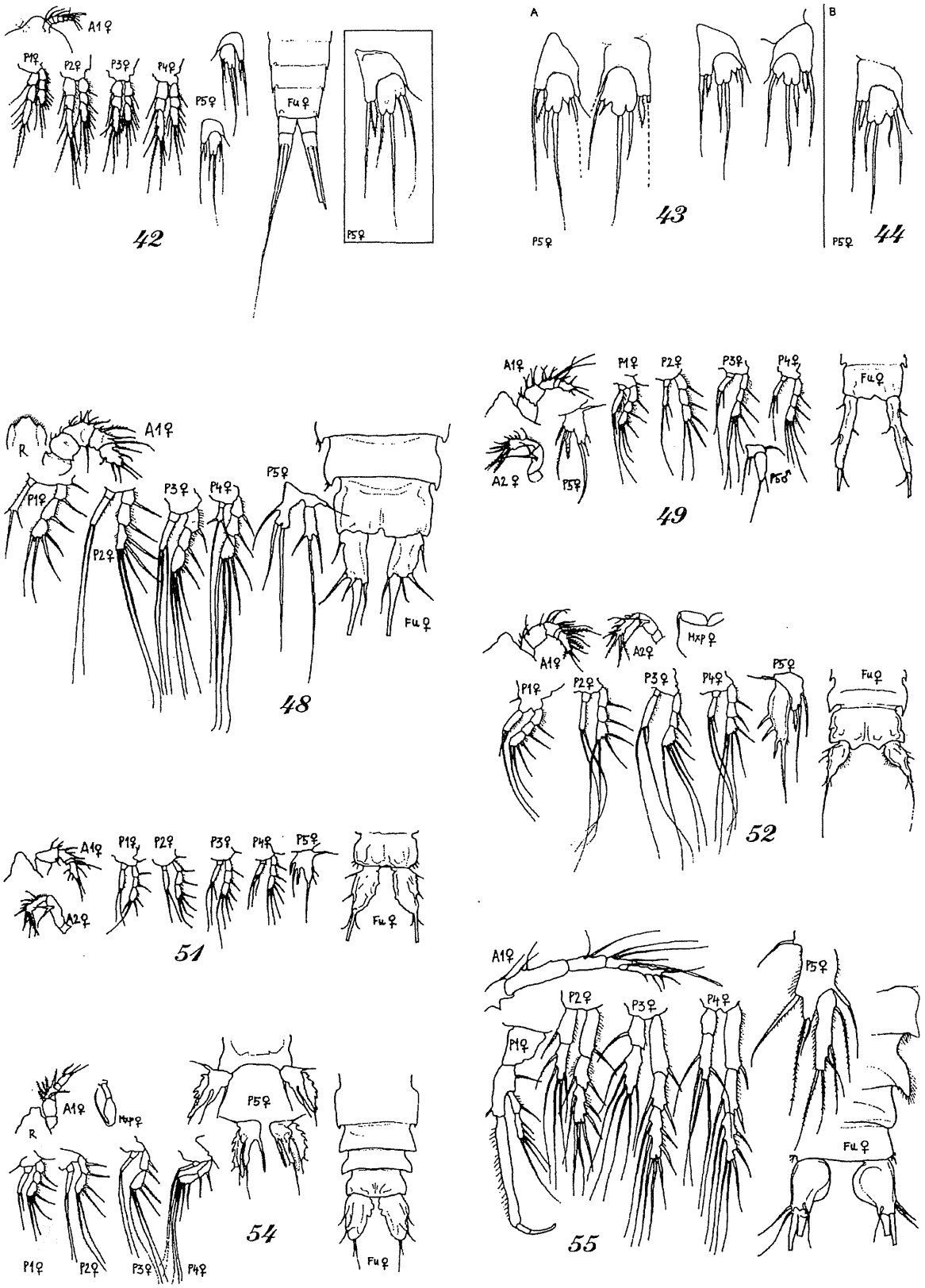


Fig./Sl. 4: 42. Ectinosoma normani, 43. Ectinosoma obtusum, 44. Ectinosoma dentatum, 48. Enhydrosoma buchholtzi, 49. Enhydrosoma caeni, 51. Enhydrosoma sordidum, 52. Enhydrosoma propinquum, 54. Enhydrosomella staufferi, 55. Esola longicauda.

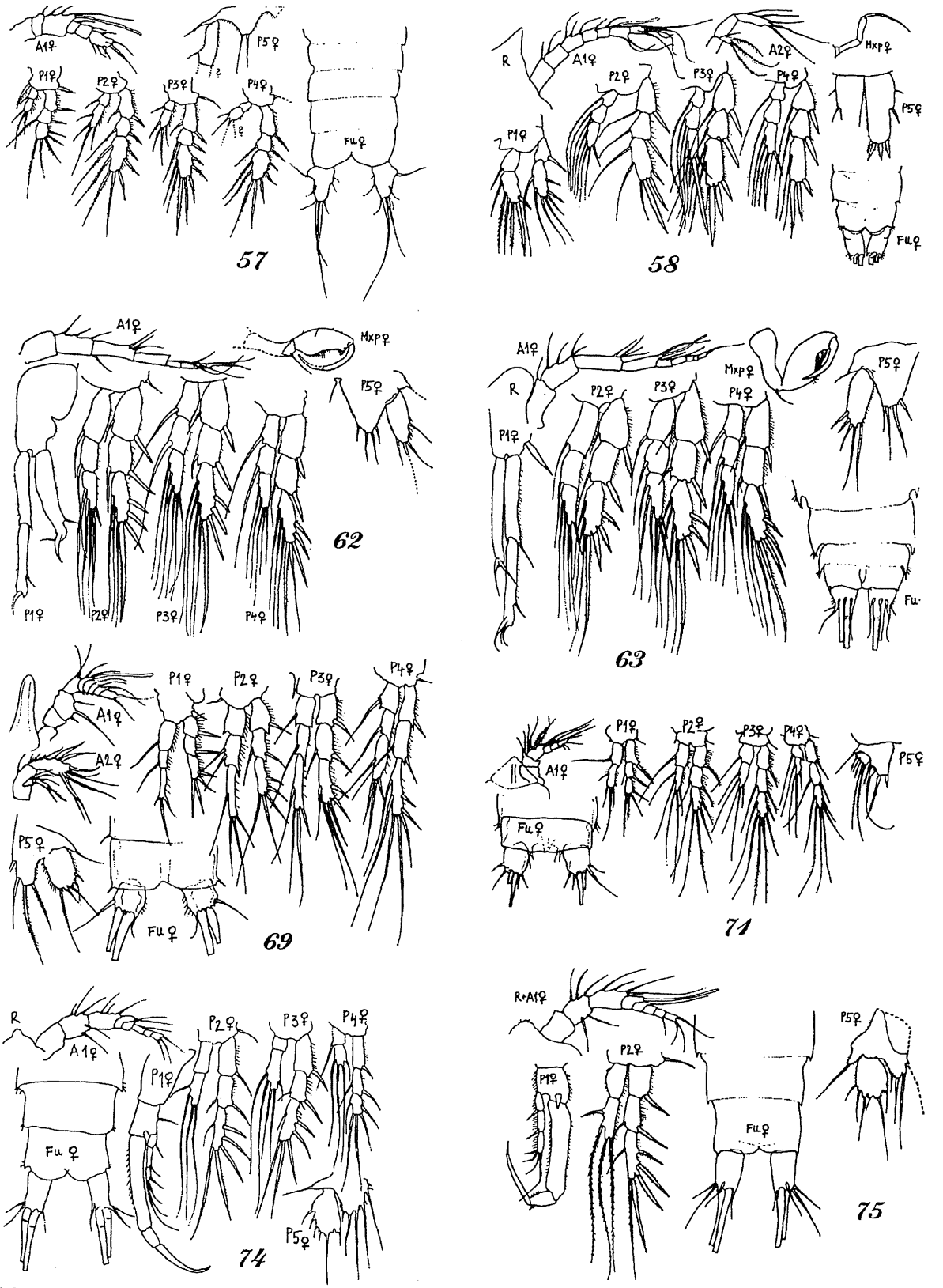
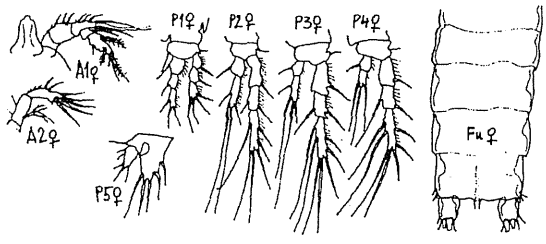


Fig./Sl. 5: 57. Eurycletodes (Oligocletodes) sp.1, 58. Euterpina acutifrons, 62. Harpacticus sp.1, 63. Harpacticus sp.2, 69. Haloschizopera pontarchis, 71. Hemimesochra nixe, 74. Heterolaophonte stroemi, 75. Heterolaophonte sp.1.



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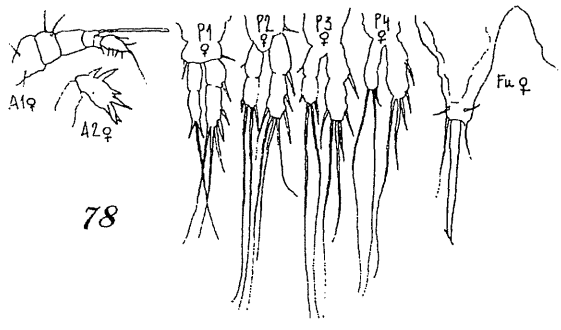

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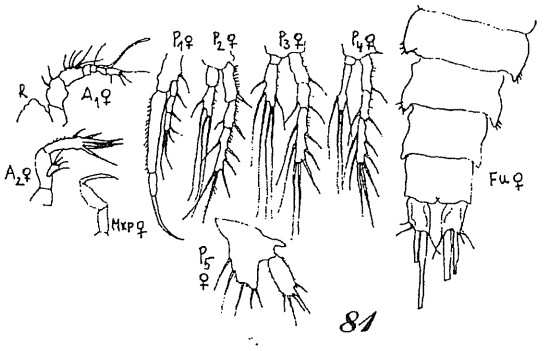

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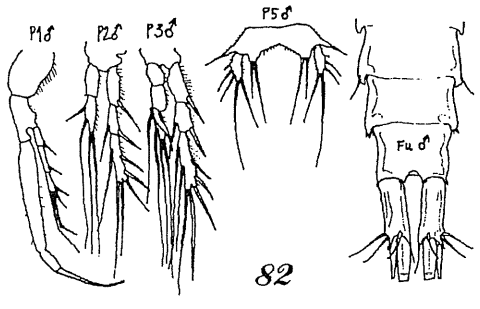

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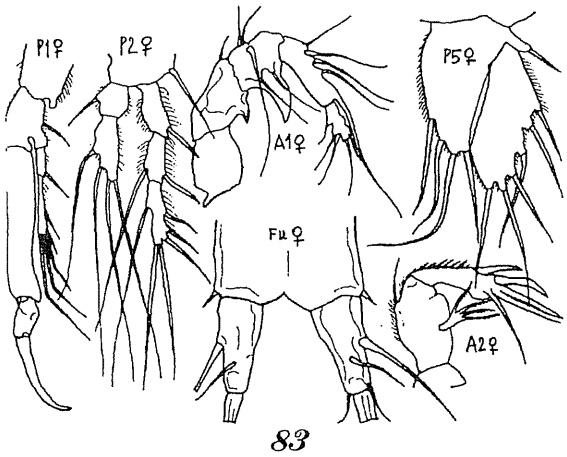

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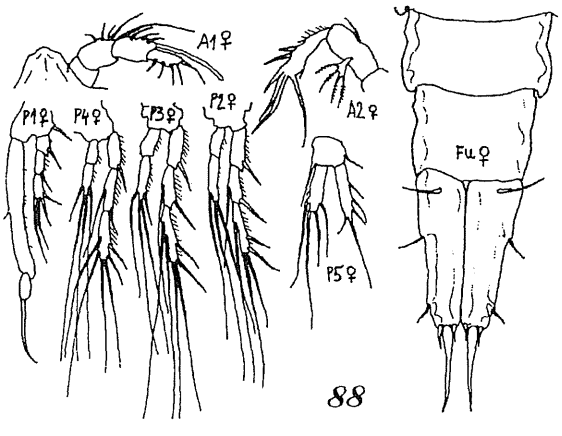

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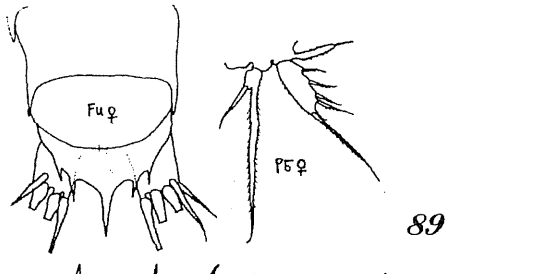

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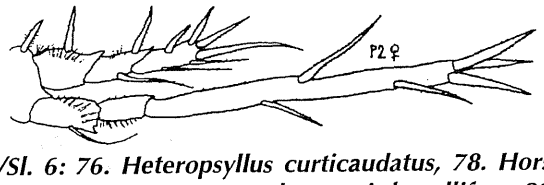

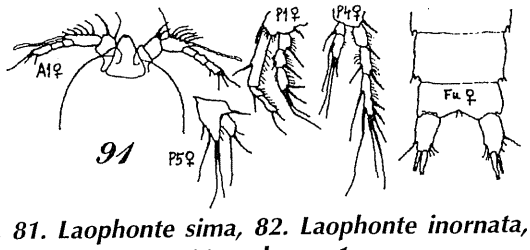

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Fig./Sl. 6: 76. Heteropsyllus curticaudatus, 78. Horsiella sp.1, 81. Laophonte sima, 82. Laophonte inornata, 83. Laophonte cornuta, 88. Laophontopsis lamellifera, 89. Longipedia coronata, 91. Mesochra sp.1.

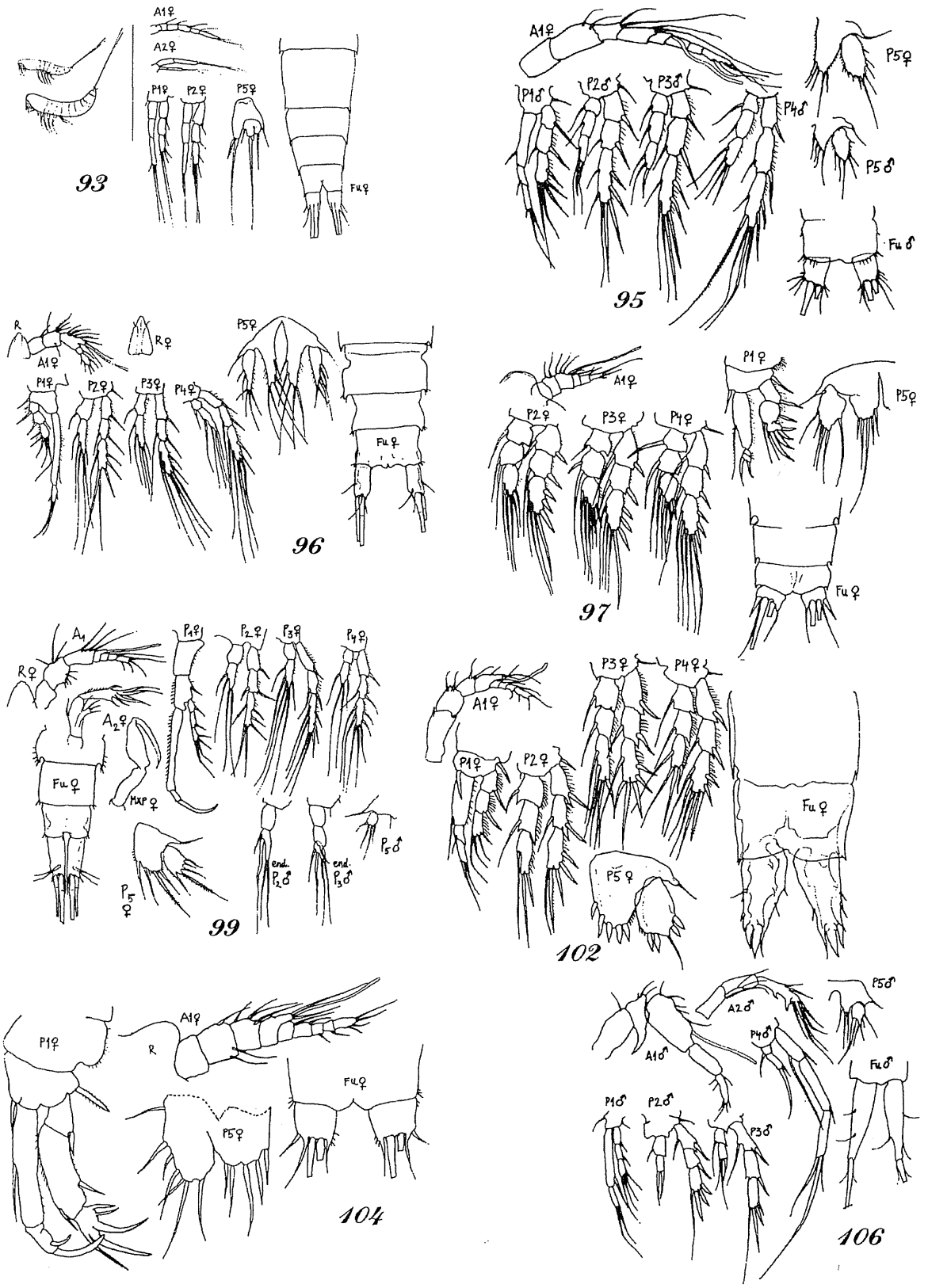
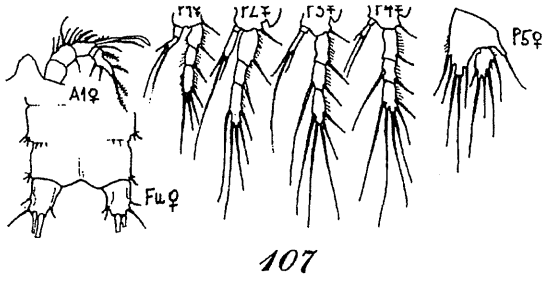


Fig./Sl. 7: 93. Microsetella norvegica, 95. Nitocra fragilis, 96. Normanella mucronata, 97. Paradactylopodia brevicornis, 99. Paralaophonte congenera var. mediterranea, 102. Paramphiascella coulli, 104. Parathalestris sp.1, 106. Phyllopodopsyllus sp.1.



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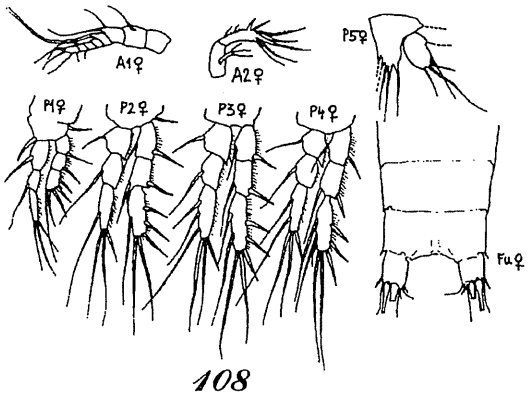

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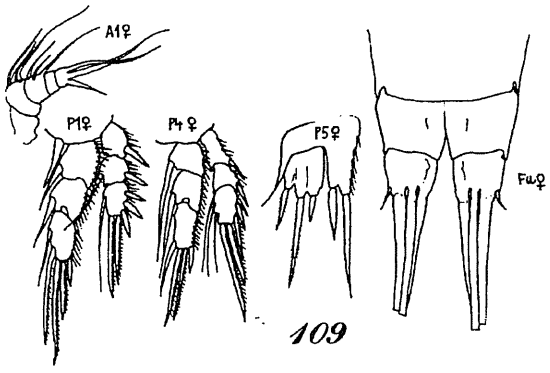

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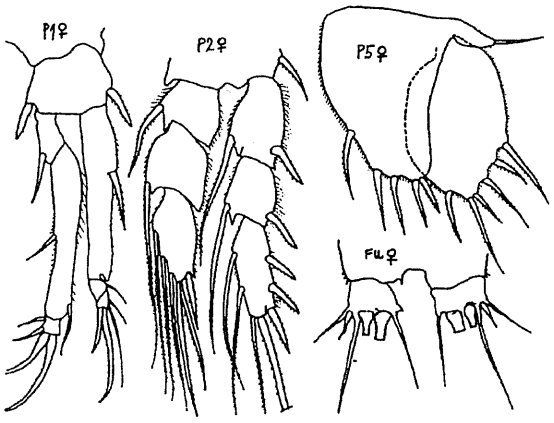

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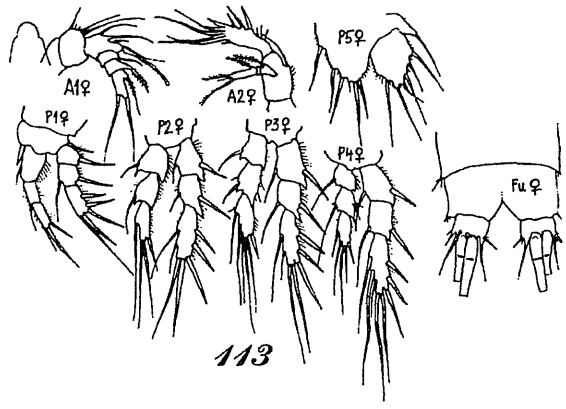

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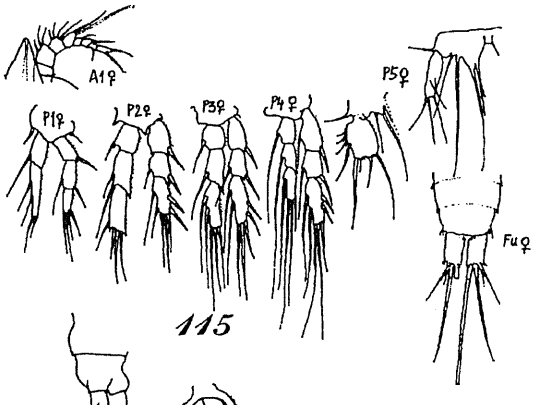

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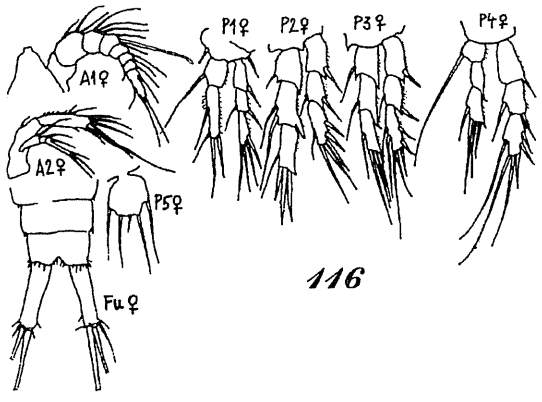

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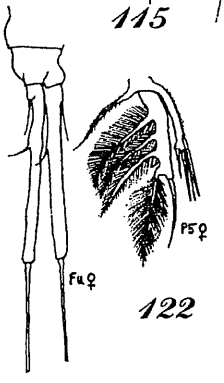


122

Fig./Sl. 8: 107. Pontocletodes ponticus, 108. Proameira sp.1, 109. Pseudobradya sp.1, 110. Rhynchothalestris rufocincta, 113. Robertsonia knoxi, 115. Stenhelia (Delavalia) normani, 116. Stenhelia (Delavalia) minuta, 122. Stylicletodes longicaudatus.

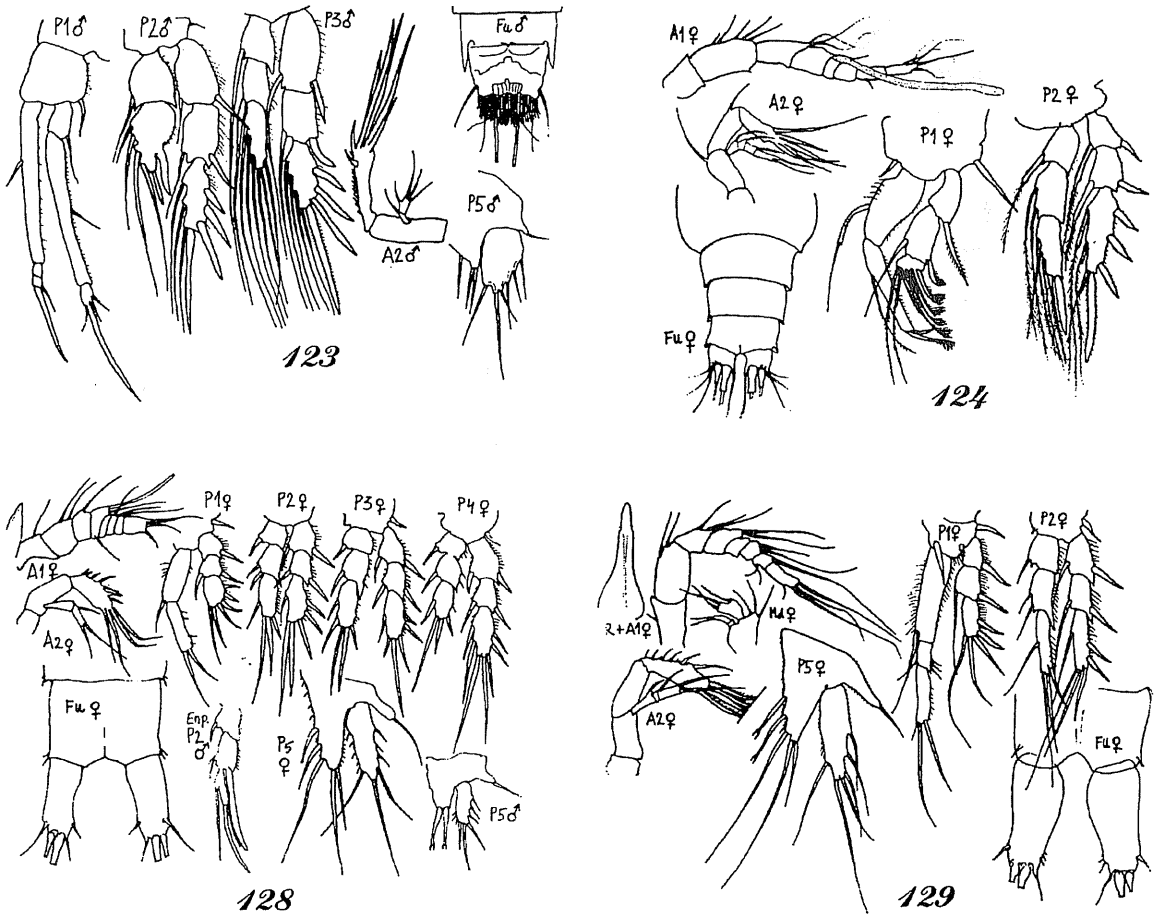
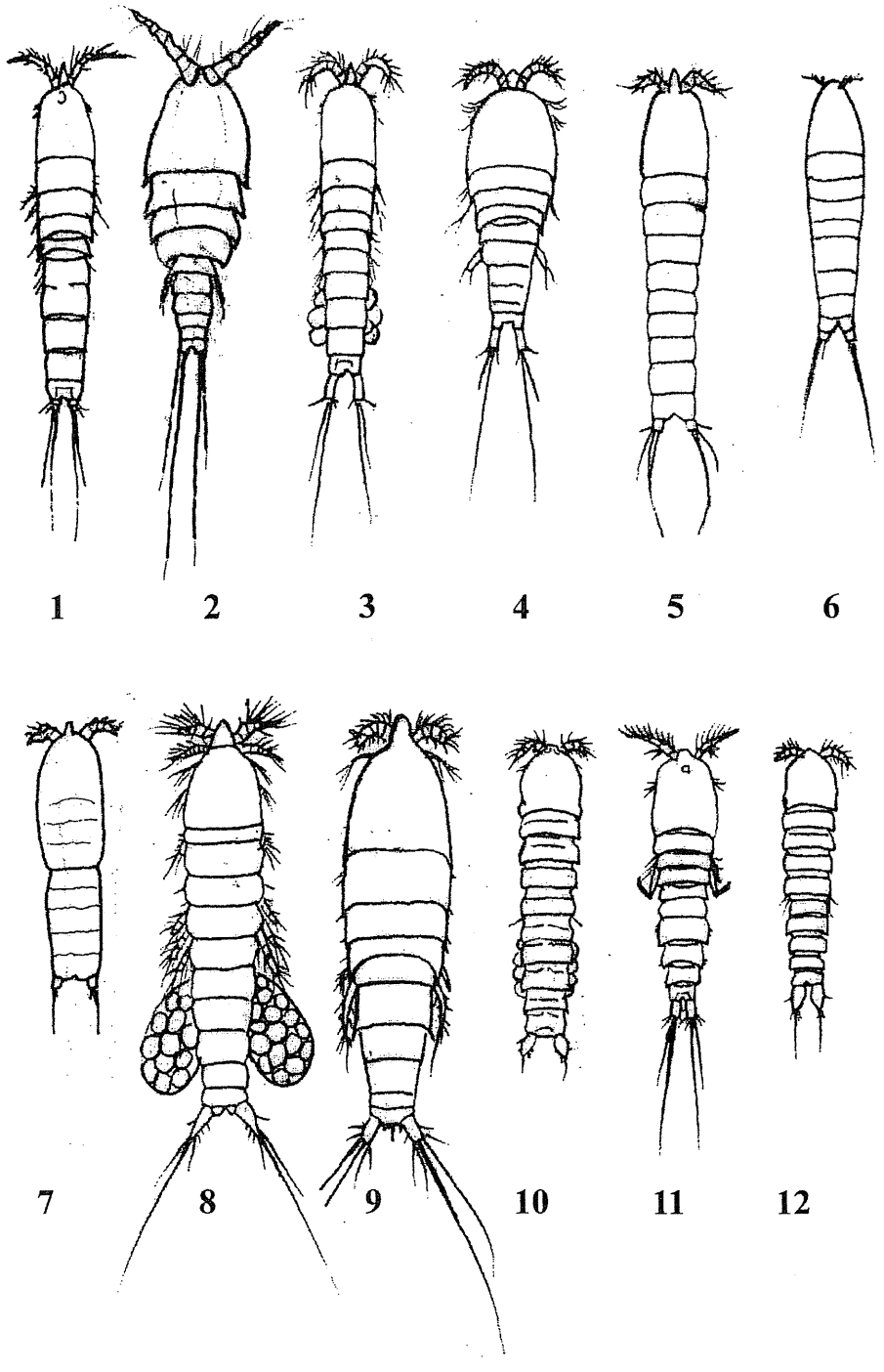


Fig./Sl. 9: 123. Thalestris rufoviolascens, 124. Tisbe lancii, 128. Typhlamphiascus confusus, 129. Typhlamphiascus sp.1.



1 *Bulbamphiascus inermis*
2 *Tisbe lancii*
3 *Typhlamphiascus confusus*
4 *Stenhelia (Delavalia) minuta*
5 *Haloschizoperus pontarchis*
6 *Ectinosoma normani*
7 *Heteropsyllus curticaudatus*
8 *Canuella perplexa*
9 *Longipedia coronata*
10 *Enhydrosoma propinquum*
11 *Paralaophonte congenera*
12 *Enhydrosoma sordidum*

Fig. 10: Some frequent Harpacticoida species from the investigated area (after Lang, 1948).
Sl. 10: Nekaj pogostejših vrst harpaktikoidov raziskovanega področja (po Langu, 1948).

MEIOBENTOŠKI HARPAKTIKOIDI (COPEPODA: HARPACTICOIDA) JUŽNEGA DELA TRŽAŠKEGA ZALIVA I. PREGLED VRST

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POVZETEK

Prispevek podaja celovit sistematski pregled prostoživečih, neparazitskih meiobentoških vrst harpaktikoidnih kopepodov, zbran in urejen iz obsežnega gradiva vseh dosedanjih raziskav te skupine na področju južnega dela Tržaškega zaliva med leti 1970 in 2000. Poudarek dela je na abecednem in sistematskem pregledu, ki obsega 130 vrst in na morfološko-taksonomskih značilnostih, prikazanih s skicami 62 vrst.

Ključne besede: Harpacticoida, Copepoda, Tržaški zaliv, seznam vrst

REFERENCES

Bodin, P. (1979): Catalogue des nouveaux Copépodes Harpacticoïdes marins (Nouvelle edition). Université de Bretagne Occidentale, Laboratoire d'Oceanographie Biologique, Brest Cedex, 228 pp.

Chappuis, P. A. (1953): Harpacticoïdes psammiques recoltes par C. Delamare - Deboutteville en Méditerranee. Vie Milieu, 4(2), 254-276.

Lang, K. (1948): Monographie der Harpacticiden I., II. Lund 1948, 1682 pp. Reprint: Otto Koeltz Science Publishers, 1975.

Marcotte, B. M. (1973): The effects of organic pollution on meiofaunal population density, species diversity and community structure in the Bay of Piran, Yugoslavia (North Adriatic). B. Sc. Thesis, Clark University, Worcester, Mass., 45 pp.

Marcotte, B. M. (1974): Two new harpacticoid copepods from the North Adriatic and a revision of the genus *Paramphiascella*. Zool. J. Linn. Soc., 55, 65-82.

Marcotte, B. M. & B. C. Coull (1974): Pollution, diversity and meiobenthic communities in the North Adriatic (Bay of Piran, Yugoslavia). Vie Milieu, 24 (2-B), 281-300.

Marinov, T. M. & A. M. Apostolov (1981a): Contribution a l etude des Copepodes Harpacticoides de la mer Adriatique (Cote yougoslave). I. Le genre *Stenhelia* Boeck. Acta zoologica bulgarica, 17, 66-72.

Marinov, T. M., & A. M. Apostolov (1981b): Contribution a'letude des Copepodes harpacticoides de la mer Adriatique (Cote yougoslave). II. Sur le meiobenthos du Cap Piran. Acta zoologica bulgarica, 18, 23-30.

Meischner, D. & J. Rumohr (1974): A light-weight high momentum gravity corer for subaqueous sediments. Senckenb. Marit., 6, 105-116.

Ogorelec, B., M. Mišič & J. Faganeli (1991): Marine geology of the Gulf of Trieste (Northern Adriatic): Sedimentological aspects. Marine Geology, 99, 79-92.

Por, F. (1964): A study of the Levantine and Pontic Harpacticoida (Copepoda Crustacea). Zool. Verh. Leiden, 64, 1-128.

Soyer, J. (1970): Bionomie benthique du plateau continental de la côte Catalane francaise, III. Les peuplements de Copépodes Harpacticoïdes (Crustacea). Vie Milieu, 21(2-B), 337-516.

Vrišer, B. (1982): Primerjave združb meiofavne čistih in onesnaženih področij. Disertacija, Univerza v Ljubljani, 85 str.

Vrišer, B. (1983): Meiofaunal community structure and species diversity in the Bays of Koper, Strunjan and Piran (Gulf of Triest, North Adriatic). Nova Thalassia, 6, 5-17.

Vrišer, B. (1986): Vpliv organskega onesnaženja na meiofavno priobalnih glinastih muljev Koprskega zaliva. Biol. vestn., 34, 93-104.

Vrišer, B. (1992): Meiofavna južnega dela Tržaškega zaliva. III. Favna in združbe harpaktikoidov (Copepoda: Harpacticoida). Biol. vestn., 40, 89-106.
Vrišer, B. (1996): Sezonska dinamika in variabilnost harpaktikoidov (Copepoda: Harpacticoida) v Tržaškem zalivu: triletna raziskava. Annales, 9, 53-60.
Vrišer, B. (1997): Seasonal and three-year variability of meiofauna in the Gulf of Trieste (Northern Adriatic). Period. biol., 99(2), 209-212.
Vrišer, B. (2000): Meiobenthic Harpacticoida (Copepoda) from the Southern part of the Gulf of Trieste. II. Ecology and spatial distribution. Annales. (*this issue*)
Vrišer, B. & A. Vukovič (1999): Meiofaunal recolonization of defaunated sediments: II. Harpacticoida (Copepoda); preliminary results. Period. biol. (*in press*)
Wieser, W. (1960): Benthic studies in Buzzards Bay. II. The meiofauna. Limnol. Oceanogr., 5, 121-137.

review article UDC 574

MEIOBENTHIC HARPACTICOIDA (COPEPODA) FROM THE SOUTHERN PART OF THE GULF OF TRIESTE (NORTHERN ADRIATIC) II. ECOLOGY AND SPATIAL DISTRIBUTION

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ABSTRACT

The article presents a review of all ecological investigations of harpacticoid copepods in the southern part of the Gulf of Trieste between 1970 and 2000, with emphasis on the spatial distribution of species, demonstrated with 90 charts. The diversity analysis of this group indicates that the greater part of the area is inhabited by a single community.

Key words: Harpacticoida, Copepoda, Gulf of Trieste, spatial distribution

ARPACTICOIDI (COPEPODA: HARPACTICOIDA) MEIOBENTONICI DELLA PARTE MERIDIONALE DEL GOLFO DI TRIESTE (NORD ADRIATICO) II. ECOLOGIA E DISTRIBUZIONE SPAZIALE

SINTESI

L'articolo presenta i risultati delle ricerche effettuate sulle caratteristiche ecologiche dei copepodi arpacticoidi della parte meridionale del Golfo di Trieste, tra il 1970 ed il 2000. Particolare attenzione e' stata prestata alla distribuzione spaziale delle specie, che viene evidenziata in 90 cartine. Nella gran parte dell'area analizzata la diversità degli arpacticoidi è pressoché uguale, pertanto l'autore parla di un'unica comunità costiera di arpacticoidi dei fondali molli.

Parole chiave: Harpacticoida, Copepoda, Golfo di Trieste, distribuzione spaziale

INTRODUCTION

Like in almost every part of the marine environment, the harpacticoid copepods in the meiofauna of the Gulf of Trieste are ranked second as far as their abundance is concerned, immediately after Nematoda. This is why ecological knowledge of this group is often the key to a wider understanding of the entire meiobenthos.

Of the total six predominantly ecological studies of meiofauna, three have dealt in somewhat greater detail with the biocenological aspects of harpacticoids and spatial distribution of species in the southern part of the Gulf of Trieste: Marcotte & Coull (1974; near Piran), Vrišer (1986; Bays of Koper, Strunjan and Piran) and Vrišer (1992; open waters of the Gulf). The position of sampling sites used during these investigations is shown in figure 1.

The more comprehensive studies of harpacticoid communities from larger areas in the Mediterranean in general are not particularly numerous, but there are certainly none of this particular kind known to us from the wider North Adriatic. In the more important Mediterranean studies, where names like Monard (1935, 1937), Chappuis (1953), Raibaut (1962, 1965, 1967), Soyer

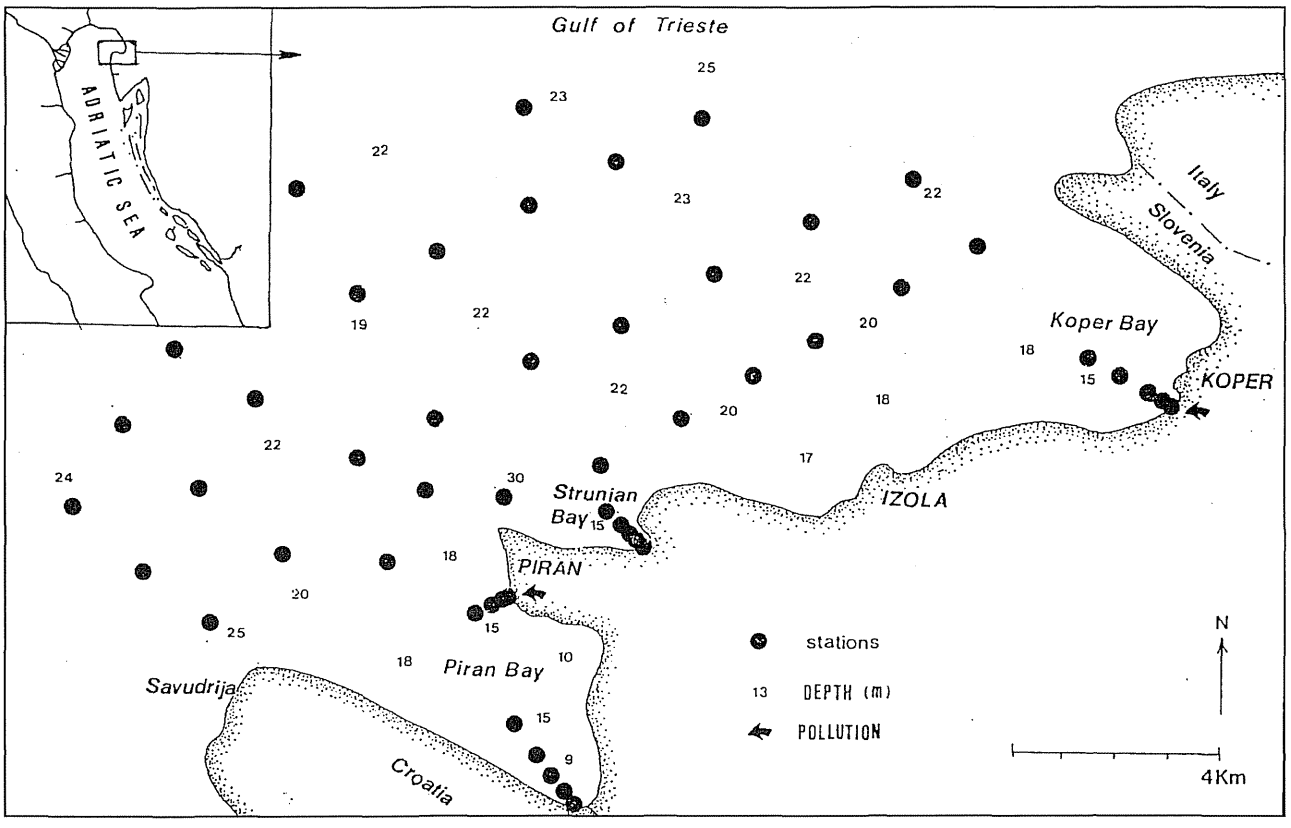


Fig. 1: Investigated area with sampling stations.
Sl. 1: Raziskovano območje z vzorčevalnimi postajami.

(1964a, b, 1969, 1970a, b), Bodin (1964, 1968), Por (1964) and Castel (1985) stand out, systematics and ecology of this group are normally depicted.

In the present article the ecological characteristics of Harpacticoida from the southern part of the Gulf of Trieste are given as a summary of the three already mentioned studies (Marcotte & Coull, 1974; Vrišer 1986, 1992), with a scheme of spatial distributions of all species in the area, while a complete list of species and the group's systematics are presented in a separate article (Vrišer, 2000).

METHODS

All samplings were carried out with the gravity core (Meischner & Rumohr, 1974), with 3 replicates (10 cm^2 sediment surface, 10 cm deep). Meiofauna was extracted with the sieving-decantation technique of Wieser (1960) on 1 mm, 0.125 mm and 0.050 mm sieves, fixed (4% formalin with seawater), stained (rose - bengal), sorted out and counted. Homogeneity of the harpacticoidal communities was examined with the similarity analysis according to Sanders (1960), while the species diversity was established with the Shanon-Wiener index (Pielou, 1969).

ECOLOGICAL CONDITIONS

Depth span of the sampling sites in the study of coastal harpactioids (Marcotte & Coull, 1974; Vrišer, 1986) was between 1 to 15 m, while in the open waters of the Gulf (Vrišer, 1992) it was between 19 and 25 m, exceptionally 30 m.

Samplings in the coastal areas between 1 and 15 m were carried out in winter (February) and summer (August), all the rest in summer (August). Only a few of the shallowest sites (1 - 5 m) in the Bays of Koper and Piran were at the time of sampling under the local influence of sewage pollution (Marcotte & Coull, 1974; Vrišer, 1986), while all the others were not.

The annual thermal conditions of the area's bottom layer vary between 9 and 21°C, salinity between 35 and 37 PSU, while average oxygen saturation reaches 90%, except during hypoxia crisis when it can fall under 40%.

The sediment of the investigated area is represented mostly by clayey silt (10-20% clay), which nearer to the coast and in the interior of the Bays gradually turns into silty clay (25% clay) and towards open waters of the Northern Adriatic into fine sands (Ogorelec *et al.*, 1991).

BIOCENOLOGICAL ANALYSIS OF HARPACTICOIDA

Abundance

Summer harpacticoid abundances of the coastal belt between the coast and the depth of 15 m are on average about 100 ind./10 cm², while in summer they are by half smaller (Marcotte & Coull, 1974; Vrišer, 1986). With the depth the abundance increases, so that out of the coastal bays but parallel to the main coastal line it reaches, at the depth of 20 m, 200-250 ind./10 cm². Towards the centre of the Gulf of Trieste and towards Cape Savudrija the abundance is evenly reduced, at places even below 40 ind./10 cm². In the central part of the investigated area this decrease is less distinct.

There were 25 harpacticoid species on average at separate localities. None of the species surpassed 9% of total relative density, and only 22 occurred with more than 1%, which means that the great majority of the species are represented by only a few individuals (Vrišer, 1992). The most common species in the area, in view of % of their relative abundance, are: *Haloschizopera pontarchis* (8.47%), *Typhlamphiascus confusus* (7.16%), *Bulbamphiascus inermis* (7.10%), *Cletodes pusillus* (6.34%), *Stenhelia adriatica* (4.96%), *etc.*

Diversity and biocenology of coastal harpacticoids

At coastal stations the values of the Hs (Shanon - Wiener) diversity index were in spite of some minor oscillations quite stable (Hs = 1.7-2.2). They drastically fell (Hs = 0.2) only in the direct vicinity of the two sewage outflows in the Bays of Koper and Piran (Marcotte & Coull, 1974; Vrišer, 1986). We believe that here we are dealing with two communities - with due to pollution impoverished community of stressful environment and with the community of the remaining clean, unpolluted coastal belt, where two associations are detected. The first, which is of somewhat higher diversity, coincides with the belt of sea meadows to the depth of 10 m, while the other, deeper association belongs to the bare sediment floor.

Diversity and biocenology of harpacticoids of the outer areas

In further text the data presented are those from the study by Vrišer (1992). The Shannon - Wiener diversity index (Hs) indicated a large diversity range (1.88-3.02) which, however, was in such diverse environment more or less expected. For the fact is that the geological structure of the sea floor changes from slimy clayey silts of the southeastern coastal margin to fine sands of the open sea in the west. Diversity increases in the direction towards the sandy floor and is here the greatest (3.02); it decreases towards the centre of the Gulf of Trieste (2.10) and in the immediate vicinity of Cape Piran.

An estimate of the affinity indices of all available pairs of harpacticoid samples for the assessment of biocenologically similar areas indicated a few nuclei. The most distinct is the area of the seven stations with high faunal affinity (over 70%) on clayey silt of the outer margin of Koper Bay (Fig. 2, area A). Other nuclei were also observed and represent a gradual transition from clayey-sandy silt to sandy floor of the open sea (Fig. 2., areas B, C, D) and in the direction of poorer community (in terms of its species composition and abundance) of the centre of the Gulf and the vicinity of Cape Piran (Fig. 2., areas E and F).

By considering the degree of associability established with the above mentioned similarity analysis, the species diversity and arrangement of the specific species occurring only on certain types of floor, and the prevailing, dominating species, we can divide the investigated area into six ecological units (Fig. 2):

Zone A - province of clayey silty floor. Seven stations of high associability. Average diversity Hs = 2.57. Specific species: *Pontocletodes ponticus, Stenhelia (Delavalia) sp.1, sp.2, Harpacticus sp.5, Laophonte sp.4, Typhlamphiascus sp.1.*; Dominant species (succession of prevalence): *Haloschizopera sp.1, Typhlamphiascus confusus, Cletodes pusillus, Stenhelia (Delavalia) adriatica, Proameira sp.1.*

Zone B - province of sandy-silty floor. Ten stations of medium associability of samples. Average diversity Hs = 2.53. Specific species: *Nitocra fragilis, Ameira sp.1*; Dominant species (succession of prevalence): *Bulbamphiascus inermis, Haloschizopera pontarchis, Haloschizopera sp.1, Cletodes pusillus.*

Zone C - province of sandy floor. Ten stations of medium associability of samples. Average diversity Hs = 2.77. Specific species: *Cletodes limicola, Paradactylopodia brevicornis, Paralaophonte sp.1, Laophonte sp.3, Harpacticus sp3., sp4., Enhydrosomella staufferi, Amphiascopsis sp.1, Ectinosoma sp.2, Pseudobradya sp.1, Harpacticus sp.1, Laophonte longicaudata*; Dominant species: *Haloschizopera pontarchis, Heteropsyllus sp.1, Bulbamphiascus inermis, Heterolaophonte stroemi, Stenhelia (Delavalia) adriatica.*

Zone D - sandy floor of deeper open waters. This probably transitional area is represented by two stations with low associability without a clear affinity for other stations in the area. Average diversity Hs = 2.59. Specific species: *D'Arcythompsonia sp.1, Ameira sp.1; Dominant species: Typhlamphiascus confusus, Haloschizopera pontarchis, Bulbamphiascus inermis, Robertsonia knoxi, Cletodes pusillus.*

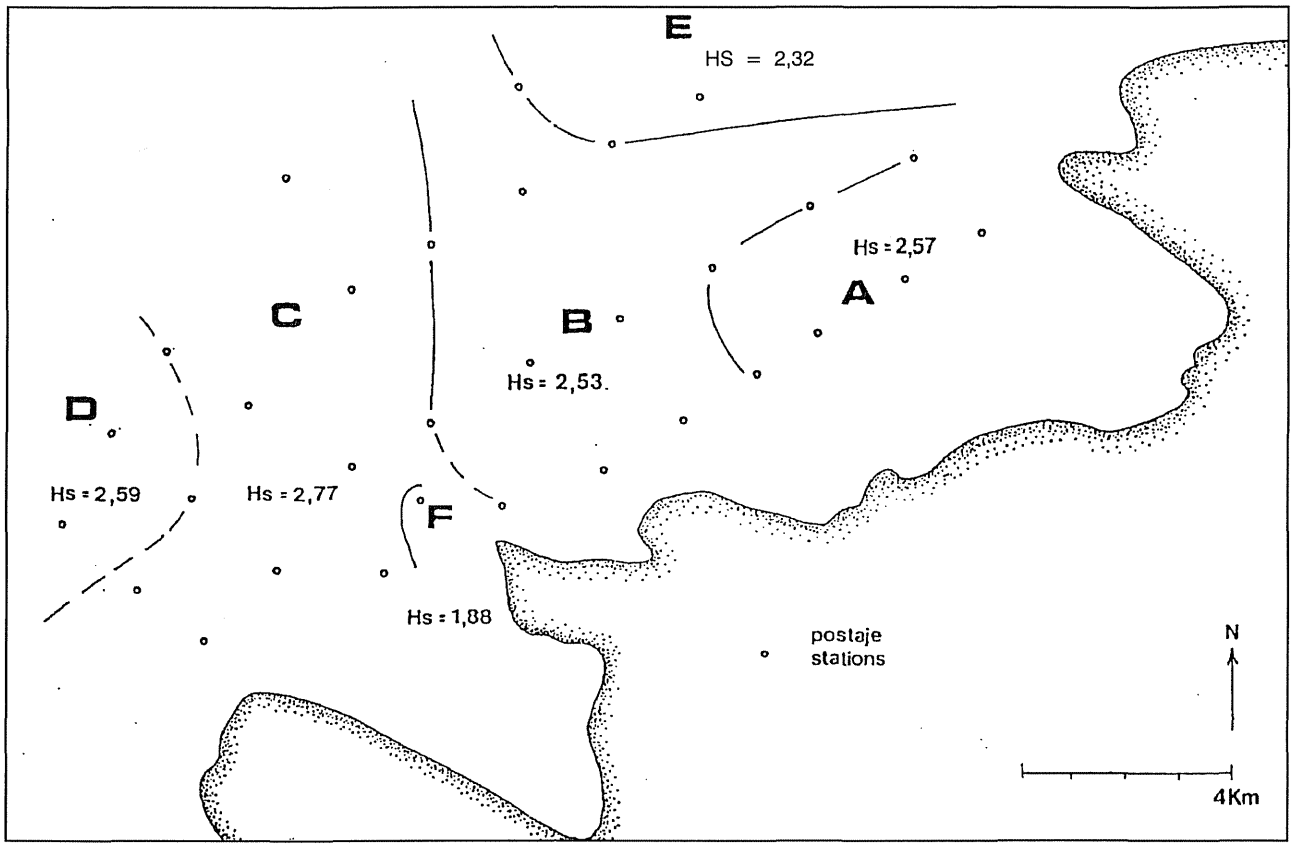


Fig. 2: Biocenological distribution of ecological provinces A, B, C in the coastal community of Harpacticoida with D, E, F transition areas.
Sl. 2: Biocenološka razmejitev ekoloških provinc A, B, C obalne združbe harpaktikoidov in njenih prehodnih področij D, E, F.

Zone E - clayey-sandy silt in the central part of the Gulf. One station only. Hs = 2.32. No specific species. Dominant species: *Enhydrosoma sordidum, Cletodes pusillus, Longipedia coronata.*

Zone F - with only one station off Cape Piran, very low affinities for the stations in zones B and C, and low diversity (Hs = 1.88). No specific species. Dominant species: *Bulbamphiascus inermis, Typhlamphiascus confusus, Cletodes pusillus.*

The presented spatial distribution of harpacticoids is similar to the distribution of the entire meiofauna and its remaining leading groups (Nematoda, Polychaeta; Vrišer, 1989, 1991). However, the reduced abundance of copepods in the direction of the Gulf's centre (known for its frequent hypoxia) and in the direction of the open sea is more distinct than in other meiofauna. A partial reason for this may lie in the smaller resistance of harpacticoids to periodical hypoxic conditions, at least in comparison with nematods, as reported in a number of studies *(e.g.* Josefson & Widbom, 1988; Murell & Fleeger, 1989; Travizi, 1990).

Among the dominant species of the entire investigated area we came across three species *(Haloschizopera pontarchis, Typhlamphiascus confusus, Cletodes pusillus),* which had been as dominant species referred to also by Soyer (1970b) after carrying out a research in Catalonia on a similar floor. All the leading species are estimated as predominantly eurivalent, distributed in places from clayey silt to sand.

Although the total diversity span of the entire area was relatively large (Hs = 1.88-3.02), it was only between 2.40 in 2.60 in the greater part of the investigated area, the only exception being the extreme NW part, where the index was higher than 2.80.

With the exception of Cape Piran (Hs = 1.88) and the centre of the Gulf (Hs = 2.26), the greater part of the area, including the coastal belt, is still more or less similar and it therefore belongs to the same harpacticoid community. The northernmost part of the area belongs to other, in terms of species and abundance truncated harpacticoid community of the central part of the Gulf known for its frequent hypoxia. The low diversity around Piran Cape is perhaps caused by specific hydrodynamics, but is for the time being still unexplainable.

The harpacticoid community of the greater part of the investigated area is not homogeneous but is, according to the associability criterion, composed of three ecological provinces, the most compact of which is the one by the entrance to the silty Koper Bay, while the other two are much less distinct. The harpacticoid investigations have in fact been confirmed by similar assessments (Vrišer, 1989, 1991) about the meiofauna's division into coastal community (although in copepods with more distinct marks of ecologically transitional area than in meiofauna) and hypoxic, poorer meiofaunal community of the Gulf's centre.

Considering that the greater part of the investigated area is in terms of its diversity more or less uniform, we believe that we are dealing with the very same coastal community of soft bottom harpacticoids composed of three subunits, which reflect the floor's transition from clayey silt to fine sand.

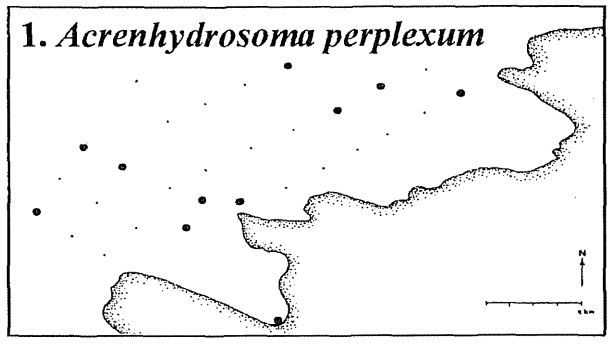
SPATIAL DISTRIBUTION OF SEPARATE SPECIES

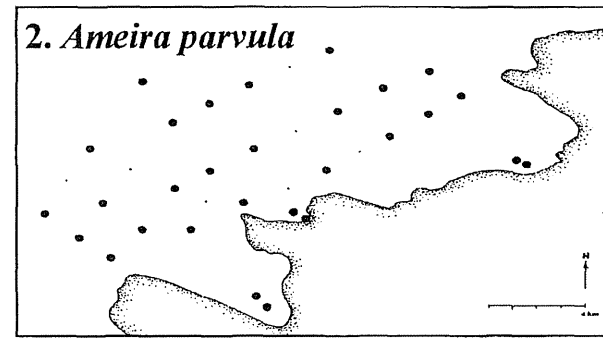
Spatial distribution of all to date registered harpacticoid species of the southern part of the Gulf of Trieste is presented on figures 3-12. The number in front of the name of each species is a successive number from the collective list of species (see Vrišer, 2000).

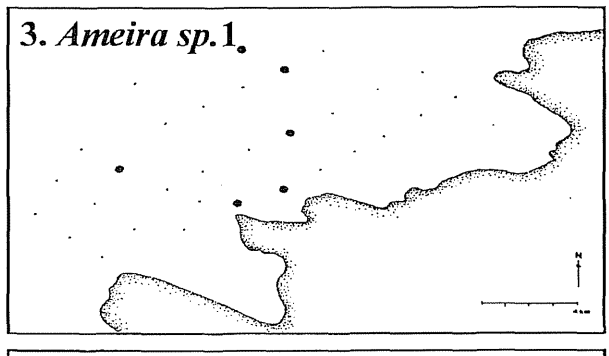
Figs. 3-12: Spatial distribution of harpacticoid species.
Sl. 3-12: Prostorska razporeditev harpaktikoidnih vrst.

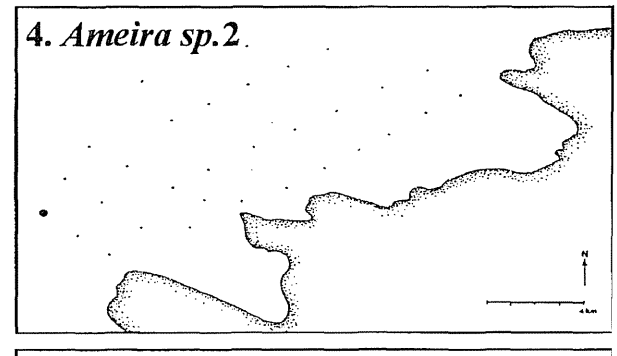
Chart K shows the distribution of the following species:
Karta K prikazuje razporeditev sledečih vrst:

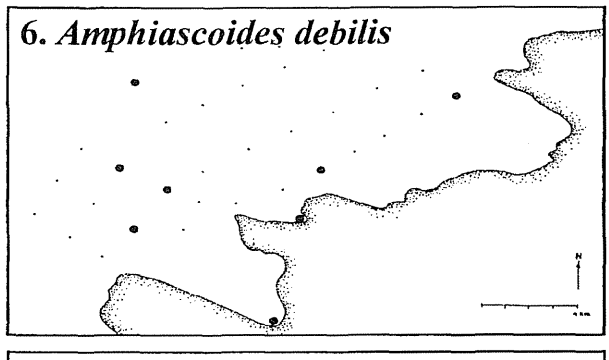
5. *Amonardia similis*, 7. *Amphiascella proxima*, 9. *Amphiascopsis thalestroides*, 10. *Amphiascopsis cinctus*, 14. *Amphiascus caudaespinosus*, 15. *Amphiascus congener*, 16. *Amphiascus minutus*, 23. *Bulbamphiascus minutus*, 25. *Brianola stebleri*, 31. *Cletodes longicaudatus*, 32. *Cletodes tenuipes*, 35. *Dactylopodella flava*, 37. *Danielssenia perezi*, 45. *Ectinosoma melaniceps*, 50. *Enhydrosoma longifurcatum*, 53. *Enhydrosoma tunisensis*, 56. *Eurycletodes (Oligocletodes) latus*, 59. *Halectinosoma angulifrons*, 60. *Harpacticus obscurus*, 61. *Harpacticus tenellus*, 67. *Haloschizopera bulbifera*, 68. *Haloschizopera junodi*, 73. *Heterolaophonte quinquispinosa*, 79. *Itunella muelleri*, 88. *Laophontopsis lamellifera*, 90. *Longipedia pontica*, 92. *Mesopsyllus atargatis*, 94. *Nitocra divaricata*, 98. *Paradanielssenia kunzi*, 100. *Paralaophonte brevirostris*, 111. *Robertgurneya rostrata*, 112. *Robertgurneya ecaudata*, 114. *Robertsonia propinqua*, 118. *Stenhelia (Delavalia) intermedia*, 119. *Stenhelia (Delavalia) reflexa*, 125. *Tisbe gracilis*, 126. *Tisbe clodiens*, 127. *Tisbe reluctans*, 130. *Zosime atlantica*

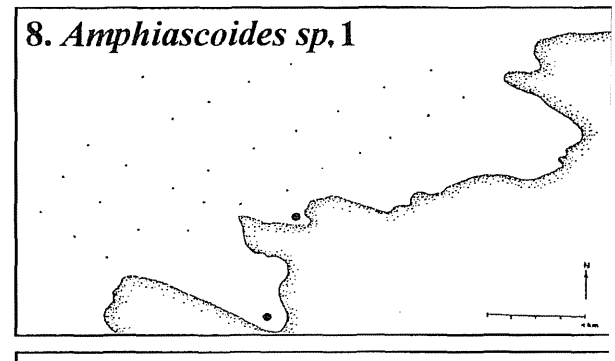

1. Acrenhydrosoma perplexum

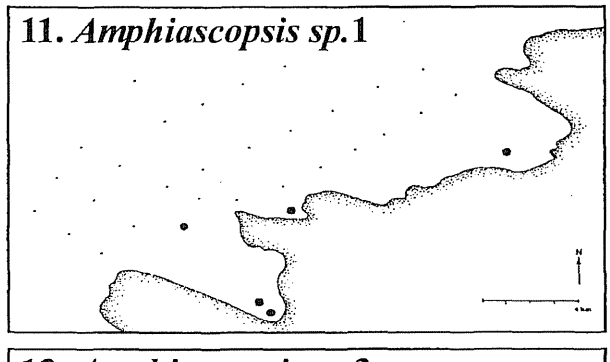

2. Ameira parvula

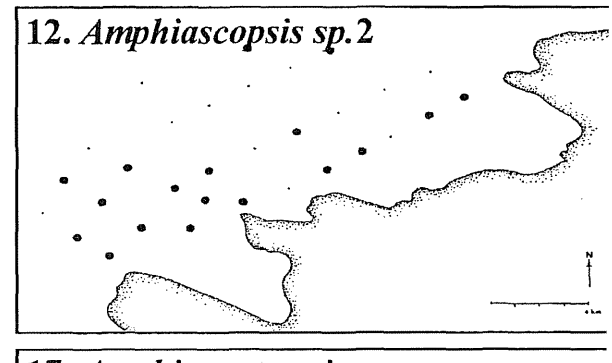

3. Ameira sp.1

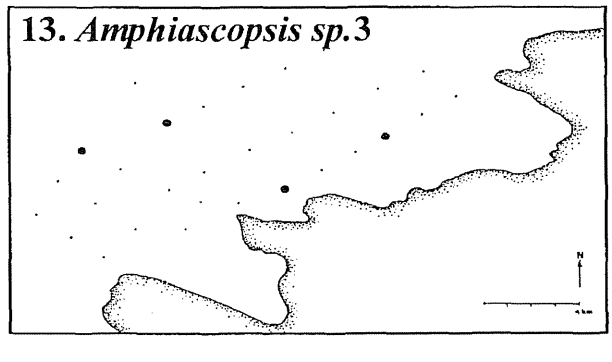

4. Ameira sp.2

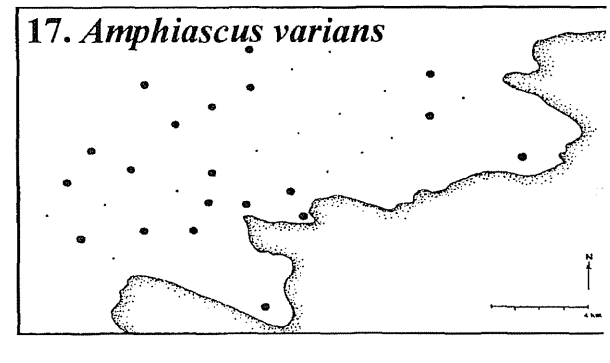

6. Amphiascoides debilis


8. Amphiascoides sp.1

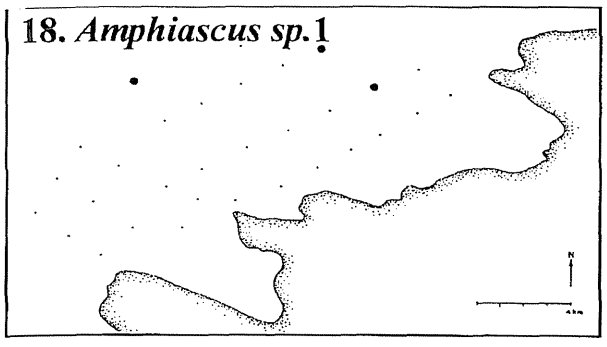

11. Amphiascopsis sp.1


12. Amphiascopsis sp.2

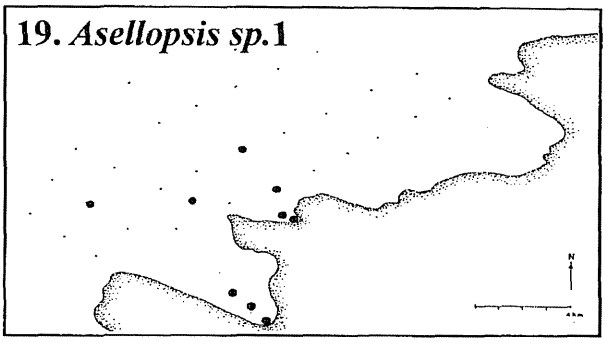

13. Amphiascopsis sp.3


17. Amphiascus varians

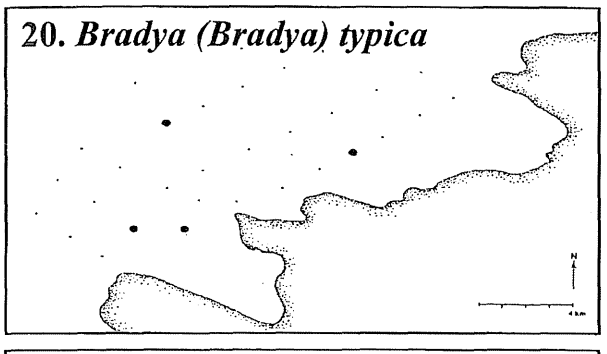
18. *Amphiascus sp.1*



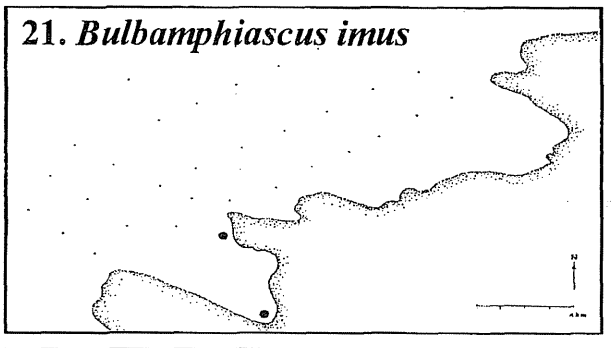
19. *Asellopsis sp.1*



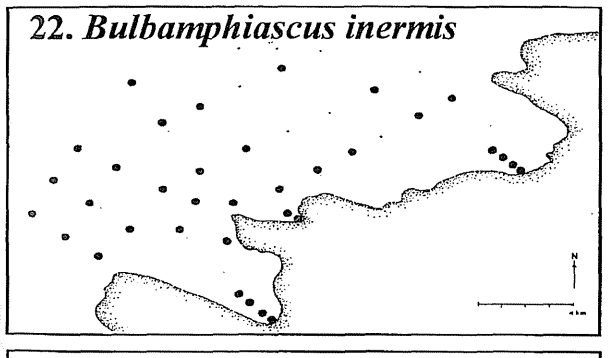
20. *Bradya (Bradya) typica*



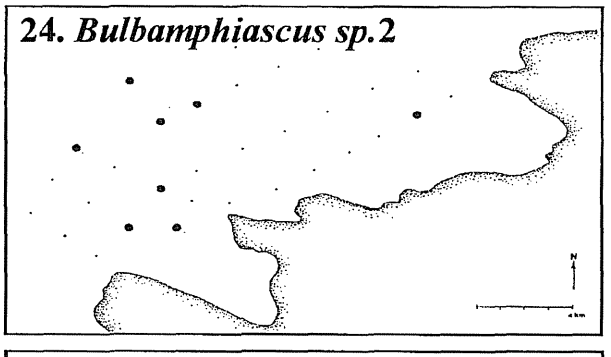
21. *Bulbamphiascus imus*



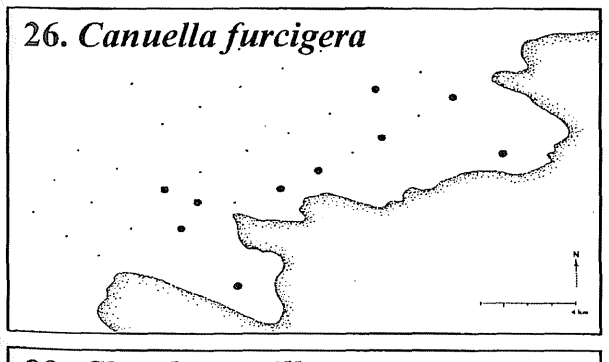
22. *Bulbamphiascus inermis*



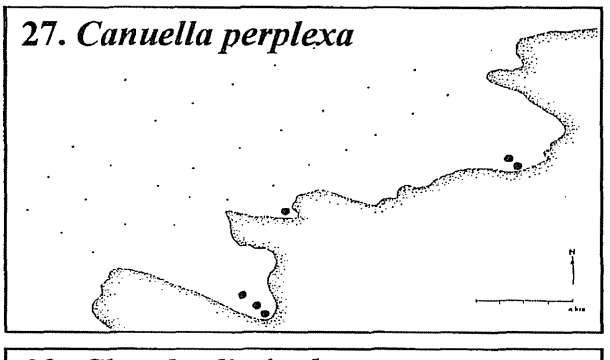
24. *Bulbamphiascus sp.2*



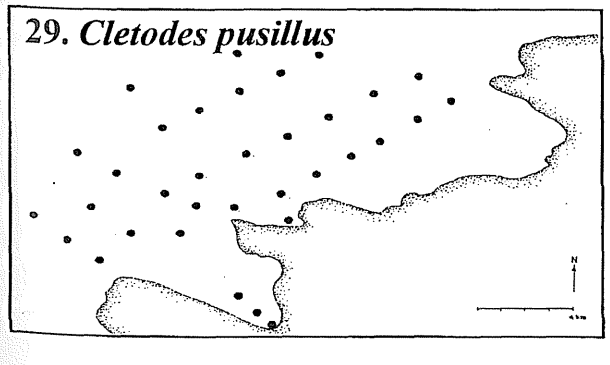
26. *Canuella furcigera*



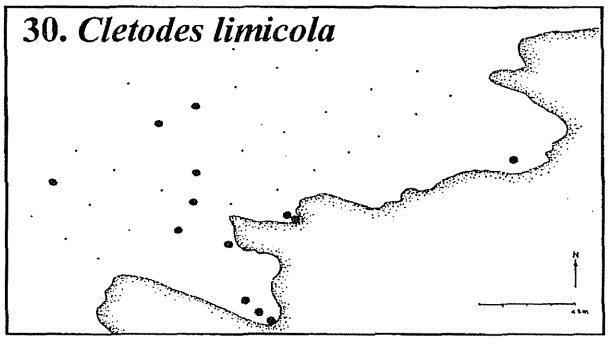
27. *Canuella perplexa*

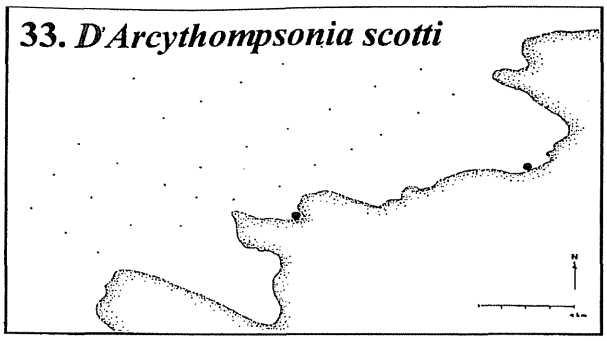


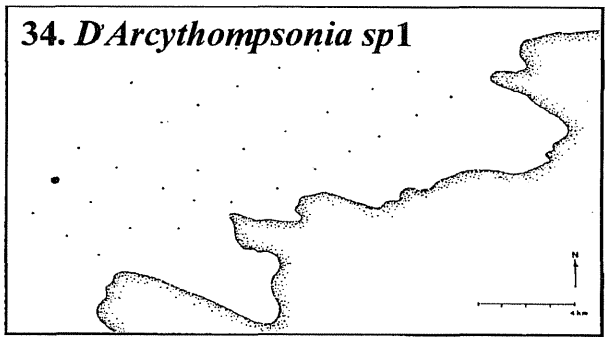
29. *Cletodes pusillus*

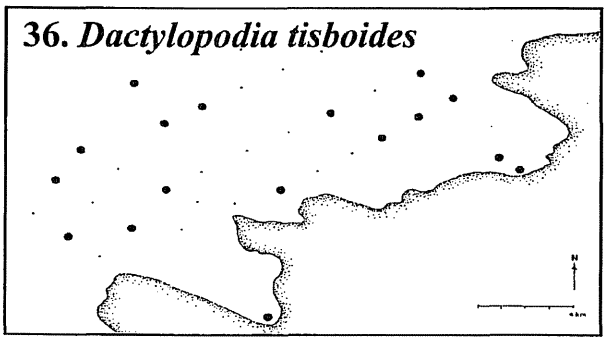


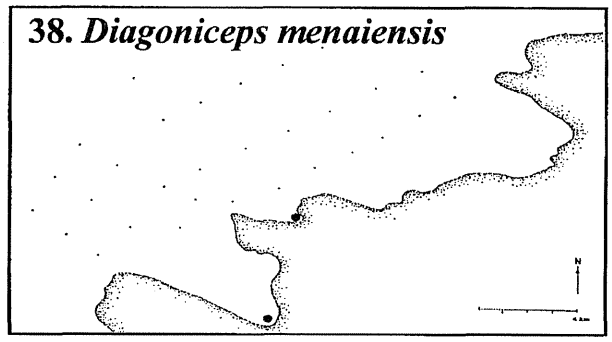
30. *Cletodes limicola*

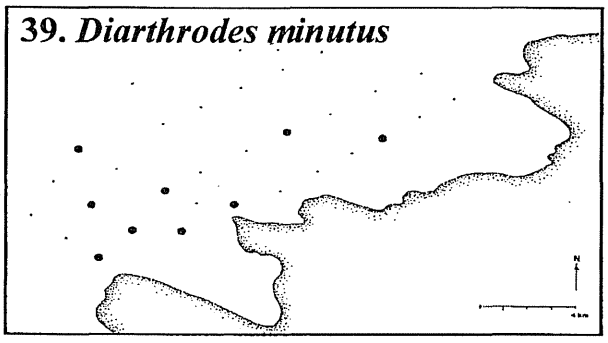


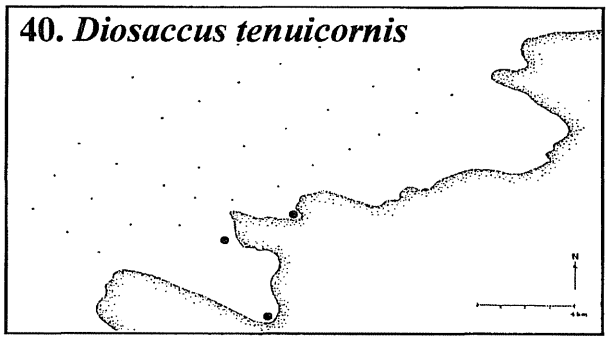

33. D'Arcythompsonia scotti

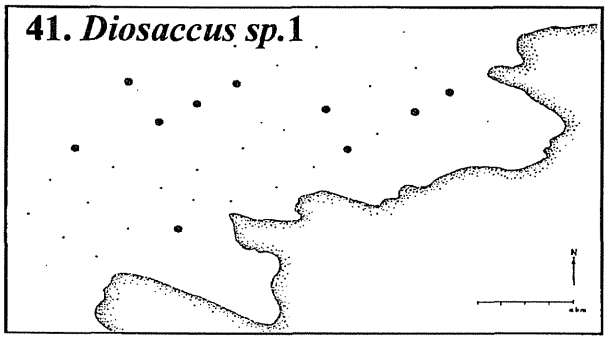

34. D'Arcythompsonia sp1

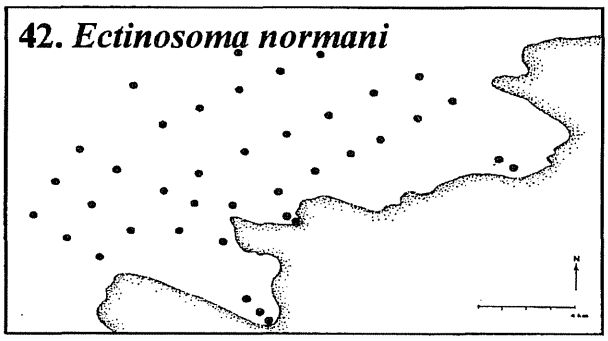

36. Dactylopodia tisboides

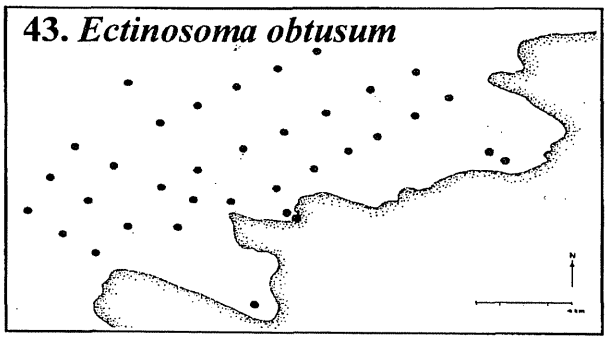

38. Diagoniceps menaiensis

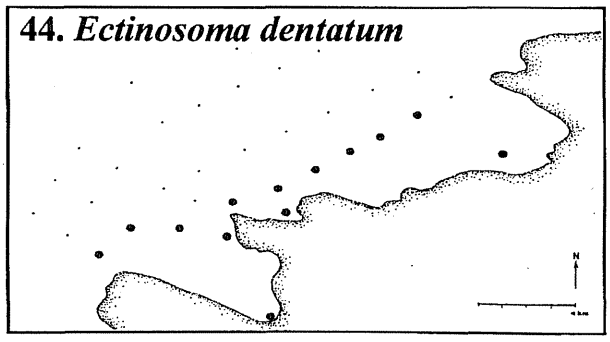

39. Diarthrodes minutus


40. Diosaccus tenuicornis

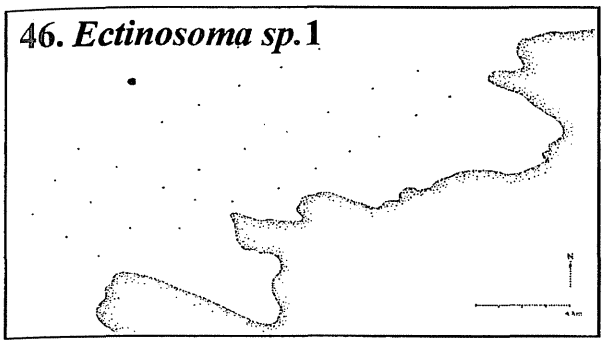

41. Diosaccus sp.1


42. Ectinosoma normani

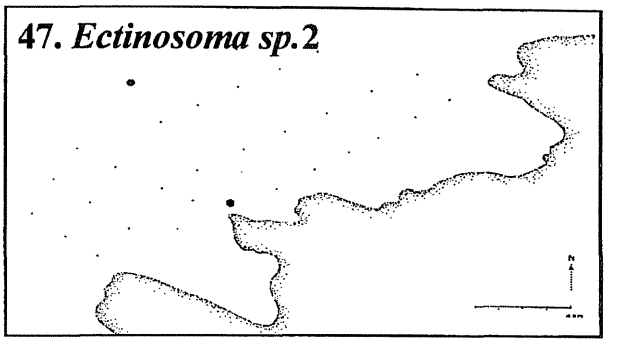

43. Ectinosoma obtusum


44. Ectinosoma dentatum

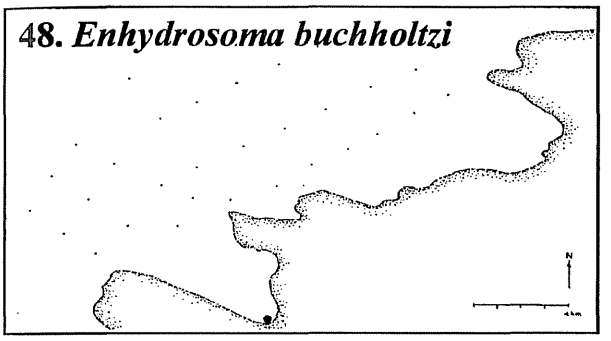
46. *Ectinosoma sp.1*



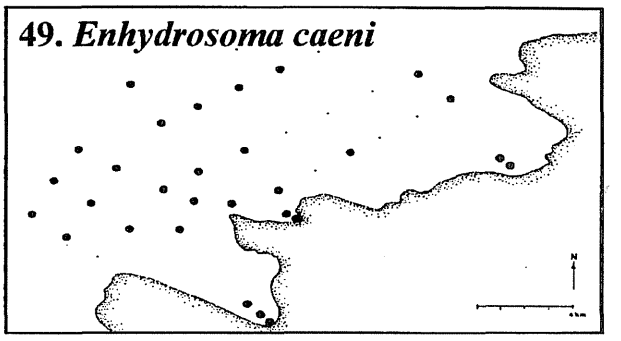
47. *Ectinosoma sp.2*



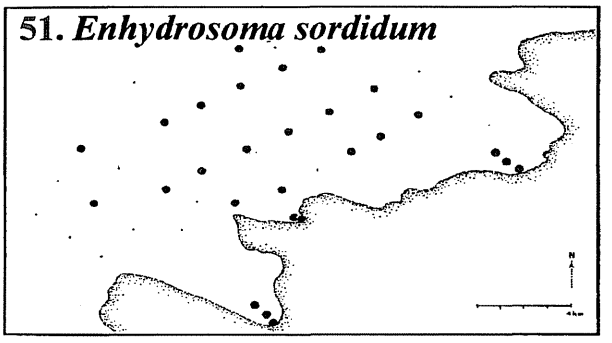
48. *Enhydrosoma buchholtzi*



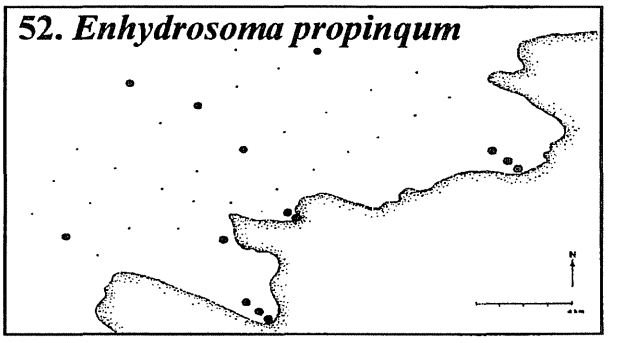
49. *Enhydrosoma caeni*



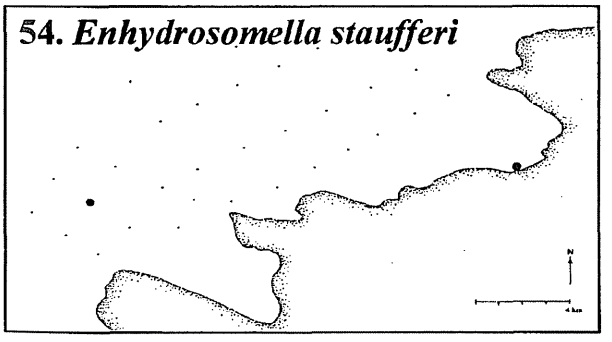
51. *Enhydrosoma sordidum*



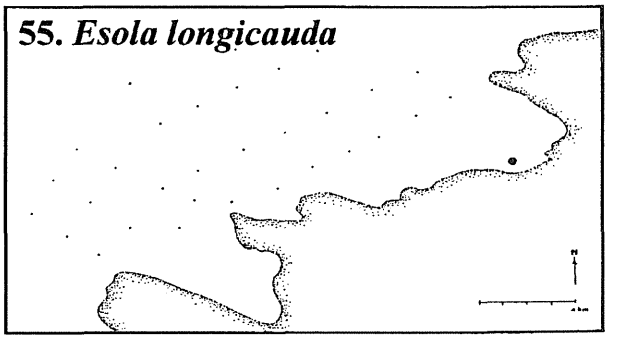
52. *Enhydrosoma propinqum*



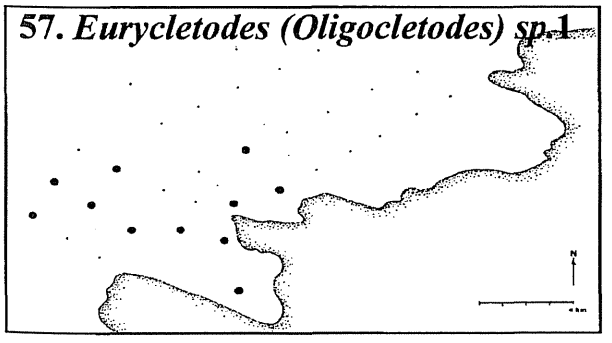
54. *Enhydrosomella staufferi*



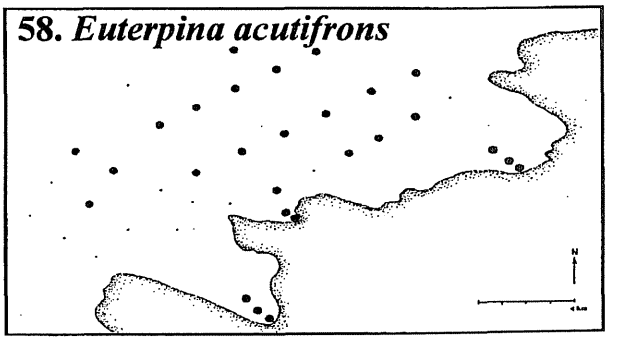
55. *Esola longicauda*

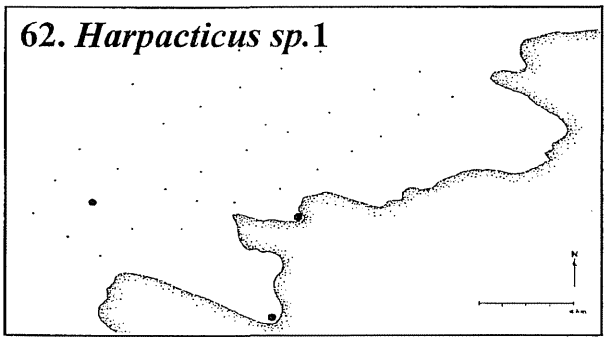


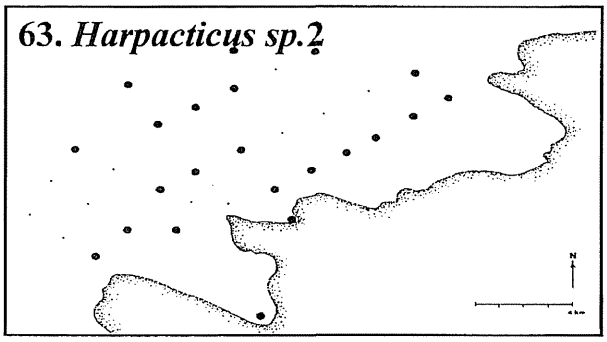
57. *Eurycletodes (Oligocletodes) sp.1*

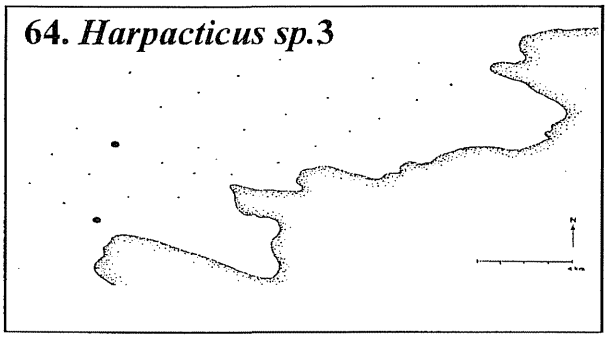


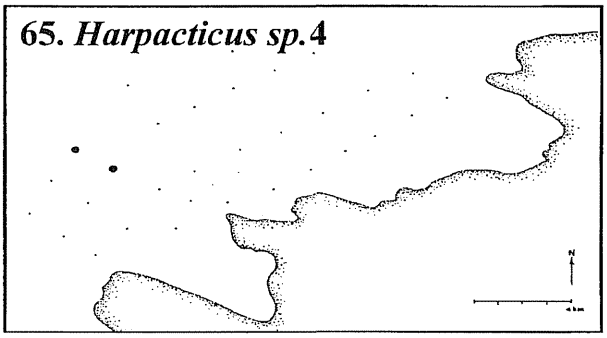
58. *Euterpina acutifrons*

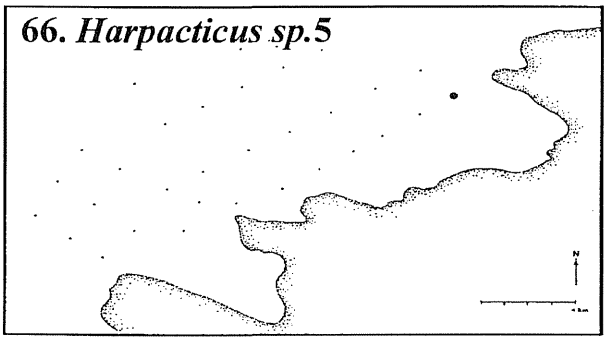


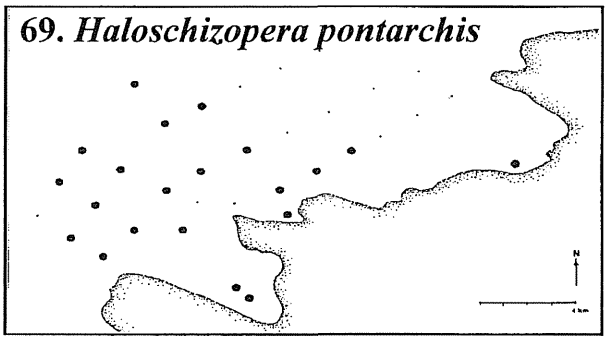

62. Harpacticus sp.1

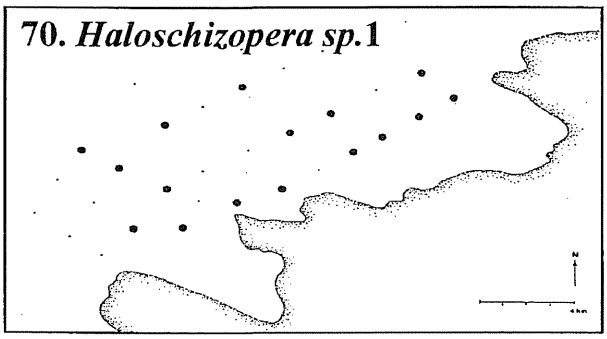

63. Harpacticus sp.2

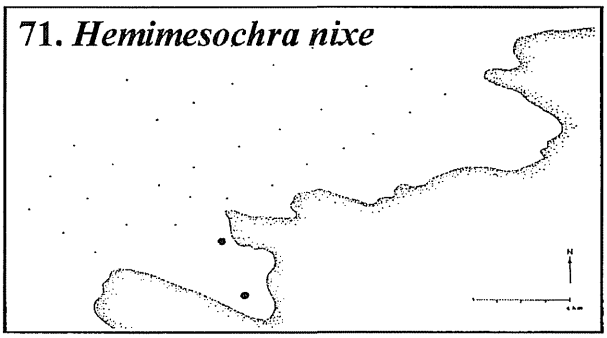

64. Harpacticus sp.3

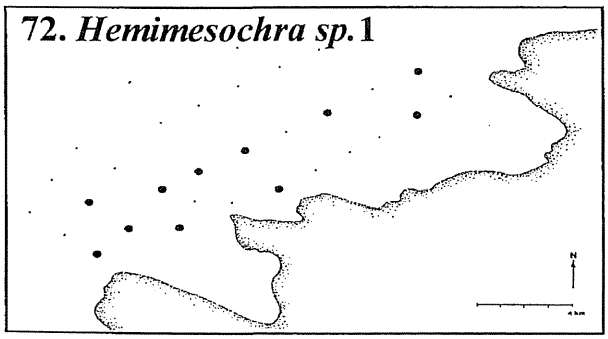

65. Harpacticus sp.4

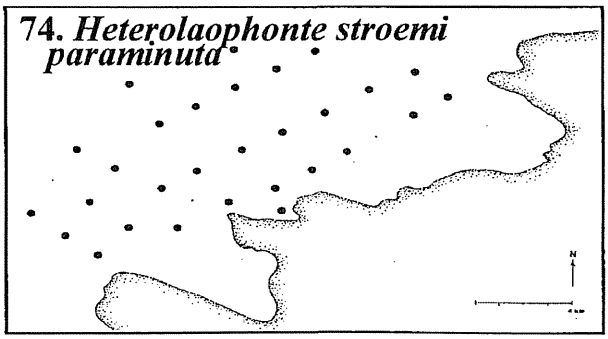

66. Harpacticus sp.5


69. Haloschizopera pontarchis

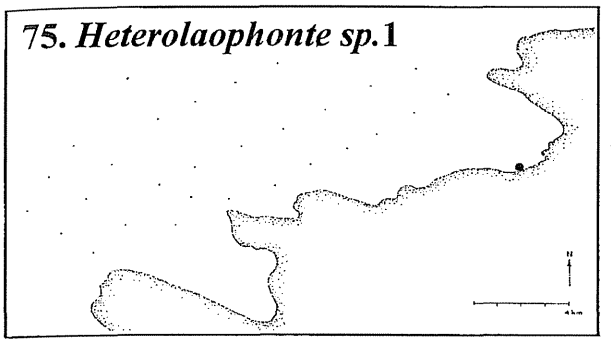

70. Haloschizopera sp.1


71. Hemimesochra nixe

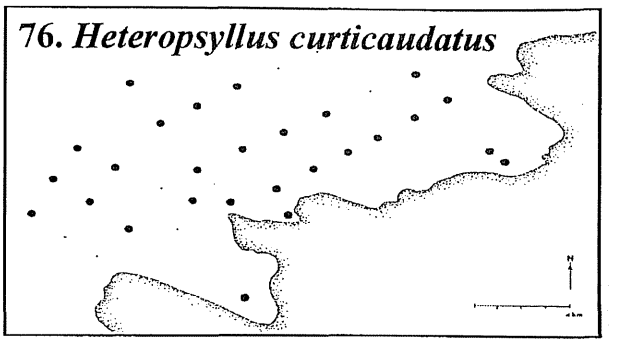

72. Hemimesochra sp.1


74. Heterolaophonte stroemi paraminuta

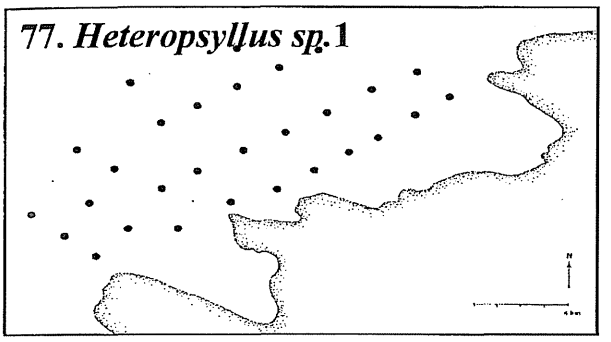
75. *Heterolaophonte sp.*1



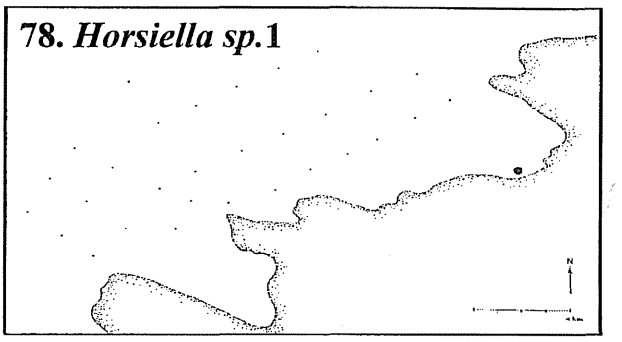
76. *Heteropsyllus curticaudatus*



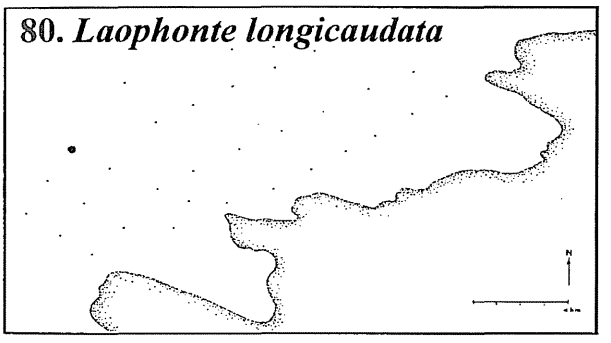
77. *Heteropsyllus sp.*1



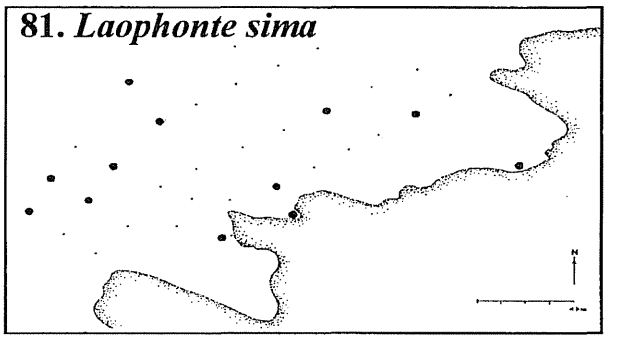
78. *Horsiella sp.*1



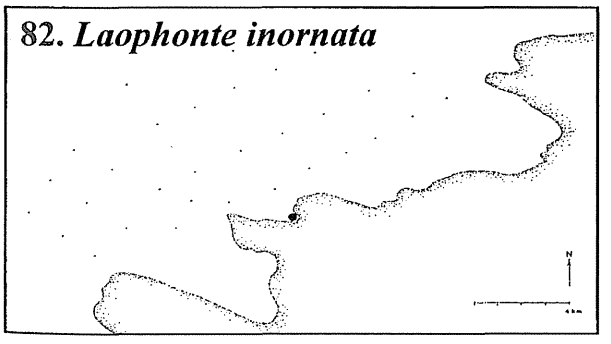
80. *Laophonte longicaudata*



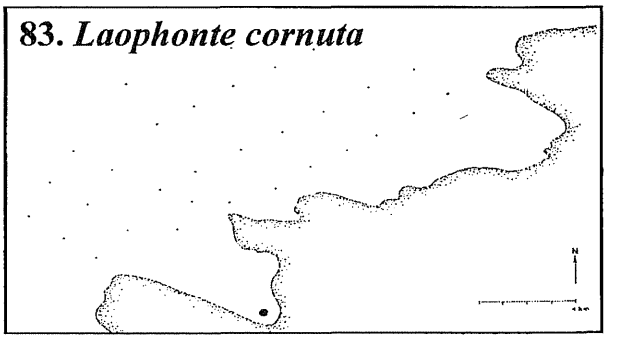
81. *Laophonte sima*



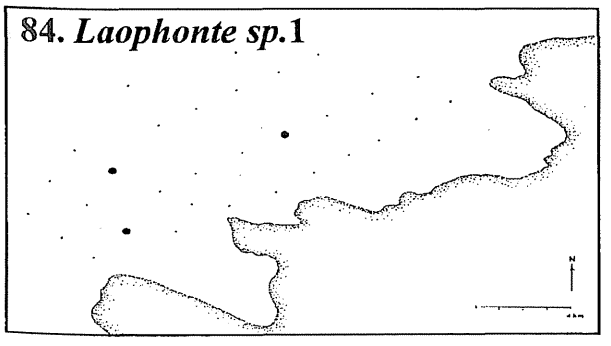
82. *Laophonte inornata*



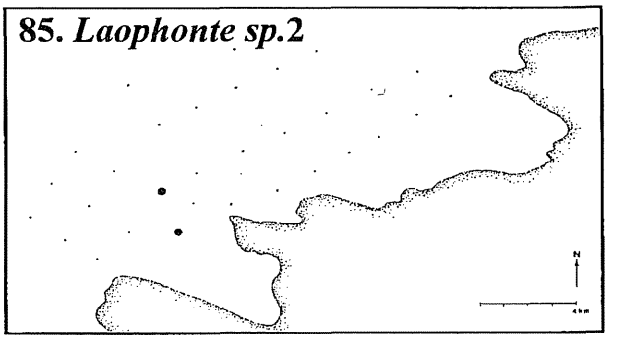
83. *Laophonte cornuta*

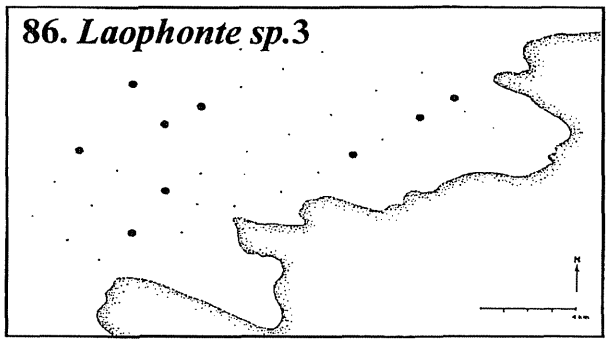


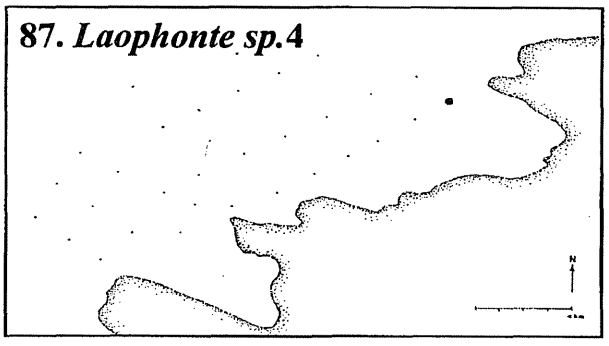
84. *Laophonte sp.*1

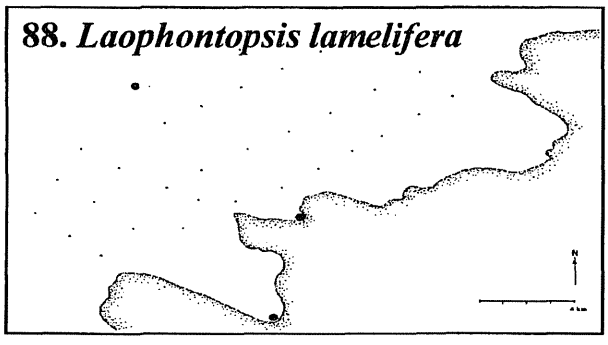


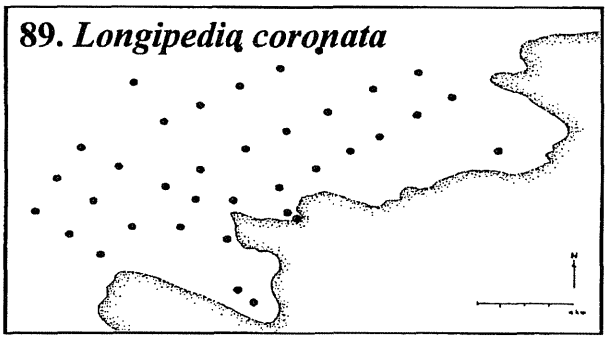
85. *Laophonte sp.*2

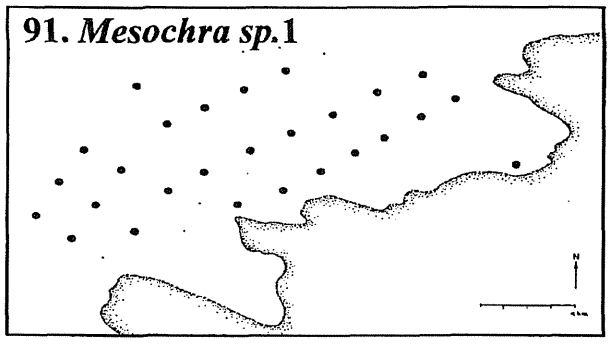


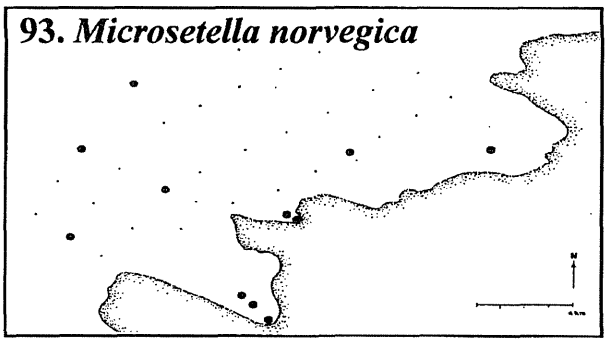

86. Laophonte sp.3

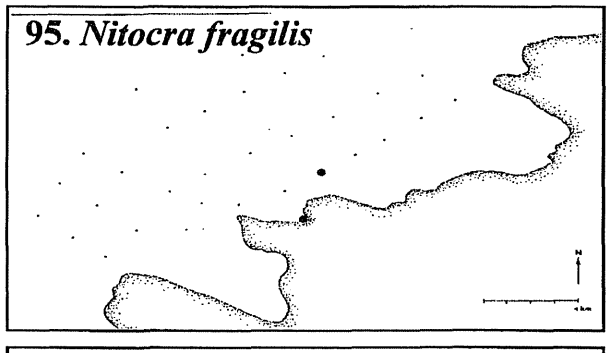

87. Laophonte sp.4

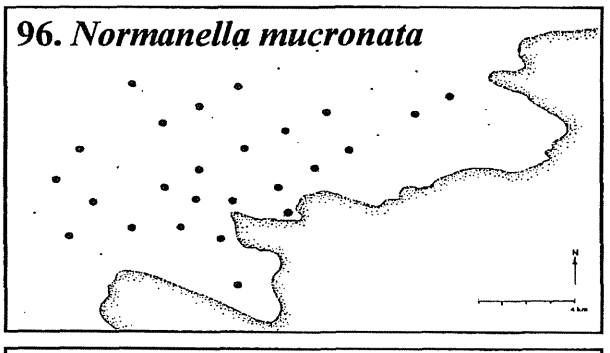

88. Laophontopsis lamelifera

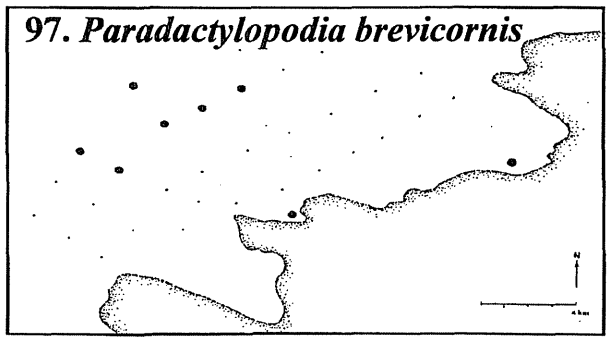

89. Longipedia coronata

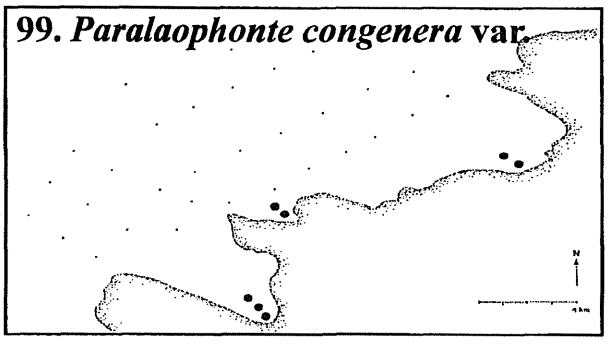

91. Mesochra sp.1


93. Microsetella norvegica

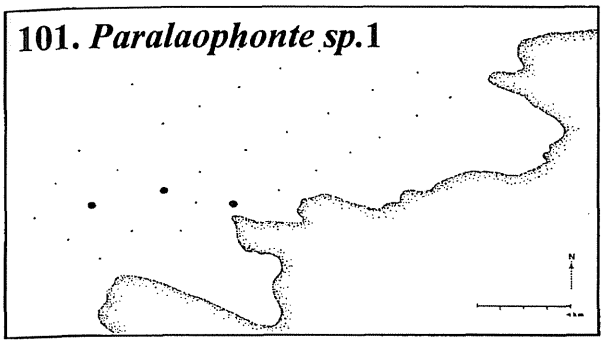

95. Nitocra fragilis


96. Normanella mucronata

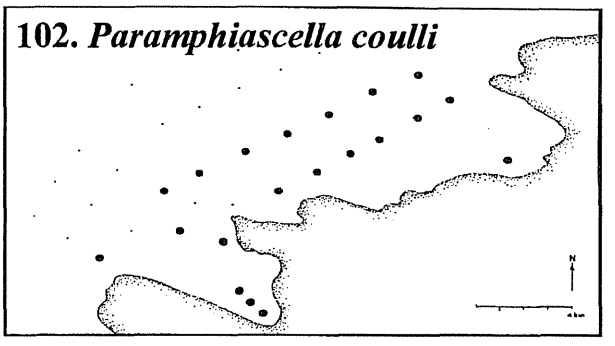

97. Paradactylopodia brevicornis


99. Paralaophonte congenera var.

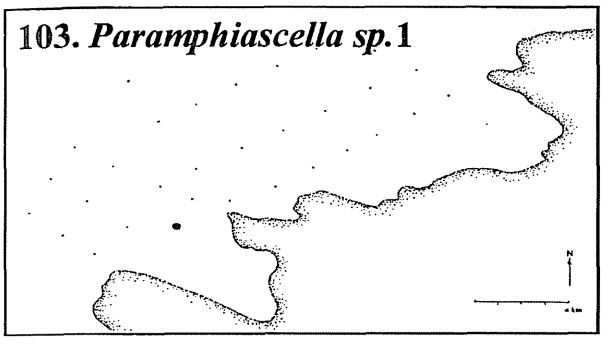
101. *Paralaophonte sp.*1



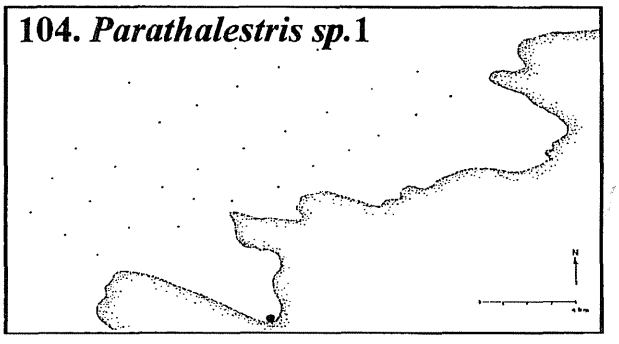
102. *Paramphiascella coulli*



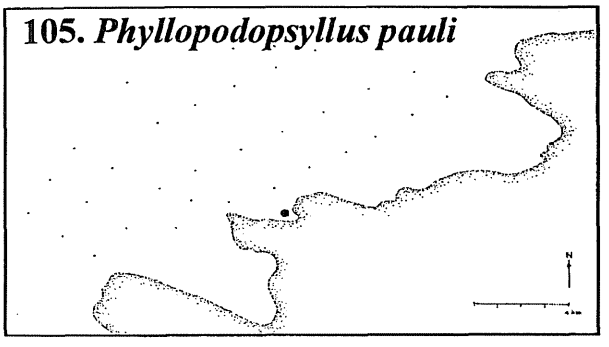
103. *Paramphiascella sp.*1



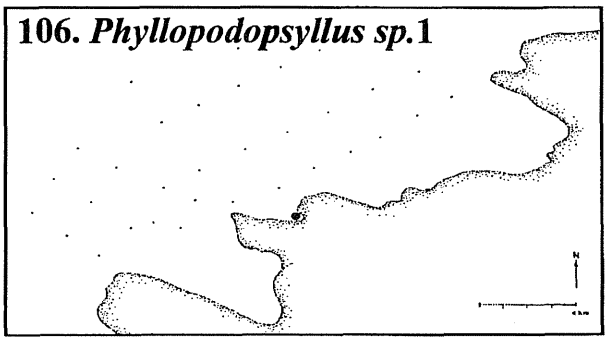
104. *Parathalestris sp.*1



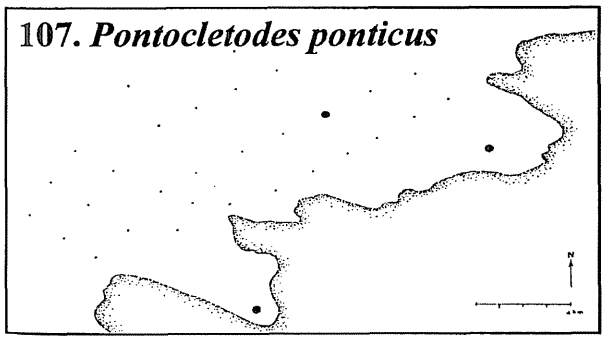
105. *Phyllopodopsyllus pauli*



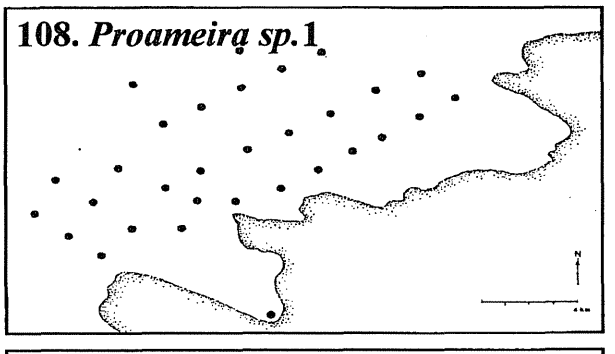
106. *Phyllopodopsyllus sp.*1



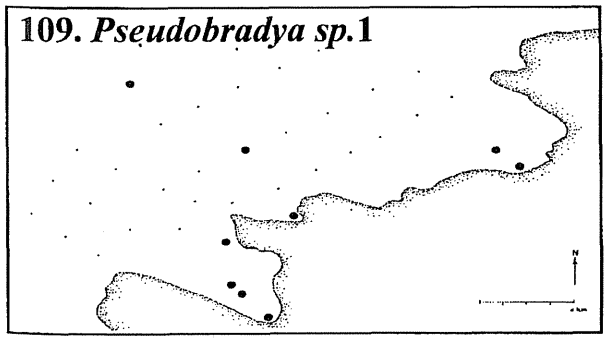
107. *Pontocletodes ponticus*



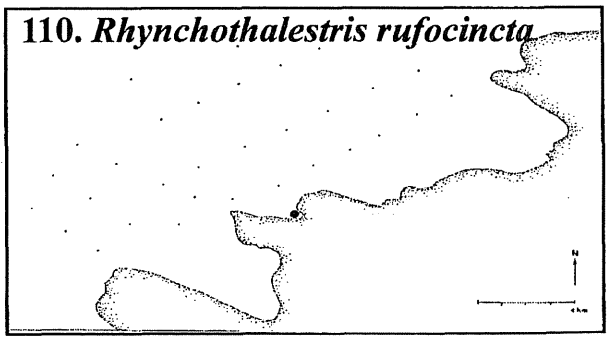
108. *Proameira sp.*1

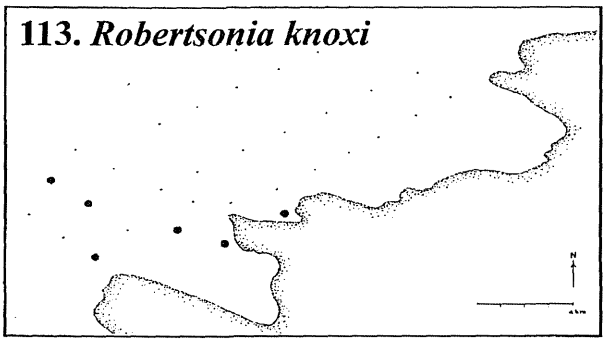


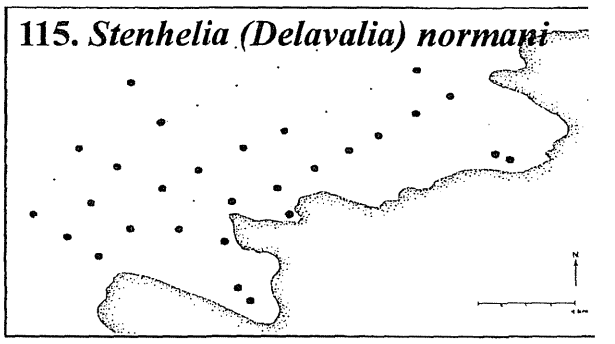
109. *Pseudobradya sp.*1

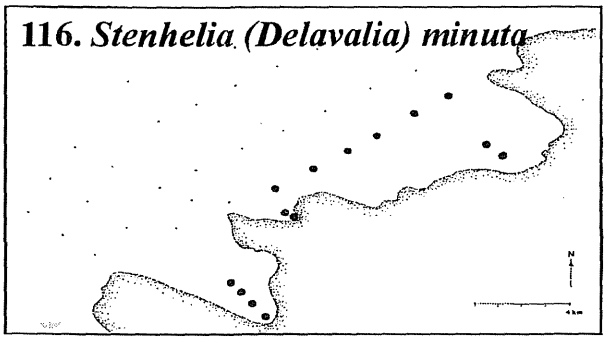


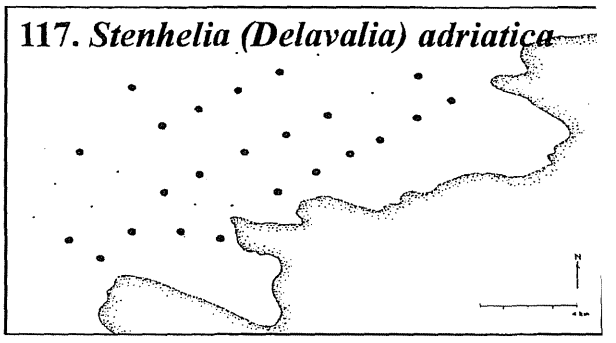
110. *Rhynchothalestris rufocincta*

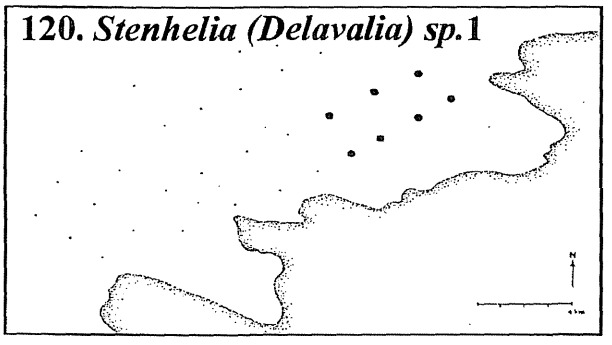


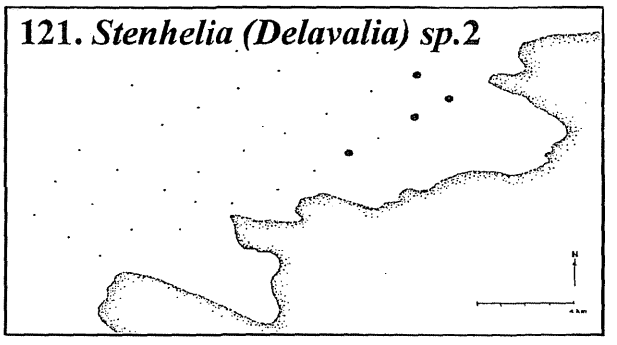

113. Robertsonia knoxi

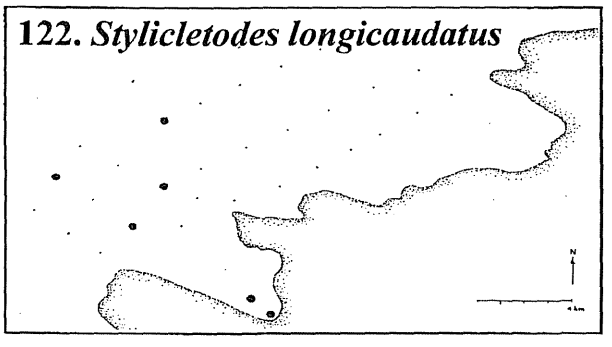

115. Stenhelia (Delavalia) normani

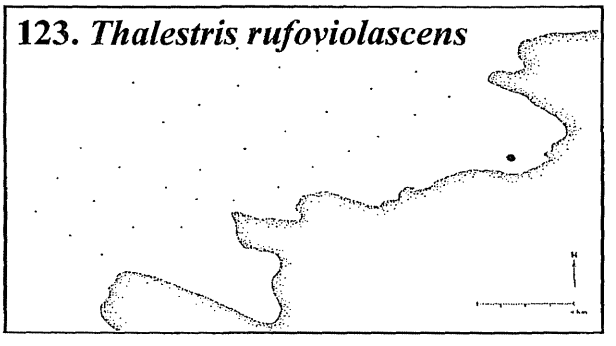

116. Stenhelia (Delavalia) minuta

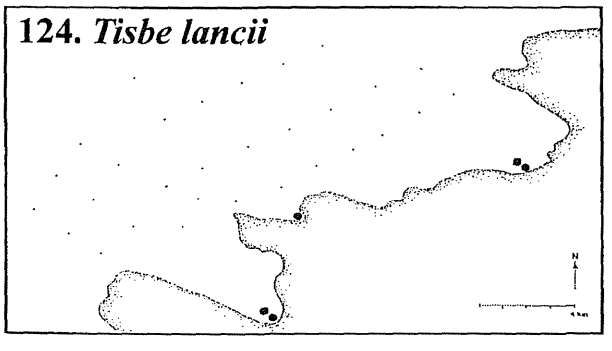

117. Stenhelia (Delavalia) adriatica

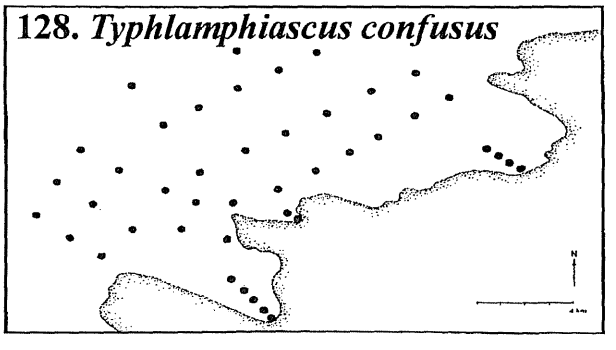

120. Stenhelia (Delavalia) sp.1

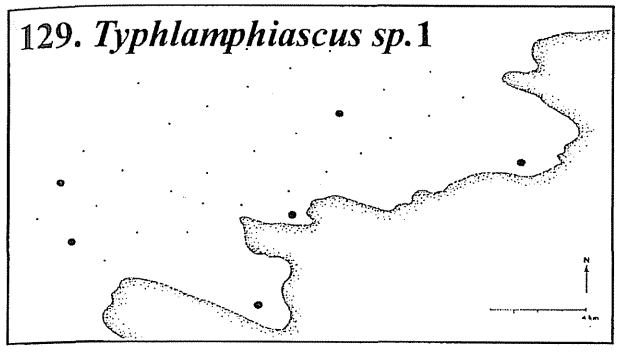

121. Stenhelia (Delavalia) sp.2

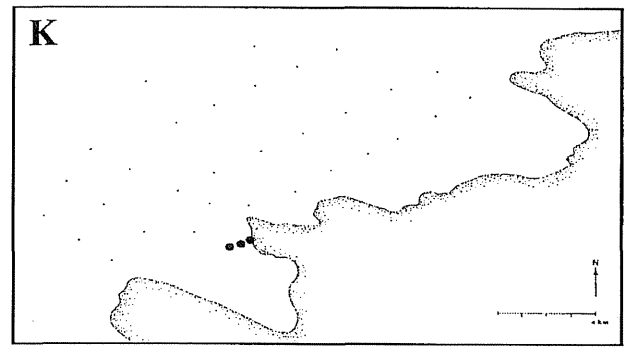

122. Stylicletodes longicaudatus


123. Thalestris rufoviolascens


124. Tisbe lancii


128. Typhlamphiascus confusus





MEIOBENTOŠKI HARPAKTIKOIDI (COPEPODA: HARPACTICOIDA) JUŽNEGA DELA TRŽAŠKEGA ZALIVA. II. EKOLOGIJA IN RAZŠIRJENOST VRST

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POVZETEK

Prispevek podaja pregled dosedanjih raziskav ekoloških značilnosti harpaktikoidov južnega dela Tržaškega zaliva s posebnim poudarkom na prostorski razširjenosti posameznih vrst, ki jih ponazarja 90 kart. Diverziteta harpaktikoidov pretežnega dela raziskovanega področja je dokaj enotna, zato lahko govorimo o eni, skupni obalni združbi harpaktikoidov mehkega dna. To združbo sestavljajo tri izrazitejše ekološke province, ki odsevajo prehod morskega dna od glinastih meljev obalnega pasu do finih peskov odprtega dela zaliva. Dve drugi opaženi združbi harpaktikoidov sta obrobnega pomena. Prva je prostorsko omejena na neposredno okolico dveh kanalizacijskih izlivov, druga, ki leži v centru Tržaškega zaliva, pa je verjetno posledica pogostih lokalnih hipoksij.

Ključne besede: Harpacticoida, Copepoda, Tržaški zaliv, razširjenost vrst

REFERENCES

Bodin, P. (1964): Recherches sur la systématique et la distribution des Copépodes Harpacticoïdes des substrats meubles des environs de Marseille. Recl. Trav. Stn. mar. Endoume, 51(35), 107-183.

Bodin, P. (1968): Recherches sur la systématique et la distribution des Copépodes Harpacticoïdes des substrats meubles des environs de Marseille. Note complémentaire. Recl. Trav. Stn. mar. Endoume, 59(43), 271-277.

Castel, J. (1985): Diversité spécifique et structure des peuplements meiobentiques d'un écosysteme lagunaire. Acta Oecologica, Oecol. Gener., 6, 395-412.

Chappuis, P. A. (1953): Harpacticoïdes psammiques récoltés par C. Delamare - Deboutteville en Méditerranée. Vie Milieu, 4(2), 254-276.

Josefson, A. B. & B. Widbom (1988): Differential response of benthic macrofauna and meiofauna to hypoxia in the Gullmar Fjord basin. Mar. Biol., 100, 31-40.

Marcotte, B. M. & B. C. Coull (1974): Pollution, diversity and meiobenthic communities in the North Adriatic (Bay of Piran, Yugoslavia). Vie Milieu, 24(2-B), 281-300.

Meischner, D. & J. Rumohr (1974): A light-weight, high momentum gravity corer for subaqueous sediments. Senckenb. Marit., 6, 105-116.

Monard, A. (1935): Les Harpacticoïdes marins de la région de Salammbô. Bull. Stat. Oceanogr. Salammbô, 34, 1-94.

Monard, A. (1937): Les Harpacticoïdes marins de la région d'Alger et de Castiglione. Bull. Stn. Aquic. Peche Castiglione, 1935(2), 9-93.

Murrell, M. C. & J. Fleeger (1989): Meiofauna abundance on the Gulf of Mexico continental shelf affected by hypoxia. Cont. Shelf Res., 9(12), 1049-1062.

Ogorelec, B., M. Mišič & J. Faganeli (1991): Marine geology of the Gulf of Trieste (Northern Adriatic): Sedimentological aspects. Marine Geology, 99, 79-92.

Pielou, E. C. (1969): An introduction to mathematical ecology. Wiley Interscience, New York, 286 pp.

Por, F. (1964): A study of the Levantine and Pontic Harpacticoida (Copepoda: Crustacea). Zool. Verh. Leiden, 64, 1-128.

Raibaut, A. (1962): Les Harpacticoïdes (Copepoda) de l'éntang des Eaux Blanches et de la crique de l'Angle. Naturalia monspel., 3, 87-89.

Raibaut, A. (1965): Sur quelques Cletodidae (Copepoda Harpacticoida) du bassin de Thau. Crustaceana, 8(2), 113-120.

Raibaut, A. (1967): Recherches écologiques sur les Copépodes Harpacticoïdes des etangs côtiers et des eaux saumâtres temporaires du Languedoc et de Camargue. These, Univ. de Montpellier, Fac. Sci., 238 pp.

Sanders, H. L. (1960): Benthic studies in Buzzards Bay. III. The structure of the soft bottom community. Limnol. Oceanogr., 5, 138-153.

Soyer, J. (1964a): Copépodes Harpacticoïdes de l'étage bathyal de la region de Banyuls-sur-Mer: I. Le genre *Eurycletodes* (Sars). Vie Milieu, 17(suppl.), 309-324.

Soyer, J. (1964b): Copépodes Harpacticoïdes de l'étage bathyal de la region de Banyuls-sur-Mer: II. Le genre *Typhlamphiascus* Lang. Vie Milieu, 14(4), 819-832.

Soyer, J. (1969): Contribution à l'étude des Copépodes Harpacticoïdes de Méditerranée occidentale. I. Cerviniidae Sars, Lang. Vie Milieu, 20(2-B), 367-386.

Soyer, J. (1970a): Contribution à l'étude des Copépodes Harpacticoïdes de Méditerranée occidentale. II. Ectinosomidae Sars, Olafsson. Vie Milieu, 21(1-B), 216-233.

Soyer, J. (1970b): Bionomie benthique du plateau continental de la côte Catalane francaise. III. Les peuplements de Copepodes Harpacticoïdes (Crustacea). Vie Milieu, 21(2-B), 337-516.

Travizi, A. (1990): Disturbance in meiofaunal community structure under anoxic stress effects. 1st Intern. Symp. "Ecol. probl. Adriatic", 44-45.

Vrišer, B. (1986): Vpliv organskega onesnaženja na meiofavno priobalnih glinastih muljev Koprskega zaliva. Biol. vestn., 34, 93-104.

Vrišer, B. (1989): Meiofavna južnega dela Tržaškega zaliva. I. Taksonomska struktura in abundanca. Biol. vestn., 37(4), 65-76.

Vrišer, B. (1991): Meiofauna of the southern part of the Gulf of Trieste (Northern Adriatic) II. Problems of the mesoscale spatial distribution. Biol. vestn., 39(1, 2), 165-176.

Vrišer, B. (1992): Meiofavna južnega dela Tržaškega zaliva. III. favna in združbe harpaktikoidov (Copepoda: Harpacticoida). Biol. vestn., 40, 89-106.

Vrišer, B. (2000): Meiobenthic Harpacticoida (Copepoda) from the southern part of the Gulf of Trieste (Northern Adriatic). I. List of taxa. Annales. *(this issue)*

Wieser, W. (1960): Benthic studies in Buzzards Bay II. The meiofauna. Limnol. Oceanogr., 5, 121-137.

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THE INFLUENCE OF MARINE ANOXIA ON PRECIPITATION OF *MYTILUS GALLOPROVINCIALIS* SHELL CARBONATE IN THE COASTAL ZONE OF THE ROVINJ BAY (NORTHERN ADRIATIC)

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ABSTRACT

The results of this study suggest changes in shell growth structure and in the isotopic, as well as chemical composition of Mytilus galloprovincialis *shells due to anoxia in the coastal zone of the Rovinj Bay, Northern Adriatic. The outer aragonitic "stress layer" of* Mytilus galloprovincialis *shells formed during pronounced summer anoxia due to intensive phytoplankton bloom in the years 1989 -1991 is massive, pink coloured and out of oxygen and carbon isotopic equilibria. It also exhibits higher C/O ratios relative to the uncoloured aragonitic layer precipitated by* Mytilus galloprovincialis *living in normal oxic conditions.*

Key words: *Mytilus galloprovincialis,* biomineralization, stable isotopes, anoxia, Rovinj Bay, Northern Adriatic

INFLUENZA DELL'ANOSSIA MARINA SULLA PRECIPITAZIONE CARBONATICA DELLA CONCHIGLIA DI *MYTILUS GALLOPROVINCIALIS* NELLA ZONA COSTIERA DELLA BAIA DI ROVIGNO (ADRIATICO SETTENTRIONALE)

SINTESI

I risultati di questo studio evidenziano variazioni nella struttura di crescita e nella composizione sia isotopica che chimica delle conchiglie di Mytilus galloprovincialis, *dovute ad anossia nella zona costiera della baia di Rovigno, Adriatico settentrionale. Lo strato esterno di aragonite delle conchiglie di* Mytilus galloprovincialis, *formatosi durante una marcata anossia estiva dovuta ad un'intensiva fioritura fitoplanctonica negli anni 1988-1991, è massiccio, di colore rosa e non rispetta l'equilibrio isotopico di ossigeno e carbonio. Questo strato esibisce, inoltre, frazioni C/O più alte rispetto a quelle dello strato di aragonite incolore, precipitato da* Mytilus galloprovincialis *in condizioni normali di ossigeno.*

Parole chiave: *Mytilus galloprovincialis,* biomineralizzazione, isotopi stabili, anossia, baia di Rovigno, Adriatico settentrionale

INTRODUCTION

Biomineralization is a complex combination of biochemical and physiological processes, depending on the endogenous activity of the organism and exogenous environmental influences. However, the influence and interaction between environmental factors, such as lack of oxygen and biomineralization, have been insufficiently investigated so far. This paper reports on the $\delta^{13}C$ and $\delta^{18}O$ values measured in selected pink coloured shell layers taken from specimens of *Mytilus galloprovincialis*, which were found growing in the coastal zone of the Rovinj Bay, Northern Adriatic, during anoxic conditions caused by intensive phytoplankton bloom in the years 1989-1991. These data were used to make interpretations regarding alterations in biomineralization processes influenced by environmental changes.

MATERIALS AND METHODS

Determination of $\delta^{18}O$ and $\delta^{13}C$ was performed on separate shell layers using a Varian MAT 250 mass spectrometer. Organic matter was eliminated prior to the determination of $\delta^{18}O$ and $\delta^{13}C$ by roasting the molluscan carbonate powder under vacuum for 1 hour at 380°C. Thereupon the carbonate powder was reacted with > 100 % H_3PO_4 at 25°C (McCrea, 1950). CO_2 gas released during acid treatment was cryogenically cleaned and analyzed for O and C isotopic composition. Data quality was maintained in part through frequent comparisons against internationally recognized isotopic standards and frequent processing of secondary laboratory standards. Before acid treatment, the mineralogical composition of the selected layer powder was checked by X-ray diffraction to determine the aragonite/calcite ratio. All results reported here are for samples of > 95 % aragonite or > 95 % calcite. Results are expressed relative to PDB for $\delta^{18}O$ and $\delta^{13}C$. The average difference of duplicate analyses was about 0.1 ‰ for oxygen and 0.09 ‰ for carbon.

For characterization of the microstructure and composition of *Mytilus galloprovincialis* shells, SEM and EDS analyses were applied. A JEOL JSM 5800 SEM equipped with a Link ISIS 300 EDS was used for overall analyses. Quantitative analyses were performed using SEM Quant software and a virtual standard package-library (VSP). Measured peak intensities in the spectra were corrected and quantified using a ZAF matrix correction program. In the case of oxygen, semi-quantitative estimation is possible only by comparison between the peak areas of oxygen peaks and different spectra without exact quantification. The relative random errors of EDS were less than 3% for major and selected minor oxides.

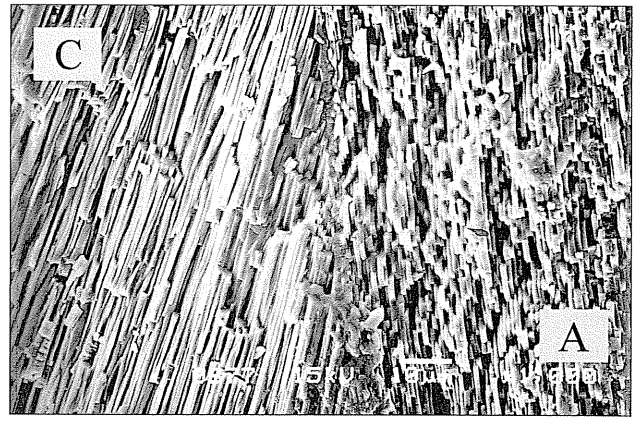

Fig. 1: SEM photo of calcite fibres (C) and prismatic nacreous aragonite (A) layer in *Mytilus galloprovincialis* ***shell.***
Sl. 1: Elektronski (SEM) posnetek apnenčastih vlaken (C) in prizmatičnega biserovinastega aragonitnega sloja (A) pri lupinicah školjke *Mytilus galloprovincialis.*

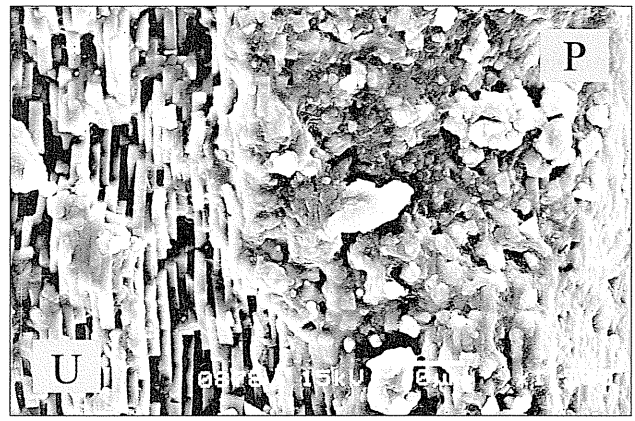

Fig. 2: SEM photo of the visible difference in morphology between the uncoloured (U) and pink (P) parts of the aragonite layer of a *Mytilus galloprovincialis* ***shell structure.***
Sl. 2: Elektronski (SEM) posnetek vidnih morfoloških razlik med neobarvanim (U) in rožnatim (P) delom aragonitnega sloja v sestavi lupinic školjke *Mytilus galloprovincialis.*

RESULTS AND DISCUSSION

SEM analyses showed that *Mytilus galloprovincialis* has an outer shell layer composed of calcite fibres and an inner nacreous shell layer, which is porcelaneous in appearance. Single fibres of the outer layer are approximately 1.5 µm thick and are inclined towards the shell exterior (Fig. 1). The inner layer is composed of equidimensional, horizontally flattened aragonite prisms about 10 - 20 µm wide, with their long axes oriented perpendicular to the shell surface. In pink coloured

shells, the inner layer is roughly divided into two sublayers. The inner uncoloured white sublayer consists of the same structure of flattened aragonite prisms, while the outer sublayer, up to 900 μm thick, is pink and composed of irregular aragonite grains and shows a massive structure (Fig. 2). These aragonite crystals are supposed to be precipitated during stress conditions and more rapidly than uncoloured ones.

Comparison between peak areas of the oxygen and carbon peaks shows that the pink coloured aragonite contains more carbon than oxygen relative to the uncoloured aragonite or calcite (Figs. 3, 4). The C/O ratio of the pink layer is 1.4 and 2.3 while that of the uncoloured aragonite from uncoloured and coloured shells varies between 0.9 and 1.2. Similar C/O values of 0.98 and 1 were also measured in calcite fibres. We believe that the high C/O ratio of the pink aragonite layer indicates anoxic conditions during its precipitation.

The *Mytilus galloprovincialis* shell carbonates show variation of $\delta^{18}O$ in the range between + 0.07 and + 2.21 ‰ and $\delta^{13}C$ between + 0.18 and - 1.31 ‰ (Tab. 1). In uncoloured shells, the calcitic layer is either slightly enriched in the heavy oxygen isotope relative to the inner aragonite layer or contains more or less the same quantity of heavy oxygen isotope as the aragonite one. Biogenic aragonite has been reported as having both ^{18}O depletion (Tarutani *et al.*, 1969; Horibe & Oba, 1972) and enrichment (Sommer & Rye, 1978; Grossman, 1982) compared to biogenic calcite. The magnitude of the ^{18}O enrichment of aragonite relative to mollusc calcite was not temperature dependent (Grossman & Ku, 1986). In the coloured shell the uncoloured aragonitic sublayer exhibits a higher $\delta^{18}O$ value than the pink aragonitic sublayer and/or calcitic layer. The 1.22 ‰ enrichment in $\delta^{18}O$ of the uncoloured aragonite sublayer relative to the pink layer would translate into a change of 4.5°C of seawater temperature using the Grossman & Ku (1986) equation. Such large changes in ambient seawater temperature most probably indicate a temperature-induced seasonal $\delta^{18}O$ signal as well as isotopic disequilibrium. The pink aragonite layer was formed between July and August during seawater anoxia when the ambient water was warmer.

The $\delta^{13}C$ of mussel carbonates vary between 0.18 and - 1.26 ‰. In all investigated samples the calcite layer contained more light carbon ^{12}C isotope than the aragonite one. The isotopic difference between the calcite and aragonite layers most probably corresponds to different equilibrium fractionation in the calcite-water and aragonite-water systems. Aragonite was found to be enriched by 1 ‰ in ^{13}C relative to coexisting calcite at the relevant temperatures (Grossman, 1984; Grossman & Ku, 1986). In the coloured shell the pink aragonite sublayer was enriched (up to 0.91 ‰) in light ^{12}C relative to the uncoloured aragonite sublayer. It is interesting to note that there is a negative correlation between $\delta^{18}O$ and $\delta^{13}C$ for the fibrous calcitic layers and a positive one for aragonitic layers (Fig. 5).

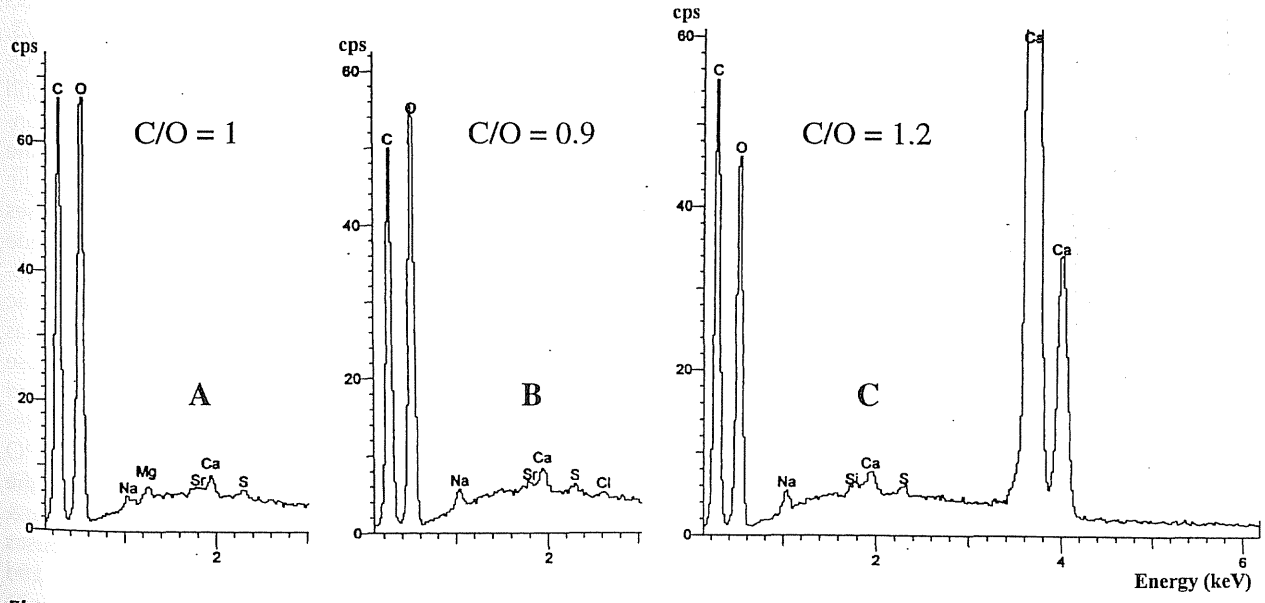

Fig. 3: Energy Dispersive Spectroscopy (EDS) spectra and C/O ratio of an uncoloured** Mytilus galloprovincialis **shell showing only small differences in the maxima of the oxygen and carbon peaks between the carbonate layers. (A) fibrous calcitic layer, (B) outer part of the aragonitic layer, (C) inner part of the aragonitic layer.

Sl. 3: EDS-spektri in C/O-razmerje neobarvane školjke** Mytilus galloprovincialis **kažejo le manjše razlike v največjih vsebnostih kisika in ogljika med dvema karbonatnima slojema. (A) vlaknati apnenčasti sloj, (B) zunanji del aragonitnega sloja, (C) notranji del aragonitnega sloja.

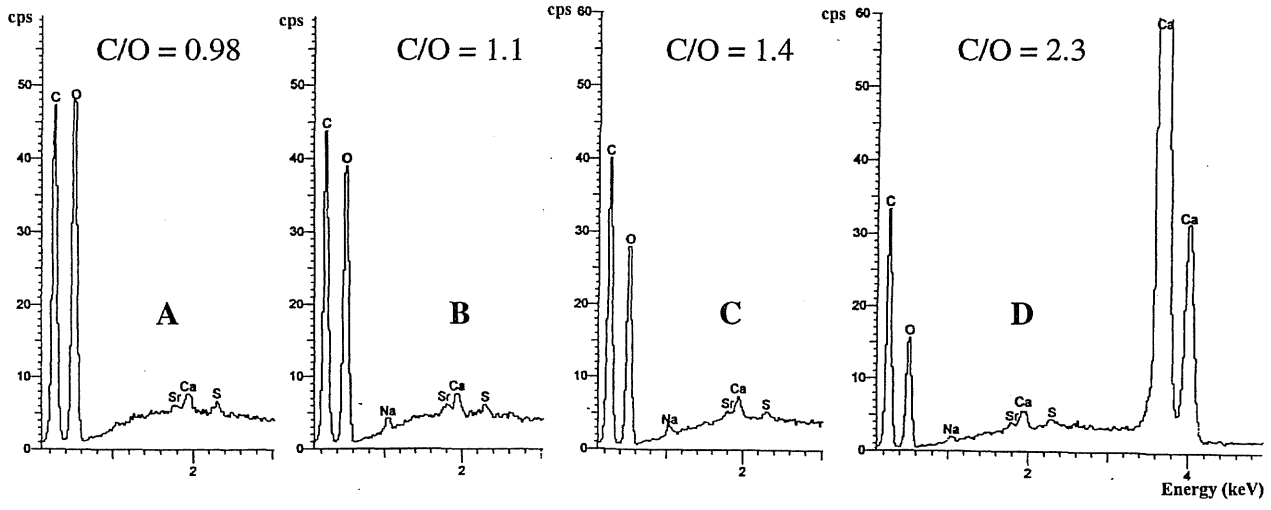

Fig. 4: Energy Dispersive Spectroscopy (EDS) spectra and C/O ratio of pink coloured *Mytilus galloprovincialis* ***shell showing appreciable differences in the maxima of the oxygen and carbon peaks between different carbonate layers. (A) fibrous calcitic layer, (B) uncoloured aragonitic sublayer, (C) inner part of pink aragonitic sublayer, (D) outer part of pink aragonitic sublayer.***
Sl. 4: EDS-spektri in C/O-razmerje rožnato obarvanih lupinic školjke *Mytilus galloprovincialis* ***kažejo na znatne razlike v največjih vsebnostih kisika in ogljika med dvema karbonatnima slojema. (A) vlaknati apnenčasti sloj, (B) neobarvani aragonitni podsloj, (C) notranji del rožnatega aragonitnega sloja, (D) zunanji del rožnatega aragonitnega sloja.***

Tab. 1. Stable oxygen and carbon isotope composition of *Mytilus galloprovincialis* ***shell carbonates.***
Tab. 1: Izotopska sestava kisika in ogljika v karbonatih lupinic školjke *Mytilus galloprovincialis.*

Sample	$\delta^{18}O$ (PDB ‰)	$\delta^{13}C$ (PDB ‰)	Remarks
R-202 a	1.65	- 1.04	calcite
R-202 b	1.04	- 0.32	aragonite
O-204 a	1.13	- 0.84	calcite
O-204 b	1.39	0.18	aragonite (u)
O-204 c	0.07	- 0.73	aragonite (p)
M-202 a	1.01	- 1.31	calcite
M-202 b	0.98	- 0.14	aragonite (pk)
S-1 a	2.21	- 1.26	calcite
S-1 b	1.22	- 0.15	aragonite
ST-1 a	0.33	- 0.77	calcite
ST-1 b	0.81	- 0.19	aragonite

R-202, S-1, ST-1 (uncoloured *Mytilus galloprovincialis* shells), O-204, M-202 (pinky to pink coloured *Mytilus galloprovincialis* shells), (u) - uncoloured, (p) -pink, (pk) -pinky

R-202, S-1, ST-1 (neobarvane lupinice školjke *Mytilus galloprovincialis*), O-204, M-202 (rahlo rožnato do rožnato obarvane lupinice školjke *Mytilus galloprovincialis*), (u) -neobarvane, (p) - rožnate, (pk) - z rožnatim nadihom

The water temperature, salinity, and the total dissolved carbon (TDC) content have been recognised as major factors controlling the oxygen and carbon isotope composition in shell carbonate of marine invertebrates (Anderson & Arthur, 1983; Rosenberg, 1980). Molluscs, in general, are believed to exert only a minimal vital effect over their isotopic composition (Jones, 1985), and thus their isotopic values are representative of environmental water conditions. However, calcium carbonate may not always be precipitated in equilibrium with the environment, and in such cases stable isotope analyses of the shell carbonate may be an unreliable technique for environmental reconstruction. Isotopic disequilibrium may be in part due to metabolic effects or kinetic effects that are inherent in fast-growing shells, or areas of shell (Mitchell *et al.*, 1994). Many molluscs use aragonite to build their shell, but calcitic molluscs and those with mixed mineralogy also are abundant. Because aragonite is found to be enriched by 0.7 ‰ in ^{18}O and by 1 ‰ in ^{13}C relative to coexisting calcite at the relevant temperatures (Grossman, 1984; Grossman & Ku, 1986) the calcitic and aragonitic layers in molluscs shells with mixed mineralogy must be sampled and treated separately. In shells with mixed aragonite-calcite composition, low temperatures are favourable for deposition of calcite, while warm waters favour the formation of aragonite (Schifano & Censi, 1986).

The calculated temperature for *Mytilus galloprovincialis* shell calcite according to the equation of Craig (1965):

$T[°C] = 16.9 - 4.2(\delta_C - \delta_W) + 0.13(\delta_C - \delta_W)^2$

(where δ_C is the oxygen isotopic composition of calcite vs. PDB and δ_W is the oxygen isotopic composition of the water from which the calcite was precipitated vs. SMOW), range from 11.8 to 19.8°C, while that of aragonite calculated according to Grossman & Ku (1986):

$T[°C] = 21.8 - 4.69(\delta^{18}O_{aragonite} - \delta^{18}O_{water})$

is between 20 and 26.2°C. Because no water samples were collected, the $\delta^{18}O$ of seawater of + 1.0 ‰ had to be taken from the literature (Dolenec *et al.*, 2000). The calculated values are generally regarded as typical of conditions in the investigated areas. The calculated temperature for *Mytilus galloprovincialis* further implies that this mussel most probably calcifies shell carbonate all the year round. During the colder months of the year the mussel precipitated more calcite, while during the summer this organism calcifies more aragonite.

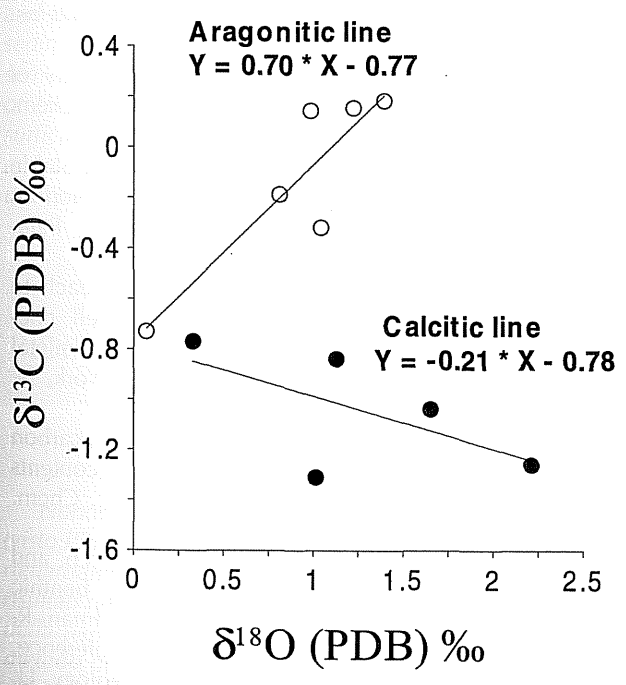

Fig. 5. *$\delta^{18}O$ vs. $\delta^{13}C$ diagram for* Mytilus galloprovincialis ***shell carbonates showing a positive trend for aragonite (○) and a negative one for calcite (●).***

Sl. 5: *$\delta^{18}O$ vs. $\delta^{13}C$-diagram za karbonate lupinic* ***školjke*** Mytilus galloprovincialis ***kaže pozitiven trend za aragonit (○) in negativen trend za kalcit (●).***

Most marine carbonates reflect the $\delta^{13}C$ of total dissolved inorganic carbon (TDC) of the water in which they form (Anderson & Arthur, 1983), and this is probably also the case with the *Mytilus galloprovincialis* from the investigated area. Whereas many organisms display a vital carbon isotope fractionation effect, molluscs are considered to precipitate carbonate in or near isotopic equilibrium with ambient water (Wefer & Berger, 1991). Normally, when calcium carbonate precipitates slowly from solution, equilibrium isotope partitioning is observed. However, faster precipitation may result in isotopic signatures, which are significantly out of equilibrium (Mitchell *et al.*, 1994). In the case of the pink coloured *Mytilus galloprovincialis* shells we feel reasonably confident that the pink aragonite sublayer represents a stress layer formed during summer anoxia. The lower $\delta^{13}C$ of this layer thus could indicate the incorporation of isotopically light bicarbonate due to the decomposition of organic matter and/or kinetic effects due to the fast growth of the pink biogenic aragonite. This hypothesis is supported by field observations as well as by structural and chemical changes in the minor aragonitic layer, which are coincidental with the higher ^{12}C content. The pink aragonite sublayer is believed to form during pronounced summer anoxia. It contains a signature of stress conditions, which reflects the changes from a slow precipitation of uncoloured flattened aragonite prisms to irregular aragonite grains precipitated at high rates. Faster precipitation may result in isotopic signatures, which are significantly out of equilibrium. Kinetic effect have been described in both fast growing biogenic carbonates (McConnaughey, 1989) and in laboratory precipitated non-biological carbonates (Turner, 1982).

CONCLUSIONS

The impact of environmental factors such as marine anoxia in the coastal zone of the Northern Adriatic on the growth of *Mytilus galloprovincialis* shells is indicated by changes in the growth structure of the outer part of the nacreous aragonitic layer, which is pink in colour and out of isotopic equilibrium with oxygen and carbon from the ambiental seawater. Isotopic disequilibrium most probably resulted from faster precipitation of aragonite during the summer period, as well as from lack of oxygen and higher concentrations of isotopically light organic derived CO_2 in the anoxic environment. The influence of higher concentrations of ambiental CO_2 is also reflected in a higher C/O ratio of pink coloured aragonite as compared to the uncoloured one.

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VPLIV MORSKE ANOKSIJE NA IZLOČANJE KARBONATA V LUPINICAH ŠKOLJKE *MYTILUS GALLOPROVINCIALIS* IZ PRIOBALNEGA DELA ROVINJSKEGA ZALIVA (SEVERNI JADRAN)

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POVZETEK

Z raziskavo smo ugotovili vpliv morske anoksije v priobalnem delu Rovinjskega zaliva na zgradbo, izotopsko in kemično sestavo lupinic školjke Mytilus galloprovincialis. *Zunanji aragonitni del "stresne" plasti, ki je nastajal med močno poletno anoksijo zaradi intenzivnega cvetenja fitoplanktona v letih 1989-1991, je masiven in rožnat ter ni v izotopskem ravnotežju s kisikom in ogljikom. Poleg tega kaže tudi večje razmerje C/O v primerjavi z neobarvanim aragonitnim slojem pri školjkah, ki žive v normalnem oksidacijskem okolju.*

Ključne besede: *Mytilus galloprovincialis,* biomineralizacija, stabilni izotopi, anoksija, Rovinjski zaliv, severni Jadran

REFERENCES

Anderson, T. F. & M. A. Arthur (1983): Stable isotopes of oxygen and carbon and their application to sedimentologic and paleoenvironmental problems. *In:* Arthur, M. A., T. F. Anderson, I. R. Kaplan, J. Veizer & L. S. Land (*eds.*): Stable Isotopes in Sedimentary Geology. Soc. Econ. Paleont. Mineral. Short Course, 10, 1-1-1-151.

Craig, H. (1965): The measurement of oxygen isotope paleotemperature. *In:* Tongiorgi, E. (*ed.*): Stable isotopes in oceanographic studies and paleotemperatures. Spoleto 1965, No. 3. Nazionale della Ricerche, Laboratorio do Geologia Nucleare, Pisa, 1-24.

Dolenec, M., S. Lojen, N. Ogrinc & T. Dolenec (2000): Environmentally controlled variations of $\delta^{18}O$ and $\delta^{13}C$ in mollusc shells from the Makirina Bay, Pirovac Bay and Murter Sea (Central Adriatic): implications and applications. (*in prep.*)

Grossman, E. L. (1982): Stable isotopes in live benthic foraminifera from the south California borderland. Ph. D. Thesis, University of Southern California, 164 pp.

Grossman, E. L. (1984): Carbon isotopic fractionation in live benthic foraminifera - comparison with inorganic precipitate studies. Geochim. Cosmochim. Acta, 48, 1505-1512.

Grossman, E. L. & T. L. Ku (1986): Oxygen and carbon isotope fractions in biogenic aragonite: temperature effects. Chem. Geol., 59, 59-74.

Horibe, Y. & T. Oba (1972): Temperature scale of aragonite-water and calcite-water system. Fossils, 23/24, 69-79.

Jones, D. S. (1985): Growth increments and geochemical variations in the molluscan shell. *In:* Broadhead, T. W. (*ed.*): Mollusks. University of Tennesee, Knoxville, Tenn. Stud. Geol., 13, 72-87.

McConnaughey, T. (1989): ^{13}C and ^{18}O isotopic disequilibrium in biological carbonates: 1. Patterns. Geochim. Cosmochim. Acta, 53, 151-162.

McCrea, J. M. (1950): On the isotopic chemistry of carbonates and paleotemperature scale. Jour. Chem. Phys., 18, 849-857.

Mitchell, L., A. E. Fallick & G. B. Curry (1994): Stable carbon and oxygen isotope composition of mollusc shells from Britain and New Zealand. Palaeog., Palaeoclim., Palaeoecol., 111, 207-216.

Rosenberg, G. D. (1980): An ontogenetic approach to the environmental significance of bivalve shell chemistry. *In:* Rhoads, D. C. & R. A. Lutz (*eds.*): Skeletal Growth of Aquatic Organisms. Plenum, New York, N. Y., 133-168.

Schifano, G. & P. Censi (1986): Oxygen and carbon isotope composition, magnesium and strontium contents of calcite from a subtidal *Pattela coerula* shell. Chem. Geol., 58, 325-331.

Sommer, M. A. & D. M. Rye (1978): Oxygen and carbon isotope internal thermometry using benthic calcite and aragonite foraminifera pairs. *In:* Zartman, R. E. (*ed.*): Short Papers 4th International Conference, Geochronoloygy, Cosmochemistry, Isotope Geology. U. S. Geological Survey, Open-File Report 78-701, p. 408.

Tarutani, T., R. N. Clayton & T. K. Mayeda (1969): The effect of polymorphism and magnesium substitution on oxygen isotope fractionation between calcium carbonate and water. Geochim. Cosmochim Acta, 33, 987-996.

Turner, J. V. (1982): Kinetic fractionation of carbon-13 during calcium carbonate precipitation. Geochim. Cosmochim. Acta, 46, 1183-1191.

Wefer, G. & W. H. Berger (1991): Isotope paleontology: growth and composition of extant calcareous species. Marine Geol., 100, 207-248.

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HYDROCARBONS IN SEA WATER AND COASTAL SEDIMENTS OF THE SLOVENIAN PART OF THE GULF OF TRIESTE

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ABSTRACT

In spite of the expected pollution of the marine environment of the Gulf of Trieste with hydrocarbons (heavy sea traffic, Ports of Koper, Trieste and Monfalcone), only a few data are available on the content of these compounds in sea water and sediment. This is the reason why the results regarding the content of hydrocarbons in sea water samples and surficial sediment from the southeastern part of the Gulf of Trieste are presented in this work. Aliphatic and polyaromatic hydrocarbons were determined with the method of gas chromatography after the extraction from sediment. In the samples of sea water, the hydrocarbons were determined spectrofluorometrically. In view of the semblance and concentration of certain hydrocarbons, the most probable sources of pollution in this part of the Gulf of Trieste with hydrocarbons were stipulated. The results indicate, on average, a significant pollution of the sea and surficial sediment with hydrocarbons. These are to a high extent of petrogenic and pyrogenic origin. A terrestrial input of natural hydrocarbons is also evident, which is in view of the fact that we are dealing with coastal water not unexpected at all.

Key words: hydrocarbons, Gulf of Trieste, pollution, marine sediments

IDROCARBURI IN ACQUA DI MARE E SEDIMENTI COSTIERI DELLA PARTE SLOVENA DEL GOLFO DI TRIESTE

SINTESI

Nonostante gli idrocarburi rappresentino un carico non indifferente per l'ambiente marino del Golfo di Trieste (visto l'intenso traffico marino, i porti di Capodistria, Trieste e Monfalcone ed il turismo nautico), scarseggiano i dati riguardanti il contenuto di queste sostanze nell'acqua di mare e nei sedimenti. Nell'articolo vengono presentati i risultati della ricerca effettuata sul contenuto di idrocarburi in campioni di acqua di mare e di sedimenti superficiali della parte sud-orientale del Golfo di Trieste. Gli idrocarburi alifatici e poliaromatici sono stati determinati con il metodo della cromatografia a gas, in seguito all'estrazione di questi dal sedimento. Nei campioni di acqua di mare gli idrocarburi sono stati determinati con la spettrofluorimetria. In base ai dati su presenza e concentrazione di determinati idrocarburi, sono state evidenziate le più probabili fonti di inquinamento da idrocarburi in questa parte del Golfo di Trieste. Sia per l'acqua di mare che per i sedimenti superficiali, i risultati in media indicano un rilevante inquinamento da idrocarburi. La gran parte di questi è di origine petrogenica e pirogenica. È stata inoltre registrata la presenza di idrocarburi naturali provenienti da terra ferma, dato prevedibile per le acque costiere.

Parole chiave: idrocarburi, Golfo di Trieste, inquinameto, sedimenti marini

INTRODUCTION

Hydrocarbons of natural and anthropogenic origin are widely distributed in the natural environment throughout the world. Different sources of introduction of these compounds into the natural environment can be stated. The most important among them are oil seepage, oil spillage, traffic, urban runoff, waste waters and sewage effluents, as well as atmospheric deposition (GESAMP, 1993). Knowledge of the various sources of the introduction of such compounds into the marine environment as well as the concentrations of these compounds in sea water, sediment and marine organisms is of crucial importance to adequately assess the state of the environment. This is especially important where extensive industrial activity or traffic might be expected.

Because of their hydrophobic nature and, as a consequence, of low solubility in water, hydrocarbons tend to adsorb on organic or inorganic particles in water column. The enriched suspended matter is settled down to the sediment surface. In the sediment phase, hydrocarbons are less subjected to physico-chemical or biological processes and may accumulate to higher levels. In this way the marine sediments often contain hydrocarbons of higher concentrations than those in the overlaying water (Landrum & Robbins, 1990).

Hydrocarbons, especially polyaromatic hydrocarbons (PAH), have been recognized as hazardous environmental chemicals (GESAMP, 1993). They may act as narcotics to marine organisms, many of them are also carcinogenic and mutagenic (Donkin *et al.*, 1991; Simpson *et al.*, 1996) due to their metabolic transformation products. Many of marine organisms living in contaminated areas accumulate hydrocarbons (Baumard *et al.*, 1998). As a consequence, the elevated concentrations of these compounds in sea food could be harmful also for human health. These are important reasons for special attention devoted to this class of organic compounds.

The aim of the present work was to determine the content of hydrocarbons in surficial sediments and sea water in the southeastern (Slovenian) part of the Gulf of Trieste and to try to identify the origin of these compounds in this region. Despite several potential sources of pollution with hydrocarbons in this area only data for other parts of the Adriatic Sea are available (Dujmov & Sučević, 1989; Guzzella & de Paolis, 1994).

MATERIAL AND METHODS

Study area

The investigated area in the southeast of the Gulf of Trieste is part of the Northern Adriatic (Fig. 1). The marine environment along the coast is affected by pollution from different sources since this area is one of the most urbanized in the Northern Adriatic.

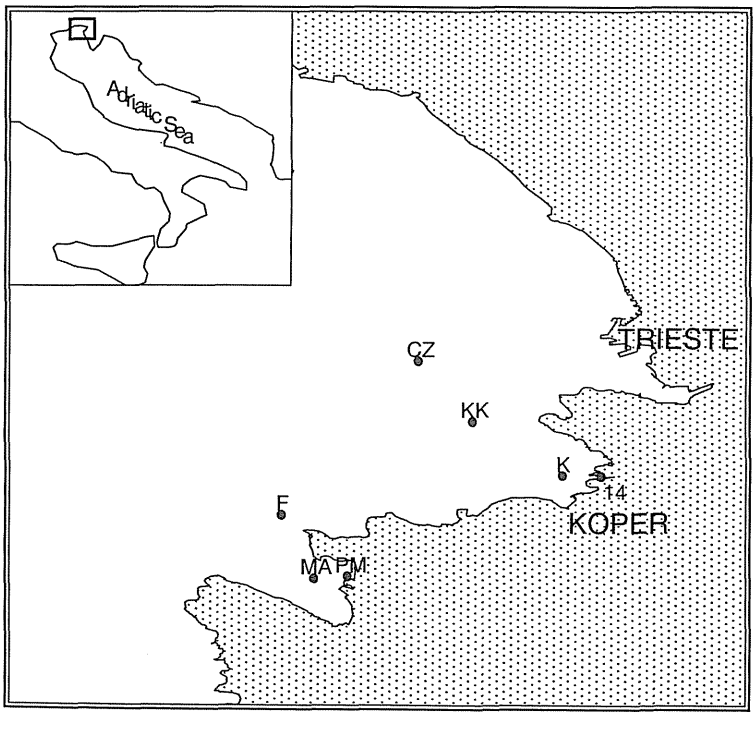

Fig. 1: Sampling sites within the investigated area.
Sl. 1: Vzorčevalna mesta na preiskovanem območju.

The estimated quantity of petroleum carried by ships to the three ports (Koper, Trieste, Monfalcone) in the Gulf of Trieste is about 30 millions tons per year. Beside the intensive maritime traffic, the nautical tourism is also well developed (3 marinas). Moreover, the marine environment within the studied area receives waste waters from several sewage treatment plants and fresh water from rivers, carrying also waste waters of the local industry, as well as waters draining rather large agricultural areas. Coastal waters in this part of the Gulf of Trieste are used for some other economically important activities, like tourism, fisheries and mariculture. According to the above mentioned facts, the knowledge about the state of marine environment in this part of the Adriatic Sea is thus very important.

Material and methods

"Distilled in glass" quality hexane, methanol and methylene chloride (Fluka) were used for extraction of hydrocarbons. All other chemicals used throughout this work were of analytical grade and purchased from Merck (Germany). Na_2SO_4, Silica, Alumina and extraction thimbles were precleaned by Soxhlet extraction with methanol and hexane (8 hours). Hg was rinsed several times with hexane.

Samples of water were collected in 3 l precleaned (methanol, hexane) bottles at 1 m depth. Hydrocarbons were extracted with 100 ml of hexane and, additionally, twice with 50 ml of hexane. The hexane phase was dried with Na_2SO_4 and concentrated on rotary evaporator at ambient temperature to about 5 ml. Concentration of hydrocarbons was determined spectrofluorometrically using a Turner 430 spectrofluorometer. The excitation and emission wavelengths were 310 and 360 nm, respectively. Calculations were made on chrysene standard basis.

Sediment samples were collected using a gravity core sampler (Meischner & Rumohr, 1974) at seven sites along the Slovenian part of the Gulf of Trieste (Fig. 1). The upper 1cm layer of each sediment sample was taken for analysis. After freeze drying, the samples were extracted in Soxhlet apparatus with hexane and methylene chloride (50:50) for 8 hours. The solution was concentrated on rotary evaporator and additionally under nitrogen stream. After sulfur removal with mercury and additional concentration, partition of hydrocarbons was performed with column chromatography (Silica, Alumina). Concentrated extracts were analyzed using a HP 5890 gas chromatograph equipped with FI detector and HP 3396 integrator. The HP Ultra 2 column (25 m x 0.32 mm, 0.17 µm film thickness) was used for analysis. C-32, n-octadecene and 9,10-dihydroanthracene were used as internal standards. Quantification was performed with external standards.

RESULTS AND DISCUSSION

Concentrations of hydrocarbon in sea water are presented in table 1. These results show somewhat higher concentrations of hydrocarbons only at sites 14 (Port of Koper) and PM (Portorož Marina), most probably due to the pollution from ships and boats.

Tab. 1: Content of total hydrocarbons in sea water (in chrysene equivalents).
Tab. 1: Vsebnost celotnih ogljikovodikov v morski vodi (v ekvivalentih krizena).

Sampl. site/ date	K *(µg/l)*	KK *(µg/l)*	*14 (µg/l)*	PM *(µg/l)*	MA *(µg/l)*
June	0.03	0.02	0.24	0.20	0.07
September	0.04	0.20	0.28	0.38	0.17
November	0.06	0.15	0.23	0.20	0.10
December	0.15	0.14	0.26	0.36	0.20

The amount of hydrocarbons in sea water at other sampling sites, compared with the results from the middle and southern Adriatic sea (Dujmov & Sučević, 1989), could be considered as relatively low.

Concentrations of aliphatic hydrocarbons in sediment samples are presented in table 2. The highest concentrations were obtained at stations 14 inside the Port of Koper, PM at the entrance of Portorož Marina, K in the middle of the Bay of Koper and CZ in the center of the Gulf of Trieste. Pollution from boats and ships appears as most probable the source of hydrocarbons at these locations. Moreover, site 14 is located in the estuary of the Rižana river and as such influenced by fresh water inputs, bringing also waste waters from the sewage treatment plant of the city of Koper. Different sources of the elevated concentrations of hydrocarbons in the Bay of Koper could be presumed. Among them, the influence of the port of Koper, the direct influence of the runoff from the coastal road between Koper and Izola (Faganeli *et al.*, 1997) and atmospheric inputs (city of Koper) (Faganeli *et al.*, 1997) could be important sources of pollution in this bay. The content of hydrocarbons in surficial sediments in the center of the Gulf of Trieste (site CZ) seems to be dependent on the transport processes of particles on which hydrocarbons are associated, sedimentation and sorptive preservation on mineral surfaces in mostly pelitic sediments (Hedges & Keil, 1995). On the other hand, the lowest amount of hydrocarbons at the site F is most probably related to the lower degree of adsorption, since the sediment is mostly composed of silty sand (Ogorelec *et al.*, 1991).

Tab. 2: Aliphatic hydrocarbons in sediment samples (ng/g dry weight).
Tab. 2: Alifatski ogljikovodiki v vzorcih sedimenta (ng/g suhe teže).

	CZ	14	PM	K	KK	MA	F
n-heptadecane	21	17	18	7	5	8	5
Pristane	12	10	3	5	<1	<1	<1
n-octadecane	25	22	20	26	7	18	9
Phytane	17	15	10	17	<1	10	<1
n-C14 to n-C34	193	182	216	117	71	78	49
Resolved aliphatics	268	246	267	197	83	114	63
UCM* (µg/g)	1.73	2.45	1.97	2.85	1.42	0.57	0.93
Total aliphatic (µg/g)	2.00	2.70	2.24	3.05	1.50	0.68	0.99

*UCM unresolved complex mixture

Concentrations of PAH, presented in table 3, followed a similar pattern of distribution to aliphatic hydrocarbons. Only concentrations at site PM were exceptionally high, with significant diversity of detected PAH.

Tab. 3: Polyaromatic hydrocarbons in sediment samples (ng/g dry weight).
Tab. 3: Poliaromatski ogljikovodiki v vzorcih sedimenta (ng/g suhe teže).

	CZ	14	PM	K	KK	MA	F
Naphthalene	9	4	5	3	<1	6	<1
1-methylnaphthalene	<1	<1	<1	<1	<1	<1	<1
1-ethylnaphthalene	<1	<1	<1	<1	<1	<1	<1
Acenaphtene	<1	3	6	<1	<1	<1	<1
Acenaphtylene	<1	3	<1	<1	<1	<1	<1
2,3,6-trimethyl-naphthalene	<1	<1	<1	<1	<1	<1	<1
Phenanthrene	8	<1	45	17	10	6	<1
Anthracene	5	<1	14	14	7	3	<1
Fluorene	6	72	10	6	6	<1	3
2-methylphenanthrene	18	11	15	19	13	8	<1
1-methylphenanthrene	23	4	<2	21	6	<2	4
Fluoranthene	8	7	87	24	14	4	6
Pyrene	5	3	75	39	22	10	<1
3,6-dimethyl-phenanthrene	<2	3	<2	<2	<2	<2	<2
Perylene	<1	12	3	<1	<1	<1	<1
1-methylpyrene	<1	<1	8	6	<1	<1	<1
Chrysene	<1	<1	64	13	4	<1	<1
Benzo[a]pyrene	<1	<1	46	<1	<1	<1	<1
Benzo[e]pyrene	13	<1	53	<1	<1	<1	<1
Benzo[a]anthracene	<1	<1	44	<1	<1	<1	<1
Resolved aromatic	86	113	484	162	82	31	13

Hydrocarbons may originate from different sources: biogenic, petrogenic and pyrogenic (La Flamme & Hites, 1978; Lipiatou & Saliot, 1991). A particular area may be affected from different sources of pollution and in such cases it is difficult to adequately distinguish between natural and mixed anthropogenic inputs. Different diagnostic criteria, such as unresolved/resolved hydrocarbons ratio, carbon preference index and PAH distribution pattern are used to determine the source of pollution (Bouloubassi & Saliot, 1993). Applying these criteria, some conclusions may be assumed about the investigated area. UCM was the major component of the aliphatic hydrocarbon fraction, higher than 80% (Tab. 2) at all sampling sites. It consists of branched and cyclic hydrocarbons (Gough & Rowland, 1990) and is usually related to degraded petroleum residues (Farrington & Tripp, 1977).

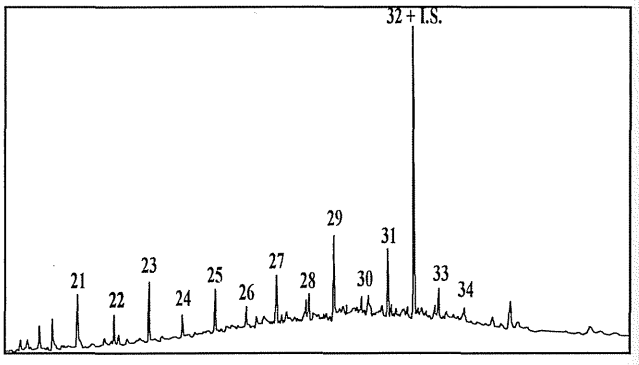

Fig. 2: Chromatogram of long-chain aliphatic hydrocarbon fraction (C_{21}-C_{34}) at site 14.
Sl. 2: Kromatogram višjemolekularne frakcije alifatskih ogljikovodikov (C_{21}-C_{34}) na mestu 14.

The compositional profile of n-alkanes showed a predominance of long-chain homologues (C_{21} - C_{34}). An elevated odd to even carbon number preference was detected especially at stations K and 14 (Fig. 2). Such distribution pattern of n-alkanes reveals the importance of terrestrial inputs in the study area (Saliot, 1981). The predominance of n-heptadecane, the hydrocarbon associated with phytoplankton (Saliot, 1981), was not observed. This reflects most probably the labile character of short-chain n-alkanes and a moderate productivity in the study area (Fonda Umani *et al.*, 1990). The presence of isoprenoid hydrocarbons pristane and phytane (Tab. 2) confirms the algal (Boehm, 1980) and anthropogenic (Anderlini *et al.*, 1981) origin, respectively.

Distribution of PAHs in surficial sediments within the study area revealed similar origin of hydrocarbons. The ratio of alkylated PAH homologues to parent compounds (especially for phenanthrene) was higher than 1 at all stations (except the station PM). This is an indication of fresh petroleum pollution (Blumer & Youngblood,

1975). The lower ratio alkylated/parent PAHs was calculated only for sediments in Portorož Marina (PM), indicating the predominance of combustion derived PAHs (Blumer & Youngblood, 1975). The appearance of pyrene, fluoranthene, benzo[a]pyrene and benzo[e]pyrene at higher concentrations at sampling site PM confirms the prevalent pyrogenic origin of hydrocarbons (Sporstol *et al.,* 1983). Fluoranthene and pyrene were detected in higher amounts in comparison to other sampling sites also at stations K and KK. This is an indication of pyrogenic pollution, originating probably from the Port and City of Koper (atmospheric deposition). The situation in the Port of Koper, regarding the appearance of PAHs, is somewhat surprising. The rather low concentrations of PAHs are most probably due to maintenance dredging and higher microbial degradation, due to elevated number of bacteria from sewage treatment plant, especially in the summer period (Faganeli *et al.,* 1988). Perylene, a biogenic aromatic hydrocarbon (Saliot, 1981), was detected at lower concentration in the Port of Koper. This could be a confirmation for terrestrial input, presumed already from the aliphatic hydrocarbon distribution.

In conclusion, the southeastern part of the Gulf of Trieste is, regarding pollution with hydrocarbons, a considerably polluted area. Hydrocarbons in surficial sediments in the investigated area are mostly of petrogenic and pyrogenic origin. Some terrestrial influence is also evident in the Port of Koper and in the middle of the Bay of Koper.

ACKNOWLEDGEMENTS

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OGLJIKOVODIKI V MORSKI VODI IN SEDIMENTU OBALNEGA MORJA SLOVENSKEGA DELA TRŽAŠKEGA ZALIVA

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POVZETEK

Ogljikovodiki, alifatski in PAH-i, so bili določeni v površinskem sedimentu slovenskega dela Tržaškega zaliva. Analize so bile opravljene s plinsko kromatografijo. Vzorci morske vode z istega področja so bili analizirani spektrofluorometrično.

Koncentracije raztopljenih/suspendiranih ogljikovodikov v morski vodi so razmeroma nizke. Le v Luki Koper in Marini Portorož so bile koncentracije nekoliko povišane, najverjetneje zaradi direktnega onesnaževanja z ladij in čolnov. Najvišje koncentracije alifatskih ogljikovodikov v površinskem sedimentu so bile izmerjene v Luki Koper, Marini Portorož ter sredi Tržaškega in Koprskega zaliva. Na razporeditev ogljikovodikov vplivajo, poleg direktnega onesnaževanja z ladij in čolnov, tudi transportni procesi in procesi sedimentacije. Ti procesi so še posebno pomembni v obeh omenjenih zalivih. Razporeditev PAH-ov je bila podobna kot v primeru alifatskih ogljikovodikov. Koncentracije v Marini Portorož so bile izrazito višje, visoka pa je bila tudi raznolikost določenih PAH-ov. Povišana vsebnost PAH-ov je bila določena tudi v Luki Koper in sredi Koprskega zaliva. Izvor ogljikovodikov je bil določen po različnih kriterijih, v literaturi opisanih v te namene. V Marini Portorož prevladujejo ogljikovodiki pirogenega izvora, na drugih vzorčevalnih mestih pa lahko sklepamo na mešani petrogeni in pirogeni izvor ogljikovodikov. V koprskem pristanišču in sredi Koprskega zaliva je opazen tudi kopenski vnos obravnavanih snovi, najverjetneje z vodami reke Rižane.

Ključne besede: ogljikovodiki, Tržaški zaliv, onesnaževanje, morski sediment

REFERENCES

Anderlini, V. C., L. Al-Harmi, B. W. DeLappe, R. W. Risebrough, B. R. T. Simoneit & A. S. Newton (1981): Distributions of hydrocarbons in the oyster *Pinctada margaritifera* along the coast of Kuwait. Mar. Poll. Bull., 12, 57-62.

Baumard, P., H. Budzinski, P. Garrigues, J. C. Sorbe, T. Burgeot & J. Bellocq (1998): Concentrations of PAH in various marine organisms in relation to those in sediments and to trophic level. Mar. Poll. Bull., 36(12), 951-960.

Blumer, M. & W. W. Youngblood (1975): Polycyclic aromatic hydrocarbons in soils and recent sediments. Science, 188, 53-55.

Boehm, P. D. (1980): Evidence for the decoupling of dissolved, particulate and surface microlayer hydrocarbons in northwestern Atlantic continental shelf waters. Mar. Chem., 9, 255-281.

Bouloubassi, I. & A. Saliot (1993): Investigation of anthropogenic and natural organic inputs in estuarine sediments using hydrocarbon markers (NAH, LAB, PAH). Oceanol. Acta, 16(2), 145-161.

Donkin, P., J. Widdows, S. V. Evans & M. D. Brinsley (1991): QSAR for the sublethal response of marine mussels (*Mytilus edulis*). Sci. Tot. Environ., 109/110, 461-476.

Dujmov, J. & P. Sučević (1989): Contents of polycyclic aromatic hydrocarbons in the Adriatic Sea determined by UV-fluorescence spectroscopy. Mar. Poll. Bull., 20(8), 405-409.

Faganeli, J., N. Fanuko, A. Malej, R. Planinc & V. Turk (1988): Vpliv reke Rižane na morje v Koprskem zalivu. Naše okolje, 3-4, 52-55.

Faganeli, J., B. Vrišer, H. Leskovšek, B. Čermelj & R. Planinc (1997): The impact of highway pollution on the coastal sea. *In:* Rajar, R. & C. A. Brebbia (*eds.*): Water pollution IV. Modelling, measuring and prediction. Computational Mechanics Publications, Southampton, UK, 161-173.

Farrington, J. W. & B. W. Tripp (1977): Hydrocarbons in western North Atlantic surface sediments. Geochim. Cosmochim. Acta, 41, 1627-1641.

Fonda Umani, S., P. Franco, E. Ghirardelli & A. Malej (1990): Outline of oceanography and the plankton of the Adriatic Sea. *In:* Colombo, G. (*ed.*): Marine eutrophication and population dynamics. Proceedings of the 25th EMBS. Olsen & Olsen, Fredensborg, Denmark, 347-365.

GESAMP (1993): Review of potentially harmful substances: oil and other hydrocarbons including used lubricating oils, oil spill dispersants and chemicals used in offshore exploration and exploitation. Impact of oil and related chemicals and wastes on the marine environment, XXII/4. Joint group of experts on the scientific aspects of marine pollution. Reports and studies, IMO, London, UK.

Gough, M. A. & S. J. Rowland (1990): Characterization of unresolved complex mixture of hydrocarbons in petroleum. Nature, 344, 648-650.

Guzzella, L. & A. de Paolis (1994): Polycyclic aromatic hydrocarbons in sediments of the Adriatic sea. Mar. Poll. Bull., 28(3), 159-165.

Hedges, J. I. & R. G. Keil (1995): Sedimentary organic matter preservation: an assessment and speculative synthesis. Mar. Chem., 49, 81-115.

La Flamme, R. E. & R. A. Hites (1978): The global distribution of polycyclic aromatic hydrocarbons in recent sediments. Geochim. Cosmochim. Acta, 42, 289-303.

Landrum, P. F. & J. A. Robbins (1990): Bioavailability of sediment-associated contaminants to benthic invertebrates. *In:* Baudo, R., J. P. Giesy & H. Muntau (*eds.*): Sediments: Chemistry and toxicity of in-place pollutants. Lewis Pubblishers, Michigan, 237-263.

Lipiatou, E. & A. Saliot (1991): Fluxes and transport of anthropogenic and natural polycyclic aromatic hydrocarbons in the western Mediterranean Sea. Mar. Chem., 32, 51-71.

Meischner, D. & J. Rumohr (1974): A light-weight, high-momentum gravity corer for subaqueous sediments. Senckenbergiana Marit., 6(1), 105-117.

Ogorelec, B., M. Mišič & J. Faganeli (1991): Marine geology of the Gulf of Trieste (northern Adriatic): Sedimentological aspects. Mar. Geol., 99, 79-92.

Saliot, A. (1981): Natural hydrocarbons in sea water. *In:* Duursma, E. K. & R. Dawson (*eds.*): Marine organic chemistry. Elsevier Oceanography, Series 31. Elsevier, Amsterdam, 327-374.

Simpson, C. D., A. A. Mosi, W. R. Cullen & K. J. Reimer (1996): Composition and distribution of polycyclic aromatic hydrocarbon contamination in surficial marine sediments from Kitimat Harbour Canada. Sci. Tot. Environ., 181, 265.278.

Sporstol, S., N. Gjos, R. G. Lichtenthaler, K. O. Gustavsen, K. Urdal, F. Oreld & J. Skel (1983): Source identification of aromatic hydrocarbons in sediments using GC/MS. Environ. Sci. Technol., 17, 282-286.

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CARLINA FRIGIDA SUBSP. *FIUMENSIS*, NEU FÜR ISTRIEN

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KURZFASSUNG

Carlina frigida *Boiss. & Heldr. ex Boiss. subsp.* fiumensis *(Simk.) Meusel & Kästner, wurde neu für Istrien gefunden. Sie wächst dort nahe der kürzlich wieder bestätigten Lokalität von* Carlina macrocephala *Moris var.* toscanensis *Meusel & Kästner nahe Skitača. In Istrien können noch weitere vier Arten der Gattung* Carlina *gefunden werden:* C. acanthifolia *All. subsp.* utzka *(Hacq.) Meusel & Kästner,* C. acaulis *L. subsp.* caulescens *(Lam.) Schübler & Martens,* C. corymbosa *L. var.* corymbosa *und* C. vulgaris *L. subsp.* spinosa *(Velen.) Vandas. Die Unterscheidungsmerkmale und die Verbreitung dieser Arten in Istrien werden diskutiert.*

Stichwörter: Compositae, *Carlina, C. acanthifolia, C. acaulis, C. corymbosa, C. frigida, C. macrocephala, C. vulgaris;* Flora von Kroatien, Flora von Slowenien

CARLINA FRIGIDA SUBSP. *FIUMENSIS* ALSO IN ISTRIA

ABSTRACT

Carlina frigida *BOISS. & HELDR. ex BOISS. subsp.* fiumensis *(SIMK.) MEUSEL & KÄSTNER, has to be addded to the flora of Istra. The species can be found near the recently re-confirmed locality of* Carlina macrocephala *MORIS var.* toscanensis *MEUSEL & KÄSTNER at Skitača, SE Istria. The other species of* Carlina *found in Istra are* C. acanthifolia *ALL. subsp.* utzka *(HACQ.) MEUSEL & KÄSTNER,* C. acaulis *L. subsp.* caulescens *(LAM.) SCHÜBLER & MARTENS,* C. corymbosa *L. var.* corymbosa, *and* C. vulgaris *L. subsp.* spinosa *(VELEN.) VANDAS. The distinguishing characteristics and the distribution areas in Istra are discussed.*

Key words: Compositae, *Carlina, C. acanthifolia, C. acaulis, C. corymbosa, C. frigida, C. macrocephala, C. vulgaris,* Flora of Croatia, Flora of Slovenia

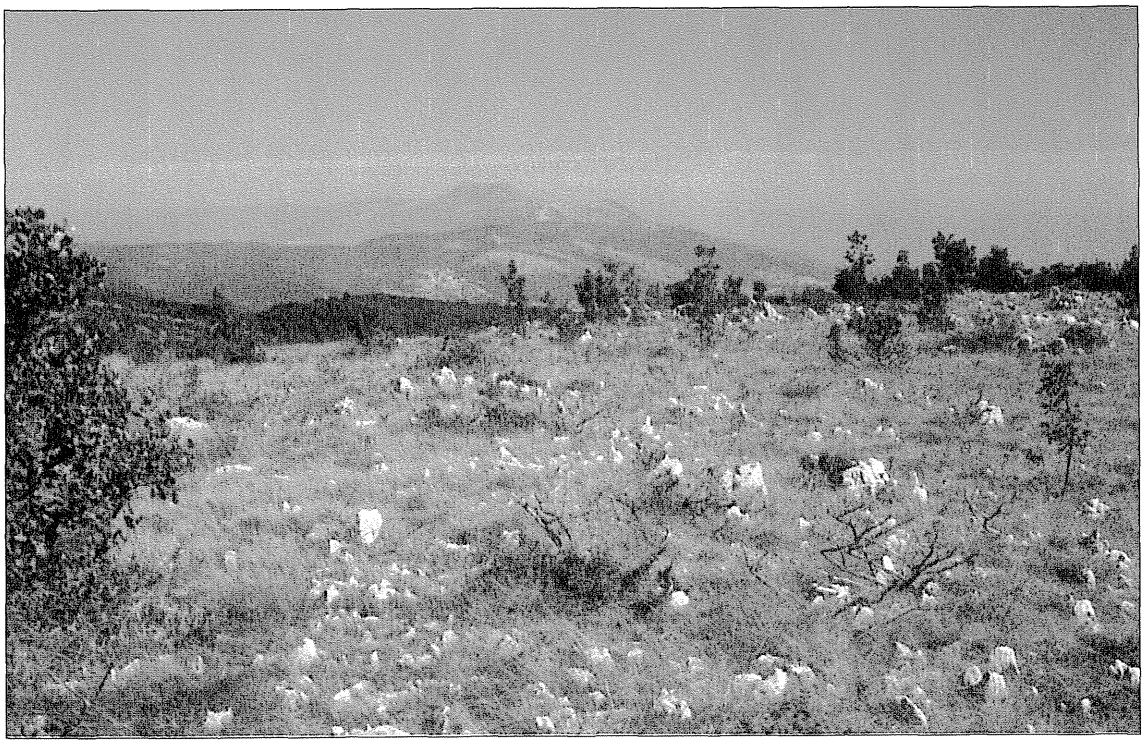
EINLEITUNG

Die Bearbeitung der Monographie der Gattung *Carlina* (Meusel & Kästner, 1992, 1994) und floristische Studien in Slowenien und Istrien führten zu einer Überprüfung der vor Jahren belegten Fundorte der Arten aus *Carlina* subsect. *Macrocephala* Meusel & Kästner: *Carlina frigida* Boiss. & Heldr.ex Boiss. und *Carlina macrocephala* Moris im nordadriatischen Gebiet.

ERGEBNISSE UND DISKUSSION

Die Vorkommen von *Carlina macrocephala* und *Carlina frigida*

Carlina macrocephala ist von Janchen 1907 auf der Insel Cres auf dem Berg Helm (sub "Monte Chelm"), zwischen den Bergen Jesenići und Gračišće (sub "Jesenovac und Gračišće"), sowie auf dem Berg Sis (sub "Syss") gefunden worden (Janchen, 1908). Ein weiterer



a

b

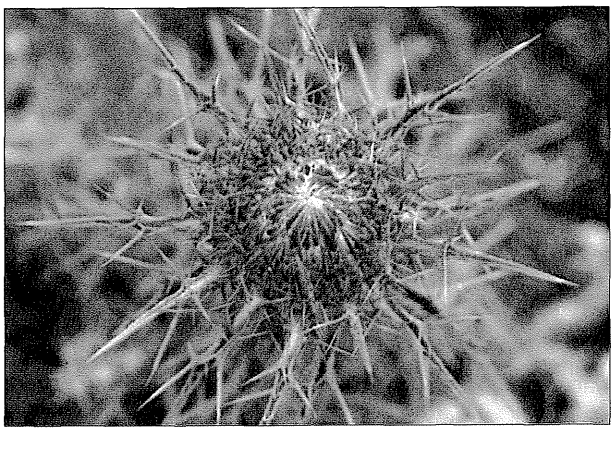


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Abb. 1: a) Überblick über den Standort von** Carlina frigida **und** C. macrocephala **bei Skitača, 1999 (Foto: E. Vitek); b)** Carlina frigida **subsp.** fiumensis **(Foto: E. Vitek); c)** Carlina macrocephala **(Foto: T. Wraber).
Sl. 1: a) Pogled na rastišče vrst** Carlina frigida **in** C. macrocephala **pri Skitači, 1999 (Foto: E. Vitek); b)** Carlina frigida **subsp.** fiumensis **(Foto: E. Vitek); c)** Carlina macrocephala **(Foto: T. Wraber).

Beleg von Janchen (gesammelt 1908, in WU) stammt von Skitača in Südostistrien.

Der Standort in Skitača konnte 1993 bestätigt werden. Die Nachsuche auf dem Berg Helm war 1992 erfolglos (Wraber, 1993), dafür konnte 1993 der Fundort auf dem Höhenrücken Jesenići-Gracišće ebenfalls bestätigt werden (leg. Wraber, LJU; vgl. Wraber, 1993).

Carlina macrocephala ist hapaxanth mit einer mehrjährigen Rosettenbildung (Abb. 3c) und besitzt silbrigweiße, an der Spitze rötliche, später ausbleichende innere Involukralblätter. Dieses submediterran/montane Element (vgl. Meusel & Kästner, 1992, 1994) tritt mit var. *macrocephala* in der subalpinen Stufe von Korsika und Sardinien auf, var. *toscanensis* Meusel & Kästner dringt von der montanen Stufe des Apennin auch in tiefere Lagen vor und erreicht mit ihren Vorposten den nordadriatischen Raum.

Carlina frigida ssp. *fiumensis* war bis vor kurzem von Küstenstandorten von Rijeka (sub "Fiume") bis zur Bakarbucht (zahlreiche Belege in BP, G, LI, LJU, W, WU [Akronyme nach Index Herbariorum]) und im Nordteil der Insel Krk (sub "zwischen Voz und Castelmucchio [= Omišalj] auf Veglia [= Krk]", 1847, leg. Plemel, LJU) bekannt. Noch vor Abschluß der Monographie konnte diese Art auch von Cres auf dem Berg Hrib (= nördlicher Teil des Berges Helm) nachgewiesen werden (1991, leg. Wraber, LJU, WU). Sie wächst hier nicht an der Küste, sondern in offenem Karstwiesen-Gelände ("Karstheide" bei Janchen, 1908). Der Vegetationstyp an dieser Stelle entspricht in etwa einer Assoziation (*Satureio-Edraeanthetum*?) aus dem Unterverband *Saturenion subspicatae* (Tab. 1).

Bei einer weiteren Nachsuche in Südistrien 1999 konnte nahe dem nochmals bestätigten Fundort von *S. macrocephala* bei Skitača eine große Population von *C. frigida* ssp. *fiumensis* gefunden werden. Die Lokalität liegt auf der Halbinsel Istrien – dem Berg Hrib auf der Insel Cres gegenüber – und befindet sich auf einem schwach ausgeprägten Höhenrücken in 400-430 m Höhe in einem wahrscheinlich durch Brand und frühere Beweidung erweiterten Trockenrasen mit vereinzelten kleinen Gebüschgruppen (Abb. 1a). Der Fundort entspricht somit auch ökologisch dem Standort auf Cres.

Carlina frigida ist hapaxanth mit einer mehrjährigen Rosettenbildung (Abb. 3b) und besitzt hellgelbe innere Involukralblätter. Als mediterranes Oreophyten-Element (vgl. Meusel & Kästner, 1992, 1994) ist sie mit mehreren Unterarten im zentral- und ostmediterranen Raum in küstennahen Gebirgen vertreten: ssp. *frigida* im Biokovo und in Griechenland, ssp. *renatae* Dittrich & Meusel im Libanon; nur ssp. *fiumensis* (Simk.) Meusel & Kästner besetzt auch Küsten-Standorte.

Das Areal von *Carlina frigida* ssp. *fiumensis* besteht nun aus vier Fundgebieten (Abb. 2), wobei das Vorkommen auf Krk noch einer neueren Bestätigung bedarf.

C. corymbosa L. ist eine perenne Staude mit einem deutlich ausgebildeten Pleiokorm (Abb. 3e) und dunkelgelben inneren Involukralblättern. Als mediterranes Element (vgl. Meusel & Kästner, 1992, 1994) folgt sie in ihrer Verbreitung mehr oder minder der Küstenlinie, nur gelegentlich dringt sie auch in weiter von der Küste entfernte Bereiche vor. Ob die auf der Karte ersichtliche Lücke im Inneren Istriens eine natürliche ist , oder ob es sich um eine Sammel-Lücke handelt, muß überprüft werden. Obwohl *C. corymbosa* auch auf den Inseln Cres und Lošinj im Spätsommer und Herbst stellenweise das Landschaftsbild dominiert, ist diese Art in den Sammlungen schlecht vertreten (Carlinen blühen außerhalb der üblichen Sammelsaison und werden wie andere Disteln ungern gesammelt). *C. corymbosa* var. *corymbosa* nimmt den größten Teil des zentralmediterranen Areal von Frankreich bis in die Türkei ein, var. *lobeliana* (Tausch) Meusel & Kästner kann in Südost-Frankreich, var. *graeciformis* Meusel & Kästner auf den Balearen gefunden werden.

Tab. 1: Artenliste des Karstwiesen-Geländes auf dem Berg Hrib, 420 m s.m., 100 m², 95% Deckung, 8.6. 1992, T. Wraber.
Tab. 1: Floristična sestava travnatega kraškega sveta na Hribu (Helm), 420 m n. m., 100 m², pokrovnost 95%, 8.6.1992, T. Wraber.

Bromus erectus	4.5
Genista sylvestris subsp. *dalmatica*	3.3
Helichrysum italicum	2.3
Leucanthemum liburnicum	2.2
Plantago holosteum	2.2
Satureja montana subsp. variegata	1.3
Koeleria splendens	1.2
Sanguisorba minor	1.2
Teucrium chamaedrys	1.2
Teucrium montanum	1.2
Thymus spec.	1.2
Eryngium amethystinum	1.1
Inula hirta	+.3
Anthyllis vulneraria subsp. *praepropera*	+.2
Edraianthus tenuifolius	+.2
Euphorbia myrsinites	+.2
Galium corrudifolium	+.2
Frangula rupestris	+.2
Fumana procumbens	+.2
Stipa pennata subsp. *eriocaulis*	+.2
Anacamptis pyramidalis	+
Carlina frigida subsp. *fiumensis*	+
Centaurea spinosociliata subsp. *tommasinii*	+
Centaurium erythraea subsp. *erythraea*	+
Juniperus oxycedrus	+
Leontodon crispus	+
Ophrys apifera	+
Ergänzungen aus den Aufzeichnungen von 2. 9. 1991 (Dopolnila iz zapiskov od 2.9.1991): *Allium moschatum, Carlina corymbosa, Centaurea weldeniana, Echinops ritro.*	

C. acaulis L. ssp. *caulescens* (Lam.) Schübler & Martens ist ebenfalls eine perenne Pleiokorm-Staude und besitzt große Köpfchen mit silbrigweißen inneren Involukralblättern (Abb. 3d). Als Element der südlichen temperaten Zone Mitteleuropas und der südeuropäischen Gebirge (vgl. Meusel & Kästner, 1992, 1994) beschränkt sie sich in Istrien auf die Höhenlagen der Učka (Belege auch sub "Mte. Maggiore"), nahegelegene andere Vorkommen sind in Gorski Kotar im Hinterland von Rijeka und auf den Monti del Carso nahe Triest. *Carlina acaulis* besitzt ein weites europäisches Areal; *C. acaulis* ssp. *caulescens* ist in den südeuropäischen Gebirgen, in den Süd- und Westalpen sowie im burgund-rhenanischen und westhercynischen Hügelland verbreitet.

C. acanthifolia All. ssp. *utzka* (Hacq.) Meusel & Kästner ist hapaxanth, die Blattrosette wird über mehrere Jahre gebildet, die Köpfchen mit gelblichen Involukralblättern sind sehr groß (Abb. 3a). Die Art besteht aus drei mehr oder weniger vikariierenden Unterarten: *C. acanthifolia* ssp. *cynara* (Pourr. ex Duby) Rouy von der Iberischen Halbinsel bis ins Französische Zentralmassiv, ssp. *acanthifolia* in Frankreich und Italien, ssp. *utzka* von Polen bis nach Griechenland. Die Fundorte in Nord-Istrien sind die westlichsten Vorposten dieser östlichen Unterart (vgl. Kaligarič, 1997).

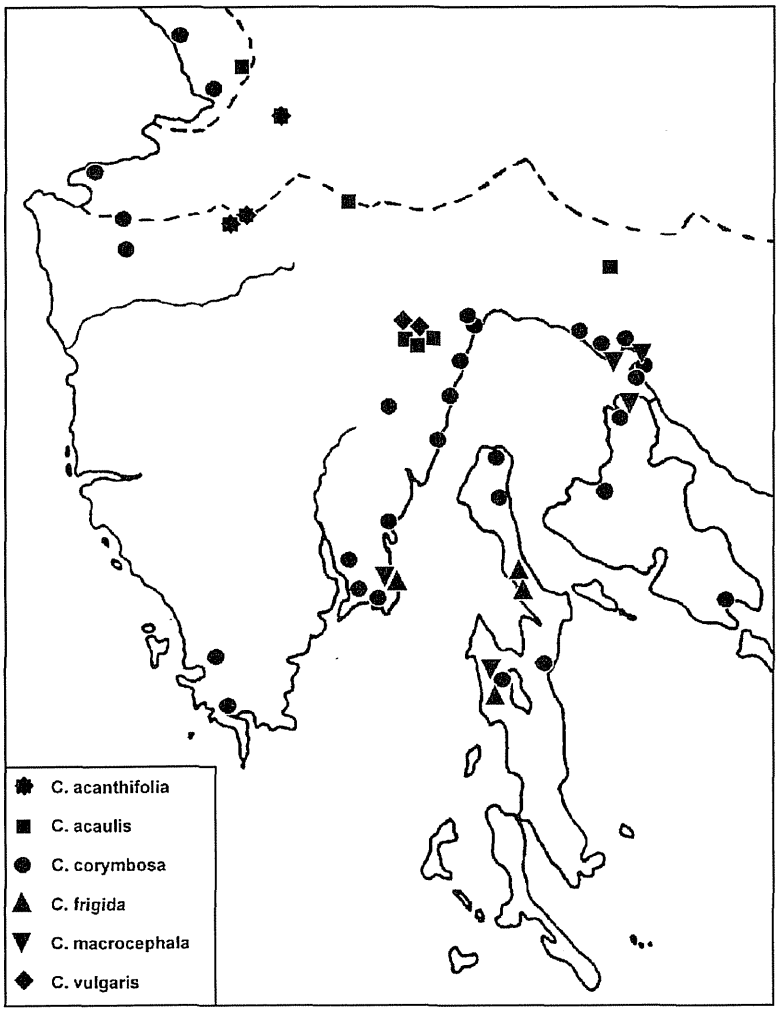

Abb. 2: Verbreitung in Istrien und den angrenzenden Gebieten von** C. acanthifolia **subsp.** utzka (✷), C. acaulis **subsp.** caulescens (■), Carlina corymbosa **var.** corymbosa (●), C. frigida **subsp.** fiumensis (▲), C. macrocephala **var.** toscanensis (▼), **und** C. vulgaris **subsp.** spinosa (◆). **Die Karte basiert auf den bei Meusel & Kästner (1994) zitierten Belegen, den Angaben bei Kaligarič (1997), neuen Aufsammlungen (siehe Anhang), sowie Geländenotizen.
Sl. 2: Razširjenost v Istri in na sosednjih območjih:** C. acanthifolia **subsp.** utzka (✷), C. acaulis **subsp.** caulescens (■), Carlina corymbosa **var.** corymbosa (●), C. frigida **subsp.** fiumensis (▲), C. macrocephala **var.** toscanensis (▼) **in** C. vulgaris **subsp.** spinosa (◆). **Karta je narejena po dokaznih primerkih, ki jih navajata Meusel & Kästner (1994), navedbah pri Kaligariču (1997), novih nabirkih (glej dodatek) in terenskih zapiskih.

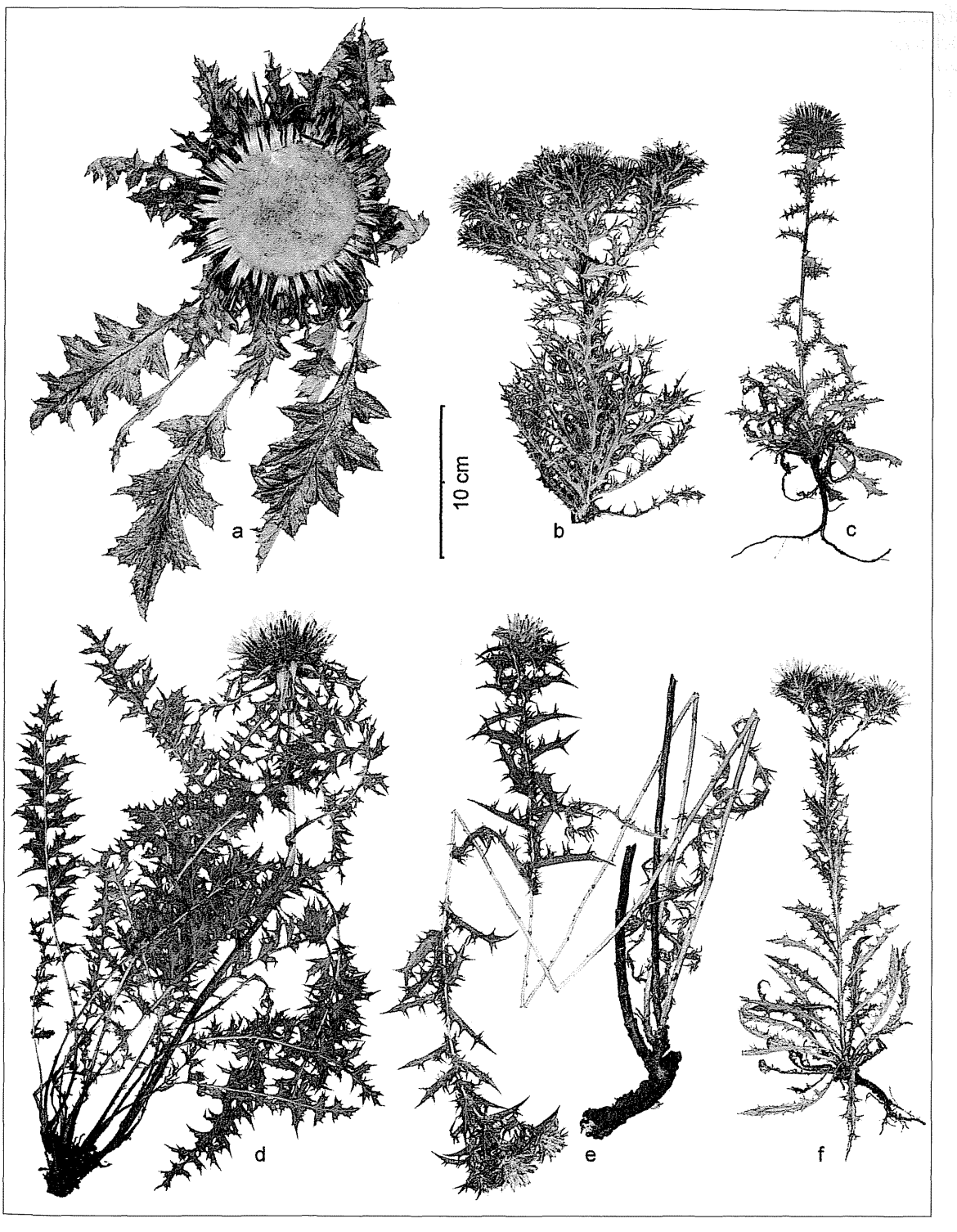

***Abb. 3: Habitusbilder der istrischen** Carlina-**Arten: a)** C. acanthifolia **subsp.** utzka; **b)** C. frigida **subsp.** fiumensis, **mit deutlichen Resten der mehrjährigen Rosette; c)** C. macrocephala **var.** toscanensis, **mit Resten der mehrjährigen Rosette; d)** C. acaulis **subsp.** caulescens; **e)** C. corymbosa **var.** corymbosa, **mit jährlicher Innovation aus dem Pleiokorm; f)** C. vulgaris **subsp.** spinosa.*

***Sl. 3: Habitus istrskih bodečih než: a)** C. acanthifolia **subsp.** utzka; **b)** C. frigida **subsp.** fiumensis, **z razločnimi ostanki večletne rozete; c)** C. macrocephala **var.** toscanensis **z ostanki večletne rozete; d)** C. acaulis **subsp.** caulescens; **e)** C. corymbosa **var.** corymbosa, **z vsakoletno inovacijo iz plejkorma; f)** C. vulgaris **subsp.** spinosa.*

Carlina acanthifolia ist im istrischen Gebiet stark zurückgegangen. Denn während Loser (1864) über das Vorkommen auf dem Berg S. Antonio (E von Triest, heute Sv. Anton in Slowenien) noch davon spricht, daß *C. acanthifolia* "hier in Menge vorkommt und häufig blüht", ist dieses Vorkommen heute nicht mehr existent.

Kaligarič (1997) zeigte den starken Rückgang dieser Art in den letzten 100 Jahren. Dieser Rückgang kann verschiedene Ursachen haben. Eine Erklärung könnte eine geänderte Nutzung an den Standorten sein - aber nach Kaligarič (1997) haben sich diese bis heute nicht wesentlich geändert. Eine andere Erklärung wäre die Lage am Rande des Verbreitungsgebiets, die offensichtlich reliktär und heute nur mehr knapp innerhalb des verträglichen Klimabereiches ist. Diese Vermutung verstärkt sich auch durch den Vergleich mit den sich in einer ähnlichen Vorpostensituation befindlichen Fundorten in der podolisch-wolhynischen Region (vgl. Meusel & Kästner,1994; Jasiewicz & Pawlowski, 1956). An diesen Fundorten sind ebenfalls, wie auch hier von Kaligarič beobachtet, nur selten und wenn, dann in geringer Anzahl ausgebildete Köpfchen zu beobachten. Falls durch einige klimatisch ungünstige Jahre Pflanzen bereits im vegetativen Zustand absterben, kann sich die geringe Vermehrung sehr rasch negativ auf eine Population im klimatischen Grenzbereich auswirken.

C. vulgaris L. ssp. *spinosa* (Velen.) Vandas ist ebenfalls hapaxanth (Abb. 3f), aber meist nur zweijährig und besitzt strohgelb bis messingfarbene innere Involukralblätter. Die Art beschränkt sich als temperates Element (vgl. Meusel & Kästner, 1992, 1994) auf das Gebiet der Učka. *C. vulgaris* ist weit verbreitet im ozeanisch-subozeanischen Europa von der Iberischen Halbinsel bis in die Türkei und von Süditalien bis Skandinavien, mit Ausstrahlungen bis in die Kolchis. *C. vulgaris* ssp. *spinosa* vertritt ssp. *vulgaris* im sub- bis selten eumediterranen Gebiet.

Anhang (Dodatek)

Neue Belege (die anderen Belege sind ausführlich zitiert in Meusel & Kästner, 1994, Herbarien nach Index Herbariorum, Privatherbar Vitek) (Novi, v monografiji (Meusel & Kästner, 1994) neupoštevani eksikati):

C. macrocephala var. *toscanensis*:
Kroatien:
E-Seite von Istrien S von Labin, ca. 1 km N von Skitača, 430 m s.m., 44°59'22"N/14°08'43"E, 24.8. 1999, Vitek 99-453 [LI, W]; - ibidem, 440 m s.m., 44° 59'25"N/14°08'34"E, 24.8.1999, Vitek 99-455 [Vitek].

C. frigida subsp. *fiumensis*:
Kroatien:
Adriaküste SE von Rijeka, Bakarbucht W von Bakarac, 30 m s.m., 45°16'50"N/14°34'19"E, 24.8.1999, Vitek 99-439 [LI, M, MA, Vitek]; E-Seite von Istrien S von Labin, ca. 1 km NNW von Skitača, 420 m s.m., 44°59'23"N/14°08'24"E, 24.8.1999, Vitek 99-454 [LI, LJU, W].

C. corymbosa subsp. *corymbosa*:
Slowenien:
0547/2, Istra, in lapidosis apricis collis Stena prope vicum Dragonja, 25 m s.m., 12.9.1974, T. Wraber [LJU].
Kroatien:
E-Küste von Istrien, SSW von Opatija, ca. 1 km N von Mošćenice; 150 m s.m.; 45°13'48"N/14°14'49"E, 24.8.1999, Vitek 99-446 [LI, Vitek]; --, SSW von Opatija, S von Brseč; 170 m s.m.; 45°10'39"N/14°13'55"E; 24.8.1999, Vitek 99-447 [W, LI]; --, ca. 1 km SE von Plomin; 180 m s.m.; 45°08'02"N/14°11'13"E, 24.8. 1999, Vitek 99-449 [W, LI, M, MA]; --, zwischen Labin und Rabac, 180 m s.m., 45°05'26"N/14°08'06"E, 24.8. 1999, Vitek 99-451 [Vitek]; --, S von Labin, bei Camping Tungarica W von Koromačno, 50 m s.m., 44° 58'02"N/14°05'52"E, 25. 8.1999, Vitek 99-461 [W, LI]; --, SW von Opatija, Straße Labin - Učka, ca. 4 km S Šušnjevica, 50 m s.m., 45°12'44"N/14°08'43"E, 26.8. 1999, Vitek 99-465 [W, LI]; Kvarner, insula Cres: In pascuis lapidosis persiccis prope vicum Ivanje, 250 m s.m., 29.8.1992, T. Wraber [LJU]; --, In pascuis inter montes Sis et Gorice, 600 m s.m., 2.9.1992, T. Wraber [LJU]; --, In pascuis siccis prope vicum Orlec, 250 m s.m., 4.9.1992, T. Wraber [LJU]; In pascuis lapidosis montis Hrib (=Helm s. lat.) prope vicum Lubenice, 2.9.1991, T. Wraber [LJU]; insula Krk, in lapidosis apricis prope pagum Malinska, 4.9.1926, F. Dolšak [LJU]; --, Omišalj, 23.8.1934, M. Zalokar [LJU]; Trsat-Sušak, na kamnitem travniku [auf einer steinigen Wiese], 10.6.1939, S. Perko [LJU]; Bakarski zaliv: Martinšćica, in graminosis lapidosis, 25 m s.m., 26.5.1964, E. Mayer [LJU]; --; inter Bakarac et Kraljevica, in declivibus lapidosis, 50 m s.m., 22.9.1964, E. Mayer [LJU];

C. acaulis subsp. *caulescens*:
Slowenien:
Kranjsko-notranjska flora. Biva med vresjem v podnožju Milanje nad Koritnicami [Innerkrainerische Flora. Wohnt am Fuß der Milanja oberhalb Koritnice], R. Justin, 24.8.1911 [LJU]; Snežnik, A. Budnar, 15.9.1946 [LJU].
Kroatien:
E-Seite von Istrien SW von Opatija, W-Seite des Učka-Passes, 900 m s.m.; 45°18'14"N/14°12'01"E, 26.8. 1999, Vitek 99-469 [LI, M, MA, W]; Istrien, Čičarija: Vodice, in graminosis lapidosis, solo calcareo, 700 m s. m., 24. 8. 1964, E. Mayer [LJU]; Gorski Kotar: In pratis lapidosis lateris austro-occidentalis montis Jasvina supra Grobničko polje. Solo calc. 850 m s. m. 25.8.1976, T. Wraber [LJU].

C. acanthifolia subsp. *utzka*:
Slowenien:
Primorsko-istrska flora: Biva v gajih med vresjem pri Klancu pod Kozino [Küstenländisch-istrische Flora: Wohnt in Hainen im Gestrüpp bei Klanec unterhalb Kozina], 8.8.1904, R. Justin [LJU]; Slovenija, Istra: 0549/1, suhi travniki ob cesti Gradin-Pregara [trockene Wiesen an der Strasse Gradin-Pregara], 5.10.1996, Kaligarič [LJU]; --, in pratis (flysch) inter vicos Gradin et Abitanti, 5.10.1996, M. Kaligarič [W].

C. vulgaris subsp. *spinosa*:
Kroatien:
E-Seite von Istrien SW von Opatija, W-Seite des Učka-Passes, wenig E der Abzweigung zum Tunnel, 550 m s.m.; 45°18'54"N/14°10'42"E, 26.8.1999, Vitek 99-467 [W, LI, M].

CARLINA FRIGIDA SUBSP. *FIUMENSIS* TUDI V ISTRI

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POVZETEK

Monografija rodu Carlina *(Meusel & Kästner, 1992, 1994) in floristične raziskave na Hrvaškem in v Sloveniji so spodbudile preveritev pred mnogimi leti ugotovljenih vrst* C. frigida *Boiss. & Heldr. ex Boiss. in* C. macrocephala *Moris na severnojadranskem območju.*

V poglavju o vrstah C. macrocephala *in* C. frigida *pisca obravnavata nastajanje vednosti o razširjenosti obeh vrst na navedenem ozemlju. Vrsto* C. macrocephala *je prvi našel Janchen (1908) na otoku Cres (vzpetine Helm, Jesenići-Gracišće, Sis) ter pri Skitači v jugovzhodni Istri. Drugi avtor (Wraber, 1993) je potrdil njeno pojavljanje na hrbtu med vrhovoma Jesenići-Gracišće (na avstrijski specialki 1: 75000 Jesenovac-Gracišće), neuspešno pa je bilo iskanje na Helmu.* C. frigida *subsp.* fiumensis *je bila do 90-ih let znana na priobalnem območju med Reko in Bakrom ter na severnem delu Krka, 1991 pa je bila odkrita - zunaj neposredne bližine obale - tudi na Helmu na Cresu (Wraber, LJU, WU). Floristična sestava tega nahajališča je razvidna iz tabele 1. V zadnjem času pa je bila odkrita tudi v Istri in sicer pri Skitači, nedaleč od potrjenega nahajališča vrste* C. macrocephala, *na rastišču, ki ekološko ustreza pojavljanju na Helmu na Cresu.*

Za obe vrsti pisca navajata tudi podatke o njuni življenjski obliki (Sl. 3), razlikovalne znake in njuno infraspecifično taksonomsko delitev. To velja tudi za nadaljnje omenjene vrste bodečih než: C. corymbosa, C. acaulis *subsp.* caulescens, C. acanthifolia *subsp.* utzka *in* C. vulgaris *subsp.* spinosa. *Tako kot že Kaligarič (1997) omenjata močno upadanje pojavljanja taksona* C. acanthifolia *subsp.* utzka *v Istri. Medtem ko Loser (1864) navaja, da je pri Sv. Antonu nad Koprom pogosten in da pogosto cveti, ga danes po opazovanjih drugega avtorja tam ni več. Ena od možnih razlag je v dejstvu, da gre za reliktno pojavljanje na robu areala in dandanes ravno še v mejah znosnih podnebnih razmer. Podobno velja za prav tako izpostavljena nahajališča v podolijsko-volinijskem prostoru, ki jih omenjata Jasiewicz & Pawlowski (1956). Tudi tam je le malo primerkov, cvetoči koški pa so redki.*

V dodatku so navedena nahajališča, ki jih Meusel & Kästner (1994) v monografiji ne omenjata. Točkovno razširjenost obravnavanih taksonov v Istri in sosednih območjih kaže slika 2.

Ključne besede: Compositae, *Carlina, C. acanthifolia, C. acaulis, C. corymbosa, C. frigida, C. macrocephala, C. vulgaris*, hrvaška flora, slovenska flora

LITERATUR

Janchen, E. (1908): Kleiner Beitrag zu einer Flora von Istrien. Mitt. Naturwiss. Ver. Univ. Wien, 6/6-7, 97-100.

Jasiewicz, A. & B. Pawlowski (1956): Nowe stanowisko *Carlina onopordifolia* Bess. w Polsce - De *Carlinae onopordifoliae* Bess. loco natali novo in Polonia reperto. Fragm. Florist. Geobot., Krakow 2/2, 12-19.

Kaligarič, M. (1997): *Carlina acanthifolia* subsp. *utzka* (Hacq.) Meusel & Kästner v Sloveniji. Annales, 11(4), 43-46.

Loser, A. (1864): Botanische Skizzen aus Inner-Istrien. Österr. Bot. Zeitschr., 14, 375-382.

Meusel, H. & A. Kästner (1992): Lebensgeschichte der Gold- und Silberdisteln. Monographie der mediterran-mitteleuropäischen Compositen-Gattung *Carlina*, I: Merkmalsspektren und Lebensräume der Gattung. Österr. Akad. Wiss., Math.-Nat. Kl., Denkschr. 127.

Meusel, H. & A. Kästner (1994): Lebensgeschichte der Gold- und Silberdisteln. Monographie der mediterran-mitteleuropäischen Compositen-Gattung *Carlina*, II: Artenvielfalt und Stammesgeschichte der Gattung. Österr. Akad. Wiss., Math.-Nat. Kl., Denkschr. 128.

Wraber, T. (1993): *Carlina frigida* subsp. *fiumensis*, kvarnerski endemit. *In:* Anonymus: Znanstveni simpozij Flora i vegetacija Hrvatske 20.-22.5.1993. Koprivnica, Novigrad Podravski, Šumarski fakultet Sveučilišta u Zagrebu.

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BIDENS PILOSA AND *CONYZA SUMATRENSIS*, TWO NEW NATURALISED SPECIES IN THE FLORA OF SLOVENIA

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ABSTRACT

The species Conyza sumatrensis *and* Bidens pilosa *are of American tropical and subtropical origin, but have in the last few years become well acclimatised in the Slovene coastal belt of Istra. This can be ascribed particularly to the milder sub-Mediterranean climate, which is clearly more advantageous to these species, and to the intensive sea traffic between the Northern Adriatic ports.* Conyza sumatrensis *can be found in dry, sunny and often stony habitats and is in the above mentioned area certainly not rare, while* Bidens pilosa *occurs only in a few localities on the Slovene side of the border,* i.e. *on more fertile and fresh ruderal sites.*

Key words: *Conyza sumatrensis, Bidens pilosa*, flora, distribution, Slovenia

BIDENS PILOSA E *CONYZA SUMATRENSIS*, DUE NUOVE SPECIE NATURALIZZATE NELLA FLORA DELLA SLOVENIA

SINTESI

Bidens pilosa *e* Conyza sumatrensis *sono specie di origine americana tropicale e subtropicale, ma negli ultimi anni si sono acclimatate bene nella fascia costiera dell'Istria slovena. Questo fatto può essere principalmente attribuito al clima submediterraneo mite, che favorisce queste specie, nonché all'intenso traffico marittimo tra i porti del Nord Adriatico.* Conyza sumatrensis *può essere trovata in habitat asciutti, soleggiati, spesso pietrosi e nell'area sopra menzionata è tutt'altro che rara.* Bidens pilosa *è invece presente in pochi habitat dell'Istria slovena e cresce su terreni ruderali più fertili e freschi e in vigneti.*

Parole chiave: *Conyza sumatrensis, Bidens pilosa*, flora, distribuzione, Slovenia

INTRODUCTION

Diversity of the adventitious flora of the Koper district was described as early as in 1983 by T. Wraber, who listed quite a number of species of Central American and Northern American distribution (*Aster squamatus, Artemisia annuua, A. verlotiorum, Bidens frondosa, Bilderdykia aubertii, Helianthus tuberosus, Tagetes minuta*). The majority of these species are limited to the warmer, sub-Mediterranean part of Slovenia and some merely to its coastal region. They have been brought here with the aid of man and his communications, par-

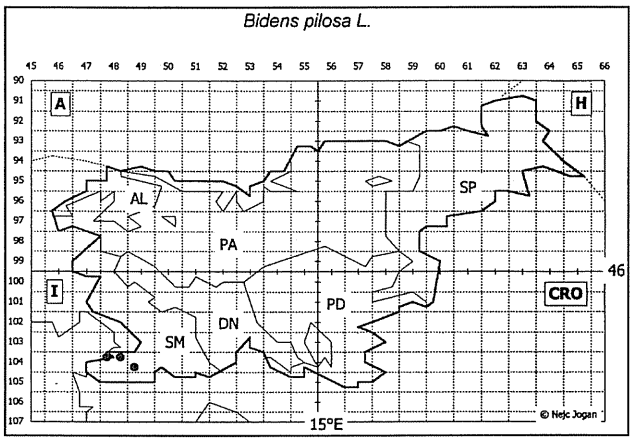

Fig. 1: Geographical distribution of** Bidens pilosa **in Slovenia.
Sl. 1: Geografska razširjenost** Bidens pilosa **v Sloveniji.

ticularly Northern Adriatic ports of Koper, Trieste and Monfalcone. Most relevant for a further expansion of certain species to the warmer habitats on the Continent are of course railway connections. We are in fact dealing with true corridors for the expansion of these species towards Ljubljana, Maribor and further on to Central Europe. Considering that the two found species, *Conyza sumatrensis* and *Bidens pilosa*, also originate from the warm (tropical and subtropical) parts of the New World, they are distributed (for the time being) only in the coastal part of Slovenia, for they favour warm habitats without or with late frost. Characteristic of *Bidens pilosa* are its extremely late blossoming and fructification (September - November), while *Conyza sumatrensis* often develops winter rosettes.

RESULTS AND DISCUSSION

Bidens pilosa L.

This American tropical species has been expanding practically to all warmer parts of the world - Asia, Oceania, Africa and Europe, where it already occurs in England and France (Stace, 1997) as well as in Spain (De Bolòs, 1998). In the neighbouring Italy it was recorded in Piemonte and Sicily (Pignatti, 1982), as well as in Liguria (Minuto, 1992), from where in fact originates the (earlier collected) herbarium specimen in LJU (Marchetti, 5. 12. 1964). The localities from the coastal part of Slovene Istra are thus the easternmost in Europe. The main reason for the occurrence of this species here is no doubt the busy sea traffic to and from the Port of Koper.

In Slovenia, the species was found for the first time in 1994 (Poldini, TSU: October 8th 1994), *i.e.* at Valdoltra near Ankaran by the coast (0448/1), and later on at

Figs. 2, 3:** Bidens pilosa **with white marginal flowers in the head. In all other species these tubular-like flowers are yellow (Photo: M. Kaligarič).
Sl. 2, 3:** Bidens pilosa **bi po slovensko lahko imenovali beli mrkač, saj so obrobni - cevasti - cvetovi v košku beli. Pri vseh drugih mrkačih so rumene barve (Foto: M. Kaligarič).

Ankaran near the coast in the vicinity of the building of the Slovene Navy (Kaligarič, LJU: October 15th 1989) (0448/2). Its occurrence in this locality was again confirmed in 1999, while its newly discovered localities

were: at a vineyard at Ankaran (Poldini, TSU, 1999) (0448/2), at Kortina near Rižana (Poldini, TSU: October 16th 1999) (0449/3), and at Šared above Izola (Kaligarič, LJU: November 1st 1999) (0447/4) (Fig. 1). The species occurs on moderately damp and with nutrients rich ground, also as weed in vineyards, or ruderally, so that flysch and alluvial deposits obviously suit its requirements. The favourable conditions for the growth of this tropical-subtropical species are due also to the mild sub-Mediterranean climate in the coastal belt (Figs. 2, 3). From here probably the reason for this species inhabits only a narrow belt along the coast. Considering that very effective epizoochoria is characteristic of the genus *Bidens*, we can expect it to expand quickly towards south-east. It is difficult to predict, however, that its occurrence as a weed plant will become a major problem, as is the case in the New World and in some places of Asia and Oceania. In Slovene Istra, however, it is climatically on the very border of its occurrence.

Conyza sumatrensis (Retz.) E. Walker

Synonyms: *Conyza albida* Willd., *C. naudini* Bonet.

The species has spread from the tropical America elsewhere, including Europe, particularly into the warmer parts of the Mediterranean, where it is already widely distributed in most of the Mediterranean countries. Its first records in Italy were made as early as in 1964 by Anzalone (1964), *i.e.* in the area spreading from Piemonte to Sicily. The species reached the Slovene border in 1977, for this is the year since documented with a herbarium specimen (Poldini, TSU) (Fig. 4). The more recent data regarding the Mediterranean also concern Albania (Baltisberger *et al.*, 1987) and Croatia (Čarni & Jogan, 1998). This species has been for quite some time mistaken for the similar species *Conyza bonariensis*, which has been naturalised in the Mediterranean for a number of years. Austrian quotations of the species *C. bonariensis* have been rectified by Melzer (1998), who has now ascertained periodical occurrence of this species also out of the Mediterranean, *i.e.* in Austrian Styria. How can we distinguish between the two species? The most reliable marks are the marginal flowers in the inflorescence, which are in the species *C. sumatrensis* zygomorphic, while in the species *C. bonariensis* all the flowers are actinomorphic. The species *C. sumatrensis* is otherwise much taller, with greater number of leaves, and branched out only in the upper part of the stem, while the leaves are bigger, wider and denticulate. *C. sumatrensis* is recognisable particularly by its often well-developed winter rosettes (see figure 5). These develop in extremely dry (strained) and warm habitats, such as cracks in asphalt, between pavements and roads, between pavements and houses, in the shelter of stone walls, etc.

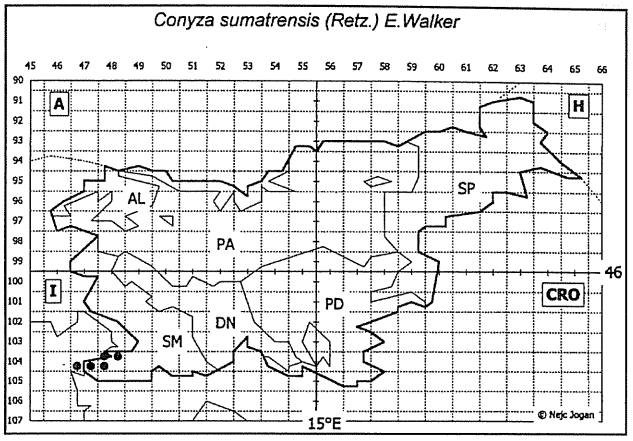

Fig. 4: Geographical distribution of** Conyza sumatrensis **in Slovenia.
Sl. 4: Geografska razširjenost** Conyza sumatrensis **v Sloveniji.

Fig. 5:** Conyza sumatrensis **is recognisable even in mid-winter for its copiously developed rosettes; it can be found in distinctly dry and warm habitats, such as asphalt cracks (Photo: M. Kaligarič).
Sl. 5:** Conyza sumatrensis **je prepoznavna tudi sredi zime po obilno razvitih rozetah; najdemo jo v izrazito suhih in toplih habitatih, kot so razpoke v asfaltu (Foto: M. Kaligarič).

The first reliable data for Slovenia are from 1984 (Poldini, TSU, December 21st 1984), *i.e.* from Gradno at Goriška Brda (9947/3). Poldini collected this species twice in 1997, namely in the centre of Izola (TSU, October 18th 1997) (0447/4) and at Brestovica na Krasu (TSU, October 1st 1997) (0147/4). In the material from the LJU herbarium there are two sheets from Lucija (T. Wraber, September 12th 1974) (0447/4) and Seča (T. Wraber, M. Lovka, October 2nd 1981) (0547/2) that are identified as *C. bonariensis*. The bottom leaves are missing and the plants are more or less in the phase of fruits, but there are zygomorphic flowers also present in

the flower head, which speaks of the fact that in both cases we are dealing with *C. sumatrensis* and not *C. bonariensis*. Apart from the stated herbarium specimens from Slovenia, the species *C. sumatrensis* was observed practically in every Slovene coastal town: in Koper at its parking places and Škocjan Inlet, in Izola also at its parking places, in Piran in its centre, etc.

We can conclude that this species, too, is more or less restricted to the warm sub-Mediterranean climate of Slovene Istra, where it inhabits explicitly dry and warm (usually anthropogenous) habitats. It can be therefore expected that it will not expand out of this area, although this does not mean that some periodical finds are not excluded. Such case is the periodical occurrence of this species in Austrian Styria (Melzer, 1998).

BIDENS PILOSA IN *CONYZA SUMATRENSIS*, DVE NOVI NATURALIZIRANI VRSTI V FLORI SLOVENIJE

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POVZETEK

Vrsti Bidens pilosa *in* Conyza sumatrensis *sta ameriškega tropskega in subtropskega izvora in sta se v slovenskem obalnem pasu Istre v nekaj letih precej udomačili. Sem sta bili zanešeni ob pomoči človeka in njegovih komunikacij, predvsem severnojadranskih pristanišč: Kopra, Trsta in Tržiča. Bistvena okoliščina, ki je prispevala k njuni udomačitvi, pa je topla submediteranska klima, ki jo obravnavani tropsko-subtropski vrsti še lahko preneseta, saj jima ustrezajo topla rastišča brez ali s pozno zmrzaljo. Izjemoma oziroma prehodno se vrsta* Conyza sumatrensis *pojavlja tudi v ostrejših podnebnih razmerah. Tako so jo npr. našli že na avstrijskem Štajerskem. Sumatransko hudoletnico najdemo na suhih sončnih, večkrat kamnitih rastiščih in na omenjenem območju ni redka. Najdemo jo predvsem na suhih antropogenih rastiščih kot so nasipališča, parkirišča, gradbišča in v razpokah asfalta ali kamnitega tlaka. Od zelo podobne vrste* Conyza bonariensis *se loči po obrobnih cvetovi v koških, ki so pri vrsti* C. sumatrensis *tudi zigomorfni, pri vrsti* C. bonariensis *pa so vsi cvetovi aktinomorfni. Sicer pa je vrsta* C. sumatrensis *znatno višje rasti, bolj gosto olistana, razrasla le v zgornjem delu stebla, listi pa so večji, širši in imajo izrazitejše stranske žile. Posebej je vrsta* C. sumatrensis *prepoznavna po svojih pogosto lepo razvitih zimskih rozetah. Vrsta* Bidens pilosa *je redkejša in jo v Sloveniji najdemo v Ankaranu in Valdoltri, v Kortini nad Rižano ter v Šaredu nad Izolo. Zanjo sta značilna izredno pozno cvetenje in fruktifikacija (september - november), uspeva na nekoliko bolj rodovitnih in svežih ruderalnih rastiščih. V tropskih in subtropskih predelih Azije in Oceanije postaja vrsta* Bidens pilosa *zelo invazivna in nadležen plevel. Ker je v Sloveniji na klimatski meji uspevanja, takšnega problema z njo vsaj za zdaj še ne pričakujemo. Ker so jezičasti cvetovi v koških bele barve - običajno so v tem rodu rumeni - predlagamo slovensko ime "beli mrkač".*

Ključne besede: *Conyza sumatrensis, Bidens pilosa,* flora, razširjenost, Slovenija

REFERENCES

Anzalone, B. (1964): Un nuovo *Erigeron* nella Flora Italiana. Annali di Botanica, 28(1), 25-39.

Baltisberger, M. & W. Lippwert (1987): Compositen aus Albanien. Candollea, 42, 679-691.

Bolòs de í Capdevilla, O. (1998): Atlas Corologic de la Flora Vascular dels Països Catalanas. Part I: *Abies - Lagoecia.* Institut d'Estudios Catalanas, p. 140 *(Bidens pilosa),* p. 270 *(Conyza sumatrensis),* Barcelona.

Čarni, A. & N. Jogan (1998): Vegetation of thermophilic trampled habitats in the bay of Kvarner. Natura Croatica, 7(1), 45-58.

Melzer, H. (1998): Neues zur Flora von Steiermark, XXXVII. Mitt. naturwiss. Ver. Steiermark. Band 128, 1-78.

Minuto, L. (1992): *Bidens pilosa* L. (Compositae). *In:* Segnalazioni Floristiche Italiane. Informatore Botanico Italiano, 24(3), 216-217.

Pignatti, S. (1982): Flora d'Italia. Edagricole, Vol. III. p. 54 *(Bidens pilosa),* Bologna.

Stace, C. (1997): New Flora of the British isles. Cambridge University Press, p. 725 *(Conyza sumatriens),* p. 754 *(Bidens pilosa),* 2 ed., Cambridge.

Wraber, T. (1982): *Aster squamatus* (Sprengel) Hieron tudi v Sloveniji (Prispevek k adventivni flori Koprskega). Biol. vestn., 30(2), 125-137.

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RAZŠIRJENOST MEDVEJK (*SPIRAEA* SPP.) V SLOVENIJI

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IZVLEČEK

*Članek na podlagi revizije herbarijskega materiala podaja pregled razširjenosti medvejk v Sloveniji. Izkazalo se je, da tu uspevajo 4 samonikle (*S. salicifolia, S. media, S. decumbens *in* S. chamaedryfolia*) in 3 naturalizirane (*S. japonica, S. tomentosa *in križanec* S. *x* pseudosalicifolia*) vrste tega rodu. Za* S. media *je bilo ugotovljeno, da populacije v južni Sloveniji pripadajo podvrsti* "mollis". *Za* S. salicifolia *se je izkazalo, da je avtohtona in da zanesljivo uspeva le v Krakovskem gozdu, subspontano pa se pojavlja* S. *x* pseudosalicifolia. *Vrsti* S. japonica *in* S. tomentosa *sta že več desetletij naturalizirani, prva uspeva raztreseno po Sloveniji in je v Vipavski dolini naturalizirana in invazivna, druga ima majhno populacijo na Ljubljanskem barju. Na koncu članka je ključ za slovenske vrste medvejk.*

Ključne besede: medvejke, *Spiraea*, flora, razširjenjost, Slovenija

DISTRIBUZIONE DI SPIREE (*SPIRAEA* SPP.) IN SLOVENIA

SINTESI

L'articolo tratta la distribuzione di spiree in Slovenia. La revisione di materiale d'erbario ha confermato la presenza di quattro specie native (S. salicifolia, S. media, S. decumbens *e* S. chamaedryfolia) *e tre naturalizzate* (S. japonica, S. tomentosa *e l'ibrido* S. *x* pseudosalicifolia) *del genere* Spiraea *in territorio sloveno. Per* S. media *è emerso che le popolazioni trovate nella Slovenia meridionale appartengono alla sottospecie* "mollis", *mentre* S. salicifolia, *che cresce soltanto nel Krakovski gozd, è risultata specie autoctona. In diverse località è stato inoltre trovato l'ibrido sterile* S. *x* pseudosalicifolia. *Le specie* S. japonica *e* S. tomentosa *risultano naturalizzate da diversi decenni; la prima cresce sparsa in diverse località slovene e presenta una popolazione naturalizzata ed infestante nella Valle del Vipacco (Vipavska dolina); la seconda è rappresentata solo da una piccola popolazione nel Ljubljansko Barje. Al termine dell'articolo si trova la chiave per la determinazione delle specie sopraccitate.*

Parole chiave: spiree, *Spiraea*, flora, distribuzione, Slovenia

UVOD

Medvejke, ki jih sicer neredko srečujemo v okrasnih nasadih, nas v naravi le redko razveselijo. Četudi naj bi bila v Sloveniji (sodeč po dosedanji literaturi) zastopana s štirimi vrstami, zagotovo ni veliko botanikov, ki bi že srečali kaj več kot "vrbovolistno" medvejko, ki naj bi bila vrh vsega le podivjana in ne avtohtona. Naše preostale tri (avtohtone) vrste so vse precej ali celo zelo redke, kar dve od njih sta zato uvrščeni v Rdeči seznam (Wraber & Skoberne, 1989). Rodovi s tako redkimi vrstami so po pravilu kar dobro obdelani, saj je vsaka najdba novega rastišča vredna kritične obravnave, a vse kaže, da so bile medvejke v Sloveniji kljub temu kar zanemarjene.

Že pogled v herbarij LJU nam razkrije, da je že od začetka tega stoletja znano tudi uspevanje vrbovolistni medvejki podobne polstene medvejke na Ljubljanskem barju; pred skoraj pol stoletja so bila znana že tudi vsaj tri rastišča, kjer se je subspontano pojavljala japonska

medvejka, prav tako pa nam ogled rastišč vrbovolistne medvejke v Krakovskem gozdu, kjer uspeva skupaj z redkima vrstama *Viola uliginosa* in *Calamagrostis canescens* (ta tu edino zanesljivo raste v Sloveniji!), vzbudi dvom o njeni domnevni neavtohtonosti.

Torej je bila potreba po kritični reviziji pojavljanja tega rodu pri nas velika in rezultati te revizije so na kratko predstavljeni v nadaljevanju.

MATERIAL IN METODE

Revidiran je bil material, zbran v herbariju LJU in v avtorjevem herbariju. Ker je bilo moč vrste zanesljivo določiti s ključi v več nedavno publiciranih obdelavah tega rodu (Schroeder, 1990; Stace, 1991; Kobližek, 1992; Adolphi, 1995; Maxwell & Knees, 1995), se v natančnejše analize razlikovanja vrst nisem spuščal. Tako je ključ (glej poglavje Ključ za slovenske predstavnike medvejk) v glavnem izdelan kot kompilacija že publiciranih ključev in kritično preizkušen na našem materialu. O znakih, katerih taksonomska vrednost je sporna, na kratko diskutiram pri obravnavi posameznih taksonov.

Poleg tega je bila pregledana starejša floristična literatura, ki obravnava ozemlje današnje Slovenije, na podlagi česar sem ponovno ovrednotil predvsem nekatere pozabljene navedbe.

Karte razširjenosti vrst v Sloveniji so bile narejene s klišeji KARARAS 2.0 (Jogan, 1998).

REZULTATI

Pojavljanje medvejk v Sloveniji lahko primerjamo s pojavljanjem predstavnikov tega rodu v srednji Evropi (Adolphi, 1995), saj ni velikih razlik.

Vse divje rastoče vrste medvejk v Sloveniji (kot tudi v srednji Evropi) pripadajo tipskemu podrodu (kakor ga pojmuje Adolphi, *ibid.*). Sekcija *Spiraea* je pri nas zastopana z avtohtono vrsto *S. salicifolia*, s pogosto podivjanim križancem *S.* x *pseudosalicifolia* in z lokalno naturalizirano vrsto *S. tomentosa*. V srednji Evropi se poleg teh dveh taksonov raztreseno naturalizirano pojavljata tudi *S. alba* Du Roi in *S. douglasii* Hook (zadnja je ena starševskih vrst prej omenjenega križanca), katerih naturalizacija v Sloveniji je potemtakem prav tako mogoča. Bližnje sorodna omenjenim vrstam (z njimi se tudi križa) je še *S. japonica*, ki neredko podivja in je lokalno naturalizirana.

Edina pri nas in v srednji Evropi rastoča avtohtona vrsta sekcije *Calospira* K. Koch je *Spiraea decumbens*.

Preostale vrste pripadajo sekciji *Chamaedryon* Seringe. Naši avtohtoni vrsti sta *S. media* in *S. chamaedryfolia*.

Poleg tega je bila pred nekaj leti v Ljubljani nabrana tudi *S. nipponica* Maxim. (Stožice, rob gozda, leg. M. Urbančič, 1995), katere status pojavljanja v Sloveniji je za zdaj še zelo nejasen in zato ni bila vključena v nadaljnjo obdelavo.

Viri iz 19. in začetka 20. stoletja (Fleischmann, 1844; Lorinser, 1860; Glowacki, 1912-1913; Fritsch, 1922) navajajo za območje današnje Slovenije še vrsti *S. obovata* W. & K. in *S. oblongifolia* W. & K., ki jo razlikujejo od *S. media*. Pri prvi vrsti, ki ima svoj areal v jugozahodni Evropi (Dostál, 1968), je šlo očitno za napačno določitev, saj že Ascherson in Graebner (1900-1905) in kasneje tudi Fritsch (1922) dvomita o njenem pojavljanju na Kranjskem, kasneje pa je sploh ne omenjajo več. Drugo ime pa velja danes za sinonim *S. media*.

Obravnava posameznih taksonov medvejk se med avtorji precej razlikuje. Razloge za to gre iskati predvsem v dejstvu, da jih obravnavajo poleg taksonomov in floristov tudi dendrologi in vrtnarji. Tako imamo vsaj tri različne pristope k pripisovanju pomena posameznim taksonomskim znakom, torej tudi tri pristope h klasifikaciji, in kar težko se je odločiti, na katerem taksonomskem rangu obravnavati posamezne ozkosorodne taksone.

PREGLED VRST RODU, KI SE POJAVLJAJO V SLOVENIJI

Spiraea salicifolia L. - vrbovolistna medvejka

zanesljiva rastišča v Sloveniji:

9952/3 Slo.: "Moosthal prope Log [= Kušljanov grad, Za blatom] in ditione Labacensi." Leg. Mulley, LJU.

0057/4 Slo.: Krakovski gozd, poplavni gozd ob potoku Martink. Leg. N. Jogan, 27. 8. 1998 (avtorjev herbarij D 215)

0158/1 Slo.: Krakovski gozd, pragozd Krakovo. Lit.: Hočevar, S. *et al.*, 1980 (napačno navajajo *S. media*, a iz opisa združbe in ekoloških razmer je razvidno, da gre lahko le za *S. salicifolia;* uspevanje *S. salicifolia* na istem rastišču potrjuje tudi ustno poročanje A. Piltaverja, ki jo je tam opazoval sredi devetdesetih let)

vprašljive navedbe za Slovenijo (obravnavane kot *S. salicifolia* agg.)

0157/2 Slo.: Dolenjska, Dobrova pri Beli Cerkvi Lit.: Paulin, 1904 (utegnila bi biti prava *S. salicifolia*!)

0357/2 Slo.: Bela krajina, Metlika. Lit.: Fleischmann, 1844

9459/2 Slo.: Štajerska, Maribor. Lit.: Hayek, 1908

9749/1 Slo.: Gorenjska, Bohinj. Lit.: Fleischmann, 1844

9855/2 Slo.: Zasavje, Izlake. Lit.: Paulin, 1904

9855/4 Slo.: Zasavje, Zagorje. Lit.: Fleischmann, 1844

9952/2 Slo.: Ljubljana, Šišenski hrib. Lit.: Paulin, 1904

9952/4 Slo.: Ljubljana, Zunanja Gorica. Lit.: Paulin, 1904

Glavnina areala te vrste je v zmernem pasu osrednje

in vzhodne Azije, v vzhodni Evropi pa ima razmeroma majhno disjunkcijo, katere zahodna meja poteka tudi skozi Slovenijo (Adolphi, 1995). Zaradi tako nenavadnega areala so še v prvi polovici tega stoletja pojavljanje te vrste v Evropi obravnavali kot sekundarno, v zadnjih desetletjih pa je prevladalo mnenje, da je tudi v Evropi avtohtona. Težave pri natančni opredelitvi areala te vrste so bile predvsem posledica zamenjevanja z drugimi podobnimi vrstami, ki v glavnem izvirajo iz Severne Amerike in jih v Evropi že dolgo gojijo, nekatere izmed njih pa so se ponekod v Evropi že tudi naturalizirale. Tako je ob uporabi literaturnih navedb pojavljanja te vrste še vedno potrebna previdnost in kritičnost in tudi prikaz razširjenosti v Sloveniji je bil zato narejen le na podlagi revizije herbarijskega materiala.

Ker je vrbovolistna medvejka rastlina poplavnih gozdov, je tudi pri nas, podobno kot drugod po Evropi, precej ogrožena. Vsekakor lahko predlagamo njeno uvrstitev med ranljive (ali celo ogrožene) vrste slovenske flore, saj danes zanesljivo uspeva v razmeroma velikih sestojih le na območju Krakovskega gozda, medtem ko usoda rastišč na Ljubljanskem Barju ni znana (enodnevno iskanje na Barju žal ni obrodilo sadov; morda je bila tu celo samo podivjana). Vrsta je ogrožena tudi v drugih srednjeevropskih državah (*cf.* Zahradnikova, 1992; Rauš & Vukelić, 1991; Adler, 1994).

Slika razširjenosti te vrste v Sloveniji lepo dopolnjuje sliki razširjenosti na avstrijskem Koroškem (Hartl *et al.*, 1992) in na Hrvaškem (Rauš & Vukelić, 1991), ekološke razmere, v katerih vrsta raste v Krakovskem gozdu, pa prav tako ustrezajo navedbam v srednjeevropski literaturi. Tako naj bi vrsta na Češkem rasla v združbah zvez *Alnion glutinosae* in *Salicion cinereae* (Kobližek, 1992), na Hrvaškem pa prav tako v poplavnih gozdovih v štirih različnih združbah (Rauš & Vukelić, 1991).

Spiraea x *pseudosalicifolia* Silverside - jalova medvejka

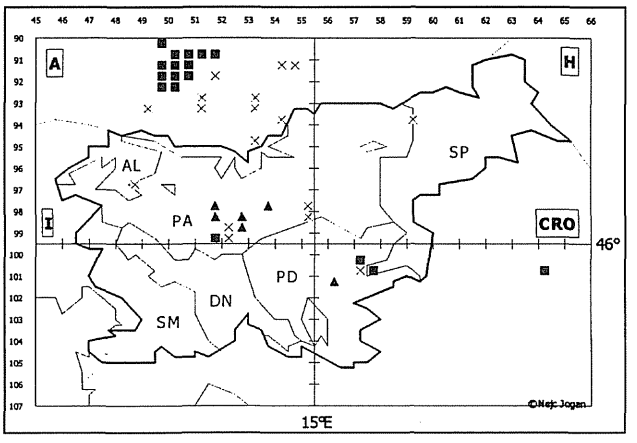
=*S.* x *billardii* auct., non Hérincq
= *S. salicifolia* x *douglasii* Hook.
rastišča v Sloveniji:

0156/4 Slo.: Novo mesto, Portovald. Leg J. Pavlin, 1990 (LJU)
9852/1 Slo.: Škofja Loka, Reteče. Leg. B. Klun, 1990 (LJU)
9852/3 Slo.: Preska pri Medvodah, v vrtnih ograjah. Leg. R. Justin, 1929 (LJU)
9853/3 Slo.: Ljubljana, Sp. Gameljne. Leg. M. Uršič, 1995 (LJU).
9854/1 Slo.: ob cesti Ljubljana-Celje, Lukovica, podivjano. Leg. T. Verčkovnik, 1981 (LJU)
9953/1 Slo.: Ljubljana, subspontano. Leg. F. Dolšak, 1934 (LJU)

Jalova medvejka je vrtnarski križanec, ki so ga ustvarili s križanjem *S. salicifolia* in severnoameriške vrste *S. douglasii*. Razmnožujejo ga vegetativno in je po vsej Evropi ena najpogosteje sajenih medvejk (Ellis, 1993; Adolphi, 1995). Razširja se v glavnem le z razraščanjem z živicami in tako je njegovo pojavljanje povsod povezano s človekovim delovanjem. Ker pa je zelo vitalen, se lahko na rastiščih, ki jih je človek že opustil, ohranja in razrašča tudi desetletja dolgo. Zanesljivih podtakov o razširjanju s semenom sicer ni, a kljub temu je pojavljanje tega križanca neredko skoraj takšno, kot da bi šlo za samostojno vrsto. To je bil tudi razlog, zaradi katerega nekateri avtorji, npr. Adolphi (1995), takson obravnavajo kot vrsto hibridnega porekla.

Očitno je tudi ponekod v Sloveniji pojavljanje jalove medvejke videti dovolj spontano, da se je v herbariju LJU nabralo kar 6 pol s tem taksonom, na etiketah katerih v glavnem ni izražen dvom o spontanosti uspevanja. Temu taksonu najverjetneje pripada tudi material iz Izlak (herb. Justin, leg. F. Lužar, 1904), ki je sicer slabo nabran in natančna določitev ni mogoča, morda pa se tudi Fleischmannove (1844) navedbe uspevanja vrbovolistne medvejke v Bohinju, Zagorju in Metliki nanašajo prav na gojeno jalovo sorodnico.

Razširjenost navidezno spontanega uspevanja jalove medvejke v Sloveniji (Sl. 1) lahko torej označimo s "PA, PD", ker pa je gojena po vsej Sloveniji, bi jo bilo gotovo moč najti na zapuščenih mestih tudi drugod.



Sl. 1: Razširjenost** Spiraea salicifolia **agg. (križci),** Spiraea salicifolia **s. str. (kvadratki) in** S. x pseudosalicifolia **(trikotniki) v Sloveniji in soseščini.
Fig. 1: Distibution of** Spiraea salicifolia **agg. (crosses),** Spiraea salicifolia **s. str. (squares) and** S. x pseudosalicifolia **(triangles) in Slovenia and adjacent territories.

Spiraea tomentosa L. - polstena medvejka

rastišča v Sloveniji:

0053/1 Slo.: Ljubljana, Havptmance, subspontanea. Leg. F. Dolšak, 1930 (LJU)
0052/2 Slo.: Ljubljansko barje, Kozlarjeva gošča. Leg. V. Strgar, 1967, 1981 (LJU)
0053/1 Slo.: Ljubljansko barje, pri Grmezu. Leg. N. Jogan, 1998 (avtorjev herbarij)

Polstena medvejka je vzhodno-severnoameriška vrsta, ki jo tu in tam gojijo kot okrasni grm, na vlažnih rastiščih pa je tudi ponekod po Evropi podivjala (Adolphi, 1995). Prvo poročilo o zanesljivo subspontanem pojavljanju te vrste na območju današnje Slovenije sega v 20. in 30. leta 20. stoletja, ko jo je pri Havptmancah na Ljubljanskem barju nabiral in tudi pravilno (!) določil Dolšak, o njej pa piše celo Bevk (1927), ki se v svoji "Botaniki za šolo in dom" v navajanje razširjenosti vrst sicer ne spušča, da "... rase divja tudi na ljubljanskem barju ...". Na podlagi teh (in verjetno tudi drugih, nedokumentiranih) najdb jo v 2. izdaji "Hegija" (Huber, 1961-1966) navajajo kot podivjano v okolici Ljubljane, kasneje (pri slovenskih avtorjih žal že v 40. letih) pa se vednost o njej izgubi. Omenjena ni niti v ključih Piskernikove, niti v Mayerjevih zbirnih delih, niti v Mali flori Slovenije in tudi material te vrste, ki ga je na Ljubljanskem barju 1967. in 1981. nabiral V. Strgar, je bil napačno določen kot *S. salicifolia*.

Vsaj v okolici Grmeza polstena medvejka še vedno uspeva (Sl.3). V mejah med travniki lahko najdemo posamezne grme, ki normalno plodijo, kar kaže, da je pojavljanje na Ljubljanskem barju vsaj ustaljeno, najverjetneje pa je vrsta tu tudi naturalizirana, a se širi počasi.

***Spiraea decumbens* Koch - polegla medvejka**
rastišča v Sloveniji: glej Praprotnik, 1997; Wraber & Skoberne, 1989

Polegla medvejka ima majhen areal v severovzhodni Italiji, ki le nekoliko sega še v zahodno Slovenijo (Breginjski kot) in morda na avstrijsko Koroško (novejših potrditev uspevanja tu ni, stare navedbe so napačne ali pa je vrsta tam izumrla; Hartl *et al.*, 1992; Adler, 1994). Navajanje uspevanja te vrste na Hrvaškem (Lukač, 1997) je zanesljivo napačno. Kljub majhnemu arealu se vrsta deli v dve dobro ločljivi podvrsti (ki bi jih bilo po mnenju nekaterih avtorjev moč razlikovati celo na vrstnem nivoju), od katerih tipska obsega vzhodni del areala in torej uspeva tudi v Sloveniji.

Podrobneje je pojavljanje polegle medvejke predstavljeno v Rdečem seznamu (Wraber & Skoberne, 1989), dopolnjuje ga le še nedavna najdba N. Praprotnik iz Kobarida (Hladnikia 8-9: 60.), kjer je najvzhodnejše trenutno znano rastišče te vrste.

***Spiraea chamaedryfolia* L., em. Jacq. - vrednikovolistna medvejka**
rastišča v Sloveniji: glej Praprotnik, 1987

Areal te vrste obsega velik del zmernega pasu Evrazije. Tipska podvrsta s ploščatimi socvetji in dlakavimi listi je razširjena v severovzhodni Aziji (Adolphi, 1995), *S. chamaedryfolia* ssp. *ulmifolia* (Scop.) J. Duvign. (*Spiraea ulmifolia* Scop.), ki ji lahko po slovensko rečemo brestovolistna medvejka in ima polobla socvetja ter gole liste, pa obsega zahodni del areala in ima klasično rastišče v Sloveniji (Scopoli, 1772, "Kobalova planina pri Idriji", 9950/3). Težišče razširjenosti te vrste je v predalpskem svetu osrednje in zahodne Slovenije (Praprotnik, 1987), posamezna najdišča pa so še južneje in vzhodneje, tako da uspeva v vseh fitogeografskih območjih Slovenije, vendar pa je pojavljanje razmeroma redko in raztreseno. Slovenska rastišča, skupaj z nekaj zahodnojulijskimi, ki ležijo v Italiji (Poldini, 1991), predstavljajo zahodno mejo areala te vrste, skrajno severozahodno mejo pa predstavlja nekaj rastišč na osrednjem avtrijskem Koroškem (Hartl *et al.*, 1992), o katerih spontanosti pa bi lahko tudi podvomili, saj jih od najbližjih rastišč v predgorju Julijcev ločujejo grebeni Ziljskih, Karnijskih in Julijskih Alp. Navajanje te vrste le kot kultivirane za Hrvaško (Lukač, 1997) je napačno, saj je tam zanesljivo avtohtona (tudi v herbariju LJU je pola, ki jo je Strgar nabral v Žumberaku).

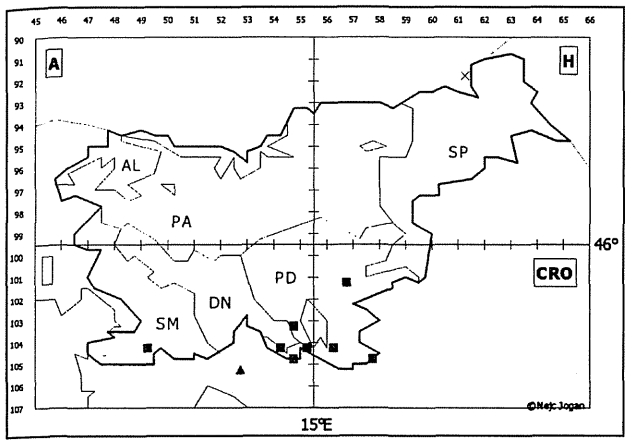
***Spiraea media* Schmidt - srednja medvejka**
= *S. oblongifolia* Waldst. & Kit.
= *S. chamaedryfolia* L., p. p.
= *S. confusa* Regel & Koernicke

Tudi areal srednje medvejke je evrazijski. Na vzhod sega vse do Japonske, na zahodu pa obsega jugovzhodno Evropo in južni del vzhodne Evrope. V srednji Evropi uspeva tudi nekoliko severneje od predhodne vrste, slovenska rastišča pa so prav tako na skrajni zahodni meji areala (če takson *S. cana* obravnavamo kot podvrsto srednje medvejke, potem leži le še eno rastišče zahodneje od Slovenije).

Če to vrsto obravnavamo v širšem smislu, jo (vsaj v Evropi) lahko razdelimo na štiri podvrste: *S. media* ssp. *media*, ki obsega severni del evropskega areala, *S. media* ssp. *mollis*, ki je razširjena v glavnem na Balkanu, *S. media* ssp. *cana*, ki je na zahodu Balkanskega polotoka simpatrična s predhodno podvrsto in z enim samim najdiščem sega v severovzhodno Italijo, ter *S. media* ssp. *polonica*, ki je (kljub imenu!) razširjena v lesostepah na zahodu Slovaške in v zahodni Ukrajini (Dobročaeva, 1954; Zahradnikova, 1992).

V Sloveniji je najverjetneje avtohtona le *S. media* ssp. *mollis*, a ker je skupina precej kritična, si na kratko oglejmo celotno problematiko (Sl. 2).

Podvrste se v glavnem razlikujejo po tipu in gostoti dlakavosti posameznih delov rastlin in so jih različni avtorji precej raznoliko obravnavali. V tipsko podvrsto so v glavnem vključevali takson *"mollis"* le kot varieteto ali celo kot popolni sinonim, po drugi strani pa je takson "*cana*" skoraj dosledno obravnavan na vrstnem nivoju. Takson *"polonica"* večinoma obravnavajo na nivoju podvrste, tako kot ga obravnavamo tudi v nadaljevanju.



Sl. 2: Razširjenost** Spiraea media **ssp.** media **(križci),** Spiraea media **ssp.** mollis **(kvadratki) in** S. media **ssp.** cana **(trikotniki) v Sloveniji in soseščini.
Fig. 2: Distribution of** Spiraea media **ssp.** media **(crosses),** Spiraea media **ssp.** mollis **(squares) and** S. media **ssp.** cana **(triangles) in Slovenia and adjacent territories.

Analiza herbarijskega materiala je pokazala, da se taksoni medsebojno razlikujejo v glavnem le po gostoti dlakavosti na posameznih delih rastline, drugi razlikovalni znaki, ki jih navajajo različni avtorji, so se izkazali za neuporabne. Tako naj bi se takson "*cana*" od ostalih razlikoval po enostavnih listih (Dostál, 1968) in mešičku, postopno zoženemu v vrat (Schroeder, 1990), a je revizija materiala pokazala, da je delež enostavnih listov pri posameznem grmu sicer lahko velik, a da so na istih poganjkih vedno tudi "normalno" nazobčani listi značilni za druge taksone. Tudi oblikovanost mešičkov se je izkazala za znak, ki znotraj skupine skoraj ne variira in imajo vsi taksoni vrh mešičkov zaokrožen in vrat nameščen obstransko, kot podaljšek mešičkovega hrbta (kar pa je uporaben znak za razlikovanje od brestovolistne medvejke).

Po vse izrazitejši razvitosti indumentuma lahko taksone skorajda pravilno razvrstimo takole:

"*media*" → "*mollis*" → "*polonica*" → "*cana*".

Predstavniki tipske podvrste so skorajda popolnoma goli, le po žilah spodnje strani listne ploskve in po listnem robu imajo lahko posamezne dlake. Pri balkanskem taksonu *"mollis"* so enoletni poganjki, spodnja stran listne ploskeve, listni rob in pecelj gosto kuštravo dlakavi, redkeje dlakava pa je tudi zgornja stran listov, os socvetja, peclji cvetov, cvetišča in mešički. Takson "polonica" ima poleg tega polsteno dlakave peclje cvetov in cvetišča, pojavi pa se še vejicatost in rumenkasta obarvanost venčnih listov, ki ju pri nobenem drugem taksonu ne srečamo (vejicatost je seveda pri herbarijskem materialu opazna, o obarvanosti pa lahko sodimo le po literaturnih navedbah). In končno srečamo pri taksonu *"cana"* indumentum, ki popolnoma prekriva enoletne poganjke, spodnjo stran listov, os socvetja, peclje cvetov in cvetišča, zgornja stran listov in plodovi pa 'ostajajo' redkeje dlakavi.

Oglejmo si še tabelarni prikaz razlik v dlakavosti (Tab. 1).

dlakavost	*media*	*mollis*	*polonica*	*cana*
listi spodaj	(+)	+/++	+/++	+++
listni rob	(+)	+/++	+/++	+++
listi zgoraj	-	+	+	++
listni pecelj	-	++	+	++
enol. poganjki	-	++	++	+++
os socvetja	-	+	+++	+++
peclji cvetov	-	+	+++	+++
cvetišče	-	+	+++	+++
rob venca	-	-	+	-
mešički	-	+	+	+

listi spodaj: leaves underneath; listni rob: leaf margin; listi zgoraj: upper leaf surface; listni pecelj: petiolus; enol. poganjki: twigs; os socvetja: inflorescence axis; peclji cvetov: pedicels; cvetišče: flower axis; rob venca: corolla margin; mešički: follicles

Tab. 1: Razlike v dlakavosti različnih delov rastlin med podvrstami vrste** S. media **(+: redka, ++: gosta, +++: popolnoma prekriva površino).
Tab. 1: Hairines on different parts of the plant in the subspecies of** S. media **(+: weak, ++: dense, +++: totally covering surface).

Še kratka opomba o avtorstu imena. V Slovenski floristični literaturi se od Mayerja (1958) dalje kot avtor imena *S. media* navaja v Pragi delujoči botanik F.(ranz) W.(illibald) Schmidt (1764-1796), medtem ko vsa druga pregledana literatura navaja za avtorja dunajskega vrtnarja in botanika (Franza) Schmidta (1751-1834) (Zander, 1984), ki je to vrsto opisal 1792. leta v reviji Österreichische Allgemeine Baumzucht (1: 53). Omenjenega opisa sicer nisem videl, a zdi se mi verjetno, da je bila napaka storjena pri nas.

S. media ssp. *media*

Kot je bilo že rečeno, je to srednjeevropska podvrsta, ki jo prepoznamo po tem, da je (skorajda) gola. V naši soseščini uspeva v Avstriji. Na območju Slovenije nabrani material, ki pripada tej podvrsti, izvira skoraj zanesljivo iz gojenih grmov. V herbariju LJU je tako pola, ki jo je Voss 1868. leta nabral v botaničnem vrtu (vendar gre zelo verjetno za napačno uvrščeni material, ki je bil v resnici nabran v botaničnem vrtu na Dunaju; T. Wraber, *ustno*), poleg tega pa je tudi material za zbirko Flora Exsiccata Carniolica mešan in pripadajo primerki delno tipski podvrsti, četudi je omenjena le lokaliteta pri Novem mestu. Skoraj gotovo gre v tem primeru za še eno Paulinovo površnost, saj si je na ta

način, z dodajanjem primerkov iz botaničnega vrta, pač poenostavil zbiranje zadostnih količin herbarijskega materiala. Material, ki ga je Strgar (1966) nabral pri razvalinah gradu Fridrihštajn (0355/3), s čimer je potrdil eno Fleischmannovih (1844) navedb, leži nekako med tipsko podvrsto in ssp. *mollis*, ker pa je na etiketi izrecno navedeno le uspevanje v okolici razvalin gradu, bi lahko sodili, da gre morda tudi tu za ostanke gojenja.

Vse torej kaže, da je v vzhodnem, torej najbolj kontinentalnem, delu Avstrije tudi jugozahodna meja areala tipske podvrste in vprašanje je, ali bi ta podvrsta lahko uspevala tudi v vzhodnih predelih Slovenije. V glavnem namreč uspeva na apnenem ali bazaltnem skalovju v združbah zveze *Prunion fruticosae* (Zimmermann *et al.*, 1989; Adolphi, 1995), v najbolj kontinentalnih delih Slovenije pa skalovja sploh ni, saj je matična kamnina prekrita z razmeroma mladimi, slabo sprijetimi sedimenti. To podvrsto bi tako morda lahko pričakovali le v okolici Gradu na Goričkem, ki leži v neposredni bližini najjužnejšega avstrijskega rastišča (*cf.* Sl. 3).

V Avstrijskem Rdečem seznamu je ta takson obravnavan kot potencialno ogrožen, na avstrijskem Štajerskem pa je tudi zavarovan (Zimmermann *et al.*, 1989).

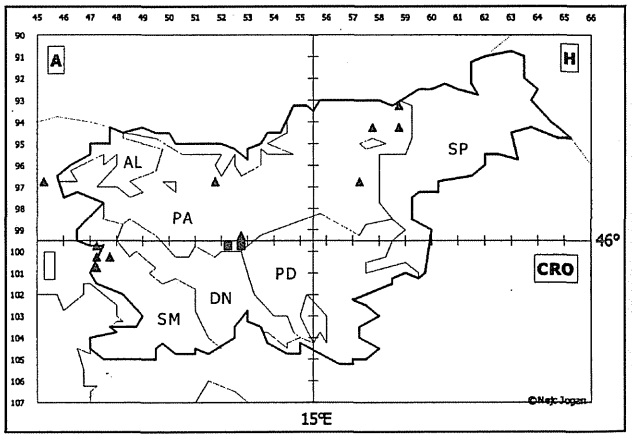
S. media ssp. *mollis* (C. Koch & Bouche) Schneid.
= *S. mollis* C. Koch & Bouche 1854
?= *S. sericea* Turcz 1843
nova ali prezrta rastišča v Sloveniji: (druga: glej Wraber & Skoberne, 1989)
0558/1 Slo.: Bela krajina, Preloka, Jakovini. leg. Seliškar & Vreš, 1998 (herbarij ZRC SAZU)
0454/4 Slo.: Dolenjska, nad Srobotnikom ob Kolpi. M. Accetto (predavanje 28. 11. 98)
0455/4 Slo.: Dolenjska, Sp. Bilpa, vznožje Volčje stene, leg. Podobnik & Jogan, 1990 (LJU)
0555/1 (?) Slo.: Dolenjska, Brod na Kolpi. Lit.: Fleischmann, 1844

Ta podvrsta obsega južni del evropskega areala srednje medvejke in slovenska rastišča so v njenem arealu najbolj severozahodna. Kot vse kaže, lahko kot zanesljivo avtohtona rastišča te podvrste v Sloveniji upoštevamo le tista na Kočevskem (Poljanska gora, Bilpa, Srobotnik), v Beli krajini in pri Novem mestu (Flora Exsiccata Carniolica), ki so podprta tudi s herbarijskim materialom. Ob tem se o novomeškem rastišču lahko porodijo rahli dvomi, saj je material v polah (kot je bilo že omenjeno) mešan s primerki (očitno kultivirane) tipske podvrste.

Zelo verjetno je tudi uspevanje podvrste *mollis* pri Brodu na Kolpi in na območju Slavnika (0449/4, Pospichal, 1897-1899), od koder ni herbarijskega materiala. Prvo od omenjenih rastišč je Paulin obiskal skupaj z Mulleyem (Paulin, 1904) in, ker sta medvejko iskala zaman, je bila Fleischmannova navedba razglašena za nezanesljivo in je kasneje niso več navajali. Vendar pa recentne najdbe te podvrste na Kočevskem podpirajo domnevo, da tudi Fleischmannovo rastišče ni izmišljeno, na kar je namigoval že Strgar (1966). Kot drugo rastišče se omenja zahodno pobočje Špičnika, 25-30 m pod vrhom (Marchesetti, 1896-1897). V Rdečem seznamu (Wraber & Skoberne, 1989) je ta lokaliteta izenačena z Malim Slavnikom (Grmado), saj je iz Tommasinijevega (1839) opisa jasno, da so ime Špičnik nekdaj uporabljali za ta vrh, ne pa za vzpetino nad Materijo, ki nosi takšno ime danes. Profesor Tone Wraber *(ustno)* je skupaj s skupino študentov srednjo medvejko tu zaman iskal že v sedemdesetih letih.

Okoli zgoraj uporabljenega imena tega taksona še vedno obstaja nekaj nomenklaturnih nejasnosti. Tako številni avtorji navajajo, da je Schneider uporabil ime *"mollis"* pravzaprav na nivoju varietete in sem uporabo na nivoju podvrste zasledil le pri Dostálu (1958), ta pa ne citira originalnega vira bazionima. Ta pridevek torej morda sploh še ni bil veljavno uporabljen na nivoju podvrste. Če je tako, bi kazalo ugotoviti, ali tipski material *S. sericea* v resnici ustreza taksonu *"mollis"* (na kar lahko sklepamo po opisih). Če je tako, bi bilo za podvrstno ime bolje uporabiti starejši sinonim *"sericea"*.

Hayek (1927) obravnava takson *"mollis"* kot križanec med *S. media* in *S. cana,* in glede na to, da po razvitosti indumentuma dejansko leži med omenjenima, možnosti nastanka tega taksona s križanjem ne moremo popolnoma izključiti.



Sl. 3: Razširjenost** Spiraea tomentosa **(kvadratki) in** S. japonica **(trikotniki) v Sloveniji in soseščini.
Fig. 3: Distribution of** Spiraea tomentosa **(squares) and** S. japonica **(triangles) in Slovenia and adjacent territories.

S. media ssp. *cana* (Waldst. & Kit.) Novak
= *S. cana* Waldst. & Kit.

To zahodnobalkansko podvrsto so v glavnem obravnavali kot samostojno vrsto, a - kot je bilo že omenjeno - je naša revizija pokazala, da gre le za najbolj dlakave oblike srednje medvejke. Literatura navaja razširjenost od Kosova in južne Srbije prek Bosne in Dalmacije do Risnjaka; eno samo, a v tem stoletju nepotrjeno rastišče,

pa leži v Italiji, na Mt. Cavallo, na meji med Furlanijo-Julijsko krajino in provinco Veneto. Presledek med skrajno zahodnima rastiščema (mimogrede, tudi za Risnjak obstajajo le stare in nepotrjene navedbe) je tako le okoli 150 km in v tem presledku leži tudi Slovenija. Če je podvrsta *cana* na omenjenih dveh rastiščih res uspevala, oziroma če morda celo še uspeva, ni izključeno tudi njeno pojavljanje na območju Slovenije. Sicer pa so njena Sloveniji najbližja in v zadnjem času potrjena rastišča na Velebitu.

S. media ssp. *polonica* (Blocki) Dostál
= *S. polonica* Blocki

Poljska medvejka je bila opisana na podlagi rastlin, ki so jih na Poljskem gojili, divje pa tam sploh ne rase (Zahradnikova, 1992). Njen naravni areal naj bi bil v lesostepah vzhodne Slovaške (*ibid.*) in zahodne Ukrajine (Dobročaeva, 1954).

Nekateri avtorji (npr. Dostál, 1958) obravnavajo ta takson kot sinonim ssp. *mollis*, od katere naj bi ga razlikovali predvsem vejicati venčni listi in gosto dlakave vejice socvetja, vsa rastlina pa naj bi bila rumenkasta.

Prvi, ki je ime *"polonica"* uporabil na podvrstnem nivoju, je bil Dostál (1948) in ne Pawlowski, 1968 (Čerepanov, 1973).

***Spiraea japonica* L. - japonska medvejka**

rastišča v Sloveniji:

0047/4 Slo.: Vipavska dolina, Stara Gora. Leg. Zirnich, 1952 (Mezzena, 1986).
0047/4 Slo.: Vipavska dolina, Stara gora. Popis N. Jogan & T. Bačič
0147/2 Slo.: Vipavska dolina, zahodni del Panovca. Popis N. Jogan & T. Bačič
0048/3 Slo.: Vipavska dolina, zahodni del Panovca. Popis N. Jogan & T. Bačič
9359/3 Slo.: Štajerska, pri Gaju nad Mariborom. Leg. H. Trauner, 1989 (LJU)
9458/3 Slo.: Štajerska, pri Lovrencu na Pohorju. Lit. Fritsch, 1934
9459/3 Slo.: Štajerska, pri Rušah. Leg. L. Vehovar, 1996 (LJU)
9751/2? Slo.: Gorenjska, v Udin borštu pri Kranju. D. Soban (*ustno*)
9757/2 Slo.: Štajerska ob Šmartinskem jezeru pri Celju. Leg. M. Žaberl, 1996. (LJU)
9953/2 Slo.: Ljubljana, Rakovnik. Leg. F. Dolšak, 1929 (LJU)

Japonska medvejka je vzhodnoazijska vrsta, ki jo v zmernem pasu gojijo kot okrasni grm tudi drugod po svetu. Ponekod je zato tudi podivjala, tako npr. na vzhodu ZDA, kjer je močno invazivna vrsta, ki v podrasti gozdov in ob vodah izpodriva naravno vegetacijo (Boone, 1996). Njeno širjenje je skorajda nemogoče omejiti, saj dobro semeni, poleg tega pa se razrašča s podzemskimi živicami in je tudi njeno fizično izkoreninjanje navadno neuspešno (*ibid.*)

V Evropi poročajo o njenem subspontanem ali naturaliziranem pojavljanju iz številnih držav (Dostál, 1968), v naši soseščini pa je naturalizirana v Furlaniji-Julijski krajini (Poldini, 1991). Podobno je Sloveniji. Japonska medvejka je naturalizirana in invazivna v spodnji Vipavski dolini, drugod po Sloveniji pa se tu in tam resda pojavlja, vendar se za zdaj še ne širi na naravna rastišča (Sl. 3). Vsekakor pa moramo biti nanjo pozorni.

Kronologijo naturalizacije v spodnji Vipavski dolini lahko do neke mere razvozlamo iz starejših navedb o uspevanju. Tako je subspontano pojavljanje japonske medvejke v tem koncu prvič opazil Zirnich (Mezzena, 1986) ob Grojni (0047/2) in pod Kalvarijo (0047/4) zahodno od Gorice že konec tridesetih let tega stoletja, na ozemlju današnje Slovenije pa jo je isti avtor nabiral v Stari gori 1952. leta. Njeno masovno uspevanje v zahodnem delu Panovca je bilo nadalje opaženo sredi devetdesetih let (Jogan, *neobjavljeno),* podrobnejše preučevanje flore spodnjega dela Vipavske doline na Študentskem raziskovalnem taboru Šempas '98 pa je razkrilo, da se japonska medvejka množično pojavlja v podrasti gozdov na območju Stare gore in zahodnega dela Panovca, dlje proti vzhodu pa se očitno še ni razširila. Na območju množičnega uspevanja je japonska medvejka, ponekod skupno z japonskim kosteničjem (*cf.* Jogan & Plazar, 1998), skoraj popolnoma nadomestila avtohtone vrste v podrasti gozdov, kar je zlasti očitno na mestih posek, ob gozdnih robovih in na redko rabljenih kolovozih, kjer so tla tu in tam popolnoma prekrita z njenimi kalicami. Očitno je torej, da se ta vrsta sicer ne širi zelo hitro, da pa se na njej ustreznih rastiščih zelo dobro zasidra in je njeno iztrebljenje praktično nemogoče.

Drugi podatki o uspevanju te vrste v Sloveniji so raztreseni po nižinskem in montanskem območju predalpskega in subpanonskega fitogeografskega območja. Na omenjenih rastiščih stopnja naturalizacije japonske medvejke ni znana.

Ključ za slovenske predstavnike medvejk

1 Socvetje češuljasto, poloblo ali diskasto, vsaj tako široko kot dolgo 2
- Socvetje piramidasto do valjasto, daljše od svoje širine 6
2 Venec rožnat, socvetje >5 cm ¤, mladi poganjki rdeči, listi dolgo priostreni ..... ***Spiraea japonica***
- Venec bel, socvetje <5 cm ¤, poganjki niso rdeči, listi (topo) koničasti 3
3 Do 30 cm visok grmiček, poganjki polegli, vejice socvetja razrasle (socvetje latasto), rastlina popolnoma gola ..... ***Spiraea decumbens***
- Vsaj 50 cm visok grm, poganjki pokončni, vejice socvetja niso razrasle (socvetje grozdasto do kobulasto), vsaj mladi poganjki in listi lahko dlakavi ... 4

4 Mladi poganjki robati, listi že v spodnjem delu ostro nazobčani ali krpati, po robu goli, venčni listi 3-6 mm dolgi, mešiček postopno zožen v vrat *Spiraea chamaedryfolia*
- Mladi poganjki v preseku okrogli, listi v dolnjem delu celorobi, proti vrhu nazobčani, vsaj po robu dlakavi, venčni listi 2-3 mm dolgi, mešiček na vrhu zaokrožen, vrat nameščen obstransko (*Spiraea media)* 5

5 Poganjki goli, popolnoma razviti listi le po robu in po spodnji strani po žilah raztreseno dolgo dlakavi, peclji cvetov, čaša in plod goli *S. media* ssp. *media*
- Enoletni poganjki gostro kuštravo dlakavi, tudi popolnoma razviti listi po peclju, spodnji strani in po robu ±gosto kuštravo dlakavi, peclji cvetov, čaša in plodovi vsaj nekoliko dlakavi *S. media* ssp. *mollis*

6 Listi po spodnji strani, vejice socvetja in plodovi polsteno dlakavi, zato umazano beli *Spiraea tomentosa*
- Listi po spodnji strani, vejice socvetja in plodovi goli ali ±redko (nikoli polsteno) dlakavi 7

7 Spodnja stran listov in mladi poganjki dlakavi, listni popki okoli 3 mm dolgi, listi v dolnjem delu celorobi, čašni listi po cvetenju razprostrti ali zavihani nazaj *Spiraea* x *pseudosalicifolia*
- Spodnja stran listov in mladi poganjki goli, listni popki do 2 mm dolgi, listi tudi v dolnjem delu nazobčani, čašni listi po cvetenju pokončni *Spiraea salicifolia*

RAZPRAVA IN ZAKLJUČKI

Kot je iz povedanega razvidno, lahko namesto o 3 avtohtonih in 1 alohtoni vrsti medvejk govorimo kar o 4 samoniklih in 3 naturaliziranih vrstah tega rodu v Sloveniji. O vrstah *S. decumbens* in *S. chamaedryfolia* ni bilo ugotovljenega nič bistveno novega (če izvzamem zanikanje neverjetnih navedb o pojavljanju na Hrvaškem). Za srednjo medvejko je bilo ugotovljeno, da populacije v južni Sloveniji pripadajo podvrsti *"mollis"*, da sega tipska podvrsta v Avstriji čisto do slovenske meje, da areal podvrste *"cana"* z Risnjaka 'skoči' še v severovzhodno Italijo in bi torej tudi pojavljanje v Sloveniji ne bilo nepričakovano, da uspevanje v jugozahodni Sloveniji v tem stoletju ni bilo potrjeno in je na Slavniku morda izumrla. Pokazalo se je, da je *S. salicifolia* avtohtona in da ima dovolj številne populacije pri nas trenutno le v Krakovskem gozdu, da pa je bila v preteklosti večkrat zamenjana s podivjanim križancem *S.* x *pseudosalicifolia*. Nadaljnji dve naturalizirani vrsti *S. japonica* in *S. tomentosa* sta bili doslej prezrti, četudi je njuno pojavljanje na območju današnje Slovenije znano že več desetletij.

Z naravovarstvenega stališča so zanimive vse štiri avtohtone vrste, od katerih sta dve *(S. decumbens in S. media)* kot 'redki vrsti' že vključeni v Rdeči seznam (Wraber & Skoberne, 1989). Kot kaže, je približno enako redka tudi *S. salicifolia*, ki ima vrh vsega še zelo ranljiva rastišča v poplavnih gozdovih in bi jo bilo zato prav tako treba vključiti v Rdeči seznam, najverjetneje kot ranljivo vrsto na meji areala. *S. chamaedryfolia* prav tako ni ravno pogosta in bi bilo pri njej treba preučiti stabilnost uspevanja na posameznih rastiščih.

Po drugi strani pa je z naravovarstvenega stališča zelo zanimiva tudi japonska medvejka, vendar je njen pomen prav nasproten. Kot izredno agresivna invazivna vrsta namreč izpodriva avtohtone vrste in s tem popolnoma spremeni vrstni sestav gozdnih združb. Dinamiko njenega širjenja v Vipavski dolini je treba začeti nemudoma opazovati, prav tako pa moramo bdeti tudi nad drugimi subspontanimi populacijami te vrste in jih morda raje uničiti, dokler je še čas.

Iz ugotovitev, navedenih v članku, pa lahko izpeljemo tudi marsikatero pomembno spoznanje o flori in floristiki v Sloveniji. Nekaj takih bi lahko bilo:
- skorajda je ni vrste, kaj šele rodu, o uspevanju katerih se v Slovenijie ne bi dalo ugotoviti še marsikaj novega, kar se pogosto izkaže tudi za rastline, ki veljajo za dobro poznane;
- nikdar se ne smemo zanašati na zanesljivost zbirnih florističnih del, saj se poleg bolj znanih pomanjkljivosti (npr. splošna nezanesljivost Fleischmanna (1844), "dopolnjevanje" herbarijskega materiala, do katerega je prišlo predvsem v nekaterih eksikatnih zbirkah, nekoliko nejasna in kasneje pogosto napačno razumljena omejitev obravnavanega ozemlja pri Mayerju (1952), izpustitev številnih neavtohtonih vrst in včasih nekritično združevanje taksonov v Mali flori Slovenije (Martinčič & Sušnik, 1969, 1984), prezrtje starejših navedb uspevanja na račun novejših potrditev v Rdečem seznamu (Wraber & Skoberne, 1989)) neredko pojavljajo tudi nepričakovani "izpadi" vednosti o posameznih taksonih; to lahko povzroči, tako kot v primeru polstene medvejke, začasno pozabo, ki jo je težko izslediti;
- večkrat podivjane ali celo lokalno naturalizirane alohtone vrste je treba nujno in dosledno vključevati v določevalne ključe, kar velja tudi za vrste, naturalizirane v bližnji soseščini Slovenije, za katere obstaja velika verjetnost, da se bodo (ali so se že!) razširile k nam;
- z določitvijo vrste po ključih v Mali flori Slovenije žal (dokler ne bo dosledno upoštevana predhodna točka) ne moremo biti zadovoljni, predvsem to velja za vrste ruderalnih in segetalnih rastišč, kjer je pojavljanje adventivk pogostejše.

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Nejc JOGAN: RAZŠIRJENOST MEDVEJK (*SPIRAEA* SPP.) V SLOVENIJI, 81-90

DISTRIBUTION OF BRIDEWORTS (*SPIRAEA* SPP.) IN SLOVENIA

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SUMMARY

The article presents the results of the critical revision of herbarium material and literature data regarding the occurrence of bridewort species in Slovenia.

S. salicifolia *has often been confused with several related cultivated species and hybrids in the past. That was most probably the reason why its occurrence in Central Europe was treated as sub-spontaneous and why the old published records of this species, which are not supported by the herbarium material, are not reliable. Today we can say that in Slovenia the species has its natural population in the floodplain forest Krakovski gozd, which is situated on the western border of its range. We cannot be sure about the indigeneity of the occurrence of* S. salicifolia *at Ljubljansko barje.* S. salicifolia *is proposed for inclusion in the Red Data List as a vulnerable species.*

S. *x* pseudosalicifolia *is an artificially produced sterile hybrid of the first mentioned species and N American* S. douglasii. *It is a popular garden shrub and can also persist for several years after its plantation has been abandoned. To a limited extent it can spread along long underground tillers. Its occurrence has been reported from several localities especially in central Slovenia, mostly under the name of* S. salicifolia.

S. tomentosa *is a frequently cultivated N American species with a small naturalized population at Ljubljansko barje (C Slovenia). From there it was reported in the 1920's and 1930's, but knowledge about its sub-spontaneous occurrence in this area later disappeared. Today we can say that it is a naturalized non-invasive species.*

S. decumbens *is an endemic SE Alpine species with only type subspecies growing in a couple of localities close to the Slovene-Italian border. As a rare plant species it has been included in the Red Data List (Wraber & Skoberne, 1989).*

S. chamaedryfolia *is represented in Europe only by the subspecies* ulmifolia, *which can also be treated as a micro-species and has its locus classicus in Slovenia (around Idrija, W Slovenia). Its localities scattered over central and southern Slovenia are representing its NW border of its range with only a few of them growing beyond the borders of Slovenia (in Friuli-Venezia Giulia (I) and Kaernten (A)).*

S. media *is a variable species, which can be divided into (at least) 4 subspecies:* S. media *ssp.* media *is an (almost) glabrous plant of C and E Europe with its SW-most locality on the Austrian-Slovene border. Its occurrence in Slovenia is linked to cultivation.*

S. media *ssp.* mollis *is a Balkan taxon doubtfully identical with* S. sericea. *It has hairy leaves, young shoots and the fruits and pedicels are also at least slightly hairy. In Slovenia it has a couple of small populations in the Kočevsko region (SE Slovenia) and most probably also an (extinct?) population in the Slavnik region (SW Slovenia). Because of its scarcity it has been included in the Red Data List as a rare species (under the name* S. media*).*

S. media *ssp.* cana *is a densely hairy taxon with an interesting area of distribution linking one locality in NE Italy with the W Balkan main range. Its two westernmost localities (Italian and on Mt. Risnjak in Croatia) have not been confirmed this century and it is possible that it has become extinct there. The majority of authors have treated this taxon as an independent species* S. cana, *but the revision has shown that* "cana" *populations are only quantitatively (indumentum density) differentiated from* S. media. *The other two distinguishing characters, namely shape of the fruit and the entire* vs. *lobed leaves, proved useless for delimitation of* "cana" *from* "media". *We can expect* S. media *ssp.* cana *also in SW Slovenia.*

There is another European subspecies S. media *ssp.* polonica *which - in respect to its indumentum - lies somehow between* "mollis" *and* "cana" *but has ciliate yellowish petals. Despite the meaning of the name 'polonica', its area of distribution is only in the steppic areas of Slovakia and Ukraine.*

S. japonica *is a frequently cultivated E Asian species being totally naturalized and invasive in the lower Vipava valley (SW Slovenia), where it has been spreading for about 60 years. Despite the facts that its seed-set is enormous, that the seeds are fully viable, and that it is also vegetativelly spreading by underground tillers, its secondary area of distribution in the mentioned valley has been expanding very slowly, only for about 2 km per decade. This species has been recorded also in a couple of other localities in Slovenia, but the current status of its potential naturalization at those localities is not known.*

Key words: brideworts, *Spiraea,* flora, distribution, Slovenia

LITERATURA

Adler, W. (1994): *Rosaceae. In:* Fischer, M. (Hrsg.): Exkursionsflora von Österreich. Ulmer Verlag, Wien.

Adolphi, K. (1995): *Spiraea. In:* Hegi, G. (Vergr.): Illustrierte Flora von Mitteleuropa IV/2. Paul Parey, München.

Ascherson, P. & P. Graebner (1900-1905): Synopsis der mitteleuropäischen Flora 6. Leipzig.

Bevk, S. (1927): Botanika za šolo in dom. Ljubljana.

Boone, D. (1996): *Spiraea japonica. In:* Randall, J. M. & J. Marinelli (*eds.*): Invasive plants, Weeds of the Global Garden. Brooklin Botanic Garden.

Čerepanov, S. K. (1973): Svod dopolnenij i izmenenij k "Flore SSSR". Nauka, Leningrad.

Dobročaeva, D. M. (1954): *Spireoideae* Agardh. *In:* Zerov, D. K. (*ed.*): Flora URSR 6. AN URSR, Kiiv.

Dostal, J. (1958): Klič k uplne kvetene ČSR. ČAV, Praha.

Dostal, J. (1968): *Spiraea* L. *In:* Tutin, T. G., V. H. Heywood, N. A. Burges, D. M. Moore, D. H. Valentine, S. M. Walters & D. A. Webb (*eds.*): Flora Europaea 2. CUP, Cambridge.

Ellis, R.G. (1993): Aliens in the British Flora. National Museum of Wales, Cardiff.

Fleischmann, A. (1844): Uebersicht der Flora Krain's. Laibach.

Fritsch, K. (1922): Exkursionsflora für Österreich und ehemals österreichischen Nachbargebiete. Wien, Leipzig.

Glovacki, J. (1912-1913): Flora slovenskih dežel. Slovenska Šolska Matica, Ljubljana.

Hartl, H., G. Kniely, G. H. Leute, H. Niklfeld & M. Perko (1992): Verbreitungsatlas der Farn- und Blütenpflanzen Kärntens. Naturwissenschaftlischer Verein fuer Kärnten, Klagenfurt.

Hayek, A. von (1908): Flora von Steiermark I. Graz.

Hayek, A. (1927): Prodromus Florae peninsulae Balcanicae 1. Berlin.

Hočevar, S. F. Batič, A. Martinčič & M. Piskernik (1980): Drugotni nižinski pragozd Krakovo v Krakovskem gozdu. Zbornik gozdarstva in lesarstva, 18(1), 5-144.

Huber, H. (1961-1966): *Spiraea. In:* Hegi, G. (*ed.*): Illustrierte Flora von Mittel-Europa IV/2. Carl Hanser Verlag, München.

Jogan, N. (1998): KARARAS 2.0 (paket klišejev za KArtiranje RAzširjenosti RAstlin v Sloveniji).

Jogan, N. & J. Plazar (1998): *Lonicera japonica* Thunb. - nova naturalizirana vrsta slovenske flore. Annales, 13, 125-130.

Kobližek, J. (1992): *Spiraea* L. - tavolnik. *In:* Hejny, S. & B. Slavik (*eds.*): Kvetena Českе Republiky 3. Academia, Praha.

Lorinser, G. (1860): Botanisches Excursionsbuch für die deutsch-österreichischen Kronländer und das angrenzende Gebiet. Wien.

Lukač, G. (1997): *Rosaceae* L. *In:* T. Nikolič: Index florae Croaticae 2. Natura Croatica, 6 (suppl. 1), 1-232.

Marchesetti, C. (1896-1897): La flora di Trieste e de'suoi dintorni.

Martinčič, A. & F. Sušnik (1969): Mala flora Slovenije. CZ, Ljubljana.

Martinčič, A. & F. Sušnik (1984): Mala flora Slovenije. DZS, Ljubljana.

Martinčič, A., T. Wraber, N. Jogan, A. Podobnik, V. Ravnik, B. Turk & B. Vreš (1999): Mala flora Slovenije: ključ za določevanje praprotnic in semenk. TZS, Ljubljana, 845 str.

Maxwell, H. S. & S.G. Knees (1995): *Spiraea* Linnaeus. *In:* Cullen, J., J. C. M. Alexander, A. Brady, C. D. Brickell, P. S. Green, V. H. Heywood, P.-M. Jörgensen, S. L. Jury, S. G. Knees, A. C. Leslie, V. A. Matthews, N. K. B. Robson, S. M. Walters, D. O. Wijnands & P. F. Yeo (*eds.*): European Garden Flora 4. CUP, Cambridge.

Mayer, E. (1952): Seznam praprotnic in cvetnic slovenskega ozemlja. Dela 5, SAZU, Clasis IV, Ljubljana.

Mayer, E. (1958): Pregled spontane dendroflore Slovenije. Gozdarski vestnik, 6-7, 161-191.

Mezzena, R. (1986): L'erbario di Carlo Zirnich (Ziri). Atti Mus. Civ. Stor. Nat. Trieste, 38(1), 1-519.

Paulin, A. (1904): Beiträge zur Kenntnis der Vegetationsverhältnisse Krains 3. Laibach.

Poldini, L. (1991): Atlante corologico delle piante vascolari nel Friuli-Venezia Giulia. Udine.

Pospichal, E. (1897-1899): Flora des österreichischen Küstenlandes 1-2.

Praprotnik, N. (1987): Ilirski florni element v Sloveniji. Doktorska disertacija, Univerza v Ljubljani, 234 str.

Rauš, Dž. & J. Vukelić (1991): *Spiraea salicifolia* L. in Croatian forests. Acta Bot. Croat., 50, 107-113.

Scopoli, J. A. (1772): Flora Carniolica I.

Schroeder, E. G. (1990): *Rosaceae.* In: Fitschen, J.: Gehoelzflora 9. Aufl. Quelle & Meyer Verlag, Heidelberg.

Stace, C. A. (1991): New Flora of the British Isles. CUP, Cambridge.

Strgar, V. (1966): Prispevek k poznavanju rastlinstva v soteski Iške. Varstvo narave, 5, 81-95.

Tommasini, M. (1839): Der Berg Slavnik im Küstenland und seine botanischen Merkwürdigkeiten, insonderheit *Pedicularis Friderici Augusti.* Linnaea, 13, 49-78.

Wraber, T. & P. Skoberne (1989): Rdeči seznam ogroženih praprotnic in semenk SR Slovenije. Varstvo narave, 14/15, 1-429.

Zahradnikova, K. (1992): *Spiraea* L. *In.:* Bertova, L. (*ed.*): Flora Slovenska IV/3. VEDA, Bratislava.

Zander, R. (1984): Handwörterbuch der Pflanzennamen 13 Aufl. Verlag Eugen Ulmer, Stuttgart.

Zimmermann, A., G. Kniely, H. Melzer, W. Maurer & R. Höllriegl (1989): Atlas gefährdeter Farn- und Blütenpflanzen der Steiermark. Graz.

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FIRST RECORD OF THREE SPECIES OF THE GENUS *CLADOPHORA* KÜTZ. IN THE COASTAL WATERS OF SLOVENIA

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ABSTRACT

Three species of the genus Cladophora *Kützing have been recorded in the coastal waters of Slovenia (Gulf of Trieste - Adriatic Sea) for the very first time. A general description of these species is given, as well as its basic morphological features and theirs habitats in the Slovene coastal waters.*

Key words: *Cladophora*, Chlorophyta, occurrence, Slovene coastal waters

PRIMA TESTIMONIANZA DELLA PRESENZA DI TRE SPECIE DEL GENERE *CLADOPHORA* KÜTZ. NELLE ACQUE COSTIERE DELLA SLOVENIA

SINTESI

Per la prima volta viene segnalata la presenza di tre specie del genere Cladophora *Kützing nelle acque costiere della Slovenia (Golfo di Trieste - mare Adriatico). Nell'articolo vengono forniti: la descrizione generale, le caratteristiche morfologiche di base e gli habitat di queste specie nelle acque costiere slovene.*

Parole chiave: *Cladophora*, Chlorophyta, evento, acque costiere slovene

INTRODUCTION

According to Gallardo *et al.* (1993), 24 species of *Cladophora* occur in the Adriatic Sea. According to Giaccone (1978) and van den Hoek (1963), 21 of these are present in the Gulf of Trieste (excluding Slovene coastal waters).

Among the Slovene scientists who have dealt with the algal flora of the Slovene coastal waters and prepared its checklist are: Matjašič & Štirn (1975), Vukovič (1980, 1981, 1982, 1984) and Battelli (1997). According to them, 19 species of *Cladophora* occur in the Slovene coastal sea.

From July to September 1998, three species of the genus *Cladophora* (*Cladophora hutchinsiae* (Dillwyn) Kützing, *Cladophora lehmanniana* (Lindenberg) Kützing and *Cladophora nigrescens* Zanardini ex Frauenfeld) were recorded for the first time in the coastal waters of Slovenia (Gulf of Trieste).

This article deals with the occurrence of these species in the Slovene coastal sea. A morphological description and habitats of these species are given. A general synoptic table of the basic characteristics of the dealt with species is also given.

COLLECTION AND OBSERVATION

Samples were collected in the coastal waters of Slovenia (from Debeli rtič in the north to the mouth of the Dragonja river in the south) in the lower midlittoral and in the upper infralittoral to a depth of about 6-8 metres (Fig. 1)

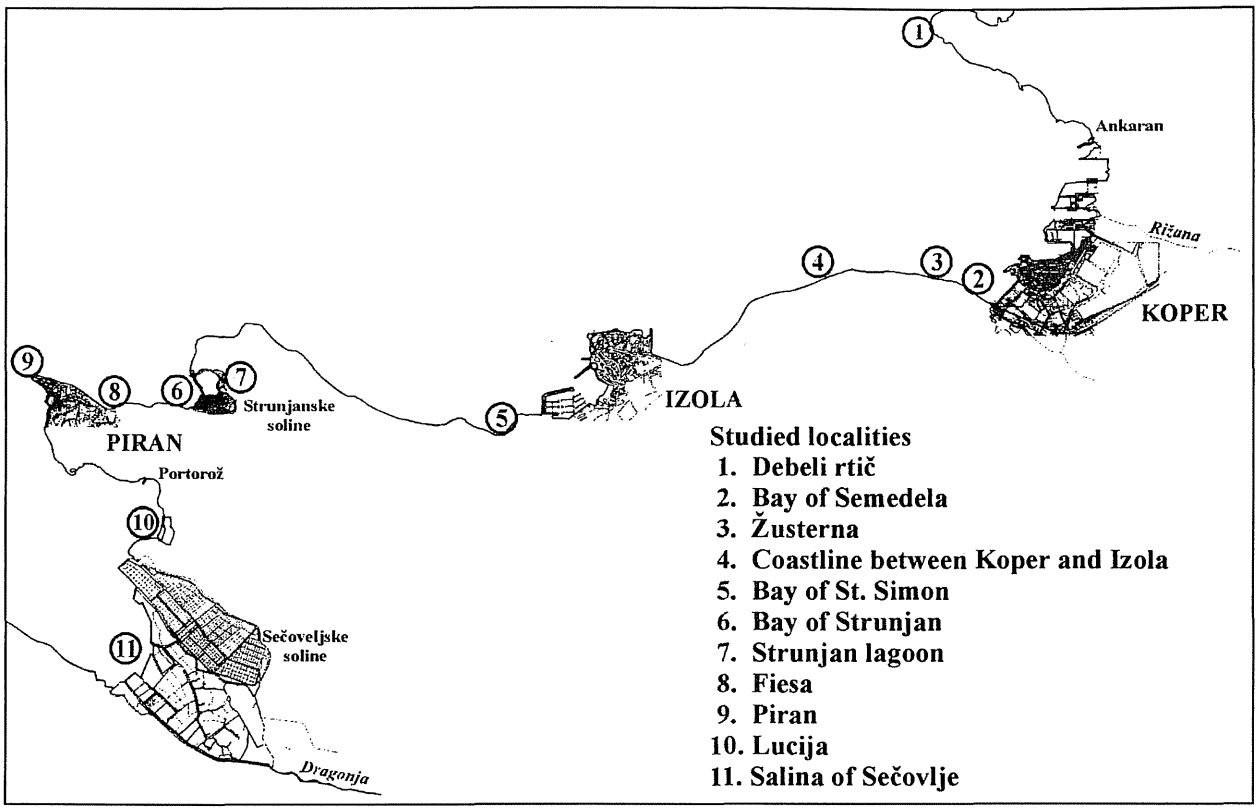

Fig. 1: Study area with sampling stations.
Sl. 1: Obravnavano območje z vzorčevalnimi postajami.

Samples were kept as dry herbarium specimens and chemically treated as wet preparations in 4 % methanal (formalin) solution in seawater.

The algae were identified according to the criteria by van den Hoek (1963), Giaccone (1972-1973) and Noailles (1995). These criteria include:

- thallus organization (acropetal, not acropetal)
- growth (apical, intercalary)
- insertion of the branches (apically, laterally)
- features of the attachment organ (primary, secondary, annular constriction)
- diameter of apical cells
- length of basal cell
- width of cell wall
- colour of dry samples

List of the dealt with species:

1. *Cladophora hutchinsiae* (Dillwyn) Kützing
2. *Cladophora lehmanniana* (Lindenberg) Kützing
3. *Cladophora nigrescens* Zanardini ex Frauenfeld

DESCRIPTION OF THE SPECIES

The species are presented in alphabetical order.

Cladophora hutchinsiae (Dillwyn) Kützing

Synonyms: *Conferva diffusa*
Cladophora diffusa Harvey

Samples had also been found in the mid-nineteenth century in the Gulf of Trieste (off Trieste) as *Cladophora virgata* by Stossich (professor at a secondary school in Koper and Trieste) and identified by Grunow (Austrian algologist) (van den Hoek, 1963).

Description

Thallus densely, pseudodichotomously branched, about 2-3 cm long, dark green (Fig. 2). Thallus attached to hard substratum with dense carpets. Dominating intercalary growth. In the apical region acropetal organization. Branches obliquely inserted at the apical poles of the cells with oblique cross-wall. Cells generally cylindrical in shape. Cell-walls thin. Diameter of apical cells 100-140 µm; diameter of ultimate branches 100-250 µm; diameter of main branches 240-400 µm.

Samples were found in the upper subtidal habitats (station 8) on sheltered and shady sites.

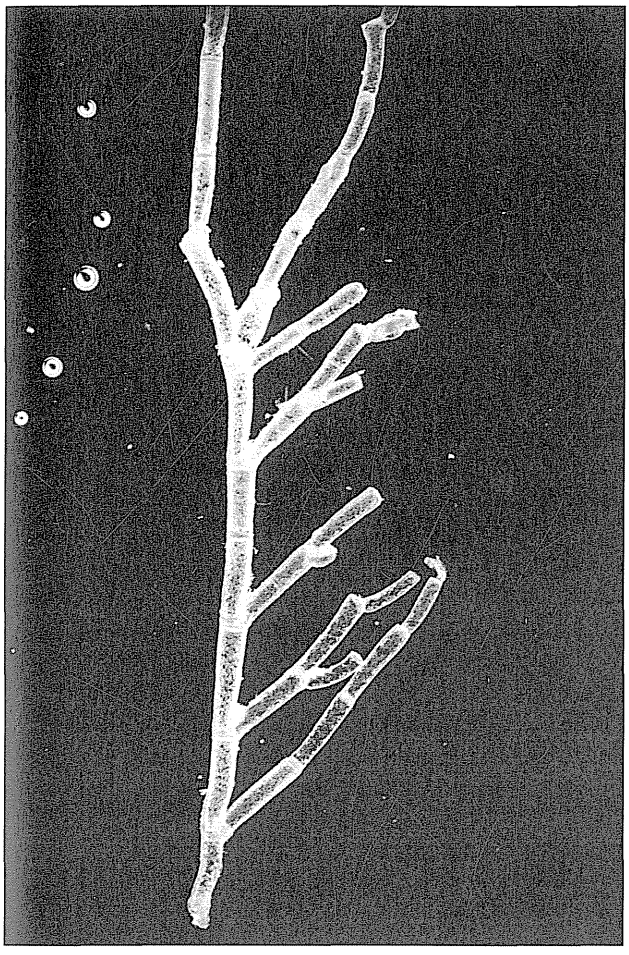

Fig. 2: Part of thallus of** C. hutchinsiae **(Photo: M. Richter).
Sl. 2: Del steljke** C. hutchinsiae **(Foto: M. Richter).

Distribution

C. hutchinsiae is a sub-cosmopolitan species. It is known from the NE Atlantic: Netherlands, Ireland, Britain, France, Portugal, Madeira (Burrows, 1991); from the Mediterranean Sea: Spain, Balearic Islands, France, Corsica and Sardinia, Western Italy, Sicily, Adriatic, the Black and Azov Seas, Turkey, Libya, Greece, Tunisia, Algeria (Gallardo *et al.*, 1993); from NE Pacific: Alaska, British Columbia, Washington, Oregon (Burrows, 1991); from the Indian Ocean: Pakistan, South Africa (Silva), as well as from southern Australia and Japan (C. van den Hoek, *pers. comm.*).

Cladophora lehmanniana (Lindenberg) Kützing

Synonyms: *Cladophora ramulosa* Meneghini
Cladophora utriculosa Kützing

The species was found in the Gulf of Trieste (off Trieste) as *Cladophora utriculosa* and near Miramare (Trieste) as *Cladophora catenata* by Hauck in the mid-nineteenth century (van den Hoek, 1963).

The species was also found in the Bay of Koper by Giuseppe Accurti (professor at a secondary school in Koper) in 1858 (Accurti, 1858), but the identification of the samples still needs to be confirmed.

Description

Thallus is densely pseudodichotomously branched, with stiff texture, about 10-15 cm long, dark green. Mainly apical growth; intercalary growth starting at some distance from the apex (Fig. 3). Insertion of the branches oblique at the apical pole of a cell with a nearly horizontal cross-wall. Cells are cylindrical, sometimes slightly club-shaped. Cell-walls generally 10 µm thick. Diameter of apical cells 95-110 µm; diameter of ultimate branches 90-120 µm; diameter of main branches about 200 µm.

Samples were found in the upper subtidal habitats (stations 4 and 5) on sheltered and shady sites.

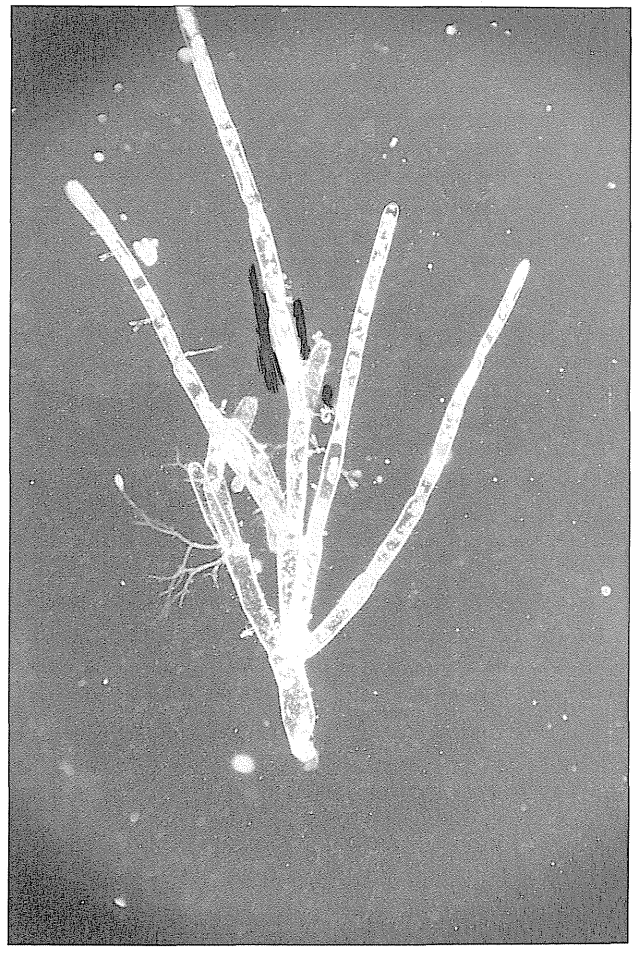

Fig. 3: Part of thallus of** C. lehmanniana **(Photo: M. Richter).
Sl. 3: Del steljke** C. lehmanniana **(Foto: M. Richter).

Distribution

C. lehmanniana is an Indo-Atlantic species. It is known from the NE Atlantic: Ireland, Britain, France, Morocco (Burrows, 1991); from the Mediterranean Sea: Spain, Balearic Islands, France, Corsica and Sardinia, Western Italy, Sicily, Adriatic, Greece, the Black and Azov Seas, Turkey, Levant States, Egypt, Libya, Tunisia, Algeria, Morocco (Gallardo *et al.*, 1993); from the Indian ocean: Australia, India, Laccadive Islands, Somalia, South Africa, Tanzania (Silva), and from southern Australia (C. van den Hoek, *pers. comm.*).

Cladophora nigrescens Zanardini *ex* Frauenfeld

The species was found at Trieste as *Cladophora scoparioides* by Hauck in 1876 (van den Hoek, 1963).

Description

Thallus is densely branched and about 4-6 cm long. Living thalli are dark green, dried specimens are dark brown colour (Fig. 4). Rhizoids with annular constrictions. Thallus mainly with acropetally organization. Insertion of the branches almost laterally inserted with steeply inclined cross-wall. Cells elongated and slightly club-shaped. Cell-walls generally 10 µm thick. Diameter of apical cells 40-75 µm; diameter of ultimate branches 45-80 µm; diameter of main branches about 120 µm.

Samples were found in the upper subtidal habitats (station 4) on sheltered sites.

Distribution

C. nigrescens is an Atlantic - boreal species. It is known from the Mediterranean Sea: Spain, Balearic Islands, Western Italy, Sicily, Corsica, Adriatic, Greece, the Black and Azov Seas (Gallardo *et al.*, 1993).

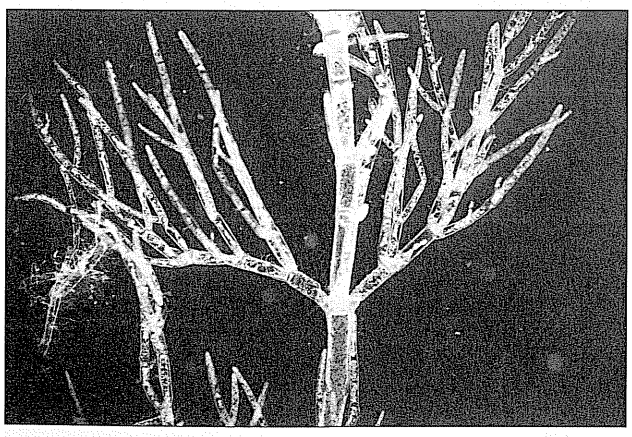

Fig. 4: Part of thallus of** C. nigrescens **(Photo: M. Richter).
Sl. 4: Del steljke** C. nigrescens **(Foto: M. Richter).

DISCUSSION AND CONCLUSION

In this work we report on the occurrence of 18 species of *Cladophora* (see Tab. 1). If we include all the species according to Matjašič & Štirn (1975) and Vukovič (1980,1981,1982,1984), 22 species of *Cladophora* occur in the Slovene coastal waters.

N.	SPECIES	ADRIATIC SEA	GULF OF TRIESTE	SLOVENE COASTAL WATERS			
1	*C. aegagropila*	+1	-	-	-	+4	-
2	*C. albida*	+1	+1	+2	+3	+5	+6
3	*C. battersii*	+1	-	-	+3	-	-
4	*C. coelothrix*	+1	+1	+2	+3	+4	+6
5	*C. dalmatica*	+1	+1	-	+3	+5	+6
6	*C. echinus*	+1	+1	+2	+3	+4	-
7	*C. feredayi*	+1	+1	+2	+3	+4	-
8	*C. fracta*	+1	-	-	-	-	-
9	*C. glomerata*	+1	+1	-	+3	+5	+6
10	***C. hutchinsiae***	+1	+1	-	-	+5	-
11	*C. laetevirens*	+1	+1	+2	+3	+5	+6
12	***C. lehmanniana***	+1	+1	-	-	+5	-
13	*C. liebetruthii*	+1	+6	-	-	-	-
14	*C. linifornis*	+1	+1	-	+3	+5	+6
15	***C. nigrescens***	+1	+6	-	-	+5	-
16	*C. pellucida*	+1	+1	+2	+3	+4	-
17	*C. prolifera*	+1	+1	+2	+3	+4	+6
18	*C. pseudopellucida*	+1	-	-	-	+4	-
19	*C. retroflexa*	+1	+1	+2	+3	+4	-
20	*C. ruchingeri*	+1	+1	-	+3	+5	-
21	*C. rupestris*	+1	+1	-	+3	+5	-
22	*C. sericea*	+1	+1	+2	+3	-	-
23	*C. socialis*	+1	+1	-	+3	-	-
24	*C. vadorum*	+1	+6	-	-	-	-
25	*C. vagabunda*	+1	+1	+2	-	-	+6
		24	21	10	16	18	8

Tab. 1: Synoptic table indicating the occurrence of species of the genus** Cladophora **in the Adriatic sea, in the Gulf of Trieste, and in the coastal waters of Slovenia.
Tab. 1: Preglednica, ki ponazarja pojavljanje vrst iz rodu** Cladophora **v Jadranskem morju, v Tržaškem zalivu in v slovenskem obalnem morju.

Legend/ Legenda: + presence/pojavljanje, - absence/ odsotnost

Sources/Viri: 1 (Gallardo** et al., **1993; Giaccone, 1978), 2 (Matjašič & Štirn, 1975), 3 (Vukovič, 1980, 1981, 1982, 1984), 4 (Battelli, 1997), 5 (this work), 6 (van den Hoek, 1963)

SPECIES	Diameter of apical cells (µm)	Insertion of the branches	Cross-walls	Cell walls	Rhizoids
C. hutchinsiae	90-190	apical/ oblique	oblique	thin	coralloid holdfast
C. lehmanniana	100-150	apical/ oblique	oblique	thin	coralloid holdfast
C. nigrescens	40-60	lateral	vertical	thick	annular constrictions

Tab. 2: General synoptic table of the basic characteristics of the dealt with species of the genus *Cladophora.*
Tab. 2: Splošna preglednica osnovnih lastnosti obravnavanih vrst iz rodu *Cladophora.*

ACKNOWLEDGEMENTS

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PRVO ZABELEŽENO POJAVLJANJE TREH VRST IZ RODU *CLADOPHORA* KÜTZING V SLOVENSKEM OBALNEM MORJU

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POVZETEK

V članku obravnavamo tri vrste iz rodu Cladophora, *ki doslej niso bile zabeležene v slovenskem obalnem morju. To so:* C. hutchinsiae *(Dillwyn) Kützing,* C. lehmanniana *(Lindenberg) Kützing in* C. nigrescens *Zanardini ex Frauenfeld. Raziskovano je bilo območje jugovzhodnega dela Tržaškega zaliva od Debelega rtiča (Koprski zaliv) do izliva reke Dragonje (Piranski zaliv) v mediolitoralu in v infralitoralu do globine 6-8 m. Vzorci so bili nabrani od julija do septembra 1998. leta med prostim potapljanjem na naslednjih postajah: Debeli rtič, Semedelski zaliv, Žusterna, obala Koper-Izola, zaliv San Simon, Strunjanski zaliv, Strunjanska laguna, Fiesa, rt Madona, Lucija in Sečoveljske soline. Vzorci so shranjeni kot suhi preparati v algariju in kot mokri preparati v 4-5 % metanalu (formalinu) v morski vodi. Za vsako obravnavano vrsto podajamo splošne morfološke značilnosti in geografsko razširjenost v svetovnih morjih ter podatke o rastiščih v slovenskem obalnem morju. Dodajamo preglednico, ki ponazarja pojavljanje vrst iz rodu* Cladophora *v Jadranskem morju, v Tržaškem zalivu in v slovenskem obalnem morju. Na koncu podajamo tudi splošno preglednico osnovnih lastnosti obravnavanih vrst.*

Ključne besede: *Cladophora,* zelene alge, pojavljanje, slovensko obalno morje

REFERENCES

Accurti, G. (1858): Cenno sulle alge di Capodistria. Programma dell' I.R. ginnasio di Capodistria. Trieste, Lloyd Austr., 1-9.

Battelli, C. (1997): Prispevki k poznavanju makrobentoških alg slovenskega obalnega morja: rod *Cladophora* (Chlorophyta). Annales, 11, 47-56.

Burrows, E. M. (1991): Seaweeds of the British Isles. Vol. 2: *Chlorophyta.* Nat. Hist. Mus., London, xi- 238.

Gallardo, T., A. Gomez Garretta, M. A. Ribera, M. Cormaci, G. Furnari, G. Giaccone & Ch. F. Boudouresque (1993): Check list of Mediterranean Seaweeds II. Chlorophyta. Bot. mar., 36(5), 399-421.

Giaccone, G. (1972-1973): Elementi di botanica marina II. Chiavi di determinazione per le alghe e le angiosperme marine del Mediterraneo. Pubbl. Ist. Bot. Univ. Trieste, serie didattica, 4-121.

Giaccone, G. (1978): Revisione della flora marina del mare Adriatico. Suppl. WWF, TS, 6/19, 108-111.

Hoek, C. van den (1963): Revision of the European species of *Cladophora*. Leiden, E. J. Brill, 248 pp.

Matjašič, J. & J. Štirn (1975): Flora in favna severnega Jadrana. Pris. 1., SAZU, Ljubljana, 4, 19-23.

Noailles, M. C. (1995): Les especes de *Cladophora* (Chlorophyta) les plus communes des côtes Nord-Finistere, région de Roscoff en particulier (France). Cah. Biol. Mar., 36, 81-121.

Vukovič, A. (1980): Asociacije morskih bentoških alg v Piranskem zalivu. Biol. vestn., 28(2), 103-124.

Vukovič, A. (1981): Značilnosti bentoških združb v izolskem zalivu. Slovensko morje in zaledje, 4-5, 101-106.

Vukovič, A. (1982): Bentoška vegetacija Koprskega zaliva. Acta Adriatica, 23(1/2), 227-235.

Vukovič, A. (1984): Prispevek k poznavanju flore morskih alg Slovenije. Slovensko morje in zaledje, 7(6-7), 187-193.

ZGODOVINA NARAVOSLOVJA

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SPIRIDION BRUSINA - ZOOLOG I PALEONTOLOG (1845-1908)

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SAŽETAK

Spiridion Brusina (1845-1908) je jedan od najpoznatijih hrvatskih prirodoslovaca 19. stoljeća i uopće. Preko trideset godina radio je u muzeju i to od 1868. godine kao pristav, od 1876. godine kao utemeljitelj i ravnatelj Hrvatskog narodnog zoološkog muzeja. Bio je i prvi sveučilišni profesor na katedri za zoologiju novoga zagrebačkog Sveučilišta (1876-1901), inicijator i jedan od osnivača Hrvatskoga naravoslovnog družtva (1885), pokretač i prvi urednik njegova Glasnika, utemeljitelj znanstvene knjižnice današnjeg Hrvatskoga prirodoslovnog muzeja, pisac prvih prirodoznanstvenih bibliografija u Hrvata. Svojim organizatorskim sposobnostima znatno je pridonjeo napredku bioloških znanosti i njihovo povezivanje sa svijetom, dok je svojim stručnim i znanstvenoistraživačkim radom u području ornitologije, ihtiologije, malakologije i mamalogije stekao velike zasluge u domovini, a svojim temeljitim istraživanjima faune neogenskih mekušaca Hrvatske i jugoistočne Europe postao je izuzetno poznat i priznat u svijetu.

Ključne riječi: Spiridion Brusina, prirodopis, Jadransko more, životopis

SPIRIDION BRUSINA - ZOOLOGO E PALEONTOLOGO (1845-1908)

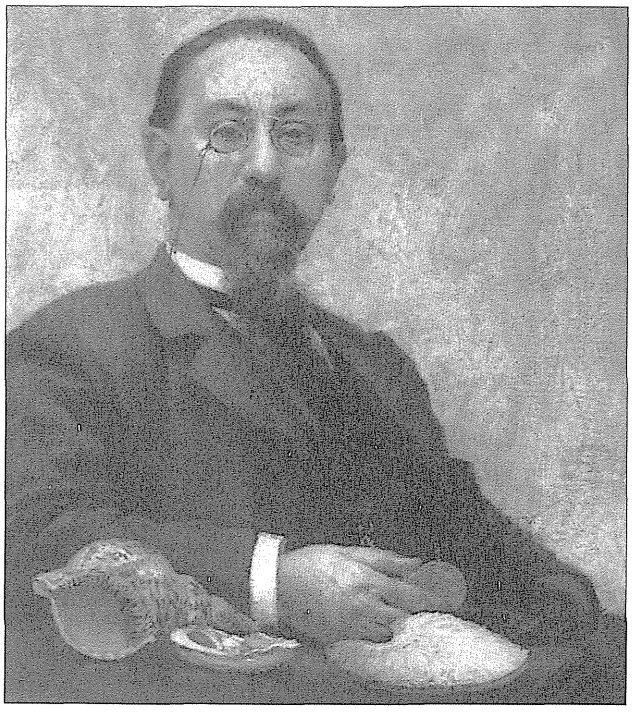
SINTESI

L'autore presenta la biografia ed il lavoro di Spiridion Brusina, scienziato croato, nel centocinquantacinquesimo anniversario della sua nascita. Il lavoro di Spiridion Brusina raggiunse il suo apice nella zoologia generale e nella paleontologia di molluschi e gasteropodi. In questi campi, lo scienziato scoprì e descrisse un ampio numero, più di 600, nuove specie (in prevalenza fossili). Brusina fondò la Società Naturale Croata ed il suo giornale 'Glasnik hrvatskog prirodoslovnog družtva' (l'odierno 'Periodicum Biologorum') nonché la biblioteca zoologica. La sua grande collezione paleomalacologica e conservata nel Museo Naturale Croato di Zagabria e viene protetta come monumento di categoria zero. Brusina vanta, inoltre, diverse pubblicazioni molto interessanti nei campi dell'ornitologia e dell'ittiologia. Brusina fu non solo un grande scienziato ma pure uno dei più grandi darwinisti del suo tempo.

Parole chiave: Spiridion Brusina, scienze naturali, Mare Adriatico, biografia

UVOD

Ove godine se navršava 155. godina od rođenja Spiridiona Brusine, zoologa i paleontologa, koji je svoj radni vijek proveo u Zagrebu u Zoološkom muzeju i na Sveučilištu (1868-1901), a svojim istraživanjima i velikim organizatorskim sposobnostima mnogo je učinio za napredak prirodnih znanosti na ovim prostorima. Postao je poznat i u svijetu, osobito po svojim radovima iz paleontologije mekušaca. U drugoj polovici 19. stoljeća Brusina je bio prava iznimka na ovim prostorima po shvaćanju mjesta i važnosti prirodne znanosti za život naroda. Neumorno je isticao kako svaki duhovni i materijalni napredak bitno ovisi o stupnju



Sl./Fig. 1: Spiridion Brusina (1845-1908).

razvoja prirodnih znanosti u nekom narodu. U skladu s tim svojim temeljnim uvjerenjem Brusina je cijelog života poduzimao veliki broj akcija da bi se prije svega u Hrvatskoj stvorili osnovni preduvjeti za znanstveni i istraživački rad, da taj rad bude dobro organiziran i uspješan na europskoj i svjetskoj razini. Nema uopće dvojbe da je tim svojim osnovnim uvjerenjem Brusina i danas aktualan i suvremen. Za malakologiju neogena i današnjice, osobito faune kopna i uzemnih voda, još i danas predstavlja među klasičnim autorima jednu od najviše navođenih ličnosti. Njegova se djela još danas mnogo upotrebljavaju. Održana je većina njegovih taksona koje je on vješto uočio i uveo u znanost.

ŽIVOTOPIS

Spiridion Brusina (Sl. 1), hrvatski zoolog i paleontolog, rođen je u Zadru 11. prosinca 1845. godine od oca Jurja (Giorgio), učitelja, i majke Josipe. Bio je sedmo od petnaestoro njihove djece. Njegov djed Ivan doselio se početkom 19. stoljeća iz Palmanove (Furlanija, Italija) u Zadar. Tijekom tri naraštaja obitelj Brusina se posve pohrvatila, tako da se Spiridion isticao i kao gorljivi hrvatski rodoljub. Još kao gimnazijalac priklanjao se autonomašima, ali se kao maturant okrenuo idealima narodnjaka (Strossmayera, Račkoga i Mrazovića). Zalagao se za sjedinjenje Dalmacije s ostalom Hrvatskom. Bio je također veliki poklonik talijanske kulture i tradicije, pa i one koje je ostavila traga u Dalmaciji. Nakon završene zadarske gimnazije (1865) četiri semestra studirao je prirodne znanosti na Sveučilištu u Beču. U jesen 1867. godine vratio se u Zadar i neko vrijeme bio šuplent na gimnaziji. Umro je u Zagrebu, 21. svibnja 1908. godine.

STRUČNI RAD

Brusina je jedan od najpoznatijih hrvatskih prirodoslovaca 19. stoljeća i uopće. Preko trideset godina radio je u muzeju i to od 1868. godine kao pristav, od 1876. godine kao utemeljitelj i ravnatelj Hrvatskog narodnog zoološkog muzeja. Bio je i prvi sveučilišni profesor na katedri za zoologiju novoga zagrebačkog Sveučilišta (1876-1901), inicijator i jedan od osnivača Hrvatskoga naravoslovnog družtva (1885), pokretač i prvi urednik njegova *Glasnika* (Sl. 2), utemeljitelj i velikim dijelom tvorac bogate i vrlo vrijedne visoko stručne i znanstvene knjižnice današnjeg Hrvatskoga prirodoslovnog muzeja, pisac prvih prirodoznanstvenih bibliografija u Hrvata. Svojim znatnim organizatorskim sposobnostima znatno je pridonjeo napredku bioloških znanosti i njihovo povezivanje sa svijetom, dok je svojim stručnim i znanstvenoistraživačkim radom u području ornitologije, ihtiologije, malakologije i mamalogije stekao velike zasluge u domovini, a svojim temeljitim istraživanjima faune neogenskih mekušaca Hrvatske i jugoistočne Europe postao je izuzetno poznat i priznat u svijetu. Jedan je od klasičnih autora koji se i danas citira. Hrvatsko naravoslovno družtvo utemeljeno je 27. prosinca 1885. godine i veliku zasluge zato upravo se pripisuju Brusini koji je družtvo utemeljio prigodom 50. obljetnice hrvatskoga narodnog preporoda. Okupio je oko 30 prirodoslovaca koji su se bavili znanstvenim i nastavnim radom u Zagrebu, nakon što je 1875. godine osnovan Matematičko-prirodoslovni odjel Mudroslovnog (filozofskog) fakulteta Sveučilišta u Zagrebu. Brusina je očekivao da će 1885. godina biti prekretnica za prirodne znanosti u Hrvatskoj, te kaže: *"Mi smo se za ovo pol vieka liepo ponieli na polju liepe književnosti, poviesti, filologije itd., a početkom druge polovice neka se izpuni moje nastojanje još od god. 1868, neka oživi hrvatsko družtvo naravoslovaca u našem bielom Zagrebu, družtvo, kojem je Darwin god. 1869. želio najbolji uspjeh. Pa kad se proslavi stogodišnjica književnog preporoda, neka bi Hrvati mogli dokazati, da pošto su, kao što je naravno, ponajprije njegovali, što im je najpreče bilo, naime poviest svoju i jezik svoj, da su napregnuli napokon sve svoje sile, mnogo liepa izkazali se na polju ovih znanosti; kao što su se davno prije preporoda proslavili Dominisi i Boškovići".*

Spiridion Brusina je osobito zaslužan za napredak i razvoj zooloških i paleomalakoloških zbirki, koje je uredio i svrstao po načelima muzejske strukture. Među zoološkim zbirkama njegovom zaslugom obogaćene su i sređene osobito ornitološka i malakološka zbirka, zatim zbirke kojima se prikazuje fauna Jadranskoga mo-

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GLASNIK

HRVATSKOGA

NARAVOSLOVNOGA DRUŽTVA.

UREDJUJE

S. BRUSINA.

GODINA III.

SA 4 LITOGRAFIČKIH TABLICA I 1 DRVOREZOM.

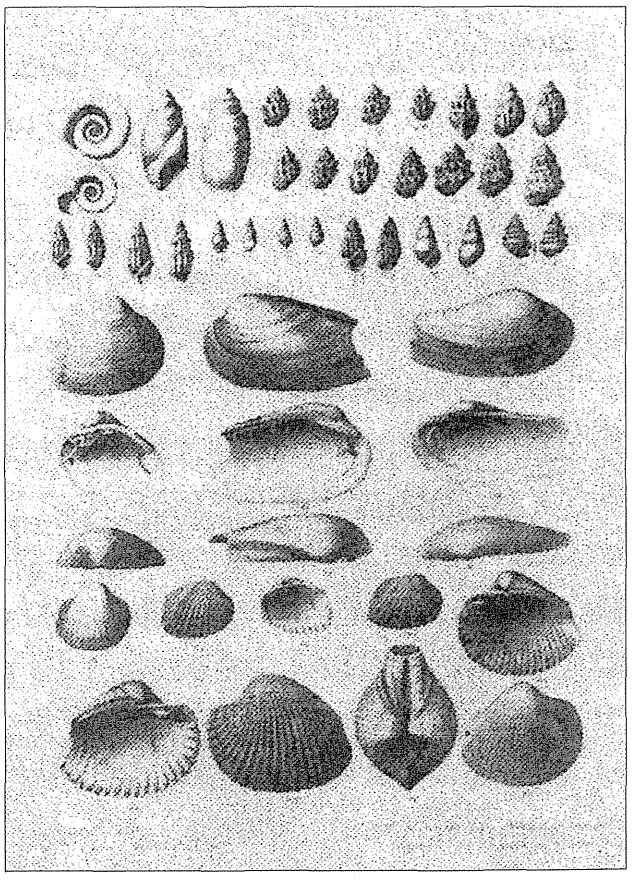
ZAGREB.

VLASTNIČTVO I NAKLADA DRUŽTVA.

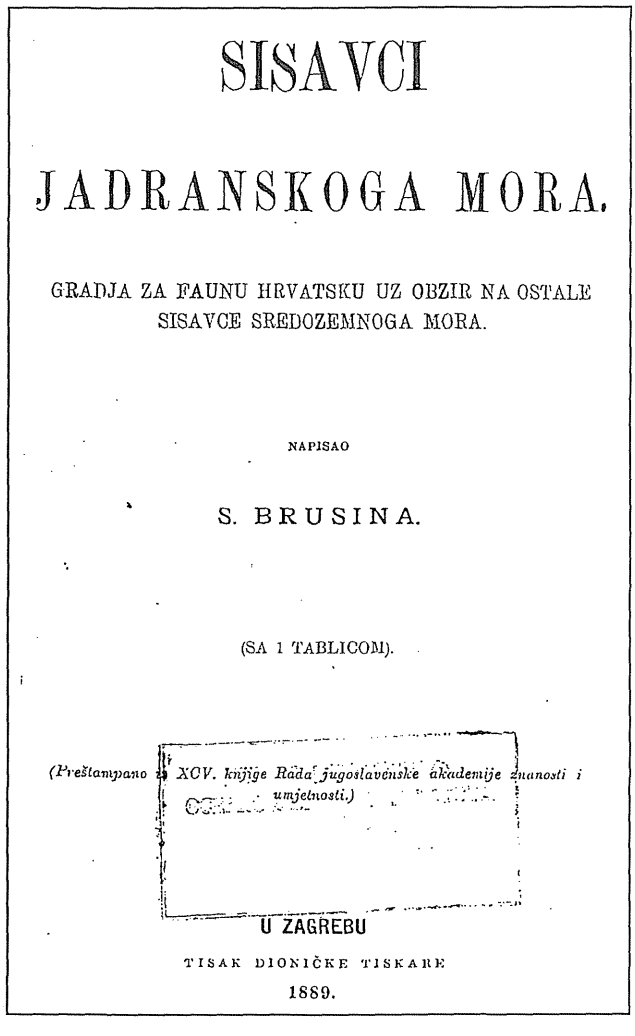
1888.

Sl. 2: "Glasnik hrvatskog naravoslovnog družtva".
Fig. 2: "Glasnik hrvatskog naravoslovnog družtva" ("Herald of the Croatian Society of Natural Science").

ra. Za njegova upravljanja Hrvatskim narodnim zoološkim muzejem ta ustanova stekla je velik ugled i bila je medu najuglednijim u ovome dijelu Europe. Brusina je bio strastveni prikupljač i sistematičar. U svome muzejskom radu težio je da prirodoslovni muzej bude mjesto gdje se prikupljaju i istražuju prirodnine kao dokumenti o stanju i mijenama tla, flore i faune. Među prvima je na ovim prostorima spoznao veliki značaj sastavljanja znanstvenih bibliografija, te je pokušao popisati autore, djela, razna izdanja koja se tiču zoologije u Hrvata. Takvi popisi, s analitičkim i kritičkim primjedbama, kao informacija istraživačima, bili su presudno važni za daljnja istraživanja. Drugo važno Brusinino djelo jest velika bogata i vrlo vrijedna zoologijska knjižnica koju je u potpunosti iz temelja sam stvorio. Većinu knjiga i časopisa uspijevao je sam nabaviti i to na dar od svojih prijatelja, znanstvenika, sa svih strana svijeta, pa i od ustanova, od vlada i slično. Kao primjer može se navesti veliki niz svezaka izvješća raznih istraživačkih ekspedicija (Novara, Challenger..), serija Folinovih Les Fonds de la Mer (1967-1883), zatim mnogobrojni prirodoslovni časopisi (Transaction of the Zoological Society of London, Proceedings of the Zoological Society, Archives de Zoologie experimentale et generale ...). Tu su također i velika klasična djela Linnaeusa, Lamarcka, Cuviera, Darwina i drugih velikih svjetskih prirodoslovaca. Brusina je odigrao veliku ulogu u dvije vrlo značajne stvari, a to su uloga pri osnutku Hrvatskoga naraslovnog družtva (1885), zatim i njegovo dalekovidno zalaganje (od 1886. godine nadalje) da se osnuje hrvatska postaja za istraživanje Jadranskog mora (ostvarena tek 1930. osnutkom današnjega Instituta za oceanografiju i ribarstvo u Splitu). Vrlo su značajna i Brusinina znanstvena putovanja na hrvatski Jadran (1868, 1871, 1873), zatim znanstvena putovanje jahtom Margita na kojem je (1894) predvodio tim prirodoslovaca biologa i geologa, te putovanje 1901, koja su mu dala mnoštvo podataka tako da je mogao pri samom kraju života objaviti (1907 i 1908) za tada najpotpuniju Faunu Jadrana popisavši 563 svojte krednjaka, žarnjaka, kolutićavaca, spužava, mekušaca, rakova, ramenonožaca, mahovnjaka, bodlji-



Sl. 3: Brusinina knjiga o izumrlim mekušcima bila je izvrsno primljena u stručnim i znanstvenim krugovima, a zapažena je njezina visoka tehnička razina.
Fig. 3: Brusina's book about extinct molluscs reached a truly high technical level and was excellently received by the professional and scientific circles.



SISAVCI

JADRANSKOGA MORA.

GRADJA ZA FAUNU HRVATSKU UZ OBZIR NA OSTALE SISAVCE SREDOZEMNOGA MORA.

NAPISAO

S. BRUSINA.

(SA 1 TABLICOM).

(Preštampano iz XCV. knjige Rada jugoslavenske akademije znanosti i umjetnosti.)

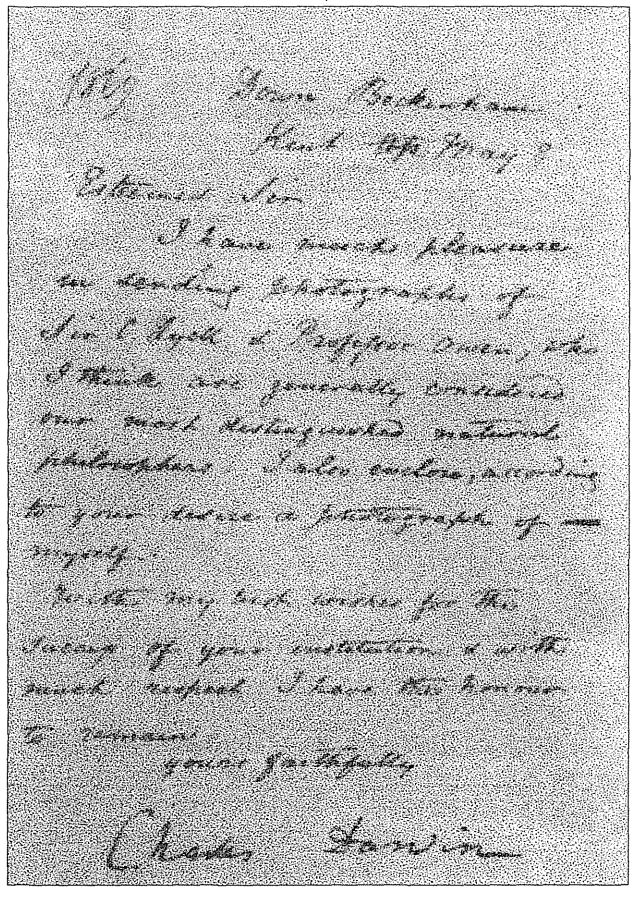
U ZAGREBU

TISAK DIONIČKE TISKARE

1889.

Sl. 4: S. Brusina: "Sisavci Jadranskog mora".
Fig. 4: S. Brusina: "Mammals of the Adriatic Sea".

kaša, riba i sisavaca. Izuzetno je vrijedno njegovo istraživanje malakofaune Prukljanskog jezera (132 svojte, od kojih 21 nova za Jadran), zatim, što je otkrio neke nove vrste sjevernomorskih mnogočekinjaša u Kvarneru, kojima se potvrđivala tzv. borealna teorija o postanku faune toga dijela Jadranskog mora. U svijetu je stekao slavu svojim neizmjernim doprinosom paleontologiji mekušaca, jer je otkrio i opisao oko 600 za znanost novih svojti fosilinih puževa i školjkaša (Sl. 3). Rezultate svojih istraživanja objavio je u oko 30-ak radova u inozemnim časopisima. Istražio je osobito faunu melanopsidnih slojeva, posebice origocerase i neritodonte Dalmacije i Slavonije, zatim faunu pontskih oblika iz kongerijskih slojeva zagrebačke okolice. Istražujući tercijarnu faunu mekušaca iz Markuševca utvrdio je neke sličnosti s recentnom takvom faunom Bajkalskog jezera. Nedavno su svjetski znanstvenici bili ugodno iznenađeni kada su Brusinina kritičnost i oko velikog stručnjaka bili fascinantno potvrđeni otkrićem predstavnika Brusinina fosilnog gastropodnog roda *Orygoceras* u podzemnim vodama države Texas. Brusina je napisao i dva vrlo važna monografska paleomalakološka djela: *"Gragja za neogensku malakološku faunu Dalmacije, Hrvatske i Slavonije, uz neke vrste iz Bosne, Hercegovine i Srbije"* (1897), te atlas *"Iconographia molluscorum fossilium"* (1902). Brusinina paleomalakološka zbirka se danas čuva u Hrvatskom prirodoslovnom muzeju u Zagrebu i proglašena je spomeničkom baštinom nulte-kategorije. Neprestano je isticao veliku važnost istraživanja i racionalnog iskorištavanja živih bogatstava Jadranskoga mora. Dosta je pisao o problemima ribarstva na Jadranu i uspio da bude donesen poseban zakon o toj važnoj privrednoj grani, odnosno prvi je predložio nacrt Zakona o ribarstvu. Bio je začetnik hrvatske ornitologije i radio je na osnivanju Ornitološkog centra. Obavljao je složena biološka istraživanja mora (Sl. 4), te je povremeno dobivao vojni brod za svoja istraživačka



Sl. 5: Pismo Charlesa Darwina od 8. svibnja 1869. Spiridionu Brusini, kojem upućuje najbolje želje za napredak Družtva.
Fig. 5: The letter written on May 8th 1869 by Charles Darwin to Spiridion Brusina, in which the famous scientist expressed his best wishes for the Society's progress.

putovanja. Sudjelovao je kod međunarodne publikacije "Les fonds de la mer", te ga neki stranci navode među prvima koji je potaknuo istraživanje faune morskih dubina.

Svoje znanstvene radove je objavljivao diljem svijeta, surađivao je sa Smithsonian Institution u Washingtonu, predsjedao je i sudjelovao na mnogim međunarodnim kongresima, bio član mnogih akademija i stručnih prirodoslovnih društava. Već zarana je prihvatio darvinizam i 1869. kad je kanio utemeljiti družtvo hrvatskih prirodoslovaca pisao je velikom Charlesu Darwinu o tome i zamolio ga da mu pošalje svoju fotografiju kako bi njome ukrasio diplomu Družtva. U svibnju 1869. Darwin mu je vlastoručno odgovorio (Sl. 5) i već je 1870. godine Brusina održao prvo javno predavanje o darvinizmu, prihvativši i braneći Darwina. Brusina je 16. 12. 1870. i 24. 3. 1871. godine predavao na *"Gospojinskim sastancima"* i pisao u tada mnogo čitanom listu *"Vienac zabavi i pouci": "Nešto o Darwinovoj teoriji"* i *"O starosti čovječjeg roda"*. Negativni odjek pojavljuje se iste godine u *"Zagrebačkom katoličkom listu"* i u *"La Dalmazia cattolica"*. Kasnije se Katolički list još nekoliko puta napao Brusinu u vezi sa "darvinizmom", a osobito onda, kad je Brusina bio jedan od osnivača slobodno-zidarske lože 1892. godine. S obzirom na veliki doprinos znanosti i značaj na ovim prostorima mogli bi Spiridona Brusinu zvati i "hrvatskim", ili još bolje "jadranskim Darwinom". Brusina je bio i članom Uprave Hrvatskog glazbenog zavoda (izuzetno glazbeno nadaren), masonske lože "Hrvatska vila" i Družtva hrvatskih književnika od njegovog osnutka 1900. godine.

Prateći Brusinine radove uočavamo kako je od sakupljača i sistematičara postupno evoluirao do tipa znanstvenika-managera. Sasvim suvremen i blizak postaje Brusina, ako se zamislimo u silne poslove koje je obavljao i koje iznosi u jednom pismu: "I ako rad napornog rada-pošto moram bez ikakve moralne i materijalne potpore za trojicu raditi-nemam kada na se i na svoje misliti, a kamo li prijatelje pohoditi, to smo mi uvijek bili dobri prijatelji." Brusina je bio veliki protivnik profesionalnog svaštarenja. Kao čovjek žive naravi i velike životne energije, u svome radnom vijeku počeo je i priveo kraju mnoge zamisli, ali glavninom svojih snaga želio je biti zoolog i paleontolog u muzeju. U susretu sa Brusinom i njegovim stvaralaštvom možda se možemo ponovno zapitati o smislu i značenju fenomena prirodne znanosti, o znanju i informacijama kao izuzetno važnom dijelu društvenog života. Također bi se mogli zapitati o onome što smo danas i, još više, što bismo mogli i trebali biti.

SPIRIDION BRUSINA - ZOOLOGIST AND PALEONTOLOGIST (1845-1908)

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SUMMARY

The author presents the biography and professional work of Spiridion Brusina, the Croatian natural scientist, at the 155th anniversary of his birth. Spiridion Brusina was most successful in general zoology and palaeontology of molluscs and gastropods. In these fields he discovered and described a great number, more than 600, new species (mostly fossils). He established the Croatian Natural Society and its journal "Glasnik hrvatskog prirodoslovnog družtva' (the present-day "Periodicum Biologorum'), as well as the zoological library. His great paleomalacological collection is deposited in the Croatian Natural Museum in Zagreb and protected as the monument of zero category. Brusina has some very interesting papers in the field of ornithology and ichthyology. He was a great scientist and one of the greatest Darwinists of that time.

Key words: Spiridion Brusina, natural sciences, Adriatic Sea, biography

IZVOD IZ OBJAVLJENIH RADOVA SPIRIDIONA BRUSINE

Brusina, S. (1865): Conchiglie dalmate inedite. Verh. k. k. zool.-botan. Ges., 15, 1-42.
Brusina, S. (1866): Contribuzione della Fauna dei Molluschi dalmati. Edit. Zool. botan. Ges., 134 pp., 1 tab.
Brusina, S. (1867): Prinesci malakologiji hrvatskoj. Rad Jugosl. akad., 1, 78-105.
Brusina, S. (1869): Gasteropodes nouveaux de l'Adriatique. J. Conchyliol., 17, 230-249.
Brusina, S. (1869): Monographie des *Campylaea* de la Dalmatie et de la Croatie. Ann. Soc. Malacol. Belg., 4, 39-79.

Brusina, S. (1870): Ipsa Chiereghinii Conchylia ovvero Contribuzione pella Malacoloigia Adriatica. Biblioteca Malacologica, 2, 280pp.
Brusina, S. (1870): Specie nuove. *Cingula Schlosseriana*. Bull. Malacol. Ital., 3, 9-11.
Brusina, S. (1870): *Rissoa filosa*. Les Fonds de la mer, tome I, p. 260.
Brusina, S. (1870): Monographie der Gattungen *Emmericia* und *Fossarulus*. Verh. zool. bot. Ges., 20, 925-938.
Brusina, S. (1871): Saggio dalla Malacologia Adriatica. Bull. Malac. Ital., 4, 5-9.
Brusina, S. (1872): Naravoslovne crtice sa sjevero-iztočne obale Jadranskog mora sabrao god. 1868. i 1871. (Dio I). Rad Jugosl. akad. znan. umjetn., 19, 105-177.
Brusina, S. (1874): Naravoslovne crtice sa sjevero-iztočne obale Jadranskog mora sabrao god. 1873. (Dio drugi). Rad Jugosl. akad. znan. umjetn., 27, 131-193.
Brusina, S. (1876): Aggiunte alla Monografia delle Campylaea della Dalmazia e Croazia. Bull. Soc. Malac. Ital., 2, 53-61.
Brusina, S. (1876): Description d'especes nouvelles, provenant des terrains tertiaires de Dalmatie. J. Conch., 24, 109-116.
Brusina, S. (1878): Molluscorum fossilium species novae et emendatae in tellure tertiaria Dalmatiae, Croatiae et Slavoniae inventae. J. Conch., 26, 347-356.
Brusina, S. (1882): Le Pyrgulinae dell'Europa orientale. Note. Bull. Soc. Malacol. Ital., 7, 229-292.
Brusina, S. (1882): *Orygoceras,* eine neue Gastropodengattung der Melanopsiden-Mergel Dalmatiens. Beitr. Pal. Österr.-Ungarn u. des Orientes, 2, 33-46.
Brusina, S. (1883): Anomalien der Ornis Croatica. Mitt. des Ornithol. Vereines in Wien, 57-63.
Brusina, S. (1885): Sull'*Helix homoleuca* del Littorale croato. Bull. Soc. Malacol. Ital., 11, 5-10.
Brusina, S. (1885): Velriba i ulješura od Lastova u Dalmaciji. Narodni list, 24(42), str. 2.
Brusina, S. (1888): Morski psi Sredozemnoga i Crljenoga mora. Glasnik Hrv. naravosl. družtva, 3, 167-230.
Brusina, S. (1888): Psina ljudožder (*Carcharodon verus*). Glasnik Hrv. naravosl. družtva, 3, 335-337.
Brusina, S. (1888): Strani ornitolozi i zbirka ptica Narodnog zoološkog muzeja. Glasnik Hrv. naravosl. družtva, 3, 337-338.
Brusina, S. (1888): Piscicoltura. Bolletino Agrario della Dalmazia. Gospodarski list dalmatinski, 17, 273-279.
Brusina, S. (1888): O ribaštini u Dalmaciji. Nar. list (Il Nazionale), 27(67), 1-2.
Brusina, S. (1888): Ptice hrvatsko-srpske s obzirom na ostali slovenski jug. Priprema za hrvatsko-srpsku ornitologiju. Spomenik Srp. kralj. akad., 1, 1-51.
Brusina, S. (1889): Riba 'mlijeko' u Dalmatinaca. Glasnik Hrv. naravosl. družtva, 4, 56-71.
Brusina, S. (1889): Sisavci Jadranskoga mora. Gradja za faunu hrvatsku uz obzir na ostale sisavce Sredozemnoga mora. Rad Jugosl. akad. znan. umjetn., 95, 79-177.
Brusina, S. (1890): Poziv odjela za ribarstvo jubilarne gospodarsko-šumarske izložbe. Glasnik Hrv. naravosl. družtva, 5, 251-257.
Brusina, S. (1892): Fauna fossile terziaria di Markuševac in Croazia, con un elenco delle Dreissenidae della Dalmazia, Croazia e Slavonia. Glasnik Hrv. naravosl. družtva, 7, 113-210.
Brusina, S. (1893): Drei *Eulima microstoma*. Nachrichtsblatt deutsch. Malakozool. Ges., 25, 79-83.
Brusina, S. (1893): U zaštitu ribarstva. Viestnik prvoga obćega hrv. družtva za gonjenje lova i ribarstva, 3, 36-42.
Brusina, S. (1894): Die fossile Fauna von Dubovac bei Karlstadt in Kroatien. Jahrb. Geol. Reichsanst., 43(2), 369-376.
Brusina, S. (1900): *Megalestris skua*. Nova ptica za hrvatsku faunu. Lovačko-ribarski viestnik, 9, 3-8.
Brusina, S. (1902): Naše jesetre. Rad Jugosl. akad. znan. umjetn., 149, 1-62.
Brusina, S. (1904): La zoologia nel giornalismo. Bolletino del Naturalista, 15, 76-77.
Brusina, S. (1906): L'Ornitologia della Bulgaria, del Montenegro e della Grecia del Reiser. Avicula, 10, 57-69.
Brusina, S. (1906): Strossmayer i evolucija. Strossmayer koledar za 1907, 121-123.
Brusina, S. (1909): Šipovo und seine Tertiär-Faunula. Wiss. Mitt. Aus Bosn. u. Herzegow., 11, 572-578.
Brusina, S. (1916-1917): Zoologie in Kroatien. Izvješća o raspr. Matem.-prir. razr. Za g. 1867-1914. Jugosl. akad. znan. umjetn. VI Zoologie, 214-216.

LITERATURA

Balabanić, J. (1989): Špiro Brusina - i danas suvremen (1908-1988). Priroda, 5, 26-27.
Dadić, Ž. (1990/1991): Priroda od 1911. do 1990/91. 2. Utemeljenje Hrvatskoga prirodoslovnoga družtva 1885. godine. Priroda, 2, 6-9.
Kochansky-Devidé, V. (1975): Prilozi povijesti geoloških znanosti u Hrvatskoj. II Spiridion Brusina. Geol. vjesnik, 28, 365-385.

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'CAPTAIN MUSAFIR' IN SLOVENIA IN 1863

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ABSTRACT

A journey through Slovenia from Trieste to Graz was made in May 1863 by an English army officer on leave from India. He published a description of it under a pseudonym, 'Captain Musafir', but he has now been identified as George Malleson. His account of visiting Sežana, Lipica and the cave at Postojna is reprinted here with some further information about Postojnska jama in 1863. In his love of Slovenia, his love of fishing and his interest in the Karst, Malleson resembles his famous predecessor Sir Humphry Davy.

Key words: Slovenia, travellers, Postojnska jama, G. B. Malleson, 1863

IL 'CAPITANO MUSAFIR' IN SLOVENIA NEL 1863

SINTESI

Nel maggio 1863, un ufficiale dell'esercito inglese in congedo dall'India fece un viaggio attraverso la Slovenia, da Trieste a Graz. Costui divulgò una descrizione del viaggio con lo pseudonimo 'Capitano Musafir', ma ora è stato identificato come George Malleson. Il suo resoconto della visita a Sezana (Sežana), Lipizza (Lipica) e alle Grotte di Postumia (Postojna) è riportato nell'articolo, con ulteriori informazioni sulle Grotte di Postumia nel 1863. Nel suo amore per la Slovenia e per la pesca e nel suo interesse per il Carso, Malleson assomiglia al suo famoso predecessore Sir Humphry Davy.

Parole chiave: Slovenia, viaggiatori, Grotte di Postumia, G. B. Malleson, 1863

INTRODUCTION

Captain Musafir visited Postojnska jama and Lipica in 1863. His signature is reproduced in figure 4. But he did not exist; the name is a pseudonym.

This article identifies who the man really was and describes his visit to Postojna (called Adelsberg at that time) and its cave, and through other parts of Slovenia as part of a longer tour in Austria and Bavaria.

'THE CALCUTTA REVIEW'

The visit of 'Captain Musafir' first came to notice in this way.

An anonymous magazine article published in 1886 (Russell, 1886, 54-71), now known to have been written by Charles Russell, explains how he was first attracted to the caves of Slovenia. Serving as a doctor in India in the 1870s, he was setting out for two months' leave in Europe:

> One of the first things I did after arriving at the hotel in Bombay was to lay in a stock of literature for the voyage, and among some dozen volumes which I purchased from an itinerant vendor of second-hand books were two odd volumes of the 'Calcutta Review', which, I saw, contained, along with much heavier matter, a series of pleasant, chatty articles, entitled 'The Unpublished Journal of Captain Musafir.' Especially was I struck with his description of the wonderful grotto at Adelsberg, a few hours' journey from Trieste.

There was no indication when 'Musafir' had been at the cave, nor of which volume of *The Calcutta Review* contained his description. The index to the first fifty volumes (1848-1870) revealed a likely series of three articles (Russell, 1866, 54-55) and one of these (Malleson, 1866-1867, in 1866, did indeed include the visit concerned:

> On the 18th May our travellers left Trieste by railway for Adelsberg, famous for its caves (Malleson, 1866, 191).

The entire description is reprinted later but at this stage the intention is to seek clues to the identity of 'Captain Musafir' and the year of his visit. 'Musafir' could not be his true name; it is the Persian word for traveller. Besides, Russell always put the name within quotation marks, thus: 'Captain Musafir'.

THE EVIDENCE FOR AUTHOR AND DATE

Charles Russell, who drew attention to Musafir's writing in his own article of 1886, provides some information about him:

Fig. 1: Colonel George Bruce Malleson (Malleson, 1894).
Sl. 1: Polkovnik George Bruce Malleson (Malleson, 1894).

> The articles in question, which, as I subsequently ascertained, were from the pen of an officer of the Bengal Army, who was then known to fame as the author of the 'Red Pamphlet,' and has since acquired a considerable reputation as an historian, contained a charming account of a holiday tour in some of the most picturesque parts of Austria (Russell, 1886, 55).

The writer of the Musafir articles himself, introducing the 'diaries' on which the articles are supposed to be based, writes:

> Captain Musafir would appear to be an officer of the Bombay [*sic*] army, who left India with his wife some four or five years ago on twenty months' sick leave to Europe. ... His journal was handed over to us with the most satisfactory proofs as to its authenticity. ... We gather from a few prefatory remarks affixed to it that Musafir was a fair German scholar, a great lover of the picturesque, an adventurous traveller, and an ardent devotee of "the gentle art [of fishing]." ...His taste for the picturesque and his love of travelling would seem to have been shared by his wife, for it is evident from the journal that she accompanied him everywhere ...
>
> We gather from the journal that after the ordinary incidents of an overland voyage, our two travellers arrived at Trieste at 11 o'clock on the 15th May (Malleson, 1866,187-188).

With regard to dates, there is this sentence, given as a footnote:

> The date of the year is not given in any part of the journal, but from the state of completion of the railways, it could not have been more than five of six years ago, possibly less (Malleson, 1866, 187-188).

The article having been written an unknown time before its publication in November 1866, this suggests 1860 or 1861 or 'possibly' later. Or a few years earlier, if there was a long delay before publication; the railway in question, from Trieste to Postojna, was completed in 1857 when the first train ran on 20 June.

When Musafir and his wife got to Postojna, they met 'some American gentlemen who were staying at the inn, and who permitted them to join their party'.

Thus the visit to the cave was made, with some Americans, by an officer of the Army in India, who later became known as a historian. It took place on 18 May, not earlier than 1858 nor later than 1866, and most probably in the early years of the 1860s.

FALSE TRAILS

Before 'Captain Musafir' was finally identified, several leads were followed without success.

The archives of *The Calcutta Review*'s publishers (R.C. Lepage in Calcutta and Longmans Green in London) cannot be traced, either in public archives or in the papers of the firms by which they were taken over.

The Postojnska jama visitors' book suggests three possibles (Stammbuch, 1859-1865):

16 May 1860	C. Munro	England	Major En Route from India to England
18 May 1860	G.J.[or I.] Wentworth	USA	Gentleman
	T. Davidson	USA	Gentleman
	J.[orl.] Lamont	Scotland	Gentleman
19 May 1863	G. Morrison	England	

Major Munro, though recorded on 16 not 18 May, was an English Army officer from India and therefore a likely person. Reference books (East India register, 1860) show that Charles Augustus Munro (b. 15 May 1833) was a lieutenant in 1860, not being promoted major until 1875, but this does not preclude his being 'Musafir', exposing only an over-enthusiastic entry in the visitors' book. But there is no indication of C. A. Munro being on leave from India at the time, and he was not due for European leave in the ordinary course until 1865.

The two Americans and the Scot visiting on 18 May 1860 have not been traced, so there is no independent information about their visits.

The G. Morrison of England on 19 May 1863 was at first dismissed because the date was not correct (19 instead of 18) and there was no indication that he had come from India, information which people from there often provided, as Munro did. The name was clearly written as Morrison and no relevant travel books by anyone of the name could be traced. This entry will be referred to again later.

AUTHOR IDENTIFIED

A more tedious approach finally provided positive identification.

It was known that the author was a British Army officer from India and that he had later become a distinguished historian, writing among other things something known as the 'red pamphlet'. If he were sufficiently distinguished he should be in *The Dictionary of National Biography.* To investigate every name in the 63 volumes of this book was clearly impracticable, but if he died in the 1890s he would be in the Supplement to 1901 (which, at only three volumes, was small enough to search right through). He did die in the 1890s (1898) and he was in the Supplement (Vol. 3), 'red pamphlet' and all. Furthermore, among his publications was listed a book *Captain Musafir's Rambles in Alpine Lands,* the title of one of *The Calcutta Review* articles (Malleson, 1867).

His name was George Bruce Malleson, so detailed information about him could now be sought.

The book itself, ... *Rambles in Alpine Lands* (Malleson, 1884), consists of a reprint of all three *Calcutta Review* articles together with a preface in which the year of the visit is given as 1863. The book is described later and so is the coincidence of G. B. Malleson visiting the cave on 18 May and G. Morrison's entry in its visitors' book on 19 May.

MALLESONS' LIFE

George Bruce Malleson (1825-1898) (The Dictionary, 1898; Board, 1891) (Fig. 1) was born on 8 May 1825, educated at Winchester College and joined the Bengal Army of the East India Company in 1842. He was in Calcutta during the Indian Mutiny of 1857-1858, and wrote an anonymous pamphlet of 30 pages analysing its causes (Malleson, 1857). Published in red covers, it became known as 'the red pamphlet'. Being an independent and outspoken book it offended many people, but Malleson's authorship of it remained unknown for many years. He was made captain in 1861 and major in 1863 with special responsibility for public health. It was in this work that he corresponded (Fig. 2) with Florence Nightingale, the famed nurse and hospital reformer of the Crimean War (1854-1855) (Nightingale papers). On November 1856 he married Marion Charlotte Battye (Marriage register, 1856) (1820?-1903) who was with him for his 1863 journey in Europe. He

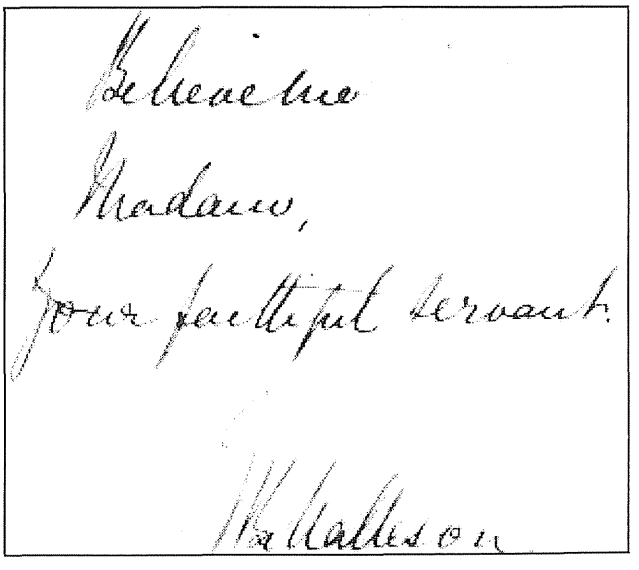
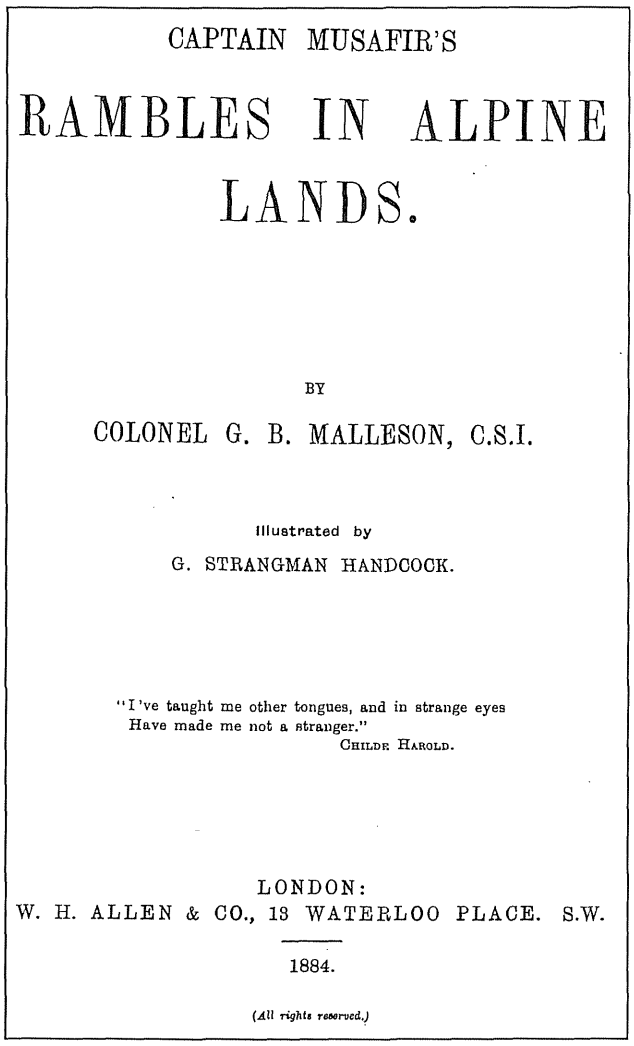


Fig. 2: Malleson's signature at the end of a letter written to Florence Nightingale from Simla (India) on 18 July 1867.
Sl. 2: Mallesonov podpis na koncu pisma, ki ga je 18. julija 1867 napisal Florence Nightingale iz Simle (Indija).



CAPTAIN MUSAFIR'S

RAMBLES IN ALPINE LANDS.

BY

COLONEL G. B. MALLESON, C.S.I.

Illustrated by

G. STRANGMAN HANDCOCK.

"I've taught me other tongues, and in strange eyes
Have made me not a stranger."
CHILDE HAROLD.

LONDON:
W. H. ALLEN & CO., 13 WATERLOO PLACE. S.W.

1884.

(All rights reserved.)

Fig. 3: The title page of the book (Malleson, 1884) in which Malleson reprinted his anonymous articles of 1866-1867.
Sl. 3: Naslovnica knjige (Malleson, 1884), v kateri so bili ponatisnjeni Mallesonovi anonimni članki iz obdobja 1866-1867.

wrote frequently for *The Calcutta Review* from 1857, and after he retired as a colonel in 1877 he wrote much on military history. He was a keen fisherman, a good cricketer and a member of the Alpine Club. He died on 1 March 1898 in London and was buried at Brompton cemetery on 5 March.

Indian Army records (The Indian Army and Civil Service, 1863) confirm that he was on leave in Europe in 1863 and 1864. Despite his own statement that 'Musafir' had left India 'on twenty months' sick leave to Europe' (Malleson, 1884, 8), this was almost certainly the normal long leave to which he was entitled after every ten years' service (Thacher's Post Office, 1864).

THE BOOK

The book *Captain Musafir's Rambles in Alpine Lands* (Malleson, 1884), in which Colonel Malleson reprinted his *Calcutta Review* articles of 1866 and 1867 (Malleson, 1866, 1867) under his own name, was published in 1884 (Fig. 3) with a second edition in the following year unaltered apart from typographical corrections. The original magazine text was unchanged except for the addition of some new footnotes. There is also in the book a ten-page preface recalling some later visits to Slovenia and other parts of Europe.

Both editions have a printed dedication to M.A.H., a young woman who was 'the life of our party in 1863'. M.A.H. has not been identified but she must have been one of the two sisters of Malleson's unnamed friend from India, the 'charming, high-spirited girls' with whom they travelled from Luzern (Malleson, 1884, 73, 83, 84, 87). M.A.H. is of particular interest because a copy of the second edition is known with an ink inscription to her (Fig. 4) written by Malleson using his old pseudonym of 'Cap[tain] Musafir', twenty-two years after they had journeyed together. Alas, she was not present for the Slovene part of the journey.

The handwriting of 'Musafir' in 1885 (Fig. 4) and of Malleson in 1867 (Fig. 2) is clearly the same. So too is that of the 'G. Morrison' in the Postojnska jama visitors' book entry of 19 May 1863 (Fig. 5). The capital M is especially diagnostic. So we have Major G.B. Malleson, alias 'Captain Musafir', disguising his identity at the cave, perhaps an indication that he already intended to write up his journey for publication under a pseudonym. The absence of any entry for his wife is not surprising, for often only the head of the family would sign. The discrepancy of date was probably not deliberate. Such errors were often made in visitors' book entries, as they are today. Indeed two corrections of date can be seen in the six entries in figure 5. So there is no reason to disbelieve the 18 May date given in Malleson's printed text.

THE JOURNEYS THROUGH AUSTRIA AND INTO BAVARIA

The three *Calcutta Review* articles reprinted in Malleson's book describe a long journey in 1863, including his Slovenia visit, and a shorter one in the following year. The Slovene visit forms only a very small part of his 1863 travels which lasted for about four months in all. His account of it is reprinted separately below.

The journey started in Trieste (then in Austria) on 15 May 1863, where Malleson and his wife arrived 'after the ordinary incidents of an overland voyage', so they had not come by sea (Malleson, 1884, 7-9). Probably they had landed at Ancona and done the 430 km journey to Trieste by train.

They put up at the Hotel de la Ville [Fig. 6], which they describe as being one of the best and most luxurious hotels on the Continent, being furnished with hot and cold baths, and every possible convenience. It is, however, dear in comparison with hotels in other parts of the continent. This arises from the fact that Trieste itself is a very expensive city (Malleson, 1884, 7-9).

The guidebooks support this view of its expensiveness:

Trieste ...Inns, all dear: Hotel de la Ville, on the quay, in a good situation (Murray, 1863)

Trieste ...Hotel de la Ville, well fitted up (Baedeker, 1868).

While in Trieste they saw Miramare, the former home of the Austrian archduke who became Emperor Maximilian of Mexico. The lodge-keeper who admitted them to the grounds was a former soldier who had fought against the Austrians in Hungary. The Mallesons' visits from Trieste to Sežana and to Lipica are reprinted later. So too is their stop at Postojna where they saw the cave on 18 May and from which they left by train the next morning for Graz.

From Graz they went to Wien, Linz (with a steamer journey up the Danube to Passau and back) and thence to Gmunden at the northern end of Traunsee, and to Ebensee and Langbath at its southern end. After eight days there they drove to Ischl for five days, continuing eastwards to Grundlsee where they spent another ten days. On from there to Hallstadt and Golling (30 km south of Salzburg), then to Berchtesgaden and to Unterstein near Königs See for some ten days' walking, fishing and shooting. From Salzburg they travelled west to spend eight days at Traunstein and Chiem See in Bavaria. Several of these places, including Traunsee, Ischl and Grundlsee, had been visited by Malleson's more illustrious fishing predecessor and lover of Slovenia, Sir Humphry Davy, in 1828.

From there they covered greater distances, usually by train, spending nearly a fortnight at München and then stopping at Augsburg and Schaffhausen *en route* to Luzern where they joined M.A.H. and her family. Travelling south together they went to Engelberg, Brienz and Grindelwald before going north again to Strasbourg and a month's rambling in the Schwarzwald.

The third of the *Calcutta Review* articles (Malleson, 1867), also reprinted in the book, describes a tour made largely on foot by Malleson and an unnamed friend in August of the following year. Having come via Bamberg and Nürnberg (where he mentions having seen 'fossil[iferous] caves' in Franconia nine years before) to München, they set out by train to Salzburg on 4 August. They went on to Mond See, Schafberg, Langbath, Gmunden, Ischl, Obertraun, Hallstadt and Golling before continuing to Königs See, Hallein, Lend, Wildbad Gastein and Innsbruck. From there they went over the highest pass to Italy, via Landeck, Pfunds, the Finztermhnz Pass (1483 m), Mals, and over the Stelvio Pass (2757 m) to Bormio and Tirano. Thence they crossed into Switzerland and over the Bernina Pass (2330 m) to Samedan near St. Moritz in the Engadin, and then by train from Chur through Bad Ragaz and Zürich to Basel. Malleson had to return to India six weeks later and it was this that limited their 1864 excursion to just under a month.

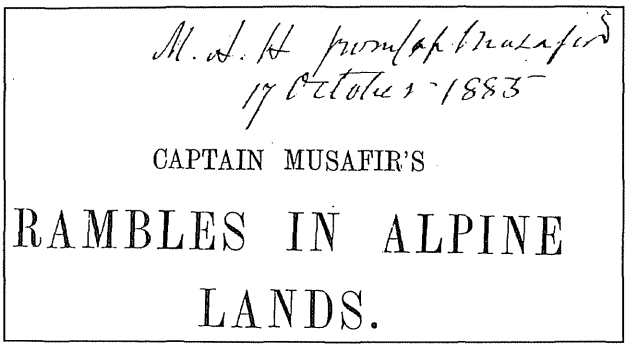

M. A. H. from Capt Musafir
17 October 1883
CAPTAIN MUSAFIR'S
RAMBLES IN ALPINE LANDS.

Fig. 4: A copy of the second edition inscribed in Malleson's handwriting as a gift to his friend "M.A.H. from Cap[tain] Musafir".
Sl. 4: Kopija druge izdaje Mallesonovega rokopisa kot darila prijateljici "M.A.H. od stot[nika] Musafirja".

IN SLOVENIA

Malleson's text on Slovenia (Malleson, 1884, 12-16) is reprinted here in full. At that stage of the journey he was accompanied only by his wife.

On 17 May:

...our travellers drove to a village called Sessana [Sežana], on the line of the Vienna railway. Sessana is nothing in itself, but the drive to it is most lovely. The road winds up a gradual ascent of 1,800 feet, and commands, during its course, after the first half-hour, a splendid view of Trieste, the Adriatic, and of the picturesque town of Pirano on the Illyrian coast. On a very clear day, free from haze, Venice may be seen. At Sessana, our travellers met an Austrian officer, a native of the province of Moravia, who had served in the Italian campaign of 1859, regarding which he conversed freely. He did ample justice to the French soldiers and their emperor. Of the latter indeed he said that if he had been at the head of the Austrian army and if Giulay had commanded the French, he was confident victory would have been with the Austrians. Their defeat at Magenta he attributed to the utter incompetence of Giulay, and their ill-success in the campaign to the

treachery and disaffection of the Hungarian and Italian regiments. He appeared most anxious for a fresh trial. "Let the Emperor," he said, "send to Italy only Moravians, Bohemians, Croats and Austrians, and let him place Benedek at their head, and, I'll answer for it, we'll win back Italy." It appears from various entries in the journal that this feeling was shared by almost all the Austrian officers and privates our travellers met with.

On their return to Trieste the travellers followed another and more circuitous road, in order to visit the Imperial breeding stud at Lipizza [Lipica] - a place famous for its grass lands. The sight here was well worth seeing. At Lipizza there are horses of all nations, amongst them many English thoroughbreds. But those that most attracted notice were the Arabs – far more perfect in shape than any Musafir had seen in India. Many of them must have been of the purest Arabian blood, so absolutely faultless was their conformation. The care bestowed on these horses, as well as on the mares and foals, cannot be exceeded. It is a pretty sight to see them loose in their large, well-built houses, all herded together, living in the most perfect amity. They are treated with affection and gentleness by their attendants. No other mode of treatment indeed could have produced the sweet temper and docility displayed by all the animals in this vast establishment.

Next comes their visit to Postojnska jama. The journey time given as 'little more than an hour' from Trieste to Postojna is interesting, for only two years earlier an American traveller (Comfort, 1863) had stated that the journey took four hours for 72 km (84 km, in fact) (Murray, 1876). Even in 1880 it was said to take three hours (Aubertin, 1880).

On the 18th May our travellers left Trieste by railway for Adelsberg, famous for its caves. The line of rail lay among the hills, and the many bends it made, and their sharpness, - sometimes almost at right angles, - appeared to have completely astonished the two Anglo-Indians. The journey itself takes little more than an hour. Adelsberg lies about 1,800 feet above Trieste, and is proportionately cooler. It is in itself but a small village, deriving all its importance from the wonderful caves in its vicinity. To inspect these was the object not only of Musafir and his wife, but of all the travellers who stop at Adelsberg. In order to see the caves in perfection, it is necessary that they should be thoroughly well lighted-up with torches and candles. Our travellers were fortunate enough on their arrival to find that orders for an extraordinary illumination had been issued by some American gentlemen who were staying at the inn, and who permitted them to join their party. Snatching a hasty meal, the whole party left the inn about 11, and arrived at the entrance of the caves a quarter of an hour later. They did not emerge till 3 o'clock. To describe accurately what they saw in that interval would require a paper by itself. Transported suddenly from the fresh, balmy, sunny air of the outside world into the very heart of the earth, - a gloomy cavern with no light save that afforded by the torches of the guides, - the travellers found themselves entering, now vast halls vaulted by rocks and supported seemingly by pillars of alabaster, - now narrow passages the flinty sides of which sparkled like diamonds. Again, they entered the nave of a glorious cathedral, at the other end of which, in the place where the altar should be, was a visible representation of the crucifixion, not carved, but formed naturally by the rock. The grandeur and dread peculiarity of the sight impressed itself on all the members of the party. They could scarcely resist the conviction that they were in another world. Sometimes depressing them by its gloominess, at others exalting them into enthusiasm by the glorious shapes formed by the alabaster-like stalactites, the effect was to make them utterly forgetful of the sun and the trees, the light and the air, the green meads and the running streams they had left outside, and to induce the idea that they were really passing through the valley of the shadow of death, to the vale that led down to the Styx. The apparition of Charon and his boat would not, in those moments, have surprised any of the party. As if to complete the illusion, there was, below them, a river dark as Erebus, flowing onwards through the depths of the earth, and seeming to indicate that there was a point yet to be reached, at which its stream would widen, and interpose a barrier between the visitors and the world beyond. Until the travellers approached the very last of the caves the spell was complete, nor did it leave them till, at a sudden turn, a flood of light reminded them that –

> The earth hath wonders, as the water hath,
> And these are of them!

Leaving Adelsberg the following morning about 9 o'clock, our travellers left for Gratz,

Malleson's description is mainly of the cave itself as they saw it, rather than the way it was visited in 1863 which is what interests us more today. At that time arrangements for the visit would be made at the office of the Grotten-Cassier (Thomas Pegu) in Adelsberg itself. There the visitors' book would be signed and the necessary fees paid. These varied, depending not only the number of people in the party but also on the quantity of torches and candles ordered (Costa, 1863). Thus on top of the entry price of 70 kroner (0.7 florin) each, a 'great illumination with 10 pounds [4½ kg] of tallow candles' cost an additional 5¼ florins. This was no doubt the 'extraordinary illumination' ordered by the American gentlemen of which Mallesons' party had the benefit.

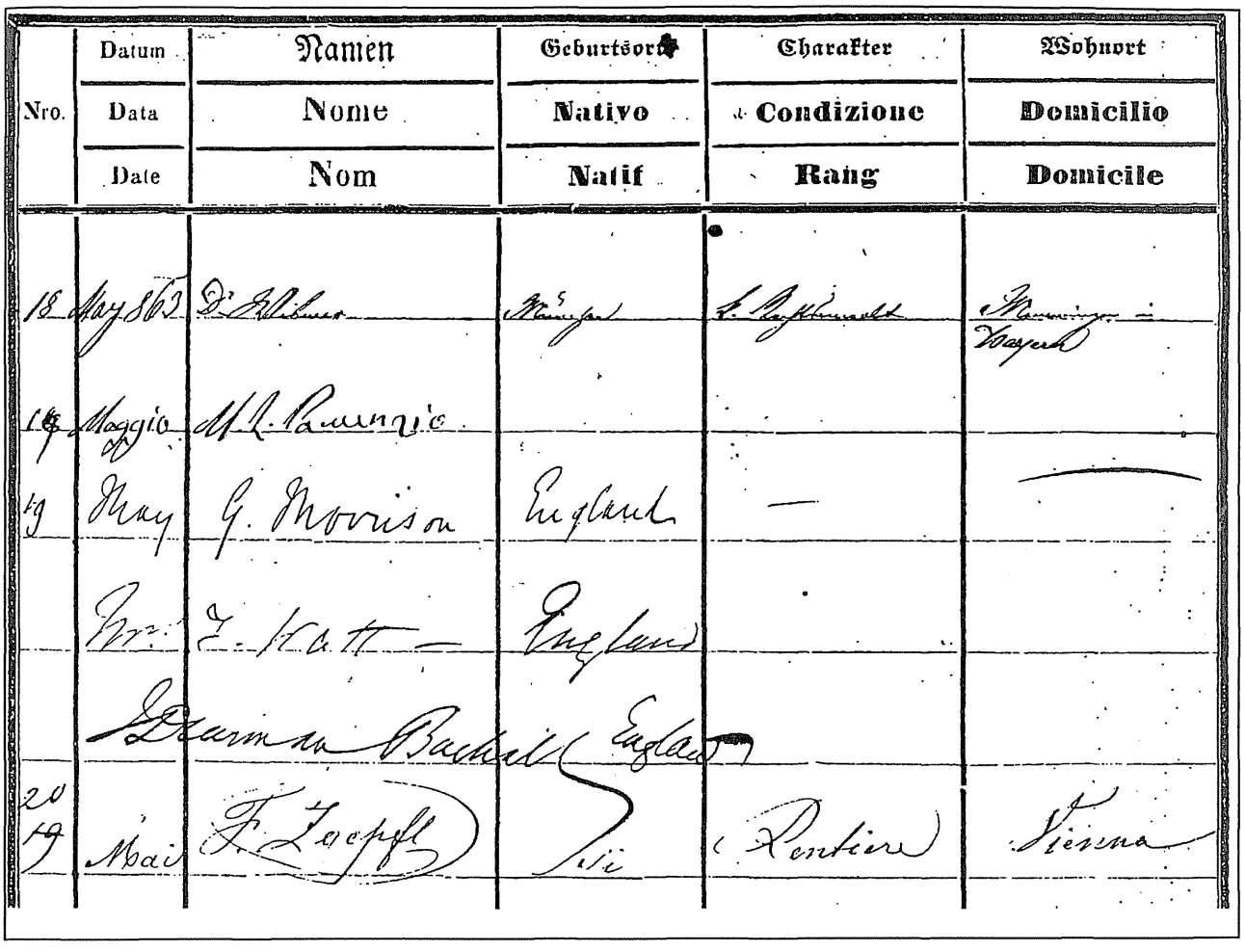


Fig. 5: The entry written in the Postojnska jama visitors' book in Malleson's handwriting on 19 May 1863, giving his name as G. Morrison.
Sl. 5: Tako se je v knjigo gostov v Postojnski jami 19. maja 1863 vpisal Malleson - kot G. Morrison.

Another tourist attraction available for the cave visitor at that time but not mentioned by Malleson was the purchase of live Proteus. According to Murray's *Handbook ...* (Murray, 1863), 'Specimens may generally by purchased at the inn at Adelsberg' and the book also advised how they could best be taken home in water.

The night they spent in Postojna after their cave visit and before catching the Graz train the next morning would have been at the Hungarische Krone, on the site where Hotel Kras now stands. Murray's *Handbook* says of it in 1863 (Murray, 1863):

> ...really good and reasonable [in price]; civil people; it is about 20 min[utes'] walk from the Stat[ion] (Murray, 1863).

Another guidebook of the time (von Radics, 1861, 11) adds that it had a lovely garden.

Malleson had clearly grown to love Slovenia, as well as other parts of Austria, for in his preface to the 1884 book he wrote:

> Since that first introduction into the country which may be called the Paradise of the World, I have made many incursions into Austria. There is scarcely a village in Carniola, in Carinthia, in the two Austrias, and but few in Tirol, in the Bavarian Highlands, and in Styria, which I have not visited; hardly a mountain stream which I have not, however slightly, despoiled.
>
> Seven years after the first glimpses of the promised Land recorded in this volume we again visited Europe. This time, also, we landed at Trieste, and proceeded at once, by way of Laibach, into Carniola. The charms, the loveliness, of that beautiful province, it would be impossible to exaggerate. Veldes [Bled], Feistriz [Bohinska Bistrica], the Wochein See [Bohinjsko jezero], the glorious Terglou [Triglav], and many kindred places hardly less admirable, rise up to give men-

tal evidence in support of this assertion. After a stay at Veldes of more than a fortnight spent in climbing, rambling, and fishing, we proceeded to the scarcely less beautiful Wurzener Thal [valley of the Sava Dolinka, past Kranjska Gora], the delight of Sir Humphrey [sic] Davy ...

On my final return from India, in 1877, I attacked the country from a new base. Again landing at Trieste, I proceeded with a friend by rail to Görz (Gorizia), and drove thence, by way of Canale [Kanal], to Tolmino [Tolmin], and from Tolmino by way of Podmenz [Podmelec], and Coritenza [Koritnica], to Podberda [Podbrdo], a country abounding in the most magnificent scenery....

Since that period scarcely a year has passed which has not seen me in one or other of the seven charming provinces - in the two Austrias, or in Tirol, or in Styria, or in Carniola, or in Carinthia, or in the Bavarian Highlands, or in all. The warm-hearted, manly, generous, and kindly people who inhabit them always give me a welcome, and make me feel that they regard me as a friend (Malleson, 1884, xi-xiii).

In his last book too, published the year before he died, he showed that his interest had not waned:

...my acquaintance with those rivers and lakes began in 1863-4. I have spent the greatest part of my holidays since that date in renewing my acquaintance with them; in walking, rucksack on back, and alpenstock and fishing-rod in hand, to every part of Tyrol, of Carinthia, of Carniola, ...

...The country around Laibach and the Julian Alps generally lends itself to the researches of men of science.... From Laibach the traveller can easily visit the marvellous caves of Adelsberg, reached by train. In those caves even the angler will realize that there are many things in the world more wonderful than were ever dreamt of in his philosophy. The underground rivers which will attract his attention, the Unz to the north, the Reka to the south, of Adelsberg; the Pi[v]k[a] at Adelsberg itself, with their living fishy inhabitants, will certainly excite his wonder (Malleson, 1897).

In his love for Slovenia, his love of fishing, and his attention to the karst, Colonel Malleson much resembles Sir Humphry Davy.

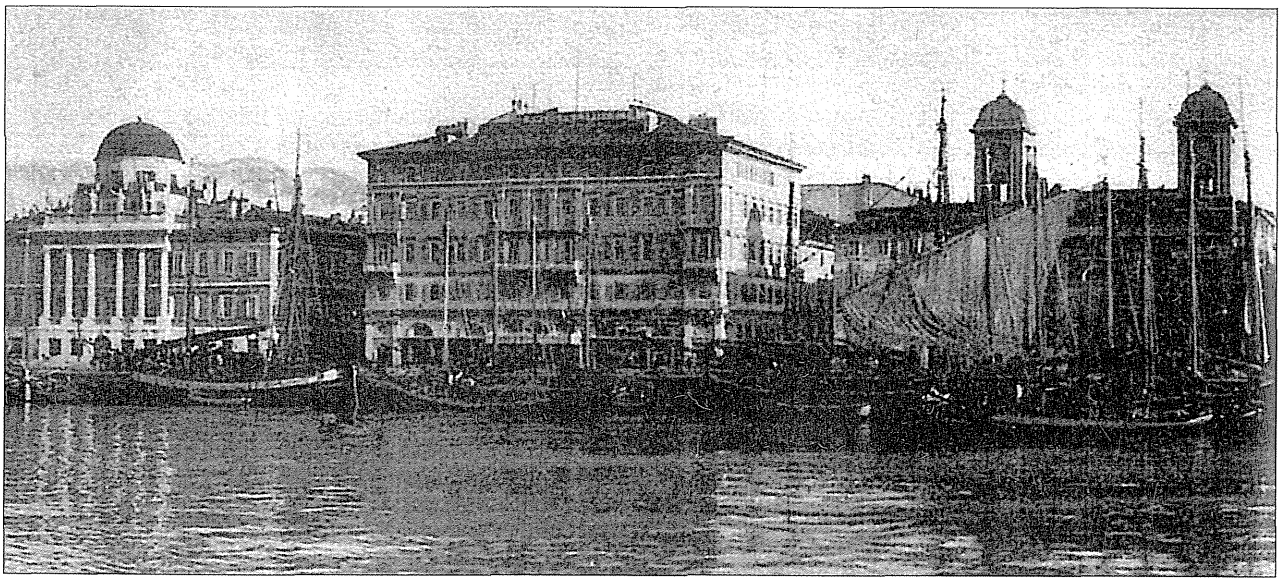


Fig. 6: The Hotel de la Ville in Trieste, at which Malleson stayed in 1863. Reproduced from a sheet of the hotel's writing paper used in 1911 and now in the archives of Postojnska jama at the Karst Research Institute, Postojna.
Sl. 6: Hotel de la Ville v Trstu, v katerem se je leta 1863 nastanil Malleson. Reproducirano z lista hotelskega pisarniškega papirja, ki so ga uporabljali leta 1911 in je zdaj v arhivu Postojnske jame na Inštitutu za raziskovanje krasa v Postojni.

'STOTNIK MUSAFIR' LETA 1863 V SLOVENIJI

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POVZETEK

Maja 1863 si je Slovenijo med potovanjem med Trstom in Gradcem ogledal dopustujoči angleški vojaški častnik, ki je takrat sicer služboval v Indiji. Svoje vtise je pozneje objavil pod psevdonimom 'Stotnik Musafir', za katerega danes vemo, da se skriva pod imenom George Malleson. V tem prispevku je objavljeno njegovo pričevanje o obisku Sežane, Lipice in posebno Postojnske jame v letu 1863. Sicer pa nas Malleson s svojo ljubeznijo do Slovenije, ribarjenja in krasa močno spominja na sira Humphryja Davyja, svojega predhodnika.

Ključne besede: Slovenija, popotniki, Postojnska jama, G. B. Malleson, 1863

REFERENCES

Aubertin, J. J. 1880: The cave of Adelsberg. *The Graphic*, London, 25 December: 664.

Baedeker, K. 1868: *Southern Germany and the Austrian Empire.* Coblenz, Baedeker, [1st edn.] xiii, 395 pp (p. 346).

Boase, F. 1921: *Modern English biography*, Truro, for the Author, 6 col. 147-148. *Who was who.* vol. 1 [for] 1897-1915, London, A. & C. Black, 4th edn. 1953:469-470. Mumm, A. L. 1923 [=1922] - 1928. *The Alpine Club register*, London, Arnld, 2: 226-228. *The Times*, London, 2 March 1898. P1, col. 1 (obituary).

Comfort, G. F. 1863: The Cave of Adelsberg. The Ladies' Repository, Cincinnati 23(10): 588-590 (p. 588).

Costa, E. H. 1863: *Die Adelsberger Grotte.* Ljubljana, Klenmayr & Bamberg, 2nd edn. 66 pp (p. 64).

East India Register and Army List, 1860. Bengal, pp. 130, 175, 280. The quarterly Indian Army list for April 1 1891:685a, 691.

Index to the first fifty volumes of The Calcutta Review. Calcutta, City Press, 1873.

Malleson, G. B. 1857: *The mutiny of the Bengal Army.* London, Chapman, 30 pp.

Malleson, G. B. 1866: From India to Europe. Unpublished Journal of Captain Musafir. The Calcutta review 44(87):183-218.

Malleson, G. B. 1866: Unpublished Journal of Captain Musafir. The Calcutta review 45(89):178-204.

Malleson, G. B. 1867: Rambles in Alpine Lands. Unpublished Journal of Captain Musafir. The Calcutta review 46(91):44-76.

Malleson, G. B. 1884: Captain Musafir's rambles in alpine lands. London, W. H. Allen, xiv(ii), 150 pp (Also 2nd edn., 1885. A review by Otto Zsigmondy appeared in Oesterreichische Alpen-Zeitung, Wien, VI Jahrgang (139), 2 May 1884:119).

Malleson, G. B. 1894: The decisive battles of India from 1746 to 1849 ... 4th edn., London. Reeves & Turner: frontispiece.

Malleson, G. B. 1897: *The lakes and rivers of Austria, Bavaria and Hungary.* London, Chapman & Hall, xvi, 155pp. (pp. [vii], 91).

Marriage register Bengal. 1856: [July-December 1856]. British Library, Oriental and India Office Collection N/1/90. Her date of death and age are stated on their tombstone in Brompton Cemetery, London. Some biographies spell her name as Marian.

Murray, J. 1863: *A handbook for travellers in Southern Germany* ... London, Murray. 9th edn., xii, 598 pp (p. 405).

Murray, J. 1867: *A handbook for travellers in Southern Germany* ... London, Murray. 10th edn., xii, 633 pp (p. 452).

Nightingale papers. British library, Add. MS. 45782, f. 228r.

Radics, P. von, 1861: *Adelsberg und seine Grotten. Trieste,* Österreichischen Lloyd. Viii, 61 pp. Lloyd's illustrierte Reisebibliothek VIII (p. 11).

Russel, C. M. 1886: In the Rekka Höhle. *The Cornhill Magazine,* London. New series vol. 6 (old Series vol. 53), no. 1, January: 54-71.

Stammbuch der Adelsberger Grotte 5, 1859-1865. Archives of Postojnska jama, held at the Karts Research Institute, Postojna.

The Dictionary of national biography. 1898. London. Smith, Elder, supplement 3:135-136.

The Indian Army and Civil List. London, Allen for July 1863 (p. 97) and Jan. 1864 (p. 97).

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PETAR LORINI - UTEMELJITELJ SUVREMENOG RIBARSTVA U ISTOČNOM JADRANU

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SAŽETAK

Ove godine navršava se 150 godina od rođenja Petra Lorinija, pučkog učitelja, vrhunskog ribarskog stručnjaka i unapreditelja ribarstva na istočnim obalama Jadrana. Djelo po kojem je Lorini najpoznatiji je svakako knjiga "Ribanje i ribarske sprave pri istočnim obalama Jadranskog mora", koja je brojila 266 stranica i 69 crteža. U knjizi je po prvi put bila obrađena cjelokupna problematika morskog ribarstva. To je djelo koje je i danas, nakon skoro cijelog stoljeća, u mnogo čemu uporabljivo, a može biti i koristan priručnik svakom tko se želi baviti problematikom morskog ribarstva. Uz ostale mnogobrojne članke, studije i radove iz problematike morskog ribarstva koje je objavio, Lorini je kao priznati ribarstveni stručnjak bio prvi nadzornik ribarstva na istočnoj obali Jadrana, imenovan od strane Pomorske vlade u Trstu, a uz to i veliki zaštitnik živih bogatstava mora.

Ključne riječi: Petar Lorini, ribarstvo, živa bogatstva mora, životopis, Jadransko more

PETAR LORINI - FONDATORE DELL'ITTICA MODERNA NELL'ADRIATICO ORIENTALE

SINTESI

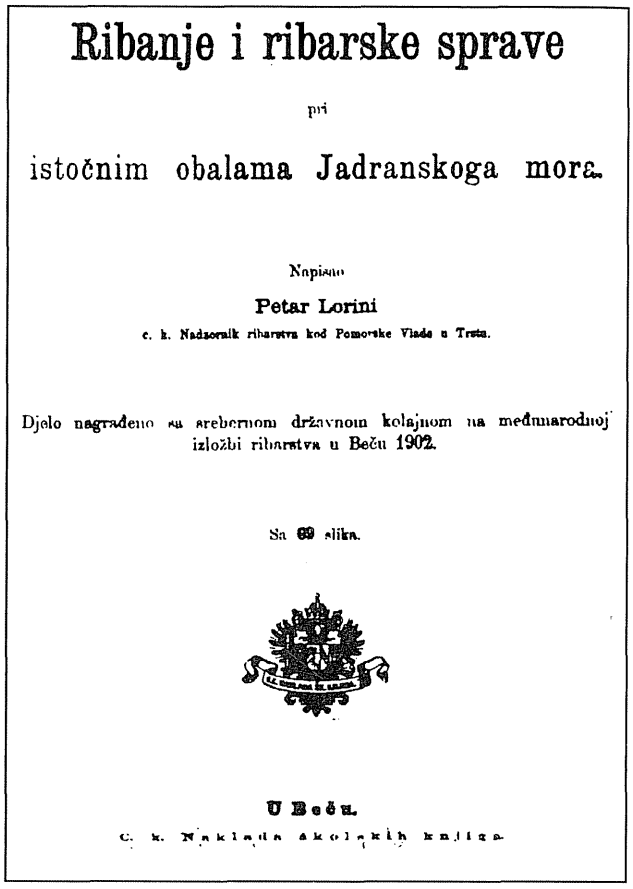
Ricorre quest'anno il centocinquantesimo anniversario della nascita di Petar Lorini - insegnante, esperto nonché promotore dell'ittica nell'Adriatico orientale. Senza dubbio, il suo lavoro più celebre è "Pesca e attrezzatura di pesca nelle acque costiere del mare Adriatico" che, in 266 pagine e 69 disegni, per la prima volta tratta la complessità della pesca in mare. Ancora oggi, dopo quasi un secolo, tale lavoro è altamente applicabile in diversi settori essendo anche un utile manuale per tutti gli interessati alla complessità della pesca in mare. A prescindere dal numero di articoli, studi e lavori inerenti l'ittica, Lorini, apprezzato esperto di ittica, è stato il primo ispettore di pesca nell'Adriatico orientale nominato dal cosiddetto Governo Marino di Trieste, ed allo stesso tempo un grande avvocato per quanto riguarda la conservazione delle risorse marine.

Parole chiave: Petar Lorini, ittica, risorse marine, biografia, mare Adriatico

UVOD

Ove godine navršava se 150 godina od rođenja Petra Lorinija (Sl. 1), pučkog učitelja, vrhunskog ribarskog stručnjaka i unapreditelja ribarstva na istočnim obalama Jadrana. U skladu s tim gledištem je i činjenica da je ime Petra Lorinija s opisom njegove djelatnosti uvršteno u iznimno značajnu knjigu "Zaslužni i znameniti Hrvati 925-1925", prvo djelo takve vrste u Hrvata. Na taj način, Petar Lorini se našao u društvu niza hrvatskih velikana, počevši od prvih hrvatskih knezova i kraljeva, banova i hercega, pa preko crkvenih dostojanstvenika i

Sl. 1: Petar Lorini kao nadzornik ribarstva pri Pomorskoj vladi u Trstu.
Fig. 1: Petar Lorini as fishing inspector appointed by the so-called Marine Government in Triste.



Ribanje i ribarske sprave

pri

istočnim obalama Jadranskoga mora.

Napisao

Petar Lorini

c. k. Nadzornik ribarstva kod Pomorske Vlade u Trsta.

Djelo nagrađeno sa srebrnom državnom kolajnom na međunarodnoj izložbi ribarstva u Beču 1902.

Sa 69 slika.

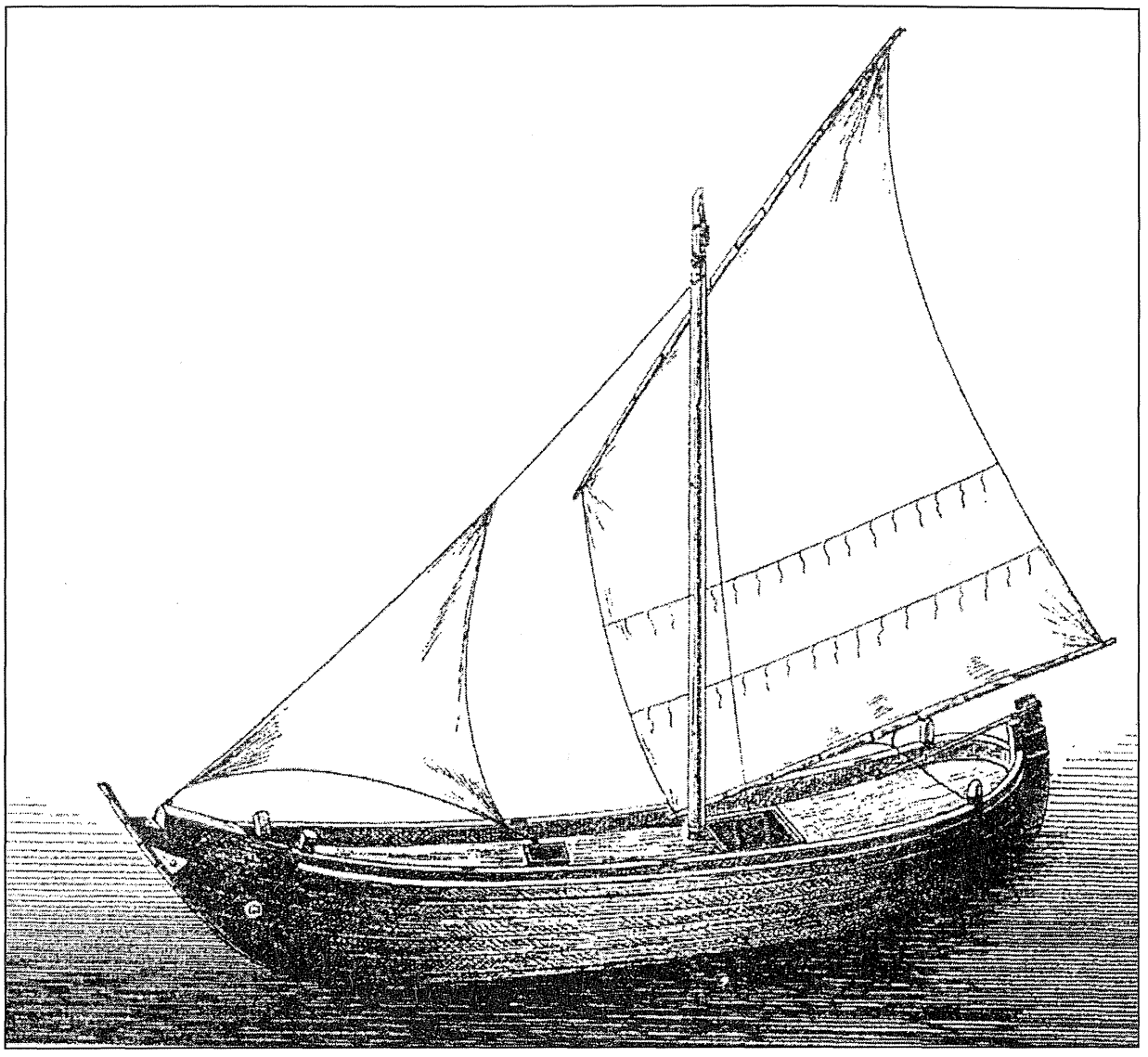
U Beču.

Sl. 2: Naslovna strana Lorinijeve knjige "Ribanje i ribarske sprave pri istočnim obalama Jadrana" izdane u Beču 1903. godine.
Fig. 2: Title page of Lorini's book "Fishing and Fishing Gear in the Coastal Waters of the Adriatic Sea" published in 1903 in Vienna.

svjetovnih velikana riječi i djela do svojih uglednih suvremenika. Lorini je za svoje vrijeme bio veliki vizionar i pobornik pravilnog gospodarenja živim bogatstvima mora. Zaokupljen neprekidnom brigom o morskom ribarstvu, neprestano se zalagao za potrebu osnivanja eksperimentalne postaje za proučavanje mora i morskih organizama, pri čemu je isticao Split kao najpogodnije mjesto. Za njegova života to nije bilo ostvareno, ali je ta misao zaživjela i napokon se ostvarila nekoliko godina kasnije, točnije 1930. godine kada je u Splitu osnovan Institut za oceanografiju i ribarstvo (tada pod imenom Biološko-oceanografski institut) koji ove godine slavi 70. godina postojanja.

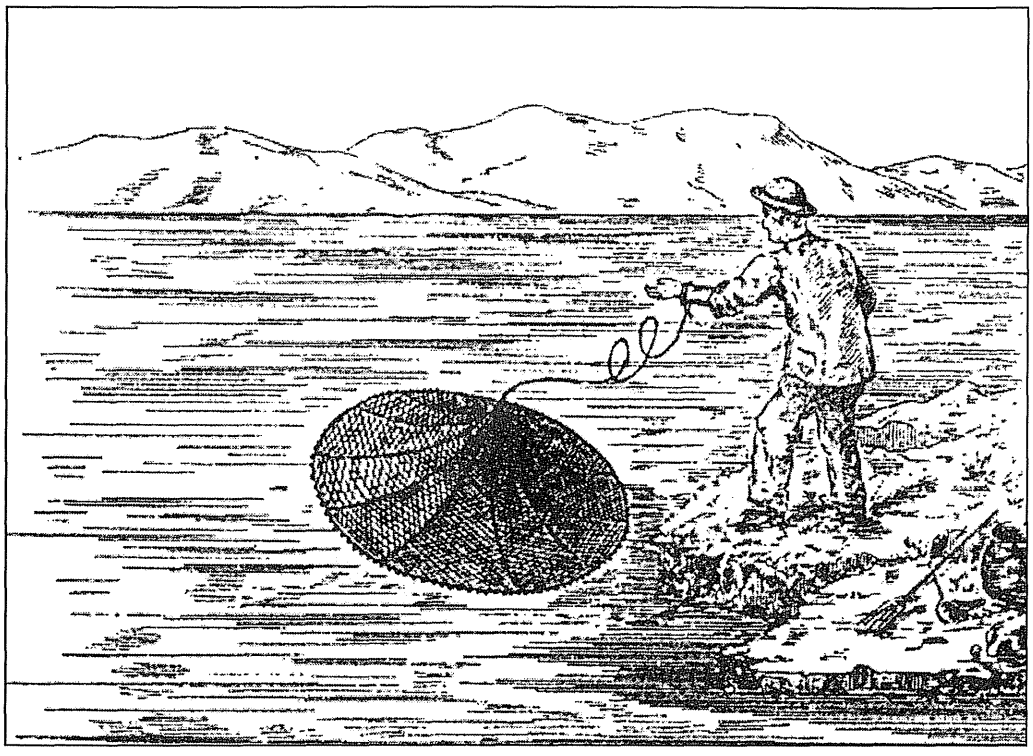
ŽIVOTOPIS

Petar Lorini je rođen 30. travnja 1850. godine u Salima na Dugom otoku, jednom od poznatijih ondašnjih ali i današnjih ribarskih središta na istočnoj obali Jadrana. Rođen u ribarskoj obitelji, već od malena odlazi u ribolov. Provodeći sa ribarima mnoge dane i noći, upoznaje se sa njihovim životom i potrebama, ali i problemima morskog ribarstva uopće. Pohađao je i završio učiteljsku školu u Dubrovniku, a kao učitelj je predavao u Kotoru, Korčuli i Salima, a službovao je i kao učitelj u vježbaonici Učiteljske škole u Arbanasima pokraj Zadra. Kao pučki učitelj, stalno je održavao kontakte sa ribarima od kojih je stjecao praktična ribarska iskustva. S obzirom da je znao nekoliko stranih jezika, imao je mogućnost praćenja strane literature te je time stjecao stručna znanja. Uslijed toga je bio ubrzo zapažen kao dobar poznavatelj problema vezanih za morsko ribarstvo. 1885. godine Pomorska vlada u Trstu mu je povjerila zadaću da istraži uzroke opadanja ulova ribe u Neretvi, prouči sustav lovljenja i predloži mjere za poboljšanje ribolova na tom području, na kojem je naglo opao ulov ribe nakon regulacije rijeke (Cetinić, 1997). Uspješno izvršenje te zadaće, kao i njegova



Sl. 3: Top - brodica upotrebljavana u Istri, Tršćanskom zaljevu i goriškoj obali.
Fig. 3: Typical boat used in Istra, in the Gulf of Trieste and in the coastal area of the province of Gorizia.

rastuća reputacija vrsnog ribarskog stručnjaka, zasigurno su pridonijeli njegovom postavljanju za prvog nadzornika ribarstva za Dalmaciju, Istru, Trst i Goričko područje u Pomorskoj vladi u Trstu 1897. godine. Od tog trenutka, Lorini je čitavo svoje veliko znanje i iskustvo posvetio unapređenju i razvoju morskog ribarstva i zaštiti živih bogatstava mora. Kao nadzornik ribarstva , postao je poznat kao dobar organizator i poznavatelj svih tadašnjih problema koji su se javljali u morskom ribarstvu. Interes u javnosti za njegov rad kao nadzornika za ribarstvo, pokazuje i činjenica da su u tadašnjim splitskim novinama "Jedinstvo" (br. 40 i 96/ 1897), bile objavljene vijesti o njegovom putovanju po Dalmaciji koje je poduzeo s ciljem što boljeg upoznavanja problema morskog ribarstva i poduzimanja mjera za njegovo unaprjeđenje. Na dužnosti nadzornika ribarstva pri Pomorskoj vladi u Trstu ostaje sve do svog umirovljenja 1912. godine. Sudjelovao je na konferenciji o donošenju Konvencije o ribolovu u Jadranskom moru, koja je sklopljena između Kraljevine Jugoslavije i Italije 1921. godine, a ratificirana 1923. godine, poznatijom pod nazivom Brijunska konvencija (zbog njezina potpisivanja na tom otočju). Lorini se uzaludno protivio donošenju te konvencije kojom se omogućavalo talijanskim koćarima slobodan ribolov u kanalima unutrašnjih morskih voda istočnog sjevernog Jadrana, pri čemu su ostale zabilježene njegove riječi da "svatko neka lovi na svome" (Basioli, 1973b). Tijekom održavanja pregovora sa Talijanima, Lorini umire u Beogradu 17. srpnja 1921. godine.



Sl. 4: Sačmarica ili orćaš pri lovu - ribolovni alat koji se više ne upotrebljava.
Fig. 4: Sačmarica or orćaš fishing net - part of the gear that is no longer in use.

STRUČNI RAD

Najznačajnije djelo Petra Lorinija je svakako knjiga "Ribanje i ribarske sprave pri istočnim obalama Jadranskog mora" (Sl. 2). To je djelo koje je i danas, nakon skoro cijelog stoljeća, u mnogo čemu uporabljivo a može biti i koristan priručnik svakom tko se želi baviti problematikom morskog ribarstva. Djelo je nastalo ponudom Pomorske vlade Loriniju da napiše knjižicu o morskom ribarstvu. Lorini je, nakon pet godina pisanja, izdao knjigu 1903. godine u Beču, koja je još neobjavljena, godinu dana prije, na međunarodnoj izložbi ribarstva u Beču bila nagrađena srebrnom državnom kolajnom. Knjiga je brojila 266 stranica i 69 crteža U knjizi je po prvi put bila obradena cjelokupna problematika morskog ribarstva: važnost ribarstva, fizičke prilike Jadranskog mora kao što su morsko dno, dubina, gustoća i slanost, prozirnost, modrina i svjetlucavost mora, temperatura i morske struje, kao i fauna Jadranskog mora. Naveo je latinske, hrvatske, talijanske i njemačke nazive za komercijalno važne morske organizme među kojima je 6 vrsta morskih sisavaca, dvije vrste kornjača, 300 vrsta riba, 15 vrsta glavonožaca, 11 vrsta puževa, 30 vrsta školjkaša, 10 vrsta rakova, 5 vrsta ježeva i zvjezdača, dvije vrste koralja i meduza i dvije vrste spužvi, a za komercijalno najvažnije morske organizme (preko stotinu vrsta) dao je i podatke o njihovom razmnožavanju. Posebna pozornost u knjizi je posvećena ribarskim plovilima (Sl. 3) i ribolovnim alatima, koji su se tada upotrebljavali u morskom ribolovu, načinima njihove uporabe, izradi i čuvanju od propadanja, te ribarenju stranih ribara u domaćim vodama. Neki od tih ribolovnih alata više nisu u upotrebi, pa da ih Lorini nije opisao u svojoj knjizi, za njih danas vjerojatno ne bismo ni znali (Sl. 4).

Lorini je također u knjizi posvetio veliku pozornost obrtnom ribarstvu, kao što su lov srdele i tuna, lovu i kulturi školjkaša, koralja i spužava. Opisao je i problematiku priređivanja morskih proizvoda za trgovinu, ribanje u lagunama i ribnjacima na moru, te lov nekih komercijalno važnih vrsta riba.

Posebno poglavlje u knjizi čini ribarsko zakonodavstvo, čije su mnoge odredbe i danas aktualne, tako da bi svatko tko se bavi zakonskim reguliranjem problematike gospodarenja živim bogatstvima mora trebao pročitati sve one pravilnike, pravila, odredbe i okružnice što ih je Lorini iznio u svojoj knjizi.

U posljednja dva poglavlja knjige, Lorini se bavi problemima vezanim za zaštitu živih bogatstava mora, imenuje uzroke osiromašenja mora, a ujedno daje i svoje prijedloge i mjere za unaprjeđenje i podizanje morskog ribarstva. Iz tog dijela knjige stajalište Lorinija se može najbolje predstaviti njegovim rečenicama: "U moru ne treba da sijemo, pošto na sjetvu misli priroda sama, preko nevjerojatne sposobnosti razplođivanja svih riba. Nama je na moru dosta žeti, ali po pravim kri-

terijima, da to bude razborita žetva, a ne samo haranje, iza kojeg ostaje pustoš".

Da je Lorini bio veliki pobornik pravilnog gospodarenja živim bogatstvima mora, govori i podatak da je za vrijeme njegovog službovanja na dužnosti nadzornika ribarstva preinačen poznati Dandolov dekret o ribolovu iz 1808. godine i zamijenjen novim Pravilima ljetnog ribolova, čije su mnoge odredbe i danas na snazi (Basioli, 1973a).

Lorini je pored svoje knjige (čija je poglavlja stalno nadopunjavao i ponovno tiskao) objavio i niz drugih radova, studija i članaka iz problematike morskog ribarstva koji su bili tiskani pojedinačno ili u ondašnjim novinama i časopisima ("Zadrugar", "Smotra dalmatinska", "Narodni list", "Lovačko-ribarski vjesnik", "Novo doba", "Glasnik Hrvatskog prirodoslovnog društva" i mnogi drugi). Određene studije nisu bile samo za tadašnje područje Austro-Ugarske monarhije, već su bile rađene i za potrebe Italije gdje je također bio prepoznat kao vrhunski ribarstveni stručnjak (Petešić, 1973).

Veliki broj ideja i preporuka koje je objavljivao Lorini su poslije poslužile kao temelj ne samo za donošenje zakona koji se tiču ribarstvene problematike, već su svoju primjenu našle i u pomorskim djelatnostima i financijskom poslovanju vezanom za te djelatnosti (Petešić, 1973).

Veliki doprinos Lorinija na unapređenju morskog ribarstva jest i organiziranje prvog ribarskog tečaja za učitelje u Komiži na otoku Visu 1897. godine, gdje je bio i jedini predavač (Božanić-Bezić, 1972). 1898. godine rukovodi pokusima koji su se odnosili na primjenu acetilenskih i petrolejskih svjetiljki u ribolovu, koje su za tadašnje prilike bile znatan korak naprijed u poboljšanju ulova male plave ribe uporabom osvijetljenja, s obzirom da se do tada za osvjetljenje koristilo drvo bora.

1907. godine konstruirao je novu mrežu plivaricu za lov male plave ribe na otvorenom moru, koja je 1908. godine bila izložena na izložbi ribarstva u Kopru. Za izradu modela te mreže Loriniju je 1910. godine u Kopru dodijeljena i počasna diploma. Kasnije je, po toj maloj mreži, Lorini u Trstu izradio veliku mrežu plivaricu, koja je po njemu nazvana "mriža Lorini" i kojom je obavljao ribolov u Salima (Grandov, 1960).

Lorini se bavio i problematikom sve težeg plasmana usoljene ribe, tako da je propagirao i pomagao izgradnju tvornica za preradu ribe, kojih je u vrijeme njegova službovanja kao ribarskog nadzornika do njegova umirovljenja izgrađeno oko dvadesetak (Basioli, 1973a).

Inicirao je i sudjelovao u upravi više društava vezanih za poslove ribarstva, pomorstva i poljoprivrede.

Kada danas sa tolike vremenske udaljenosti, možemo kritički ocjenjivati i objektivno vrednovati rad i djelo Petra Lorinija, trebamo ustvrditi da je njegov doprinos razvoju i unapređenju morskog ribarstva, kao i zaštiti živih bogatstava mora veoma značajan, te ga se stoga, s pravom može smatrati utemeljiteljem suvremenog morskog ribarstva na istočnom Jadranu.

PETAR LORINI - FOUNDER OF MODERN FISHERIES IN THE EASTERN ADRIATIC

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SUMMARY

A century and a half will pass this year since the birth of Petar Lorini - a teacher, a true expert in fisheries, and its promoter in the Eastern Adriatic. His most renowned work is no doubt "Fishing and Fishing Gear in the Coastal Waters of the Adriatic Sea" covering 266 pages and 69 drawings, in which the entire complexity of sea fishing was dealt with for the very first time. It is certainly the work that is even at present, after almost an entire century, highly applicable in many respects and can be at the same time a useful manual for all those who are interested in the complexity of sea fishing. Apart from a number of his other published articles, studies and works dealing with the subject of fisheries, Lorini was, as an acknowledged fishing expert, the first fishing inspector in the eastern waters of the Adriatic Sea, appointed by the so-called Marine Government in Trieste, and at the same time a great advocate concerning the conservation of the living resources of the sea.

Key words: Petar Lorini, fisheries, living resources of the sea, biography, Adriatic Sea

LITERATURA

Basioli, J. (1973a): Petar Lorini i njegovo djelo. Morsko ribarstvo, 25(1), 1-3.

Basioli, J. (1973b): Petar Lorini i Brionska konvencija o ribolovu. Morsko ribarstvo, 25(2), 79-83.

Božanić-Bezič, N. (1972): Prvi tečaj pomorskog ribarstva za pučke učitelje. Školski vjesnik, 21(2), 155-159.

Cetinić, P. (1997): Doprinos Petra Lorinija razvoju hrvatskog morskog ribarstva. Tisuću godina prvog spomena ribarstva u Hrvata, Zagreb, 309-317.

Grandov, Š. (1960): Mriža Lorini – prilog historiji plivarice i historiografiji Petra Lorinija. Morsko ribarstvo, 12(10), 158-159.

Petešić, Ć. (1973): Petar Lorini i ribarstvo. Morsko ribarstvo, 25(3), 126-131.

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DR. FRA JURE RADIĆ - BOTANIČAR, MALAKOLOG I EKOLOG (1920-1990)

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SAŽETAK

Dr. fra Jure Radić je bio svjetski priznati stručnjak iz područja malakologije, botanike i ekologije. Osnivač je makarskog Malakološkog muzeja po kojemu je ostao zabilježen u svjetskoj literaturi, znanstvene publikacije "Acta Biokovica", Instituta "Planina i more", botaničkog vrta u Kotišini, izdavač ogromnog broja samostalnih znanstvenih radova i članaka. Fra Jure Radić je otkrio neke nove endemične vrste biljka iz roda Centaurea *I* Allium. *Kao aktivan član planinarskog društva "Biokovo", svesrdno se je zalagao za očuvanje sklada prirode Makarskog primorja.*

Ključne riječi: Jure Radić, prirodopis, Dalmacija, Jadransko more

DR. FRA JURE RADIĆ - BOTANICO, MALACOLOGO ED ECOLOGO (1920-1990)

SINTESI

Gli autori presentano la biografia ed il lavoro del dr. fra Jure Radić, scienziato croato, nell'ottantesimo anniversario della sua nascita e decimo della morte. Fra Jure Radić era un sacerdote che nutriva un grande amore per le persone e la natura. Il suo lavoro scientifico amatoriale diede i migliori risultati nella ricerca botanica e malacologica, campi in cui lui scoprì e descrisse alcune specie endemiche del genere Centaurea *ed* Allium. *Fra Jure Radić, inoltre, registrò e descrisse la distribuzione del gasteropode* Mitra zonata *nel mare Adriatico, fondò l'Istituto "Montagna e mare", registrò il giornale "Acta Biokovica", il Museo Malacologico a Makarska nonché il Giardino Botanico sul monte Biokovo.*

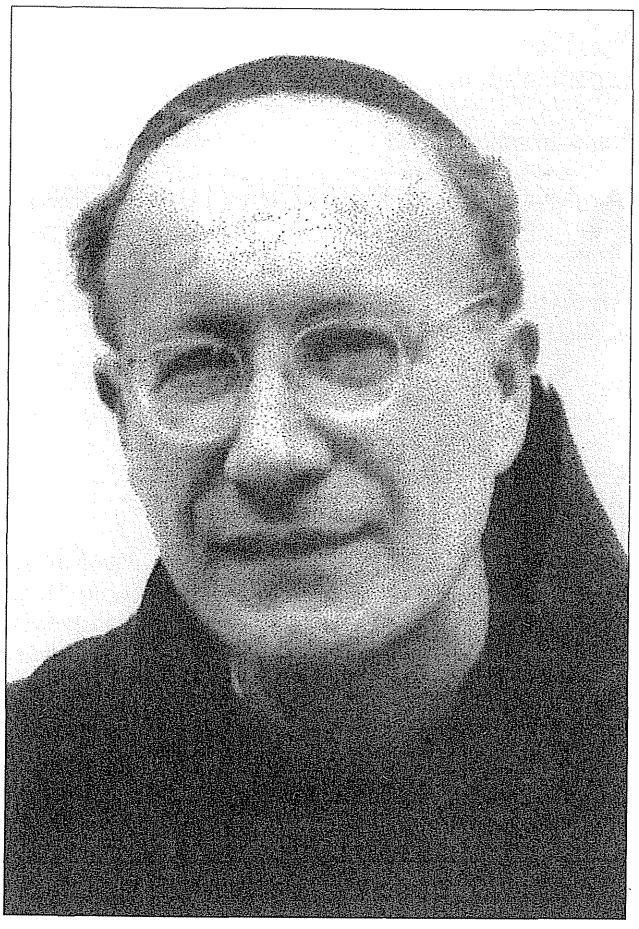
Parole chiave: Jure Radić, scienze naturali, Dalmazia, Mare Adriatico

UVOD

Dvadesetpetog srpnja 1990. godine umro je u splitskom KBC "Firule" u 70. godini života dr. fra Jure Radić (Sl. 1), profesor na Visokoj franjevačkoj bogosloviji u Makarskoj. Glas najpoznatijeg svećenika splitske Franjevačke provincije u domovini i u svijetu stekao je kao liturgist i prirodoslovac. Bio je svjetski priznati stručnjak iz područja malakologije, botanike i ekologije, osnivač je makarskog Malakološkog muzeja po kojemu je ostao zabilježen u svjetskoj literaturi, znanstvene publikacije "Acta Biokovica", Instituta "Planina i more", botaničkog vrta u Kotišini, izdavač ogromnog broja samostalnih znanstvenih radova i članaka. Pun životne energije, aktivan je član planinarskog družtva "Biokovo", svesrdno se zalaže za očuvanje sklada prirode Makarskog primorja. Umro je na dan svetoga Jakova, zaštitnika školjki.

ŽIVOTOPIS

Dr. fra Jure Radić rođen 29. studenog 1920. godine u Baškoj Vodi, kao prvo dijete Jure Radiča i Milke rođene Granić, na razmeđi Biokova i mora, cijelim svojim bićem do svog posljednjeg ostaje vezan za taj kraj. Kršten je u crkvi sv. Nikole i dobio ime Ante. Stradanje oca Jure u brodolomu parobroda "Daksa" u Biskajskom zaljevu određuje njegov put u samostan, a kada je



Sl./Fig. 1: Dr. Fra Jure Radić.

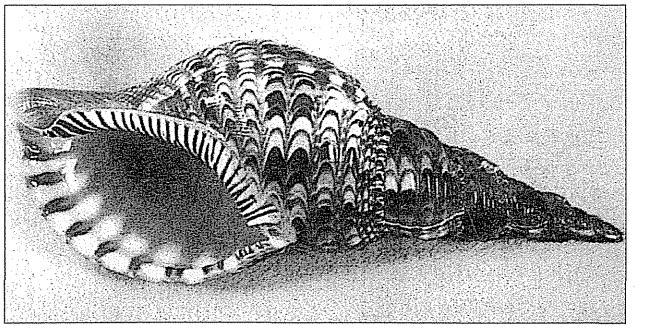
stupio u franjevački red, uzima očevo ime. Završivši klasičnu gimnaziju, a ujedno i dva razreda filozofije, maturirao je u Sinju 28. lipnja 1940. godine. Zatim dolazi u Makarsku i 15. rujna 1940. godine upisuje se na Franjevačkoj visokoj bogosloviji. Završivši teologiju, fra Jure je i dalje nastavio studirati da se što bolje usavrši u poznavanju teologije. Stoga je u Zagrebu na Bogoslovskom fakultetu nastavio postdiplomski studij te 1957. godine doktorirao. Neprestano je pratio sva suvremena teološka zbivanja, posebno na liturgijskom području. Aktivno je sudjelovao kao predavač na raznim skupovima. Pisao je u tadanjim rijetkim listovima. Od djetinjstva je bio sklon prirodoslovlju. Osim u gimnaziji stalno se bavio amaterskim istraživanjem bilja i njegovim sakupljanjem. Nije nikada pohađao prirodoslovni fakultet, već prirodno nadaren sklonošću nadomjestio je to čitanjem, proučavanjem raznih djela i druženjem s vrsnim prirodoslovcima. Fra Jure je proživio svoj životni vijek najviše kao profesor (40 godina), od toga na Bogosloviji 35 (70 semestara); bio je rektor Bogoslovije 13 godina (1961-1973). Fra Jure Radić je bio dobitnik nagrade ZAVNOH-a, Ordena zasluga za narod sa srebrnim vijencem, i nagrade općine Makarske. Fra Jure Radić je bio poseban i jedinstven čovjek. Ako bismo analizirali ove pojmove onda bismo ih morali sažeti sve u jedan, kako je napisala jedna djevojčica u školskoj zadaći, na pitanje: *"Koji je smisao života na Zemlji?"* Odgovorila je: *"Biti čovjek, znači biti malo sunce za sve ljude. Da svatko gdje god se nađeš, svima oko tebe bude ljepše i toplije. Zato što ti živiš!"* Bio je čovjek neobično široka pogleda, obdaren bistrinom duha, veoma originalan u govoru i rasuđivanju i ponašanju. U punini svoje filozofske misli kao 70 godišnjak napisao je cilj svih svojih napora: *"sve sam to činio da se korak po korak približimo beskrajnoj i neshvatljivoj stvarnosti koju s različitih gledišta pokušavamo nazvati različitim imenima (ne atributivno nego substativno): Logos, Razum, Red, Zakonitost, Život, Uzrok, Sila, Moć, Ostvarenje sklada, Trajnost, Vječnost, Besmrtnost"*. I dok se njegov fizički bitak u prevelikoj čežnji na neki način gušio, da upozna i što dublje zađe u dubine Božjeg djela i njegove njemu tako zorne prisutnosti na otisku svega stvorenoga u mikrokozmosu i makrokozmosu, njaednom je klonuo prešavši granicu ovozemnog života. Fra Jure Radić je umro 25. srpnja 1990. godine na svetkovinu sv Jakova, svoga zaštitnika.

Dr. FRA JURE RADIĆ KAO PRIRODOSLOVAC

Svoje znanje iz prirodoslovlja stekao je fra Jure marljivim proučavanjem brojne literature koju je imao uvijek u izobilju u svojoj biblioteci, a jednako tako

Sl. 2: Naslovna stranica knjige Dr. Fra Jure Radića - "Blago mora".
Fig. 2: Title page of the book "The Riches of the Sea" by Dr. Fra Jure Radić.

pokloni su stizali bilo u knjigama, bilo u brošurama, ili u znanstvenim časopisima iz zemlje i inozemstva. Ipak za uspjeh u istraživanju i prezentiranju najviše fra Jure zahvaljuje druženju sa znanstvenicima istraživačima od kojih je mnogo primio i stalno bio s njima u kontaktu. Imao je dar posebnoga zapažanja i lako bi uočio nešto što drugima nakon dugog truda uspijeva. Tako na primjer kada je bio simpozij o Visijaniju u Šibeniku 1979. godine na kome je prezentirano Vizijanijevo djelo: *"Ogled dalmatinskog bilja"*, a preveo ga fra Jure i izdao. Fra Jure Radić je prezentirao svoj rad o centaureama (rod *Centaurea*) i dokazao, da je otkrio neke nove vrste. Također je proučavao rodove *Quercus* i *Pistacia*. Fra Jure piše: *"Morske dubine kriju u sebi mnoga čudovišta i ljepote. Najljepši oblici i najfantastičnije boje pripadaju bez sumnje veličanstvenim tvorevinama nerazumnih i nesvjesnih graditelja-morskih puževa i školjkaša."* Napisao je knjigu: "Blago mora, čarobni svijet školjaka" (Makarska, 1970; formata 21.5 x 20.7 cm, tvrdo ukoričena) koja ima 116 stranica teksta i sadržaj, mnogo slika i crteža u crno bijeloj tehnici, a šest fotografija školjaka u boji (Sl. 2). Druga knjiga fra Jure Radića nosi naslov: *"Lice mora"* (Makarska, 1991; formata 20 x 14 cm) i ima 94 stranice i donosi 35 slika školjaka u boji, a ispod je natpis imena školjke te kratki opis na četiri svjetska jezika. Onim što je priredio preko pisanog teksta i datih fotografija, živopisnih oblika i boja kučica-školjaka, zanimljivost morske malakofaune, prikazao je na njemu svojstven način. Tako je znakovito svoj opus dovršio djelom *"Lice mora"*, mora s kojim je svakodnevno intenzivno i zanosno živio, otkrivajući, proučavajući i poučavajući nas kako preko onog što se vidi spoznati ono što se ne vidi. Treća njegova knjiga nosi naslov: *"Bilje Biokova"* (Makarska, 1976; formata 14.5 x 21 cm) koja ima 237 stranica, 64 fotografije i 113 crteža. U njoj je opisao 1275 vrsta i podvrsta biljaka. U predgovoru je među ostalima navedeno i 11 imena svih biokovskih endema. Dr fra Jure Radić je bio osnivač, glavni urednik i suradnik znanstveno-stručnog časopisa "Acta Biokovica" (godišnjak, Makarska, 1981-1989) u kojem su se uglavnom sakupljali znanstveni radovi vezani uz planinu Biokovo i makarsko područje Fra Jurini radovi u "Acta Biokovica": 1. "Biokovske endemične centaureje", 2. "Hrastovi biokovskog područja", 3. "Biokovski živi fosil vapnojed i prodornik", 4. "Vjetrovice biokovskog područja", 5. "Slani luk, *Allium salsuginis*, i drugi samonikli lukovi Podbiokovlja". Bio je i osnivač Malakološkog muzeja koji je bio otvoren 30. travnja 1960. godine u konobi starog samostana u Makarskoj. Paralelno sa skupljanjem školjaka organizirao je i skupljanje fosila okamenjenih ostataka mekušaca. U Malakološkoj zbirci živućih vrsta zastupana su sva svjetska mora, a u Paleontološkoj zbirci su pretežno fosili mekušaca što su nekoć živjeli na području srednje Dalmacije (Sl. 3). Fra Jure je 7. listopada 1979. godine započeo inicijaciju Instituta "Planina i more" koje objašnjava riječima: *"Najuočljivije lice biološke nauke u naše dane jest, bez sumnje, ekološko lice. Suvremena biologija promatra život kroz ekološku prizmu abiotičkih i biotičkih faktora. Što se tiče čovjeka, njegov odnos s prirodom proučava bezbroj različitih znanosti, a odnos ljudi jednih prema drugima prvenstveno sociologija. Principi suvremene sociologije prodrli su i u crkveno područje. No, nije mi poznato da se osnovne principe ekologije organizirano i znanstveno primjenjuje na sakralno područje, premda su ih kroz svu povijest kršćanstva crkvene ustanove u praksi bolje ostvarivale nego profane. Skromni pokušaj da bi se ta praznina počela popunjavati jest formiranje Instituta "Planina i more""*. Biokovski Botanički vrt Kotišina osnovan je Odlukom skupštine općine Makarska 2. listopada 1984. godine prema zaključcima I. i II. *"Znanstvenog skupa o prirodi Biokovskog područja"*, a po ideji i zamisli fra Jure Radića. Ovaj botanički vrt je vrt biljnoga svijeta užeg i šireg prostora planinskog masiva Biokova i nalazi se u podnožju planine Biokovo, na južnim padinama iznad sela Kotišine na nadmorskoj visini od 350 do 500 m. Osnovna svrha i namjena vrta je upoznavanje, popularizacija i znanstvena istraživanja flore i vegetacije planinskog masiva Biokova. Sastavni je dio posebno zaštićenog objekta prirode "Park prirode Biokovo" i zauzima površinu od 15 hektara (sadrži preko 300 biljnih vrsta). Natpis na litici pred ulazom u botanički vrt glasi: *"Očima pameću srcem po onom što se vidi do onoga što se ne vidi" (Oculis mente corde per visibilia ad invisibilia)* i njegov autor je fra Jure Radić. Premda se od 1959. godine intenzivno bavi školjkašima, nije napustio svoju veliku ljubav planinarenje. U Planinarsko društvo "Biokovo" se učlanio kao član Organizacijskog odbora za obnovu rada samog društva, pa je za zasluge i nagrađen priznanjem Planinarskog saveza Hrvatske.



Sl. 3: Puž** Charonia tritonis **- tritonova truba.
Fig. 3: Triton's horn** Charonia tritonis **- a trumpet shell.

DR. FRA JURE RADIĆ - BOTANIST, MALACOLOGIST AND ECOLOGIST (1920-1990)

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SUMMARY

At the 80th anniversary of birth and the 10th anniversary of death of Dr. Fra Jure Radić, the Croatian natural scientist, the authors present his biography and work. Dr. Fra Jure Radić was a priest with a great love of people and nature. His amateur scientific work was most successful in his botanical and malacological research, the fields in which he discovered and described some endemic species of the genera Centaurea *and* Allium. *He also recorded and described distribution of the gastropod* Mitra zonata *in the Adriatic Sea. He is the founder of the Institute "Mountain and Sea", the journal "Acta Biokovica", the Malacological Museum in Makarska and the Botanical Gardens in the Biokovo Mountain.*

Key words: Jure Radić, natural sciences, Dalmatia, Adriatic Sea

BIBLIOGRAFIJA PRIRODOSLOVNIH RADOVA Dr. fra JURE RADIĆA

Radić, J. (1969): Gastropod *Mitra zonata* u Jadranskom moru. Thalassia Jugoslavica, 5, 277-282.
Radić, J. (1976): Prilog poznavanju flore Biokova. Acta Botanica Croatica, 33, 219-222.
Radić, J. (1977): Drugi prilog poznavanju flore Biokova. Acta Botanica Croatica, 36, 173-175.
Radić, J. (1978): Dalmatinski bor, *Pinus dalmatica* Visiani na Biokovu. Horticultura, 3, 101-106.
Radić, J. (1978): Preteča dalmatinske fitologije Robert Visiani. Ogled dalmatinskog bilja, Split, 193-198.
Radić, J. (1978): Malakološke zbirke u SFRJ. Pomorska enciklopedija, 2, 201 str.
Radić, J. (1978): Malakološki muzej u Makarskoj. Biološki vodič kroz muzeje, Sarajevo, 160-165.
Radić, J. (1979): Doprinos fitogeografiji Biokovskog područja. Acta Botanica Croatica, 38, 95-103.
Radić, J. (1979): Mikroklimatski uvjeti rasprostranjenosti nekih biljaka Biokova. I znanstveni skup o prirodi Biokovskog područja, Makarska rivijera, 17-18.
Radić, J. (1981): Biokovske endemične centaureje. Acta Biokovica, 1, 71-144.
Radić, J. (1982): Ekološki odnosi biljnog pokrova Crnogorskog primorja i Biokovskog područja. Glasnik Republičkog zavoda za zaštitu prirode, Titograd, 15, 197-217.
Radić, J. (1982): Contribution a la connaissance de la distribution des Mollusque (Molusca) dans les biocoenoses benthiques du littoral de Makarska. Acta Adriatica, 23, 175-195.
Radić, J. (1983): Hrastovi biokovskog područja. Acta Biokovica, II, 1-103.
Radić, J. (1983): Doprinos poznavanju rujevine *Cotinus coggyria* Scop. Zbornik radova povodom jubileja Pavla Fukareka, Sarajevo, 215-220.
Radić, J. (1983): Biokovski endem *Centaurea cuspidata* Visiani. Zbornik Roberta Visijanija Šibenčanina, Šibenik, 411-423.
Radić, J. (1983): Doprinos R. Vizijanija poznavanju flore Biokova. Zbornik Roberta Visijanija Šibenčanina, Šibenik, 137-142.
Radić, J. & D. Papež (1983): Studije kromosoma biokovskih endemičkih centaureja. Acta Biokovica, II, 1-207.
Radić, J. (1984): Doprinos poznavanju dendrohazomofita Biokovskog područja. III kongres ekologa Jugoslavije, Knjiga II, Sarajevo, 423-430.
Radić, J. (1984): Biokovski živi fosili vapnojed i podornik. Acta Biokovica, III, 3-144.
Radić, J. (1986): Mjesto biokovske tršlje u evoluciji i migracijama roda Pistacea. VII kongres biologa Jugoslavije, Budva.
Radić, J. (1987): Vjetrovice biokovskog područja. Acta Biokovica, IV, 73-96.
Radić, J. (1989): Slani luk i ostali samonikli lukovi Podbiokovlja. Acta Biokovica, V, 5-84.
Radić, J. (1990): Biljni svijet biokova. Šume Hrvatske u današnjim ekološkim i gospodarskim uvjetima. Glasnik za šumarske pokuse, XXVI, 291-306.
Radić, J. (1990): Contribution to the knowledge of reproduction peculiarity of genus *Allium* L. in the Podbiokovlje. SAZU Razprave, XXXI(17), 247-269.
Radić, J. (1991): Prilog sagledavanju problematike kod nomenklature biljnih vrsta u biblijskim tekstovima. U službi Riječi (Zbornik), 69-77.

LITERATURA

Radić, N. (1998): Dr. Fra Jure Radić. Knjižnica Zbornika "Kačić" - Monografije, dokumenti, građa... br. 28. Split-Makarska, 296 pp.

MISCELLANEA

strokovni članek

UDK 551.44:625.7/.8(497.4)

KARTA RANLJIVOSTI KRASA VZDOLŽ AVTOCEST V SLOVENIJI

Stanka ŠEBELA
Inštitut za raziskovanje krasa ZRC SAZU, SI-6230 Postojna, Titov trg 2

IZVLEČEK

V triletnem projektu "Karta ranljivosti krasa vzdolž avtocest v Sloveniji" smo predstavili vse kraške pojave, ki jih najdemo v trasah ali v neposredni bližini tras avtocest, potekajočih prek kraških terenov v Sloveniji. Vsi kraški pojavi (vrtače, udornice, jame brez stropa, žlebiči, griže, škraplje, kraške jame, kraški izviri), ki so bili znani že od prej ali pa so se razkrili med graditvijo avtocest, so dokumentirani v Katastru jam IZRK ZRC SAZU ter na topografskih kartah. Povzetek raziskav ponazarjata 2 karti ranljivosti krasa, ki zajemata avtocestno omrežje v JZ Sloveniji (Vrhnika-Kozina, Divača-Fernetiči). Na kartah so zbrani pomembnejši kraški izviri, smeri podzemeljskih vodnih tokov in večje kraške jame. Označena so odlagališča komunalnih odpadkov. V tabeli 1 pa so predstavljeni podatki števila vrtač na 1 km² ter število kraških jam na 1 km avtoceste glede na različne avtocestne odseke.

Ključne besede: krasoslovje, graditev avtocest čez kras, vrtače, kraške jame, denudirane jame

MAPPA DELLA VULNERABILITÀ DEL CARSO LUNGO LE AUTOSTRADE IN SLOVENIA

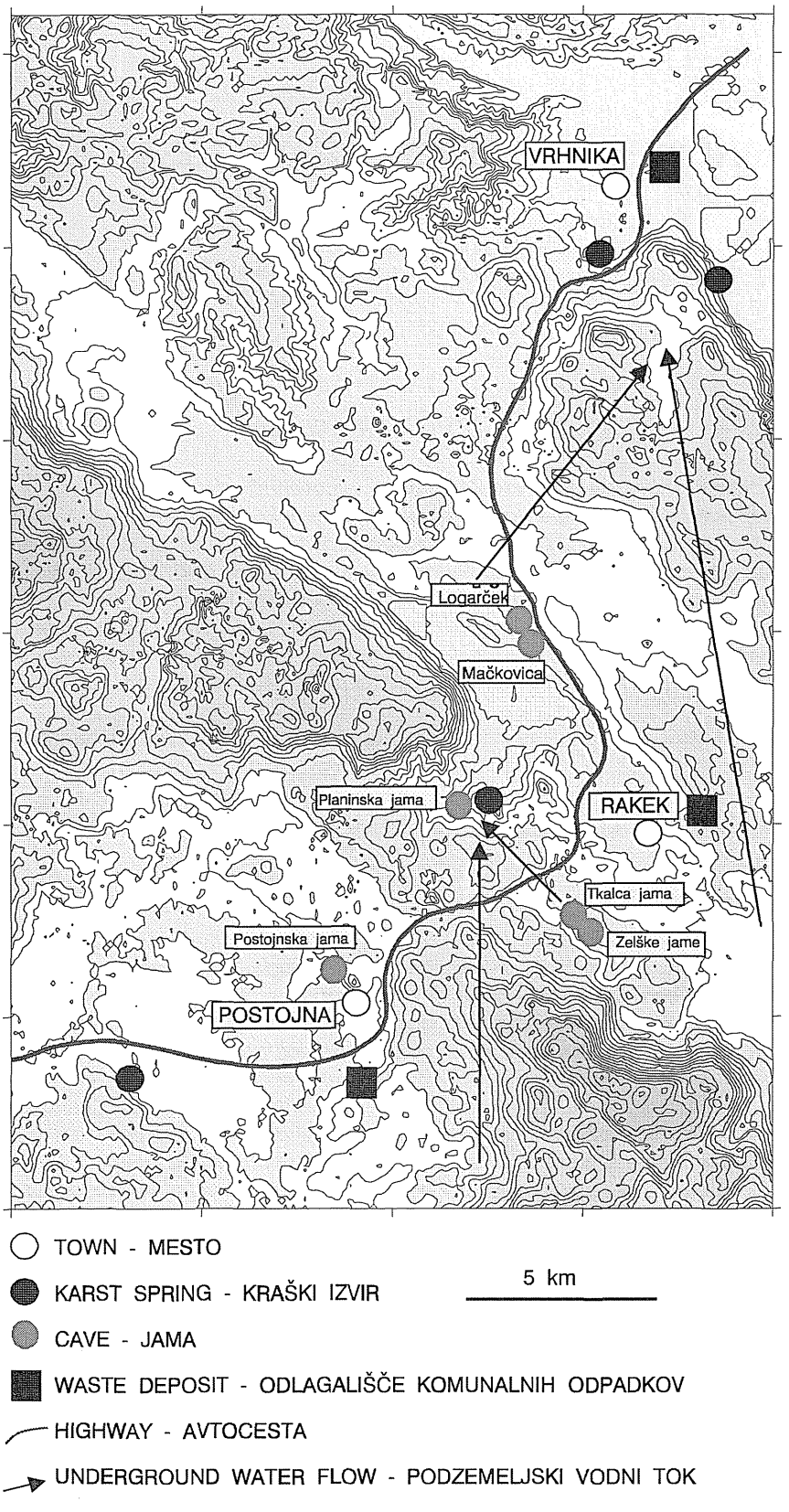
SINTESI

Con il progetto triennale "Mappa della vulnerabilità del Carso lungo le autostrade in Slovenia" gli autori hanno presentato tutti i fenomeni carsici riscontrabili in prossimità o su tracciati autostradali, che attraversano i terreni carsici in Slovenia. I fenomeni carsici (doline, doline di crollo, grotte scoperchiate, scanalature, piccoli crepacci, campi solcati, grotte carsiche e sorgenti carsiche), sia quelli conosciuti da tempo che quelli scoperti durante la costruzione di autostrade, sono documentati nel Catasto delle grotte dell'Istituto per la Ricerca del Carso ZRC SAZU e su mappe topografiche. Il sunto delle ricerche effettuate è rappresentato in due mappe sulla vulnerabilità carsica, che comprendono la rete autostradale della Slovenia sud-occidentale (Vrhnika-Kozina, Divača-Fernetiči). Nelle mappe vengono evidenziate le piu importanti sorgenti carsiche, le direzioni dei corsi d'acqua sotterranei e le maggiori grotte carsiche. Sono inoltre segnate le discariche dei rifiuti urbani. Nella tabella 1 troviamo i dati inerenti il numero di doline per chilometro quadrato nonché il numero di grotte carsiche per chilometro di autostrada, in base ai diversi settori autostradali.

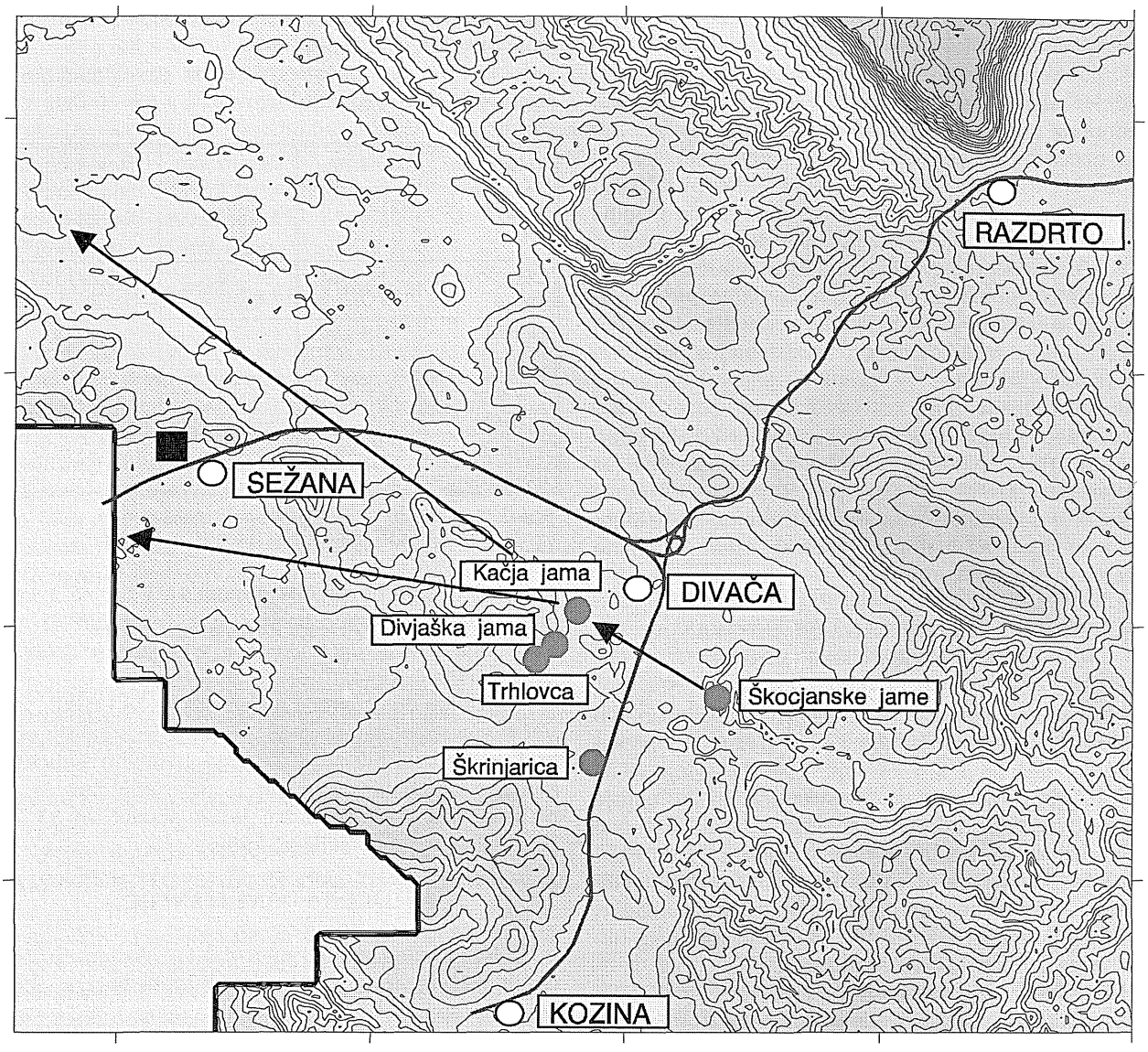
Parole chiave: carsologia, costruzione autostradale attraverso il Carso, doline, grotte carsiche, grotte scoperchiate

UVOD

V obdobju od leta 1996 do začetka leta 1999 je bil Inštitut za raziskovanje krasa ZRC SAZU izvajalec aplikativno raziskovalnega projekta z naslovom "Karta ranljivosti krasa vzdolž avtocest v Sloveniji". Triletni projekt so sofinancirali Ministrstvo za znanost in tehnologijo RS, Krasoslovno društvo Anthron, Zavod za varstvo naravne in kulturne dediščine Nova Gorica, Kovod Vodovod Kanalizacija PO Postojna in Občina Postojna. Nosilka naloge je bila dr. Stanka Šebela, sodelavci pri projektu pa: dr. Tadej Slabe, dr. Andrej Kranjc, dr. Andrej Mi-



Sl. 1. Trasa avtoceste Vrhnika-Postojna. Izohipse so na 40 m.
Fig. 1. The Vrhnika-Postojna motorway. Contour lines are for 40 m.



Sl. 2. Trasa avtoceste Razdrto-Kozina in Divača-Fernetiči. Izohipse so na 40 m.
Fig. 2. The Razdrto-Kozina and Divača-Fernetiči motorways. Contour lines are for 40 m.

hevc, mag. Nadja Zupan-Hajna, mag. Janja Kogovšek, mlada raziskovalca Tanja Pipan in Franci Gabrovšek ter tehnična sodelavca Franjo Drole in Jure Hajna. Inštitut za raziskovanje krasa ZRC SAZU ima že tridesetletne izkušnje v kraškem nadzoru ob graditvi avtocest v Sloveniji. Že leta 1969 so sodelavci Inštituta sodelovali pri graditvi avtoceste Vrhnika-Postojna (Habič & Kranjc, 1969). Kasneje smo opravljali predhodne kraške raziskave načrtovane trase avtoceste Kozina-Rupa (Habič *et al.*, 1990), po osamosvojitvi Slovenije leta 1991 pa so se naše raziskave usmerile v JZ Slovenijo, v zadnjih letih tudi na Dolenjsko.

Glavne raziskave so bile usmerjene v identifikacijo vseh kraških površinskih oblik (vrtač, udornic, jam brez stropa, žlebičev, grižev, škrapelj) in podzemeljskih kraških oblik (kraške jame). Nekatere kraške oblike, predvsem vrtače in včasih jame brez stropa, lahko identificiramo še pred začetkom graditve avtoceste, to je iz originalne kraške morfologije. Večina kraških jam se odpre med graditvijo avtoceste, nekaj pa je tudi primerov, ko se je kraška jama odprla, v neposredni bližini voznih pasov, ko je promet po cesti že stekel.

Več raziskav je bilo opravljenih tudi glede spremljanja kakovosti vode, odtekajoče z avtoceste (Kogovšek, 1995).

Preden se graditev avtoceste začne, opravijo geoelektrične in geofizikalne raziskave. Na predelih, kjer bodo gradili viadukte, mostove, nadvoze in podvoze, pa

opravijo tudi geomehanske raziskave stabilnosti kamnine. V samostojni Sloveniji od leta 1994 opravljamo krasoslovni nadzor pri graditvi avtocest čez kraške terene. Nekateri krasoslovni nadzori so bili opravljeni kot predhodne raziskave, še pred graditvijo avtoceste, večina nadzorov pa poteka sočasno z graditvijo. Glavni namen krasoslovnega nadzora je predvideti in raziskati kraške pojave, ki se odkrijejo pred, med ali po graditvi avtocest. Naše študije kažejo, da je predvidevanje kraških pojavov pred graditvijo zadovoljivo le za vrtače, udornice in deloma jame brez stropa. Sklepanje na pojavljanje neznanih kraških jam je mnogo manj zadovoljivo. Ko je trasa avtoceste že asfaltirana, opravijo georadarske raziskave. V primerih, kjer sklepajo na javljanje praznih prostorov v nevarni bližini trase avtoceste, pa opravijo tudi testna vrtanja. Nenadni udori na krasu niso nenavadni in tudi avtoceste čez kras so izpostavljene takšnim možnostim. Temeljite raziskave geologije, geomorfologije, stabilnosti terena, kraških pojavov so osnovna naloga, s katero lahko ocenimo nevarnosti nenadnih udorov.

IZKUŠNJE IZ 27-LETNEGA OBRATOVANJA AVTOCESTE VRHNIKA-POSTOJNA

Na avtocesti Vrhnika-Postojna (Sl. 1), ki so jo zgradili leta 1972, so na 29 km odkrili 22 novih kraških jam, kar pomeni 7 jam na 1 km² (Kranjc, 1983). Kasneje je na dveh mestih prišlo do nenadnega udora. Pri Postojni je bilo že kmalu po odprtju avtoceste opaziti udor nad kraško jamo na kontaktu med apnencem in nekarbonatnimi kamninami. Dvajset let po obratovanju avtoceste pa se je na zelenici, med voznima pasovoma, pri Verdu udrla okrog 10 m³ velika kraška jama zaradi nepravilnega spiranja voda s cestišča.

Neposredno pod avtocesto pa najdemo več globljih brezen, kot so: Jama Medvednica (globina 38 m), Brezno II pod železniško postajo (globina 13 m), Avanzova jama (globina 28 m), Škantlovo brezno (globina 10 m). Položaji vseh jam, ki danes ležijo v trasi avtoceste, so označeni na topografski karti 1:5.000, jame so sanirane, vhodi oziroma brezna so danes nedostopni.

Pri Uncu poteka naravnost pod avtocesto rov jame Logarček. Dolžina jame je 2.285 m in globina 83 m (Gams, 1963). Debelina stropa med Severnim rokavom in avtocesto na površju je 50 m, debelina stropa med Podorno dvorano in avtocesto pa le 13 m. Glede na 27-letno obratovanje avtoceste in le 2 nenadna udora zunaj voznih pasov lahko sklepamo na zadovoljivo stabilnost avtoceste.

Avtocesta Vrhnika-Postojna poteka čez 470 vrtač. Premer vrtač je 20-80 m, globina 5-15 m. Povprečje vrtač je 250-300 na 1 km² (Tab. 1).

Tab. 1: Osnovna statistika števila kraških jam in vrtač na avtocestah v Sloveniji.
Tab. 1: Principal statistics of karst caves and doline numbers on Slovene motorways.

avtocesta / motorway	dolžina / length	število jam na 1 km / No. of caves per 1 km	število vrtač na 1 km² / No. of doline per 1 km²
Čebulovica-Dane	14 km	76	5,0-11,0
Dane-Fernetiči	4,8 km	72	7,44
Divača-Kozina	6,7 km	50	271,6
Vrhnika-Postojna	29 km	22	250-300

AVTOCESTA ČEBULOVICA-DANE

Pri Divači je povprečna gostota 11 vrtač na 1 km², med Divačo in Sežano pa le 5 vrtač na 1 km² (Sl. 2). Najgloblja vrtača, ugotovljena z vrtanjem, je globoka 27,5 m (Habič, 1974).

Na 14 km dolgi avtocesti smo odkrili 76 kraških jam. Večinoma so to manjše jame, saj jih je le 6 daljših od 5 m. Dve jami sta bili znani že pred graditvijo avtoceste. Med novo odkritimi jamami je 57 starih jam in 19 brezen. Med starimi jamami je 24 praznih in 33 zapolnjenih s sedimenti (Slabe, 1996).

AVTOCESTA DANE-FERNETIČI

Odsek Dane-Fernetiči meri 4,8 km. Skupno je bilo odkritih 72 novih jam, od teh je bilo 46 brezen. Blizu avtoceste so izmerili 110 m globoko jamo. Vhod v jamo se odpira v vrtači, ki so jo predvideli za zajetje odpadnih voda z avtoceste. Vhod v jamo so sanirali, saj pomeni vsako nekontrolirano izplakovanje odpadnih voda v kraški sistem onesnaženje kraške podtalnice. Na tem odseku avtoceste je 7,44 vrtač na 1 km² (Tab. 1).

AVTOCESTA DIVAČA-KOZINA

S predhodnimi krasoslovnimi raziskavami trase avtoceste Divača-Kozina (6,7 km; Sl. 2) smo identificirali 4 jame brez stropa (Šebela, 1996), kasneje, ob začetku gradbenih del, pa so odkrili še 2 jami brez stropa. Na 6,7 km dolgi avtocesti je bilo 6 kraških jam znanih že od prej, 9 jam smo odkrili s predhodnimi raziskavami, končno število 50 jam je bilo določenih sočasno z gradbenimi deli. Povprečje vrtač je 271,6 vrtač na 1 km².

Tik ob trasi avtoceste je vhod v jamo Škrinjarico (dolžina je 270 m in globina 130 m), debelina stropa

med avtocesto in horizontalnim rovom je 85 m. Jama je zavarovana kot naravni spomenik št. 882 in vpisana v naravno dediščino Slovenije.

V globini okrog 200 m pod traso avtoceste južno od Divače poteka neznan rov s tokom podzemeljske Reke, ki ponika v Škocjanskih jamah. Martelova dvorana v Škocjanskih jamah leži okrog 450 m zračne razdalje JV od avtoceste in zajema prostornino 2.000.000 m³ (Mihevc, 1995).

HITRA CESTA SELO-VIPAVA

Hitra cesta skozi Vipavsko dolino se večinoma gradi v flišnih kamninah, ki pa tudi vsebujejo do 10 m debele plasti kalkarenita, ki je lahko zakrasel. Med graditvijo so odkrili več manjših jam, eno od brezen globine 9 m leži v neposredni bližini mostovnih betonskih nosilcev.

Četudi nekatere kamnine, kot npr. neprepustni fliš, niso tako zakrasele kot npr. apnenci, pa lahko znotraj karbonatnih plasti pričakujemo tudi kraške jame in podzemeljsko kraško pretakanje vode.

AVTOCESTA V JV DELU SLOVENIJE

Tudi na Dolenjskem gradijo avtoceste, ki v veliki meri potekajo čez kras. Dolenjski kras je v nasprotju z Notranjskim prekrit z debelejšo plastjo pliocenskih in kvartarnih glin in aluvija. Naplavina in preperina na krasu pa pomenita še večjo nevarnost nenadnih udorov.

POMEN APLIKATIVNIH KRAŠKIH ŠTUDIJ ZA REŠEVANJE TEORETIČNIH KRAŠKIH PROBLEMOV

Aplikativno raziskovalni projekt nam je pomagal tudi pri reševanju teoretičnih kraških problemov. Prav s krasoslovnimi raziskavami tras avtocest v JZ Sloveniji smo odkrili nov geomorfološki pojem "jame brez stropa ali denudirane jame" (Mihevc *et al.*, 1998), ki se uveljavlja tudi v svetovnem kraškem izrazoslovju.

Glede na podatke meritev z mikrometrom (Cucchi *et al.*, 1994) je zniževanje površja na Krasu 0,02 mm na leto ali 20 m v 1.000.000 letih. Analize starosti sige z U/Th in paleomagnetne analize klastičnih sedimentov kažejo, da so jame brez stropa starejše od 730.000 let, v nekaterih primerih ocenjujejo starost celo na več milijonov let (Bosak *et al.*, 1998).

ZAKLJUČEK

Ker bomo v prihodnosti avtoceste čez kras v Sloveniji še gradili, npr. čez Kraški rob ali na Dolenjskem, je triletna študija le stanje do konca leta 1998. V prihodnosti bi veljalo projekt nadaljevati na novih trasah, ob sočasnem spremljanju avtocest v obratovanju. Vsi opisani kraški pojavi ob avtocestah so dokumentirani. Načrti jam so vneseni v Kataster jam IZRK ZRC SAZU, položaji vrtač, udornic in kraških izvirov so dokumentirani na topografskih kartah. Sodelavci pri projektu so rezultate svojega dela predstavili javnosti na mednarodnih in domačih srečanjih ter v znanstvenih in strokovnih publikacijah (Šebela & Mihevc, 1995; Šebela *et al.*, 1999).

Ob konkretnem terenskem delu se je odprlo tudi pomembno vprašanje, ki zajema novi teoretski pristop k razvoju kraškega površja. To so tako imenovane jame brez stropa ali denudirane jame. Gre za stare rove, ki so zaradi dviganja terena in procesov erozije in korozije danes brez nekdanjega stropa in jim na površju lahko sledimo kot morfološke depresije, zapolnjene s sedimenti. Še v začetku leta 1994 so take ostanke kraških jam pripisovali površinskim vodnim tokovom. Prav graditev avtocest v JZ Sloveniji je razkrila takšne jame in nam omogočila njihovo temeljito študijo. Termin denudiranih jam se uveljavlja tudi v svetovnem merilu, v letu 1999 je Inštitut za raziskovanje krasa ZRC SAZU priredil že 7. mednarodno krasoslovno šolo "Klasični kras", tokrat na temo "denudirane jame".

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THE VULNERABILITY MAP OF THE KARST ALONG HIGHWAYS IN SLOVENIA

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SUMMARY

With a three-year project "The vulnerability map of the karst along highways in Slovenia", all karst phenomena that can be found on or near highways crossing the karst areas in Slovenia were introduced. All karst features (dolines, collapse dolines, denuded caves, grooves, grikes, karren, karst caves, karst springs), which had been known before or were discovered during the construction of highways, are documented in the Cave Cadastre of the Karst Research Institute ZRC SAZU and on topographic maps. The summary of the project investigations is represented by 2 vulnerability maps of the karst regarding highways in SW Slovenia (Vrhnika-Kozina, Divača-Fernetiči). On the maps, important karst springs, directions of underground water flow, waste deposit sites and important larger karst caves are presented. In table 1, data for numbers of doline per 1 km² and numbers of karst caves per 1 km are presented in view of different highway sections.

Key words: karstology, highway construction across the karst, dolines, karst caves, denuded caves

LITERATURA

Bosak, P., P. Pruner & N. Zupan Hajna (1998): Palaeomagnetic research of cave sediments in SW Slovenia. Acta carsologica SAZU, Ljubljana, XXVII/2, 151-179.

Cucchi, F., F. Forti & F. Ulcigrai (1994): Zniževanje kraškega površja zaradi korozije. Acta carsologica SAZU, XXIII, 55-62.

Gams, I. (1963): Logarček. Acta Carsologica SAZU, 3, 5-84.

Habič, P. (1974): Poročilo o kraških pojavih na AC Senožeče-Divača-Sežana. Elaborat IZRK ZRC SAZU, Postojna, 20 str.

Habič, P. & A. Kranjc (1969): Preiskave vrtač v trasi avtoceste Vrhnika-Postojna. Elaborat IZRK ZRC SAZU, Postojna, 11 str.

Habič, P., M. Knez, J. Kogovšek, A. Kranjc, A. Mihevc, T. Slabe, S. Šebela & N. Zupan (1990): Kraški pojavi v trasi avtoceste Kozina-Rupa. Elaborat IZRK ZRC SAZU, Postojna, 3-24.

Kataster jam IZRK ZRC SAZU. Postojna.

Kogovšek, J. (1995): Podrobno spremljanje kvalitete vode, odtekajoče z avtoceste in njen vpliv na kraško vodo. Annales, 7, 149-154.

Kranjc, A. (1983): Speljava hitrih cest čez kras. Obzornik, 4, 316-319.

Mihevc, A. (1995): New surveys in the Martel Hall, Škocjanske jame. Naše jame, 37, 39-44.

Mihevc, A., T. Slabe & S. Šebela (1998): Denuded caves - An Inherited element in the Karst Morphology; The case from Kras. Acta Carsologica SAZU, XXVII/1, 165-174.

Slabe, T. (1996): Karst features in the motorway section between Čebulovica and Dane. Acta Carsologica SAZU, 25, 221-240.

Šebela, S. (1996): Predhodne krasoslovne raziskave trase avtoceste Divača-Kozina. Annales, 9, 103-106.

Šebela, S. & A. Mihevc (1995): The problems of constructions on karst - The examples from Slovenia. V: Beck, B. F. (ed.): Karst geohazards. A.A. Balkema, Brookfield, Rotterdam, 475-479.

Šebela, S., A. Mihevc & T. Slabe (1999): The vulnerability map of karst along highways in Slovenia. V: Beck, B. F., A. J. Pettit & J. Gayle Herring (eds.): Hydrogeology and engineering geology of sinkholes and karst - 1999. A. A. Balkema, Brookfield, Rotterdam, 419-422.

izvirno znanstveno delo

UDK 556.3:551.44(497.4 Postojnska jama)
504.054:556.3

UGOTAVLJANJE NAČINA PRETAKANJA IN PRENOSA SNOVI S SLEDILNIM POSKUSOM V NARAVNIH RAZMERAH

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IZVLEČEK

V nasprotju s sledenjem v juniju 1993, ko smo sledilo zalili s 5,5 m³ vode, kar lahko primerjamo z razlitji večjih količin nevarnih tekočin ob nesrečah, je bil sledilni poskus novembra 1996 opravljen v naravnih razmerah. Na površju smo kvantitativno injicirali 15 g uranina in počakali na padavine, ki so sledilo spirale skozi 100 m debele karbonatne kamnine v curke in kapljanja v Postojnski jami. Uranin se je pojavil najhitreje in najizraziteje v curku I (s hitrostjo 0,12 cm/s), v curkih J in L pa kasneje (s hitrostjo 0,028 oz. 0,019 cm/s) in manj izrazito. Po najbolj prepustnem prevodniku I se je v enem mesecu spralo le 0,1% injiciranega uranina, kar nakazuje le počasen, zato pa dolgotrajen prenos topnih snovi skozi vadozno cono z naravnim spiranjem ob padavinah. Tako se spirajo tudi nevarne snovi iz raznih odlagališč na kraškem površju in ogrožajo kakovost kraške vode.

Ključne besede: krasoslovje, kraška voda, sledilni poskus, Postojnska jama, Slovenija

UTILIZZO DI TRACCIANTI PER LA DETERMINAZIONE DELLA VIA DI PERCOLAZIONE E TRASPORTO, IN CONDIZIONI NATURALI, DELLE SOSTANZE DISCIOLTE IN ACQUA

SINTESI

A differenza dell'esperimento effettuato a giugno del 1993, quando gli autori diluirono un tracciante con 5,5 metri cubi d'acqua (il che può venir paragonato al versamento accidentale di grandi quantità di sostanze tossiche), nel novembre 1996 il tracciante è stato utilizzato in condizioni naturali. In superficie sono stati iniettati 15 g di uranina, che la pioggia ha poi condotto attraverso rocce carbonatiche spesse 100 m e fatto gocciolare nelle Grotte di Postumia (Postojna). Le più alte concentrazioni di uranina sono state ritrovate, in tempi brevi, nel getto I (con una velocità pari a 0,12 cm/s); nei getti J e L sono state riscontrate, in un secondo tempo, minori concentrazioni di uranina (con una velocità rispettivamente di 0,028 e 0,019 cm/s). Nell'arco di un mese, attraverso il conduttore più permeabile I è passato solo lo 0,1% dell'uranina iniettata, il che conferma un passaggio lento, quindi di lunga durata, delle sostanze disciolte in acqua piovana. Allo stesso modo vengono trasportate anche sostanze tossiche provenienti da varie discariche sulla superficie carsica, che minacciano la qualità dell'acqua carsica.

Parole chiave: carsologia, acqua carsica, utilizzo di traccianti, Grotte di Postumia (Postojna), Slovenia

UVOD

Preučevanje prenikanja padavin skozi 100 m debele apnence smo od leta 1988 spremljali v Kristalnem rovu in delu Glavnega rova Postojnske jame (Kogovšek, 1995a). Ugotovili smo onesnaženo preniklo vodo in vzrok na površju - odtok odpadne komunalne vode iz manjšega vojaškega objekta. Ker nam tedaj ni bil omo-

gočen dostop na površje, smo v jami redno spremljali sestavo 4 curkov onesnažene prenikle vode, za primerjavo pa še sestavo bližnjega čistega kapljanja, medtem ko smo sledilne poskuse, ki nam naj bi pokazali smeri odtoka vode, dinamiko pretakanja in način prenosa snovi po posameznih prevodnikih, načrtovali za prihodnost.

Po razpadu SFRJ in odhodu vojske smo junija 1993 napravili prva dva sledilna poskusa iz ponikovalnice odpadne vode, kjer smo injicirali uranin, in iz bližnje vrtače, kjer smo injicirali rodamin. Sledili smo tedaj zalili z večjo količino vode (5,5 m^3). To sledenje nam je pokazalo povezavo površja s curki in kapljanji 100 m globlje v jami in način pretakanja vode in sledila v razmerah, ko smo sledilo zalili z večjo količino vode (Knez *et al.*, 1995; Kogovšek, 1997a, 1997b). Takšne razmere nastopijo ob prometnih in drugih nesrečah, v katerih so udeleženi prevozniki tekočin, ko pride do razlitja raznih nevarnih snovi na kraškem površju (Kogovšek, 1995b).

Sledenje novembra 1996 pa smo opravili ob naravnih razmerah, ko smo sledilo raztopili v majhni količini vode, ga injicirali, nato pa počakali na spiranje sledila s padavinami. Tako se spirajo s površja v krasu v vodi topne snovi iz številnih najrazličnejših odlagališč odpadkov (Kogovšek, 1996), gnojila in zaščitna sredstva s kmetijskih površin, onesnaženje s cestnih (Kogovšek, 1995c) in parkirnih površin.

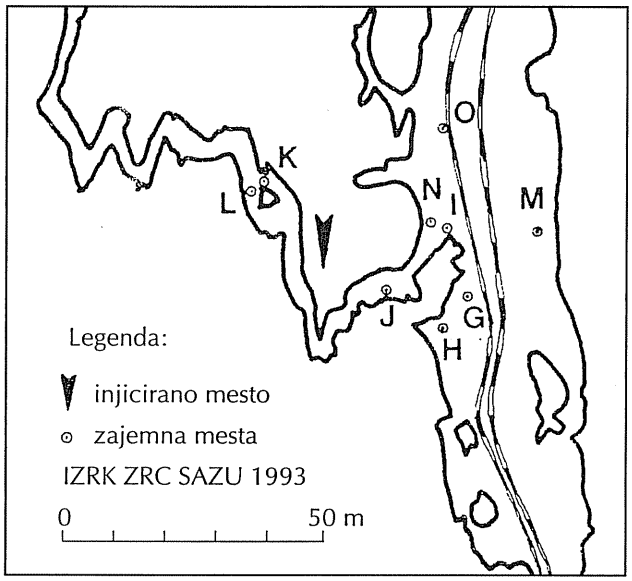
MATERIAL IN METODE

Uporabljene metode dela

Debelina jamskega stropa je bila določena na osnovi stabiliziranega poligona v jami in prenosa poligonskih točk na površje, in znaša 100 m z natančnostjo do 0,5 m. Izmera elementov poligona je bila napravljena z elektronskim razdaljemerom NIKON DTM-A10 LG.

Meritve pretoka curkov in kapljanj smo opravljali z ustreznim merilnim valjem in štoparico. Vsakokrat smo pretok merili trikrat in vzeli povprečno vrednost. Za podatke o količini padavin smo uporabili meritve Hidrometeorološkega zavoda RS za padavinsko postajo Postojna. Vzorce vode kapljanj in curkov smo zajemali ročno in neposredno v polietilenske steklenice, tako da smo počakali, da so se napolnile. Le v primeru minimalnih pretokov smo običajno pobrali vzorce naslednjega dne zjutraj in še istega dne opravili kemične analize. V sledilnem poskusu smo zajemali vodne vzorce tudi z avtomatskim vzorčevalnikom WTW PB 10/T. Specifično električno prevodnost (referenčna temperatura 25°C) kot tudi temperaturo smo določali takoj ob zajemu vzorca s prenosnim aparatom WTW LF 196. Vsebnost kloridov smo določevali po standardni metodi z živosrebrovim nitratom, sulfate po standardni turbidimetrični metodi, o-fosfate po standardni metodi s kositrovim kloridom (Standard Methods, 1992), vsebnost nitratov pa po metodi z natrijevim salicilatom.

Fluorescenco vzorcev sledilnega poskusa smo merili z luminiscenčnim spektrometrom PERKIN ELMER LS 30 pri ekscitacijskem maksimumu 492 nm in emisijskem maksimumu 515 nm z mejo določljivosti 0,005 ppb. Hitrosti pretakanja vode v krasu računamo glede na razdaljo med točko injiciranja in izvirom oz. curkom, kjer se sledilo pojavi. Zato so tako dobljene vrednosti navidezne hitrosti pretakanja. Dejanske vodne poti so daljše in zato so tudi dejanske hitrosti pretakanja večje, vendar so za zdaj dejanske dolžine vodnih poti v krasu še nedostopne, ker danes znane metode ne omogočajo vpogleda v kraško notranjost.

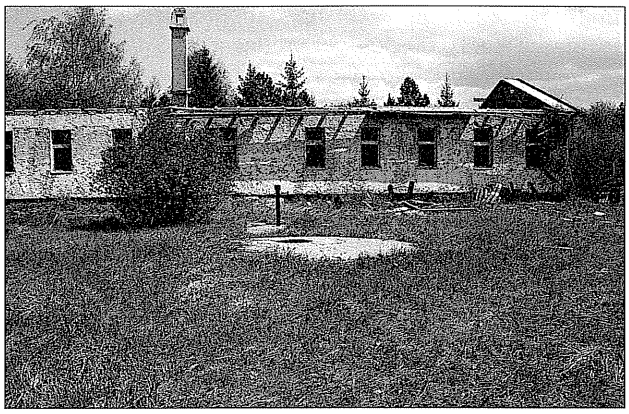


Sl. 1: Območje Glavnega in Kristalnega rova v Postojnski jami, kjer smo v okviru sledilnega poskusa novembra 1996 opazovali curke in kapljanja: G, H, I, J, K, L, M, N in O.
Fig. 1: The area of Glavni and Kristalni rov in Postojnska jama, where trickles G, H, J, K, L, M, N, and O were observed after water tracing in November 1996 (arrow - injection point, circle - sampling point).

Izvedba sledilnega poskusa

Injiciranje sledila

Sledilni poskus smo opravili 17. novembra 1996, ko smo od 11.20 do 11.35 injicirali 15 g uranina, ki smo ga kvantitativno sprali z 20 l vode. Počakali smo na dež, ki je nato spiral uranin v smeri Kristalnega in Glavnega rova Postojnske jame. Uranin smo injicirali, podobno kot ob sledenju junija 1993, v ponikovalnico odpadne vode bivšega objekta JLA, ki je spomladi 1991 zapustila območje (Sl. 1, 2).



Sl. 2: Površje nad Postojnsko jamo, kjer smo v nekdanjo ponikovalnico odpadnih voda injicirali 15 g uranina (Foto: J. Kogovšek).
Fig. 2: The surface above Postojnska jama, where 15 g of uranin was injected into former sink of waste waters (Photo: J. Kogovšek).

Tab. 1: Vsebnost kloridov, nitratov, sulfatov in fosfatov v curkih I, J in L septembra 1996 pred sledenjem 17. novembra.
Tab. 1: The content of chlorides, nitrates, sulphates and phosphates in trickles I, J and L in September 1996 before tracing was carried out on November 17th.

Curek Trickle	SEP SEC	Kloridi Chlorides	Nitrati Nitrates	Sulfati Sulphates	Fosfati Phosphates
	µS/cm	mg/l	mg/l	mg/l	mg/l
I	483	2,1	20	24	0,33
J	459	1,9	7,6	19	1,4
L	469	3,8	18	17	0,34

Po prenehanju svežega onesnaževanja je dež postopoma spiral onesnaženi jamski strop, kar smo spremljali s kemičnimi analizami curkov v jami. Naše meritve sestave prenikle vode v času injiciranja po dobrih 5 letih spiranja s padavinami so pokazale že močno znižane vrednosti merjenih parametrov, ki so razvidne iz tabele 1.

Zajemanje vzorcev

Glede na rezultate sledilnega poskusa junija 1993, ko smo vzorčevali 25 kapljanj in curkov prenikle vode na širšem območju, smo tokrat vzorčevali na 9 mestih: G, H, I, J, K, L, M, N in O (Sl. 1), na točkah, kjer smo pričakovali pojav uranina, ter na dodatnih robnih točkah. Najpodrobneje smo vzorčevali curek I na vhodu v Kristalni rov, kjer smo si pomagali z avtomatskim zajemalnikom vzorcev, na drugih zajemnih mestih pa smo zajemali vzorce ročno in hkrati merili pretok.

Hidrološke razmere

Padavine

September in oktober 1996 sta bila kar obilna s padavinami, saj je padlo 203,5 oz. 185,5 mm dežja. Vendar pa je v treh tednih pred injiciranjem padlo v Postojni skupno le 20 mm dežja, tako da so pretoki curkov in kapljanj v Postojnski jami upadali in so v času injiciranja dosegali minimalne vrednosti (Tab. 2).

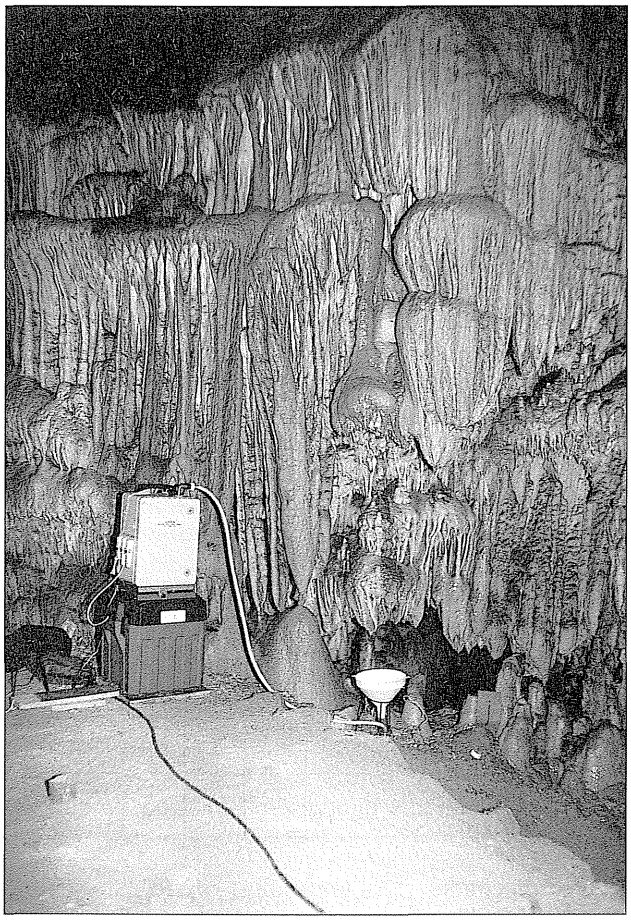
Tab. 2: Pretok curkov in kapljanj v času injiciranja ter minimalni in maksimalni pretoki v okviru večletnih občasnih meritev.
Tab. 2: Discharge (Q) of trickles and drippings at the time of injection, and minimal and maximal discharges within the framework of longstanding seasonal measurements.

Curek - Trickle	G	H	I	J	L
Pretok 17.11.96 (ml/min) - Q	1	20	5	1,5	2
Pretok - min (ml/min) - Q_{min}	0,5	1	1	1	1,5
Pretok - max (ml/min) - Q_{max}	55		1500	184	12

Po injiciranju 17. novembra so še istega dne popoldne sledile manjše padavine (4,5 mm). Do polnoči je padlo še nadaljnjih 6 mm. Nato je začelo intenzivneje deževati in do 18. novembra ob 5.30, ko smo izmerili že močno povečan pretok curka I ter zajeli vzorec, je padlo kar 41,5 mm dežja. Do 9.30 je deževalo zmerno, nato pa do 11.00 intenzivno ter skupaj padlo še nadaljnjih 34 mm dežja. Zmerno je deževalo še do 15.00 (10 mm). Zvečer je ponovno začelo deževati in do 19. novembra ob 7.00 padlo 16 mm dežja.

Prek dneva (18. novembra) je tako padlo skupno 89 mm dežja. Dne 19. novembra ni deževalo, naslednjega dne, 20. novembra, pa je padlo 34 mm dežja. Sledil je zopet dan brez padavin, 22. novembra pa je prek dneva ponovno deževalo in padlo 20 mm dežja. Nato sta bila dva dneva brez omembe vrednih padavin. Do konca meseca so sledili dnevi z manjšimi padavinami v obliki snega, prva dekada decembra pa je bila suha.

Kasneje je v decembru padlo 166 mm padavin kot sneg. Januarja 1997 je padlo 163,3 mm dežja, v februarju, marcu, aprilu in maju pa skupno le 166,5 mm padavin, od tega 64,5 mm v maju. Junija in julija je padlo 149, oz. 154 mm dežja, avgust in september pa sta bila zelo suha. Oktobra je padla večina dežja v nevihti 8. oktobra (100 mm). Prve intenzivne in izdatne padavine so sledile novembra, ko je padlo 367,5 mm dežja in decembra z 216,4 mm padavin.



Sl. 3: Zajemanje vzorcev vode na točki I na vhodu v Kristalni rov z avtomatskim zajemalnikom (Foto: J. Kogovšek).
Fig. 3: Water sampling at point I at the entrance into Kristalni rov with automatic sampler (Photo: J. Kogovšek).

REZULTATI

Rezultati meritev pretokov curkov in kapljanj v času sledilnega poskusa

Curek I

Izhodna vrednost pretoka curka I (Sl. 3) v času injiciranja sledila je bila le 5 ml/min. Naslednjega dne, 18. novembra ob 5.30, ko je padla glavnina intenzivnega dežja v tem dnevu (41,5 mm), ki je začel padati opolnoči, smo zabeležili močno povečan pretok. Ocenjujemo, da je začel pretok curka strmo naraščati že po četrti uri in je v štirih urah ob 8.00 dosegel skoraj maksimalno zabeleženo vrednost (1,32 l/min), ki je bila 260-krat večja od izhodne vrednosti. Prek dneva je nato pretok nekoliko nihal do vrednosti 1,4 l/min, nato pa je bil praktično stalen vse do 22. novembra (3 dni), ko je upadel na 1,3 l/min. Opazneje je začel upadati proti večeru in 23. novembra ob 10.00 dosegel vrednost 0,55 l/min (23. in 24. novembra ni bilo padavin). Sledilo je najprej počasnejše upadanje pretoka zaradi manjših padavin konec novembra, nato pa hitrejše do 10. decembra, ko ni bilo več padavin in je pretok dosegel 40 ml/min. Ponovne padavine v decembru 96 ter januarju in maju 97 so bile razlog za ponovne poraste pretoka (Sl. 4, 6, 7).

Curek J

Izhodna vrednost pretoka curka J (Sl. 8) v Kristalnem rovu je bila le 1,5 ml/min. Po padavinah 18. novembra ob 10.00 je začel pretok naraščati. Toda naraščanje ni bilo tako hitro kot pri curku I, saj je maksimalno vrednost dosegel šele 25 ur po začetku naraščanja pretoka. Maksimalno vrednost 86 ml/min, ki je bila 60-kratna vrednost izhodnega pretoka, je dosegel 19. novembra ob 11.30. Pretok je nato le malo nihal in vztrajal 5 dni na vrednosti nekoliko nad 80 ml/min vse do 24. novembra ob 10.00 (Sl. 9). Sledilo je zložno upadanje pretoka, počasnejše kot v curku I. Ob ponovnih intenzivnejših padavinah decembra je pretok ponovno porasel, vendar z določenim časovnim zaostankom za curkom I.

V zaledju curka J je v primerjavi s curkom I opazno močnejše dušenje pretakanja, ki se izkazuje v manjših nihanjih pretoka, v njegovem počasnejšem reagiranju na padavine in kasneje v počasnejšem in zadržanem upadanju pretoka.

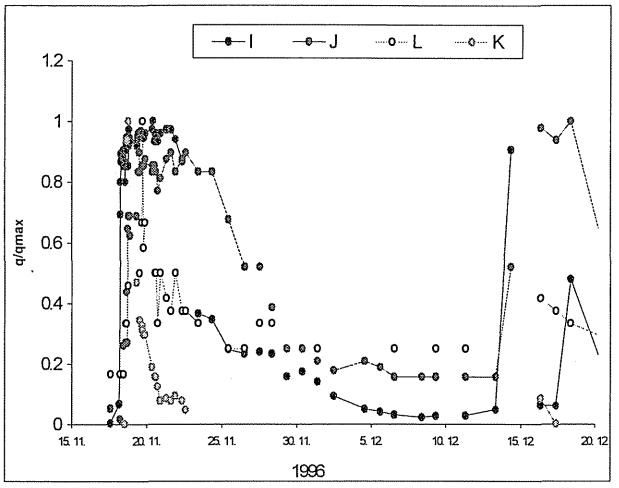
Kapljanje L in občasni curek K

Kapljanje L v Kristalnem rovu ima prek leta zelo konstanten pretok, ki tudi po intenzivnih padavinah le redko preseže 10-kratno vrednost minimalnega pretoka. V času injiciranja je dosegal 2 ml/min, na izdatne padavine 18. novembra pa je reagiral šele zvečer istega dne ob 18.00, medtem, ko je maksimalno vrednost 12 ml/min dosegel naslednjega dne ob 17.00, kar je 6 ur za curkom J (Sl. 10).

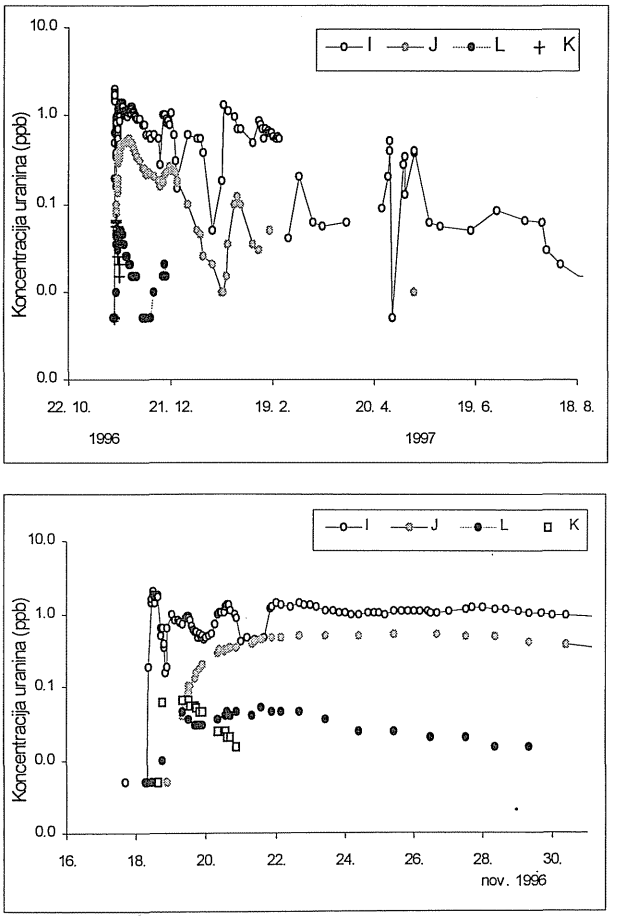
Občasni curek K v neposredni bližini je bil v času injiciranja suh, prvi vzorec pa se nam je nabral 18. novembra do 14.30. Pretok je v treh urah porasel do 128 ml/min, nato pa brez opaznejših nihanj upadal do 23. novembra, ko je ponovno presušil (Sl. 11).

Rezultati sledilnega poskusa z uraninom

Uranin se je pojavil v curkih: I, J, K in L (Sl. 5). Najizraziteje se je pojavil v curku I, slabše pa v curku J, kapljanju L in v občasnem curku K. Na osnovi rezultatov sledenja junija 1993 smo pričakovali pojav uranina tudi v curkih G in H, vendar ga na teh dveh mestih nismo določili. Temu je zelo verjetno vzrok majhna količina injiciranega sledila (4-krat manjša kot junija 1993) in razmere daljšega in manj intenzivnega



Sl. 4: Potek pretokov (q/q_{max}) v curkih I, J, K in L, kjer se je pojavil uranin.
Fig. 4: Flow through-time (q/q_{max}) in trickles I, J, K, and L where the uranin appeared.



Sl. 5: Sledilne krivulje curkov: I, J, K in L.
Fig. 5: The tracer recovery curve in trickles I, J, K, and L.

spiranja, kar je verjetno vzrok za pojav uranina v curkih G in H v koncentracijah pod mejo določljivosti.

Curek I

Prvo sled uranina smo izmerili 18. novembra ob 8.00, nekako 4 ure za prvim porastom pretoka (Sl. 5, 6). Koncentracija je čez 3 ure že dosegla maksimalno vrednost 2 ppb, nato pa ob sicer konstantno visokem pretoku (Sl. 7) večkrat zanihala. Štiri ure po koncu intenzivnih padavin (dopoldne 18. novembra) je začela upadati tudi koncentracija uranina. Ponovne manjše padavine so bile razlog za nadaljnje spiranje uranina in porast njegove koncentracije, vendar ne prek vrednosti 1 ppb. Sledil je dan brez padavin, ko je ob maksimiranem pretoku koncentracija uranina postopno upadala, ob ponovnih manjših padavinah pa porasla v tretji vrh sledilnega vala. Ob maksimiranem pretoku so pojav več vrhov v sledilni krivulji uranina povzročale vsakokratne padavine, ki so potiskale uranin.

Sledeče izdatnejše padavine pa so povzročile upadanje koncentracije uranina, ker je prišlo do razredčevalnega učinka. Sledil je dan brez padavin, kar je povzročilo počasno upadanje pretoka in hkrati naraščanje koncentracije uranina. Ponovne padavine so zadržale upadanje pretoka, ki je vztrajal na vrednosti 1,3 l/min; koncentracija uranina pa je bila 1,3 ppb. Izostanek nadaljnjih padavin je bil razlog za hiter upad pretoka ter vzporedno zelo zadržano upadanje koncentracije uranina.

Nihanja koncentracije uranina ob maksimiranem pretoku nakazujejo dotok vode iz širšega zaledja curka I, ki pa se mu je ob vsakokratnih padavinah intenzivneje pridružil dotok vode z uraninom po najbolj prepustnem prevodniku s točke injiciranja.

Skozi curek I je v času po injiciranju sledila in pred njegovim pojavom v curku izteklo približno 300 l čiste vode, kar pomeni zapolnjenost zaledja curka I v danih hidroloških razmerah, torej ob slabši zapolnjenosti in majhnih pretokih curka (Sl. 6).

Ponovno intenzivnejše spiranje uranina je bilo po padavinah decembra ter januarja 1997 vse do konca februarja, ko je koncentracija uranina upadla na 0,04 ppb, ter ponovno ob majskih padavinah. Do novembrskih intenzivnih in izdatnih padavin (eno leto po injiciranju), ko je prišlo ponovno do intenzivnejšega spiranja uranina, je koncentracija upadla na 0,015 ppb. Novembra 1998 uranina ni bilo več.

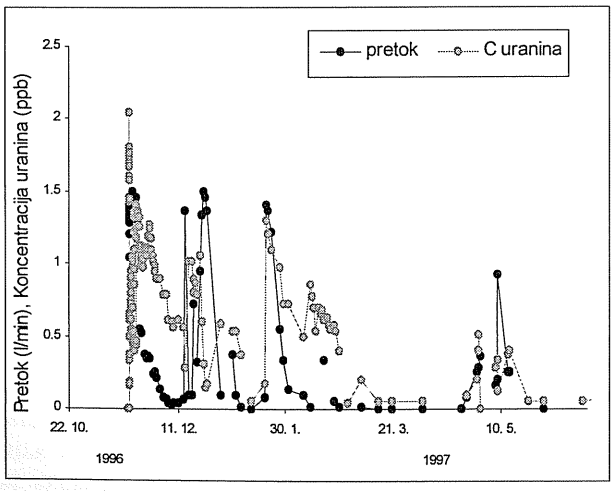
Ker ne poznamo dolžine dejanske vodne poti, navajam navidezne hitrosti pretakanja, ki so izračunane glede na razdaljo daljice med injicirno točko in kapljanjem oz. curkom v jami. Navidezna hitrost pretakanja uranina v curek I je bila glede na njegov prvi pojav 0,14 cm/s oz. 4,9 m/h, glede na maksimalno koncentracijo pa 0,12 cm/s oz. 4,3 m/h (Tab. 3).

Tab. 3: Hitrosti pretakanja uranina glede na doseženo maksimalno koncentracijo za stalne curke I, J in L ter občasni curek K.
Tab. 3: Flow through-time of the uranin in view of the maximal concentration for constant trickles I, J and L and seasonal trickle K.

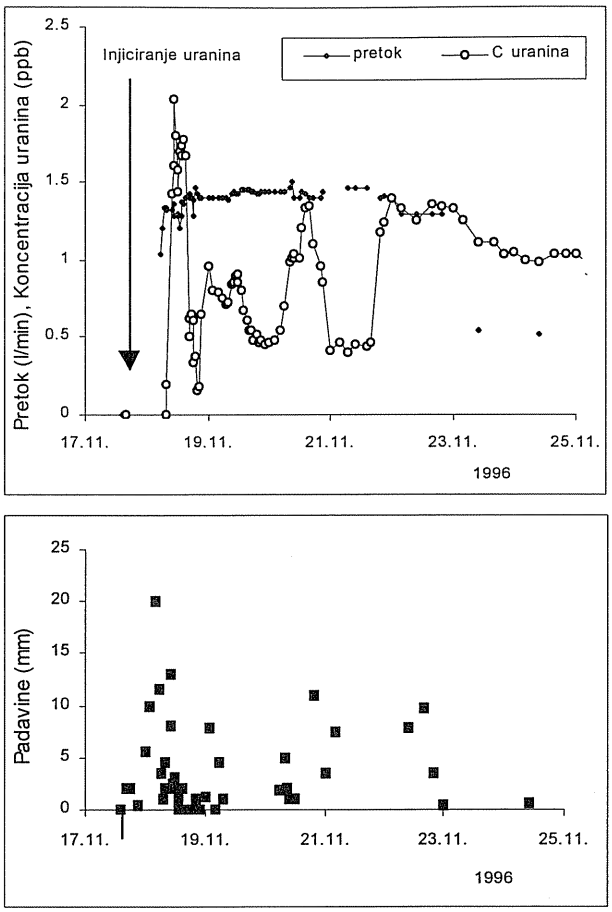
Curek - Trickle	I	J	L	K
Hitrost – Velocity (m/h)	4,3	0,67	1,02	2
Hitrost – Velocity (cm/s)	0,12	0,02	0,03	0,06

Curek J

Po injiciranju so se prve sledi uranina pojavile v curku J 19. novembra ob 11.00, kar je 24 ur za reakcijo pretoka, koncentracija pa je nato hitro naraščala in oblikoval se je izrazit sledilni val brez večjih nihanj koncentracije, kot smo to zabeležili v curku I (Sl. 9). Šele ko je pretok curka v posameznem vrhu dosegel maksimalno vrednost, je začela naraščati tudi koncentracija uranina, sam vrh sledilnega vala pa se je oblikoval v času upadanja pretoka. Najizraziteje se je oblikoval prvi vrh sledilnega vala, kasnejši vodni valovi pa so povzročili oblikovanje manjših vrhov ob siceršnjem trendu upadanja koncentracije uranina. Dne 20. januarja 1997 je bila koncentracija uranina 0,01 ppb, po padavinah je ponovno porasla, 21. februarja pa upadla pod mejo določljivosti. Po prvih intenzivnejših padavinah, ki so sledile maja, smo v curku spet odkrili sledi uranina, vendar pa je koncentracija ponovno hitro upadla pod mejo določljivosti. Ponovno smo sled uranina določili še novembra, eno leto po injiciranju uranina in po izdatnih in intenzivnih padavinah, vendar tedaj točke J nismo podrobneje vzorčevali.



Sl. 6: Curek I: krivulja pretoka in sledilna krivulja.
Fig. 6: Trickle I: discharge curve and a tracer recovery curve.

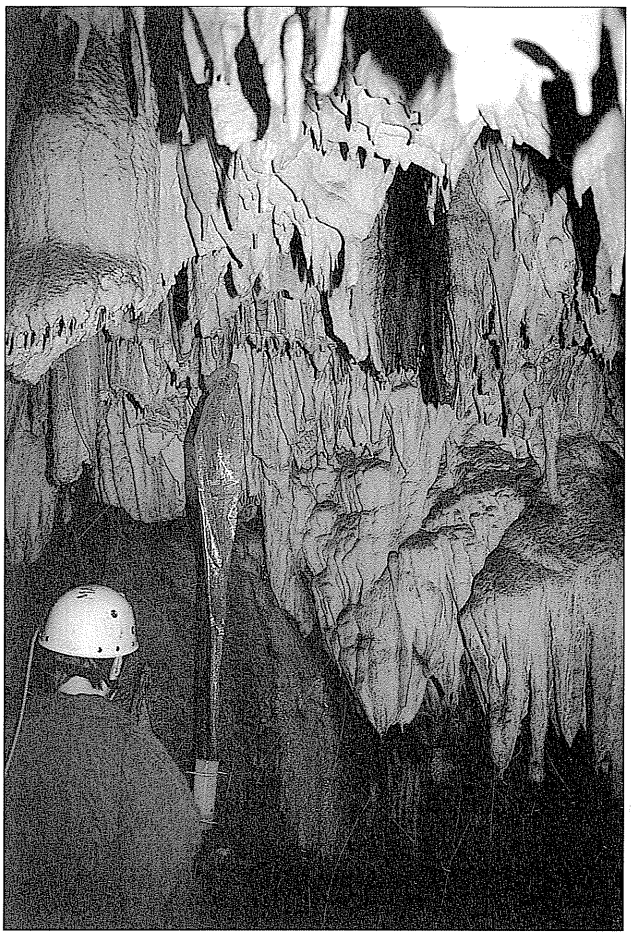


Sl. 7. Curek I: podroben potek pretoka, koncentracije uranina in padavin prvi teden po injiciranju.
Fig. 7: Trickle I: a detailed discharge curve and tracer recovery curve.

Navidezna hitrost pretakanja v curek J glede na prvi pojav uranina je bila 0,058 cm/s oz. 2,1 m/h, glede na doseženo maksimalno koncentracijo pa 0,019 cm/s oz. 0,67 m/h (Tab. 3).

Kapljanje L

Prvi pojav uranina v kapljanju L smo zabeležili hkrati s povečanjem pretoka 18. novembra ob 18.00 (Sl. 10). Koncentracija uranina je v 13 urah porasla na 0,045 ppb. Povečanje pretoka do maksimalne vrednosti 12 ml/min je povzročilo upad koncentracije uranina, ki je ponovno porasla do maksimalne vrednosti 0,05 ppb ob upadu pretoka do 4,5 ml/min. Ob upadanju pretoka do 3 ml/min je upadala tudi koncentracija uranina, ki pa je ponovno porasla že ob povečanju pretoka na 4 ali 5 ml/min v decembru. Ob koncu decembra, ko smo končali z zajemanjem vzorcev, je bila koncentracija v upadanju in je dosegala vrednost 0,01 ppb.



Sl. 8: Ročno zajemanje vzorcev in meritve pretoka na točki J (Foto: J. Kogovšek).
Fig. 8: Manual sampling and discharge measurements at point J (Photo: J. Kogovšek).

Navidezna hitrost pretakanja v kapljanje L je bila glede na prvi pojav uranina 0,09 cm/s oz. 3,3 m/h, glede na pojav maksimalne koncentracije pa 0,028 cm/s oz. 1,02 m/h (Tab. 3).

Curek K

Curek K je občasen in je bil v času injiciranja uranina suh. Prvi vzorec, voda, ki je skozi curek pritekla do 18. novembra ob 14.30, ni vseboval uranina. Prvo sled uranina smo določili že čez 1 uro, čez 3 ure pa je ob najvišjem pretoku dosegel že koncentracijo 0,075 ppb. Ob upadanju pretoka je koncentracija uranina nekoliko zanihala in dosegla pri pretoku 44 ml/min maksimalno vrednost 0,1 ppb, nato pa upadala do 22. novembra, ko je pri pretoku 6 ml/min dosegla vrednost 0,035 ppb. Naslednjega dne je curek presahnil.

V začetku decembra je bil curek zopet aktiven, koncentracija uranina pa je bila pod mejo določljivosti. Dne 16. in 17. decembra pa smo ob porastu pretoka zopet izmerili sledi uranina. Nato pa je bila koncentracija uranina do konca januarja, ko je curek presahnil, pod mejo detekcije.

Navidezna hitrost pretakanja v curek K je bila glede na prvi pojav uranina 0,1 cm/s oz. 3,6 m/h ter glede na maksimalno koncentracijo uranina 0,06 cm/s oz. 2 m/h (Tab. 3).

RAZPRAVA IN ZAKLJUČKI

Primerjava (vodnih valov) reagiranja pretokov curkov I, J, K in L

Kar 89 mm dežja, ki je padel 18. novembra, glavnina kot intenziven dež nekaj ur po polnoči, je bil razlog za reakcijo opazovanih curkov in kapljanj v Postojnski jami. Najprej je reagiral curek I, curek J je zaostajal za njim 6 ur, kapljanje L in občasni curek K pa za 14 ur. Najhitreje je naraščal pretok curka I, nekoliko počasneje in stopničasto pa pretok curka J in kapljanja L (Sl. 4).

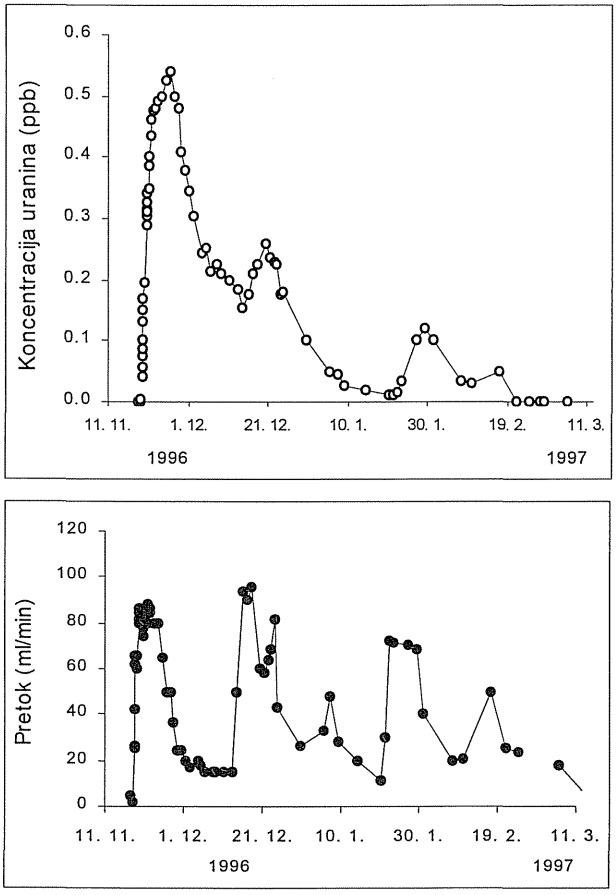
Po doseženih maksimalnih pretokih curkov I in J kljub kasnejšim ponovnim intenzivnejšim padavinam ni prišlo do nadaljnjega naraščanja pretokov, ampak do daljšega vztrajanja na maksimiranih pretokih. Curek I je vztrajal na pretoku nekoliko nad 1,4 l/min dobre 3 dni, curek J pa na pretoku nekoliko nad 80 ml/min 5 dni. Curek I reagira na padavine najhitreje in najizraziteje in začne kasneje tudi hitreje in močneje upadati kot curka J in L. Tak način pretakanja je posledica močnejšega dušenja padavin pri pretakanju padavin v curek J in še izraziteje v kapljanje L kot v curek I.

Pretok občasnega curka K je reagiral skoraj sočasno s kapljanjem L, vendar zelo izrazito. Pretok pa je nato hitro upadal, in ko je začel pretok curka L upadati, je curek K že presahnil. Očitno ta curek odvaja le visoke vode, ki se odtekajo v tej smeri. Skozi kapljanje L je odtekalo le do 12 ml/min vode, medtem ko je večji del visoke vode (do 128 ml/min) odtekal skozi občasni curek K.

Primerjava sledilnih krivulj uranina opazovanih curkov

Iz slike 5 je razviden potek uranina v vseh curkih oz. kapljanjih, kjer se je pojavil I, J, K in L. Najizraziteje, v največjih koncentracijah in z največjimi nihanji se je pojavil v curku I, ki je očitno najprepustnejši prevodnik s površja v 100 m globlje podzemlje. Uranin smo v tem curku ugotavljali več kot eno leto.

Opazno dušen, zvezen pojav uranina smo ugotavljali v curkih J in L, vendar izraziteje v 10-krat višjih koncentracijah v curku J. Padavine so nekaj uranina potisnile tudi v občasen curek K, vendar je njegova koncentracija sočasno s pretokom upadala in ni oblikovala sledilne krivulje z več vrhovi kot pri curkih J in L (Sl. 9, 10, 11).



Sl. 9: Curek J: krivulja pretoka in sledilna krivulja.
Fig. 9: Trickle J: discharge curve and tracer recovery curve.

Ugotovljene hitrosti pretakanja glede na pojav sledila in količina povrnjenega uranina

Iz sledilnih krivulj smo lahko izračunali hitrosti pretakanja v posamezne curke. Ugotovili smo, da se je v danih razmerah voda s sledilom kar 4-krat hitreje pretakala skozi curek I kot skozi curka J in L (Tab. 3) in da so te hitrosti opazno manjše kot v primeru sledilnega poskusa 1993 (Knez *et al.*, 1995), ko smo sledilo zalili s cisterno vode in simulirali razlitje topne snovi ob nesreči.

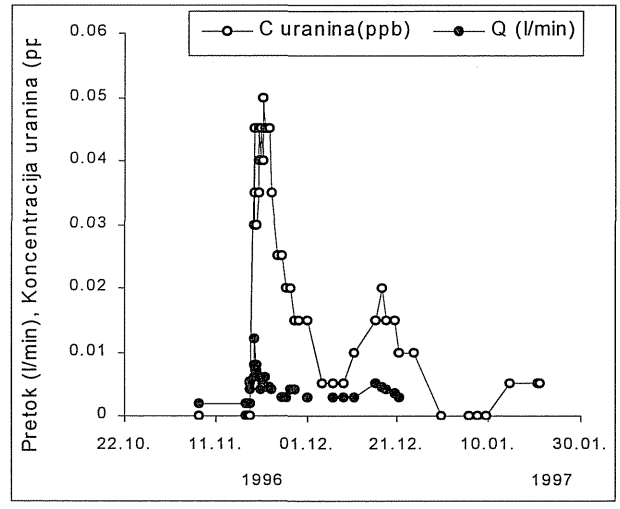
Sledilne krivulje curkov in meritve pretokov kažejo, da je bil količinsko najpomembnejši prenos sledila po prevodniku curka I, sledi curek J, najslabši pa po kapljanju L. Vendar pa je v enem mesecu po injiciranju skozi curek I izteklo le 0,1 % injiciranega sledila, kar v takih razmerah pomeni dolgotrajen prenos snovi v manjših količinah.

ZAKLJUČEK

Rezultati opisanega sledenja v naravnih razmerah so pokazali način pretakanja vode in prenos topne snovi, v našem primeru uranina, skozi 100 m debel apnenec. Tako se prenašajo v notranjost krasa, kjer so zaloge vode, razpoložljive topne snovi s kraškega površja, npr. topne komponente iz najrazličnejših odlagališč (Kogovšek, 1996), gnojila in zaščitna sredstva, ki se uporabljajo v kmetijstvu, onesnaženje s cestnih in parkirnih površin in drugo. Čeprav je najhitrejši prenos po najbolj prepustnih prevodnikih, pa tudi v takih primerih traja izpiranje snovi do vzpostavitve osnovnega stanja zelo dolgo. V primeru onesnaženja nad Kristalnim rovom Postojnske jame še 8 let po odstranitvi vira onesnaženja ni vzpostavljeno izhodno stanje. V takih primerih onesnaževanja ni hitrih, katastrofalnih posledic. Ker pa se onesnaženje dalj časa zadržuje v kraškem masivu, pomeni akumulacijo onesnaženja v krasu in njegovo dolgotrajno spiranje.

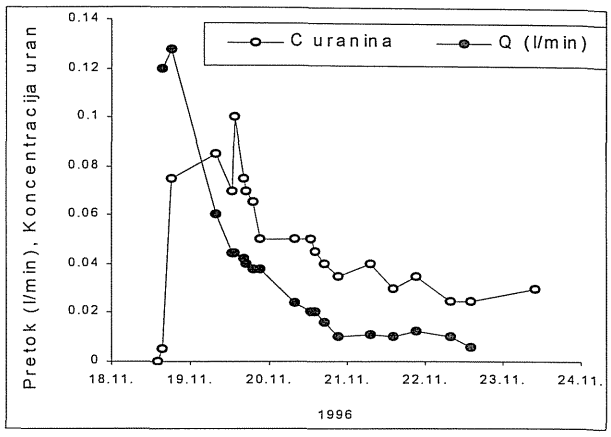
Sledenje, kjer smo sledilo v času pol ure zalili z večjo količino vode, je pravzaprav simulacija razlitja topne snovi ob raznih nesrečah, pogosto v prometnih nesrečah, in je podalo bistveno drugačen prenos onesnaženja kot ob spiranju onesnaženja s padavinami. Izsledki so tako praktično uporabni v primerih, ko pride do večjih razlitij na kraškem površju (Kogovšek, 1995b). V takih primerih gre za hitrejši prenos onesnaženja, posebno po bolj prepustnih prevodnikih.

Lahko zaključim, da se oba načina izvedbe sledenja, ko injiciramo sledilo na kraškem površju brez aktivnega vodnega toka, dopolnjujeta in nam dajeta zelo uporabne informacije o pretakanju topnih snovi skozi vadozno cono krasa v različnih razmerah.



Sl. 10: Kapljanje L: nihanje pretoka in sledilna krivulja.
Fig. 10: Drip L: discharge oscillations and tracer recovery curve.

Sl. 11: Občasni curek K: ob pojavu vode v curku K po padavinah, smo zabeležili tudi pojav uranina.
Fig. 11: Seasonal trickle K: when water appeared in trickle K after rainfall the uranin also appeared.



HOW TO DETERMINE THE WAY OF PERCOLATION AND TRANSPORT OF SUBSTANCES BY WATER TRACING TEST IN NATURAL CONDITIONS

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SUMMARY

The water tracing test carried out in June 1993 indicated connection of surface with trickles and drippings 100 m deeper in Postojnska jama and also pattern of water and tracer flow when a greater amount of water is added. Such circumstances occur during spill of greater quantities of substances in event of traffic or other accidents. Water tracing on November 17, 1996 was carried out in natural conditions; 15 g of uranin were dissolved in a small amount of water and injected into a sinking stream at the surface. We waited until the tracer was washed out by precipitations as this simulates pattern of flow when rainfall washes soluble substances from various dumping places. The samples were taken at nine different sites named G, H, I, J, K, L, M, N, and O and tracer reappeared in trickles I, J, K and L (Fig. 1).

On November 18, there was 89 mm of rain, most of it as an intensive shower some hours after midnight; this rain affected the reaction of observed trickles and drippings in Postojnska jama. The first to react was trickle I, after 6 hours trickle J, while drippings L and seasonal trickle K were delayed for 14 hours. The fastest to increase was trickle I, and slightly slower trickle J and dripping L (Fig. 4). When trickles I and J reached their maximum discharge, there was no further increase in spite of heavy rain that followed and they remained for some time at the same maximum. Trickle I persisted with the discharge slightly above 1400 ml/min for more than 3 days, and trickle J at more than 80 ml/min for 5 days. As trickle I is the first to react in a most distinctive way to rainfall it also decreases faster and stronger than trickles J and L. The pattern of flow into trickle J and even more into dripping L shows strongly suffocated rainfall.

The seasonal trickle K reacted almost at the same time as dripping L. When the discharge through L started to decrease, trickle K was already almost dry. Obviously this trickle conveys only high waters flowing in this direction. Through dripping L only up to 12 ml/min of water was drained, while larger amount of high waters (up to 128 ml/min) flowed through the seasonal dripping K.

Figure 5 shows the uranin drainage through all the trickles and drippings where the tracer occurred. Most distinctly, in highest concentrations and with greatest variations, the uranin appeared in trickle I, which is obviously the most permeable conduit from the surface underground, 100 m deeper. The uranin was being detected in this trickle for more than one year. Visibly suffocated yet continuous appearance of the uranin was detected in trickles J and L, yet concentrations in trickle J were 10 times higher.The rainfall pushed some of the uranin into the seasonal trickle K, but its concentration decreased together with discharge decrease and did not shape the tracer recovery curve with many peaks as it happened at trickles J and L (Figs. 9, 10, 11).

The dye recovery curve allowed to calculate the velocity of drainage in single trickles. We stated that at given circumstances the water with tracer flowed through trickle I 4 times faster than through trickles J and L (Tab. 3) and that these velocities are considerably smaller than those in 1993, when tracer was watered by a road tanker thus simulating the flow pattern of soluble substance during an accident. Regarding the quantity, most of the tracer flowed through the conduit of trickle I, followed by trickle J and the least through dripping L. But after one month only 0.1% of the injected tracer reappeared through trickle I.

Key words: karstology, karst water, water tracing, Postojnska jama cave, Slovenia

LITERATURA

Knez, M., J. Kogovšek, A. Kranjc, A. Mihevc, S. Šebela, & N. Zupan Hajna (1995): National Report for Slovenia.- COST Action 65, Hydrogeological aspects of groundwater protection in karstic areas. Final Report, European Commission, 247-260, Luxembourg.

Kogovšek, J. (1995a): The Surface Above Postojnska jama and its Relation with the Cave. The Case of Kristalni rov. Bossea MCMXCV, Atti del simp. internationale grotte turistiche e monitoraggio ambientale. Cigna, A. A. *(ed.),* 29-39, Frabosa Soprana.

Kogovšek, J. (1995b): Izlitja nevarnih snovi ogrožajo kraško vodo. Annales, 7, 141-148.

Kogovšek, J. (1995c): Podrobno spremljanje kvalitete vode, odtekajoče z avtoceste in njen vpliv na kraško vodo. Annales, 7, 149-154.

Kogovšek, J. (1996): Kako smetišča ogrožajo kakovost kraške vode. Annales, 9, 111-114.

Kogovšek, J. (1997a): Pollution transport in the vadose zone: An example from Postojnska jama - Slovenia. Karst Waters & Environmental Impacts, Proceedings of 5th International Symposium and Field Seminar on Waters and Environmental Impacts, Antalya, Turkey, 10-20 September 1995. Gunay, G. & A. I. Johnson *(eds.),* 161-165, Balkema, Rotterdam.

Kogovšek, J. (1997b): Water tracing tests in vadose zone. Tracer Hydrology 97, Proceedings of the 7th International Symposium on Water Tracing, Portorož, Slovenia, 26-31 May 1997. Kranjc, A. *(ed.),* 167-172, Balkema, Rotterdam.

Standard Methods for Examination of Water and Wastewater (1992): 18th Edition, Washington.

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STRUCTURE OF MOTOR ABILITIES OF FIVE AND A HALF YEARS OLD GIRLS

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ABSTRACT

The subject sample encompassed 189 girls, five and half years old (+/- 3 days). The test battery consisted of 28 composite motor tasks. The results were analysed with The SPSS-x statistical programme at the Computing Centre of Pedagogical Faculty of the University of Maribor (Slovenia). The Kaiser-Guttman criterion was used for factor extraction and the initial structure rotated to an Oblimin solution. The extraction of significant factor gave an eight factor model of basic motor abilities: realisation of rhythmic motor structures, balance, agility, whole-body coordination, explosive power, manipulative ability of the hands, kinaesthetic solving of spatial problems and factor x (provisionally-motor intelligence).

Key words: children, motor abilities, tests

STRUTTURA DELLE CAPACITÀ MOTORIE DI BAMBINE DI CINQUE ANNI E MEZZO D'ETÀ

SINTESI

All'Università di Maribor è in corso un progetto di ricerca pluriennale, intitolato Struttura e relazioni di capacità psicomotorie e caratteristiche morfologiche, psicosociali e sanitarie di bambini in tenera età. L'esperimento ha preso in considerazione più di 1400 bambini di entrambi i sessi, tra i cinque ed i sei anni e mezzo. L'articolo presenta la struttura motoria latente di bambine di cinque anni e mezzo. In Slovenia ricerche simili sono state condotte da Planinšec (1995), Pišot (1998), Rajtmajer (1994, 1997), Strel & Šturm (1981) e Videmšek & Cemič (1991). Il campione analizzato ha compreso 189 bambine di 5 anni e mezzo (piu/meno 3 giorni). L'esperimento è stato effettuato mediante 28 compiti motori compositi. I dati sono stati elaborati con il programma SPSS-x. Per l'estrazione delle componenti principali è stato utilizzato il criterio di Guttman-Kaiser $\lambda \geq 1$, mentre la rotazione dei fattori è stata effettuata nella posizione di Oblimin. L'estrazione dei fattori significativi ha portato ad un modello delle capacità motorie di queste bambine a 8 fattori: la realizzazione delle strutture ritmiche del movimento, l'equilibrio, l'agilità, la coordinazione del corpo, la forza esplosiva, la capacità manipolativa delle mani, la soluzione cinestetica dei problemi spaziali ed il fattore x, che gli autori hanno condizionatamente chiamato intelligenza motoria.

Parole chiave: bambini, capacità motorie, esperimenti

INTRODUCTION

At the University of Maribor, we have been studying latent and manifest motor abilities and anthropometric, psychosocial and health characteristics of young children since 1988. The object of this study is the structure of motor abilities of 5.5 years old girls. Analysis is based on the results of studies by Strel & Šturm (1981), Zimmer & Volkamer (1984), Kiphard (1987, 1989), Cetin (1991), Videmšek & Cemič (1991), Rajtmajer (1994, 1997),

Planinšec (1995) and Pišot (1997). The above-stated authors studied motor structure of children between five and seven years of age. In setting the model of motorics of five-and-a-half years old girls we of course took into account also the findings of basic studies of motorics by Chaidze (1965), Berstein (1967), Agrež (1975), Gredel (1975), Kurelić *et al.* (1975), Šturm (1975), Hošek (1976), Mueller (1978), Boes & Mechling (1983), Luria (1983), Singer (1985) and many more. In order to define the motor status of the children as objectively as possible, it was necessary to study numerous researches, where the authors studied motorics of young children, from schooling children and youth to adults. It is a fact - and this is also the working hypothesis of the entire project, which encompasses four sub-populations aged 5, 5.5, 6 and 6.5 years old children of both genders - that motorics of a child is in some segments very similar or even identical to motorics of other populations, but that it also differs from them. This study also bases on a part of Gardner's (1995) theory of multiple intelligences, where the author defines physical-motor and partly spatial intelligence.

METHODS

In this study 189 girls five and a half years old (± 3 days) were tested, sampled from a population of about 900 girls entered into the register at the Paediatric Ward of the Health Clinic in Maribor, Slovenia. The testing battery consisted of twenty-eight composite motor tests, covering the following hypothetical sub-spaces of motorics: explosive and repetitive strength, speed of frequency of simple movements, balance, manipulative ability of arms, motor intelligence, reorganisation of stereotypes, whole-body co-ordination, agility. Choice of tests was made on the basis of the already mentioned authors, our own multi-year experiences and the requirement that the tests are sufficiently simple to be used by pedagogues in actual praxis. The data was analysed with the SPSS-X statistical package at the University of Maribor. The Kaiser-Guttman criterion was used for extraction of factors, deeming as significant all factors with an eigen value over one, representing the upper bound of the number of extracted factors.

RESULTS

The extraction of factors gave an eight-factor model of basic motorics of 5.5 year-old girls (Tab. 1). A weakness of the Kaiser-Guttman criterion ($\lambda \geq 1$) is in the hyper-production of factors, the good side is that all information is preserved. Because of the same reason we used the structure matrix, *i.e.* perpendicular projections of variable vectors on the factors, as the interpretation base, since they give somewhat higher coefficients than parallel projections (pattern matrix).

The first factor is defined by rather different tests according to their structure, but they do have a common object of measurement in cyclic motor actions for the same period of time (20 s): various tapping, lateral hops, bench stepping and ball circling around the body. These are simple repetitive movements, which can be named as the ability for realisation of rhythmic motor structures (F1). The second and the third factor have a simple structure; according to the classic terminology we can recognise them as the ability of balance on one leg (F2) and the ability for quick direction changes - agility (F3). The fourth factor is defined by the motor task running after rolling, which is for children this age a demanding movement from the co-ordination point of view, where the entire body co-operates in its realisation. In accord with this, we shall name it the ability of whole body co-ordination (F4). The fifth factor can be clearly recognised as explosive power (F5), the sixth as the ability for manipulation with the arms (F6), the seventh - with salient projections from the walking backwards through loops tests - is the well known ability of kinaesthetic solving of spatial problems (F7). The eighth factor is characterised by the test block building and throwing the ball at the floor. The execution of these two tests do not require cortical control of movement, since the action can be performed at this age only through "trial and error". We shall name it as the ability of motor intelligence (F8).

DISCUSSION

Motor structure of 5.5 year-old girls is much more complicated than the one of boys of the same age (Ratmajer, 1997). In the psychomotor co-ordination subspace there are several unusual correlations. It is obvious that one cannot use the same criteria in analysis of motorics for girls this age. The differences are evident; the most outstanding is the role of cyclic motor actions, *i.e.* characteristic rhythm. This hypothesis can be confirmed already with an analysis of the first factor, where the 20 s repetitive action requires rhythm of execution, rather than the energy part of repetitive strength.

We cannot confirm the hypothetical model of motor abilities of 5.5 year-old girls, especially significant are the differences in the tests that Gardner (1995) classifies with motor intelligence into the sub-space of skilful manipulation of objects: tests with a ball and tests with blocks do not have a common object of measurement for boys. For girls, the differentiation is much more demanding and manifests itself in the division by rhythm, simple manipulation and cortical control on the basis of trial and error. The test stepping on a bench, whose intentional object of measurement is repetitive strength, is completely irrelevant for girls this age - it does not have a measurement object of its own and therefore acts as a polygon test.

Tab. 1: Structure of the obtained factors
Tab. 1: Struktura izoliranih faktorjev

M	Variable	F1	F2	F3	F4	F5	F6	F7	F8
1.	Standing broad jump					.81			
2.	Triple jump					.76			
3.	High jump					.66			
4.	Stepping on a bench	.49			.45	.41			-.46
5.	Lateral hops	.78							
6.	Lateral hops - frontal support on arms	.75						.41	
7.	Tapping - arm 1								-.47
8.	Tapping - leg	.66							
9.	Tapping - arm 2	.75							
10.	Lateral stance on lying block		.84						
11.	Frontal stance on lying block		.86						
12.	Stance on standing block		.68						
13.	Circling ball around body	.61							-.44
14.	Rolling ball standing up				.58				
15.	Rolling ball around hoop							.49	.51
16.	Building with hollow blocks								.64
17.	Building with wooden blocks						.77		
18.	Building with plastic blocks						.86		
19.	Walking on ladder backwards							.67	
20.	Walking through hoops backward							.83	
21.	Walking backward - polygon							.81	
22.	Jumping over and crawling under a bench							.55	.40
23	Crawling with a ball							.50	
24.	Running after rolling				.62				
25.	Shuttle runs			-.83					
26.	Lateral running			-.90					
27.	Zigzag running							.41	
28.	Throwing ball at floor								-.62

CONCLUSIONS

Factor analysis of motor space of five-and-a-half years old girls, defined by 28 composite motor tasks, gave an eight-factor model of basic motorics of girls this age. The first four factors are relatively simple, the other four construct very complex latent dimensions. The factors are inter-correlated relatively weakly, or not at all. The results of this study are important also for praxis, since it is possible to quickly and easily identify representative tests with which sport pedagogues can test children in praxis. An already constructed system of centile norms of manifest motor abilities (Rajtmajer, 1997) enables the use of findings of this study in actual praxis for diagnostic-prognostic purposes: an analysis of the motor status of a child and the construction of an operative exercise programme.

STRUKTURA MOTORIČNIH SPOSOBNOSTI PET IN POLLETNIH DEKLIC

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POVZETEK

Na Univerzi v Mariboru izvajamo večletni raziskovalni projekt z naslovom Struktura in relacije psihomotoričnih sposobnosti, morfoloških, psihosocialnih in zdravstvenih karakteristik mlajših otrok. Podatke smo zbrali s pomočjo

testiranja preko 1400 od pet do šest in polletnih otrok obeh spolov. V tej študiji predstavljamo latentno motorično strukturo pet in polletnih deklic. Podobne raziskave so v Sloveniji izvedli še Strel & Šturm (1981), Videmšek & Cemič (1991), Rajtmajer (1994, 1997), Planinšec (1995) in Pišot (1997). Vzorec merjenk je zajel 189 deklic, starih pet let in pol (plus/minus 3 dni). Testni instrumentarij je obsegal 28 kompozitnih motoričnih nalog. Rezultati so bili obdelani s programom SPSS-x. Za ekstrakcijo glavnih komponent je bil uporabljen Guttman-Kaiserjev kriterij λ≥1, rotacija faktorjev pa je bila izvedena v oblimin poziciji. Ekstrakcija značinih faktorjev je dala 8-faktorski model motoričnih sposobnosti deklic te starosti: realizacijo ritmičnih struktur gibanja, ravnotežje, agilnost, koordinacijo vsega telesa, eksplozivno moč, manipulativno sposobnost rok, kinestetično reševanje prostorskih problemov in faktor x, ki smo ga pogojno poimenovali kot motorično inteligenco.

Ključne besede: otroci, motorične sposobnosti, testi

REFERENCES

Agrež, F. (1975): Kanonične korelacije mera fleksibilnosti i prostora ostalih motoričkih sposobnosti. Zagreb, Kineziologija.

Bernstein, M. A. (1966): Očerki po fiziologiji dviženii i fiziologiji aktivnosti. Medicina, Moskva.

Boes & Mechling (1983): Dimensionen sportmotorischer Leistungen [Dimensions of Motor Abilities]. Hofmann Verlag.

Chaidze, L. V. (1970): Ob upravljenii dviženianii čeloveka. Fiskultura i sport, Moskva.

Cetin, H. N. (1991): Koordinationsfaehigkeiten von Vorschulkinder [Co-ordinative Abilities of Pre-school Children]. S. August, Academia Verlag.

Gardner, H. (1995): Razsežnosti uma, Teorija o več inteligencah. Založba Tangram, Ljubljana.

Gredelj, M. *et al.* (1975): Model hierarhijske strukture motoričnih sposobnosti. Kineziologija br. 1-2, Zagreb.

Hošek, A. (1972): Struktura motoričkog prostora, Kineziologija br. 2, Zagreb.

Hošek, A. (1981): Struktura koordinacije, Kineziologija, Zagreb.

Kiphard, E. J. (1987): Wie weit ist ein Kind entwickelt? Mosernes lernen, Dortmund.

Kiphard, E. J. (1989): Ausgewaelte Themen der Motopaedagogik und Mototherapie. Psychomotorik in Praxis und Theorie, Floetmann Verlag.

Kurelić, N. (1975): Struktura i razvoj morfoloških i motoričkih dimenzija omladine. FFK, Beograd.

Luria, S. R. (1976): Osnovi neuropsihologije. Nolit, Beograd.

Mueller, S. (1978): Motorik im Vorschulalter [Motorics in Pre-school Age Groups]. Schorndorf, Hofmann Verlag.

Pišot, R. (1997): Model motoričnega prostora 6.5 letnih otrok pred in po parcializaciji morfoloških značilnosti [Model of Motor Space of 6.5 Year-old Children before and after Partialisation of Morphologic Characteristics]. Doktorska disertacija, Univerza v Ljubljani, Fakulteta za šport.

Planinšec, J. (1995): Relacije med nekaterimi motoričnimi in kognitivnimi sposobnostmi 5 letnih otrok [Relations between some Motor and Cognitive Abilities of 5 Year-old Children]. Magistrsko delo, Univerza v Ljubljani, Fakulteta za šport.

Rajtmajer, D. (1994): Psychomotorische Faehigkeiten der jungeren Kinder [Psychomotor Abilities of Younger Children]. University of Maribor, Pedagogical Faculty.

Rajtmajer, D. (1997): Diagnostično-prognostična vrednost norm nekaterih motoričnih sposobnosti pri mlajših otrocih [Diagnostic-Prognostic Value of Norms of some Motor Abilities of Younger Children]. University of Maribor, Pedagogical Faculty.

Singer, R. S. (1985): Motorisches Lernen und menschiche Leistung [Motor Learning and Human Abilities]. Limpert Verlag.

Strel, J. & J. Šturm (1981): Zanesljivost in struktura nekaterih motoričnih sposobnosti 6.5 letnih učencev [Reliability and Structure of some Motor Abilities of 6.5 Year-old Children]. Ljubljana, Fakulteta za šport.

Šturm, J. (1975): Merjenje in vrednotenje telesnih sposobnosti učencev in učenk v osnovni šoli. Zavod RS za šolstvo, Ljubljana.

Videmšek, M. & S. Cemič (1991): Analiza in primerjava dveh različnih modelov obravnavanja motoričnih sposobnosti 5.5 letnih otrok [Analysis and Comparison of two Models of Motor Abilities of 5.5 Year-old Children]. Magistrsko delo, Univerza v Ljubljani, Fakulteta za šport.

Zimmer, R. & M. Volkamer (1984): Motoriktest fuer vier bis sechsjaerige Kinder [Motor Tests for 4 to 6 Year-old Children]. Weinheim.

POROČILA IN OCENE

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REPORTS AND REVIEWS

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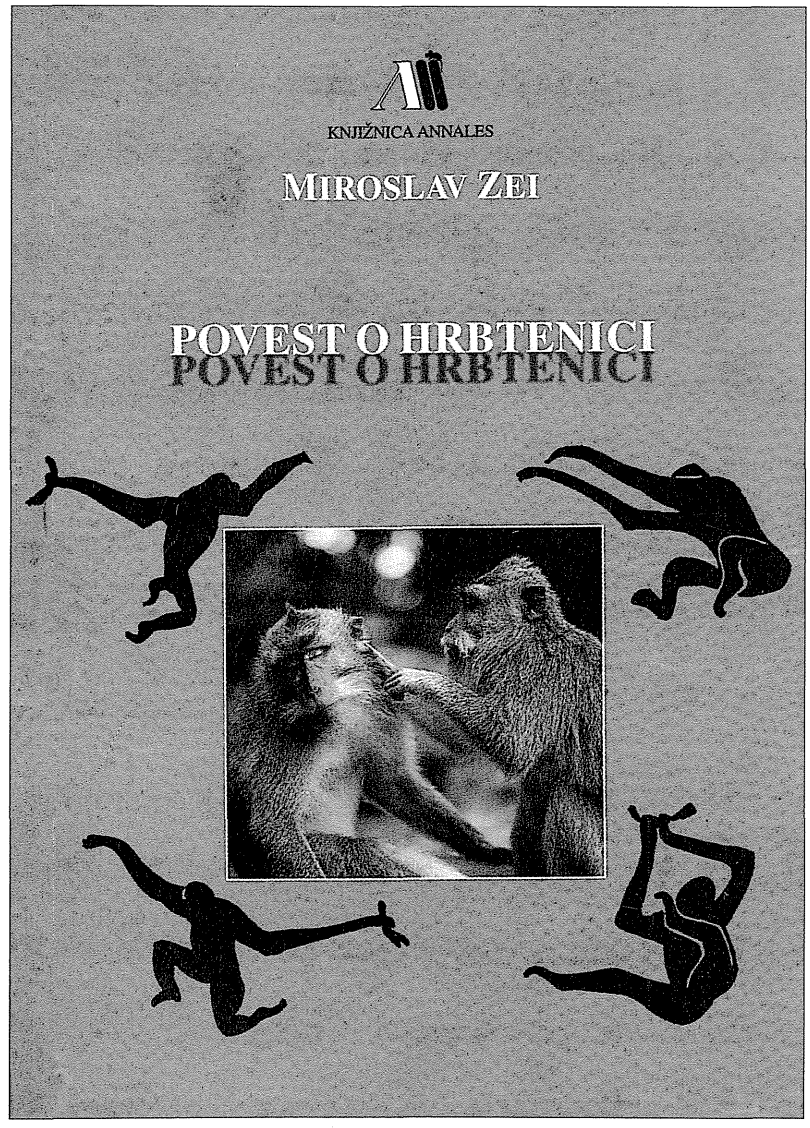
POROČILA IN OCENE
RELAZIONI E RECENSIONI
REPORTS AND REVIEWS

Miroslav Zei: POVEST O HRBTENICI, Knjižnica Annales 21, Zgodovinsko društvo za južno Primorsko Koper & ZRS Koper, Koper 1999, 128 str.

Ni dolgo tega, kar sem v voščila ob avtorjevi okrogli obletnici, zapisal v Proteusu: *"da bi nam poklanjal svoje znanje, izkušnje in zapisane misli na njegov zeijevski način."* Pa se je to zares izpolnilo. V zakladnico našega naravoslovja je položil novo delo: **Povest o hrbtenici**. Kot pripoveduje ga je misel na to zgodbo spremljala že zelo dolgo. Njeno uresničitev pred štirimi desetletji, ko je načrt vsebine ponudil knjižnemu uredništvu neke založbe, je bila zavrnjena. "Odgovornim" naslov ni bil všeč. Naravoslovno vsebino so prezrli in predvsem pomislili, da bi utegnil avtor mimogrede sprožiti razmišljanje o "trdnosti in upogljivosti človeške hrbtenice." *"No, tega pa že ne":* so rekli in tako se je *Povest o hrbtenici* rodila šele sedaj. Morda pa je ta dolgi odlog prispeval k zorenju avtorjeve misli in dokazani kakovosti pripovedi.

Profesor Zei je znanstvenik. Biolog in zoolog po izobrazbi, oceanograf, morski biolog in ihtiolog po raziskovalnem ustvarjanju. Njegovo odkritje menjave spola pri ribah giricah je odprlo nov pogled v biologijo spolnosti pri vretenčarjih. Kot univerzitetni učitelj in odličen pedagog pa je dolga leta posredoval svoje bogato znanje iz primerjalne anatomije vretenčarjev in biolo-



gije morja študentom. Profesor Zei je znal spodbujati in pritegniti zanimanje za stroko. Mnogi učenci smo mu sledili, dajal nam je prepričljiv vzgled. Primerjalno anatomijo vretenčarjev, še posebej manj vabljivo osteološko snov, je s smiselnim izborom in primerjalnimi zvezami oblikoval v dinamično evolucijsko zaporedje. Njegova predavanja so bila zato privlačna in predavalnica vedno polna. Predavanj ni nikoli bral, kar je bila tedaj še navada mnogih, le redko je uporabil droben listič za vodilo. Beseda je tekla preudarno in sproščeno. Kot znanstvenik in poznavalec stroke pa je bil hkrati tudi vešč avtor poljudnoznanstvenih beril. Bera njegovih knjig je velika. To so knjige: *Iz življenja rib, Iz življenja dvoživk in plazilcev, Iz življenja sesalcev, Vretenčarji* in mnoge knjige o živem svetu v morju. Posebno imenitna je knjiga *"Življenje našega Jadrana"*, ki jo še vedno radi prebiramo. Ko sem poudaril njegov prispevek na knjižno polico poljudnoznanstvenega naravoslovja moram povedati, da je malo znanstvenikom dano tako vešče sukati pero, kot to uspeva prav Zeiju. Tudi novo berilo *Povest o hrbtenici* je privlačen vrelec avtorjevih razmišljanj o evoluciji vretenčarjev.

Povest o hrbtenici je resnična zgodba o organu, katerega evolucijska posledica smo tudi mi ljudje, ki sedaj obnavljamo njeno sto in sto milijonov let dolgo razvojno pot. Profesor Zei nas popelje po tej poti na izredno privlačen in razumljiv način.

Ko sem sledil besedilu rokopisa *Povesti o hrbtenici* sem se v mislih vrnil v balkonsko dvorano, predavalnico na stari Univerzi, kjer so potekala predavanja iz primerjalne anatomije vretenčarjev. Zapisanemu razmišljanju sem prisluhnil, kot tiste davne dni, ko smo študenti z zanimanjem sledili profesorjevemu podajanju dokaj težke vsebine. Primerjalna anatomija je pač veda, ki jo lahko posredujemo opisno in suhoparno ali pa zelo dinamično, kot to zna avtor.

Zgodovine pomembnega izuma, katere zasnova se je pojavila pri preprostih strunarjih in kasneje pri njihovih potomcih oblikovala v hrbtenico, se je lotil v povezavi z dogodki in potrebami, ki jih je izzivalo okolje. Miselno nit tvori anatomska zgradba v povezavi z gibanjem in življenjskimi nalogami vretenčarjev, torej gre za soodvisnost med hrbtenico in ekologijo živali. Vodi nas skozi 500 milijonov let trajajoči razvoj izpopolnjevanja in spreminjanja osnovnega gradbenega načrta zaradi osvajanja novega okolja in ustreznih načinov premikanja; plavanja, plazenja, hoje, teka, plezanja in letanja. Spoznamo, kako "smotrno" uporablja narava gradiva, hrustanec in kost. Kako rešuje konstrukcijske probleme, kot so npr. stabilnost in gibljivost, trdnost in prožnost, nosilnost in upornost glede na vodno ali atmosfersko osredje. "Izdelki" ustrezajo potrebam in nikoli ne obremenjujejo okolja z odpadki. Kar je ostalo so okamnine in te nam pomagajo odkrivati poti in stran poti v razvoju. Avtor na zares svojevrsten in berljiv način splete znanje iz geologije, paleontologije, zoologije in ekologije v rdečo nit vretenčarske evolucije.

Le narava v svoji časovni dolgotrajnosti in iznajdljivi raznovrstnosti preizkuša ter razvija organe, sisteme in funkcije bolje od tega kar si izmišlja misleči človek in izdela homo faber. Zato se v naravi lahko učimo, učimo hitrega plavanja pri mečarici, jadranja pri albatrosu, urnega teka pri čiti itd. Doseganje teh in mnogih drugih lastnosti je neskončna veriga poskusov in izpopolnjevanj v milijone let trajajoči evoluciji. Pameten človek zato lahko izkoristi "izume narave" pri reševanju svojih tehničnih problemov. Tudi Ikarus in Leonardo da Vinci sta se ozirala po pticah, ko sta sanjala sanje o letu. Sodobni načrtovalci nadzvočnih letal se zgledujejo po hitrih ribah, kajti zrak se pri velikih hitrostih letal vede kot voda. Tudi take primerjave so v Zeijevi knjigi in so lahko vzpodbude za tiste, ki razmišljajo o tehničnih rešitvah. Navsezadnje pa se je s hrbtenico vzravnal tudi naš prednik in postal dvonožec, zgrabil z rokami za kamen - orodje in se razvil v mislečega človeka. Pokončnost hrbtenice pa hkrati simbolizira tudi človekovo trdnost in poštenost. Zato tudi velja, da razvoj hrbtenice ni le naravni pojav ampak, da se njena lastnost, kot metafora, odseva tudi v družbenih odnosih. Od tod pa tudi tisti "prastrah", ki je za desetletja prestavil izid Zeijeve knjige.

Ker je avtor obdelal zahtevno vsebino na zelo razumljiv in privlačen način, jo priporočam ne le biologom temveč tudi drugim naravoslovcem, tehnikombionikom in ljubiteljem resničnih povesti. Knjigi želim srečno pot v slovenski kulturni prostor.

Kazimir Tarman

Boris Kryštufek: OSNOVE VARSTVENE BIOLOGIJE, Tehniška založba Slovenije 1999, 155 strani

Pri Tehniški založbi Slovenije je izšla knjiga avtorja dr. Borisa Kryštufka o osnovah varstvene biologije. Publikacija je vezana v mehke platnice in opremljena s številnimi grafikoni, ilustracijami in črno-belimi fotografijami. V slovenski prostor prinaša vpogled v novo biološko panogo, ki jo avtor že v uvodu definira kot znanost o biodiverziteti in njeni trajnostni rabi. Dandanes že vsi vemo, kaj je biodiverziteta, vsi tudi že "vemo", kako biodiverziteto varovati. No, ko preberemo knjigo *Osnove varstvene biologije,* hitro spoznamo, da varstvo narave ni le anarhično zavzemanje za zaščito neke vrste ali območja. Tudi tu obstajajo stroga pravila (nekatera so znana že iz ekologije!), ki so za nameček pogosto zunaj dosega naših občutkov. Kazni za nepoznavanje teh pravil se pišejo v novih in novih izumrlih vrstah.

Delo je razdeljeno na osem poglavij, v katerih nas avtor popelje od opisov in razlag nekaterih bioloških/ekoloških pojmov, ki so osnova tej disciplini (poglavja: Varstvena biologija, Biološka vrsta, Geni in varstvena biologija, Demografija ogroženih populacij), do zadnjih spoznanj, zakaj je biodiverziteta ogrožena, kdo in kako jo ogroža (poglavja: Propadanje biodiverzitete, Diverziteta in stabilnost ekosistemov, Fragmentacija) ter kakšni so osnovni principi njenega varovanja (Ohranjanje biodiverzitete). Tematike se, podobno kakor procesi v naravi, med poglavji tesno prepletajo, tako da bi bralci z drugačnimi pristopi do branja ta poglavja verjetno razvrstili drugače.

Zakonitosti biodiverzitete so v knjigi večinoma predstavljene zelo osnovno - surovo, z matematičnimi formulami. Ker se avtor zaveda, da so enačbe trn v peti večini biologov, nam jih skuša dodatno pojasniti. Knjiga je tako opremljena s številnimi pojasnevalnimi grafikoni, tabelami, poseben pečat pa ji dajejo t.i. okvirji , ki so iz meni neznanih razlogov grafično ponazorjeni le z dvema pokončnima črtama. To so poglavja znotraj poglavij, ki jih za samo razumevanje knjige v resnici niti ni treba prebrati. Vendar so v njih skriti številni praktični primeri na teoretični ravni razloženih zakonitosti. Vsekakor primeren dodatek, ki bo marsikateremu bralcu dal potrebno vzpodbudo za nadaljnje branje. Večina opisanih primerov je iz sveta vretenčarjev. Tu se pač pozna, da so avtorjev ožji krog zanimanja sesalci in vretenčarji in da so te živalske skupine med najbolje raziskanimi živimi bitji na svetu. Po moji oceni to knjigi vrednosti ne zmanjšuje, kvečjemu nasprotno. Primeri so za povprečnega bralca tako neprimerno bolj "živi" in prepričljivi, saj si jih z znano (ali karizmatično, kakor jih imenuje avtor) živaljo pred očmi laže predstavlja.

V Sloveniji se s teoretično varstveno biologijo na osnovi številk in enačb, kakor nam jo predstavlja avtor, ne ukvarja nihče. Znanje, ki je natisnjeno v knjigi tako hočeš nočeš temelji predvsem na tujih izkušnjah in tujih prispevkih. Izvirni del so avtorjevi prispevki o velikosti biodiverzitete v Sloveniji in na Balkanu. Glede na slabo poznavanje teorije varstva vrst in ekosistemov, predvsem pa slabega poznavanja literature s tega področja, verjetno pri nas tudi ni človeka, ki bi knjigo lahko kritično predstavil. No, avtorjev ugled v znanstvenih krogih doma in po svetu nam pri tem vliva veliko mero zaupanja.

Avtorjeva želja je, da bi s pričujočo knjigo pospešil razvoj varstvene biologije na Slovenskem. Dejstvo je, da panoga pri nas nima tradicije (tudi drugod po svetu traja šele kaki dve desetletji!), nima raziskovalcev in niti posnemovalcev tujih spoznanj. V takšnih razmerah gledam na knjigo kot na neko vrsto pionirskega učbenika. Neko vrsto zato, ker študija varstvene biologije pri nas ni in je izobraževanje tako prepuščeno volji vsakega posameznika. Pionirskega zato, ker je pač prvi izdelek te vrste pri nas in se verjetno ne bo mogel izogniti običajnim, pionirskim težavam, ki jih prinašajo novi pogledi na ustaljene metode reševanja neke problematike. Kakor piše avtor v predgovoru, nam Slovencem pri varstvu narave ni treba zardevati, saj smo do danes v primerjavi s preostalo Evropo ohranili dobršen del narave. To je dejstvo, ki nam vliva dobršno mero samozavesti, po drugi strani pa nam prav ta samozavest lahko omeji sprejemanje novih pogledov na reševanje narave, češ, mi smo dokazali, da vemo, kako se stvari streže. Je že res, da se zaradi kompleksnosti problematike subjektivizmu pri varstvu narave ne da povsem izogniti, kar v knjigi priznava tudi avtor, pa vendar bi osebno raje prepustil usodo narave nekomu, ki je velik del njene kompleksnosti doumel tudi na teoretičnem nivoju, kot nekomu, ki naravo ohranja zgolj s subjektivnimi presojami. Vse priznanje tistim, ki jim je uspelo ohraniti slovensko naravo na zavidljivi ravni, a ker smo danes priče drugim časom, so tudi pri varovanju potrebni drugačni, bolj pragmatični, a znanstveno podprti pristopi. Če vas zanima kakšni so ti pristopi, je knjiga pravšnja za vas.

Veliko vrednost knjige vidim tudi v tem, da je nekako uradno poslovenila in v domačem jeziku pomensko opisala številne izraze. Pri slovnično bolj podkovanih biologih in naravovarstvenikih bodo nekateri izmed teh izrazov morda naleteli na neodobravanje, pa vendar. Osnova je podana, vsem je dostopna, boljše ideje pa še vedno lahko sprejmemo. Osebno me bolj moti, da knjiga (tudi) s takšnim poslanstvom nima stvarnega kazala, s katerim bi vse te nove in manj nove izraze zlahka poiskali. Bralcem, ki knjige še niso prebrali, pričakujejo pa, da jo bodo še kdaj potrebovali, toplo priporočam, da si ga ob prebiranju izdelajo kar sami.

Dandanes izhaja velik del različnih pogledov na varstvo narave iz osnovne dileme: varovati naravo zaradi narave ali zaradi človeka? Čeprav sem do zadne strani knjige pričakoval, da se bo avtor jasno opredelil do tega pomembnega vprašanja, pa je njegov odgovor ostal skrit med vrsticami. Morda pa bi bilo to res preveč za knjigo, ki že tako prinaša v naš prostor veliko novega.

Davorin Tome

OBLETNICE
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Mitja Kaligarič

PROFESSOR LIVIO POLDINI - AT THE SEVENTIETH ANNIVERSARY OF HIS BIRTH

This year is the seventieth in the life of Dr. Livio Poldini, professor of botany at the Trieste University, the man who is due to his exceptional scientific and for no less than half a century lasting work considered one of the greatest phytosociologists in Central Europe today. His botanical knowledge of the Northern Adriatic Karst, Friuli, Southeastern Alps as well as of Istra and the Mediterranean is truly superb, and it is thanks to him that the northwestern part of Italy is the best "covered" Italian province. He is, of course, also a true expert for the neighbouring Slovene and Croatian regions, for nature knows no political and national borders, and so much less for Prof. Poldini who has always been and still is an exceptionally open and honourable man.

He was born in Trieste on September 7th 1930 and concluded his studies with a PhD in Natural Sciences in 1949 at the University of Padova. He became associated botanical curator at the Natural History Museum of Trieste in 1958 (till 1960). In 1961 he became assistant senior lecturer of Pharmacological Botany. He improved and perfected his knowledge under Prof. J. Braun-Blanquet at the Station Internationale de Geobotanique Mediterranéenne et Alpine in the years 1961-62. He became an assistant professor in 1968 and a senior lecturer at the University of Trieste in 1976. Since 1979 he has been lecturing Plant Ecology at the University of Trieste.

His research work is concerned mainly with floristic, phytogeographic, phytosociologic and phytochemical studies, with vegetation mapping and naturalistic land assessment. Among his numerous papers there are a monograph on vegetation of the Northern Adriatic Karst and a chorological atlas of the flora of Friuli-Venezia Giulia. He participated in the preparation of sylvicoltural typologies both of Veneto and Friuli-Venezia Giulia.

He was also devoted to applied ecology and nature conservation. He did the spadework in nature conservation - theoretically and practically. In the seventies he participated in the preparation of the Regional Urbanistic Plan with the aim to lay out nature parks and reserves in Friuli-Venezia Giulia. From 1994 to 1996 he was the scientific supervisor of the project "Natura 2000 - Bioitaly" for the Friuli-Venezia Giulia region, with an aim to create a catalogue of the areas with a prominent naturalistic value. In the years 1996 to 1998 he was responsible for the project of vegetational restoration along the pipelines built in the Karst environment, in collaboration with SNAMPROGETTI. He was one of the first scientists who focused on the problem of abandonment and overgrowth in the Karst areas. Together with Prof. E. Feoli's team he developed the so-called "Trieste School" of numerical ecology and was one of the very first phytosociologists who used the computer supported numerical analysis as early as in the seventies!

At the moment he is in charge of the national MURST project on "Biodiversity and processes of vegetational recovery in marginal areas", focusing on the reconstruction of mantels and bush encroachment in different altitudinal belts (from plain to mountain) and on the relationships with the climatic-edaphic factors. His half-century experiences, knowledge and numerous floristic and vegetational data are now used by Prof. Poldini in his project "Causal analysis of the north-eastern Italian vegetation", where the main aim is to systematically analyse the vegetation cover of the Friuli-Venezia Giulia region, in order to produce a complete monograph on the regional vegetation. Could there have been done any more in a single region? Very recently he has also been devoted to halophyte vegetation and coastal problematics. He is taking part in the "Project for the coastal and marine conservation in Friuli-Venezia Giulia". The most fascinating for me whenever I joined him during field excursions was the combination of taxonomic (floristic) knowledge with the ecological approaches. According to the Central-European tradition he is simply a perfect florist. At the moment he is compiling the Checklist of the Flora of the Friuli-Venezia Giulia region, in order to define the correct nomenclature and to produce a catalogue of synonyms. He is also a regional adviser for the "Illustrierte Flora von Mitteleuropa" and "Atlas Flora Europaea".

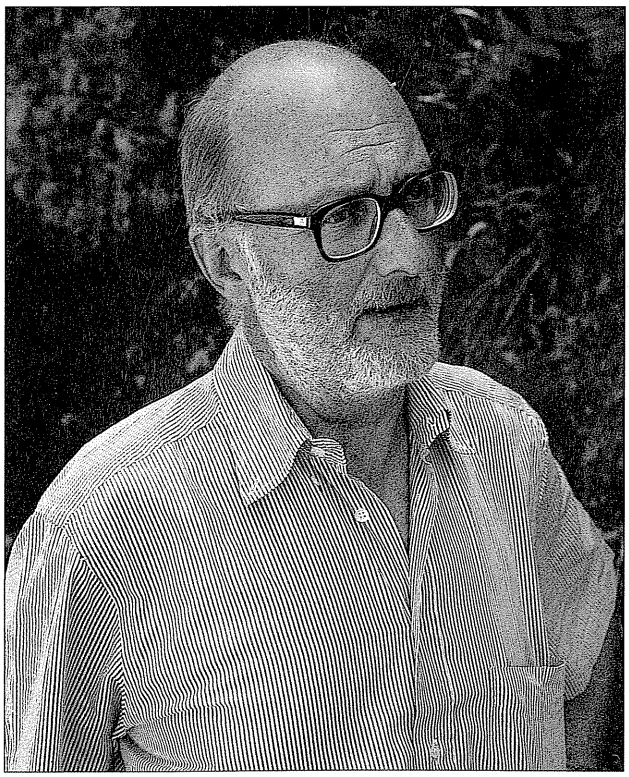
Although Prof. Poldini is Italian, his mentality and way of thinking as well as working is more Central European. Apart from it, he has retained some of the Austro-Hungarian spirit. He is a modest, hardworking and systematic man and has always stuck, together with his associates, to certain discipline. All this has resulted in hundreds of published articles, dozens of completed projects, some voluminous books, and plenty of still unfinished things.

Prof. Poldini is an extremely open personality (particularly as a citizen of Trieste) for understanding the contact area of the Northern Adriatic, Karst, Istra, Dinarids and the Alps also from the anthropological, national, cultural, linguistic and historical points of view. His very rich and perfectly spoken German, which he proposes to become the "conversation language" between Central European countries, and enthusiasm to learn Slovene also enabled him to cooperate frequently with Slovene and Croatian botanists in the past and pre-

sent. Because of his very "open mind" he is also a correspondent member of the Slovene Academy of Sciences and Arts, as well as a member of several editorial boards: Studia Geobotanica, Flora Mediterranea, Gortania, Hladnikia and - lately - also of the journal Annales.

I am very proud to consider Prof. Poldini my phytosociological teacher: the hours, days and months I spent in his room at the university were certainly the most productive in my botanical career. During every morning that I spent at the computer and during every afternoon that I spent in a fruitful discussion with him certain conclusions were made. He gave much of his time to the students, colleagues and amateur botanists. For years he has been leading the "Regional Group for Floristic Research - GREF", which is very active in the Friuli-Venezia Giulia region and broader.

Prof. Poldini is celebrating his seventieth birthday in the midst of a number of very important scientific and applicative projects, student diplomas and other faculty commitments. We sincerely hope that in the years to come he will retain all that penetrating mind and creative inspiration, and at the same time wish him a lot of good health and of course many happy moments in nature amongst plants.



Livio Poldini (foto: T. Wraber).

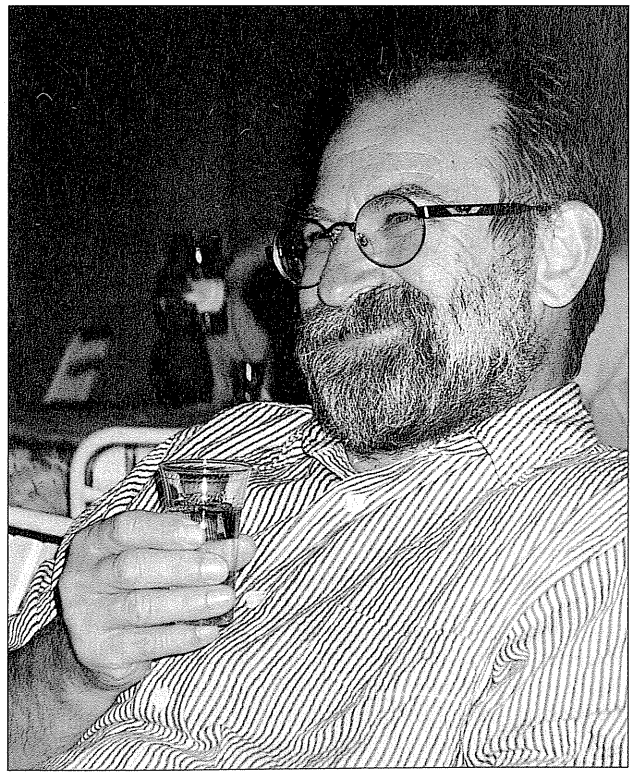
IN MEMORIAM

Robert Turk

BORIS KRIŽAN 1948-2000

Dolina Dragonje, Kraški rob, Sečoveljske soline, Škocjanski zatok. Če jih še imamo in če obstaja upanje, da bodo še naprej na seznamu vseslovenskega naravnega bogastva, potem je to v veliki meri zasluga Borisa Križana, naravovarstvenika in v zadnjih letih tudi direktorja Medobčinskega zavoda za varstvo naravne in kulturne dediščine Piran. In če se lahko Slovenija po svetu hvali z zelo zadovoljivim odstotkom zavarovane in ohranjene naravne obale, je to predvsem Borisova zasluga. In če načrtovalci razvoja slovenske obale dandanes vsaj potihem pomislijo, da bi bilo morda dobro ohraniti tisto malo naravne in kulturne dediščine, ki nam je - bolj po sreči kot ne - še ostala, potem je tudi to posledica Borisovega neprestanega in neutrudnega dokazovanja in prepričevanja o nujnosti naravi prijaznega razvoja.

Od kod je prinesel to širino in pronicljivost? Ali je posrkal vso širino in prostranost rodnega Prekmurja ali morda uvidel zapletenost in medsebojno povezanost naravnih procesov in socialnih pojavov med študijem geografije? Kdo bi vedel. Dejstvo je, da je dovolj zgodaj stopil na pravi breg, da je vedel za pravo smer že takrat, ko v slovenskem besednjaku skorajda ni bilo zaslediti tega,



Boris Križan

čemur danes pravimo sonaravni ali trajnostni razvoj. Potrditve Borisove daljnovidnosti na področju varstva naravne in kulturne dediščine so številne in nedvoumne. Naj naštejem le nekatere: vpis Sečoveljskih solin na Ramsarski seznam mokrišč svetovnega pomena, uvrstitev slovenskih morskih in obalnih zavarovanih območij med več kot 130 območij najpomembnejše sredozemske naravne dediščine, vključitev Slovenije v sredozemski projekt preučevanja in gospodarjenja z mokrišči, odločitev države, da zavaruje Škocjanski zatok, da uvrsti dolino Dragonje in območje Kraškega roba med naravne parke državnega pomena, da izdela načrt gospodarjenja za Sečoveljske soline in nenazadnje Steletovo priznanje Slovenskega konservatorskega društva za pomembni prispevek k ohranitvi in predstavitvi naravne dediščine slovenskega morja. Pravzaprav je nemogoče popisati vse tisto, kar je Boris v nepolnih dvajsetih letih delovanja na področju varstva naravne in kulturne dediščine naredil, ne le za uveljavitev naravovarstva, pač pa za uresničitev razvojnega modela, ki bo tako nam kakor našim potomcem in tudi vsem drugim prebivalcem modrega planeta omogočil kaj več kot le golo preživetje. Samo predstavljamo si lahko, kaj vse je še snoval v želji, da bi se slovenski naravni in kulturni dediščini vremena vendarle dokončno zjasnila. Samo predstavljamo si lahko. In naredimo vse, kar je v naših močeh, da njegovo delo nadaljujemo.

"Ti kar pojdi", je rekel ob najinem zadnjem srečanju, "jaz se bom medtem porihtal in potem gremo dalje, novim zmagam naproti." Besede, ki pravzaprav povedo vse o Borisovi odločnosti in nepopustljivosti. Tako kot se je odločno postavil v bran Dragonje in njenega rastlinskega in živalskega sveta v časih, ki so bili za naravovarstvo milo rečeno neugodni, tako se je v zadnjem letu spopadal z boleznijo, za katero je dobro vedel, da je prav tako neugodna in malodane neprizanesljiva. Žal mu to zadnje ni uspelo. In zagotovo ne bom nikoli več pritrdil njegovemu "Vsaka stvar je za nekaj dobra!". Ta zagotovo ni bila.

KAZALO K SLIKAM NA OVITKU

SLIKA NA NASLOVNICI: Beli morski volk *(Carcharodon carcharias)* je bil še pred sto leti razmeroma običajna vrsta morskega psa v Jadranskem morju, danes pa so zapisi o njegovem pojavljanju v Jadranu že zelo redki. (Foto: Arne Hodalič)
Sl. 1: Spielbergov film Žrelo je pred petindvajsetimi leti predstavil belega morskega volka v negativni luči. Za belega morskega volka je človek znatno nevarnejši kot beli morski volk za človeka. (Foto: Arne Hodalič)
Sl. 2: Vrbovolistna medvejka *(Spiraea salicifolia)* uspeva v Sloveniji zanesljivo le v Krakovskem gozdu, zato bi jo bilo treba uvrstiti na seznam ranljivih vrst slovenske flore. (Foto: N. Jogan)
Sl. 3: Večina starinskih ribolovnih tehnik počasi izginja z Jadrana. Ribič iz Milne na Braču vsakodnevno spusti v morje posebno mrežo z velikimi mrežnimi režami, primerno za lov rarogov, jastogov in velikih pridnenih rib. (Foto: D. Podgornik)
Sl. 4: Japonska medvejka *Spiraea japonica* je zelo agresivna invazivna vrsta, ki v Sloveniji izpodriva avtohtone vrste. (Foto: N. Jogan)
Sl. 5: Značilna oblika belega morskega volka, ki se v milijonih let ni kaj bistveno spremenila, izdaja močnega in hitrega plenilca. (Foto: Arne Hodalič)
Sl. 6: Za določevanje vrst alg iz rodu *Cladophora* je potrebno izdelati mikroskopske preparate, na podlagi katerih je možno prepoznati morfološke posebnosti. (Foto: M. Richter)
Sl. 7: V Jadranskem morju živi 24 vrst alg iz rodu *Cladophora*, kar 21 od teh pa najdemo v Tržaškem zalivu. (Foto: M. Richter)
Sl. 8: *Carlina frigida* subsp. *fiumensis* je vrsta bodeče neže, ki je bila najdena v reški okolici, na Cresu in pred kratkim tudi v Istri. (Foto: E. Vitek)

INDEX TO PICTURES ON THE COVER

FRONT COVER: A century ago, the great white shark *(Carcharodon carcharias)* was a relatively common shark species in the Adriatic Sea. Today, however, the records about its occurrence in the Adriatic are very rare indeed. (Photo: Arne Hodalič)
Fig. 1: Twenty-five years ago, Spielberg's *Jaws* depicted the great white shark as a very bad and harmful creature. The truth is, however, that man is a much greater danger to the great white shark than the latter is to man. (Photo: Arne Hodalič)
Fig. 2: In Slovenia, bridewort *(Spiraea salicifolia)* prospers with certainty only in Krakovski gozd and should therefore be added to the list of vulnerable plant species of Slovenia. (Photo: N. Jogan)
Fig. 3: Most of the old fishing techniques are gradually disappearing from the Adriatic. Each day this fisherman from Milna on the island of Brač drops into the sea a special net with large spaces between threads, suitable for catching lobsters and large fish living at the bottom of the sea. (Photo: D. Podgornik)
Fig. 4: Japanese bridewort *Spiraea japonica* is a very aggressive invasive species, which is in Slovenia gradually replacing the indigenous species. (Photo: N. Jogan)
Fig. 5: The characteristic shape of the great white shark, which has not changed a great deal over millions of years, speaks of a powerful and swift predator. (Photo: Arne Hodalič)
Fig. 6: In order to identify various seaweed species from the genus *Cladophora*, some microscopic preparations must be made, on the basis of which certain morphological characteristics can be established. (Photo: M. Richter)
Fig. 7: There are 24 species of the genus *Cladophora* living in the Adriatic, with 21 of them occurring in the Gulf of Trieste. (Photo: M. Richter)
Fig. 8: *Carlina frigida* subsp. *fiumensis* is a carline thistle found in the surroundings of Rijeka, on the island of Cres and, recently, in Istra. (Photo: E. Vitek)

NAVODILA AVTORJEM

1. ***ANNALES:*** *Anali za istrske in mediteranske študije - Annali di Studi istriani e mediterranei - Annals for Istran and Mediterranean Studies* (do 5. številke: *Anali Koprskega primorja in bližnjih pokrajin - Annali del Litorale capodistriano e delle regioni vicine - Annals of the Koper Littoral and Neighbouring Regions)* je znanstvena in strokovna interdisciplinarna revija humanističnih, družboslovnih in naravoslovnih vsebin v podnaslovu opredeljenega geografskega območja.

2. Sprejemamo prispevke v slovenskem, italijanskem, hrvaškem in angleškem jeziku. Uredništvo ima pravico prispevke jezikovno lektorirati.

3. Prispevki naj obsegajo največ 24 enostransko tipkanih strani s po 30 vrsticami. Na levi pustite 3 do 4 cm širok rob. Zaželjeno je tudi (originalno) slikovno gradivo, še posebno pa oddaja prispevka na računalniški disketi v programih za PC (osebne) računalnike.

4. Naslovna stran tipkopisa naj vsebuje naslov in podnaslov prispevka, ime in priimek avtorja, avtorjeve nazive in akademske naslove, ime in naslov inštitucije, kjer je zaposlen, oz. domači naslov vključno s poštno številko in morebitnim naslovom elektronske pošte.

Uredništvo razvršča prispevke v naslednje **kategorije:**

Izvirni znanstveni članki vsebujejo izvirne rezultate lastnih raziskav, ki še niso bili objavljeni. Dela pošlje uredništvo v recenzijo. Avtor se obvezuje, da prispevka ne bo objavil drugje.

Pregledni članki imajo značaj izvirnih del. To so natančni in kritični pregledi literature iz posameznih zanimivih strokovnih področij.

Predhodno sporočilo in *Gradiva* imajo ravno tako značaj izvirnih del.

Strokovni članki prikazujejo rezultate strokovnih raziskav. Tudi te prispevke uredništvo pošlje v recenzijo in avtor se obveže, da prispevka ne bo objavil drugje.

Poročila vsebujejo krajše znanstvene informacije o zaključenih raziskovanjih ali kratek opis strokovnih in znanstvenih knjig ali srečanj. Taki prispevki ne smejo presegati 5 strani.

Mladinske raziskovalne naloge morajo biti urejene kot strokovna dela.

Komentarji so namenjeni aktualnostim s strokovnega področja. Ne smejo presegati 2 strani.

Obvestila so namenjena društvenemu življenju. Obsegajo 1 stran.

5. Prispevek mora vsebovati **povzetek** in **izvleček.** Izvleček je krajši (cca. 10 vrstic) od povzetka (cca. 30 vrstic) in v nasprotju s povzetkom tudi ne vsebuje komentarjev in priporočil.

V *izvlečku* na kratko opišemo namen, metode dela in rezultate. Navedemo, čemu smo delo opravili ali napisali dokument. Na že objavljeno gradivo se sklicujemo le, če je to glavni motiv dela. Na kratko opišemo metode in tehnike dela - kolikor je potrebno za razumevanje. Nove tehnike opišemo le, kjer se razlikujejo od že znanih. Če v delu ne opisujemo eksperimentalnega ali praktičnega dela, opišemo vire informacij. Rezultate in zaključke lahko združimo. Kar se da informativno navedemo le, kaj smo ugotovili oziroma odkrili.

Povzetek začnemo s stavkom, ki vsebuje glavno sporočilo dela. Stavki naj bodo popolni in ne predolgi. Pišemo v tretji osebi, le izjemoma uporabimo glagole v neosebni obliki. Uporabljamo pravilni strokovni jezik in se izogibamo slabše znanim kraticam. Ohraniti moramo osnovno informacijo in poudarke iz glavnega besedila. V povzetku ne sme biti ničesar, česar glavno besedilo ne vsebuje.

6. Avtorji so dolžni definirati in pripisati ustrezne **ključne besede** (pod izvlečkom) članka. Zaželjeni so tudi **angleški (ali slovenski) prevodi** ključnih besed, podnapisov k slikovnemu in tabelarnemu gradivu. Priporočamo se še za angleški (ali slovenski) prevod povzetka, sicer bo za to poskrbelo uredništvo.

7. V besedilu se po možnosti držimo naslednjih poglavij:

1. Uvod.
2. Pregled dosedanjih objav.
3. Materiali in metode (Dokazni postopek).
4. Rezultati.
5. Razprava ali diskusija.
6. Zaključek (Sklepi).
7. Zahvala - če avtor želi.
8. Priloge - če je potrebno.
9. Literatura (Viri, Bibliografija).
10. Povzetek (Summary).
11. Izvleček.
12. Ključne besede (neobvezno).

8. Ločimo **vsebinske** in **bibliografske** *opombe.* Vsebinske opombe besedilo še podrobneje razlagajo ali pojasnjujejo, postavimo jih *pod črto.* Z bibliografsko opombo pa mislimo na citat - torej sklicevanje na točno določeni del besedila iz neke druge publikacije (navedemo tudi točno stran, kjer je citat objavljen) ali na publikacijo (članek) kot celoto (točne strani, kjer smo besedilo prevzeli, ne navajamo).

Bibliografsko opombo sestavljajo naslednji podatki:

Avtor, leto izida in - le če citiramo točno določeni del besedila - tudi navedba strani.

Celotni bibliografski podatki citiranih in uporabljenih virov so navedeni v poglavju *Literatura* (Viri, Bibliografija).

Primer citata med besedilom:
(Grafenauer, 1993, 11).
Primer navajanja vira kot celote, brez citiranja: (Grafenauer, 1993).
Popolni podatki o tem viru v poglavju Literatura pa se glasijo:
Grafenauer, B. (1993): Miti o "Istri" in resnica istrskega polotoka. V: Acta Histriae I. Koper, Zgodovinsko društvo za južno Primorsko, 9-52.

Če citiramo *več del istega avtorja iz istega leta*, poleg priimka in kratice imena napišemo še črke po abecednem vrstnem redu, tako da se viri med seboj razlikujejo. Primer:
(Grafenauer, 1993a); (Grafenauer, 1993b).

Bibliografska opomba je lahko tudi del vsebinske opombe in jo zapisujemo na enak način.
Posamezna dela ali navedbe virov v isti opombi ločimo s podpičjem. Primer:
(Gombač, 1996; Grafenauer, 1993b).

9. Pri **citiranju arhivskih virov** navedemo najprej arhiv, nato ime fonda ali zbirke in signaturo. V članku navajamo kratico arhivskega vira v oklepaju med besedilom. Kratico pa razložimo v poglavju o virih na koncu prispevka.

Primer navajanja arhivskega vira v oklepaju med besedilom: (PAK. RAG, 1)

Primer navajanja arhivskega vira v poglavju o virih: PAK. RAG - Pokrajinski arhiv Koper, Rodbinski arhiv Gravisi, a. e. (arhivska enota) 1.

Podobno poskušamo ravnati pri uporabi časopisnih virov.

10. Poglavje o literaturi in virih je obvezno. Bibliografske podatke navajamo takole:
- Opis zaključene publikacije kot celote - knjige:
Avtor (leto izida): Naslov. Zbirka. Kraj, Založba. Npr.:
Verginella, M., Volk, A., Colja, K. (1995): Ljudje v vojni. Druga svetovna vojna v Trstu in na Primorskem. Knjižnica Annales 9. Koper, Zgodovinsko društvo za južno Primorsko.

V zgornjem primeru, kjer je *avtorjev več kot dva*, je korekten tudi citat:
(Verginella et al., 1995)

Če navajamo določeni del iz zaključene publikacije, zgornjemu opisu dodamo še številke strani, od koder smo navedbo prevzeli.

- Opis prispevka v **zaključeni publikaciji** - npr. prispevka v zborniku:
Avtor (leto izida): Naslov prispevka. V: Avtor knjige: Naslov knjige. Izdaja. Kraj, Založba, strani od-do. Primer:

Verginella, M. (1995): Poraženi zmagovalci. Slovenska pričevanja o osvobodilnem gibanju na Tržaškem. V: Verginella, M. et al.: Ljudje v vojni. Druga svetovna vojna v Trstu in na Primorskem. Knjižnica Annales 9. Koper, Zgodovinsko društvo za južno Primorsko, 13-51.

- Opis članka v **reviji:**
Avtor (leto izida): Naslov članka. Naslov revije, številka. Kraj, Založba, strani od-do. Primer:

Gombač, B. (1996): Osvoboditev Trsta maja 1945. Annales 8/'96. Koper, Zgodovinsko društvo za južno Primorsko - Znanstveno-raziskovalno središče Republike Slovenije Koper, 141-150.

Članki so razvrščeni po abecednem redu priimkov avtorjev ter po letu izdaje, v primeru da gre za več citatov istega-istih avtorjev.

11. Tiskarski znaki za poudarke naj bodo:
podčrtano za **polkrepko,**
valovito podčrtano za *ležeče.*
Računalniški zapis naj vključuje ustrezne oznake za bold in *italics.*

12. Kratice v besedilu moramo razrešiti v oklepaju, ko se prvič pojavijo. Članku lahko dodamo tudi seznam uporabljenih kratic.

13. Pri **ocenah publikacij** navedemo v naslovu prispevka avtorja publikacije, naslov, kraj, založbo, leto izida in število strani (oziroma ustrezen opis iz točke 10).

14. Prvi odtis prispevkov uredništvo pošlje avtorjem v **korekturo.** Avtorji so dolžni popravljeno gradivo vrniti v treh (3) dneh. Besedilo popravljamo s korekturnimi znamenji, ki jih najdemo na koncu Slovenskega pravopisa (1962), Ljubljana, ali v: Slovenski pravopis 1. Pravila (1990). Ljubljana, SAZU-DZS, 13-14.

Širjenje obsega besedila ob korekturah ni dovoljeno. Druge korekture opravi uredništvo.

15. Uredništvo prosi avtorje, naj navodila vedno upoštevajo. Ob vseh nejasnostih je uredništvo na voljo za vsa pojasnila.

UREDNIŠTVO

INSTRUCTIONS TO AUTHORS

1. ***ANNALES:*** *Annals for Istran and Mediterranean Studies - Anali za istrske in mediteranske študije* (up to No. 5: *Annals of the Koper Littoral and Neighbouring Regions - Anali Koprskega primorja in bližnjih pokrajin*) is a scientific and research interdisciplinary review covering the humanities, sociology and natural science in the area as stated in the review's subtitle.

2. Articles (papers) written in Slovene, Italian, Croatian and English languages will be accepted. The Editorial Board reserves the right to have them linguistically revised and corrected.

3. Articles should be written on max. 24 pages with double spacing and on one side of the sheet only. On the left side of each page, a 3-4 cm wide margin is to be left. Original photographs, drawings and tables are welcomed, as well as diskettes containing the texts, together with reference to the programme used.

4. Title page of typescript is to include title and subtitle of the article (paper), author's name, any (academic) titles and name of institution by which employed or personal address with eventual E-mail address.

Articles are arranged in the following eight **categories:**

Original scientific papers containing not yet published results of the author's own research. Such works will be reviewed by scientists chosen by the Editorial Board. Authors oblige themselves not to offer their material to any other journal or magazine.

Review articles bearing the character of original works. These are critical and detailed reviews of literature from various interesting fields of research.

Preliminary communication and Materials also bearing the character of original works.

Professional papers presenting results obtained through research. They too will be reviewed, and authors oblige themselves not to publish them elsewhere.

Reports include short scientific information on integral research work or a short description of scientific or specialist books or meetings of experts. Such articles are not to exceed 5 pages.

Youth research compositions are to be presented in the same was as research works.

Explanatory comments include topical issues from various fields of research and are not to exceed 2 pages.

Notices include news from various associations and should not exceed 1 page.

5. Articles should include both **summary** and **abstract.**

Abstract is the shorter of the two (with up to 10 lines) and does not include, in contrast to summary (with up to 30 lines), explanatory comments and recommendations.

Abstract is to contain a short description of the purpose and methods of the work and its results. Author should also state why the work has been carried out and why a document has been written about it. References to the already published material are made only if this is the main purpose of the work. Methods: if necessary, work methods and techniques are to be briefly described (new techniques are to be stated only if differing from the already known ones). If no experimental or practical work is described, sources of information are to be given. Results and conclusions may be incorporated. Findings are to be presented as briefly as possible.

At the beginning of summary the essential points of the carried out work are to be presented. Sentences should be concise and not too long. The text is to be written in the third person; verbs may be used in impersonal form only exceptionally. The not so well known abbreviations are to be avoided. Summary is to retain the basic information from the main part of the text, and should not contain anything that does not appear in the main text itself.

6. Authors are obliged to define and state **key words** (below abstract) in their articles. **English (or Slovene) translation** of key words, texts accompanying figures and tables are welcomed, as well as English (or Slovene) translation of abstracts; if this is not convenient, the Board of Editors will provide for it.

7. Texts should include, if at all possible, the following chapters:

1. Introduction
2. Works published to date
3. Material and methods
4. Results
5. Discussion
6. Conclusions
7. Acknowledgements (if desired by author)
8. Supplements (if necessary)
9. References (Sources, Bibliography)
10. Summary
11. Abstract
12. Key words

8. Two kinds of *notes* are distinguished: those regarding the **contents** of the text, and those referring to **bibliography.** The first elucidate the text in even greater detail and are to appear *at the bottom of the page (under line).* Bibliographical notes, which are to appear in brackets in the text itself, deal with quotations and refer to a precisely stipulated part of the text from some other publication (the page on which quotation appears is to be therefore stated as well) or to a publication (article) as a whole (in this case no page from which the text has been taken is to be stated).

Bibliographical notes are made up of the following details:

Author, year of its publication, and page (but only if a precisely stipulated part of the text is quoted).

The entire bibliographical data of the quoted and used sources are to be stated under *References* (Sources, Bibliography).

Example of quotation referring to a precisely stipulated part of the text: (Sommerville, 1995, 11).

Example of source quotation as a whole, with no citation: (Sommerville, 1995).

The entire data of this source are to be stated in the references and sources chapter as follows:

Sommerville, M. R. (1995): Sex and Subjection. Attitudes to Women in Early-Modern Society. London-New York-Sydney-Auckland, Arnold.

If a number of works *by the same author from the same year* are quoted, letters in alphabetical order are to be stated apart from the author's surname and abbreviation of his first name, in order that the sources are clearly divided between each other. Example:

(Sommerville, 1986a); (Sommerville, 1986b).

Bibliographical note can also be a part of the note referring to the contents and is to be written in the same way, i.e. in brackets within the note referring to the contents.

Separate works or source quotations under the same note are to be separated with semicolon. Example: (Sommerville, 1986b; Caunce, 1994).

9. When **quoting archive sources,** the archive is to be stated first, then the name of the fund or collection and shelfmark. The abbrevation of archive source is to be stated in brackets in the text of the article. The abbrevation is to be explained in the references chapter at the end of the article.

Example of citing archive source in brackets in the text itself: (ASV. CSM, 240).

Example of citing archive source in the reference chapter: ASV. CSM - Archivio di Stato di Venezia. Cinque Savi alla Mercanzia, fasc. 240.

Review sources are to be stated in the same way.

10. The **references and sources** chapter is compulsory. Bibliographical data are to be stated as follows:

- Description of **integral publication:**

Author (year when published): Title. Volume - Collection. Place of publication, published by. Example:

Caunce, S. (1994): Oral History and the Local Historian. Approaches to local history. London and New York, Longman.

If there are *more than two authors,* the work can be also cited as:

(Matthews et al., 1990, 35)

If a specific part from an integral publication is quoted, the page numbers from which the quotation has been taken are to be added to the above description.

- Description of the **article (paper) in integral publication** - e.g. text in a collection of scientific papers: Author (year of its publication): Title of the paper. In: Author of the book: Title of the book. Volume - Collection. Place of publication, published by, pages from - to. Example:

Matthews, R., Anderson, D., Chen, R. S., Webb, T. (1990): Global Climate and the Origins of Agriculture. In: Newman, L. F. (ed.): Hunger in History. Food Shortage, Poverty, and Deprivation. Oxford-Cambridge, Blackwell, 27-55.

- Description of **article in certain review:** Author (year of its publication): Title of article. Name of review, its number. Place of publication, published by, pages from - to.

Example:

Sluga, G. (1996): Identity and Revolution: The History of the "Forty Days" of May 1945. Annales 8/'96. Koper, Zgodovinsko društvo za južno Primorsko - Znanstveno-raziskovalno središče Republike Slovenije Koper, 125-140.

If the same author(s) is (are) cited a number of times, *the articles are to appear in alphabetical order of the* authors' surnames and year of publication.

11. Printer's marks for accentuations are to be as follows:

underlined for **semi-bold,**

undulatory line for *italics.*

Computer notation is to include suitable marks for bold and *italics.*

12. Abbreviations in the texts are to be explained in brackets when appearing for the first time. A list of used abbreviations can be added to the article.

13. When **assessing a publication,** its author, title, place, publishing house, year of publication and page numbers (or appropriate description from Item 10) are to be stated in the title of the article.

14. First copies of printed articles will be sent to authors for **proof-reading.** Authors are obliged to return them in three (3) days. No new sentences are allowed to be added during proof-reading. The second (printing) proofs will be read by the Editorial Board.

15. Authors are kindly requested to consider these instructions at all times. In case of any indistinctness, please do not hesitate to contact the review's Editorial Board.

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Za izdaje Annales so prispevali še: