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Dimensions: 20.5 cm x 14.0 cm*

Prvo dvojezično, hrvatsko-englesko izdanje časopisa Prirodoslovlje

The first bilingual, Croatian-English edition of the journal Prirodoslovlje

Kad je godine 2001. izašao prvi svezak časopisa Prirodoslovlje s tiskanim radovima referiranima za znanstveni skup Hrvatski prirodoslovci 10 (Dubrovnik), bio je to veliki korak za sve nas koji smo u tome sudjelovali – od Uredništva časopisa, Odjela za prirodoslovlje i matematiku, pa i samu Maticu hrvatsku, tada predvođenu predsjednikom akademikom Josipom Bratulićem i glavnim tajnikom, također akademikom Stjepanom Damjanovićem.

Sve je bilo u znaku Matice hrvatske – i radovi autora (ponajviše članovi Matičina ogranka iz Dubrovnika) i članova Odjela u Zagrebu. Imali smo jasnu programsku orijentaciju, sadržajnu koncepciju, pa i grafičku identifikaciju. A sve u cilju predstavljanja hrvatske znanstvene baštine i prirodnih posebnosti Lijepe Naše domaćoj i svjetskoj javnosti.

Iz bogate riznice znanstvene baštine crpili smo prirodoslovne sadržaje koje smo u prošlih 20 godina pretočili u 224 kategorizirana rada od kojih 205 znanstvenih (66 izvornih znanstvenih radova, 67 preglednih radova, 7 autorskih pregleda, jedno prethodno priopćenje, 64 izlaganja sa znanstvenih skupova) i 19 stručnih članaka na ukupno 4 004 stranice časopisa. To znači da su naši autori samo za kategorizirane radove ispisali 8 768 760 slovnih znakova, konkretnije 5 846 kartica teksta. Drugi je važan (brojčani) pokazatelj da tih

When the first issue of the journal Prirodoslovlje was published in 2001 with the papers referred at the scientific meeting Hrvatski prirodoslovci 10 (Dubrovnik), it was a big step for all of us who participated in it – from the Editorial Board of the journal, the Division of Natural Sciences and Mathematics, and even Matica Hrvatska itself, then led by the president academician Josip Bratulić and the general secretary, also academician Stjepan Damjanović.

Everything was in the spirit of Matica Hrvatska – both the works of authors (mostly members of Matica's branch from Dubrovnik) and members of the Division in Zagreb. We had a clear publicizing program orientation, content conception, and even graphic identification. And all with the goal of presenting the Croatian scientific heritage and natural qualities of our beautiful homeland Lijepa Naša to the domestic and international public.

From the rich treasury of scientific heritage, we drew natural history content, which in the past 20 years we decanted into 224 categorized papers, of which 205 are scientific (66 original scientific papers, 67 review papers, 7 author's reviews, one preliminary note, 64 conference papers) and 19 professional papers on a total of 4,004 journal pages. This means that our authors have print-

4 004 stranice od ukupno 4 518 stranica časopisa čini 88,03 % recenziranoga sadržaja, koji je još k tome prošao terminološku, metrološku, bibliografsku, stilsku i jezičnu redakciju, uz inzistiranje na što opsežnijim literaturnim referencijama i izvorima, kako bi zainteresirani čitatelji u njima našli početno štivo za produbljivanje znanja i daljnja istraživanja.

Tako se časopis *Prirodoslovlje* s vremenom isprofilirao kao jedini hrvatski znanstveni časopis s prirodoslovnim temama o očuvanju znanstvene baštine i hrvatskoga identiteta. Kao i dosad, u jednom bi svesku bili zastupljeni prirodoslovci s područja Matičinih ograna u domovini i inozemstvu, a drugi bi svezak bio tematski, posvećen zaslužnim prirodoslovcima ili aktualnim temama. Ove je godine prvi svezak vezan uz Dane ogranka Matice hrvatske u Splitu, koji obilježava visoku 70. obljetnicu utemeljenja. Prvi tematski broj bit će posvećen Nikoli Tesli, zatim Ruđeru Boškoviću i brojnim drugima još neutvrđenim redoslijedom.

Za očuvanje prirodoslovne znanstvene baštine dvojezično, hrvatsko-englesko izdanje časopisa pokazalo se neupitnom potrebom. Ta je ideja tinjala u nama svih ovih godina i prerasla je u ozbiljan projekt. Poticajnima su se pokazale dvije okolnosti – časopis je zaokružio svojih (prvih) 20 godina izlaženja u 180. godišnjici osnutka Matice hrvatske! Da smo se pitali kada bi to dvojezično izdanje ugledalo svjetlo dana, odgovor bi bio: Kada, ako ne sada?!

ed 8,768,760 characters, more specifically 5,846 cards of text, just for categorized works. Another important (numerical) indicator is that those 4,004 pages out of a total of 4,518 pages of the journal make up 88.03% of the reviewed content, which also underwent terminological, metrological, bibliographic, stylistic and linguistic redaction, with an insistence on the most comprehensive literature references and sources, so that interested readers can find in there deepening knowledge and further research.

The journal *Prirodoslovlje* became the only Croatian scientific journal with natural history topics on the preservation of scientific heritage and Croatian identity. One issue would feature naturalists from Matica's branches in the homeland and abroad, and the second issue would be thematic, dedicated to well-known naturalists or current topics.

For the preservation of the natural science heritage, a bilingual, Croatian-English edition of the journal proved to be an unquestionable necessity. This idea simmered in us all these years and grew into a serious project. Two circumstances proved to be encouraging – the journal completed its (first) 20 years of publishing on the 180th anniversary of the foundation of Matica Hrvatska! If we wondered when that bilingual edition would see the light of day, the answer would be: When, if not now?!

Barbara Bulat

Glavna i odgovorna urednica
Editor-in-Chief

Znameniti hrvatski fizičar dr. Nikola pl. Cindro (1931. – 2001.)*

The well-known Croatian physicist Dr. Nikola Cindro (1931–2001)*

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SAŽETAK

U radu se prikazuje život i djelo fizičara dr. Nikole Cindre, čiji su radni vijek i sveukupna djelatnost bili uglavnom vezani uz Hrvatsku (Institut *Ruder Bošković*), iako je povremeno djelovao i u inozemstvu. Osobita je pozornost posvećena prikazu njegove doktorske disertacije kao i njegovim pedagoškim, znanstvenopopularnim aktivnostima i javnom djelovanju, što u postojećoj literaturi dosad nije bilo predmetom znanstvene obrade. Njegova do sada objavljena autorska znanstvena biografija dopunjena je tako da je dobiven najopsežniji prikaz njegove publicistike.

SUMMARY

The paper presents the life and work of the physicist Dr. Nikola Cindro. Although his life, his career, and all his activities included Croatia (Ruder Bošković Institute), he was active abroad as well. It gives special attention to his Ph.D. thesis and to his educational activities, popular science activities and public engagements. The existing literature did not present and analyze some of these. The authors updated and supplemented the list of his scientific works, so it is now the most complete list of his publications.

* Članak je djelomice referiran na znanstvenom skupu *Hrvatski prirodoslovci 31*, Split, 25. – 26. studeni 2022.

* *The paper was partially referred at the scientific meeting Croatian naturalists 31, Split, Croatia, November 25–26, 2022.*

** Sada u miru. / ** *Now retired.*

KLJUČNE RIJEČI

Nikola pl. Cindro

- nuklearna fizika
- reakcije teških iona
- znameniti fizičar i učitelj

1. Životopis Nikole pl. Cindre (Split, 29. VIII. 1931. – Zagreb, 25. III. 2001.)

Nikola Cindro (**slika 1**) rođen je 29. kolovoza 1931. u Splitu. Otac mu je bio Mihovil Cindro, odvjetnik, a majka Ljubica, rođ. Biro. (1) U Splitu je Nikola za-



Cindro Nikola



N. Cindro

SLIKA 1. Fotografije N. Cindre s potpisima: lijevo godine 1954., desno 1992.

FIGURE 1. N. Cindro's photos with his signatures: left in 1954, right in 1992

vršio osnovnu školu i realnu gimnaziju s odličnim uspjehom. Njegova obitelj imala je svoje obiteljsko imanje u Strožancu kraj Splita, a posjedovala je i plemićki naslov (**slika 2**). Prema riječima Nikolčinog sina Branka, obitelj Cindro jedna je od četiri najstarije obitelji u Hrvatskoj. Nikola je od 1995. osnivač i predsjednik Plemićkoga zbora Hrvatske, iako začetci toga zbora postoje od 1991. (2)

KEYWORDS

Nikola Cindro

- heavy-ion reactions
- nuclear physics
- well-known physicist and teacher

1) Biography: the nobleman Nikola Cindro (Split, August 29, 1931– Zagreb, March 25, 2001)

Nikola Cindro (**Figure 1**) was born on August 29, 1931 in Split. His father's name was Mihovil Cindro, a lawyer, and his mother's name was Ljubica, née Biro. (1) In Split Nikola attended prima-

ry school and gymnasium with the best marks. His family had a family estate in Strožanac near Split. Cindros were a noble family and according to the words of Nikola's son Branko they belong to one of the four oldest families in Croatia (**Figure 2**). In 1995 Nikola was the founder and the first president of the Association of Croatian Nobility although one can trace the beginning of this association back to 1991. (2) (In Croatia a nobility has pl. in front of his/hers family name, so N.C. is Nikola pl. Cindro.)

Godine 1950. Nikola je došao u Zagreb i upisao Prirodoslovno-matematički fakultet (dalje PMF), Odsjek Matematičko-fizički, struku matematika, užu struku: b) primijenjena matematika. Usput je slušao i polagao ispite iz predmeta struke fizika, uže struke: a) teorijska fizika. Od 1951. bio je demonstrator, najprije na struci matematika, a nakon toga na struci fizika. Dana 6. studenoga 1954. diplomirao je obranom diplomskoga rada, na užoj struci: teorijska fizika, s odličnim uspjehom. Naslov diplomskog rada bio je: *Nuklearne strukture (Shell model i A. Bohrov model jezgre)*, a voditelj toga rada bio je dr. Ivan Supek. (3)

Nakon diplomiranja zaposlio se kao asistent u Nuklearno-strukturnoj grupi Instituta *Ruđer Bošković* u Zagrebu. Od 26. rujna 1955. do 30. kolovoza 1956. služio je vojni rok, a nakon toga radio je kao asistent u Odjelu nuklearne fizike II. u istom institutu. Godine 1956./1957. radio je kao honorarni asistent na PMF-u u Zagrebu. Od listopada 1957. bio je na specijalizaciji u USA (na MIT-u dvanaest mjeseci i na University of California dva mjeseca). Za to je vrijeme radio na proučavanju reakcija dobivenih korištenjem ciklotronskog snopa (elastično raspršenje deuteronu u sklopu optičkoga modela te reakcije (α, p) (α, d) i na analizi elastičnog raspršenja deuteronu u sklopu optičkoga modela. Na temelju tih je rezultata 1959. položio usmeni doktorski ispit i obranio doktorski rad (disertaciju). Tema njegove doktorske disertacije bila je *Elastično raspršenje deuteronu od 13,5 i 15 MeV na atomskim jezgrama i analiza u okviru op-*

In 1950 Nikola came to Zagreb where he enrolled at the Faculty of Science (PMF), Department of Mathematics, in the applied mathematics



SLIKA 2. Plemički grb obitelji Cindro
FIGURE 2. Coat of arms of the Cindro family

program. Parallel, he attended lectures in theoretical physics and he took exams as well. From 1951 he was a teaching fellow in the mathematics and later in the physics program. On November 6, 1954 he graduated with the best marks by defending a thesis in the theoretical physics program. The title of the thesis was „Nuclear Structures (Shell Model and A. Bohr’s Model of Nucleus)“. The thesis supervisor was Dr. Ivan Supek. (3)

After graduation, he found a job as an assistant in the Nuclear Structure group at the Ruđer Bošković Institute in Zagreb. From September 26, 1955 to August 30, 1956 he spent in military service.

tičkog modela. Godine 1959./1960. predavao je kolegij Statistika u sklopu poslijediplomskoga studija na Institutu *Ruđer Bošković*.

Sudjelovao je s referatima na međunarodnim kongresima u Hrvatskoj (Mali Lošinj – 1957., Herceg Novi – 1959. i 1960., Beograd – 1960., Herceg Novi – 1962.) i u inozemstvu (New York – 1960., Napoli – 1960., Krakow – 1963.). Održao je niz pozivnih predavanja, od kojih su najvažnija na University of California, Los Angeles – 1958., University of Minnesota, Minneapolis – 1958. te Institut CISE, Milano – 1959.). Prema podacima, koje je autorima dao Nikolin sin Branko, dr. Cindro je od 1969. do 1995. održao 35 pozivnih predavanja u Italiji, Rumunjskoj, Poljskoj, SSSR-u, DDR-u, ČSSR-u, Americi, Njemačkoj, Bugarskoj, Japanu i Mađarskoj. Također je u inozemstvu radio na izračunu nuklearnih reakcija u Krakowu (1960.) te Saclayu (1961. i 1962.). Bio je gostujući predavač na Institutu teorijske fizike u Kopenhagenu na poziv prof. N. Bohra. Od 1961. nastavnik je na III. stupnju studija PMF-a u Zagrebu, gdje predaje kolegij *Statistički model nuklearnih reakcija*. (4) Također je 1961. izabran za izvanrednoga profesora na Elektrotehničkom fakultetu i Kemijsko-tehnološkom fakultetu u Splitu, gdje je do 1964. predavao kolegije *Fizika i Uvod u atomsku i nuklearnu fiziku*, i bio šef Zavoda za fiziku. Savjet Instituta *Ruđer Bošković* izabrao ga je godine 1961. u znanstvenog suradnika, 1963. u višeg znanstvenog suradnika te 1970. za znanstvenog savjetnika. (5, 6)

After that, he was employed as an assistant in the Department of Nuclear Physics II at the same institute. In the year 1956/57 he was working as an honorary assistant at PMF in Zagreb. From October 1957 he was in the USA at MIT for twelve months and at the University of California for two months. During that time he researched the reactions obtained by cyclotron beams: elastic deuteron scattering within the optical model, reactions (α, p) and (α, d) and the elastic scattering of deuterons within the optical model. Based on this research in 1959 he passed the oral doctoral exam and defended his Ph.D. thesis with the title „Elastic scattering of deuterons of 13.5 and 15 MeV on atomic nuclei and the analysis within the optical model“. In the year 1959/60 he was lecturing in the course „Statistics“ within a graduate program at the *Ruđer Bošković* Institute.

He participated with contributions to different international conferences in Croatia and abroad: Mali Lošinj in 1957, Herceg Novi in 1959, 1960 and 1962, Belgrade in 1960, New York in 1960, Naples in 1960, Krakow in 1963. He lectured as an invited speaker at different institutes such as the University of California, Los Angeles (1958), the University of Minnesota, Minneapolis (1958), Institut CISE, Milano (1959) and others. His son Branko says that Nikola Cindro gave 35 invited talks and lectures in Italy, Romania, Poland, USSR, DDR, USA, ČSSR, Germany, Bulgaria, Japan and Hungary between 1969 and 1995.

In Krakow (1960) and at Saclay (1961, 1962) he was doing research on different nuclear reactions. By invitation of professor Niels Bohr, he was the visiting lecturer at the Institute of Theoretical Physics in Copenhagen. From 1961 at the University of Zagreb, he was lecturing in the course „Sta-

Godine 1965. Cindro je otišao u poznati laboratorij iz nuklearne fizike i fizike teških iona CEN Saclay, Francuska, gdje je proveo dvije godine radeći na strukturi sferičnih jezgri. Radovi na otkriću tzv. „core“ stanja atomske jezgre kao i rad na uočavanju važnosti tzv. jednostavnih konfiguracija u strukturi atomske jezgre donijeli su mu 1967. francusko priznanje reda za znanstvene zasluge *Chevalier de l'Ordre du Mérite Scientifique*. Osim toga, godine 1997. dobio je odličje francuske vlade *Officier dans l'Ordre des Palmes Academiques* kao i hrvatska odličja *Danica Hrvatska* s likom Ruđera Boškovića, 1996. i *Zlatni grb grada Splita*, 1999.

Nakon povratka u Zagreb radi na neutronske fizici i usavršavanju eksperimentalnih metoda. Također je predavao nuklearne fizike na međunarodnim školama Villara (Švicarska, 1965.) Trst (1969.), Predeal (Rumunjska, 1970.), Rudziska (Poljska, 1971.), Mikolajki (1973.), Alusta (SSSR, 1974.), Varenna (Italija, 1974.), Zakopane (Poljska, 1975). Bio je predsjedatelj i pozvani referent na međunarodnim kongresima: Heidelberg (1966. i 1969.), St. Malo (1968.), La Cassacia (1970.), Budapest (1972.), Colby, USA (1972.), Smolenice (1974.).

Od 1972. voditelj je Laboratorija za nuklearnu spektroskopiju, kasnije se bavi nuklearnom fizikom teških iona u preimenovanom laboratoriju, gdje zajedno s F. Cocuem i drugima eksperimentalno potvrđuje fragmentaciju nuklearnih teškoi-onskih rezonancija (1977.), a s F. Haasom i D. Freemanom eksperimentalno dokazuje postojanje nuklearnog Landau-Zene-

tistical model of nuclear reactions“ at the graduate level. (4) Also in 1961 he was elected to the position of associate professor at the Faculty of Electrical Engineering and at the Chemical Technology Department in Split. In Split, he was lecturing „Physics“ and „An Introduction to Atomic and Nuclear Physics“ at the same time as the Head of the Physics department.

In the year 1961. he was elected to the position of research associate by the Ruđer Bošković Institute. In 1963 he advanced to a higher research associate and in 1970 he was elected to the position of a research adviser. In the year 1965, he left to the well-known nuclear physics laboratory and heavy ions physics CEN Saclay in France. He spent two years there working on a structure of the spherical nuclei. For the discovery of the „core“ states of atomic nuclei as well as recognizing the importance of the so-called simple configurations in the structure of atomic nuclei he was awarded Chevalier de l'Ordre du Mérite Scientifique (1967), a French award for scientific achievements. Also in 1997 by the French government he was awarded the title Officier Dans l'Ordre des Palmes Academiques. In 1996 he was awarded by the Croatian government the Croatian honorary medal Danica Hrvatska with a figure of Ruđer Bošković, and two years later he got The golden coat of arms of the city Split.

After his return to Zagreb, he was working on the physics of neutrons and on the advancement of experimental methods. He was lecturing nuclear physics in summer schools in Villara, Switzerland (1965), Trieste (1969), Predeal, Romania (1970), Rudziska, Poland (1971) Mikolajki (1973), Alusta, USSR (1974), Varenna, Italy (1974) and Zakopane, Poland (1975).

rova efekta (1983). Autor je modela nuklearnih molekularnih rezonancija (1978. i 1983.) (7, 8) Njegov rad na području fizike teških iona pridonio je uspješnom prijenosu tih istraživanja i na ostale hrvatske fizičare te je tako odgojena skupina fizičara poznata kao Zagrebačka škola teškoionske fizike.

Godine 1969./1973. bio je izvanredni profesor na Elektrotehničkom fakultetu u Zagrebu, a predavao je i na Građevinskim fakultetima u Splitu i Zagrebu (1974./1977.). Od 1988. je redoviti profesor na Građevinskom fakultetu u Zagrebu, 1980. gostujući je profesor na Sveučilištu u Frankfurtu na Majni, 1985./1986. na Sveučilištu Duke, 1986./1987. je gostujući profesor na Sveučilištu u Strasbourgu, a 1988./1989. u Frankfurtu/M. (6, 8) Na poslijediplomskoj nastavi na PMF-u na Sveučilištu u Zagrebu predavao je predmet Nuklearne reakcije, a predmet Odabrana poglavlja nuklearne fizike na Fakultetu elektrotehnike, strojarstva i brodogradnje Sveučilišta u Splitu. Također je predavao kolegij *Schwerionenphysik* na *Graduirterkolleg* Giessen – Frankfurt/M, Darmstadt, 1991. i kolegij *A Course on Nuclear Reactions: Formalism; reaction models*. CRN/COURS 87/01 na Université Louis Pasteur, Strasbourg 1986./1987. – temeljem kojeg je napisan i službeni udžbenik.

Prema istraživanjima sina Branka, Nikola Cindro je u razdobljima 1969./1976. i 1983./1997. održao 51 znanstveno predavanje u Francuskoj, SAD-u, Njemačkoj, Italiji, Japanu, Izraelu, Mađarskoj i Češkoj. Tome treba dodati 18 znanstveno-po-

He was an invited lecturer and chairman of international congresses in Heidelberg (1966 and 1969), St. Malo (1968), La Cassacia (1970), Budapest (1972), Colby, USA (1972), Smolenice (1974). In 1972 he was appointed the leader of the Laboratory for nuclear spectroscopy. Later when his interest shifted towards heavy ion physics the name of the laboratory was changed and there in collaboration with F. Cocu and others, he experimentally confirmed fragmentation of the nuclear heavy ion resonances (1977). In collaboration with F. Haas and D. Freeman, he proved experimentally the existence of the nuclear Landau-Zener effect (1983). He authored the model of nuclear molecular resonances (1978 and 1983). His research on heavy ion physics has helped to transfer the knowledge of heavy ion physics to the Croatian physics community and as a consequence of that a successful group of heavy ion physicists was formed known as the „Zagreb school of heavy ion physics“.

From the year 1969 to 1973 he was elected an associate professor in physics at the Faculty of Electrical Engineering in Zagreb. He was also lecturing at the Civil engineering faculties in Zagreb and Split. From 1988 he was a full professor in physics at the Civil engineering faculty in Zagreb. He was a visiting professor at the University in Frankfurt/Main (1985/86 and 1988/89), Duke University (1986/87) and University Strasbourg (1988/89). At the Zagreb University, Faculty of Science he was lecturing the course Nuclear reaction and Nuclear Physics – Special Topics at the Split University. He was also lecturing the course *Schwerionenphysik* on *Graduiertenkolleg* Gießen-Frankfurt/M, Darmstadt, in 1991 and the course with the title *Course on Nuclear Reactions: Formalism; reaction*

pularnih predavanja održanih u razdoblju 1982./1995. Sin Branko također naglašava da je njegov otac bio recenzent uglednih časopisa poput *Nuclear Physics A*, *Zeitschrift für Physik A, Hadrons and Nuclei*, *Journal of Physics G, Nucl. and Particle Physics*, *Physics Letters B*, *North Holland*, *Physical Review (C)* i *Physical Review Letters*.

Nikola Cindro bio je predsjednik i potpredsjednik Društva matematičara i fizičara SR Hrvatske (1968. – 1972.). Također je u Europskom fizičkom društvu bio član Izvršnoga savjeta (1969. – 1974.), Izvršnog odbora (1971. – 1973.), a 1973. – 1974. i potpredsjednik toga društva. U razdoblju 1971. – 1975. potpredsjednik je Nuklearno-fizičkog odjela Europskog fizičkog društva. U Hrvatskom fizikalnom društvu bio je član Izvršnog odbora od 1992., a bio je i član Talijanskog fizičkog društva. Uza sve to razvio je i zapaženu djelatnost u brojnim odborima i povjerenstvima: Odboru za nominiranje kandidata za nagradu *Japan prize of Science and Technology* (1985.), Organizacijskom odboru proslave 40-godišnjice Instituta *Ruđer Bošković* (1990.), Matičnom povjerenstvu za područje fizike imenovan je od strane Skupštine zajednice hrvatskih sveučilišta (1993.), Saborskom odboru za dodjelu nagrada *Ruđer Bošković* (1993.), Saborskom odboru za dodjelu državnih nagrada za znanost (četverogodišnji mandat počev od 1996.).

Osim već spomenutoga francuskog priznanja 1967., dobio je i nagradu *Martin-Marietta* zajedno s grupom istraživača (1992.), kao i nagradu Instituta *Ruđer Bošković* (1990.) i Nagradu Hrvatske aka-

models.CRN/COURS 87/01 at Universite Louis Pasteur, Strasbourg (1986/87). Following his lecture, the official textbook was published. According to the words of Nikola's son Branko, Nikola gave 51 scientific lectures in France, USA, Germany, Italy, Japan, Israel, Hungary and the Czech Republic. Apart from that, he gave 18 public lectures on popular science in the period from 1982 to 1995. According to his son Branko, Nikola was refereeing for eminent journals like *Nuclear Physics A*, *Zeitschrift für Physik A, Hadrons and Nuclei*, *Journal of Physics G, Nucl. and Particle Physics*, *Physics Letters B*, *North Holland*, *Physical Review (C)* and *Physical Review Letters*.

Nikola Cindro was the president and vice president of the Society of Mathematicians and Physicists of the Republic of Croatia (1969–1972). Also, he was a member of the Executive Council of the European Physics Society (1969–1974), a member of the Executive Board (1971–1973) and the vice president of the Society (1973/74). From 1971 to 1975 he was the vice president of the Nuclear division of the European Physical Society. In the Croatian Physical Society, he was a member of the Executive Board from 1992. He was also a member of the Italian Physical Society. He was active in different boards and committees: a member of the nominee board for candidates for the „Japan prize for Science and Technology“ (1985), an organizational board for the 40th Anniversary of the *Ruđer Bošković* Institute, a member of the Elective committee for physics, nominated by the Assembly of Croatian universities, member of the Parliamentary nominee board for the award „*Ruđer Bošković*“ (1993), member of the Parliamentary nominee board for the state award for science (four years term started in 1996).

demije znanosti i umjetnosti za prirodne znanosti i matematiku za 1994. koju je dijelio s dr. Beneom Nižićem. (6, 9) Također je proglašen počasnim profesorom Fakulteta elektrotehnike, strojarstva i brodogradnje Sveučilišta u Splitu i počasnim profesorom Fakulteta prirodoslovno-matematičkih znanosti i odgojnih područja Sveučilišta u Splitu. Nagrađen je i za životno djelo nagradom Poglavarstva općine Podstrana.

Godine 1958. oženio se Nikola Cindro sa Željkom rođ. Knežević. Bračni par Cindro ima troje djece: Branka, rođenog 1960., Jasnu, rođenu 1961. i Michela, rođenog 1967. (10)

Dana 31. prosinca 1996. prestao je ugovor o radu između Nikole Cindre i Instituta *Ruđer Bošković* jer je te godine navršio 65 godina života. Nakon toga je s Institutom sklopio ugovor o radu na određeno vrijeme, koji je otkazao zbog odlaska u starosnu mirovinu. Sporazumom o prestanku ugovora o radu N. Cindro i Institut usuglasili su se da će ugovor o radu prestati 30. lipnja 1998., a pravo na starosnu mirovinu priznato mu je 1. srpnja 1998. (11) I nakon toga aktivno je djelovao kao vanjski suradnik na Fakultetu prirodoslovno-matematičkih znanosti i odgojnih područja u Splitu.

Na novinarski upit o njegovu najznačajnijem otkriću Cindro je izjavio: „... Moje se ime najviše vezuje uz nešto što se naziva – nuklearne molekule. Što su to nuklearne molekule? U atomskoj jezgri postoje nukleoni, a to su protoni i neutroni... Nuklearne molekule su rezultat spoznaje da se ti nukleoni u jezgrama ne

Apart from the already mentioned French awards in 1967, Nikola Cindro was awarded the Martin-Marietta award in 1992, together with a research group. In the year 1990 the Ruđer Bošković Institute Award was given to N. Cindro, and the Croatian Academy of Sciences Award in 1994. N. Cindro shared with Dr. Bene Nižić. The Faculty of Sciences and Electrical Engineering, Mechanical Engineering and Shipbuilding of the Split University awarded him honorary professor status. By the municipality Government of Podstrana, he was awarded the lifetime achievement award.

In the year 1958 Nikola pl. Cindro married Željka nee Knežević. They have a son Branko born in 1960, a daughter Jasna (1961) and a son Michel (1967).

On December 31, 1996 Nikola Cindro retired after that year he was 65 years old. After retirement, the Institute Ruđer Bošković and N. Cindro signed a short term contract of collaboration. After two years N. Cindro and the Institute came to an agreement to terminate the collaboration and N. Cindro retired on June 30, 1998. He got his pension on July 1, 1998. At the Split University, Faculty of Sciences and Education he continued to teach as an external associate.

In an interview with the press N. Cindro was asked about his most important discovery, and his reply was: „My name is often tied to something that is called the nuclear molecules. What are the nuclear molecules? In an atomic nucleus there exist nucleons and these are protons and neutrons. Nuclear molecules are the result of cognition that these nucleons do not behave erratically but that they form smaller groups, clusters. And these clusters have the form of molecules. My contribution to this notion is that these kinds of structures in

ponašaju bilo kako. Nego da se sklapaju u manje nakupine. U grozdove. I da te nakupine imaju oblik molekule... I ono što sam ja pridonio da se otkrije jest to da takve složene strukture u atomskim jezgrama, koje podsjećaju na molekule, postoje u čitavom nizu jezgara, da nisu vezane samo za dvije, tri jezgre.“ (12)

Nikola pl. Cindro umro je 25. ožujka 2001. u Zagrebu, a tri dana kasnije ukopan je na groblju Lovrinac u Splitu.

2. O doktorskoj disertaciji Nikole Cindre

Ako se uspoređi postignuće Nikole Cindre s tada važećim Zakonom o doktoratu nauka iz 1955. (13) može se uočiti da je u tom postupku stjecanja doktorata prošao sve faze. Naime, on je imao uvjet za stjecanje doktorata znanosti jer je posjedovao diplomu PMF-a o završetku propisane znanosti na tom fakultetu, pa je mogao steći doktorat na istom fakultetu i to iz iste znanstvene discipline (fizike). Dana 30. siječnja 1959. prijavom svoje disertacije i predajom izrađene disertacije u deset primjeraka fakultetu vrlo lako je ostvario prvu fazu. Fakultetsko vijeće PMF-a je na svojoj sjednici 26. ožujka 1959. odredilo komisiju za ocjenu disertacije i područja usmenoga dokorskog ispita i to: detekcija nuklearnog zračenja, prolaz nuklearnog zračenja kroz tvar i nuklearni modeli. Time je ostvarena druga faza. Treća faza stjecanja doktorata znanosti ostvarena je na način da je Fakultetsko vijeće PMF-a na svojoj sjednici 25. lipnja 1959. prihvatilo izvješće komisije za ocjenu doktorske di-

atomic nuclei, which remind us of molecules, exist in a whole bunch of nuclei and that they are not connected to only two or three nuclei.“

Nikola pl. Cindro died on March 25, 2001 in Zagreb and three days later he was buried in the Lovrinac cemetery in Split.

2) Doctoral Thesis of Nikola pl. Cindro

If one compares the achievements of Nikola Cindro with the then valid Doctoral law from 1955 (13) it is evident that N. Cindro fulfilled all the required phases. He had all the prerequisites for a doctoral degree having a Faculty of Sciences diploma and he could have obtained his doctoral degree at the same faculty in the same field – physics. So he announced his dissertation and submitted ten required copies on January 30, 1959 to complete the first phase of the procedure. The Faculty Council in the session on March 26 1959 appointed a committee for the evaluation of the dissertation and defined topics for the oral doctoral-qualifying exam: detection of nuclear radiation, the transition of nuclear radiation through the material, and nuclear models. It was the second phase of the procedure. In the third phase the Faculty Council in the session on June 25, 1959 accepted the report of the committee for evaluation and appointed a committee for the oral qualifying exam. The members of the examining committee were Dr. Mladen Paić, president, Dr. Ivan Supek, a member, and Dr. Branimir Marković, a member. In agreement with N. Cindro, the oral exam and defence was held on July 3, 1959. (**Figure 3**). According to the documentation N. Cindro was asked the following questions: ionizing chamber, fission chamber, deexcitation of an ex-

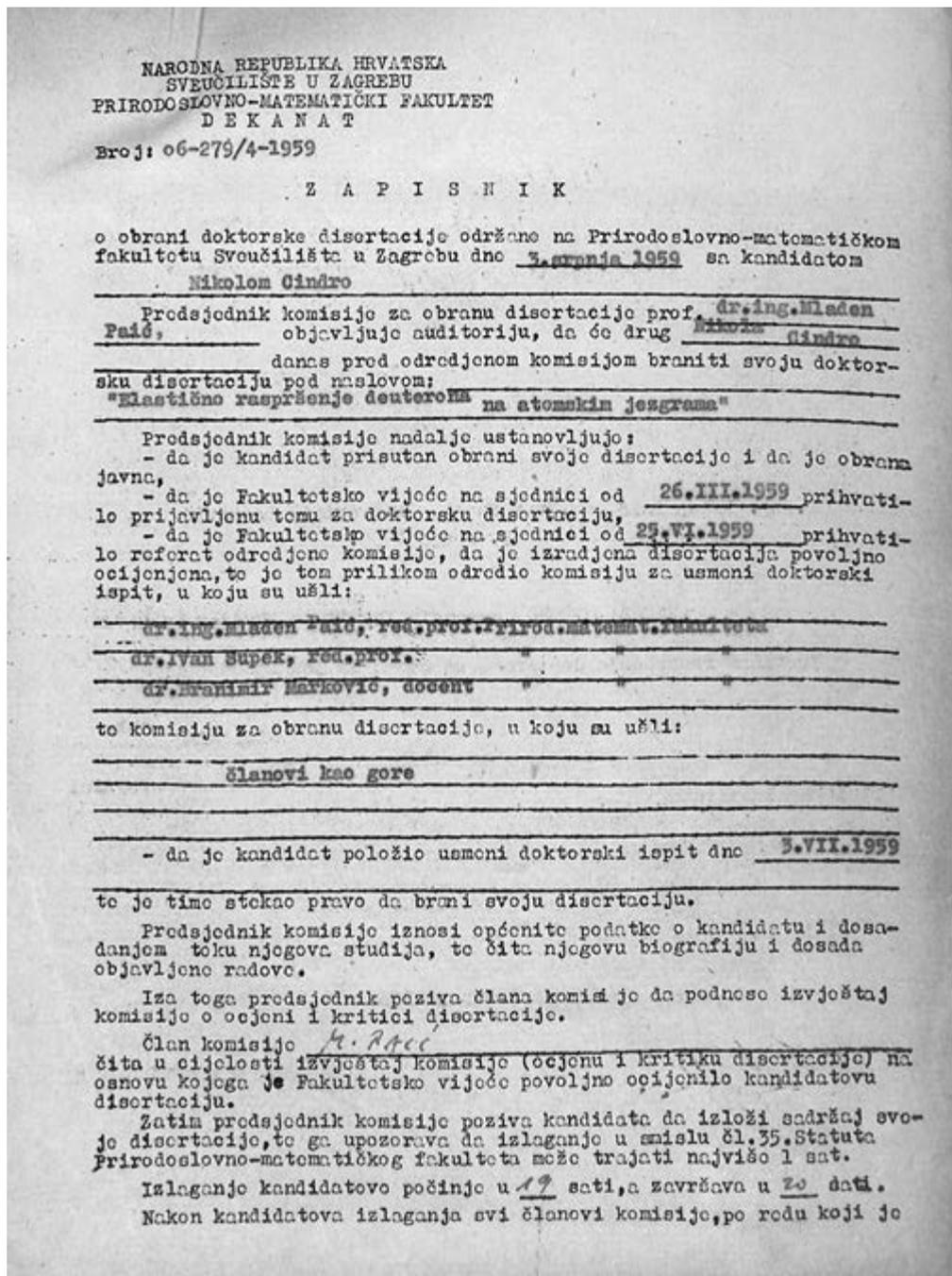
sertacije te izabralo komisiju za usmeni ispit. Komisija je bila u sastavu: dr. Mladen Paić, predsjednik; dr. Ivan Supek, član; dr. Branimir Marković, član. U dogovoru s N. Cindrom održan je usmeni ispit 3. srpnja 1959. Prema Zapisniku s toga ispita Cindri su postavljena pitanja: ionizacijska komora, fiziona komora, deekscitacija uzbuđenog atoma, model kapljice, potencijal belt modela, teorije potencijala, prolaz gama zraka kroz tvar – na koja je Cindro uspješno odgovorio i položio taj ispit te tako ostvario četvrtu fazu postupka. Odmah nakon usmenog ispita održana je i obrana disertacije pred istom komisijom. Prema zapisniku o obrani (**slika 3**), Cindro je u trajanju od jednog sata izložio svoju disertaciju te nakon postavljenih pitanja za pola sata s uspjehom obranio svoju doktorsku disertaciju i okončao petu fazu postupka. Šesta faza bila je najlakša jer se radilo o promociji na kojoj se trebalo samo pojaviti. Dana 7. srpnja 1959. Dekanat PMF-a izvijestio je Rektorat Sveučilišta u Zagrebu da je Nikola Cindro obranio svoju doktorsku disertaciju, uz zamolbu da Rektorat provede postupak promoviranja Nikole Cindre na znanstveni stupanj doktora fizičkih znanosti. (14)

Potpune jasnoće radi potrebno je razjasniti što se, prema navedenom Zakonu, smatralo doktorskom disertacijom. Ta je disertacija morala biti samostalan znanstveni rad i trebala je predstavljati prilog znanosti. Na usmenoj obrani te disertacije kandidat je trebao pokazati da potpuno vlada materijom koju je obradio i da obrazloži i obrani znanstvene zaključke do kojih je u svom radu došao.

cited atom, drop model, the potential of the belt model, the potential theory and the transition of gamma rays through the material. For all questions N. Cindro gave satisfying answers. So he completed the fourth phase. Immediately after the qualifying exam in front of the same committee, N. Cindro successfully defended his thesis. Within one hour he presented his dissertation and by that, he completed the fifth phase. The sixth phase was the easiest one since it was the promotion. On July 7, 1959 the Dean of the Faculty of Sciences reported to the Rector of Zagreb University that Nikola Cindro had successfully defended his dissertation and the Dean asked the Rector to promote N. Cindro to the scientific degree: doctor of physical sciences. (14)

In order to clarify the issue it must be clarified what was considered a doctoral thesis – dissertation – according to the valid Law mentioned before. A dissertation had to be an original, independent scientific achievement. It had to contribute to science. At the oral defence of the thesis, a candidate had to show that he mastered the subject which was the main topic in his dissertation and he had to explain and defend scientific results and conclusions which stemmed from his research. Apart from this formal explanation the content of his defence had to be built into the doctoral thesis.

In N. Cindro's dissertation the energy angular distributions of scattered deuterons at 13.5 and 15 MeV on about 20 nuclei from Al to Pb are given. The results show deviations from the Rutherford scattering and peaks characteristic of optical models. Light elements show a considerable relative increase of the cross section for backward angles. It was noticed as well that Nishid's theory which ex-



SLIKA 3. Zapisnik o obrani doktorske disertacije za kandidata Nikolu Cindru
FIGURE 3. Official record of the doctoral dissertation defence of the candidate Nikola Cindro

Osim toga formalnog objašnjenja treba nešto sadržajno iznijeti i o samoj disertaciji. U disertaciji su dane angularne distribucije energije elastično raspršenih deuteronu energija 13,5 i 15 MeV na oko 20 jezgara od aluminijskog do olova. Rezultati pokazuju odstupanje od Rutherfordova raspršenja i vrhove karakteristične za optičke modele. Laki elementi pokazuju znatan relativni porast udarnoga presjeka za stražnje kutove. Također je uočeno da se teorija Nishide, koji tumači odstupanja udarnih presjeka elastičnog raspršenja od Rutherfordove formule, električnim cijepanjem deuteronu ne slaže s eksperimentalnim rezultatima. U radu prikazana analiza, u okviru optičkoga modela, prva je sistematska analiza deuteronkoga elastičnog raspršenja. Opći zaključak je da se optički model nuklearnih reakcija sasvim pouzdano može primijeniti i na deuteronsko raspršenje.

2.1. Pregled nekih znanstvenih radova i publikacija Nikole pl. Cindre

U radu autora Basraka, Čaplar i Paara (15) najpotpunija je znanstvena bibliografija (139 bibliografskih jedinica) Nikole Cindre. Ovdje će se ukratko komentirati kako je teкао Cindrin znanstveni i životni put, a referencije koje se navode odnose se upravo na rad tih autora.

Iz životopisa i znanstvene bibliografije Nikole pl. Cindre vidimo da su njegov znanstveni interes i njegova najveća postignuća ostvarena u području nuklearne fizike. Odmah valja dodati i važnu činjenicu, a to je i motivacija ovog rada, da je uz čisti znanstveni interes, N. Cindro bio

plains deviations from Rutherford's formula for cross sections for elastic scattering by the electric splitting of deuterons is not in agreement with experimental results. In the thesis, an analysis given within the optical model is the first systematic analysis of deuteron elastic scattering. The general conclusion is that the optical model of nuclear reactions is also a reliable model for deuteron scattering.

2.1) Review of some scientific and other publications by Nikola Cindro

The work written by Basrak, Čaplar, and Paar (15) is the most complete N. Cindro's bibliography (with 139 entries). Here we will comment on the journey through his scientific life and how this was reflected in his publications. Cited references will be taken from the ref. 15.

From his curriculum vitae and his scientific bibliography, one can see that N. Cindro's interest and most achievements belong to the field of nuclear physics. However we have to add an important fact before we go on that apart from the purely scientific interest he was susceptible to all aspects of science with an emphasis on educational aspects as well as the popularization of science, especially (nuclear) physics. This becomes clear by looking at his opera (given before) where in addition to a large number of scientific publications (15) one can see many contributions written for the journal *Matematičko fizički list* and for *Priroda*. Also one can see publications concerning the social aspects of science and scientific research. Certainly, his great success is two university textbooks that were published in more editions and which were highly rated by university professors and students. Only those who read this text and who are authors of a university textbook could un-

otvoren svim aspektima znanosti, a posebno edukacijskom i popularizatorskom. To je posve jasno iz pregleda njegovih publikacija danih ranije, u kojima, uz golem broj izvornih znanstvenih radova u najuglednijim svjetskim znanstvenim časopisima (15), vidimo niz tekstova objavljenih u *Matematičko-fizičkom listu* i *Prirodi*, ali i tekstova u kojima se promišlja i društveni aspekt znanosti i znanstvenih istraživanja.

Njegovo veliko postignuće su i dva sveučilišna udžbenika koji su doživjeli niz izdanja i koje su izuzetno cijenili i sveučilišni nastavnici i studenti. Samo oni koji čitaju ovaj tekst, a autori su nekoga udžbenika, znaju koliko napora zahtijeva zaokruženje jednoga visokoškolskog udžbenika u knjigu koja zatim predstavlja pouzdano sredstvo prijenosa znanja od (dobrog) autora do (zainteresiranog) studenta.

Ipak, vratimo se nuklearnoj fizici u kojoj je N. Cindro decenijama boravio i u kojoj je pronašao nove ideje i nova znanja koja ostaju kao naslijeđe generacijama.

Može se kazati da je nuklearna fizika počela glasovitim eksperimentom E. Rutherforda (1871. – 1937.) godine 1911. i njegovih suradnika (H. Geigera i E. Marsdena) koji su pokazali da se atom može opisati „planetarnim modelom“, tj. da se sastoji od male nakupine pozitivne tvari u središtu golemoga praznog prostora okružene negativnom sfernom raspodjelom negativnog naboja. Pokus se sastojao od bombardiranja zlata (u tankim listićima) alfa-česticama. Rutherford je s pomoću klasične mehanike i klasične elektrodina-

derstand how much energy and devotion are required to write a text and turn it into a university textbook which then becomes a reliable transporter of knowledge from an (expert) author to an (interested) student.

But, let us turn to nuclear physics where N. Cindro had been residing for decades and where he found new ideas and new knowledge which stay there as his legacy to generations.

We can say that nuclear physics started with the famous experiment by E. Rutherford (1871–1937) and his associates (H. Geiger and E. Marsden) in the year 1911. They showed that an atom could be described by a „planetary model“ which consists of an amount of positive matter in the middle of a huge empty space which is then surrounded by a negative charge distributed over the sphere. The experiment consisted of a source of alpha particles that targeted golden foils and the number of scattered particles – small sparks on a screen – was counted (by Geiger and Marsden). Rutherford derived his famous formula using classical mechanics and classical electrodynamics. Even today scientists doing calculations for similar scattering processes often refer to this formula. One has to remember that it was the pre-quantum age since quantum mechanics – the theory of microscopic processes was „invented“ about one decade later. After the discovery of the proton as the source of the positive charge in the nucleus of the planetary model and after the discovery of the neutron as its neutral partner the whole nucleon family was known. It was evident that these particles within the nucleus keep together some peculiar force, certainly not of electromagnetic origin since it holds together with the same strength protons as well (neutral) neutrons. Therefore, one of

mike izveo čuvenu Rutherfordovu formulu na koju se i danas fizičari pozivaju pri razmatranju sličnih procesa raspršenja. Tu se valja sjetiti da je to bilo predkvantno vrijeme, tj. teorija mikroskopskih procesa – kvantna mehanika „izumljena“ je deceniju kasnije. Nakon otkrića protona kao one pozitivne tvari koja čini jezgru „planetarnog modela“ i njegovog partnera neutrona, čime je zaokružena obitelj nukleona, postalo je jasno da te čestice u jezgri drži neka druga sila, jača od (odbojne) elektromagnetske, ali i posebna, zato jer jednako jako drži zajedno protone i neutrone (koji, sjetimo se, nisu električki nabijeni). Prema tome, jedan od centralnih problema nuklearne fizike jest razumijevanje nuklearne sile i to traje od slavinih dvadesetih i tridesetih godina dvadesetog stoljeća sve do danas. Odmah sljedeći problem, usko vezan uz prvi, jest razumijevanje strukture jezgre. Tu su se, kao i kod opisa sile, stvarali različiti modeli jezgre (optički model, model ljski itd.) i tu je N. Cindro dao važan doprinos (**slika 4**).

Načini raspršenja bili su, kao i danas, najvažniji izvor podataka o procesima i strukturama. To je vidljivo i iz početka drugoga znanstvenog rada (**slika 5**), koji je zapravo djelomični sadržaj Cindrine doktorske disertacije.

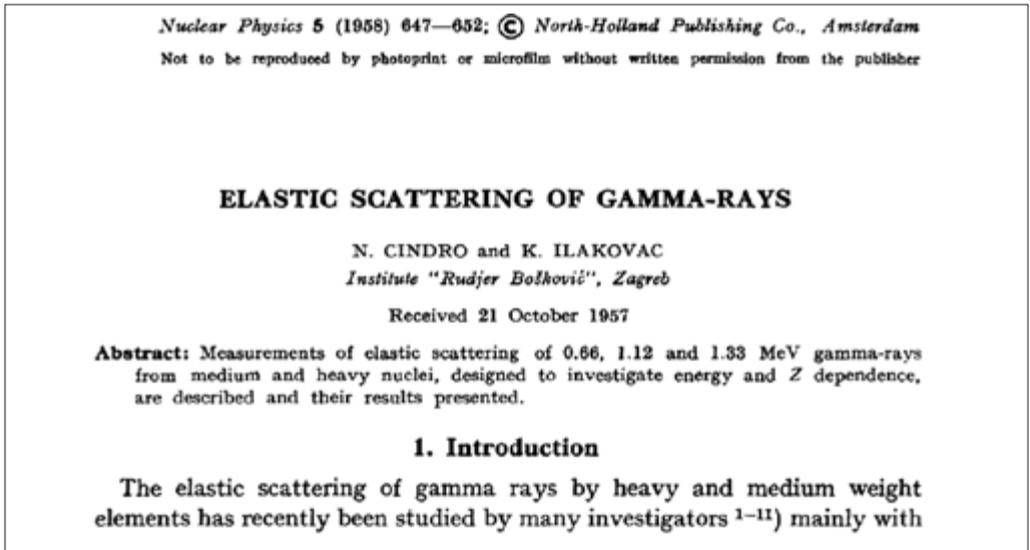
Uz jaku nuklearnu silu koja drži nukleone u jezgri te već od ranije poznate elektromagnetske sile, danas znamo da postoji i treća mikroskopska sila – slaba (nuklearna) sila koja ima važnu ulogu u mikroskopskim procesima (elementarnih čestica i jezgre). Četvrta osnovna sila u prirodi, gravitacijska sila, ostaje za sada

the central problems of nuclear physics was (and still is) understanding this mysterious force. These efforts last until today, from the glorious days of the twentieth century. The next important problem, closely connected to the first one, is understanding the structure of the nucleus. As in the case of the nuclear force for the nuclear structure have been constructed different models (optical model, shell model, etc.) and here N. Cindro gave important contributions (**Figure 4**).

Scattering processes were, as they are today, the most important source of data about processes and structures within nuclei. This could be seen from the introduction of the second scientific paper by N. Cindro and N. S. Wall which is reproduced in **Figure 5**. This paper is in fact the main content of N. Cindro's doctoral dissertation.

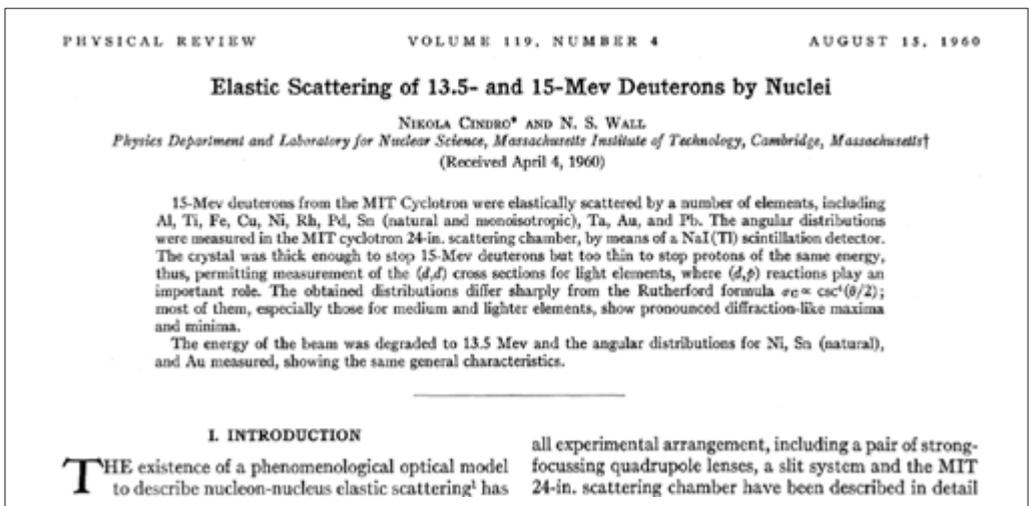
Apart from the (strong) nuclear force which holds the nucleons together and from the electromagnetic force known for a long time, we know today that there is another, third microscopic force – weak (nuclear) force which plays a very important role in the microscopic processes (of elementary particles and in the nucleus). The fourth fundamental force in nature is the gravitational force which is somewhat remote from the unified model of the first three fundamental forces in the model called the Standard model.

The serious research in nuclear physics, which stems from experiments „a la Rutherford“ and from the theory of microscopic processes – quantum mechanics, produced a research topic that established itself as an independent research field – elementary particle physics. This common origin can be seen in many books that have titles like „Nuclear Physics and Physics of Elementary Particles“. For years people doing research in nuclear



SLIKA 4. Naslovna stranica prvoga znanstvenog rada Nikole Cindre i Ksenofonta Ilakovca, ref. [1] iz (15)

FIGURE 4. The title page of the article was written with Ksenofont Ilakovac as the first scientific paper by Nikola Cindro, a ref. [1] from (15)



SLIKA 5. Naslovna stranica rada koji prikazuje djelomični sadržaj doktorske disertacije N. Cindre, ref. [3] iz (15)

FIGURE 5. The title page of the paper, in fact, represents the partial content of N. Cindro's doctoral dissertation, ref. [3] from (15)

nekako odvojena od ujedinjene teorije sila u modelu zvanom Standardni model.

Nuklearna fizika čije je pravo istraživanje izniklo iz eksperimenata „*a la Rutherford*“ i iz teorije mikroskopskih procesa – kvantne mehanike, bila je odskočna daska za danas posve samostalan smjer istraživanja – za fiziku elementarnih čestica. To zajedničko ishodište vidi se u nizu naslova knjiga (malo starijih izdanja) koje nose naslove poput *Nuklearna fizika i fizika elementarnih čestica*. Ono što je dovelo do ponovnog „spajanja“ nuklearne fizike i fizike elementarnih čestica je otkriće kvantne kromodinamike – QCD. To je teorija jakog međudjelovanja, teorija jake nuklearne sile koja na metodama kvantne teorije polja objašnjava jako međudjelovanje kvarkova – čestica od kojih je „složen“ proton i neutron. Današnji trenutak nuklearne fizike i fizike elementarnih čestica ima niz važnih dodirnih točaka u kojima se metode jedne pretaču u metode druge i obrnuto. Tu valja istaknuti primjerice tzv. kiralnu perturbacijsku teoriju poniklu u česticama a primijenjenu u jezgri. Svaka-ko, zanimljiva je i hipernuklearna fizika u kojoj je u jezgri jedan nukleon zamijenjen elementarnom česticom zvanom hiperon, elementarna čestica koja (najčešće) ima kvark koji se normalno ne nalazi u jezgri. Niz procesa kojima se istražuju ta područja povezana su s teškim ionima, što je tema koja je i Nikolu Cindru zaokupila krajem 1970-ih godina.

Ovdje je ipak dobro sjetiti se velikoga talijanskog fizičara Enrica Fermija (1901. – 1954.), za kojeg se danas kaže da je bio „čovjek koji je sve znao“ (a tako glasi i nje-

physics and in particle physics could not see too many connections between these two research areas. But the situation changed after the discovery of quantum chromodynamics (QCD). QCD is the theory of strong interaction between quarks, the theory of the strong force which is based on the quantum field theory and explains the interaction between quarks which are building stones of nucleons. The force is mediated by gluons. Today, nuclear physics and elementary particle physics have many common points at which methods of the first are used by the second and vice versa. It could be mentioned the chiral perturbation theory which stems from particle physics and enters nuclear physics, or hypernuclear physics which is the basic physics of particles containing quarks that are not present in a nucleus, and such a particle replaces one nucleon with remarkable global properties. The problems of the interaction of nuclei and heavy ions certainly belong to the common points and precisely this part of (nuclear) research became part of N. Cindro's interest in the late seventies.

It is interesting to recall the great Italian physicist Enrico Fermi (1901–1954) for whom today people use to say that he was „the man who knew everything“ (and these words are part of the title of his biography). Translating those words to physics one arrives at the notion of the physicist who possessed expertise in experimental physics, in constructing experimental facilities (like the first nuclear reactor in 1942 in Chicago), but at the same time who was able to interpret and understand experimental results using the most sophisticated physical theories. Such a man united the „two cultures“. Also, E. Fermi is well-known as the author of a series of textbooks in theoretical phys-

gova biografija). U prijevodu na fiziku, to se može objasniti tako da je riječ o fizičaru koji je jednako dobro znao graditi eksperimentalne uređaje (pa i prvi nuklearni reaktor godine 1942. u Chicagu) kao i opisati ih najpreciznijom teorijom. Riječ je, dakle, o čovjeku koji je u sebi ujedinio „dvije kulture“, a uz to bio je poznat po nizu tekstova iz teorijske fizike koji i dalje predstavljaju prava remek-djela nastavne literature iz fizike.

Nikola Cindro bio je sigurno eksperimentalni fizičar iz područja nuklearne fizike. Ali, iz njegova znanstvenog opusa vidljiv je niz revijalnih članaka (u eminentnim časopisima) poput *Review of Modern Physics*, ref. [22] iz (15); *Rivista del nuovo cimento* ([34], [61]), *Nukleonika* ([41]), *Ann. Phys. Fr.* ([82]) itd. koji pokazuju da N. Cindro nije bio samo ekspert u „slaganju“ eksperimenata i mjerenja već je razumio i duboku teorijsku pozadinu problema, što nas upravo i podsjeća na sintagmu „čovjek koji je sve znao“.

Već je ranije spomenuto buđenje Cindrina interesa za procese raspšenja teških iona. Taj je zaokret vidljiv iz njegove znanstvene bibliografije (15), gdje se javlja rad godine 1976., a zatim sve češće prema 1980-ima. Fizika teških iona dominira ostatkom njegove znanstvene karijere. U okviru tih istraživanja došao je do nekih spoznaja koja sam navodi kao vrhunac svojega znanstvenog rada, a riječ je o nuklearnim molekulama koje nastaju pri procesima raspšenja. Tu je i početak stvaranja grupe uglednih fizičara iz Hrvatske (Institut *Ruđer Bošković*, Sveučilište u Zagrebu, Sveučilište u Splitu) koji su se uz

ics which even today represent the highest standards in physics.

N. Cindro was certainly an experimental physicist from the experimental nuclear physics research but among his scientific publications, one can see the number of publications of the review type in the most eminent review journals like *Review of Modern Physics*, ref. [22] in (15), *Rivista del nuovo cimento*, ref. [34], [61], *Nukleonika* [41], *Ann. Phys. Fr.* [82] it is evident that apart from the experimental skills he understood the theoretical background of the problems and these facts certainly remind us of the syntagma „the man who knew everything“.

We have already mentioned N. Cindro's interest in processes with heavy ion scattering. This turning point in his experimental work is first seen around 1976, and more often in later years towards the eighties. The physics of heavy ions will dominate the rest of his scientific career. Within this research, he arrived at some results which he himself called the peaks of his contribution to (nuclear) physics. The heavy ion scattering showed some results which he interpreted as the existence of certain nuclear molecules present in many nuclei. Here one can trace also the beginning of the formation of the group of physicists from Croatia (IRB, University of Zagreb, University of Split, **Figure 6**). These physicists acquired international recognition and careers. Here we will omit their names but which could be found in ref. (15), from 1976 on.

This interest in the transfer of knowledge N. Cindro best realized in his university textbooks *Fizika 1* and *Fizika 2*. These textbooks were for a long time the best reference books for teachers and students in technical universities in Zagreb

Cindrinu pomoć afirmirali u svjetskim razmjerima. Ovdje izostavljamo njihova imena ali upućujemo na referencije iz (15) od godine 1976. pa nadalje.

Iz ranije opisane biografije vidimo da je kod N. Cindre cijelo vrijeme postojao interes približavanja komplicirane fizike mikrosvijeta mlađim naraštajima, pa možemo slijediti niz članaka u *Matematičko-fizičkom listu* (slika 6) i u *Privodi*.

Taj je interes za prenošenje znanja N. Cindro najbolje realizirao u svojim sveučilišnim udžbenicima (slika 7) koji su bili nezaobilazni izvori znanja iz fizike generacijama studenata tehničkih fakulteta u Zagrebu i Splitu. U tom je kontekstu zanimljiva suradnja N. Cindre i Waltera

and Split (Figure 7). It is interesting here to note that N. Cindro has some publications with Walter Greiner, a ref. [64] in (15), a German physicist who is well-known as the author of a list of university textbooks on modern physics topics like quantum mechanics, special relativity, nuclear physics, quantum field theory, etc.

Epilogue

These pages certainly do not exhaust the presentation of N. Cindro's contributions to Croatian physics but we believe that the text showed that he was a versatile man, a physicist „who knew everything“ and who was always prepared to share his expertise and broad knowledge with those who feel the same urge which carried N. Cindro in the



SLIKA 6. Početak Cindrina rada iz *Matematičko-fizičkog lista* o jednom izuzetno važnom zakonu u fizici

FIGURE 6. Opening sentences of an article about a very important physical principle in the journal *Matematičko fizički list*, the journal for high school students

Greinera, primjerice ref. [64] iz (15), poznatog autora niza udžbenika iz moderne fizike (kvantne mehanike, specijalne relativnosti, nuklearne fizike, kvantne teorije polja itd.).

Epilog

Ovim prikazom rada N. Cindre sigurno nije iscrpljen cijeli njegov doprinos hr-

world, but which brought him back to his country, to his family and to his people.

3) Other publications and activities by Nikola Cindro

In chapter 2.1) it has already been pointed out that so far the most complete list of Cindro's scientific publications was published by Zoran Basrak,

vatskoj fizici, ali je, vjerujemo, pokazao da je N. Cindro bio svestran čovjek, fizičar „koji je sve znao“ i koji je uvijek bio spreman to svoje bogato znanje podijeliti s onima koji osjećaju isti poriv koji je i njega samoga odveo tako daleko u svijet, ali ga je i vratio njegovoj domovini, njegovoj obitelji i njegovom narodu.



SLIKA 7. Naslovne stranice sveučilišnih udžbenika (*Fizika 1* i *Fizika 2*) N. Cindre; ti su udžbenici godinama bili izvor znanja iz klasične fizike

FIGURE 7. Title pages of university textbooks (*Fizika 1* and *Fizika 2*) by N. Cindro; these textbooks have been a source of knowledge in classical physics for years

3. Ostale publikacije i aktivnosti Nikole Cindre

U poglavlju 2.1. već je istaknuto da su dosad najpotpuniji popis Cindrinih znanstvenih publikacija (radova) objavili Zoran Basrak, Roman Čaplar i Vladimir Paar. Navedeno je 139 bibliografskih jedinica. (15) Tome pridodajemo popis ostalih Cindrinih publicističkih aktivnosti: uređivačka djelatnost, savjeti i odbori – 12 zaduženja (2, 8).

Roman Čaplar and Vladimir Paar; 139 bibliographic units are listed. (15) We add a list of Cindro's other publications: editorial activity, councils and committees – 12 responsibilities (2, 8).

The following is a new list of works in journals and proceedings – 58 bibliographic units (further: b. j.), in the journal *Matematičko-fizički list* – 9 b.

j. (16) and *Priroda* – 7 b. j. (17), in other magazines – 3 b. j., then books and newsletters – 7 b. j., chapters in books and proceedings and progress reports – 5 b. j. and one book translation as one bibliographic unit.

3.1) Editing (editor, coeditor, member of the publication board)

1. *Nuclear Structure and Nuclear Reactions*, Proceedings of Ninth Summer Meeting of Nuclear Physicists, Herceg Novi, 1964.

Slijedi novi popis radova u časopisima i zbornicima radova – 58 bibliografskih jedinica (dalje: b.j.), u časopisu *Matematičko-fizički list* – 9 b. j. (16) i *Prirodi* – 7 b. j. (17), u ostalim časopisima – 3 b. j., zatim knjige i bilteni – 7 b. j., poglavlja u knjigama i zbornicima radova – 5 b. j. i jedan prijevod knjige kao jedna bibliografska jedinica.

3.1. Uređivačka djelatnost (urednik ili suurednik, član izdavačkog savjeta i član uredničkoga odbora)

1. *Nuclear Structure and Nuclear Reactions*, Proceedings of Ninth Summer Meeting of Nuclear Physicists, Herceg Novi, 1964.
2. *Proceedings of the Europhysics Study Conference on Intermediate Processes in Nuclear Reactions*, Plitvice, 1972, Berlin-Heidelberg, 1973. zajedno s P. Kulišićem i T. Mayer-Kuckukom.
3. *Nuclear Molekular Phenomena*, Hvar, 1977.
4. *Dynamics of Heavy Ion Collisions*, Amsterdam 1981.
5. *Fundamental Problem in Heavy Ion Reactions*, Singapore, 1984. zajedno s W. Greinerom i R. Čaplarom.
6. *Frontiers of Heavy Ion Physics*, Singapore, 1987. zajedno s W. Greinerom i R. Čaplarom.
7. *Proceedings of the 174. Weberaeus – Seminar: NEW IDEAS on Clustering in Nuclear and Atomic Physics*, Njemačka, 1997. zajedno s W. Scheidom.
8. *Scientists against the War in Croatia*, Zagreb, 1992.

Su-urednik urednik časopisa

1. *Heavy Ion Physics*

Član međunarodnoga izdavačkog savjeta časopisa

1. *Acta Physica Slovaca*
2. *Europhysics Letters*, do 1987.

2. *Proceedings of the Europhysics Study Conference on Intermediate Processes in Nuclear Reactions*, Plitvice, 1972, Berlin-Heidelberg, 1973. together with P. Kulišić and T. Mayer-Kuckuk.
3. *Nuclear Molecular Phenomena*, Hvar, 1977.
4. *Dynamics of Heavy Ion Collisions*, Amsterdam 1981.
5. *Fundamental Problem in Heavy Ion Reactions*, Singapore, 1984. together with W. Greiner and i R. Čaplar.
6. *Frontiers of Heavy Ion Physics*, Singapore, 1987. together with W. Greiner and R. Čaplar.
7. *Proceedings of the 174. Weberaeus – Seminar: NEW IDEAS on Clustering in Nuclear and Atomic Physics*, Germany, 1997. together with W. Scheid.
8. *Scientists against the War in Croatia*, Zagreb, 1992.

Coeditor of the journal

1. *Heavy Ion Physics*

Member of the international publishing board for the journals

1. *Acta Physica Slovaca*
2. *Europhysics Letters*, to 1987.

Member of the editorial board

1. *Scientific Research in Croatia*, MZT, Zagreb, 1995.

3.2) Publications in other journals, proceedings and books of abstracts

1. N. Cindro and P. Klein: *Alpha-d Reactions on B^{10} and N^{14}* , Progress Report, Mass. Inst. of Technology (LNS) (1957/1958) 149–150.
2. P. Klein and N. Cindro: *A Time – of – flight Apparatus for fast Neutrons*, Progress Report, Mass. Inst. of Technology (LNS) (1958) 144–145.
3. M. A. Mekannof and N. Cindro: *Analysis of Elastic Scattering of Deuterons with Optical Model*, Proc. of the Tallahassee Conf. On the Nuclear Optical Model, 1958, pp. 272–286.

Član uredničkog odbora časopisa

1. *Scientific Research in Croatia*, MZT, Zagreb, 1995.

3.2. Radovi u časopisima i zbornicima radova

1. N. Cindro and P. Klein: *Alpha-d Reactions on B^{10} and N^{14}* , Progress Report, Mass. Inst. of Technology (LNS) (1957/1958) 149–150.
2. P. Klein and N. Cindro: *A Time – of – flight Apparatus for fast Neutrons*, Progress Report, Mass. Inst. of Technology (LNS) (1958) 144–145.
3. M. A. Mekannof and N. Cindro: *Analysis of Elastic Scattering of Deuterons with Optical Model*, Proc. of the Tallahassee Conf. On the Nuclear Optical Model, 1958, pp. 272–286.
4. N. Cindro: *A Method of Charged Particle Selection*, Glas. Matem.-fiz. i astron. **15** (1960) 113–118.
5. L. W. Swenson and N. Cindro: *Energy and Angular Distributions of Protons from (α , p) Reactions*, Bull. Am. Phys. Soc. **5** (1960) 76–77.
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13. N. Cindro: *Basic evidence and properties of single-particle levels*, In: *Theory of nuclear structures*, IAEA, Vienna, 1970, pp. 195–226.
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 13. N. Cindro: *Basic evidence and properties of single-particle levels*, In: *Theory of nuclear structures*, IAEA, Vienna, 1970, pp. 195–226.
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 16. N. Cindro: *Selected topics in nuclear reaction mechanisms*, Proc. 4th Summer School of Nucl. Phys. Rudziska, Poland, Vol. II, 1971, pp. 73–182.
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1. Frank Close: *Svemirska lukovica – Kvarkovi i priroda svemira*, Školska knjiga, 1997.

Zaključno

Najpotpuniji popis Cindrinih radova do sada iznosio je 139 referencija. On se u ovome radu dopunjuje s još 90 referencija pa ukupni popis njegovih referencija iznosi 229. Novonavedenih 90 referencija grupirano je u pet kategorija: radovi u časopisima i zbornicima (58), stručni i popularni radovi (19), knjige i bilten (7), po-

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The final word

The most complete list of N. Cindro's publications consists of 139 entries (15). Here we have added another 90 entries so the total list of his publications gives 229 entries. New entries are grouped into five different categories: 58 in other journals and proceedings, 19 popular texts, 7 books and bulletin, 5 book chapters and proceed-

glavlja u knjigama i zbornicima radova (5) i prijevod knjige (1). Na osnovi navedenog može se zaključiti da je Cindro imao značajniju ulogu u povijesti publicistike fizike nego što se dosad pretpostavljalo.

ZAHVALA

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ings, and 1 book translation. It is more than evident that N. Cindro had an important role in the history of physics publications, much more than it has been assumed.

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Starohrvatske crkvice šesterolisnog tipa na splitskom području – prirodno načelo ekonomičnosti ili štedljivosti*

Old Croatian churches of the six-leaf type in the Split area – a natural principle of economy or thrift*

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SAŽETAK

Promatrajući niz temeljnih poglavlja kojima se bavi znanstvena analiza teorije arhitekture i povijesti umjetnosti, moguće je uočiti nekoliko, iako različitih, međusobno čvrsto povezanih bitnih tema. Među njima se, kao vodeći, ističe problem graditeljskoga oblika koji se javlja kao posljedice utjecaja organizacije prostora, fizički definiranoga konstruktivnom strukturom djela, dok na likovno-estetskom planu nalazimo postojanje skale elemenata i načela sređivanja svake arhitektonsko-graditeljske kompozicije. Budući da su teme arhitektonskih oblika, to jest, definicija arhitektonskog korpusa, gotovo neiscrpne, s obzirom na ukupno široke mogućnosti prilaženja svakoj od njih,

SUMMARY

Observing a number of fundamental chapters dealing with the scientific analysis of architectural theory and art history, it is possible to note several, albeit different, closely related topics. Among them, the most prominent is the problem of the architectural form, which arises as a consequence of the influence of the organization of space, physically defined by the construction structure of the work, while on the visual and aesthetic plane, there is a scale of elements and principles of arranging each architectural construction and architectural composition. Since the themes of architectural forms, that is, the definition of the architectural corpus, are almost inexhaustible, given the broad possibilities of being attached to each of them, this paper presents a narrow analysis that looked at the influence of nat-

* Članak je djelomice referiran na znanstvenom skupu *Hrvatski prirodoslovci 31*, Split, 25. – 26. studeni 2022.

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u ovom se radu prišlo užoj analizi kojom je promatran utjecaj prirodnih zakonitosti na arhitektonsko djelo i to u segmentu načela ekonomičnosti ili tendencije ka štedljivosti u djelima starohrvatske arhitekture na splitskom području. Na temelju eksperimentalne geometrijsko-matematičke analize, koja je ovim radom po prvi put javno predstavljena u Hrvatskoj, nastojalo se što egzaktnije utvrditi pravu vrijednost ekonomičnog postupanja u definiranju dispozicije tlorisa crkvice centralnoga šesterolisnog tipa, promatrajući njegovu interpretaciju u likovnosti njihovih habitusa i kompaktnosti unutarnje strukturalne jezgre. Obradom odabranih primjera nastojalo se steći što pouzdaniju sliku o učinku i ulozi prirodnih zakonitosti u kreiranju tih autohtonih starohrvatskih „malih katedrala“ na području Splita.

KLJUČNE RIJEČI

crkvice šesterolisnog tipa

- načelo ekonomičnosti ili štedljivosti
- splitsko područje
- starohrvatska sakralna arhitektura

Uvod

Osnovna poglavlja teorije arhitekture obuhvaćaju problem definicije prostora u arhitekturi, funkcije prostora, konstrukcije, koja kao materijalno-tehničko ostvarenje definira željeni arhitektonski prostor i njegov morfološki plan – oblik, uz kompozicijske zakonitosti, tj. usklađenje elemenata oblikovanja temeljem načela arhitektonske kompozicije – reda, ritma, simetrije, proporcije, euritmije i drugih kompozicijskih zakonitosti. (1)

U razvoju teorijske misli postoje raznoliki pristupi navedenim temama, raznoli-

ural laws on architecture work, in the segment of the principles of cost-effectiveness or tendency towards frugality in the works of early Croatian architecture in the Split area. On the basis of the experimental geometric-mathematical analysis, which was for the first time publicly presented in our country, we tried to determine, as precisely as possible, the true value of a cost-effective way of doing things in defining the layout of the planes of churches of the central hexagonal planar type, observing its interpretation in the likeness of their habitus and the compactness of the internal structural core. By working on selected examples, we tried to get as reliable a picture as possible of the effect and role of natural laws in the creation of these indigenous old Croatian „small cathedrals“ in the Split area.

KEYWORDS

hexagonal-type churches

- old Croatian sacral architecture
- principle of cost-effectiveness or thrift
- Split area

Introduction

Basic chapters of the theory of architecture are concerned with the problem of defining space in architecture, the function of space and construction, which, as a material-technical realisation, defines the proposed architectural space and its morphological plan form, with compositional rules, i.e., harmonisation of the designing elements on the basis of the principle of architectural composition – order, rhythm, symmetry, proportion, eurythmy and other rules of composition. (1)

The development of theory involves various approaches to the above topics, various methods of solving them, as well as various conclusions, as a result of different conceptual, design, formal, rational, constructivistic or functionalistic approaches to the analysis. (2)

ke metode njihova rješavanja i raznoliki zaključci kao posljedica raznolikoga idejnog, oblikovnog, formalnog, racionalnog, konstruktivističkog ili funkcionalističkog pristupa analizi. (2)

Promatrajući široku materiju koju proučava teorija arhitekture, moguće je uočiti da je niz čimbenika koji sudjeluju u procesu nastanka pojedinog arhitektonskog djela, a osobito u definiciji njegova materijalnog tijela (korpusa), još uvijek u znatnom dijelu otvoreno za znanstvenu analizu.

Jedno od područja u kojemu nalazimo bogatstvo istraživačkoga materijala, osobito u pogledu morfološkoga plana, predstavlja područje prirode.

U prirodi, kojoj pripada i sam čovjek, nalazimo gotovo nesagledivo bogatstvo oblika koje u globalnoj podjeli možemo razvrstati u oblike anorganske (nežive) i organske (žive) prirode. Tu je još jedno isto tako nedovoljno istraženo polje oblika, koje pripada graditeljstvu živih bića niže organizacijske razine od čovjeka.

U svim tim prostornim definicijama postoje zakonitosti koje njihove sastavne elemente drže na okupu, stvarajući oblik koji vidimo u prostoru. Prema njihovu učinku ti oblici izgledaju upravo tako kako su predstavljeni u realnosti.

Oblici u prostoru i zakonitosti njihova definiranja

Kao što je već spomenuto, u našem prirodnom okolišu postoji velebni fond izvedenih oblika. U krugu analize oblika živoga svijeta, razlikuju se tri glavne grupe oblika – biljni svijet, životinje i čovjek. A u podgrupi oblika koji su „izgrađeni“ nalazi-

Observing the broad area investigated by the theory of architecture, it can be seen that a number of factors involved in the process of creating a particular piece of architecture, especially regarding the definition of its material body (corpus), are still in a considerable manner open to scientific analysis.

One of the fields that offer an abundance of material for research, particularly regarding the morphological plan, is the area of nature. Nature, which includes man as well, contains an almost endless wealth of forms, which, in the global division, could be sorted into the forms of inorganic (inanimate) and organic (living) nature. There is also another under-researched field of forms, belonging to the building activities of a lower organisational level than human one.

All of these definitions of space include rules that keep their constituent elements together, creating a form we can see in space. According to their effects, these forms appear exactly as they are represented in reality.

Forms in space and the rules of their definition

As mentioned above, our natural environment offers a magnificent fundus of derived forms. Three main types of forms can be distinguished in the area of analysing the living world – plant worlds, animals and man. In the subgroup of the “constructed” forms, there are the objects of human building and architecture, together with, not often perceived but still fascinating, group of built objects apart from this world and the impact of man-building performed by nature itself. (3) Construction analysis of these forms reveals the regularity by which they are structured, and which can be interpreted mathematically as proof of their presence.

One of the acting rules of structuring spatial forms is cost-effectiveness or thrift, which is in an

mo djela ljudskoga graditeljstva i arhitekture i ne tako zapaženu, ali fascinantnu grupu uradaka graditelja koji stoje izvan toga svijeta i utjecaja čovjeka – graditeljstvo same prirode. (3) U analizi građe svih tih oblika uviđamo pravilnost po kojoj su oni strukturirani, a koje se mogu matematički interpretirati kao dokaz njihove prisutnosti.

Jedna od djelujućih zakonitosti strukturiranja prostornih oblika je ekonomičnost ili štedljivost, koju u neživom svijetu proizvodi sama sila gravitacije povezujući tvari u kuglaste oblike (planeti, zvijezde, galaksije), a u živom svijetu štednja je u neposrednoj funkciji samoga održanja jedinke u prostoru (egzistencijalne potrebe).

Prema načelu štedljivoga postupanja stvoren je termin „lex parsimonia“; lex, legis, f. (*lat.* zakon) (4) i parsimonia -ae, f. (*lat.* štedljivost, štednja). (5) Tumačenje pojma ekonomičnosti nalazimo kao „načelo postupanja u gospodarskoj aktivnosti koje teži ostvarenju što većeg učinka uz što manji utrošak neophodnih činilaca.“ (6)

Kao vizualna posljedica primjene načela ekonomičnog postupanja ili tendencije prema štedljivosti, nalazimo kvalitetu jednostavnosti. Pojam jednostavnosti razumijeva odsutnost bilo kakvoga balastnog materijala i dodatne dekorativnosti. U likovnom izražavanju ostvarivanju kvalitete jednostavnosti izrazito pridonosi uporaba ritma, razmjera i osobito simetrije u strukturiranju mase određenog djela.

Opće je prihvaćeno tumačenje da se Priroda ispoljava u većini svojih aktivnosti i nastalih oblika upravo karakterom izrazite štedljivosti i jednostavnosti u svojim postupcima. (7) Također je nedvojbe-

inanimate world caused by gravity itself, joining matter in spherical forms (planets, stars, galaxies), while cost-effectiveness is in a living world in a direct function of individual survival in space (existential need).

The term „lex parsimonia“; lex, legis, f. (*lat.* law, rule) (4) and parsimonia -ae, f. (*lat.* cost-effectiveness, thrift) has been coined following the rule of cost-effective practice. (5) The term „cost-effectiveness“ is described as „*the principle of acting in economic activities so as to aim at as high an effect as possible, with as low expenditure of necessary factors as possible.*“ (6)

The visual result of applying the principle of cost-effective practice or the tendency of thrift is the quality of simplicity. Simplicity includes the lack of any unnecessary material and additional decorativeness. In the field of artistic expression, the quality of simplicity is strongly promoted by the use of rhythm, proportion and, particularly, symmetry in structuring the mass of a particular object.

It has generally been acknowledged that Nature expresses itself in most of its activities and forms created exhibiting the character of extreme cost-effectiveness and simplicity in all of its actions. (7) It has also been proved without a doubt that cost-effectiveness and its values are directly linked to the act of creation in Nature. (8)

The cost-effectiveness component in Nature

In general, numerous phenomena and forms can be found in Nature that have been created by the most diverse activities and creation processes. If we, on one hand, disregard exclusive explanations on a completely predetermined process of formation for these phenomena and forms in Nature, (9) and on the other, the opposite explanations on a completely independent process of arbitrariness and coinci-

no dokazano kako su ekonomičnost i nje-
ne vrijednosti neposredno vezane uz sam
stvaralački čin Prirode. (8)

Komponenta ekonomičnosti u Prirodi

Općenito uzevši, u Prirodi nailazimo
na brojne fenomene i oblike koji su nastali
iz najrazličitijih aktivnosti i procesa stva-
ranja. Ako se s jedne strane izuzmu isklju-
čiva tumačenja o unaprijed posve deter-
miniranom procesu nastajanja tih pojava
i oblika u Prirodi, (9) a s druge strane to-
me suprotna tumačenja o potpuno neovi-
snom procesu proizvodnosti i slučajnosti,
(10) preostaje prihvatljivije tumačenje da
su svi oni u najvećoj mjeri upravo rezultat
interakcijskoga odnosa organske i anor-
ganske materije i određenih energetske
potencijala, koji djeluju u skladu s nizom
opće poznatih zakonitosti fizičke prirode.

Kod organskih oblika nailazimo na niz
čimbenika koji aktivno djeluju u tom pro-
cesu od samoga početka njihova nastaja-
nja. Dominiraju termo-dinamički procesi
(11) i opće poznati faktori selekcije i mo-
difikacije. Osim tih tendencija javljaju se i
ostali čimbenici – momenti svrhe, stabil-
nosti i volje. (12)

U tom postupku nastajanja osjeća se i
snažno djelovanje općih prirodnih težnji
prema jednostavnosti, ravnoteži i srede-
nosti oblika.

U procesu nastajanja graditeljskih obli-
ka životinja-graditelja, dominira skala ni-
za prirodnih čimbenika, kojih je osnovni
karakter automatizam i stalnost u djelo-
vanju, uz osnovni cilj punoga zadovolje-
nja njihovih primarnih egzistencijalnih

dence, (10) what remains is a more acceptable ex-
planation that they (phenomena and forms) are to
a great extent the result of the interactional relation
of organic and inorganic matter with particular en-
ergy potentials, such that act in accordance with a
number of well-known laws of physical nature.

Organic forms show a series of factors that act in
the process from the very beginning of their exist-
ence. Thermodynamic processes are prevalent (11),
as well as the commonly recognise factors of selec-
tion and modification. Apart from these trends,
other factors also occur – the moments of purpose,
stability and will. (12)

A strong impact can be seen within the process
of creation, of a general natural tendency towards
simplicity, balance and neatness of form.

A series of natural factors, as a key characteris-
tics of which are automatism and permanence of
activity, dominate in the process of forming build-
ers forms of animal-builders, where the key pur-
pose is satisfying their primary existential needs.
(13) Namely, the principle of entropy, as the sec-
ond law of thermodynamics, undoubtedly says that
everything is subjected to the tendency of univer-
sal balance and suspension of all unnecessary ten-
sions and divisions. (8) It has also been generally re-
nowned that the tendencies towards simplicity and
cost-effectiveness are generally present in Nature as
a whole. They are manifested in the body build of
living creatures – plants, animals and man himself,
quite often in the definition of the form of inorgan-
ic nature and building forms of animal-builders as
well.

A cross-section of the human thigh bone (fe-
mur) clearly shows trajectories of porous substance,
while their distribution follows exactly the distribu-
tion of the forces of pressure and tensile load. This
cost-effective distribution of bone mass offers an
optimal ratio of lightness (weight) and strength,

potreba. (13) Naime, već samo načelo entropije kao drugi zakon termodinamike, nedvojbeno dokazuje da je sve podvrgnuto težnji sveopće ravnoteže i ukidanju svih nepotrebnih napetosti i podjela. (8) Također je prihvaćeno tumačenje da je težnja prema jednostavnosti i štedljivosti opće prisutna u cjelokupnoj Prirodi. Ona se ispoljava u građi živih bića – biljaka, životinja i samoga čovjeka, a nerijetko i u definiciji oblika anorganske prirode i graditeljskim oblicima životinjsko-graditelja.

U presjeku glave bedrene kosti čovjeka jasno su vidljive trajektorije spongiozne supstancije, a njihov raspored prati isključivo raspored sila tlačnoga i vlačnoga opterećenja. Takav štedljivi raspored mase kosti daje optimalni odnos lakoće (težine) i čvrstoće i s minimumom građe postiže se maksimalna otpornost (slika 1).

Fascinantni primjer matematički precizne ekonomične redukcije balastnog tkiva nenosivog materijala i zadržavanje samo neophodno potrebne nosive statičke mase za prihvat sila vanjskog i unutarnjeg naprezanja, nalazimo u primjeru stabljike žitarice. Vlat, kao nosiva konstrukcija stabljike štedljivo je definirana u vidu kružnog prstena, a mehaničko stanište koje preuzima sile opterećenja, nalazi se na njegovu obo-

while minimum constitution material offers maximum strength (Figure 1).

Grain stems offer a fascinating example of mathematically precise, cost-effective reduction of non-bearing ballast tissue, while keeping only unavoidable and necessary bearing static mass, which can accept the static forces of interior and exterior stress. Blade, as a bearing construction of the stem, is defined in a cost-effective manner as a circular ring, while mechanical cells, which take loading forces, are situated on the brim, which is as far as possible from the non-bearing dead central hollow of the stem (Figure 2). (14, 15)

Eagle bones are a good example from the animal kingdom, as they exhibit a considerable reduction in bone mass at the “V”-stiffening, forming a natural grid-like carrier, with optimum stiffness and strength and the least possible use of the matter. Obviously, the primary aim is to construct a light and cost-effective structure (Figure 3). (16)

The example of the snowflake (ice crystal) illustrates,

in the world of inanimate nature, pronounced poly-symmetry, a comprehensive geometric regularity and characteristics of order in the overall composition of the form (Figure 4). (16)

Ever since ancient times, honeycomb has, among the forms “built” by animal builders, attracted open admiration, due to its unsurpassable characteristics, the most cost-effective manner of filling in a plane with groups of hexagons pressed together. This mathematical phenomenon was also

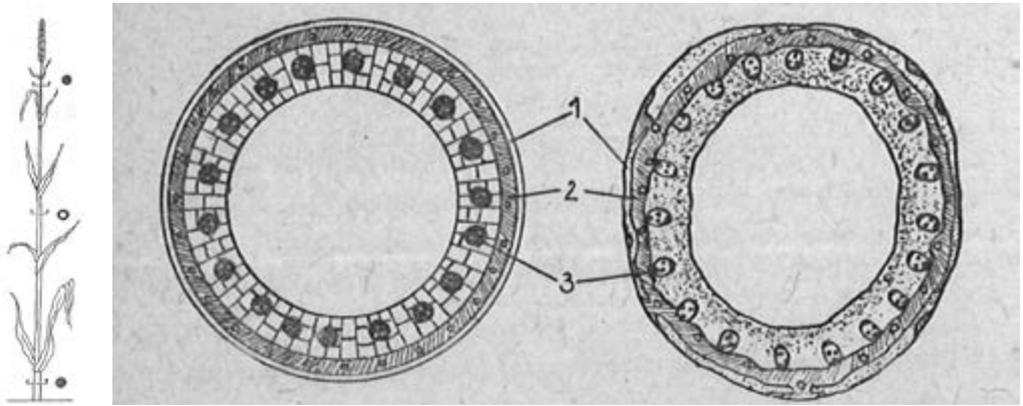


SLIKA 1. Presjek glave bedrene kosti čovjeka

FIGURE 1. Cross section of human thigh bone

du, što dalje od nenosive mrtve središnje šupljine stabljike (**slika 2**). (14, 15)

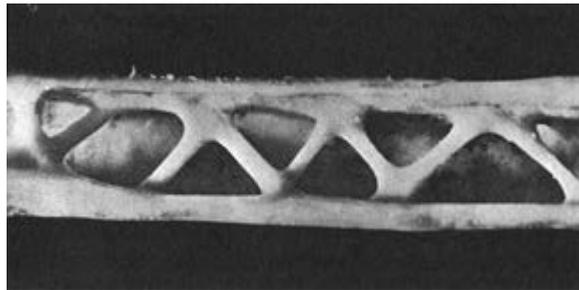
analysed by giants like Johannes Kepler and Ruder Bošković (**Figure 5**). (17)



SLIKA 2. Prikaz građe vlati raži (lijevo), presjek kroz vlati raži (desno); 1 – asimilacijsko staniće, 2 – mehaničko staniće, 3 – provodni snopovi

FIGURE 2. Representation of rye blade (left), rye blade cross-section (right); 1 – assimilation cell, 2 – mechanical cell, 3 – wire bundles

Na primjeru iz životinjskoga svijeta – orlove kosti, vidljiva je snažno smanjenje mase kosti na „V“-ukrućenja, koja oblikuju prirodni rešetkasti nosač, gdje je postignuta optimalna krutost i čvrstoća uz što manji utrošak tvari, s dominantnim ciljem izgradnje lagane i ekonomične konstrukcije (**slika 3**). (16)



SLIKA 3. Detalj orlove kosti
FIGURE 3. Detail of an eagle bone

U svijetu anorganske prirode, na primjeru pahuljice snijega (kristal leda), vidljive su naglašena polisimetričnost, sveobuhvatna geometrijska pravilnost i

Analysing all of these areas of Nature, it can be concluded that, apart from a wide range of all the factors mentioned above and principles taking part in defining the forms, a considerable tendency towards cost-effectiveness and thrift in their overall arrangement can be clearly seen.

analysed by giants like Johannes Kepler and Ruder Bošković (**Figure 5**). (17)

Cost-effectiveness in architectural creation

Written treatises dealing with quality in architecture realised within the scope of morphological solutions of structural-bearing part of the construction, compositional structure, or direct physical re-

karakteristika reda u ukupnoj kompoziciji oblika (**slika 4**). (16)

Od oblika „izgrađenih“ od životinja-graditelja, još je u davnim vremenima pčelinje saće izazivalo neskriveno divljenje zbog svojih nenadmašnih karakteristika, najštedljivijeg načina popunjavanja ravnine skupnim priljubljenim šesterokutima. Tim su se matematičkim fenomenom bavili velikani poput Johannesesa Keplera i Rudera Boškovića (**slika 5**). (17)

Analizirajući sva ta područja Prirode, možemo ustvrditi da se pored široke lepeze svih dosad navedenih čimbenika i načela koji sudjeluju u definiranju oblika, u značajnoj mjeri provlači i težnja prema ekonomičnosti i štedljivosti u njihovu sveobuhvatnom sređivanju.

Ekonomičnost u arhitektonskom stvaralaštvu

U pisanim raspravama o kvaliteti u arhitekturi ostvorenoj unutar kruga morfoloških rješenja konstruktivno-nosivog dijela strukture, kompozicijskom ustroju ili pak neposrednoj fizičkoj realizaciji arhitektonskoga djela u prostoru, ne nailazimo tako često na analize i tumačenja ekonomičnosti kao posebno izdvoje-

alisation of a piece of architecture in space, do not often include analyses and explanations of cost-effectiveness, as a separate notion and subject of analysis. This is true, although, taking into account the

historical-architectural analysis, the value and importance of cost-effectiveness within the scope of architectural creation, could be found as early as with the Roman architect-theoretician Vitruvius.

Within the practical environment of Roman civilisation, Vitruvius wrote of economising with material and with authority asked for the need to follow the standards in realising the idea of cost-effectiveness. (18)

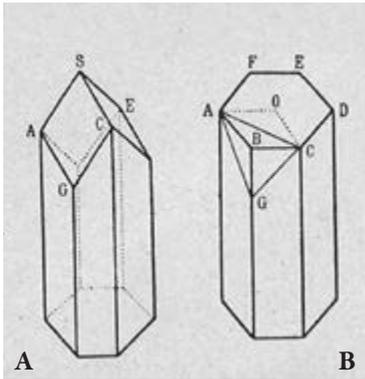
A kind of continuation of this trend to the spirit of cost-effectiveness can also be found in the theory of archi-

tecture in the period of the Renaissance (L. B. Alberti), which followed the reaffirmation of the rational approach of antiquity. (19)

On the other hand, “performance (executive) building” was in a constant pursuit of a maximally cost-effective approach to executing objects and solving a number of details, directly associated with the execution. At the end, this resulted in the establishment of statics as a scientific discipline, bringing about dimensions of building element masses necessary to build a piece of architecture. (20) Architecture as a science, contrary to the above, quite often neglected the problem, primarily because of the potential possibility that this principle could easily grow into a kind of limiting factor when creating pieces of architecture in space. (21)



SLIKA 4. Pahuljica snijega
FIGURE 4. *Snowflake*



SLIKA 5. Geometrijski oblik stanice pčelinjeg saća (A) i postanak stanice iz prizme ravnog dna (B); matematički izvod tupoga kuta romba „alfa“ (prema Ruđer Boškoviću)

FIGURE 5. The geometric shape of the honeycomb cell (A) and the origin of the cell from the flat bottom prism (B); mathematical derivation of the obtuse angle of the rhombus „alpha“ (according to Ruđer Bošković)

noga pojma i predmeta analize. Premda, gledajući kroz povijesno-arhitektonsku analizu, na vrijednost i važnost ekonomičnosti unutar arhitektonskog stvaranja ukazuje već rimski arhitekt-teoretičar Vitruvije.

Unutar pragmatičnog okoliša rimske civilizacije u svojim raspravama o arhitekturi, Vitruvije navodi ekonomiju materijala i autoritativno upućuje na potrebu poštivanja normi vezanih uz njezino ostvarivanje. (18)

Svojevrsni nastavak priklanjanja duhu ekonomičnosti nalazimo u raspravama teoretičara arhitekture renesansnog razdoblja (L. B. Alberti), koje se javljaju

Oplošje stranice sastoji se od 6 trapeza i 3 romba

$$6 \text{ trapeza} = 6 \frac{b+(b-x)}{2} \cdot a = 6ab - 3ax$$

$$3 \text{ romba} = 3 \cdot a \sqrt{3} \sqrt{x^2 + \frac{a^2}{4}} = \frac{3a\sqrt{3}}{2} \sqrt{4x^2 + a^2}$$

Prema tome je oplošje stranice (Sl. A)

$$P = 6ab - 3ax + \frac{3a\sqrt{3}}{2} \sqrt{4x^2 + a^2}$$

$x = ?$ za $P = \min$

$$\frac{dP}{dx} = -3a + \frac{3a\sqrt{3}}{4} \cdot \frac{8x}{\sqrt{4x^2 + a^2}} = 0$$

$$2x\sqrt{3} = \sqrt{4x^2 + a^2}$$

$$x = \frac{a}{\sqrt{8}}$$

$$\text{ako je } AC^2 = 3a^2, \text{ a } GS^2 = 4x^2 + a^2 = \frac{4a^2}{8} + a^2 = \frac{3a^2}{2},$$

onda je

$$GS^2 = \frac{1}{2} AC^2, \text{ iz čega slijedi } \angle = 109^{\circ}28'16''$$

However, recent trends reveal a strong inclination to the principle of cost-effective and thrift, most often when designing mass living and office architecture, especially in creating shell or other free-standing spatial forms, the appearance of which has impacted the appearance of a new aesthetic standpoint on architectural object artistic value in general. (22)

Circle, or circular form and regular hexagon can be pointed out among morphological matrices as the most consistent expression of cost-effectiveness and thrift in designing. It is quite realistic to assume that the appearance and introduction of the circle (circular form) in architecture was, among other things, a result of seeking for a technical most cost-effective building form. (23) Circle, as a plani-

u svjetlu ponovne afirmacije racionalnog pristupa antike. (19)

S druge strane, „izvedbeno graditeljstvo“ bilo je tako reći u stalnom traganju za što egzaktnijim ekonomičnim nastupom pri izvedbi djela i rješavanju niza detalja, neposredno vezanih za tu izvedbu, što je na kraju rezultiralo ustrojstvom statike kao znanstvene discipline, koja donosi dimenzije neophodno potrebne mase gradbenih elemenata da bi se djelo izgradilo. (20) Arhitektonska je znanost, suprotno tome, u najvećoj mjeri zastavljala taj problem, zbog potencijalne mogućnosti da bi to načelo moglo prerasti u svojevrzni ograničavajući čimbenik u postupku prostorne kreacije njenih djela. (21)

No, u najnovije doba nalazimo na snažno priklanjanje načelu ekonomičnosti i štedljivosti, i to izrazito pri oblikovanju masovne stambene i uredske arhitekture, posebice pri stvaranju ljuskastih i drugih samostojećih prostornih oblika, čija je pojavnost utjecala i na oblikovanje novoga estetskog stava o likovnoj vrijednosti arhitektonskoga djela uopće. (22)

Od morfoloških matrica, kao najdosljedniji izraz ekonomičnog postupanja i štedljivosti u oblikovanju, možemo izdvojiti krug, tj. krugoliki oblik i pravilni šesterokut. Realno se pretpostavlja da je do nastanka i uvođenja kruga (kružnog oblika) u arhitekturi došlo, između ostalog, i u traganju za tehnički što ekonomičnijim graditeljskim oblikom. (23) Krug kao planimetrijski lik izražava u karakteru svoje definicije naglašenu usklađenost s bitnim određenjima pojma ekonomičnosti: 1. sve

metric shape, expresses by the character of its definition obvious compliance with key features of the notion of cost-effectiveness: 1. All the points of its perimeter are at the same distance from the center; 2. Only a single dimension is required to construct it – its radius; 3. The perimeter line of a circle is shorter, compared to other regular geometrical shapes, as related to the surface it encloses.

In the language of architecture, it can be said that, compared to other forms, circular one is structurally the simplest, and most cost-effective in execution, as for the necessary amount of building material. (24) If the same circular form is elevated from ground-plan and regarded in its spatial, 3-D rotational variant – as a globe or sphere, the same advantage can be noted – favourable relation between the enclosed space and outer perimeter. (25)

Careful distribution of the ceiling mass in the form of a spherical calotte or some related form, results in an even more cost-effective architectural form - a dome or cupola. (26) This morphological development enables enclosing and covering more of the inner space, with a reduced amount of necessary building material for its realisation.

Primary cost-effectiveness becomes increasingly obvious when dome-shaped structure development is analysed, augmented by the development of new materials, to culminate recently in the definition of thrift. (27) Dome is absolutely the most effective form, as related to the minimal amount of material to get the effect of enclosing space. Dome represents one of the most consistent expressions of applying the authority of cost-effectiveness in defining an upper closing zone of the architectonic space. (28) This high degree of thrift and simplicity is, among other factors, the reason for the early implementation of a circle in architecture and its broad application in various socio-economic formations.

točke njegova oboda jednako su udaljene od središta; 2. za njegovu konstrukciju dovoljna je samo jedna veličina – njegov polumjer; 3. u usporedbi s ostalim pravilnim geometrijskim likovima, u odnosu na površinu koju zatvara, obodna linija kruga je najkraća.

Prevedeno na jezik arhitekture proizlazi da se u odnosu na ostale, kružni oblik iskazuje kao strukturalno najjednostavniji, a glede izvedbe najštedljiviji u odnosu na potrebnu količinu građe. (24) Ako taj isti kružni oblik uzdignemo iz tlorisne vodoravne ravnine i promatramo ga u njegovoj prostornoj, trodimenzionalnoj rotacijskoj varijanti – kugle ili sfere, ponavlja se navedena povoljnost odnosa zatvarajućeg prostora i vanjskog oboda. (25)

Rasporedom mase svoda u obliku sferne kalote ili njoj srodnom obliku, dobiva se još štedljiviji arhitektonski oblik od svoda – kupola. (26) Tim morfološkim napretkom omogućeno je zahvaćanje i prekrivanje još više unutarnjeg prostora uz smanjenje potrebne građe za njegovu realizaciju.

Promatrajući razvoj kupolastih oblika i usporedno tome pojavnost novih materijala, afirmacija primarne ekonomičnosti sve je intenzivnija, da bi u najnovije doba kulminirala u definiciji svoje štedljivosti. (27) Naime, kupola drži neosporni primat u odnosu na kriterij korištenja minimalne količine materijala prema dobivenom efektu zatvaranja prostora. Kupola predstavlja jedan od najdosljednijih izraza primjene autoriteta ekonomičnosti u definiranju gornje zatvarajuće zone arhitektonskog prostora. (28) Upravo u

Qualitative expression of cost-effectiveness and rational thrift, as related to the length of the enclosing perimeter and inner surface obtained thus, compared to regular plane curves, is inversely proportional to the increase of their geometrical complexity. The advantage of the curve which forms a regular circle is quite obvious intuitively as well (Figure 6).

Mathematic derivation of the perimeter and surface interdependence at the comparative view of circle, ellipse, square, triangle and polygon, is an exact contribution to the unambiguous proof that architectonic forms exhibiting the shape of a circle in their horizontal cross-section and ground-plan projection, have a more favourable coefficient of thrift and cost-effectiveness, when physically defined, as compared to the forms that exhibit any other shape (square, triangle, etc.) (Figure 7).

Regular hexagon, as well as a circle, finds their ideographic origin in the workings of Nature itself. However, while the circular form draws its full power through an independent, detached setup, a hexagon is to a high extent dependent on multiple occurrences of the same form in a plane. Only regular hexagons, equilateral triangles and squares, of all the regular polygons, cover the whole area of a plane, with no remainder. When the extent of the forms mentioned is concerned, hexagons cover the largest area as well (Figure 8).

Ancient Split and the Early Middle Ages

When analysing the impact of Rome at the Croatian coast we can see that „*Roman antique acted with the full force of its civilising and political mission at our geographical area, and has left significant traces of high urban culture*“. (29) Looking at Split as an antique heritage at the Adriatic eastern coast, it should be noted that it continued its life with the

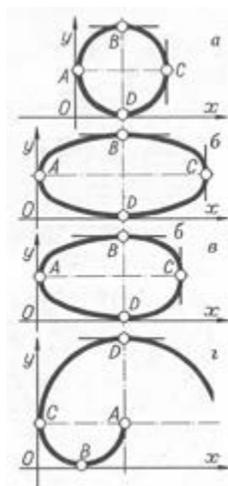
tom posjedovanju visokoga stupnja kvalitete štedljivosti i jednostavnosti, moguće je između ostalog, naći razlog ranog uvođenja kruga u arhitekturu i njegove široke primjene u najrazličitijim društveno-ekonomskim formacijama.

Kvalitativna ispoljenost ekonomičnosti i racionalne štedljivosti, glede odnosa veličine zatvarajućeg oboda i unutarnje dobivene površine, u odnosu na pravilne ravninske krivulje, obrnuto je razmjerna s narastanjem njihove geometrijske složenosti. Nadmoćnost krivulje koja tvori lik pravilnoga kruga i intuitivno je posve očita (slika 6).

Matematički izvod međusobne zavisnosti opsega i površine kod usporednog prikaza kruga, elipse, kvadrata, trokuta i mnogokuta, egzaktni je prilog jednoznačnom dokazu da arhitektonski oblici, koji u svojim vodoravnim presjecima i tlocrtnoj projekciji iskazuju lik kruga, imaju povoljniji koeficijent štedljivosti i ekonomičnosti kod svog fizičkog definiranja, od oblika koji sadrže neke druge likove (kvadrat, trokut i sl.) (slika 7).

Kao za kružnicu i krug tako i za pravilni šesterokut možemo zapaziti da vuku svoje ideografsko podrijetlo iz samih uradaka Prirode. No, dok kružni oblik svoju punu snagu emanira kroz samostalni postav, šesterokut je u mnogo čemu ovisan od višestruke pojavnosti tih istih likova u ravnini. Od pravilnih mnogokuta samo pravilni šesterokuti, jednakostranični trokuti i kvadrati, pokrivaju čitavu ravninu bez ostatka. U odnosu na opseg promatranih likova, šesterokuti obuhvaćaju i najveću površinu (slika 8).

downfall of Roman empire influence and onset of the epoch of migration of peoples. Split was spared from devastation, particularly by the Eastern Goths in the first half of the 6th century, the Avars at the beginning of the 7th century, of course, the Slavs. The fact is that most of the towns in coastal Croatia ceased to exist. However, some of them succeeded in preserving their urban identities, such as Zadar, Trogir and Kotor, while some appear as successors of demolished towns, such as Split (Aspalathos) a successor of Salona and Dubrovnik (Ragusium) as a successor of Epidaurus.



SLIKA 6. Ravninske krivulje i odraz graditeljske štedljivosti

FIGURE 6. Plane curves and reflection of thrift

The inhabitants of antique Salona, demolishing of which meant an interruption of all life there, found shelter, as Toma archdeacon noted, at least most of them, under the protection of the walls of Diocletian's palace. Thus, the downfall of Salona and the migration of its inhabitants to Split made this town an heir of Salona's cultural and urban achievements.

Antički Split i rani srednji vijek

Analizirajući utjecaj Rima na hrvatskom priobalju uviđamo: „na našem geografskom području rimska je antika djelovala punom silinom svoje civilizatorske i političke misije, te je ostavila značajne tragove visoke urbane kulture“. (29) Promatrajući Split kao antičko naslijeđe na istočnoj obali Jadrana, treba naglasiti da je on padom utjecaja Rimskog carstva dalje nastavio svoj život u epohi seobe naroda, jer je bio pošteđen razaranja osobito Istočnih Gota u prvoj polovici 6. stoljeća i Avara početkom 7. stoljeća i naravno, Slavena. Naime, većina hrvatskih gradova uz more prestala je egzistirati, no neki su očuvali svoj urbani identitet poput Zadra, Trogira i Kotora kao i oni koji se javljaju kao nasljednici porušenih gradova poput Splita (Aspalathos), kao nasljednika Salone, i Dubrovnika (Raousion) kao nasljednika Epidaura.

Stanovništvo antičke Salone, čije je rušenje značilo prekid života grada, kako bilježi Toma arciđakon, sklonilo se u najvećem broju među zidine Dioklecijanove palače. Tako je padom Salone i odlaskom njezinih stanovnika u Split, taj grad postao nasljednikom njezinih kulturnih i urbanih tekovina.

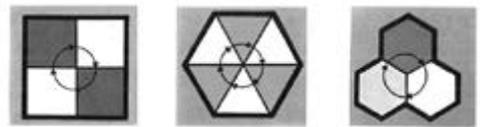
O Splitu se može govoriti kao o gradu koji je baštiniio urbane tradicije nekoga drugoga porušenoga grada. Split je povijesni nasljednik porušene Salone, iako ih dijeli različitost lokacijske dispozicije. Carska Dioklecijanova palača bila je i prije sporadično naseljavana, ali je padom Salone jugozapadno smješten Split (Aspalathos) u potpunosti preuzeo njezinu ulogu prema Bizantu i prema ranim hr-

krug	elipsoa	kvadrat	trokut	osnogiuk
$P = 25$	$P = 25$	$P = 25$	$P = 25$	$P = 25$
$P = r^2 \cdot \pi$	$P = a \cdot b \cdot \pi$	$P = a^2$	$P = \frac{a^2 \sqrt{3}}{4}$	$P = 5a^2$
$r = 2.81$	$a = 2b$	$a = 5.00$	$a = 7.80$	$a = 2.24$
$O = 2r \cdot \pi$	$O = \sqrt{1+b^2} \cdot 1.5a$ /a+b/- aab	$O = 4a$	$O = 3a$	$O = 12a$
$O = 17.64$	$O = 19.30$	$O = 20.00$	$O = 22.50$	$O = 26.8$
$a = 0.00$	$a = 9.41$	$a = 13.37$	$a = 29.25$	$a = 52.5$

a = povećanje u odnosu na veličinu opsega kruga, izračunato u %, uz $P = \text{const.}$

SLIKA 7. Pravilni geometrijski likovi i faktor ekonomičnosti

FIGURE 7. Regular geometric figures and cost-effectiveness factor



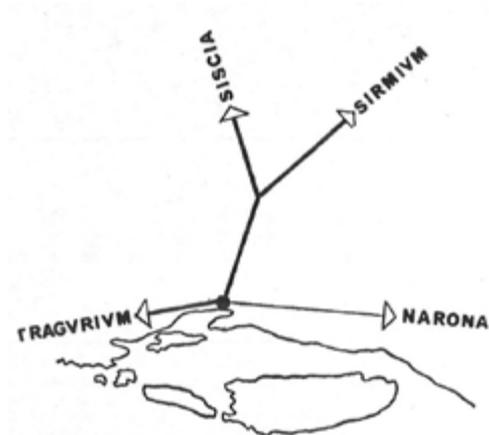
SLIKA 8. Geometrijske sheme međusobno povezanih ravninskih likova

FIGURE 8. Geometric schemes of interconnected plane figures

Split can also be considered a town that inherited the urban traditions of another demolished town. Split is a historical successor of demolished Salona, although their locations are separated. Imperial Diocletian's palace had been inhabited sporadically. However, with the downfall of Salona, Split (Aspalathos), located in the southwest of the palace, completely took its role, in relations with Byzantium and early Croatian rulers (Figure 9, 10). (30) Diocletian's palace gradually later transformed from a place of refugees to a medieval urban entity.

Split was spared from numerous demolitions in the course of the turbulent migration of nations in Europe (Figure 11, 12). Upon the full affirmation of the Croatian people from the transition of the VI

vatskim vladarima (slike 9, 10). (30) Dioklecijanova se palača od prvobitnog refugija postupno kasnije transformirala u srednjovjekovno urbano središte.



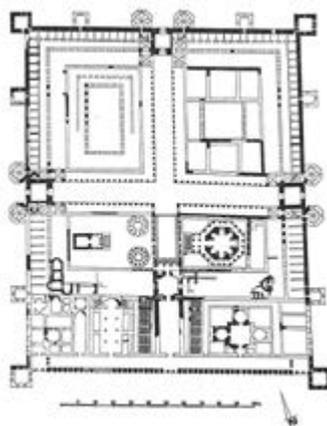
SLIKA 9. Povezanost antičkih komunikacija Salone (30)

FIGURE 9. The connection of ancient communications of Salone (Suić)

U tijeku turbulentne seobe mnogih naroda u Europi, Split je ostao pošteđen brojnih razaranja (slike 11, 12). Punom afirmacijom hrvatskoga naroda na prijelazu VI. u VII. st. do prijelaza XI. u XII. st. Hrvati razvijaju vrlo intenzivnu kulturnu i umjetničku djelatnost u okviru koje se grade brojni arhitektonski objekti. U početnom su razdoblju to jednostavne građevine, a u razvijenoj fazi (IX., X. i XI. st.) grade se brojni vrijedni sakralni objekti, počevši od jednobrodnih bazilika i jednostavnih centralnih objekata pa do razvijenijih tipova trobrodnih bazilika i složenih centralnih objekata. (31)

Tu je potrebno naglasiti da snaga tradicijske konstante novonadošlih Slavena-Hr-

to the VII century until the transition of the XI to the XII century, Croats developed intensive cultural and artistic activities, including building numerous architectonic objects. In the beginning, those were



SLIKA 10. Dioklecijanova palača u Splitu (30)

FIGURE 10. Diocletian's palace in Split (Suić)

simple buildings, while in the later, developed phase (IX, X and XI c.) a number of valuable sacral buildings, starting with single-nave basilicas and simple central objects, to sophisticated types of three-nave basilicas and complex central objects. (31)

It should be noted that the power of the traditional constant of newly-arrived Slavs-Croats left a mark on the artistic expression of this early Croatian historical period, with ever-present reflections of Roman and Byzantine influence from the past times. (31)

Early Croatian Sacred Architecture and the Split Area

When analysing the buildings from the early Croatian period, it is necessary to consider cost-ef-

vata daje pečat umjetničkom izrazu toga starohrvatskoga povijesnoga razdoblja u kojem se nalazi i odraz rimskoga i bizantinskoga utjecaja iz prošlih vremena. (31)

fectiveness in light of the capacities of the time and realities of an underdeveloped, modest cultural environment and ambiental-geographical values of, conditionally speaking, isolated area (Figure 13).



SLIKA 11. Karta porušenih i pošteđenih rimskih gradova od seobe naroda (Suić)

FIGURE 11. *Map of destroyed and spared Roman cities from the migration of peoples (Suić)*



SLIKA 12. Dioklecijanov mauzolej u Splitu (Mohorovičić)

FIGURE 12. *Diocletian's mausoleum in Split (Mohorovičić)*

Starohrvatska sakralna arhitektura i područje Splita

U razmatranju zdanja iz starohrvatskoga razdoblja, potrebno je gledati ekonomičnost u svjetlu tadašnjih mogućnosti i datosti toga još nedovoljno razvijenoga, skromnoga kulturnoga miljea i ambijentalno-geografskih vrijednosti, uvjetno rečeno, jedne izolirane sredine (slika 13).

Building activity considerably flourished in the area of Dalmatia during the period of Croatian national rulers. „*The stage of early Croatian architecture is the territory of the early Croatian state – ninth to the eleventh century.*“ (32)

Defining sacral building as a material expression of their new perceiving and attitude to life in the confines of Christian doctrine, can be seen through a broad scope of various forms and geometric pat-

U vrijeme hrvatskih narodnih vladara dolazi do izrazitog bujanja graditeljske aktivnosti na području tadašnje Dalmacije. „*Pozornica starohrvatske arhitekture je teritorij stare hrvatske države, vrijeme – deveto do jedanaesto stoljeće.*“ (32)

Definiranje sakralnih zdanja kao materijalnog izraza njihova novog spoznavanja i gledanja na život u sklopu kršćanskoga nauka, javlja se u širokoj paleti najraznovrsnijih oblika i geometrijskih predložaka. No, unatoč toj morfološkoj različitosti, moguće je provesti relativno konciznu klasifikaciju tih zdanja u odnosu na matriču tlocrtnu dispozicije.

U analizi starohrvatskih crkvice podizanih do XI. vijeka, Karaman (33) navodi da „*nisu građene u obliku pačtetvorinaste bazilike na tri broda, koji je Crkva širila svojim ugledom po zapadu Europe, već često pokazuju raznovrsne tlorisne osnove – na trolist, četverolist, šesterolist, na križ i tako dalje.*“ A u pogledu definiranja uspravnog volumena tih građevina, Karaman govori da su „*starohrvatske crkvice pokrivenne svodovima i kupolicama, u vrijeme kada je monumentalno crkveno graditeljstvo na zapadu Europe upotrebljavalo gotovo isključivo drveni strop.*“ (33)

Osim tih posebnih morfoloških značajki izgrađenih zdanja, pozornost svakog istraživača privlači skromnost u veličini – horizontalni i vertikalni gabaritni doseg starohrvatskih crkvice je krajnje suzdržan. U literaturi možemo naići na znakovit naziv za ta zdanja – „*male katedrale.*“ (32)

Starohrvatsko graditeljstvo sakralne funkcije možemo morfološki razlikovati kroz dvije dominantne grupe. Jednu bi čini-

terns. However, despite this morphological variety, it is possible to make a relatively concise classification of these buildings, in relation to the matrix of ground-plan disposition.



SLIKA 13. Pogled na Split
FIGURE 13. *View of Split*

Karaman (33) said in the analysis of early Croatian small churches built before the XI c. that „*they were not built in the rectangular shape of a three-nave basilica, which the Church proliferated using its reputation throughout the west of Europe, but often exhibit various ground-plan bases – three-leaf, four-leaf, six-leaf, cross et cetera.*“ On defining the vertical volume of these buildings, Karaman said that „*early Croatian small churches were covered with arches and small domes, at the time when monumental ecclesiastical building in western Europe used wooded ceilings almost without exception.*“ (33)

Apart from these special morphological characteristics of the buildings erected, researchers' attention is drawn to the modesty of size – the horizontal and vertical size of early Croatian small churches is utterly unassuming. Literature often, quite significantly, calls them „*small cathedrals.*“ (32)

Early Croatian sacral buildings can be morphologically recognised through two dominant groups.

le bi male presvođene crkvice u modeliranju kojih preteže kružna matrica, dok bi drugu grupu oblikovale monumentalne zgrade naglašene pravolinijske ortogonalnosti. (34) Te dvije osnovne morfološke skupine u općoj tipologiji crkvene arhitekture – centralne i longitudinalne građevine – gotovo su podjednako zastupljene u predromaničkoj crkvenoj arhitekturi u Dalmaciji. (35)

Šesterokonhni ili šesterolisni oblik najizrazitiji je tip centralnih građevina rano-srednjovjekovne arhitekture Dalmacije. Karakterizira ga šesterolisni tlocrt, poznat do sada na sedam primjera u Dalmaciji, od kojih se tri nalaze na splitskom području – crkva Sv. Trojice u Splitu, crkva Sv. Marije u Trogiru i crkva Sv. Mihovila u Brnazima kod Sinja (**slike 14-16**). (35)

Sve te navedene građevine imaju zajednički šesterolisni tlocrt i središnju kupolu sa šest uokolo postavljenih konhi. Sve su gotovo istih dimenzija i izgrađene u rustikalnoj tehnici gradnje.

O tome da su racionalnost upotrijebljenoga građevnog materijala kao i opća ekonomičnost u modeliranju bili vodeći čimbenici tih prethodnih oblika gradske arhitekture, opisuje Andre Mohorovičić u traktatu „*O analizi pučke arhitekture*“ kada kaže: „*Faktor lokalnog nalaza materijala, ekonomičnost i mogućnost obrade igraju u ovom slučaju glavnu ulogu kod izbora i primjene materijala. U spontano kreiranoj pučkoj arhitekturi elementi tehničke i ekonomske komponente svakako su prioritetni, dapače u početnoj fazi razvoja isključivi i odlučujući.*“ (36)

Morfološki predlošci starohrvatske sakralne arhitekture imaju još jednu zanimlji-

One would be small domed churches modeled predominantly by a circular matrix, while the other group would be monumental buildings with pronounced rectilinear orthogonality. (34) These two basic morphological groups in the general typology of ecclesiastical architecture – central and longitudinal buildings – are present in almost equal number in pre-Romanic ecclesiastical architecture in Dalmatia. (35)

Hexagon of six-leaf shape is a most prevalent type of central buildings in early medieval architecture in Dalmatia. It is characterised by a six-leaf ground-plan, recognised at seven different sites in Dalmatia, three of them situated at Split area – the church of Holy Trinity in Split, the church of St. Mary in Trogir and the church of St. Mihovil in Brnaze near Sinj (**Figure 14-16**). (35)

All the above buildings had a common six-leaf ground-plan and a central dome with six conches situated around it. They were of almost identical dimensions and were built employing rustic building techniques.

Andre Mohorovičić in his treatise „*On the analysis of folk architecture*“ confirmed that rationality of the building material used, as well as general cost-effectiveness in modeling, were leading factors in constructing these early forms of city architecture, saying: „*The issue of locally available material, cost-effectiveness and the possibility of working the material, play in this case a major role in selecting and using the material. The elements of technical and economic components are obviously the highest priority in spontaneously created folk architecture, indeed, in the initial development phase they were exclusive and decisive.*“ (36)

Morphological patterns of early Croatian sacral architecture are characterised by another interesting feature – multicoloured apses or conches. The inner space of the forms analysed consists of a central



ŠESTEROKONHNI TIP

SV. TROJICA U SPLITU
PRETPOSTAVLJENO IZVORNO STANJE
(J. Marasović)



SLIKA 14. Sv. Trojica u Splitu
FIGURE 14. *Holy Trinity in Split*



SV. MARIJA U TROGIRU
(Istražio T. Marasović; snimak M. Marasović)



SLIKA 15. Sv. Marija u Trogiru
FIGURE 15. *St. Mary in Trogir*

vost – višebrojne apside ili konhe. Unutar-nji prostor promatranih oblika sastoji se od centralne glavne mase valjkastog prostora na koju se nadovezuje niz manjih poluvaljkastih (ili tri četvrtine valjkastih) prostora, smještenih u radialno postavljenim konhama. Raščlamba toga jedinstvenoga prostora putem konha ili apsida jedinstveno je i specifično graditeljsko rješenje. Budući da je morao ostati očuvan fokus interesa u samom centru, što je neizbježno kod svih „introvertnih“ građevina centralnog tipa (a izbjeći bilo kakvu pojavu longitudinalnog usmjeravanja prostora), rubno po kružnici postavljene pojedinačne apside organski

main cylindrical mass, to which a number of smaller semi-cylindrical (or three-quarter cylindrical) spaces are attached, located in radially situated conches. The breakdown of this unique space by means of conches or apses is a unique and completely specific building solution. As the focus of interest had to be preserved in the center itself, which is unavoidable with all „introvert“ buildings of central type (while any longitudinal directing of the space has to be avoided), on the perimeter of the circle individual apses are situated, which organically „flourish“ from the central mass of space, with no need for interspace or unnecessary physical partitions. (37)

These are rather modest architectonic assemblies, when the number of spatial elements is con-

„bujaju“ iz te centralne mase prostora, bez iziskivanja ikakvih međuprostora ili nepotrebnih fizičkih pregrada. (37)



SLIKA 16. Sv. Mihovil u Brnazima kod Sinja

FIGURE 16. *St. Mihovil in Brnaze near Sinj*

Prema broju upotrijebljenih prostornih elemenata, to su skromni arhitektonski sklopovi, koji s minimalnim brojem elemenata uspješno konstituiraju prostorno vrijedan i nadasve originalan arhitektonski oblik. (32)

Jedna od prevladavajućih vanjskih vizualnih karakteristika tih zdanja njihova je izrazito mala veličina, s obzirom da je promjer središnjeg prostora iznosio prosječno šest metara, a promjer čitavog objekta kao i njegova visina oko deset metara.

Šesterokonhni oblik te ranosrednjovjekovne hrvatske arhitekture nalazimo i izvan Dalmacije, a unutar njezina opsega Split je pored Zadra bio drugo važno žarište te arhitekture (slika 17).

Geometrijsko-eksperimentalna analiza tlorisa splitskih šesterolista u odnosu na čimbenik ekonomičnosti

Već sâm alternativni naziv šesterolist za šesterokonhni vijenac apsida, ukazuje da je

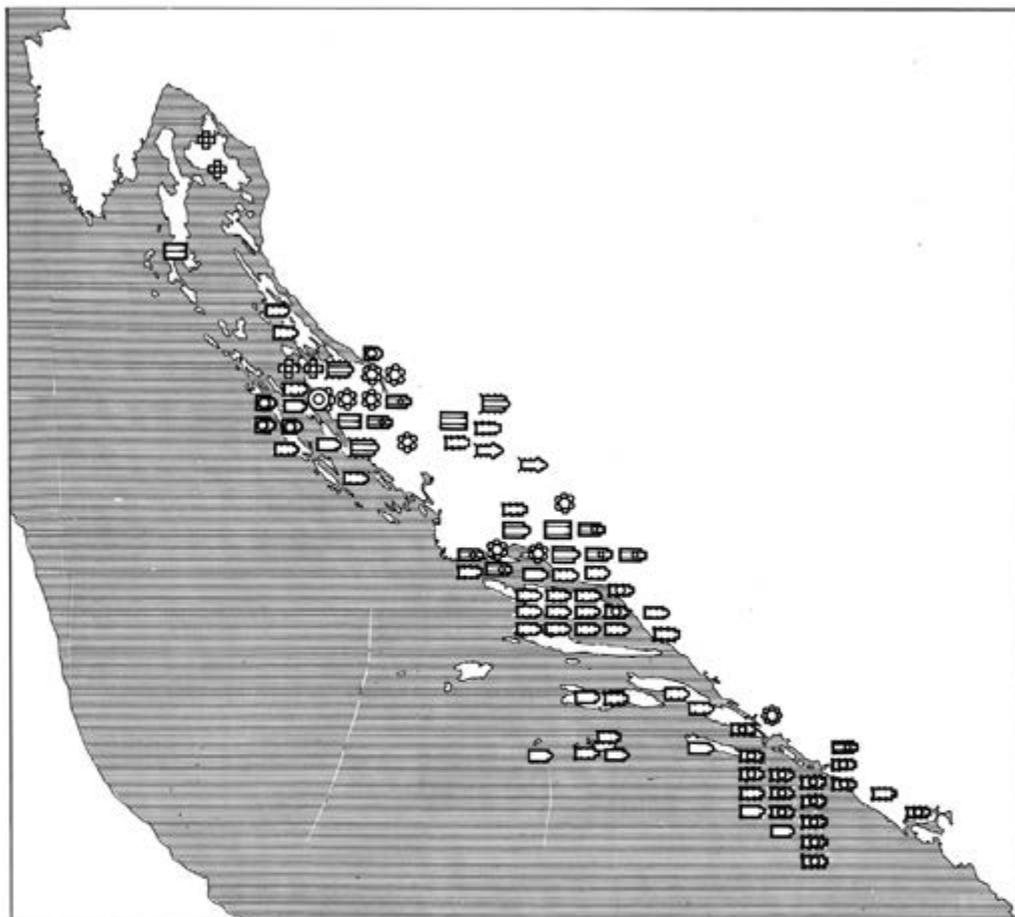
sidered, as they successfully design spatially valuable and primarily original architectonic forms, with a minimum number of elements. (32)

One of the outstanding outer visual characteristics of these buildings is their pronounced small size, as the diameter of the central space is six meters on average, while the diameter of the whole object, as well as its height, amounts to ten meters.

The hexaconch shape of this early medieval Croatian architecture can also be found in Dalmatia, while in Dalmatia Split is, together with Zadar, an important hotspot of this architecture (Figure 17).

Geometric-experimental analysis of the ground-plan for the Split „six-leaf“ in relation to the cost-effectiveness factor

The alternative name „six-leaf“ for the hexaconch crown of apses itself indicates that the phytomorphic component is clearly expressed and almost intuitively recognised. According to the grand division of rectilinear, rectangular and curved, circle-like forms, where the first are attributed to man's creativity and second to organic Nature, artistic compatibility of early Croatian hexaconch small churches with natural forms, particularly of the plant-phytomorphic circle. An experiment with the aim to prove the presence of the principle of cost-effectiveness and the trend of rational thrift will be organised with the aid of a geometrical scheme of ideal circle and interconnected regular hexagons, as a matrix the basis of which is mathematically provable cost-effectiveness within the domain of Nature. As these artistic patterns can be found outside of human construction, it is correct to call them their precedents. This is particularly so as circular and circle-like shapes can be found in plant structures, in shells, in the construc-



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- 1. CENTRALNI JEDNOAPSIDNI TIP
- 2. KRŽNO-ČETVEROKOJNI TIP
- 3. ŠESTEROKOJNI TIP
- 4. OKTOKOJNI TIP
- 5. TIP CENTRALNOG RAŠČLANJENOG PROSTORA
- 6. JEDNOBROJNI NERAŠČLANJENI TIP
- 7. JEDNOBROJNI TIP RAŠČLANJENE UNUTRAŠNOSTI
- 8. JEDNOBROJNI TIP RAŠČLANJENE VANJŠTINE
- 9. JEDNOBROJNI TROAPSIDNI TIP
- 10. DVOBROJNI DVOAPSIDNI TIP
- 11. TROBROJNI JEDNOAPSIDNI TIP
- 12. TROBROJNI TROAPSIDNI TIP S KONTRAFORMA
- 13. TROBROJNI TROAPSIDNI TIP S UPISANIM PREZBITERIJEM
- 14. JEDNOBROJNI TIP S KUPOLOM
- 15. TIP S UPISANIM TRANZEPTOM I KUPOLOM
- 16. TROBROJNI TIP S KUPOLOM

SLIKA 17. Rasprostranjenost osnovnih tipova ranosrednjovjekovnih crkvice u Dalmaciji (T. Marasović)

FIGURE 17. *Distribution of basic types of early medieval churches in Dalmatia (T. Marasović)*

tu fitomorfna komponenta jasno izražena i gotovo intuitivno prepoznata. Prema velikoj podjeli na pravolinijske, pravokutne i zavojite, krugolike oblike, od kojih prve pripisujemo ljudskom stvaralaštvu a druge organskoj Prirodi, ističe se likovna kompatibilnost starohrvatskih šesterokonznih crkvice s oblicima prirode, osobito vegetabilno-fitomorfnoga kruga. Eksperiment u svrhu dokazivanja prisutnosti načela ekonomičnosti i tendencije racionalne štedljivosti, izvršiti će se uz pomoć geometrijske sheme idealnog kruga i međusobno povezanih pravilnih šesterokuta, kao matrica koje su nositelji matematički dokazive ekonomičnosti unutar domene prirode. Kako te likovne obrasce nalazimo izvan ljudskoga graditeljstva, opravdano ih je smatrati njihovim presedanima. Osobito zato što kružne i krugolike oblike nalazimo u građi biljaka, školjaka, ptičjih gnijezda i slično, a matricu šesterokuta kod prostorne rešetke radiolaria i u jednom od najfascinantnijih uradaka u Prirodi – u građi sača pčela. (3)

Krug je u pogledu zahvaćanja unutrašnje površine u odnosu na vanjski obod vodeća figura u građi bilo kakvog oblika, jer iziskuje najmanje građe za svoje zatvaranje, a međusobno poredani šesterokuti jedini su od svih ostalih pravilnih geometrijskih likova koji popunjavaju ravninu bez ikakva ostatka balastnog prostora. (38)

A) Matrica kružnih oblika

Promatrajući crkvicu Sv. Marije u Trogiru, uviđamo da u dispoziciji tlocrta obrisa kružnice nije iskazan u strogo pravilnom

tion of bird's nests and the like, while the hexagon matrix can be found in the spatial grid of radiolaria and in one of the most fascinating workpieces of Nature – in the structure of honeycomb. (3)

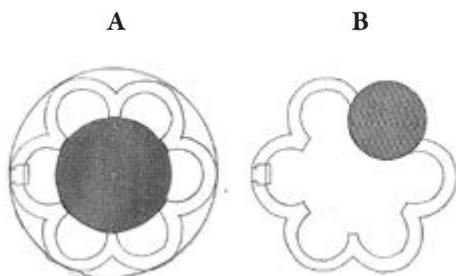
The circle is, regarding the ratio of covering the inner area and the length of the outer parameter, the best figure in constructing any shape, as it asks for the least amount of building material to be enclosed, while interconnected hexagons are the only ones, among all the other regular geometric figures, that fill-in the plane with no residual ballast space. (38)

A) Circular matrix

If we analyse the church of St Mary in Trogir, we can see that in its ground-plan disposition the shape of the circle is not geometrically strictly regular. However, the circle is clearly outlined in its essence. It can be seen in the shape of circular inner space (A), as well as in the shape of semi-circular, on the inner side three-quarter circular conches or leaves (B), **Figure 18**. The reflection of a circle can also be seen in a geometric image of the intersection of the central space circle and circles belonging to circumferential spaces of conches (**Figure 19**).

The existence of symmetry and rhythm in these circle-like compositions leads to the indirect conclusion that the trend to cost-effectiveness is strongly pronounced in their composition. Regardless of the fact that in designing early Croatian churches of this group in the Split area there is no strict, geometrically regular pattern in execution, symmetric division in ground-plan disposition is indisputable and is expressed as poly-symmetry. Six radial axes can be distinguished in total, theoretically dividing the space into two parts of equal area surface. Two groups of axes are clearly distinguishable. In one, the axes pass through apse vertexes and central focus point (A) and in the other axes also pass

geometrijskom izrazu. Međutim, kružnica, odnosno krug, je u njegovoj biti izrazito izražena. To se očituje u obliku kružnoga središnjeg prostora (A), i u obliku polukružnih, iznutra 3/4-kružnih konha ili listova (B) (slika 18). Odraz kruga nalazimo i u geometrijskoj slici zone međusobnog presijecanja kruga centralnog prostora i krugova obodnih prostora konhi (slika 19).



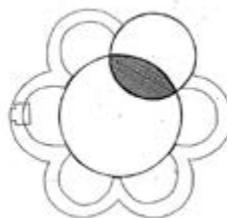
SLIKA 18. Grafička analiza tlocrta Sv. Marije u Trogiru, prema dominantnoj matrici kruga (autor)

FIGURE 18. *Graphic analysis of the floor plan of St. Mary in Trogir, according to the dominant circle matrix (author)*

Postojanje simetrije i ritma u tim kružolikim kompozicijama navodi nas na posredni zaključak da je u njihovom komponiranju težnja ka emonimičnosti izrazito zastupljena. Bez obzira što pri oblikovanju starohrvatskih crkvice te grupe promatranih primjera na splitskom području nema strogoga, geometrijski pravilnog uzorka u izvedbi, simetrična podjela u tlocrtnoj dispoziciji nesporna je i javlja se u vidu poli-simetrije. Pritom se može razli-

through the centre of the composition, but through the points of apses, the side touches the center line as well (B), dividing the ground-plan mass sparingly into two parts (Figure 20).

As an outer component of the ground-plan, rhythm is, regardless of often underlined irregularities in the size of circularly situated apses, also in principle clearly expressed in small Split churches – through the interchange of the same area units, as well as in mutual distance of their sequences. The



SLIKA 19. Grafička analiza tlocrta Sv. Marije u Trogiru, prema interferenciji kruga centralnog prostora i kruga konhe (autor)

FIGURE 19. *Graphic analysis of the floor plan of St. Mary in Trogir, according to the interference of the central space circle and the conches circle (author)*

aps crowns of the churches in question are developed in the interspace of two concentric circles (A). Although there is, even here, certain irregularity in executing their radii, we can conclude that the distance between conche vertexes – S is equal to the outer radius – R (B), and also that rhythm is generally quite clearly pronounced in the form of the corpus, as a phenomenon of juxtaposition of approximately identical apse surfaces (C and D) (Figure 21).

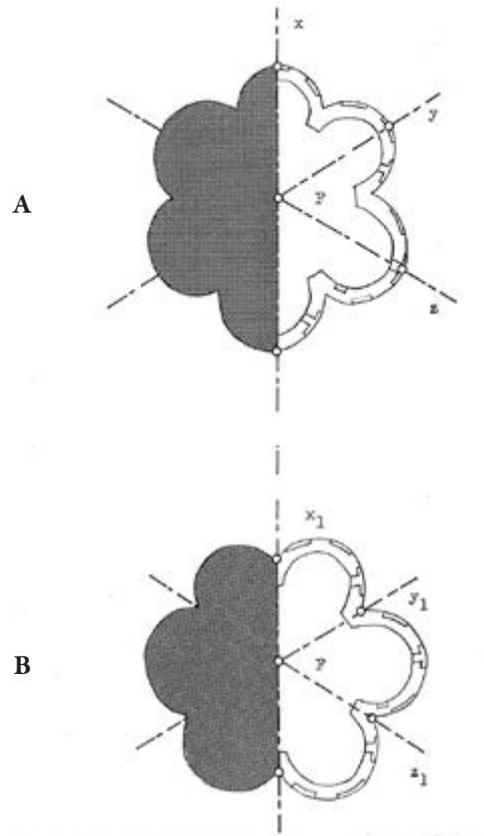
The above analyses of cost-effective work reveal another fascinating solution – basic precedents

kovati ukupno šest radijalnih osi, koje tlocrt teorijski dijele na dva površinski jednaka dijela. Mogu se posve jasno razlikovati dvije grupe osi. Jednu, gdje osi prolaze tjemena apsida i centralnom fokusnom točkom (A) i drugu, gdje osi također prolaze kroz središte kompozicije, ali i točkama simetrala bočnoga dodira apsida (B), dijeleći tako štedljivo tlocrtnu masu na dva dijela (slika 20).

Kao vanjska komponenta tlocrta, bez obzira na često naglašavanje nepravilnosti u veličini kružno postavljenih apsida, ritam se također principijelno jasno iskazuje kod splitskih crkvice – u izmjeni realno istih površinskih jedinica, i u njihovom međusobnom razmaku nizanja. Vijećnic apsida promatranih crkvice razvija se u međuprostoru dva koncentrična kruga (A). Premda i tu postoji određena nepravilnost u izvedbi njihovih polumjera, moguće je zaključiti da je razmak između tjemena konhi – S, jednak vanjskom polumjeru – R (B), i da je u obliku korpusa principijelno veoma jasno izražen ritam, kao fenomen nizanja približno identičnih površina apsida (C i D) (slika 21).

U navedenim analizama ekonomičnog postupanja nalazimo još jedno fascinirajuće rješenje – principijelne presečane koje nalazimo u samoj prirodi i to u građi samoga čovjeka. Naime, morfologija ljudskoga mozga, osobito njegova vanjska ovojnica je „smežurana“ pa stoga ima znatno povećanu površinu bez negativnog utjecaja na neželjeno povećanje volumena. Analognu matricu ekonomičnosti nalazimo kod starohrvatskih crkvice splitskoga područja, kao i svih ostalih

found in Nature and in the constitution of human body itself. As human brain morphology shows, it is, and especially the meninges, „wrinkled“, which significantly increases its surface with no detri-



SLIKA 20. Grafička analiza simetričnosti tlocrta crkvice Sv. Trojice u Splitu (autor)

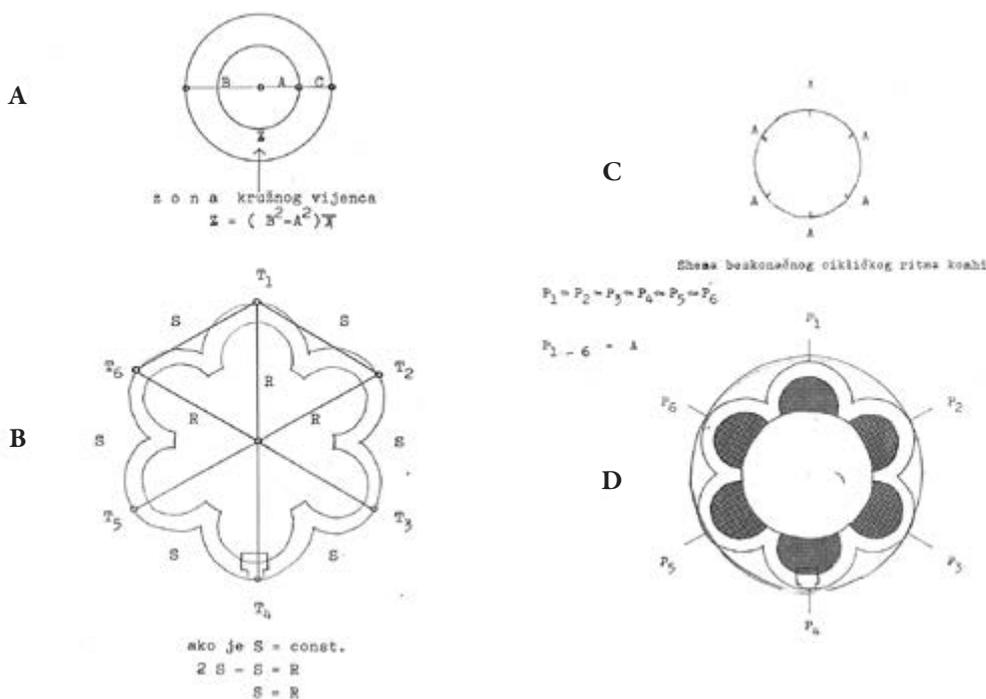
FIGURE 20. *Graphical analysis of the symmetry of the ground-plan of the church of Holy Trinity in Split (author)*

mental impact on the uncalled-for increase in volume. A similar matrix of cost-effectiveness could be found with early Croatian churches in the Split region, as well as with all the others of molticonche

višekonhnog tipa. Naime, geometrija kao egzaktna disciplina jasno tumači da se površina jedne obodne plohe znatno povećava, ako se ta ploha mjestimice izboči ili udubi. S druge strane, površina ili prostor koji tako „deformirana“ ploha obujmljuje, ne podliježe tom povećanju, jer unatoč nizu promjena na njegovom obodu, prostor zadržava približno prvobitnu veličinu.

Geometry, as an exact discipline, clearly says that the surface of one circumferential plane increases significantly if the plane is locally bulged or dented. On the other hand, the surface or space that such a „warped“ plane encompasses, does not increase at the same time, as despite a number of changes in the circumference, the space retains approximately its original value.

The ground-plan of St. Mary church in Trogir (A), as well as the ground-plan of a hypotheti-



SLIKA 21. Grafička analiza ritma u tlocrtu crkvice Sv. Marije u Trogiru (autor)
 FIGURE 21. *Graphic analysis of the rhythm in the ground-plan of the church St. Mary in Trogir (author)*

Tlocrt crkve Sv. Marije u Trogiru (A) i tlocrt hipotetskog modela (B), s opsegom koji odgovara razvijenoj površini apsida crkvice (ukupni opseg građevine),

cal model (B), with the circumference of the developed surface of church apses (total building circumference), prove mathematically the principle of cost-effectiveness. Namely, for the same cir-

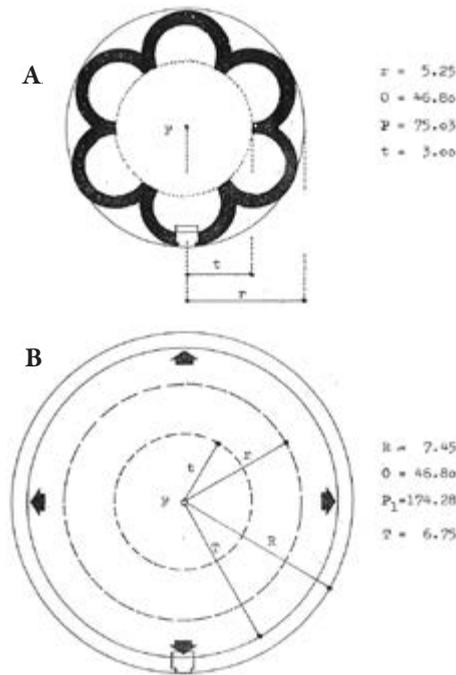
matematički potvrđuju načela ekonomičnosti. Naime, za jednaki O (opseg), hipotetski model imao bi više nego dvostruko veću tlocrtnu površinu (232%), a unutarnji polumjer tambura kupole također bi se značajno povećao (225%) (slika 22).

U nizu pojedinačnih analiza pojave načela ekonomičnosti kroz primijenjeni oblik kruga, kod starohrvatskih crkvića centralnoga šesterolisnog tipa, nezaobilazno je i oblikovanje njihovih konhi ili apsida. Povijest arhitektonskih oblika poznaje pojam apsida kao arhitektonske forme još iz antičkog doba kao polukružni završetak onovremenih bazilika, da bi od IV. stoljeća u kršćanskim crkvama bile preuzete kao bitni sastavni element njihova prostora. (39) Prema svojoj geometrijskoj shemi, apside se u kasnijim razdobljima javljaju u obliku kružnih segmentata, kvadrata i pravilnih poligona. (39)

cumference, the hypothetical model would have more than the double ground-plan surface (232%), while the inner radius of the dome would also be significantly increased (225%) (Figure 22).

Within the series of individual analyses of the cost-effectiveness principle through the applied circular shape, the analyses of early Croatian churches of central, six-leaf type, unavoidably point at the design of their conches or apses. The history of architectonic forms recognised the term apse as an architectonic form as early as antique times, defining it as semi-circular termination of basilicas at that time. Apses have been taken by Christian churches since the IVc., as a key constituent element of their space. (39) Apses later appear, according to their geometrical scheme, in the form of circular segments, squares and regular polygons. (39)

The analysis of their comparative values, as related to cost-effectiveness and rationality of their physical definition, compared to the apses of the analysed six-leaf buildings in Split, indicates that, with the same P (inner enclosed surface) the perimeter, or circumference, of the outer apses shell, designed in the form of a polygon, especially with



SLIKA 22. Grafička analiza vanjskoga zatvarajućeg plašta Sv. Marije u Trogiru (A) i pripadajućega hipotetskoga modela razvijenih konhi (B) (autor)

FIGURE 22. *Graphic analysis of the outer cloak of St. Mary in Trogir (A) and the associated hypothetical model of the developed conches (B) (author)*

of the analysed six-leaf buildings in Split, indicates that, with the same P (inner enclosed surface) the perimeter, or circumference, of the outer apses shell, designed in the form of a polygon, especially with

Analiza njihovih usporedivih vrijednosti glede ekonomičnosti i racionalnosti njihove fizičke definicije, u odnosu na apside promatranih šesterolatičnih splitskih zdanja, pokazuje da je uz isti P (unutarnja zatvarajuća površina) opseg vanjskih ovojnica apsida oblikovanih *u vidu poligona*, osobito kvadratne matrice, redovito nepovoljniji od opsega koji u tlocrtu konhi iskazuju lik kruga, tj. kružnice (slika 23).

B) Matrica pravilnih šesterokuta

U kompoziciji starohrvatskih crkvice središnjega šesterolisnog tipa uočava se jedan posebno kompleksni prostorno-arhitektonski problem, koji proizlazi iz međusobnoga povezivanja prostora s kružnom matricom, a predstavlja nesumnjivu specifičnost jer se krugovi kao likovi ne mogu međusobno povezati bez ostatka međuprostora (koji se u ovom primjeru nije smio iskazati, jer bi nepovratno narušio koncepciju jednodimenzionalnosti građevine).

U pokušaju otkrivanja ekonomičnosti postojećega rasporeda koji obiluje krugolikim oblicima, u geometrijsku je analizu uvedena, kao pomoćno ispitno sredstvo, matrica međusobno povezanih pravilnih šesterokuta, kao teorijski najuspjeliji uzorak u rješavanju problema ekonomičnog pokrivanja zadanog dijela ravnine.

square matrix, almost always less favourable than the circumference when the conches ground-plan is circular, or in the form of a circle (Figure 23).

B) Matrix consisting of regular hexagons

The composition of early Croatian small churches of central six-leaf type exhibits a particular complex spatial-architectonic problem, arising from the interconnection of spaces with a circular matrix. It is quite specific since circles as shapes cannot be connected to each other with no residual interspace (which was not supposed to be exhibited as it would irretrievably ruin the concept of a single-space building).

Polukrug	Izvod	$k = 0.70$
	$r = 2.82$ $P = r^2 \pi / 2$ $P = 12.50$ $O = 2\pi r / 2$ $O = 2\pi r$ $O = 8.85$	$P = 12.50$ $O = 8.85$
Poligon	Izvod	$k = 0.73$
	$\alpha = 360/n$ $n = 6$ $\alpha = 45^\circ$ $\alpha_n = 22.5^\circ$ $P = 1.5625 a^2$ $v = 2.746 a$ $a/2 = 1.137 a$	$P = 12.50$ $O = 9.10$
Segment	Izvod	$k = 0.76$
	$\alpha = 120^\circ$ $I = r^2 \alpha / 360$ $I = r^2 1.046$ $r = 1.155 a$ $r = 4.52$ $n = 3.91$ $v = 2.26$	$P = 12.50$ $O = 9.45$
Kvadrat	Izvod	$k = 0.85$
	$a = 3.253$ $P = a^2$ $O = 3a$ $O = 10.60$	$P = 12.50$ $O = 10.60$

SLIKA 23. Komparativni prikaz oblika konhi u odnosu na povećanje njihova opsega, uz P = konstantno (autor)
FIGURE 23. Comparative representation of conch shapes with respect to increasing their circumference, with P = constant (author)

Matematičko-geometrijskim eksperimentom prekrivanja tlocrtne dispozicije starohrvatske šesterolisne crkvice (A) mrežom međusobno povezanih pravilnih šesterokuta (B), dobiven je vrijedni nalaz (C) iz kojeg se jasno očituje da je međusobno povezivanje središnje mase promatranog zdanja s vijencem njegovih polukružnih apsida (apsidiola, konhi), konstrukcijski veoma blisko najracionalnijoj matrici povezivanja istovrsnih ravninskih likova u zadani oblik (slika 24).

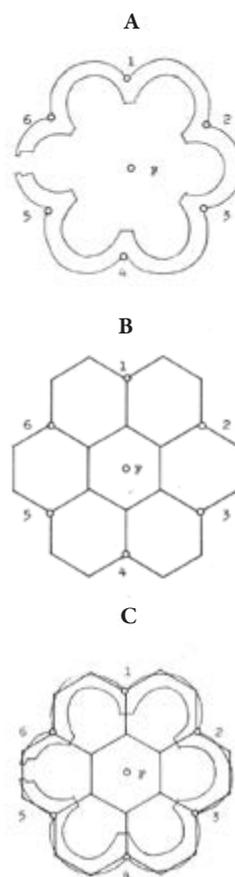
Kako je ta matrica međusobno povezanih pravilnih šesterokuta u svom najvećem dijelu manifestacija djelovanja načela štednje u njenoj morfogenezi, u pogledu najštedljivijeg omjera upotrijebljenog materijala za njeno definiranje, dobiveni nalaz trebao bi predstavljati pouzdanu potvrdu da i u morfogenezi promatrane građevine načelo štednje i ekonomičnosti ima značajnu ulogu.

Zaključak

Provedene pojedinačne analize u ovom radu, gdje su teze o postojanju načela ekonomičnosti u morfogenezi starohrvatskih crkvice središnjega šesterolisnog tipa na području Splita, potkrijepljene matematičko-geometrijskim eksperimentima kojima su bili podvrgnuti ti oblici, dobiveni su ovi zaključci:

1. Štedljivi registar likovnih elemenata

U svjetlu činjenice da svako kvalitetno arhitektonsko djelo putem svojega vanjskoga morfološkog izraza jasno odražava



SLIKA 24. Tlocrt crkvice Sv. Marije u Trogiru i mreža pravilnih šesterokuta (autor)

FIGURE 24. *Ground plan of the church Sv. Maria in Trogir and a network of regular hexagons (author)*

Trying to discover the cost-effectiveness of the actual distribution, abounding in circle-like shapes, we have introduced in our geometrical analysis, as an auxiliary testing tool, the matrix of interconnected regular hexagons, as a theoretically the most successful example in solving the problem of cost-effective covering of a particular part of a plane.

va ciljeve i ambicije svojih graditelja i profil tadašnjeg društva, razvidno je da se ta umjetnička „poruka“ može različito definirati primjenom isto tako različitog registra likovnih elemenata.

Nastojanje da se osigura jedan kontemplativni, posvećeni prostor, neometan dinamikom svakodnevnog života, koji će potpuno zadovoljavati potrebe onovremenog čovjeka za njegovom duhovnom dimenzijom, jasno i nedvosmisleno izražava sam taj oblik arhitektonskog djela.

Kod splitskih šesterolisnih crkvice raspoznaje se prisutnost čimbenika ekonomičnosti i racionalne štedljivosti u jednoj izrazito specifičnoj ulozi. Naime, upravo suprotno od načina da se s mnoštvom različitih likovno-arhitektonskih znakova iskaže taj segment arhitektonske vrijednosti djela, ovdje je upravo štedljivo raspolaganje elementima arhitektonskih oblika pridonijelo većoj jasnoći izražavanja te metaforičke dimenzije djela.

Morfološka matrica fokusirana je isključivo na lik kruga i kružnice, kojom se kreira tlocrtna dispozicija i vertikalni gabarit djela.

2. Ekonomičnost u odabiru i uporabi materijala

Lako je uočljivo da su zidna platna promatranih zdanja prostorno definirana kao krute, kompaktne površinske mase, izgrađene od nepravilnih komada lomljenog kamena. Općenito uzevši, u razmatranju razdoblja starohrvatske sakralne arhitektonske umjetnosti nailazimo na tu pojavu „endemske“ isključivosti u uporabi građevnog materijala. Stari su Hrvati „gradili

Mathematical-geometric experiment that included covering a ground-plan disposition of an early Croatian six-leaf church (A) by a network of interconnected regular hexagons (B), resulted in a valuable find (C), which clearly indicated that the interconnection of the central mass observed with the circle of its semi-circular apses (apsidiales, conches), was structurally quite close to the most rational matrix of connecting plane figures of the same type in a given shape (**Figure 24**).

Since the matrix of interconnected regular hexagons is mostly a manifestation of the workings of the principle of cost-effectiveness in its morphogenesis, as to the most economical ratio of the material used to define it, the result obtained should represent a reliable proof that the principle of thrift and cost-effectiveness play a major role even in morphogenesis of the building in question.

Conclusions

Individual analyses done within the scope of this study, where the thesis of the presence of the cost-effectiveness principle in the morphogenesis of early Croatian small churches of central, six-leaf type in the region of Split, supported by mathematical-geometric experiments performed on the given forms, resulted in the following conclusions:

1. Thrifty register of artistic elements

Having in mind the fact that every high-quality architectonic work, through its outer morphological expression, clearly reflects the goals and ambitions of the builder and the profile of the society of the time, it is quite obvious that this artistic „message“ can be differently defined when applying a different register of artistic elements.

The ambition to provide a contemplative, consecrated space, undisturbed by everyday life dynamics, such that would completely satisfy the

od prvog početka svoje crkve od kamena. Oni su to činili u vrijeme, kada su ostali slavenski narodi, još dizali svoje prve bogomolje u drvu, koje se lako troši i propada“. (33) Kako prirodne datosti okoliša bogata kamenim materijalom, a oskudna drvetom, to priklanjanje lako dostupnoj građi nepobitni je dokaz o ekonomičnom promišljanju i postupanju onovremenih graditelja.

3. Statičko jedinstvo jezgre i obodnih konhi

U istraživanju nosivog dijela korpusa koji bi u vidu konstrukcije prenosio sva javljena unutarnja i vanjska opterećenja tih građevina, dolazimo do nalaza, a on nije izdvojen u vidu posebnog elementa, već je sadržan u samoj definiciji korpusnog plašta, kojem se osim osnovne funkcije zatvaranja unutarnjeg prostora, dodaju i funkcije pune statičke stabilnosti izgrađenog korpusa i potporna nadvišenoga valjkastog tambura i kupole. Tu je složen arhitektonsko-statički program riješen s minimumom upotrijebljenih graditeljskih sredstava.

4. Posredni dokazi o štedljivosti u oblikovanju

O postojanju snažnoga latentnoga momenta ekonomičnosti u općoj konstituciji i oblikovnom sređivanju graditeljskih oblika starohrvatskih predromaničkih crkvice, jasno potvrđuju upravo neka novija istraživanja, koja su za svoju glavnu analizu imala posve drugačiju temu. (40) Ispitivanjem morfogeneze tih sakralnih zdanja s funkcionalnom tezom o apsolutnom autoritetu kozmičkih sila i doga-

needs of contemporary man for his spiritual dimension, clearly and unambiguously is reflected by the form of the piece of architecture studied.

The factors of cost-effectiveness and thrift with Split six-leaf small churches are recognised in a particular and quite specific role. Contrary to the idea that a multitude of various artistic-architectonic signs could present this segment of architectonic value, in the case of these churches thrifty use of the architectonic form elements contributed to better clarity of expression and better presented metaphoric dimensions of these pieces of architecture.

The morphological matrix is focused exclusively on the circular shape and form, using them to create the ground-plan disposition, as well as the vertical size of the building.

2. Cost-efficiency in the selection and use of the material

It is easy to note that wall canvases in the objects observed are spatially defined as stiff, compact surface masses, made of irregular pieces of broken stone. Generally, this phenomenon of „endemic“ exclusiveness in using building materials can be seen when the period of early Croatian sacral architectonic art is observed. Early Croats „used stone in building their churches from the very beginning. They did it at the time when other Slavic peoples used wood, which is easily spent and deteriorates, to build their temples“. (33) As the natural environment was rich in stone material, and lacked wood, this inclination to use easily available building material is an obvious proof of cost-efficient deliberation and action of the builders at the time.

3. Static unity of the core and circumferential conches

Investigation of the bearing corpus, which through construction transfers all inner and outer loads, leads to the conclusion that it is not detached

đanja pri ustrojstvu njihova oblikovnog sklopa (iako bez nekog šireg dokaznog analitičkog postupka), jasno se zastupa teza o štedljivoj uporabi i ekonomičnom korištenju oblika. Naime, pretpostavlja se da postojeći oblici u graditeljskoj kompoziciji nisu bili raspoređivani isključivo putem nekoga prevladavajućeg formalističko-apstraktnog reda, već je tu bio snažno izražen cilj da se s „minimumom sredstava ostvari opsežan graditeljski program“. (40)

Jasno je da takve sekundarne analize doprinose rasvjetljavanju uloge načela ekonomičnosti kod promatranih crkvice starohrvatske arhitektonske baštine.

Stoga se može zaključiti da su eksperimenti izvedeni na tlocrtnim dispozicijama starohrvatskih arhitektonskih šesterolista na području Splita, potvrdili da je isto prirodno načelo ekonomičnoga grupiranja više istovrsnih manjih prostora u zajedničku cjelinu, preslikano u tim arhitektonskim zdanjima. Te starohrvatske crkvice izrastaju kao djela značajno usklađena s datostima svoga povijesnog vremena i općih prirodnih zakonitosti pripadajućeg prostora.

Upravo se kod šesterolatičnih tipova crkvice, kroz vanjsku oblikovnu manifestaciju aktivnog djelovanja načela ekonomičnosti u sveukupnom ustrojstvu tih djela, jasno iskazuje genij hrvatskoga predromaničkoga stvaralaštva, gdje je taj organski racionalizam nastao primarno iz nužde za egzistencijalnim opstankom u tim prostorima dugi niz godina, da bi kasnije izrastao u najvišu estetsko-likovnu vrijednost tih djela.

as a separate element but is contained in the definition of the corpus mantle itself, which apart from the basic function of enclosing the inner space, also performs the function of full static stability of the outer tambour and dome. This complex architectonic-static problem has been solved using the minimum amount of building material.

4. Indirect proofs of thrift in designing

Some recent investigations that were concerned with completely different topics (40) clearly confirmed the thesis that there was a strong latent moment of cost-effectiveness in the general construction of early Croatian pre-Romanic small churches. Investigations of morphogenesis of these sacral objects, with the functional thesis of the absolute authority of cosmic forces and phenomena in creating their design assembly (although with no broader analytical procedure to prove it), clearly supported the thesis on thrifty and cost-effective use of the forms. It is reasonable to suppose that the existing forms in building composition were not distributed only by some prevailing formalistic-abstract order, but also by a strongly pronounced will of „using minimum resources to realise a comprehensive building program“. (40)

These secondary analyses obviously contribute to clarifying the role of the principle of cost-effectiveness in the churches observed that represent early Croatian architectonic heritage.

It can be seen that the experiments performed on ground-plan dispositions of early Croatian architectonic six-leaves in the Split region confirmed that the same natural principle of a cost-effective grouping of a number of identical small spaces into a joint unit, was copied in these architectural objects. These early Croatian small churches have grown as pieces of architecture considerably harmonised with the realities of its historic period and the general natural laws of the region in question.

Razvidno je kako je upravo načelo ekonomičnosti i opće graditeljske štedljivosti kod promatranih starohrvatskih crkvice središnjega šesterolisnog tipa na splitskom području, značajno pridonio punoj spontanosti izražavanja svih onih unutarnjih težnji i vjerovanja čovjeka onoga vremena, putem odabranih oblika, kao i da se to „značenje“ prenese kroz tako daleku vremensku distancu u svom prvobitnom, iskrenom i neizmijenjenom obliku.

It is exactly the six-leaf church type that, by its outer design including the active impact of the cost-effectiveness principle in its overall structure, clearly exposes the genius of Croatian pre-Romanic creation, where this organic rationalism was born primarily through a necessity for the existential survival in the region for a long period of time, to grow only later into the highest aesthetic-artistic value of these objects.

It is obvious that the principle of cost-effectiveness and general building thrift in the early Croatian small churches of the central six-leaf type observed contributed significantly to the full spontaneity of expressing all the inner aspirations and beliefs of the man at that time, through selected forms, as well as to the success in transferring this „meaning“ through such a long period of time in its primary, earnest and unchanged form.

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Akademik Sibe Mardešić, matematičar i profesor (1927. – 2016.)*

Academician Sibe Mardešić, mathematician and professor (1927–2016)*

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SAŽETAK

Akademik Sibe Mardešić bio je svjetski poznati hrvatski matematičar s više od 200 znanstvenih i stručnih članaka i drugih radova te oko 20 knjiga, monografija i udžbenika uglavnom iz područja algebarske topologije, teorije oblika i matematičke analize. Čitav radni vijek proveo je na Odsjeku za matematiku Prirodoslovno-matematičkog fakulteta (PMF) Sveučilišta u Zagrebu, gdje je na dodiplomskom studiju predavao razne predmete – od matematičke analize, topologije, algebre i drugih. Jedan je od osnivača prvoga poslijediplomskoga studija matematike u ovom dijelu Europe (1960.); bio je voditelj i prvi predavač na tome studiju u Zagrebu i voditelj pripadnoga seminara (kružoka). Također je jedan od osnivača studija matematike u

SUMMARY

Academician Sibe Mardešić was a world-known Croatian mathematician with more than 200 scientific and professional papers and other works, as well as 20 books, monographs and textbooks mostly from the area of algebraic and general topology and mathematical analysis. He worked at the Department of Mathematics within the Faculty of Sciences (PMF), University of Zagreb. He taught many undergraduate courses such as mathematical analysis, topology and algebra. He was one of the founders of the first graduate study of mathematics in this part of Europe (1960) and the first lecturer at that graduate school in Zagreb who led the graduate seminar. He co-founded the Department of Mathematics at the University of Split. He was a guest professor or visiting professor, invited to many well-known universities around the world, from the USA, Mexico, around

* Članak je djelomice referiran na znanstvenom skupu *Hrvatski prirodoslovci* 31, Split, 25. – 26. studeni 2022.

* *The paper was partially referred at the scientific meeting Croatian naturalists* 31, Split, Croatia, November 25–26, 2022.

** Sada u miru. / ** Now retired.

Splitu. Bio je gostujući profesor ili je posjetio po pozivu brojna ugledna sveučilišta diljem svijeta, od SAD-a, Meksika, gotovo čitavu Europu, od Japana do Rusije, Ukrajine i Turske. Smatra se jednim od osnivača i svjetskih eksperata teorije oblika (vrste globalne teorije homotopije). Bio je dugogodišnji glavni i odgovorni urednik *Glasnika matematičkog* i član uredništva više inozemnih i domaćih časopisa. Objavio je gotovo 300 referata (opisa radova) u američkom referativnom časopisu *Mathematical Reviews* i oko 180 u njemačkom časopisu *Zentralblatt*. Osnivač je i sudionik više domaćih i međunarodnih konferencija, primjerice u Dubrovniku. Bio je dekan i prodekan fakulteta, predsjednik Hrvatskoga matematičkog društva (HMD) i suradnik (fellow) Američkoga matematičkog društva (AMS). Bio je redoviti član Hrvatske akademije znanosti i umjetnosti, HAZU (prije JAZU) i Europske akademije. Dobitnik je nagrade *Ruđer Bošković*, nagrade grada Zagreba i nagrade za životno djelo. Desetak dana nakon smrti objavljena mu je impresivna matematička, kulturološko-povijesna i životna autobiografija na gotovo 500 stranica koju je pomalo pisao tijekom nekoliko godina.

KLJUČNE RIJEČI

Sibe Mardešić

- profesor matematike
- teorija homologije
- teorija oblika
- topologija

Obiteljsko podrijetlo, djetinjstvo i srednja škola

U svojoj autobiografiji (1), Sibe (Josip) Mardešić kaže da je prezime Mardešić iz Knina na otok Vis, odnosno Komizu,

Europe, Japan to Russia, Ukraine and Turkey. They saw him as one of the founders and world experts in shape theory (global homotopy theory). For years he was the editor-in-chief of *Glasnik matematički* and a member of the editorial board of a number of domestic and foreign journals. He published almost 300 reviews in the American journal *Mathematical Reviews* and almost 180 in the similar German *Zentralblatt*. He founded and participated in a number of international conferences, for instance, the one in Dubrovnik. He was the dean and the vice-dean of the faculty, president of the Croatian Mathematical Society (HMD) and a fellow of the American Mathematical Society (AMS). He was a full member of the Croatian Academy of Science and Art (HAZU, formerly JAZU) and of the European Academy. He received the *Ruđer Bošković* award, the award of the City of Zagreb and the lifetime achievement award. Ten days after his death the impressive mathematical, cultural-historical and autobiographical book of almost 500 pages appeared which he wrote for many years.

KEYWORDS

Sibe Mardešić

- homology theory
- professor of mathematics
- shape theory
- topology

Family background, childhood and high school

In his autobiography (1), Sibe (Josip) Mardešić says that the surname Mardešić came from Knin to the island of Vis, or Komiza, at the beginning of the 16th century. Sibe's grandfather Josip (Sibe) and father (Pavao) were born in Komiza, and, among other things, were engaged in fishing for sardines with so-called „gajeta Falkuša“ in Palagruža and other Adriatic fishing grounds. Sibe's other grandparents

došlo početkom 16. stoljeća. U Komiži su rođeni Sibin djed Josip (Sibe) i otac (Pavao), koji su se, među ostalim, bavili i ribolovom gajetom falkušom na srdele u Palagruži i drugim jadranskim lovištima. Drugi Sibini baka i djed bili su Josip (Bepo) Karaman i baka Eulalija Karaman (rođ. Nakić), nakladnici i organizatori prvih kina u Splitu. Sibin otac Pavao (1895. – 1978.) diplomirao je brodogradnju i strojarstvo u Beču, a majka Anka (1898. – 1986.), rođ. Karaman, završila je splitsku klasičnu gimnaziju. Roditelji su od 1922. do 1929. živjeli u Hamburgu, a Sibe se rodio u Bergedorfu (predgrađe Hamburga) 20. lipnja 1927., a kršten je u obližnjoj katoličkoj crkvi. Nakon kraćeg boravka u Čileu, a uslijed svjetske krize, obitelj se polovicom 1930. vraća u Split. Od dolaska u Split do odlaska na služenje obveznog vojnog roka u Jugoslavensku narodnu armiju (JNA) 1945., odnosno odlaska na studij u Zagreb, Sibe je proveo u Splitu kojeg je uvijek osjećao kao svoj zavičaj, a obiteljsku kuću u Podšpilju kod Komiže na otoku Visu kao ljetnu kuću za odmor.

U Splitu je Sibe Mardešić završio osnovnu i srednju školu, s tim da je u 4. razredu realne gimnazije (u dobi od 14 godina) dočekao početak Drugoga svjetskoga rata (travanj, 1941.). Otac je odlučio da Sibe i njegov mlađi brat Uroš ne će ići u školu dok traje rat, nego su učili i polagali ispite kod kuće. Tijekom talijanske okupacije dijelova Hrvatske za vrijeme Nezavisne Države Hrvatske (NDH), Sibe i brat mu privatno su polagali 5. do 7. razreda. Tada naučeni talijanski kasnije mu je dobro došao kad je predavao matema-

were Josip (Bepo) Karaman and grandmother Eulalija Karaman (née Nakić), publishers and organizers of the first cinemas in Split. Sibe's father Pavao (1895–1978) graduated in shipbuilding and mechanical engineering in Vienna, and mother Anka (1898–1986), born Karaman, she graduated from Split's classical high school. From 1922 to 1929, his parents lived in Hamburg, and Sibe was born in Bergedorf (a suburb of Hamburg) on June 20, 1927, and was baptized in a nearby Catholic church. After a short stay in Chile, due to the world crisis, the family returned to Split in the middle of 1930. From his arrival in Split until his required military service in the Yugoslav People's Army (JNA) in 1945, i.e. his departure to study in Zagreb, Sibe spent his time in Split, which always felt like his home, and the family house in Podšpilje near Komiža on the island Vis. In Split, Sibe Mardešić finished primary and secondary school, with the fact that in the 4th grade of the real gymnasium (at the age of 14) he saw the start of World War II (April, 1941). The father decided that Sibe and his younger brother Uroš would not go to school during the war, but instead studied and took exams at home. During the Italian occupation of parts of Croatia through the Independent State of Croatia (NDH), Sibe and his brother took their 5th to 7th grades privately. The Italian he learned then came into practice later when he taught mathematics at various Italian universities to which he was invited. In addition, he also studied German, which he „had in his ear“ since he was born (in Hamburg). He also started learning English privately during the war, but his Jewish teacher was taken away by the Germans and killed, and he soon continued with another English (and French) teacher. After World War II, English became the predominant language, the *lingua franca*, in which Sibe Mardešić taught, wrote and communicated

tiku na raznim talijanskim sveučilištima na koje je bio pozivan. Osim toga, učio je i njemački koji je već od rođenja (u Hamburgu) „imao u uhu“. Engleski je također počeo učiti privatno za vrijeme rata, ali su mu učiteljicu Židovku Nijemci odveli i ubili, no nastavio je ubrzo s drugom učiteljicom engleskog (i francuskog). Nakon Drugoga svjetskoga rata, engleski je ionako postao prevladavajući jezik, *lingua franca*, na kojem je Sibe Mardešić predavao, pisao i komunicirao diljem svijeta. U ožujku 1945. upoznao je starijeg kolegu Berislava Makjanića, koji ga je uputio na studij matematike na upravo osnovani PMF u Zagrebu. Maturu je 1945. položio po skraćenom postupku i nikad nije prežalio što je nije završio „normalno“. No, ipak, čini se da mu je to dalo dodatnu inspiraciju i snagu da dostigne i prestigne „normalne“ srednjoškolce.

Student matematike, asistent, doktorat, Princeton

Najopsežniji izvori informacija o životu i radu akademika Sibe Mardešića njegova je sjajna autobiografija (1). Zatim su tu članci (2, 3), knjiga iz povijesti znanosti (4) i druge navedene na kraju popisa literature. Ovdje ćemo za čitatelje *Prirodoslovlja* navesti i neke nove pojedinosti iz životnog puta Sibe Mardešića, kao i o njegovu bogatom znanstvenom i profesorskom opusu.

Ujesen 1946. Sibe Mardešić upisuje Matematičko-fizički odsjek PMF-a na Marulićevu trgu 19 u Zagrebu (**slika 1**), koji se netom odvojio od Mudroslovnoga odnosno Filozofskoga fakulteta.

all over the world. In March 1945, he met an older colleague, Berislav Makjanić, who guided him to study mathematics at the just-founded PMF in Zagreb. In 1945, he took his maturity exam on the condensed procedure and never regretted that he did not finish it „normally“. However, it seems that this gave him additional inspiration and strength to reach and surpass „normal“ high school students.

Mathematics student, Assistant, Ph.D., Princeton

The most extensive sources of information about the life and work of academician Sibe Mardešić are his excellent autobiography (1). Then there are the articles (2, 3), a book on the history of science (4) and others listed at the end of the references list. Here, for the readers of *Prirodoslovlje*, we will provide some new details from Sibe Mardešić's life path, as well as about his rich scientific and professorial work.



SLIKA 1. Zgrada PMF-a, Marulićev trg 19, Zagreb, oko 1982. (1, str. 36)

FIGURE 1. PMF building, Marulić Square 19, Zagreb, around 1982 (1, p. 36)

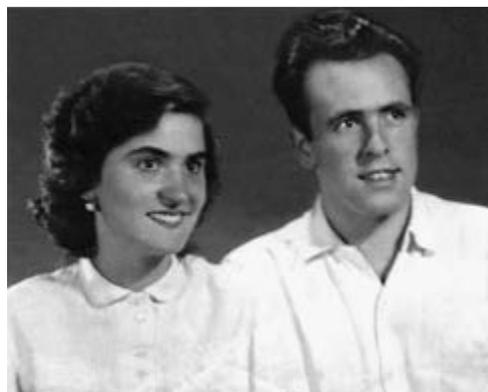
In the fall of 1946, Sibe Mardešić enrolled in the Mathematics-Physics Department of the PMF at Marulić Square 19 in Zagreb (**Figure 1**), which separated from the „Mudroslovni“ i.e. Faculty of Philosophy.

Sibe je tada stanovao u podstanarskoj sobici (3,50 m × 1,70 m) na Staljinovu, kasnije Krešimirovu trgu 8, kod gospođe Štefice Vičan, rodom iz Mostara, punih sedam godina. Profesori i asistenti na fakultetu su mu bili Đuro Kurepa (5), koji je naslijedio profesora Vladimira Varičaka (6), Rudolf Cesarec (7), Mladen Paić i Stanko Bilinski (8, 9), Zlatko Janković (10), Vladimir Vranić (11) i Željko Marković (12). Vježbe nekih predmeta mu je držao Pavle Papić (13). Sviđala su mu se predavanja iz geometrije profesora Bilinskoga i Cesarca.

Na studiju je Sibe upoznao buduću suprugu Veru Župarić-Mardešić (1930. – 2021.), rodom iz Osijeka, s kojom je bio u skladnom braku više od 65 godina (slika 2). Vjenčali su se 14. studenoga 1951. u crkvi Sv. Marka. Vera je također diplomirala u jesen 1953. kod profesora Đure Kurepe s temom *Konveksne funkcije*. Kasnije je magistrirala i predavala matematiku na Fakultetu strojarstva i brodogradnje (FSB) u Zagrebu. Pratila je Sibua na brojnim znanstvenim skupovima u zemlji i svijetu. Imali su dvoje djece: Milica Mihaljević (rođena Mardešić, 1958.), jezikoslovka na Institutu za hrvatski jezik i jezikoslovlje, i Pavo (r. 1960.), matematičar i profesor u Dijonu, Francuska, stručnjak iz dinamičkih sustava.

Sibe Mardešić uživao je u svom studentskom životu, bio je izvrstan student, s lakoćom je savladao gradivo, pjevao s društvom ulicama Zagreba (Jurjevska ulica, Cmrok itd.). Diplomirao je u jesen 1950. Profesor Marković mu je na kauzalnom ispitu zadao dva zadatka: 1. opisati

At that time, Sibe lived in a tenant's room (3.50 m x 1.70 m) at Staljin, later Krešimir Square 8, at Mrs. Štefica Vičan, a native of Mostar, for seven years. His professors and assistants at the faculty were Đuro Kurepa (5), who succeeded professor Vladimir Varičak (6), Rudolf Cesarec (7), Mladen Paić and Stanko Bilinski (8, 9), Zlatko Janković (10), Vladimir Vranić (11) and Željko Marković (12). Pavle Papić (13) led some practice subjects. Mardešić liked the geometry classes by professors Bilinski and Cesarec.



SLIKA 2. Vera i Sibe Mardešić, Zagreb, 1950. (1, str 34)

FIGURE 2. Vera and Sibe Mardešić, Zagreb, 1950 (1, p. 34)

In their student days, Sibe met his future wife, Vera Župarić-Mardešić (1930–2021), a native of Osijek, with whom he was happily married for more than 65 years (Figure 2). They married on November 14, 1951 in the church of St. Mark in Zagreb. Vera also graduated in the fall of 1953 by professor Đuro Kurepa with the thesis *Convex functions*. Later, she earned her master's degree and lectured mathematics at the Faculty of Civil Engineering and Shipbuilding (FSB) in Zagreb. She travelled with Sibe to numerous scientific meetings

Cantorov trijadski skup, i 2. riješiti jedan zadani sustav od četiri obične linearne diferencijalne jednadžbe. Profesor Cesarec mu je zadao ova dva pitanja: 1. odrediti pupčaste točke jedne zadane plohe, i 2. odrediti jednadžbu loksodrome, tj. krivulje na sferi koja siječe sve meridijane pod istim kutom. Sibe je to riješio više-manje rutinski i diplomirao s odlikom.

Oko godine 1951. Sibe je od profesora Željka Markovića, kojem je bio asistent (1950./1951.) prvi put čuo riječ „topologija“ i „dinamički sustavi“. – „Time bi se Vi kolega, mogli početi baviti...“, Marković je predložio Sibi Mardešiću, kako je mnogo kasnije rekao Sibe. Ostalo je povijest. Sibe je zagrizao tu udicu i napravio svjetski uspješnu karijeru, kao što ćemo vidjeti u nastavku ovoga članka.

Sibe Mardešić bio je asistent na PMF-u 1951. – 1957. Vodio je vježbe iz predmeta *Diferencijalni i integralni račun* te iz *Teorije funkcija kompleksne varijable*. U međuvremenu je objavio prve radove: *Preslikavanja prostora kod zrcaljenja na šupljolj staklenoj kugli* i *O visinama trokuta u hiperboličkoj geometriji*, oba u *Glasniku Mat.-Fiz. Astron.* Oba su rada bila iz geometrije, više stručna nego čisto znanstvena, te rad (14) iz algebre na njemačkom, također u *Glasniku*.

No, tih je godina po napatcima Ž. Markovića temeljito proučavao knjigu H. Seiferta i W. Threlfalla (15) iz topologije (na njemačkom), a nešto kasnije knjige iz algebarske topologije autora: S. Lefschetz, S. Eilenberg i N. Steenrod te P. Aleksandrova i H. Hopfa. Zanimljivo, Seifert mu je mnogo kasnije rekao da su veći dio svo-

in the country and abroad. They had two children: Milica Mihaljević (born Mardešić, 1958), a linguist at the Institute of Croatian Language and Linguistics, and Pavo (born 1960), a mathematician and professor in Dijon, France, an expert on dynamical systems.

Sibe Mardešić enjoyed his student days, he was an excellent student, he passed easily all exams, and he sang with his friends in the streets of Zagreb (Jurjevska ulica, Cmrok, etc.). He graduated in the fall of 1950. Professor Marković asked him two questions on the causal exam: 1. describe Cantor's triadic set, and 2. solve a given system of four ordinary linear differential equations. Professor Cesarec asked him the following two questions: 1. determine the extreme points of a given surface, and 2. determine the equation of the loxodrome, i.e. the curve of the sphere which intersects all meridians at the same angle. Sibe solved it more or less routinely and graduated with best grade.

Around 1951, Sibe first heard the terms words „topology“ and „dynamical systems“ from professor Željko Marković, to whom he was an assistant (1950/1951). – „You, colleague, could start studying that stuff...“, Marković suggested to Sibe Mardešić, as Sibe said to us many years later. The rest is history. Sibe bit the hook and made a worldwide successful career, as we will see in the rest of this article.

Sibe Mardešić was a teaching assistant at PMF from 1951 till 1957. He led the practice of subjects *Differential and integral calculus* and the *Theory of functions of complex variables*. In the meantime, he published his first papers: *Mapping space as symmetry in a hollow glass sphere* and *On altitudes of a triangle in hyperbolic geometry*, both in *Glasnik Mat.-Fiz. Astron.* Both papers were on geometry, more professional than purely scientific, and then the paper (14) on algebra in German, also in *Glasnik*.

je knjige napisali 1930-ih ljetujući u Hrvatskoj, u Makarskoj.

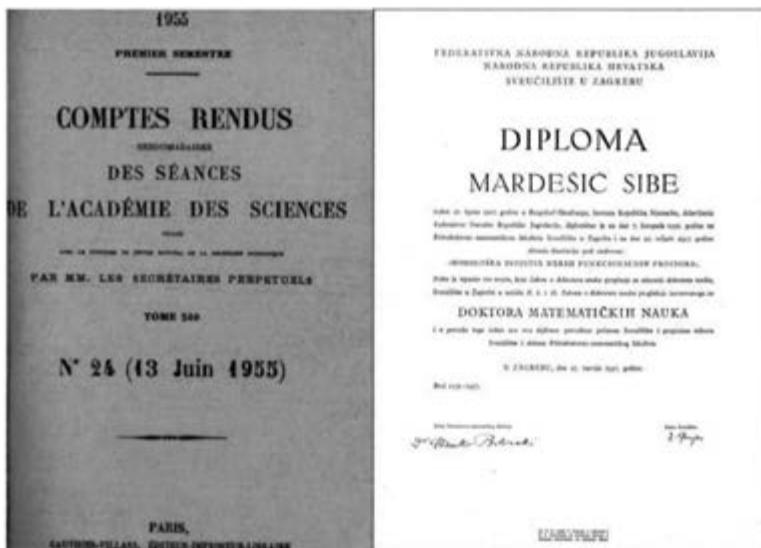
Usljedio je nekoliko članaka iz algebre i opće topologije objavljenih također u *Glasniku*, jedan zajedno s prof. Pavlom Papićem (16). Sredinom 1950-ih Mardešić je u poljskom časopisu *Fundamenta Mathematicae* pronašao zanimljiv članak Karola Borsuka o homološkim svojstvima nekih funkcionalnih prostora (17). Kao konačni ishod istraživanja, Mardešić je dokazao da ako je X metrički kompakt dimenzije k , onda za prostor neprekidnih preslikavanja sa X u m -sferu, $k < m$, vrijedi da mu je $(m-k)$ -ta homologija izomorfna k -toj kohomologiji samog prostora X i da se pritom može uzeti singularna homologija, što je do tada bilo nepoznato. Nakon što je objavio četiri kraće najave svojih istraživanja u *Comptes Rendus* Francuske akademije (slika 3) i opsežni članak na 73 stranice u *Glasniku* (18), profesor Marković je smatrao da s tim materijalom Sibe može doktorirati. Obranio je doktorat 22. veljače 1957. s temom *Homološka svojstva nekih funkcionalnih prostora (slika 3)* na gotovo 180 stranica, pred povjerenstvom u sastavu Ž. Marković, Đ. Kurepa i S. Bilinski, u zamjeni P. Papić.

Već je 1956. Sibe Mardešić bio pozvan na 4. kongres rumunjskog saveza matematičara (slika 4), gdje je govorio o svojim novim rezultatima istraživanja. Pritom je osobno upoznao brojne poznate topologe i s njima izmijenio iskustva korisna za daljnji rad; među ostalima, to su bili K. Borsuk, K. Kuratowski, S. Eilenberg, G. de Rham, L. Vietoris, K. Sitnikov, A. H. Stone, W. T. Wu, te Rumunji S. Stoilow,

However, in those years, at the suggestion of Ž. Marković, Sibe started thoroughly studying the book *Topologie* (in German) by H. Seifert and W. Threlfall (15), and a little later he studied the books on algebraic topology by the authors: S. Lefschetz, S. Eilenberg and N. Steenrod and P. Aleksandrov and H. Hopf. Interestingly, Seifert told him many years later that they wrote the major part of their book in the 1930s while vacationing in Croatia, in Makarska.

Several articles from algebra and general topology followed, also published in *Glasnik*, one together with prof. Pavle Papić (16). In the mid-1950s, Mardešić found an interesting article by Karol Borsuk on the homology properties of some functional spaces in the Polish journal *Fundamenta Mathematicae* (17). As the final result of the research on this topic, Mardešić proved that if X is a metric compact dimension k , then the space of all maps from X to the m -sphere, $k < m$, then the $(m-k)$ -th homology of this space is isomorphic to the k -th cohomology of X and this can be considered in singular homology, which was unknown at that time. After publishing four short announcements of his research in the *Comptes Rendus* of the French Academy (Figure 3) and an extensive 73-page article in *Glasnik* (18), Professor Marković considered all these to be quite adequate material for Sibe to get his doctorate. He defended his doctorate on February 22, 1957, with the topic *Homological properties of some functional spaces (Figure 3)* about almost 180 pages, in front of a committee composed of Ž. Marković, Đ. Kurepa and S. Bilinski, replaced by P. Papić.

Already in 1956, Sibe Mardešić was invited to the 4th Congress of the Romanian Association of Mathematicians (Figure 4), where he spoke about his new research results. There he personally met numerous famous topologists and exchanged expe-



SLIKA 3. *Comptes rendus*, Francuske akademije, 1955. (lijevo) i doktorska diploma Sibe Mardešića, Zagreb, 1957. (desno) (1, str. 49)

FIGURE 3. *Comptes rendus*, French Academy, 1955 (left) and doctoral diploma of Siba Mardešić, Zagreb, 1957 (right) (1, p. 49)



SLIKA 4. Mardešićevo prvo predavanje u inozemstvu, Bukurešt, 1956. (1, str. 47)

FIGURE 4. Mardešić's first lecture abroad, Bucharest, 1956 (1, p. 47)

G. Vranceanu, I. Bucur, T. Ganea, I. Berstein i drugi. Nakon novih spoznaja iz Rumunjske, napisao je članak za *Fundamenta Mathematicae* (19), u kojem je poopćio rezultate iz disertacije.

Nakon par pisama (bez interneta!) izmijenjenih s profesorom Solomonom Lefschetzom, predložio je Mardešiću da provede neko vrijeme na studijskom boravku na *Institute of Advanced Study* u Princetonu, tada (a i sada) jednom od najprestižnijih svjetskih matematičkih instituta. Uz preporuke kolega koje je sreo u Rumunjskoj te profesora Vilima (William) Feller (1906. – 1970.), inače Zagrepčanina i tada redovitog profesora na Sveučilištu Princeton¹ dobio je odobrenje za studijski boravak u Americi. Nakon dosta peripetija oko dobivanja izlazne i ulazne američke vize, na put je krenuo 18. kolovoza 1957. teretnim brodom *Vojvodina* od Rijeke do New Yorka, koji je trajao 26 dana. U messinskom su tjesnacu putnici uz pomoć kapetana i mornara bacili u more zapečaćene boce s pismima obiteljima. Na sreću, supruga Vera je u Splitu dosta brzo primila Sibino pismo iz boce!

Nakon nekog vremena upoznavanja s Institutom i uklapanja u „američki način života“ Sibe se priviknuo na život i rad u SAD-u. Brojni su europski znanstvenici Židovi (a i ne-Židovi) 1930-ih i 40-ih pred naletom nacizma našli utočište u Americi, naročito u Princetonu, primjerice Albert Einstein (koji je tamo i umro 1955.), John von Neumann (koji je također tamo umro 1957.), Hermann

riences with them useful for further work; among others, they were K. Borsuk, K. Kuratowski, S. Eilenberg, G. de Rham, L. Vietoris, K. Sitnikov, A. H. Stone, W. T. Wu, and the Romanians S. Stoilow, G. Vranceanu, I. Bucur, T. Ganea, I. Berstein and others. After new knowledge from Romania, he wrote an article for *Fundamenta Mathematicae* (19), in which he summarized the results of the dissertation.

After a couple of letters (without the Internet!) exchanged with professor Solomon Lefschetz, he suggested that Mardešić spend some time on a study stay at the *Institute of Advanced Study* in Princeton, then (and now) one of the world's most prestigious mathematical institutes. With the recommendations of colleagues, he met in Romania, and professor Vilim (William) Feller (1906–1970), a native of Zagreb and then a full professor at Princeton University¹, he got approval for a study stay in the USA. After a lot of vicissitudes regarding obtaining an exit and entry American visa, he set off on August 18, 1957, on the cargo ship *Vojvodina* from Rijeka to New York, which lasted 26 days. Inside the Strait of Messina, passengers, with the help of captains and marines, threw closed bottles with letters to their families into the sea. Luckily, Sibe's spouse Vera got his letter from the bottle quite quickly in Split!

After some period of accommodation into the „American way of living“, Sibe adapted to the Institute and to living and working in the USA. Numerous European Jewish (and non-Jewish) scientists in the 1930s and 40s before the assault of Nazism emigrated to the USA, especially in Princeton, for example, Albert Einstein (who died there in 1955), John von Neumann (who also died there in 1957), Hermann Weyl, Kurt Gödel and others. But the

¹ O Felleru vidi knjigu D. Žubrinića (20).

¹ O Felleru vidi knjigu D. Žubrinića (20).

Weyl, Kurt Gödel i dr. No također su stalni članovi Instituta bili i poznati američki matematičari Oswald Veblen, James W. Alexander, Marston Morse, Hassler Whitney, John Milnor, Andre Weil, Armand Borel, Atle Selberg, Jean Leray, John F. Adams, Morris Hirsch i drugi. Tu se Sibe Mardešić posebno sprijateljio s njemačkim topolozima Albrechtom Doldom i Dieterom Puppeom iz Heidelberga, inače studentima H. Seiferta, čiju je knjigu *Topologie* Mardešić pomno proučavao. Susreo se tu i s Brankom Grünbaumom (1929. – 2018.) kojeg je poznao još iz Zagreba jer je taj osječki Židov započeo studij matematike 1947. u Zagrebu, a već je 1949. sa zaručnicom Zdenkom emigrirao u Izrael (3). Od 1965. bio je profesor u Seattleu, Wa., SAD, geometar svjetskoga glasa, s kojim se Mardešić družio u Seattleu godinama kasnije.

Na elitnom Sveučilištu Princeton bilo je također iznimnih svjetskih matematičara i fizičara u to doba. Tamo je S. Mardešić pohađao predavanja (i seminare) topologa J. C. Moorea iz algebarske topologije, R. H. Foxa iz teorije uzlova, N. Steenroda o kohomološkim operacijama, J. Milnora o diferencijalnoj topologiji i karakterističnim klasama te G. Whiteheada o teoriji homotopije. Pohađao je i *Topološki seminar* i tu upoznao i slušao neke čuvene matematičare-goste kao S. MacLane, S. Eilenberg, H. Cartan, S. Chern, R. Bott, A. Grothendieck, E. Spanier i mnogi drugi. Na Princetonu, na kojem je boravio 1957. – 1959., izbrusio je svoja znanja koja je uglavnom stekao kao samouk, dobio mnoge zamisli za nove radove, stekao

well-known American mathematicians Oswald Veblen, James W. Alexander, Marston Morse, Hassler Whitney, John Milnor, Andre Weil, Armand Borel, Atle Selberg, Jean Leray, John F. Adams, Morris Hirsch and some others were also full members of the Institute at that time. There, Sibe Mardešić became good friends with the German topologists Albrecht Dold and Dieter Puppe from Heidelberg, students of H. Seifert, whose book *Topologie* Mardešić studied in detail. There he also met Branko Grünbaum (1929–2018), whom he knew from Zagreb, because this Osijek Jew started studying mathematics in Zagreb in 1947, and already immigrated to Israel in 1949 with his fiancée Zdenka. (3) From 1965 he was a professor in Seattle, Wa., USA, and a world-renowned geometer, with whom Mardešić became friends in Seattle years later. At the elite Princeton University, there were also some well-known mathematicians and physicists at that time. There, S. Mardešić audited lectures (and seminars) given by topologist J. C. Moore from algebraic topology, lectures on knot theory by R. H. Fox, lectures on cohomology operations by N. Steenrod, differential topology and characteristic classes by J. Milnor and on homotopy theory by G. Whitehead. He also attended the *Topological Seminar* and there he met and listened to some top guest mathematicians delivering lectures such as S. MacLane, S. Eilenberg, H. Cartan, S. Chern, R. Bott, A. Grothendieck, E. Spanier and many others. At Princeton, he spent from 1957 to 1959 and bettered his knowledge, which he mostly acquired as a self-taught student, got many ideas for new works, gained enormous new experience and new colleagues and friends, topologists and mathematicians in general, and some physicists as well as Paul Dirac, Eugen Wigner and many more. However, it was important experience to see at Princeton how to organize post-graduate studies and scientific seminars.

golemo novo iskustvo i nove kolege i prijatelje topologe i uopće matematičare, pa i neke fizičare kao Paula Diraca, Eugena Wignera i druge. No, važno je istaknuti da je na Princetonu stekao iskustvo kako organizirati poslijediplomski studij i znanstvene seminare (kružoke).

Docent, profesor, Seattle, Heidelberg, prvi udžbenik

To se razdoblje Mardešićeva života odnosi otprilike na godine 1959. – 1976. Do 1960. Sibe Mardešić objavio je više izvornih radova u prestižnim časopisima kao što su *Trans. Amer. Math. Soc.*, *Illinois J. Math.*, *Michigan Math. J.*, *Glasnik Mat.-Fiz.-Astr.*, *Rad JAZU*, *Proc. Amer. Math. Soc.* Potpuni bibliografski podatci su u literaturi (2). Njegova tri sažetka predavanja sa sastanaka AMS mogu se naći u *Notices AMS*, prosinac, 1958. U to je doba (1960.) dokazao tzv. *teorem o faktorizaciji* (22). Taj teorem kaže da se svako (neprekidno) preslikavanje među Hausdorffovim kompaktnim prostorima može profaktorizirati kroz preslikavanje na metrički kompakt sa svojstvom da ako je dimenzija domene najviše n , onda je i taj kompakt dimenzije najviše n a njegova je težina najviše jednaka težini kodomene. Glavna je ideja dokaza da je svaki Hausdorffov kompaktni prostor dimenzije (prekrivanja) najviše n limes nekog inverznog sustava metričkih kompakata čiji svaki član ima dimenziju najviše n . Kako je svaki metrički kompakt limes inverznog niza poliedara, slijedi da je takav prostor dvostruki limes inverznih sustava polieda-

Docent, profesor, Seattle, Heidelberg, the first textbook

This period of Mardešić's life refers approximately to the years 1959–1976. In that period, till 1960, Sibe Mardešić published several original papers in world prestigious journals such as *Trans. Amer. Math. Soc.*, *Illinois J. Math.*, *Michigan Math. J.*, *Glasnik Mat.-Phys.-Astr.*, *Rad JAZU*, *Proc. Amer. Math. Soc.*

Complete bibliographic data are in the references (2). His three abstracts of lectures from American Mathematical Society (AMS) meetings can be found in the issue of *Notices AMS*, December 1958. At that time (1960), he proved the so-called *factorization theorem* (22). This theorem states that any (continuous) mapping between Hausdorff compact spaces can be factorized by a map to a metric compact such that its dimension is at most n if the domain has dimension at most n and its weight is at most the weight of the codomain of the mapping. The main idea of the proof is that any Hausdorff compact space of (covering) dimension at most n is the limes of an inverse system of metric compacts whose each member has dimension at most n . Since any metric compact is the limes of an inverse system of polyhedra, it follows that such a space is the double limes of inverse systems of polyhedra each dimension at most n (this is called the *developing theorem*). According to Mardešić himself: „The factorization theorem is probably the most important theorem that I have proved in my mathematical career“ (1, p. 65). This theorem is still actually debated today.²

After his return to Zagreb from Princeton in mid-May 1959 and his habilitation lecture on July 9, 1959 entitled *On Homology Groups*, the process

² See e.g., M. G. Charalambous: *Dimension Theory*, Springer Nature, Switzerland AG, 2022.

ra svaki dimenzije najviše n (to je *teorem o razvoju*). Prema riječima samog Mardešića: „Teorem o faktorizaciji vjerojatno je najvažniji teorem koji sam dokazao u svojoj matematičkoj karijeri“ (1, str. 65). O tome se teoremu razglaba i danas.²

of Mardešić's election as an assistant professor began on March 28, 1960 (**Figure 5**).

Two years later, Sibe Mardešić became an associate professor, and on June 30, 1966, a full professor at the Department of Mathematics of the Faculty of Science, University of Zagreb. Already in June



SLIKA 5. Proslava Mardešićeve docenture u Zagrebu, 1960.: sjede (slijeva) prof. S. Bilinski, činovnica M. Galeković, knjižničarka N. Hofman, S. Mardešić i E. Vernić; stoje D. Palman, V. Sedmak, S. Kurepa, R. Drašić, G. Lukšić, K. Horvatić i P. Papić (1, str. 82)

FIGURE 5. *Celebration of Mardešić's assistant professorship in Zagreb, 1960: seated (from left) prof. S. Bilinski, clerk M. Galeković, librarian N. Hofman, S. Mardešić and E. Vernić; standing D. Palman, V. Sedmak, S. Kurepa, R. Drašić, G. Lukšić, K. Horvatić and P. Papić (1, p. 82)*

Nakon povratka u Zagreb iz Princetona sredinom svibnja 1959. i habilitacijskog predavanja 9. srpnja 1959. pod naslovom *O grupama homologije*, započeo je postupak Mardešićeva izbora za docenta, 28. ožujka 1960. (**slika 5**).

1960, he visited the universities of Heidelberg and Bonn (topology meeting known as the *Hirzebruch Tagung*) and the famous ETH in Zürich, where the *Differentialgeometrie und Topologie* conference was held with the world „*crémé de la crémé*“ of topology at the time: J. F. Adams, M. Atiyah, P. S. Aleksandrov, A. Borel, R. Bott, W. Browder, S. Chern, P. J. Hilton, F. Hirzebruch, I. M. James, J. Leray, J. Milnor, S. Smale, N. E. Steenrod, R. Thom, C. T. C. Wall, H. Whitney and host Heinz Hopf. On that

² Vidi npr., M. G. Charalambous: *Dimension Theory*, Springer Nature, Switzerland AG, 2022.

Dvije godine kasnije Sibe Mardešić izabran je za izvanrednoga, a 30. lipnja 1966. za redovitoga profesora na Matematičkom odsjeku (tada odjelu) PMF-a Sveučilišta u Zagrebu. Već u lipnju 1960. posjetio je sveučilišta u Heidelbergu i Bonnu (sastanak topologa poznat kao *Hirzebruch Tagung*) te čuveni ETH u Zürichu na kojem se održavala konferencija *Differentialgeometrie und Topologie*, gdje se okupila svjetska „*crème de la crème*“ tadašnje topologije: J. F. Adams, M. Atiyah, P. S. Aleksandrov, A. Borel, R. Bott, W. Browder, S. Chern, P. J. Hilton, F. Hirzebruch, I. M. James, J. Leray, J. Milnor, S. Smale, N. E. Steenrod, R. Thom, C. T. C. Wall, H. Whitney i domaćin Heinz Hopf. S. Mardešić je na toj miniturneji održao predavanja *The Hahn-Mazurkiewicz theorem for non-metric spaces* te *On homology local connectedness*. U srpnju 1961. na poziv Aleksandrova, Mardešić odlazi u tadašnji SSSR na 4. *svesavezni matematički kongres*, u Lenjingradu (sadašnji Sankt Peterburg). Nakon trodnevna putovanja vlakom Zagreb – Beograd – Budimpešta – Kijev – Moskva, gdje je ostao cijeli dan u razgledavanju Kremlja, Crvenog trga s hramom Vasilija blaženoga, Lenjinova mauzoleja i Sveučilišta Lomonosov. Na konferenciji je održao predavanje na ruskom, uz pomoć kolege Rajka Draščića (1923. – 1972.)³, asistenta s Geometrijskoga zavoda na studijskom boravku u Moskvi. Mardešić je održao predavanje

mini-tour, S. Mardešić provided lectures on *The Hahn-Mazurkiewicz theorem for non-metric spaces* and *On the homology of local connectedness*. On July 1961, at the invitation of Aleksandrov, Mardešić went to the then-USSR to attend the *4th All-Union Mathematical Congress*, in (former) Leningrad (now Saint Petersburg). After a three-day trip by train from Zagreb–Belgrade–Budapest–Kyiv–Moscow, he spent the whole day sightseeing the Kremlin, Red Square with the temple of St. Basil the Blessed, Lenin’s Mausoleum and Lomonosov University.

At the conference he delivered a lecture in Russian, with a little help from his colleague Rajko Draščić (1923–1972)³, an assistant at the Geometry seminar in Zagreb, then at graduate study in Moscow. Mardešić lectured on *Kontinuumy svjaznie posredstvom uporedjenih kontinuumov*. There he met Soviet (mainly Russian) topologists V. G. Boltyansky, M. F. Bukhštaber, L. V. Keľdisheva, V. Rohlin, L. Pontryagin, and the younger A. V. Arkhangel’sky, B. A. Pasyнков, as well as some Georgian, Armenian and other topologists.

In the school year 1959/60 Mardešić started to teach the subject *Mathematical Analysis II*, to second-year students at the Department of Mathematics of PMF, which was entrusted to him after habilitation by prof. Ž. Marković. He also started teaching the non-obligatory subject of *Combinatorial Topology and its Applications* for fourth-year students. In the year 1960/61 S. Mardešić, based on his experiences in the USA, introduced the postgraduate study of mathematics, the study of III. degree. In the same year, he also introduced the first postgraduate course of the *Topology Seminar* and delivered the first seminar titled *Topological Groups*.

³ D. Veljan: *Hrvatska matematika, teorija relativnosti i osvrt na Rajka Draščića*, *Prirodoslovlje* **19**(1-2) (2019) 3–21.

³ D. Veljan: *Hrvatska matematika, teorija relativnosti i osvrt na Rajka Draščića*, *Prirodoslovlje* **19**(1-2) (2019) 3–21.

Kontinuumy svjaznie posredstvom uporedjočennyh kontinuumov. Tu je upoznao sovjetske (uglavnom ruske) topologe V. G. Boltjanskoga, M. F. Buhštibera, L. V. Kel'diševu, V. Rohlina, L. Pontrjagina, i mlade A. V. Arhangel'skoga, B. A. Pasyukova, kao i neke gruzijske, armenske i druge topologe.

Šk. god. 1959./1960. Mardešić je počeo predavati predmet *Matematička analiza II*, za studente druge godine Matematičkog odjela PMF-a kojeg mu je nakon habilitacije povjerio prof. Ž. Marković. Počeo je predavati i neobvezatni predmet *Kombinatorna topologija i njene primjene* za studente četvrte godine. Šk. god. 1960./1961. S. Mardešić je, temeljem iskustava u SAD-u, uveo poslijediplomski studij matematike, studij III. stupnja. Te je godine održao i prvi poslijediplomski kolegij *Topološke grupe*, a osnovan je i *Seminar za topologiju*. Mardešić je bio voditelj poslijediplomskoga studija matematike od 1960. do 1971. Tako je započela tzv. *Zagrebačka škola*. Zapravo, Zagrebačku školu ugrubo čini lanac: Varićak–Bilinski, Janković, Cesarec, Marković, Feller, Blanuša, Đ. Kurepa, Papić–Mardešić, S. Kurepa, Z. Janko (1932. – 2022.) i mlađi. Oko pokretanja toga studija osim Mardešića, znatnu su ulogu imali i profesori Svetozar Kurepa (1929. – 2010.), Vladimir Devidé (1925. – 2010.) i Pavle Papić (1919. – 2005.). Mardešić je tijekom karijere održao ukupno 13 poslijediplomskih kolegija u Zagrebu.

Godine 1963. Sibe Mardešić preuzima uredništvo časopisa *Glasnik Mat.-Fiz.-Astr.*, koji je 1966. preimenovan u *Gla-*

Mardešić was the head of the postgraduate study of mathematics from 1960 to 1971. This is how began the so-called *Zagreb School*. In fact, the *Zagreb School* roughly consists of a chain: Varićak–Bilinski, Janković, Cesarec, Marković, Feller, Blanuša, Đ. Kurepa, Papić–Mardešić, S. Kurepa, Z. Janko (1932–2022) and younger. In starting this study, besides from Mardešić, professors Svetozar Kurepa (1929–2010), Vladimir Devidé (1925–2010) and Pavle Papić (1919–2005) also played a significant role. During his career, Mardešić lectured in a total of 13 postgraduate courses in Zagreb.

In 1963, Sibe Mardešić took over the editorship of the journal *Glasnik Mat.-Fiz.-Astr.*, which was renamed *Glasnik matematički* in 1966. Under his editorship until 1976, *Glasnik* became a respected international mathematical journal. Let's mention that in 1964/65 Mardešić was vice-dean of PMF, and the following school year a guest professor at the University of Washington in Seattle, Wa., USA. In 1965, he received the Ruđer Bošković Republic Award for his scientific and professional work (**Figure 6**).

In Seattle, Mardešić lectured undergraduate courses *Calculus* and *Number Theory* and the *Continuum Theory* at the postgraduate level. There he started a scientific collaboration and lifetime friendship with Jack Segal; together they wrote five common papers published for instance in *Trans. Amer. Math. Soc.* (23) and *Michigan Math. J.* (24). Their best-known and most-cited paper in two parts, *ε -Mappings and Generalized Manifolds*, was published in 1967 in *Michigan Math. J.* (24).

In August 1968, Mardešić was invited to the international scientific conference *Topology and its Applications* (25) in Herceg Novi, Montenegro, where he gave a lecture on locally connected continua without real locally connected subcontinua.

The Polish mathematician Karol Borsuk (1905–1982) gave a lecture on the shape of (met-

snik matematički. Pod njegovim uredništvom do 1976. *Glasnik* je postao ugledan međunarodni časopis. Spomenimo da je 1964./1965. Mardešić bio prodekan PMF-a, a sljedeće školske godine gostujući profesor na Sveučilištu Washington u Seattleu, Wa., SAD. Za svoj znanstveni i stručni rad dobio je 1965. republičku nagradu *Ruđer Bošković* (slika 6).

U Seattleu je Mardešić, osim predavanja *Calculus* i *Teorije brojeva* na diplomskom studiju, predavao *Teoriju kontinuuma* na poslijediplomskom studiju. Znanstveno se tu sprijateljio s Jackom Segalom; zajedno su napisali pet članaka, objavljenih u primjerice u *Trans. Amer. Soc* (23) i *Michigan Math. J.* (24). Najpoznatiji i najcitiraniji zajednički članak u dva dijela *ε -mappings and generalized manifolds* objavljen je 1967. u *Michigan Math. J.* (25).

U kolovozu 1968. Mardešić je pozvan na međunarodni znanstveni skup (konferenciju) *Topology and its Applications* (25) u Herceg Novom u Crnoj Gori, gdje je održao predavanje o lokalno povezanim kontinuumima bez pravih lokalno povezanih podkontinuuma. Poljski matematičar Karol Borsuk (1905. – 1982.) održao je predavanje o obliku (metričkih) kompakata, i tu se Mardešić susreo s pojmom *teorija oblika* (*shape theory*), čime će se znanstveno najviše baviti do kraja života. Teorija oblika je, grubo rečeno, izvjesna globalna teorija homotopije. Borsukov glavni primjer, koji je on prvi prikazao je tzv. Varšavska kružnica (jer je Borsuk iz Varšave), koja je istog „oblika“ kao obična kružnica, no nisu homotopne, ne mogu

ric) compacts, and there Mardešić encountered for the first time the concept of the shape theory. On that scientific topic he mostly spent the rest of his life. The shape theory is, roughly speaking, a certain global theory of homotopy. Borsuk's main example, which he first demonstrated publically is the so-called Warsaw Circle (because Borsuk is from Warsaw), which has the same „shape“ as an ordinary circle, but not the same homotopy type because they cannot be continuously deformed into each other (Figure 7).



SLIKA 6. Godine 1965. Mardešić je dobio Republičku nagradu za znanstveni rad s likom *Ruđera Boškovića* (naličje, lijevo i lice, desno)

FIGURE 6. In 1965 Mardešić received the Croatian scientific *Ruđer Bošković* medal (back side, left and face, right)

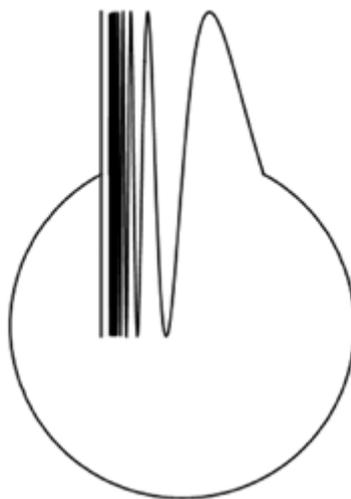
Just as in analysis, an „ugly“ function tries to be approximated by polynomials (nice functions) so in topology „ugly“ spaces are tried to be approximated by „good“ spaces such as polyhedra. Mardešić already had the basic idea from the factorization theorem. He reached the polyhedra into the game by the concept of the nerve of an open cover of the compact Hausdorff space, i.e. the simplicial complex whose k -simplexes correspond to the k -sets of members of open cover with non-empty intersection. The body of that simplicial complex is a polyhedron. At the aforementioned meeting, S.

se neprekidno deformirati jedna u drugu (slika 7).

Kao što se u analizi „ružna“ funkcija aproksimira polinomima sve većeg i većeg stupnja (iz Taylorovog razvoja), tako se u topologiji „ružni“ prostori nastoje aproksimirati „dobrim“ prostorima-poliedrima. Osnovnu je ideju Mardešić već imao iz teorema o faktorizaciji. Do poliedara je došao preko nerva otvorenog pokrivača kompaktnoga Hausdorffovog prostora, tj. simplicijalnoga kompleksa čiji k -simpleksi odgovaraju k -torki članova pokrivača koji imaju neprazan presjek. Tijelo toga simplicijalnoga kompleksa je poliedar. Na spomenutom je sastanku S. Mardešić predložen za člana savjeta novo osnovanog časopisa *Topology and its Applications* (prvotno *General Topology and its Applications*). U tom će časopisu godinama objavljivati brojne članke, a posljednji 2015. (26). U svojoj knjizi (1, str. 135), Mardešić navodi da je konferenciju zasjenila sovjetska invazija Čehoslovačke! Osim toga, A. Dold je pozvao u Heidelberg Jacka Segala i Sibua Mardešića, koji su dogovorili da Segal kasnije provede studentsku godinu u Zagrebu.

U rujnu 1968. su Mardešić i Segal pozvani na konferenciju u Bukureštu, gdje je Mardešić održao predavanje *Inverse limits of ANR's and generalized manifolds* na kojemu su nazočili neki poznati topolozi kao W. Browder, L. Siebenmann, C. T. C. Wall, ali su mnogi rumunjski topolozi već odavno emigrirali uglavnom u SAD, primjerice I. Berstein, D. Burghilea, A. Deleanu, T. Ganea. Mardešić spominje kako se na tom znanstvenom skupu također osje-

Mardešić was proposed as a member of the Board of executive editors of the newly established journal *Topology and its Applications* (previous name *General Topology and its Applications*). In this journal S. Mardešić published many papers over the years, the last one in 2015 (26). In his book (1, p. 135), Mardešić states that the conference was overshadowed



SLIKA 7. Varšavska kružnica Karola Borsuka

FIGURE 7. *Karol Borsuk's Warsaw circle*

owed by the possible Soviet invasion of Czechoslovakia! In addition, A. Dold invited Jack Segal and Sibe Mardešić to Heidelberg, who arranged for Segal to spend an academic year in Zagreb.

In September 1968, Mardešić and Segal were invited to a conference in Bucharest, where Mardešić gave a lecture on *Inverse limits of ANR's and generalized manifolds*, which was attended by some well-known topologists such as W. Browder, L. Siebenmann, C. T. C. Wall. But many Romanian topologists already emigrated abroad, mainly to the USA, for instance, I. Berstein, D. Burghilea, A. De-

čala tjeskoba i strah da bi sovjetske trupe mogle svakog časa ući u Rumunjsku!

Šk. god. 1969./1970. Segal provodi u Zagrebu kao gostujući profesor i predaje poslijediplomski predmet *Introduction to algebraic topology* (kojega je kao diplomski student odslušao i autor ovog članka; Mardešićevi su kolegiji bili puno „sočniji“). Mardešić i Segal nastavljaju raditi na teoriji oblika, objavljuju tri članka, a najcitiraniji je *Shapes of compacta and ANR systems* (27), koji je Mardešićev najcitiraniji članak citiran 192 puta do 2022. prema bazi podataka Google Scholar. U tome su članku uspjeli proširiti kategoriju oblika na kompaktnu Hausdorffovu prostore. Krajem lipnja 1970., Mardešić je na PMF-u u Zagrebu organizirao *Ljetnu školu za topologiju* i pozvao desetak predavača iz SAD-a i Njemačke, a kao slušače četrdesetak polaznika iz čitave tadašnje države.

Šk. god. 1971./1972. Mardešić je gostujući profesor u Heidelbergu, jednom od najboljih njemačkih sveučilišta, posebice u matematici, gdje je predavao nekoliko predmeta i seminara na njemačkom jeziku. Te je godine napisao članak koji je objavljen 1973. u časopisu *General Topology Appl.* (28) u kojemu je uspio definirati kategoriju oblika Sh za bilo koje topološke prostore. Taj je članak također često citiran (oko 130 puta do 2022. prema bazi Google Scholar). Ubrzo je svoj opis kategorije Sh dao i Kiiti Morita iz Tokija poopćenjem Mardešić-Segalova rada s kompaktnoga na nekompaktni slučaj.

Već u zimskom semestru 1972./1973. Mardešić je proveo tri mjeseca u Pittsbur-

leanu and T. Ganea. Mardešić in his book (1) mentions also feeling at that scientific meeting – anxiety and fear that Soviet troops could enter Romania at any moment!

The academic year, 1969/70 Segal spent in Zagreb as a guest professor and lectured the course *Introduction to algebraic topology* (which the author of this article also took as an undergraduate student, but Mardešić's courses were much more „juicy“).

Mardešić and Segal continued to work on shape theory. They published three papers, and the most cited of which is *Shapes of compacta and ANR systems* (27), which is Mardešić's most cited paper, 192 times till 2022 according to the Google Scholar database. In this paper, the authors extended the category Sh of shapes for all topological spaces. At the end of June 1970, Mardešić organized a *Summer School for Topology* at the Faculty of Science in Zagreb and invited a dozen lecturers from the USA and Germany as well as 40 students from the entire country at the time.

In the school year 1971/72 Mardešić is a guest professor at Heidelberg, one of the best German universities, especially in mathematics, where he taught several math subjects and seminars in German. That year he wrote an important paper published in 1973 in the journal *General Topology Appl.* (28), where he defines a category of shapes Sh for any topological spaces. That paper is also often cited (about 130 times by 2022 according to the Google Scholar database). Soon after, Kiiti Morita from Tokyo also gave his description of the Sh category by generalizing Mardešić-Segal's work from the compact to the non-compact case.

Already in the winter semester of 1972/73 Mardešić spent three months in Pittsburgh, Pa., USA, where he was invited by professor Nagata. But before that, in June 1972, a large international conference on *Set Theory and Topology* was

ghu, Pa., SAD, na poziv profesora Nagate. No prije toga, u lipnju 1972. održana je u Keszthelyju na Blatnom jezeru u Mađarskoj velika međunarodna konferencija *Set Theory and Topology* na kojoj su sudjelovali mnogi eminentni mađarski matematičari kao P. Erdős, L. Lovász, I. Juhász, V. Sós-Turan i drugi, dosta američkih i europskih te popriličan broj hrvatskih, slovenskih i drugih matematičara. U Pittsburghu je 1972./1973. Mardešić predavao poslijediplomski predmet *Algebarska topologija* (tri sata tjedno) i u *Nagatinom seminaru* o teoriji oblika. U toj je godini Mardešić napisao više članaka objavljenih nešto kasnije u časopisu poljske akademije znanosti *Bull. Acad. Polon. Sci. Ser. Sci. Math. Astron. Phys.* (29), američkim *Trans. Amer. Math. Soc.* (30), *Proc. Amer. Math. Soc.* (31) i drugima. U njima je razrađivao ideje iz teorije oblika. Tu je naišao i na ideju koja se kasnije u nekim knjigama nazivala „Mardešićev trik“ (katkad i „Deligne-Mardešićev trik“), a riječ je o tome da se svaki inverzni sistem može zamijeniti ekvivalentnim koji je indeksiran kofinitnim skupom, znači usmjerenim skupom u kojem svaki element ima samo konačno mnogo prethodnika (31).

Povratkom u Zagreb 1973., Mardešić počinje intenzivnije raditi na udžbeniku *Matematička analiza u n-dimenzionalnom realnom prostoru*. I. dio, namijenjen studentima matematike (32) izašao je 1974. (a nakon toga još tri izdanja do 1991.), a 1977. je izašao II. dio pod nazivom *Integral i mjera* (33) (nakon toga još dva izdanja).

held in Keszthely on the Mud Lake in Hungary, in which participated many eminent Hungarian mathematicians such as P. Erdős, L. Lovász, I. Juhász, V. Sós-Turan and others, quite a few American and European and a considerable number of Croatian, Slovenian and other mathematicians. In Pittsburgh in 1972/73 Mardešić taught the graduate course *Algebraic Topology* (three hours a week) and in *Nagata's seminar* a series of lectures on shape theory. During that year, Mardešić wrote several papers published a little later in the journal of the Polish Academy of Sciences, *Bull. Acad. Polon. Sci., Ser. Sci. Math. Astron. Phys.* (29), in American *Trans. Amer. Math. Soc.* (30), *Proc. Amer. Math. Soc.* (30) and others. In these papers, he developed some details of the shape theory. There he came up with an idea that later in some books was called „Mardešić's trick“ (sometimes also „Deligne-Mardešić's trick“), that any inverse system can be replaced by an equivalent system whose index set is cofinite, which means by the directed set where every element has only finitely many predecessors (31).

Returning to Zagreb in 1973, Mardešić started to work more intensively on his textbook *Mathematical analysis in n-dimensional real space*, Part I, intended for students of mathematics (32), and was published in 1974 (and then three more editions until 1991). In the year 1977, *Integral and measure*, Part II (33), was published (and two more editions after that).

At that time, S. Mardešić also „did“ two important social activities. From 1971 to 1973, he was the president of the Society of Mathematicians and Physicists of Croatia, and after that, 1974/75 and 1975/76 he was dean of PMF. From 1970 to 1975, he was the vice president of the Union of Yugoslav Societies of Mathematicians, Physicists and Astronomers. At that time, the „famous“ Šušvar school reform took place, so it was necessary to „save“ what

U to je vrijeme S. Mardešić „odradio“ i dvije važne društvene djelatnosti. Od 1971. do 1973. bio je predsjednik Društva matematičara i fizičara Hrvatske, a nakon toga šk. god. 1974./1975. i 1975./1976. bio je dekan PMF-a. Od 1970. do 1975. bio je potpredsjednik Saveza društava matematičara, fizičara i astronoma Jugoslavije. U to je doba nastala i „čuvana“ Šuvarova reforma školstva, pa je trebalo „spasiti“ za matematiku što se spasiti moglo. I tu je Mardešić učinio mnogo. Uza sve obveze 1975./1976. te 1976./1977. predavao je na Filozofskom fakultetu u Zadru matematiku studentima posebnog studija matematike i filozofije (podsjetimo, zadarsko je sveučilište najstarije hrvatsko sveučilište, osnovano 1396.; predavao je tamo matematiku oko 1500. i fra Luca Pacioli suradnik Leonarda da Vincija). I za osnutak studija matematike 1974. u Splitu zaslužan je profesor S. Mardešić. Svakom bi prilikom posjećivao svoje roditelje i svoj voljeni Split. Više je puta, šaleći se, kazao da je on „Splićanin na privremenom radu u Zagrebu“. U lipnju 1975. Sibe Mardešić je izabran za izvanrednog člana JAZU (sada HAZU).

Od društvenih događanja valja spomenuti tzv. topološke izlete. Upravo je Sibe Mardešić još 1963. bio inicijator društvenih izleta grupe topologa autobusom u razna područja (Samobor, Karlovac, pa u Sloveniju, Istru, Bosnu, Vojvodinu, otok Krk i drugdje), sve do 1983. Obilazili bi crkve, manastire i razne spomenike kulture. Najzabavnije su bile vožnje autobusima, gdje je bilo viceva, smijeha, pjesme, igre „pantomima“ itd. U duhovitim dosjet-

could be saved for mathematics. And Mardešić did a lot of what was possible. Besides the obligations in 1975/76 and in 1976/77, he taught mathematics at the Faculty of Philosophy in Zadar to the students in the special study of mathematics and philosophy. (The University of Zadar is the oldest Croatian university, founded in 1396 and among the first that taught mathematics. Fra Luca Pacioli, Leonardo da Vinci's associate, taught mathematics there around 1500.) Professor S. Mardešić is also one of the founders of the Department of mathematics in 1974 in Split. At any opportunity, he visited his parents and his beloved Split. One of his legendary jokes was: „I am a Splitman temporarily employed in Zagreb“. In June 1975, Sibe Mardešić was elected as an associate member of the Academy JAZU (today HAZU).

Among the social events, it is worth mentioning the so-called topological excursions. In 1963, Sibe Mardešić initiated the social trips of a group of topologists to visit various areas (Samobor, Karlovac, then Slovenia, Istria, Bosnia, Vojvodina, the island of Krk and elsewhere) until 1983. They would visit churches, monasteries and various cultural monuments. The most fun was the bus rides with many jokes, laughter, songs, a play of „pantomime“ etc. The humorous jokes were made by legendary professors and Sibe's friends, professors Boris Pavković (1931–2006) (34) and Krešo Horvatić (1930–2008) (35), both obtained their master's degrees under S. Mardešić. Let us mention here that professor Pavković skilfully drew all the figures for Mardešić's books and was one of their correctors.

Professor Sibe Mardešić proved himself as a tireless and successful organizer of the International conference and course in 1976 in Dubrovnik, within the framework of the Interuniversity Center. He organized the *Shape theory and pro-homotopy* inter-

kama prednjačili su legendarni profesori i Sibini prijatelji profesori Boris Pavković (1931. – 2006.) (34) i Krešo Horvatić (1930. – 2008.) (35), koji su i magistrirali pod njegovim vodstvom. Ovdje valja spomenuti da je profesor Pavković vješto nacrtao sve slike za Mardešićeve knjige i sudjelovao u njihovim korekcijama.

Kao neumoran i sposoban organizator profesor Sibe Mardešić se iskazao i u organizaciji međunarodne konferencije u školu *Shape theory and pro-homotopy* 1976. u Dubrovniku u okviru Interuniverzitetskog centra – opširno o tome piše u (1). Bio je direktor skupa, okupio je 15-ak predavača i suradnika te 40-ak slušača. Osim Mardešića, hrvatski predavači bili su profesori K. Horvatić i Ivan Ivanšić (1931. – 2020.) (36), koji je često surađivao s Mardešićem u organizacijama znanstvenih skupova. Sličnih škola odnosno konferencija održano je u Dubrovniku još sedam za Mardešićeva života (1981., 1986., 1998., 2002., 2007., 2011. i 2015.), iako u tri posljednja Sibe više nije bio „glavni i odgovorni“.

Utah, Kentucky, Oklahoma, Seattle, Japan

Tu je riječ o razdoblju otprilike 1977. – 1987., kada je profesor Sibe Mardešić možda najviše putovao. Prvo je zimski semestar šk. god. 1977./1978. proveo kao gostujući profesor u SAD-u na Sveučilištu Utah u Salt Lake Cityju, a ljetni na Sveučilištu Kentucky u Lexingtonu. No i odatle je putovao u Provo, Seattle i druga mjesta. U to se doba zajedno s domaćini-

national conference and course and he described it in detail in his book (1). He was the director of the conference and invited about 15 lecturers and about 40 listeners. Apart from Mardešić, the Croatian lecturers were professors K. Horvatić and Ivan Ivanšić (1931–2020) (36), who often collaborated with Mardešić in the organization of scientific conferences. Seven more similar conferences and schools were held in Dubrovnik during Mardešić's lifetime (1981, 1986, 1998, 2002, 2007, 2011 and 2015), although in the last three Sibe was no longer the „main and responsible“.

Utah, Kentucky, Oklahoma, Seattle, Japan

Here we are talking about the period approximately 1977–1987, when professor Sibe Mardešić perhaps traveled the most. First is the winter semester of the academic year 1977/78 spent as a guest professor in the USA at the University of Utah in Salt Lake City, and in the summer at the University of Kentucky in Lexington. But from there he also traveled to Provo, Seattle and other places. At that time he worked and collaborated with various domestic peoples on shape fibrations and published several articles and records about it, for example (37).

One of the greatest professional honors in his career that professor Sibe Mardešić experienced was when (while still in Salt Lake City) he was an „invited speaker“ at the *World Mathematical Congress* in Helsinki in August 1978, i.e. an invited lecturer and gave a lecture for 45 minutes (*Shape theory*), which was published in the proceedings of the congress on eight pages (38). World mathematical congresses (ICM) are held every four years. Apart from Mardešić, only a few other Croatian mathematicians (so far) have been invited lecturers at world congresses. These are Vladimir Varićak

ma dosta bavio s fibracijama oblika i o tome objavio nekoliko članaka i zapisa, npr. (37)

Jedna od najvećih stručnih počasti u karijeri koju je profesor Sibe Mardešić doživio bilo je kad je (još u Salt Lake Cityju) pozvan da u kolovozu 1978. na Svjetskom matematičkom kongresu u Helsinkiju bude „Invited speaker“, tj. pozvani predavač i održi predavanje od 45 minuta (*Shape theory*), koje je objavljeno u zborniku kongresa na osam stranica (38). Svjetski se matematički kongresi održavaju svake četvrte godine. Osim Mardešića, samo su još nekolicina hrvatskih matematičara (do sada) bili pozvani predavači na svjetskim kongresima. To su Vladimir Varićak (1865. – 1942.) (6) na kongresu u Rimu 1908., predavanje *Zur nicht euklidischen analytischen Geometrie*, Đuro Kurepa na kongresu u Amsterdamu 1954. predavanje *Uloga matematike i matematičara u današnjici* (na francuskom), te na kongresu u Edinburghu 1958. predavanje *Some principles of mathematical education*, Vilim Feller (plenarni predavač) na kongresu u Edinburghu 1958. predavanje *Some new connections between probability and classical analysis*, Zvonimir Janko (1932. – 2022.) na kongresu u Nici, Francuska, 1970., predavanje *Sporadic groups* te Mladen Bestvina (r. 1959.) na kongresu u Pekingu, Kina, 2002., s predavanjem *Group of outer automorphisms of a free group of rank n* , te na virtualnom kongresu u Helsinkiju 2022. predavanje *Groups acting on hyperbolic spaces – a survey*.

Poslije Helsinkija profesor Mardešić pozvan je na veliku 10-dnevnu konferen-

(1865–1942) (6) at the congress in Rome in 1908, the lecture *Zur nicht euklidischen analytischen Geometrie*, Đuro Kurepa at the congress in Amsterdam in 1954, the lecture *The Role of Mathematics and Mathematicians in Today* (in French), and at a congress in Edinburgh in 1958, the lecture *Some principles of mathematical education*, Vilim Feller (plenary lecturer) at the congress in Edinburgh in 1958, lecture *Some new connections between probability and classical analysis*, Zvonimir Janko (1932–2022) at the congress in Nice, France, 1970, lecture *Sporadic groups* and Mladen Bestvina (b. 1959) at the congress in Beijing, China, 2002, with the lecture *Group of outer automorphisms of a free group of rank n* , and at the virtual congress in Helsinki in 2022, the lecture *Groups acting on hyperbolic spaces – a survey*.

After Helsinki, professor Mardešić was invited to a large 10-day conference on geometric topology in Warsaw, Poland. There he completed an article with J. Keesling on shape fibrations published in *Pacific J. Math.* (39). The same school year Aleksandar Šostak from Riga was a guest professor in Zagreb (he obtained his Ph.D. at the Moscow State University, MGU). Mardešić and Šostak later published three common papers.

At that time, Mardešić also started to work with resolvents of spaces and mappings related to shape and independently published an article about it in 1981 in the *Fund. Math.* on 25 pages. (40) At the shorter topological conference at the V. A. Steklov Institute in June 1979 in Moscow, where Mardešić held a lecture on resolvents, he met Jurij Lisica and invited him to spend a year in Zagreb. Mardešić was sent from Moscow for three days to Tbilisi, Georgia, at the expense of the Soviet Academy of Science. That's when he started thinking about strong shape. After the USSR, from September 9, he spent a month at the University of LAquila, Abruzzo

ciju iz geometrijske topologije u Varšavi u Poljskoj. Tu je dovršio članak s J. Keeslingom o fibracijama oblika objavljen u *Pacific J. Math.* (39). Te je školske godine u Zagrebu bio gost Aleksandar Šostak iz Rige, inače doktorand na MGU s kojim je S. Mardešić napisao tri rada.

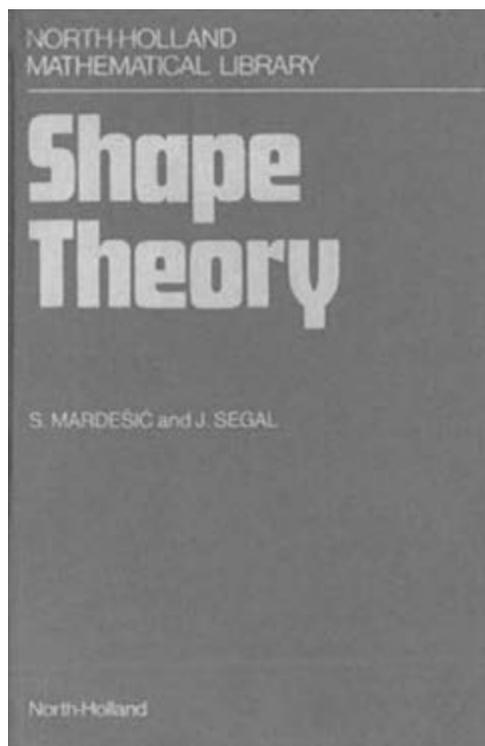
U to se doba Mardešić počeo baviti i rezolventama prostora i preslikavanja vezano za oblike i o tome samostalno objavio članak 1981. u *Fund. Math.* na 25 stranica. (40) Na kraćoj topološkoj konferenciji Instituta V. A. Steklova u lipnju 1979. u Moskvi, gdje je Mardešić održao predavanje o rezolventama, dogovorili su dolazak Jurija Lisice u Zagreb na godinu dana. Iz Moskve je na trošak Sovjetske akademije Mardešić poslan na tri dana u Tbilisi, Gruzija. Tu je počeo razmišljati o jakom obliku. Nakon SSSR-a, od 9. rujna, mjesec je dana proveo na Sveučilištu L'Aquila, provincija Abruzzo, gdje je na talijanskoj održao niz od osam predavanja.

Godine 1982. izašla je u izdanju North Hollanda monografija S. Mardešića i J. Segala (41), često citirana u literaturi (oko 684 puta do 2022. prema bazi podataka Google Scholar), **slika 8**.

Usljedila su kraća gostovanja u Sarajevu, Torinu, Beču i drugdje, svuda s predavanjima. Profesor Mardešić se počeo intenzivnije baviti teorijom *jakog oblika*, finijom od teorije oblika. Krajem ljeta 1981. Mardešić i supruga Vera putuju u Japan na Sveučilište Tsukuba. Nakon izvjesne prilagodbe japanskom načinu života, Mardešić predaje kolegije i širi svoja saznanja o Japanu, gdje se doktorat iz matematike može steći na samo deset sveuči-

province, where he gave a series of eight lectures in Italian.

In 1982, a monograph by S. Mardešić and J. Segal (41) was published by North Holland, often cited in the literature (about 684 times by 2022 according to the Google Scholar database), **Figure 8**.



SLIKA 8. Naslovnica monografije *Shape Theory* S. Mardešića i J. Segala (41)

FIGURE 8. Cover page of the monograph *Shape Theory* by S. Mardešić and J. Segal (41)

This was followed by shorter guest appearances in Sarajevo, Torino, Vienna and elsewhere, with lectures everywhere. Professor Mardešić began to work more intensively on the strong shape theory, which is finer than the theory of shape. At the end of the summer of 1981, Mardešić and his wife Ve-

lišta, od kojih je sedam još od prije Drugoga svjetskog rata. (U knjizi (1) Mardešić navodi podatak da japanska djeca nakon devet godina učenja u školi svladaju 1 850 osnovnih znakova pisma *kanji*, te fonetsko slogovno pismo *katakana*.) Posebno ih se dojmio Kyoto, bivši glavni grad Japana (od 794. do 1868.), gdje su u jednom hramu, na veliko iznenađenje, naišli na akademika Vladimira Devidéa i njegovu japansku suprugu Yasuyo Hondo. U dva je mjeseca profesor Mardešić održao deset predavanja po Japanu.

U razdoblju 1981. do 1987. Mardešić se znanstveno uglavnom fokusira na teoriju jakog oblika koja je finija od obične teorije oblika i jake homologije koja je invarijantna na jaki oblik, a sve temeljeno na inverznim sustavima ANR-ova (apsolutnih okolinskih retrakata). Mardešić i Jurij Lisica u Zagrebu su na tu temu napisali sedam radova, a započeli su sa serijom od tri rada u *Glasniku* na više od 100 stranica (42) i nastavili u *Topology Appl.* te *Tsukuba J. Math.* (43)

Zanimljivo je spomenuti da ako preslikavanje među metričkim kompaktima inducira izomorfizam oblika, mora li inducirati i izomorfizam jakog oblika? I danas (50 godina poslije) to je otvoreno pitanje.

Poslije velike topološke konferencije 1982. u tadašnjem Lenjingradu (danas Sankt Peterburg), razgledavanja Ermitaža, Petro-dvoreca, gotovo svi sudionici došli su na groblje Aleksandra Nevskog na polaganje cvijeća na grob jednog od najvećih matematičara svih vremena, Švicarca Leonharda Eulera (1707. – 1783.) koji je služio na dvoru ruske carice Katarine

ra traveled to Japan to the University of Tsukuba. After some adaptation to the Japanese way of life, Mardešić taught courses and bettered his knowledge about Japan, where a doctorate in mathematics can be obtained at only ten universities, seven of which date back to before the World War II. [In the book (1), Mardešić states that after nine years of studying at school, Japanese children master 1,850 basic *kanji* characters and the phonetic syllabic *katakana* alphabet.] They were impressed by Kyoto, the former capital of Japan (from 794 to 1868), where, to their great surprise, they encountered academician Vladimir Devidé and his Japanese wife Yasuyo Hondo in a temple. In two months, professor Mardešić led ten lectures around Japan.

In the period from 1981 to 1987, Mardešić scientifically focuses mainly on the strong shape theory, which is finer than the ordinary shape theory, and strong homology, which is invariant to the strong shape, all based on inverse systems of ANRs (absolute neighborhood retracts). Sibe Mardešić and Jurij Lisica wrote seven papers on this topic in Zagreb, and they started with a series of three papers in *Glasnik* on more than 100 pages (42) and continued in *Topology Appl.* and *Tsukuba J. Math.* (43)

It is interesting to mention that if a mapping among metric compacta induces a shape isomorphism, must it also induce a strong shape isomorphism? Even today (50 years later) it is an open question.

After the big topological conference in 1982 in Leningrad (today Saint Petersburg), sightseeing of the Hermitage, Petro-dvorec, almost all the participants came to the cemetery of Alexander Nevsky to lay flowers on the grave of one of the greatest mathematicians of all time, the Swiss Leonhard Euler (1707–1783) who served at the court of the Russian empress Catherine the Great. And his last in-

Velike. I posljednja slutnja mu se pokazala ispravnom, kad je rekao (pred desetak unučadi): sutra ću umrijeti. Euler je dokazao na stotine teorema, među ostalim (oko 1765.) ambijetalnu nejednakost $R \geq nr$, gdje su R i r polumjeri opisane i upisane kugle u n -dimenzionalnom simpleksu. Autor ovoga članka je 2021./2022. profinirao tu nejednakost u vidu intrinzične nejednakosti ovisne o duljinama bridova simpleksa [(*J. Geom.*, (44))] s primjenom na vjerojatnost u astrofizici.

Uslijedili su Mardešićevi kraći posjeti u Italiju, München, Atenu, proveo je mjesec i pol na Topološkom semestru u *Banach centru* u Varšavi, bio je na topološkom sastanku u Oberwolfachu, zatim krajem rujna 1984. u Madridu, a svibanj 1985. proveo je na Sveučilištu u Perugiji. U međuvremenu je na nekoliko dana 1983. „skoknuo“ u Skopje i tadašnji Titograd (danas Podgorica), a u rujnu 1985. na kongres u Prištini, šest je dana u listopadu bio na konferenciji *Topology and its Applications* u Dubrovniku. Sibe Mardešić i Jože Vrabec iz Ljubljane bili su voditelji topološkog seminara *Zagreb-Ljubljana*, s četiri-pet godišnjih sastanaka. U travnju 1986. Mardešić je opet u L'Aquilli na konferenciji *Categorical Topology*, a potom u dva navrata u Beogradu gdje je održao niz od deset sati predavanja: *Osnovi teorije homotopije i oblika*. U lipnju kratko gostuje u Trstu, a u listopadu 1986. je u Dubrovniku održana 12-dnevna treća škola za teoriju oblika pod imenom *Geometric topology*, gdje su Mardešić i Segal bili direktori i urednici pripadnog zbornika objavljenog u renomiranoj Springe-

tuition turned out to be genuine when he said (in front of ten grandchildren): I will die tomorrow. Euler proved hundreds of theorems, among others (around 1765) the ambient inequality $R \geq nr$, where R and r are the radii of the circumscribed and inscribed spheres in the n -dimensional simplex. The author of this article in 2021/22 refined this inequality in the form of an intrinsic inequality depending on the lengths of the edges of the simplex [(*J. Geom.*, (44))] with application to probability in astrophysics.

This was followed by Mardešić's shorter visits to Italy, Munich, Athens, he spent a month and a half at the *Topological Semester* at the *Banach Center* in Warsaw, and he was at a topological meeting in Oberwolfach, then at the end of September 1984 in Madrid, and he spent May 1985 at the University of Perugia. In the meantime, for a few days in 1983, he „jumped“ to Skopje and Titograd (today Podgorica), and in September 1985 to a congress in Priština, and for six days in October he was at the *Topology and its Applications* conference in Dubrovnik. Sibe Mardešić and Jože Vrabec from Ljubljana were the leaders of the topology seminar *Zagreb-Ljubljana*, with four or five annual meetings. In April 1986, Mardešić was again in L'Aquila at the *Categorical Topology* conference, and then on two occasions in Belgrade, where he held a series of ten-hour lectures: *Basics of homotopy and shape theory*. In June, he made a short visit to Trieste, and in October 1986, a 12-day third school for the theory of shapes called *Geometric topology* was held in Dubrovnik, where Mardešić and Segal were the directors and editors of the related proceedings published in Springer's renowned *Lecture Notes in Mathematics*. (45) A. Koyama, T. Watanabe and A. Prasolov spent several months in Zagreb working with Mardešić, which resulted in several papers, for instance (46, 47). At the end of October, he held

rovoj seriji *Lecture Notes in Mathematics* (45). U Zagrebu su više mjeseci zbog rada s Mardešićem proveli A. Koyama, T. Watanabe i A. Prasolov, što je rezultiralo s nekoliko zajedničkih članaka, npr. (46, 47). Krajem listopada održao je na susretima matematičara Graza i Zagreba predavanje *Strong shape and strong homology*.

Godine 1985./1986. kao Fulbrightov stipendist u Zagrebu je boravio profesor Leonard Rubin sa Sveučilišta Oklahoma u Normanu, Oklahoma, SAD, koji je imao ambicije raditi s Mardešićem, ali zbog majčine bolesti tek u veljači 1987. Mardešić kreće u Oklahomu pa onda u Seattle. Neumorni Sibe Mardešić nastavlja znanstveni rad sada s kolegom L. Rubinom na problemima tipa može li CE preslikavanje među metričkim kompaktima povisiti dimenziju. Neke pozitivne rezultate na tu temu su ubrzo objavili u *Pacific J. Math.* (48). Nakon Oklahome, gdje je i Vera Mardešić održala predavanje *Convex functions* u klubu studenata matematike, bračni par Mardešić leti opet u Seattle. Netom kako su stigli u Seattle, profesor Mardešić je po pozivu na konferenciju napravio mini turneju na jugoistok SAD-a: Birmingham, Alabama, Greensboro, North Carolina i Athens, Georgia, gdje je održao predavanja.

Po povratku u Seattle dali su mu da predaje dodiplomski predmet *Linearna algebra*, a slušao je poslijediplomski predmet koji je predavao D. C. Ravenel, jedan od najboljih algebarskih topologa onog vremena. Gotovo svi ostali slušači su bili Kinezi i poneki Korejac i Japanac. I Mardešićevi demonstratori su bili Kinezi Cheng,

the lecture *Strong shape and strong homology* at the meetings of mathematicians of Graz and Zagreb.

In 1985/1986 professor Leonard Rubin from the University of Oklahoma in Norman, Oklahoma, USA, had ambitions to work with Mardešić, but due to his mother's illness, stayed in Zagreb as a Fulbright scholar until February 1987. Mardešić trips to Oklahoma and then to Seattle. The tireless Sibe Mardešić continues his scientific work now with his colleague L. Rubin on problems such as whether a CE mapping among metric compacta can raise the dimension. They soon published some positive results on that topic in *Pacific J. Math.* (48). After Oklahoma, where Vera Mardešić also held a lecture on *Convex functions* in the mathematics students' club, the Mardešić couple flew to Seattle again. As soon as they arrived in Seattle, professor Mardešić made a mini-tour to the southeast of the USA: Birmingham, Alabama, Greensboro, North Carolina and Athens, Georgia, where he held lectures.

Upon his return to Seattle, he was assigned to teach an undergraduate course in *Linear Algebra*, and he took a graduate course taught by D. C. Ravenel, one of the best algebraic topologists of the time. Almost all the other listeners were Chinese and a few Koreans and Japanese. And Mardešić's demonstrators were the Chinese Cheng, Chang and Chung. Segal and Mardešić continued to work and publish, and Rubin with them at a distance. Vera Mardešić also attended the *Geometry and Combinatorics Seminar* of professors Klee and Grünbaum that year and later published a paper in the prestigious journal *Geometriae Dedicata* (50).

As the Mardešićs studied Japanese intensively with Devidé and his wife Hondo for the past eight years, they wanted to check their knowledge on the spot, so they went on a one-month tour of Japan from Seattle, where Mardešić also held sever-

Chang i Chung. Segal i Mardešić nastavili su raditi i objavljivati, a s njima na daljinu i Rubin. I Vera Mardešić je te godine pohađala *Seminar za geometriju i kombinatoriku* profesora Kleeja i Grünbauma i kasnije objavila rad u uglednom časopisu *Geometriae Dedicata* (50).

Kako su posljednjih osam godina Mardešići uz Devidéa i njegovu suprugu Hondo intenzivno učili japanski, htjeli su na licu mjesta provjeriti svoja znanja pa su iz Seattlea otišli na jednomjesečnu turneju po Japanu, gdje je Mardešić održao i nekoliko predavanja. Nakon povratka u Seattle predavao je u jesenskom kvartalu 1987./1988. *Elementarne diferencijalne jednadžbe*, posjetio je Knoxville (Tennessee) i još neka mjesta prije dolaska u Zagreb, pred sam Božić.

Akademija, umirovljenje, profesor emeritus, nova knjiga

Ovdje će se opisati život i rad profesora Sibe Mardešića u razdoblju otprilike 1988. – 2000. U početku se bavio tzv. aproksimativnim rezolventama, a prve ideje je razradio još u Japanu s T. Watanabeom. To je rezultiralo s nekoliko članaka u *Glasniku mat.* (46) i drugdje. Osim zagrebačkih topologa koji su se bavili i teorijom oblika poput I. Ivanšića, Š. Ungara, Z. Čerin i drugih, uspio je Mardešić animirati i neke splitske kolege: V. Matijević, N. Uglešić, N. Koceić-Bilan i druge da rade u teoriji oblika. Glavnina aktivnosti ipak se odvijala na zagrebačkom topološkom seminaru. Tako je i nastalo ime *Zagreb school*, koje su inicirali stranci – gosti seminara.

al lectures. After returning to Seattle, he taught in the fall quarter of 1987/88 *Elementary differential equations*, he visited Knoxville (Tennessee) and some other places before arriving in Zagreb, right before Christmas.

Academy, retirement, professor emeritus, new book

Here, the life and work of professor Sibe Mardešić will be described in the period around 1988–2000. Now the topic in the focus was approximate resolvents, and he developed the first ideas back in Japan with T. Watanabe. This resulted in several papers in *Glasnik mat.* (46) and elsewhere. Apart from topologists from Zagreb who also dealt with shape theory, such as I. Ivanšić, Š. Ungar, Z. Čerin and others, Mardešić succeeded in animating some colleagues from Split: V. Matijević, N. Uglešić, N. Koceić-Bilan and others to work in the theory of shapes. Most of the activities, however, took place at the topology seminar in Zagreb. That is how the name *Zagreb school* was born, which was initiated by foreigners – guests of the seminar.

There were other mathematical areas of excellence, such as representation theory, analysis, geometry, discrete mathematics and graph theory, especially chemical, and others, later number theory and probability theory. According to Mardešić's words (1, p. 309): „I consider the introduction of approximate systems and resolvents among my best ideas“. And about these ideas, he published a few papers alone or in co-authorship in *Glasnik mat.*, *Topology Appl.*, *Rad HAZU*, *Tsukuba J. Math.*, e.g. (46, 49, 51, 52) and other journals. After that, he returns to work on strong homology. The Georgian Z. Miminoshvili works on axiomatic strong homology. With his exact sequences, they were

Bilo je i drugih matematičkih područja izvrsnosti, kao teorija reprezentacija, analiza, geometrija, diskretna matematika i teorija grafova, posebno kemijska, i druge, kasnije teorija brojeva i teorija vjerojatnosti. Prema Mardešićevim riječima (1, str. 309): „Uvođenje aproksimativnih sistema i rezolventi ubrajam među svoje najbolje ideje.“ I o tim je idejama objavio što samostalno, što zajednički nekoliko članaka u *Glasnik mat., Topology Appl., Rad HAZU, Tsukuba J. Math.*, npr. (46, 49, 51, 52) i drugi časopisi. Nakon toga vraća se radu na jakoj homologiji. Gruzijac Z. Miminošvili radi na aksiomatici jake homologije. S njegovim egzaktnim nizovima uspjeli su dokazati još neke tvrdnje (aksiom o grozdu i aksiom o relativnom homeomorfizmu). Nakon još nekoliko radova [(*Glasnik mat., Topology Appl. i Rad HAZU*, npr. (53)], u lipnju 1988. proglašen je Sibe Mardešić redovitim članom tadašnje Jugoslavenske akademije znanosti i umjetnosti (JAZU), od 1991. Hrvatska akademija znanosti i umjetnosti (HAZU). Od matematičara su u to vrijeme, ili nešto kasnije, redoviti članovi Akademije bili još S. Bilinski i V. Devidé, (koji je postao redoviti član 1990.) i Žarko Dadić (koji je postao redoviti član 1992.), dok su D. Blanuša i Z. Janković umrli 1987. Kasnije će redovitim članovima HAZU-a od matematičara postati M. Tadić, J. Pečarić, A. Dujella te G. Muić. Redovitih članova-matematičara HAZU je od uvijek imala najčešće četiri a najviše pet.

Nakon kraće konferencije u Sorrentu, Italija, u travnju 1989., te jednog manjeg sveučilišnog centra u Walesu, krajem

able to prove some other propositions (cluster axiom and relative homeomorphism axiom). After several more works [(*Glasnik mat., Topology Appl. and Rad HAZU*, e.g. (53)], in June 1988, Sibe Mardešić was declared a regular member of the Yugoslav Academy of Sciences and Arts (JAZU), since 1991 Croatian Academy of Sciences and Art (HAZU). Among mathematicians at that time, or a little later, regular members of the Academy were S. Bilinski and V. Devidé (who became a regular member in 1990) and Žarko Dadić (who became a regular member in 1992), while D. Blanuša and Z. Janković died in 1987. Mathematicians M. Tadić, J. Pečarić, A. Dujella and G. Muić will later become regular members of HAZU. HAZU has always regular members-mathematicians, usually four and at most five.

After a short conference in Sorrento, Italy, in April 1989, and a smaller university center in Wales, at the end of April, he visited the famous English University of Oxford, where he held a lecture on *Approximate inverse systems and cohomological dimensions*. Already in May, he went to Italy again on an invitation and held four lectures at a summer school in algebraic and geometric topology in Umbria. At the end of September, he went to Seville, Spain, where he also held several two-hour lectures on *Strong shape theory and homology*. The Spaniards were concerned with the theory of proper homotopy in which compact subsets ordered by inclusion are observed, so they considered that they could apply the techniques developed in the theory of shapes in their considerations. In October 1989, he was invited to a two-day meeting of geometers in Novi Sad, where he held a lecture on *Some new developments in the theory of dimensions*, and in November in Trieste, at the University and International Center for Theoretical Physics, where he gave two lectures on *Strong shape and strong homol-*

travnja posjećuje čuveno englesko Sveučilište Oxford gdje je održao predavanje *Approximate inverse systems and cohomological dimensions*. Već u svibnju odlazi opet na poziv u Italiju i drži četiri predavanja na ljetnoj školi iz algebarske i geometrijske topologije u Umbriji. Krajem rujna odlazi u Seville, Španjolska, gdje je održao više dvosatnih predavanja *Strong shape theory and homology*. Španjolci su se bavili teorijom prave homotopije u kojoj se promatraju kompaktni podskupovi uređeni inkluzijom pa su smatrali da tehnike razvijene u teoriji oblika mogu primijeniti u svojim razmatranjima. U listopadu 1989. pozvan je na dvodnevni skup geometričara u Novi Sad, gdje je održao predavanje *Neka nova dostignuća u teoriji dimenzija*, a u studenome u Trst, na Sveučilište i Međunarodni centar za teorijsku fiziku gdje je održao dva predavanja na temu *Strong shape and strong homology*. Potkraj iste 1989. S. Mardešić se počeo zanimati i za povijest znanosti, pa je u kraćem razdoblju napisao spomenicu preminulom akademiku Zlatku Jankoviću (54), te spomenicu u povodu 100. godišnjice rođenja Željka Markovića (55). Iste je godine Sveučilište u Zagrebu slavilo 320 godina postojanja, pa je S. Mardešić napisao članak o doprinosu matematike razvoju Zagrebačkoga sveučilišta (56). Iste je godine Sibe Mardešić postao i član Europske akademije, *Academia Europea*, sa sjedištem u Londonu (1), **slika 9**. Do godine 2000., Mardešić je bio jedini hrvatski matematičar član te Akademije, a na njegov je prijedlog tada izabran i akademik Marko Tadić.

ogy. At the end of 1989, S. Mardešić became interested in the history of science, so in a short period of time, he wrote a memorial to the deceased academician Zlatko Janković (54), and a memorial on the occasion of the 100th anniversary of the birth of Željko Marković (55). In the same year, the University of Zagreb celebrated its 320th anniversary, so S. Mardešić wrote an article about the contribution of mathematics to the development of the University of Zagreb (56). In the same year, Sibe Mardešić also became a member of the European Academy, *Academia Europea*, based in London (1) (**Figure 9**). Until 2000, Mardešić was the only Croatian mathematician member of that *Academy*, and academician Marko Tadić was also elected at his suggestion.

In May 1990, academician Mardešić again spent a month in Perugia, where he held 12 lectures, this time in Italian. Followed by a visit to Genoa, with a lecture at the then university. Already in June of the same year, the fifth Dubrovnik conference *Topology and its Applications* was held, where Mardešić held a lecture on *Homology and strong shape theory*. At the end of August 1990, he embarked on his third trip to Japan. He participated in the *General and Geometric Topology* symposium in Tsukuba. It was a three-week Japanese tour where he held five lectures in different places; one of them with the title *The relative homeomorphism and wedge axioms*, and the second two days later in Kobe *Approximate resolutions of spaces*, while the third was held in Osaka under the title *Strong homology theory*.

In 1990, Sibe Mardešić, at the proposal of the Mathematical Department of PMF, was awarded for excellent scientific work in the field of natural sciences, in the field of mathematics, especially topology: the *Republic Award for Lifetime Achievement* (1), **Figure 10**.

Although academician Sibe Mardešić retired on April 1, 1991 (a touching farewell lunch was pre-

U svibnju 1990. akademik Mardešić je opet na mjesec dana u Perugii, gdje je održao 12 predavanja ovaj put na talijanskom. Slijedi posjet Genovi, s predavanjem na ondašnjem sveučilištu. Već u lipnju iste godine održana je peta dubrovačka konferencija *Topology and its Applications*, gdje je Mar-

pared at the Laguna Hotel on April 10), without taking advantage of the possibility of extending his work until the age of 70, that was not the end of his research or scientific activities. On the contrary!

Academician Sibe Mardešić was then accepted as the main researcher on the MZTIRH project with 12 researchers. At that time, the faculty was



SLIKA 9. Povelja o primanju akademika Sibe Mardešića u Europsku akademiju (1)
(prijevod s latinskoga Ana Mihaljević)

FIGURE 9. Charter on admission of academician Sibe Mardešić to the Academia Europaeae
(1) (Translated from Latin by Ana Mihaljević)

dešić održao predavanje *Homology and strong shape theory*. Krajem kolovoza 1990. kreće na svoje treće putovanje u Japan. Sudjeluje na simpoziju *General and Geometric Topology* u Tsukubi. Bila je to trodnevna japanska turneja na kojoj je održao pet predavanja u različitim mjestima; jedno od njih s naslovom *The relative homeomorphism and wedge axioms*, a drugo dva dana kasnije u Kobeu *Approximate resolutions of*

moved from Marulić Square 19 to Bijenička Cesta 30 in Zagreb.

On the third day after his retirement, professor Mardešić went to Genoa for the *Convegno Nazionale di Topologia*. In May 1991, he briefly stayed in Niš, Serbia, and held a lecture on *Approximate resolvents of topological spaces*, and in August 1991, at the *7th Prague Topological Symposium*, where Mardešić lectured on *Approximate inverse systems*.

spaces, dok je treće održao u Osaki pod nazivom *Strong homology theory*.

Godine 1990. dobio je Sibe Mardešić, na prijedlog Matematičkog odjela PMF-a, još jedno priznanje za istaknuti znanstveni rad u oblasti prirodnih znanosti, u području matematike, napose topologije: *Republičku Nagradu za životno djelo* (1), **slika 10**.

Iako se 1. travnja 1991. akademik Sibe Mardešić umirovio (dirljiv oproštajni ručak pripremljen je u hotelu *Laguna* 10.

As the aggression of Serbia and the JNA against Croatia flared up at that time, numerous activities were suspended, for example, the Dubrovnik conference on geometric topology and shape theory (it was held only in 1998).

Despite everything, Mardešić continued to work, so in 1992/93 he wrote, alone or in co-authorship, four papers in reputable journals, e.g. (57). At the end of November 1991, he went on a two-week tour of Italy (Milan, Genoa, Perugia, L'Aquila and Trieste) and lectured everywhere, sometimes even twice, in Italian.



SLIKA 10. *Republička Nagrada za životno djelo akademiku Sibi Mardešiću* (1)
FIGURE 10. *Republic Lifetime Achievement Award to academician Sibe Mardešić* (1)

travnja), ne iskoristivši mogućnost produženja rada do 70. godine, to nije bio kraj njegovih istraživanja niti znanstvenih djelovanja. Naprotiv!

Akademik Sibe Mardešić tada je prihvaćen i za glavnog istraživača na projektu MZTIRH s 12 istraživača. U to je doba fakultet preseljen s Marulićevog trga 19 na Bijeničku cestu 30 u Zagrebu.

In March 1993, he was invited to hold a 20-hour mini-course on algebraic topology at the new doctoral studies in Milan. In June of the same year, the Mardešić couple went to Split to repair their apartment destroyed by aggressors during the Homeland War. On that occasion, he started a Topology Seminar at the at the PMF in Split, where he himself gave the first lectures.

Već treći dan nakon umirovljenja profesor Mardešić odlazi u Genovu na *Convegno Nazionale di Topologia*. U svibnju 1991. kratko je boravio u Nišu, Srbija, i tamo održao predavanje *Aproksimativne rezolvente topoloških prostora*, a u kolovožu 1991. na 7. *Prague Topological Symposium* Mardešić je održao predavanje *Approximate inverse systems*. Kako se u to doba agresija Srbije i JNA na Hrvatsku razbuktala, brojne aktivnosti su suspendirane, npr. dubrovačka konferencija iz geometrijske topologije i teorije oblika (održana je tek 1998.).

Unatoč svemu, Mardešić je nastavio raditi, pa je 1992./1993. napisao, sam ili u suautorstvu, četiri rada u uglednim časopisima, npr. (57). Krajem studenoga 1991. krenuo je na dvotjednu turneju po Italiji (Milano, Genova, Perugia, L'Aquila i Trst) i svuda održao predavanje, ponegdje i dva, na talijanskome. U ožujku 1993. pozvan je da u Milanu na novom doktorskom studiju održi mini kolegij iz algebarske topologije od 20 sati. U lipnju iste godine bračni par Mardešić odlazi u Split popraviti stan koji je pogođen s agresorskog razarača u Domovinskom ratu. Tom je prilikom na PMF-u u Splitu pokrenuo *Seminar iz topologije*, na kojem je sam održao prva predavanja.

Drugi *Gauss Symposium*, 2. – 7. kolovoza 1993., održan je na Sveučilištu Ludwig-Maximilian u Münchenu. Karl Friedrich Gauss (1777. – 1855.) bio je jedan od najvećih matematičara u povijesti. Na skupu s oko 500 sudionika, profesor Sibe Mardešić je održao predavanje *Approximating spaces by polyhedra*, koje je

The second *Gauss Symposium*, August 2–7, 1993, was held at the Ludwig-Maximilian University in Munich. Karl Friedrich Gauss (1777–1855) was one of the greatest mathematicians in history. At a meeting with about 500 participants, professor Sibe Mardešić gave a lecture on *Approximating spaces by polyhedra*, which was published in the corresponding collection published by the publisher de Gruyter from Berlin (58).

A topological convention was held in Trieste on September 5–10, 1993, where S. Mardešić gave a lecture similar to the one in Munich. In November 1993, after two and a half years, the *Zagreb-Ljubljana* topological meeting was held again.

Scientifically, at that time, Sibe Mardešić worked intensively on an open problem: whether higher limes of homology pro-groups vanish for non-compact spaces. After months of work, he found counterexamples and published a paper about it in the world's leading journal *Topology*, which was published not until 1996. (59)

In the summer of 1994, in the old family house in Podšpilje, Mardešić constructed a paracompact space whose strong homology is nonzero, and every compact subset has a trivial strong homology. An article about it was rejected in *Trans. AMS*, but was accepted without objection in *Topology Appl.* (60).

In August of the same year, Mardešić went to the *World Mathematical Congress* in Zürich, where he presented a poster written with a felt-tip pen in large letters about his latest research.

At the end of March 1995, at the invitation of the organizers, he attended a conference for general topology in Spain, and then „on the way“ he was invited to Madrid, then to Valencia.

All spring and summer Mardešić works on strong homology and spectral sequences, which three years later resulted in an important article in *Topology Appl.* on about 30 pages (co-authored

objavljeno u pripadnom zborniku u izdanju nakladnika de Gruyter iz Berlina (58).

U Trstu je 5. – 10. rujna 1993. održana topološka konvencija na kojoj je S. Mardešić održao predavanje slično kao u Münchenu. U studenome 1993. je nakon dvije i pol godine ponovno održan topološki sastanak *Zagreb-Ljubljana*. Znanstveno je u to vrijeme Sibe Mardešić intenzivno radio na otvorenom problemu: da li viši limesi homoloških pro-grupa iščezavaju za nekompaktne prostore. Protuprimjere je nakon mjeseci rada našao i rad o tome objavio u vrhunskome svjetskom časopisu *Topology*, koji je izašao tek 1996. (59).

U ljeto 1994., u staroj obiteljskoj kući u Podšpilju, Mardešić je konstruirao parakompaktni prostor čija je jaka homologija nenul, a svaki kompaktni podskup ima trivijalnu jaku homologiju. Članak o tome mu je odbijen u *Trans. AMS*, ali je bez primjedbe prihvaćen u *Topology Appl.* (60). U kolovozu iste godine otišao je na *Svjetski matematički kongres* u Zürichu, gdje je izložio poster pisan flomastrom krupnim slovima o svojim najnovijim istraživanjima.

Krajem ožujka 1995. na poziv organizatora boravio je na konferenciji za opću topologiju u Španjolskoj, a onda „usput“ bio pozvan u Madrid, pa u Valenciju. Cijelo proljeće i ljeto radi na jakoj homologiji i proučava spektralne nizove, što je tri godine kasnije rezultiralo važnim člankom u *Topology Appl.* na 30-ak stranica (u suautorstvu s A. V. Prasolovim koji je deset godina ranije proveo studijsku godinu u Zagrebu): *Strong homology of compact spaces* (61). U studenome iste godine

with A. V. Prasolov, who ten years earlier spent a study year in Zagreb): *Strong homology of compact spaces*. (61) In November of the same year, L. Rubin invited Mardešić to a joint meeting of the Mexican and American mathematical societies, but first he spent about 15 days in Oklahoma and held several lectures at the university there.

On May 14, 1996, academician Sibe Mardešić was elected to the title of *Professor Emeritus* of the University of Zagreb. This selection was initiated by the Mathematics Department of the Faculty of Sciences, submitting all documented activities, from numerous scientific papers in renowned international journals, professional papers, books in well-known publishing houses, numerous social activities, etc. At the end of May 1996, a celebration of the 100th anniversary of the birth of Kuratowski and the 90th anniversary of the birth of Borsuk was held at the Banach Institute in Warsaw, both very key figures for Mardešić. Therefore, he held a two-hour lecture on *Strong shape and homology* and met with old prominent friends – Segal, Rubin, Keesling, Toruńczyk, Maria Moszysyńska, Nowak, Spieß, Ferry, Dranishnikov, Dydak and others.

At that time, the 120th anniversary of the first lecture in natural sciences and mathematics at the University of Zagreb was celebrated, and an occasion memorial was issued in which S. Mardešić wrote a chapter on the Department of Mathematics. He also wrote a short history of the development of mathematics in Croatia (62).

For the monograph *The History of Topology* published by North Holland, the editor I. M. James from Oxford invited Mardešić to write the article *The history of ANR theory and shape theory* (63). On July 1996, the *First Croatian Mathematical Congress* was held in Zagreb, which succeeded beyond all expectations. Almost all prominent Cro-

L. Rubin poziva Mardešića na zajednički sastanak meksičkoga i američkoga matematičkog društva, ali je prvo 15-ak dana proveo u Oklahomi i održao nekoliko predavanja na tamošnjem sveučilištu.

Dana 14. svibnja 1996. akademik Sibe Mardešić izabran je u zvanje *profesor emeritus* Sveučilišta u Zagrebu. Taj je izbor pokrenuo Matematički odjel PMF-a, prilažući sve dokumentirane aktivnosti, od brojnih znanstvenih radova u renomiranim svjetskim časopisima, stručnih radova, knjiga u poznatim izdavačkim kućama, brojnim društvenim aktivnostima itd. Krajem svibnja 1996. u Varšavi je na Banachovom institutu održana proslava 100. obljetnice rođenja Kuratowskog i 90. obljetnice rođenja Borsuka, obojica Mardešiću ključne osobe. Stoga je održao dvosatno predavanje *Strong shape and homology* i susreo se sa starim zncancima – Segal, Rubin, Keesling, Toruńczyck, Maria Moszsyńska, Nowak, Spież, Ferry, Dranishnikov, Dydak i drugi.

U to je vrijeme proslavljena 120. obljetnica prvoga predavanja iz prirodoslovlja i matematike na Sveučilištu u Zagrebu, a izdana je i prigodna spomenica u kojoj je S. Mardešić napisao poglavlje o Matematičkom odsjeku. Napisao je i kratku povijest razvitka matematike u Hrvatskoj (62).

Za monografiju *The History of Topology* u izdanju North Hollanda, urednik I. M. James iz Oxforda pozvao je Mardešića da napiše članak *The history of ANR theory and shape theory* (63). U srpnju 1996. održan je u Zagrebu *Prvi hrvatski matematički kongres*, koji je uspio iznad svih očekivanja. Odazvali su se gotovo svi ista-

atian mathematicians responded, especially those from abroad. S. Mardešić held one of only four domestic invited lectures: *Strong shape and homology*. In October, he was invited to the *First Macedonian Mathematical Congress* in Ohrid, and in November 1996, by invitation, he held a colloquium at the HMD branch in Osijek on the topic of *30 years of shape theory*. As a lecturer, S. Mardešić always knew how to adapt to the audience and assess the level of knowledge of them, so he was gladly invited and listened to in all environments.

It is natural that scientists with more experience and years of doing science become interested in the history of their profession. Thus, on the occasion of the *50th anniversary of HMD* on November 4, 1995, Sibe Mardešić held a lecture under that title at the headquarters in Zagreb, and repeated it a few months later in Split in front of a large audience. He was glad to hear after the lecture when some approached him and said „he was their favorite professor“. The author of this text agrees with that.

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On June 20, 1997, the Mathematics Department of PMF and HMD celebrated the 70th anniversary of the academician Sibe Mardešić with a festive gathering. That spring and summer, Sibe and his wife Vera spent most of their time in Split and in Podšpilje near Komiža on island Vis. In Split, he also held 10 hours of lectures at a topological seminar, mainly on coherent homotopy, as well as a historical review of *30 years of shape theory*.

During the school year 1997/98 and the following, S. Mardešić taught the courses *Strong shape of topological spaces* and *Higher limes and strong homology* at the postgraduate studies in Zagreb. He

knuti hrvatski matematičari, posebno oni iz inozemstva. S. Mardešić je održao jedno od samo četiri domaća pozvana predavanja: *Strong shape and homology*. U listopadu je pozvan na *Prvi makedonski matematički kongres* u Ohridu, a u studenome 1996. po pozivu je održao kolokvij u podružnici HMD-a u Osijeku s temom *30 godina teorije oblika*. Kao predavač S. Mardešić se uvijek znao prilagoditi publici i procijeniti razinu znanja slušateljstva, pa je bio rado pozivan i slušan u svim sredinama.

Prirodno je da se znanstvenici s više iskustva i godina bavljenja znanosti počinju zanimati za povijest svoje struke. Tako je i Sibe Mardešić u povodu *50. obljetnice HMD-a* 4. studenog 1995. održao u središnjici u Zagrebu predavanje pod tim naslovom, i to ponovio nekoliko mjeseci kasnije u Splitu pred velikim slušateljstvom. Bilo mu je drago čuti nakon predavanja kad su mu neki prišli i kazali „da im je bio najdraži profesor“. S time se slaže i autor ovog teksta.

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Matematički odsjek PMF-a i HMD su 20. lipnja 1997. prigodnim svečanim skupom obilježili 70. godišnjicu akademika Sibe Mardešića. Toga su proljeća i ljeta Sibe i supruga Vera najviše vremena proveli u Splitu i u Podšpilju kod Komiže na Visu. U Splitu je održao i 10 sati predavanja na topološkom seminaru, uglavnom o koherentnoj homotopiji kao i povijesni pregled *30 godina teorije oblika*.

did all this preparing for the new book *Strong Shape and Homology* (64), and according to the principle „when you don't know anything well, give lectures“. At the end of 1997, S. Mardešić was elected a member of the HAZU Presidency, and deputy secretary of the class for mathematical, physical and chemical sciences.

In the book *The History of Topology* edited by I. M. James, about 1,000 pages and published by Elsevier in 1999, as mentioned earlier, Mardešić's article *Absolute neighborhood retracts and shape theory* of about 30 pages was published (63). Two years later, in 2001, in another monograph published by Kluwer *Handbook of the History of General Topology*, S. Mardešić and J. Segal wrote a 30-page contribution *History of shape theory and its application to general topology*. (66)

In May 1998, S. Mardešić finished his two-year work on the book *Strong Shape and Homology* (Figure 11) (1, p. 387). In the same month, he visited his son Pavo, a professor of mathematics at the University of Dijon, France, and in their topology seminar gave a French lecture on the theory of shapes and possible applications in the theory of dynamic systems, which Pavo Mardešić successfully deals with. More and more often, Sibe Mardešić also writes memories of deceased colleagues, and in 1999, the last professor who taught him as a student, Stanko Bilinski (1910–1999), died. He spent May–June 1998 in Perugia, and again in October 1999, and was invited to give a lecture on the history of science, *Topology in Eastern Europe, 1900–1950*, which was published in *Topology Proc. 2000* on 33 pages (67). Mardešić himself says (1, p. 378): „I gained a new perspective on the history of mathematics as a very interesting and important discipline. The historians of mathematics that I met there are interested in modern mathematics and have a good command of it, which is a prerequisite

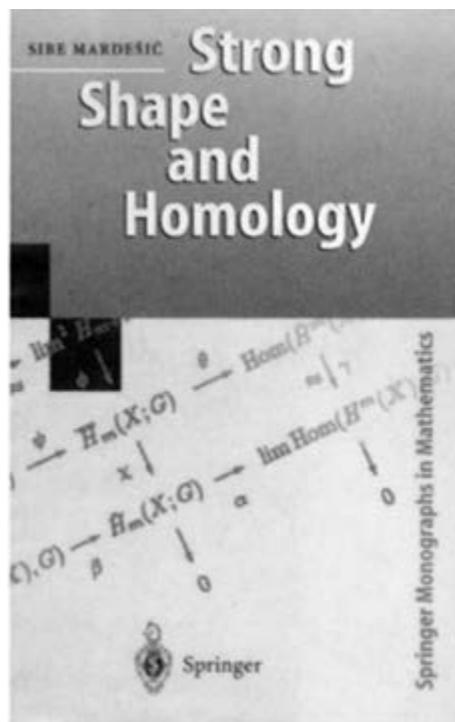
Šk. god. 1997./1998. i sljedeće S. Mardešić je u Zagrebu na poslijediplomskom studiju držao predmete *Jaki oblik topoloških prostora* te *Viši limesi i jaka homologija*. Sve je to radio pripremajući se za novu knjigu *Strong Shape and Homology* (64), a prema načelu „kad nešto ne znaš najbolje, održi predavanja“. Krajem 1997. S. Mardešić je izabran za člana Predsjedništva HAZU, te za zamjenika tajnika razreda za matematičke, fizičke i kemijske znanosti.

U knjizi *The History of Topology* urednika I. M. Jamesa od oko 1 000 stranica u izdanju Elseviera 1999., kako je ranije rečeno, izašao je i Mardešićev članak *Absolute neighborhood retracts and shape theory* od 30-ak stranica (63). Dvije godine kasnije, 2001. u drugoj monografiji u izdanju Kluwera *Handbook of the History of General Topology*, S. Mardešić i J. Segal napisali su prilog od 30-ak stranica *History of shape theory and its application to general topology*. (66)

U svibnju 1998. S. Mardešić je završio dvogodišnji rad na knjizi *Strong Shape and Homology* (slika 11) (1, str. 387). Istog je mjeseca posjetio sina Pavu, profesora matematike na Sveučilištu u Dijonu, Francuska, te u njihovom seminaru za topologiju održao na francuskom predavanje o teoriji oblika i moguće primjene u teoriji dinamičkih sistema, čime se Pavo Mardešić uspješno bavi. Sve češće Sibe Mardešić piše i sjećanja na preminule kolege, a 1999. umire i posljednji profesor koji mu je predavao kao studentu, Stanko Bilinski (1910. – 1999.). Svibanj–lipanj 1998. provodi u Perugi, pa opet u listopadu 1999., a na poziv je održao predavanje iz povije-

for being able to successfully describe the development of certain ideas“.

After a smaller topological conference in Hungary at the beginning of August 1998, he spent



SLIKA 11. Naslovna stranica knjige Sibe Mardešića *Strong Shape and Homology*, Springer Monographs in Mathematics, Springer, 2000. (1, str. 387)

FIGURE 11. The front page of Sibe Mardešić's book *Strong Shape and Homology*, Springer Monographs in Mathematics, Springer, 2000 (1, p. 387)

the second half of August in Berlin at the *World Mathematical Congress* with about 4,000 participants, where he gave a short presentation. He was most impressed by the lecture of A. Wiles, who three years earlier solved the famous Fermat prob-

sti znanosti *Topology in Eastern Europe, 1900–1950.*, koje je objavljeno u *Topology Proc. 2000.* na 33 stranice (67). Sam Mardešić kaže (1, str. 378): „Dobio sam nov pogled na povijest matematike kao vrlo zanimljivu i važnu disciplinu. Povjesničare matematike koje sam tu upoznao zanima suvremena matematika i njome dobro vladaju, što je preduvjet da mogu uspješno opisati razvoj pojedinih ideja“.

Nakon manje topološke konferencije u Mađarskoj početkom kolovoza 1998., drugu polovicu kolovoza provodi u Berlinu na *Sujetskom matematičkom kongresu* s oko 4 000 sudionika, gdje je održao kratko priopćenje. Najviše ga se dojmilo predavanje A. Wilesea koji je tri godine ranije riješio čuveni Fermatov problem iz 1637. da ne postoje prirodni brojevi a, b, c i $n \geq 3$ tako da je $a^n + b^n = c^n$. U listopadu je u Dubrovniku na *Geometric topology* koju su organizirali profesori Ivan Ivanšić i Šime Ungar, a u studenome u Varšavi na sastanku na temu *Algebraic aspects of dimension theory* na koji je pozvan da održi predavanje o nadlaganjima (*overlays*). O tome je s profesoricom Vlastom Matijević iz Splita napisao već spomenuti članak u *Topology Appl.* na više od 40 stranica, tiskan 2001. (52). Početkom 2000. izašla mu je monografija *Strong Shape and Homology* (64). U (1) Sibe detaljno prenosi mišljenja recenzenata i pozitivnih opisa knjige u uglednim svjetskim časopisima, npr. opis knjige Tima Portera u *Bull. London Math. Soc.* iz 2001. (69)

Krajem lipnja 2002. ne može se oduprijeti pozivu Japanaca i odlazi na *Second Japan-Mexico Topology Symposium*. Na skupu blizu Osake bilo je više od 130 ljudi iz

lem from 1637 that there are no natural numbers a, b, c and $n \geq 3$ such that $a^n + b^n = c^n$. In October, he was in Dubrovnik at *Geometric topology* organized by professors Ivan Ivanšić and Šime Ungar, and in November in Warsaw at a meeting on *Algebraic aspects of dimension theory*, where Mardešić was invited to hold a lecture on overlays. About this, together with professor Vlasta Matijević from Split, he wrote the aforementioned article in *Topology Appl.* on more than 40 pages, printed in 2001 (52). At the beginning of 2000, his monograph *Strong Shape and Homology* (64) was published. In (1) Sibe reports in detail the opinions of reviewers and positive descriptions of the book in reputable world journals, for example, Tim Porter's description of the book in *Bull. London Math. Soc.* from 2001. (69)

At the end of June 2002, he cannot resist the invitation of the Japanese and went to the *Second Japan-Mexico Topology Symposium*. At the gathering near Osaka, there were more than 130 people from 20 countries, and S. Mardešić held a lecture on *Products in shape theory. A resolution in the product of a compactum with a polyhedron*, about which the article (68) was published not until 2003. At the beginning of October 2002, the *Geometric Topology II* meeting was held in Dubrovnik with 62 participants from 15 countries. A month later, there was a topological workshop in Warsaw, where Mardešić spoke about the aforementioned joint work with professor Nikica Uglešić of Split *On iterated inverse limits* (51).

After the celebration of 30 years of the topological seminar *Zagreb-Ljubljana* in June 2003, Sibe Mardešić was elected a corresponding member of the Slovenian Academy of Sciences and Arts. In March 2004, the Ministry of Science, Education and Sports of the Republic of Croatia elected academician Sibe Mardešić as the presi-

20 zemalja, a S. Mardešić je održao predavanje *Products in shape theory. A resolution for the product of a compactum with a polyhedron* o čemu je članak (68) izašao tek 2003. Početkom listopada 2002. u Dubrovniku je sastanak *Geometric topology II.* sa 62 sudionika iz 15 zemalja. Mjesec dana kasnije u Varšavi je topološka radionica na kojoj je Mardešić govorio o već spomenutom zajedničkom radu s profesorom Nikicom Uglešićem iz Splita *On iterated inverse limits* (51).

Nakon proslave 30 godina rada topološkog seminara *Zagreb-Ljubljana* u lipnju 2003., Sibe Mardešić je izabran za dopisnoga člana Slovenske akademije znanosti in umetnosti. U ožujku 2004. Ministarstvo znanosti, obrazovanja i športa RH izabralo je akademika Sibua Mardešića za predsjednika Povjerenstva za izradu Hrvatskoga nacionalnog obrazovnog standarda za matematiku u osnovnoj školi (HNOS). Bio je to veliki posao mnogo (nas) matematičara, profesora i nastavnika koji je s prekidima trajao više od godinu dana.

U studenome 2003. na desetak je dana S. Mardešić opet u Madridu, gdje je održao dva predavanja, odsjeo je u poznatom Residencia de Estudiantes, pomno razgledavao muzej *Prado*, a nakon toga je također održao predavanja u nekoliko manjih sveučilišta blizu Madrida. U svibnju 2004., zajedno s prof. I. Ivanšićem pozvan je u Lavov u Ukrajini na topološku konferenciju i održao predavanje *On products in the shape categories*. Na dvije stranice sažeto i jasno obrazlaže povijest Ukrajine (1), posebice grada Lavova koji je bio malo u Galiciji (Austro-Ugarska Monarhija), malo u Poljskoj,

dent of the *Committee for the Creation of the Croatian National Educational Standard for Mathematics in Elementary School* (HNOS). It was a big job for many (us) mathematicians, professors and teachers that lasted more than a year with interruptions.

In November 2003, S. Mardešić was again in Madrid for ten days, where he held two lectures, stayed in the famous Residencia de Estudiantes, carefully looked at the *Prado* museum, and after that, he also held lectures in several smaller universities near Madrid. In May 2004, together with prof. I. Ivanšić he was invited to Lviv in Ukraine for a topological conference and held a lecture *On products in the shape categories*. In two pages, he concisely and clearly explains the history of Ukraine (1), especially the city of Lviv, which was a little in Galicia (Austro-Hungarian Monarchy), a little in Poland, then in the USSR and finally in Ukraine. Hence the witty answer of the mathematician Stefan Banach (1892–1945) from Lviv, when asked if he ever crossed the border, he said: „no, but the border crossed over me several times“. Prince Danilo founded Lviv in the 13th century and it was named after his son Lev, who in turn married the daughter of the Hungarian-Croatian King Bela IV, who took refuge from the Mongols in Zagreb and gave it the status of a royal city (Golden Bull from 1242). Another link with Ukraine is that the pharmacist Eugen Feller, the father of the famous Croatian mathematician Vilim Feller, was born in Lviv and emigrated from there to Zagreb, where he founded a company whose most famous product between the two world wars was „Elsa fluid“ and the illuminated advertisement on Jelčić Square in Zagreb. About ten days in June 2004, Mardešić is in Perugia for the ninth time, where he teaches in Italian. Immediately after that, the

pa u SSSR-u i konačno u Ukrajini. Odatle i duhovit odgovor matematičara Stefana Banacha (1892. – 1945.) iz Lavova kad je upitan je li ikad prelazio granicu rekao: „ne, ali je granica više puta prelazila preko mene“. Lavov je osnovao knez Danilo u 13. st. a ime je dobio po njegovu sinu Levu koji je pak oženio kćer ugarsko-hrvatskoga kralja Bele IV., koji se sklonio od Mongola u Zagrebu i dao mu status kraljevskoga grada (Zlatna bula iz 1242.). Druga je poveznica s Ukrajinom što je ljekarnik Eugen Feller, otac slavnoga hrvatskoga matematičara Vilima Feller, rođen u Lavovu i odatle emigrirao u Zagreb, gdje je osnovao tvrtku koje je najpoznatiji proizvod između dva svjetska rata bio „Elsa fluid“ i svijetleća reklama na Jelačićevu trgu u Zagrebu.

Desetak dana u lipnju 2004. Mardešić je već deveti put u Perugi, gdje predaje na talijanskome. Odmah nakon toga, 3. *hrvatski matematički kongres* u Splitu uspio je iznad svih očekivanja (kongres je otvorio tadašnji predsjednik HMD-a, autor ovoga članka). U svom stanu u Splitu (Nazorova 4), Sibe i Vera ugostili su neke inozemne matematičare.

Sredinom 2004. Mardešić je postavio pitanje koje mu se prirodno nametnulo: je li Kartezijev produkt havajske naušnice i punktirane sume jediničnih kružnica produkt u kategoriji $\text{Sh}(\text{Top})$? Dugo se bavio tim problemom, ali ga nije uspio riješiti do kraja života. I danas je to otvoreno pitanje.

Po pozivu profesora S. Illmana iz Finske u rujnu 2004. posjetio je Helsinki i tamo održao dva predavanja: *Shape theory i Topology in Eastern Europe 1900–1950*.

3rd Croatian Mathematics Congress in Split succeeded beyond all expectations (the congress was opened by the then president of HMD, the author of this article). In their apartment in Split (Nazorova 4), Sibe and Vera hosted some foreign mathematicians.

In the middle of 2004, Mardešić asked a question that naturally occurred to him: is the Cartesian product of the Hawaiian earring and the one-point union of the unit circles a product in the category $\text{Sh}(\text{Top})$? He dealt with this problem for a long time but was unable to solve it until the end of his life. Even today it is an open problem.

At the invitation of professor S. Illman from Finland in September 2004, Mardešić visited Helsinki and held two lectures there: *Shape theory and Topology in Eastern Europe 1900–1950*. In the book (1), Mardešić wrote a short history of Finland and Helsinki, and interesting mathematical conversations with Illman, for example, can every real analytic manifold be analytically embedded in some Euclidean space? And that question is still open today.

In September–October 1999, Mardešić was again in Perugia and Umbria, and at the end of October in Madrid. At the end of May 2000, he was invited (for the umpteenth time) to Seattle on the occasion of the retirement of his most frequent co-author and friend professor Jack Segal (b. 1934), with whom he has 12 joint papers, one monograph and several edited conference proceedings. In June 2000, S. Mardešić participated in the *2nd Croatian Mathematical Congress*, and in August 2000 in Istanbul at the *First Turkish Intl. Conf. of Topology and its Appl.* Then for seven days in September 2000, he was in Ohrid again, and then in Perugia for three days. In those days, he was elected to the position of secretary of the Department for Mathematical, Physical and

U knjizi (1) je napisao kratku povijest Finske i Helsinkija, te zanimljive matematičke razgovore s Illmanom, npr. može li se svaka realna analitička mnogostrukost analitički smjestiti u neki euklidski prostor? I to je pitanje i danas otvoreno.

U rujnu–listopadu 1999. Mardešić je opet u Perugi i Umbriji, a krajem listopada u Madridu. Krajem svibnja 2000. pozvan je (po tko zna koji put) u Seattle u povodu umirovljenja svog najčešćeg suautora i prijatelja profesora Jacka Segala (r. 1934.) s kojim ima 12 zajedničkih članaka, jednu monografiju i nekoliko uređenih zbornika s konferencija. U lipnju 2000. S. Mardešić je sudionik 2. hrvatskoga matematičkog kongresa, a u kolovozu 2000. u Istanbulu na *First Turkish Intl. Conf. of Topology and its Appl.* Zatim je sedam dana u rujnu 2000. opet u Ohridu, pa tri dana u Perugi. Tih je dana izabran na dužnost tajnika Razreda za matematičke, fizičke i kemijske znanosti HAZU, koju je obnašao tri godine. U studenome 2001. saznaje da je njegov suautor sedam radova i prijatelj Jurij Lisica obranio doktorat na MGU. Spomenimo ovdje da od 15-ak inozemnih matematičara koji su u Zagrebu proveli 1-2 semestra zbog rada s Mardešićem, s gotovo svakim od njih ima bar jedan zajednički rad.

U siječnju 2005. pozvan je Mardešić u Bari, Italija, u redakciju novog časopisa *Mediterranean J. Math.*, a 3. – 10. srpnja 2005. u Poljskoj je održana velika konferencija *Geometric Topology* u povodu 100 godina rođenja K. Borsuka. Naravno, S. Mardešić je bio jedan od glavnih govornika, uz još šest hrvatskih matematičara.

Chemical Sciences at HAZU, which he held for three years. In November 2001, he found out that his co-author of seven papers and friend Jurij Lisica defended his doctorate at MGU. Let's mention here that about 15 foreign mathematicians spent 1-2 semesters in Zagreb due to work with Mardešić, he has at least one joint work with almost every one of them.

In January 2005, Mardešić was invited to Bari, Italy, to the editorial office of the new journal *Mediterranean J. Math.*, and on July 3–10, 2005, a large *Geometric Topology* conference was held in Poland on the occasion of the 100th anniversary of the birth of K. Borsuk.

Of course, S. Mardešić was one of the main speakers, along with six other Croatian mathematicians. One of the main stars of the conference was the Croatian-American mathematician Mladen Bestvina, a professor at the University of Utah, an expert in the geometric theory of groups who gave four excellent lectures, as stated in (1) by Mardešić. In September, Mardešić was invited to the congress of the *Austrian Mathematical Society*, and in November, professor Jože Vrabec retired in Ljubljana with a joint *Zagreb-Ljubljana* seminar. And there, Mardešić presented a brief history of that seminar, which he was the main initiator of.

For most of 2006 until the end of February 2007, Mardešić worked on the geometry of certain simplex decompositions that belong to the theory of convex polytopes, which he needed for the construction of certain morphisms in the pro category H (pro-Top). He published an article about it in *Glasnik mat.* (70), and the second part in *Topology Appl.* and *Math. Commun.* (71). A total of 110 pages of text and almost 400 technically very complicated formulas. For an 80-year-old man – impressive.

Jedna od glavnih zvijezda konferencije bio je hrvatsko-američki matematičar Mladen Bestvina, profesor na University of Utah, stručnjak za geometrijsku teoriju grupa koji je održao četiri odlična predavanja, kako u (1) navodi Mardešić. U rujnu je Mardešić pozvan na kongres *Austrijskoga matematičkog društva*, a u studenome je u Ljubljani umirovljen profesor Jože Vrabec uz zajednički seminar *Zagreb-Ljubljana*. I tu je Mardešić izložio kratku povijest toga seminara čiji je bio glavni pokretač.

Veći dio 2006. do kraja veljače 2007. Mardešić je radio na geometriji određenih dekompozicija simpleksa što spada u teoriju konveksnih politopa što mu je trebalo za konstrukciju izvjesnih morfizama u prokategoriji $H(\text{pro-Top})$. Članak o tome objavio je u *Glasnik mat.* (70), a drugi dio u *Topology Appl.* i *Math. common* (71). Ukupno 110 stranica teksta i gotovo 400 tehnički vrlo zamršenih formula. Za čovjeka od 80 godina – impresivno.

U travnju su Sibe i supruga Vera dva dana proveli u Osijeku na skupu *Mathematics and children*, na kojem je bilo riječi o podizanju standarda metodike nastave matematike u osnovnim školama. U svibnju su Sibe i Vera sedam dana proveli u Madridu, gdje je Sibe održao dva predavanja, pa kaže (1, str. 439): „Mislim da su predavanja dobro uspjela, a tako ih je ocijenila i Vera, koja je inače strog kritičar i njezino mi je mišljenje uvijek važno“.

Osamdeset mu je godina tek, AMS Fellow, Prirodoslovlje

Matematički odjel PMF-a je za 80. rođendan akademiku Sibi Mardešiću prire-

In April, Sibe and his wife Vera spent two days in Osijek at the *Mathematics and children* meeting, where they discussed raising the standards of mathematics teaching methods in elementary schools. In May, Sibe and Vera spent seven days in Madrid, where Sibe gave two lectures, so he says (1, p. 439): „I think the lectures went well, and so did Vera, who is normally a strict critic and her opinion is always important to me“.

He is only eighty, AMS Fellow, Prirodoslovlje

For the 80th birthday of the academician Sibe Mardešić, the Mathematical Department of PMF organized a formal session attended by about 60 members of the Department and about 20 guests. Besides the rich snack one volume of *Glasnik matematički* (72), where Mardešić was the editor-in-chief for many years, is also dedicated to him. The volume has 256 pages and 16 papers, all with the subtitle *Dedicated to Professor Sibe Mardešić on the occasion of his 80th birthday*. He also received a number of electronic congratulations from numerous associates, colleagues and friends.

In September, the conference *Categories in geometry and mathematical physics* was held in Split, organized by the *Ruder Bošković* Institute (IRB) at the MEDILS institute, where Mardešić gave a lecture on *Direct products in the shape categories*. The participants were distinguished mathematicians such as M. Kontsevich (winner of the Fields Medal), P. Cartier (a friend of Mardešić's from Princeton), both from Paris, and others. And already in October, *VI. Geometric Topology* was in Dubrovnik, a very strong conference with more than 70 participants from about 15 countries around the world. Sibe Mardešić gave one of the plenary lectures.

In June 2008, the *4th Croatian Mathematics Congress* was held in Osijek. Sibe gave a short

dio svečanu sjednicu na kojoj je bilo oko 60 članova Odjela i 20-tak gostiju. Osim bogate zakuske, posvećen mu je i svezak *Glasnika matematičkog* (72), kojega je svojedobno bio dugogodišnji glavni urednik. Svezak ima 256 stranica i 16 radova i svi su s podnaslovom *Dedicated to Professor Sibe Mardešić on the occasion of his 80th birthday*. Dobio je i niz elektroničkih čestitaka od brojnih suradnika, kolega i prijatelja.

U rujnu je u Splitu u organizaciji Instituta *Ruđer Bošković* (IRB) u institutu MEDILS održana konferencija *Categories in geometry and mathematical physics*, gdje je Mardešić održao predavanje *Direct products in the shape categories*. Sudionici su bili ugledni matematičari kao M. Kontsevich (dobitnik Fieldsove medalje), P. Cartier (Mardešićev prijatelj još iz Princetona) obojica iz Pariza i drugi. A već u listopadu bila je u Dubrovniku *VI. Geometric Topology*, vrlo jaka konferencija s više od 70 sudionika iz 15-ak zemalja diljem svijeta. Sibe Mardešić je imao jedno od plenarnih predavanja.

U lipnju 2008. je u Osijeku održan *4. hrvatski matematički kongres*. Sibe je održao kratko priopćenje o tome da ne postoji fantomsko preslikavanje čija je kodomena dimenzije 1. S njim je došla i supruga Vera „u njezin Osijek“. Jedno je plenarno predavanje održao i Mladen Bestvina, profesor na University of Utah, Salt Lake City, Utah, SAD, rođen 1959. u Osijeku, a diplomirao je 1982. u Zagrebu kod prof. Mardešića. U rujnu je S. Mardešić pozvan u Ohrid na proslavu 85. godišnjice profesora Blagoja Popova.

speech about the fact that there is no phantom mapping whose codomain is dimension 1. His wife Vera came with him „to her Osijek“. One plenary lecture was also held by Mladen Bestvina, professor at the University of Utah, Salt Lake City, Utah, USA, born in 1959 in Osijek, and graduated in 1982 in Zagreb with prof. Mardešić. In September, S. Mardešić was invited to Ohrid to celebrate the 85th anniversary of the professor Blagoje Popov.

Although meticulous, Sibe Mardešić made mistakes (very rarely); namely, he only recently discovered that the proofs of two lemmas from his paper from 1958 are not entirely correct. However, in the summer of 2009, he managed to correct the proofs of the lemma so that the main theorem was saved. In *Glasnik mat.* in 2010, he published a five-page correction (73).

On the occasion of the 100th anniversary of the birth of academician Stanko Bilinski, otherwise Mardešić's professor from way back in 1949/50, HAZU erected a bust of him in his native Našice in 2010. In 2009–2010, Mardešić's colleagues and friends, professors Dominik Palman (1924–2008)⁴, Zdravko Kurnik (1937–2010), Vladimir Devidé (1925–2010), Krešo Horvatić and Svetozar Kurepa (1929–2010), passed away. Kurepa, together with Mardešić, was the main organizer of the postgraduate study of mathematics in Zagreb in 1960. On the occasion of the 50th anniversary of that study, at the Department's ceremonial session on June 8, 2011, Mardešić gave a brief overview of the history of mathematics studies at the University of Zagreb, from the first professors Karel Zahradnik in 1876, to Vladimir Varičak from 1899, Chair of Geometry Juraj Majcen and Ru-

⁴ D. Veljan i V. Volenc: *Profesor geometrije Dominik Palman (1924. – 2008.)*, *Prirodoslovlje* **18**(1-2) (2018) 87–104.

Iako pedantan, Sibe Mardešić je (vrlo rijetko) i pogriješio; naime tek je nedavno otkrio da dokazi dviju lema iz njegova rada iz 1958. nisu posve korektni. No, u ljeto 2009. uspio je korigirati dokaze lema tako da je glavni teorem spašen. U *Glasniku mat.* 2010. objavio je korekciju na pet stranica (73).

U povodu 100. godišnjice rođenja akademika Stanka Bilinskoga, inače Mardešićeva profesora iz davne 1949./1950., HAZU mu je 2010. u rodnim Našicama podigla poprsje. U godinu i nešto dana 2009. – 2010. preminuli su Mardešićevi kolege i prijatelji, profesori Dominik Palman (1924. – 2008.)⁴, Zdravko Kurnik (1937. – 2010.), Vladimir Devidé (1925. – 2010.), Krešo Horvatić i Svetozar Kurepa (1929. – 2010.). Kurepa je s Mardešićem još 1960. bio glavni organizator poslijediplomskoga studija matematike u Zagrebu. U povodu 50. obljetnice toga studija, na svečanoj sjednici Odjela 8. lipnja 2011., Mardešić je u kraćem osvrtu ukratko ispričao povijest studija matematike na zagrebačkom sveučilištu, od prvih profesora Karela Zahradnika 1876., pa Vladimira Varićaka od 1899., katedre za geometriju Jurja Majcena te Rudolfa Cesarca, katedre za teorijsku fiziku i primijenjenu matematiku 1939., preko osnivanja PMF-a 1946./1947., prvih čelnika zavoda Đure Kurepe, Stanka Bilinskoga i Željka Markovića sve do osnivanja spomenutog studija i usporedbe s današnjim

dolf Cesarec, chair of theoretical physics and applied mathematics in 1939, through the establishment of PMF in 1946/47, the first heads of the institute Đuro Kurepa, Stanko Bilinski and Željko Marković until the establishment of the mentioned study and comparison with today's contemporary doctoral study, about which he wrote extensively in (1).

Sibe Mardešić continues to work scientifically and professionally, and between 2010 and 2012 he publishes several papers, for example in *Top. Appl., Rad HAZU* (74-76). In (74, 75) he considers the so-called phantom mappings among CW complexes that have the property that restrictions on finite subcomplexes are nullhomotopic.

Here is the connection between Academician Mardešić and the Division of Natural Sciences and Mathematics of Matica Hrvatska. Academician Mardešić accidentally met Dr. Marko Tarle, the former head of the Division and suggested that on June 1, 2012, as a resident of Komiža and an academician, he give a lecture about the rich history of the island of Vis at the *Waters and Seas of the Island of Vis* meeting on June 1, 2012 under the title *The stormy history of the island of Vis*.

In October 2012, at the meeting *Croatian naturalists 21* (Hrvatski prirodoslovci 21) in Imotski, professor S. Mardešić spoke and wrote an article for *Prirodoslovlje* about the teacher of descriptive geometry Juraj Božičević (77, 78), who also taught his father at the Split high school. At the next meeting in October 2013 in Križevci, prof. Mardešić and the author of this article wrote together at the *Croatian naturalists 22* (Hrvatski prirodoslovci 22) an article about professor Vladimir Vranić (1896–1976), a pioneer of electronic computing in Croatia (11). Namely, professor Vranić at the time of the purchase of the first computer (which occupied two rooms) in

⁴ D. Veljan i V. Volenec: *Profesor geometrije Dominik Palman (1924. – 2008.)*, *Prirodoslovlje* 18(1-2) (2018) 87–104.

suvremenim doktorskim studijem, o čemu je opširno pisao u (1).

Sibe Mardešić nastavlja znanstveno i stručno djelovati pa 2010. – 2012. objavljuje više radova, primjerice u *Top. Appl., Rad HAZU* (74-76). U (74, 75) razmatra tzv. fantomska preslikavanja među CW kompleksima koje imaju svojstvo da su restrikcije na konačnim podkompleksima nulhomotopne.

Evo i veze akademika Mardešića s Odjelom za prirodoslovlje i matematiku Matice hrvatske. Akademik Mardešić je slučajno upoznao dr. Marka Tarlea, nekadašnjeg pročelnika Odjela, koji mu je predložio da na skupu „Vode i more otoka Visa“ 1. lipnja 2012. kao Komižanin i akademik uvodno kaže ponešto o bogatoj povijesti otoka Visa, pa je održao predavanje pod naslovom „Burna povijest otoka Visa“.

U listopadu 2012. na skupu *Hrvatski prirodoslovci 21* u Imotskome, profesor S. Mardešić je govorio i napisao članak za *Prirodoslovlje* o profesoru nacrtne geometrije Jurju Božičeviću (77, 78), koji je predavao i njegovu ocu u splitskoj gimnaziji. Na sljedećem skupu u listopadu 2013. u Križevcima, prof. Mardešić i autor ovoga članka zajedno su na skupu *Hrvatski prirodoslovci 22* s člankom o profesoru Vladimiru Vraniću (1896. – 1976.), pioniru elektroničkog računarstva u Hrvatskoj (11). Naime, prof. Vranić je u doba nabavke prvog računala (koje je zauzimalo dvije sobe) 1967. iz Francuske za IRB, bio ravnatelj tadašnjeg Instituta za matematiku preko kojeg je računalo kupljeno. Zato je u članku nazvan „pionir“.

1967 from France for the IRB, was the director of the then Institute of Mathematics through which the computer was purchased. That is why he was called a „pioneer“ in the article.

In January 2013, the American Mathematical Society (AMS), the strongest of its kind in the world, included Sibe Mardešić as *Fellow*, one can say honorary member (1), **Figure 12**. On that list of 1,119 prominent mathematicians in the world (out of about 35,000 AMS members), Mardešić is the only one from Croatia, along with three other Croatian mathematicians who live and work in America (M. Bestvina, B. Grünbaum and D. Miličić, and from 2020 Sunčica Čanić). This is a great honor given to him by the profession for outstanding contributions to the creation, clarification, progress and application of mathematics. He was very proud of it. Rightly so!

Mardešić continues to work tirelessly. In 2014 and 2015, he published three more articles, two in *Topology Appl.* (26), and one in *Rad HAZU, Mat. Zn.* (78) In June 2015, the *Dubrovnik VIII* conference was organized, a series that Sibe Mardešić started back in 1976. This time the focus of the conference was no longer on the shape theory, but on the geometric theory of groups, geometric topology and dynamical systems.

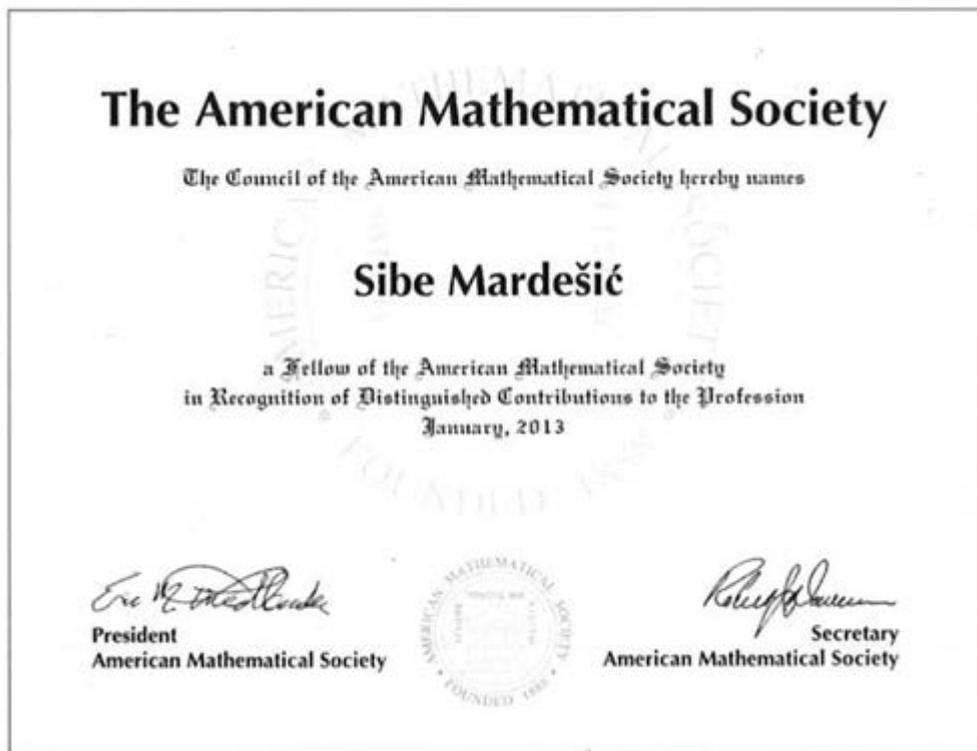
In June 2016, the *6th Congress of Croatian Mathematicians* was held in Zagreb, to which academician Sibe Mardešić also registered with a lecture scheduled for June 17. Unfortunately, he fell ill two days earlier, he was immediately transferred to the KBC Zagreb hospital, where he died of heart failure on June 18, 2016, two days before his 89th birthday.

Here are the last sentences of that giant of science, mathematics, especially topology and the even more special theory of (strong) shape and homology, a lover of science, thinker and professor, who tried to understand history, art, and glob-

Američko matematičko društvo (AMS), najjače takve vrste u svijetu je u siječnju 2013. Sibua Mardešića uvrstilo u *Fellows*, može se reći počasne članove (1), **slika 12**. Na tom popisu od 1 119 istaknutih matematičara u svijetu (od oko 35 000 članova AMS-a), jedino je Mardešić iz Hrvatske, uz

al politics, but until his last breath still science, and the last sentences of his impressive book (**Figure 13**), read (1):

„My wish was to solve the problem of the product of the Hawaiian earring and the one-point union of the 1-spheres sequence before completing this book and to include the result in the book. Un-



SLIKA 12. Akademik Sibe Mardešić, *Fellow* Američkoga matematičkog društva (1)
FIGURE 12. *Academician Sibe Mardešić, Fellow of the American Mathematical Society (1)*

još tri hrvatska matematičara koji žive i rade u Americi (M. Bestvina, B. Grünbaum i D. Miličić, a od 2020. i Sunčica Čanić). To je velika čast koju mu je iskazala struka za istaknute doprinose u stvaranju, pojašnjavanju, napretku i primjeni matematike. Bio je vrlo ponosan na to. S pravom!

fortunately, despite all efforts, this did not happen. At some moments it seemed to me that I was close to a solution, and I even spoke about it at the seminars in Split (May 5 and 6, 2016) and Ljubljana (May 14, 2016), but no solution was reached. This is often the case in mathematics. One link in the reasoning chain gives way and everything collapses.“

Mardešić i dalje neumorno radi. Godine 2014. i 2015. izašla su mu još tri članka, dva u *Topology Appl.* (26), i jedan u *Rad HAZU, Mat. zn.* (78). U lipnju 2015. organizirana je konferencija *Dubrovnik VIII.*, setija koju je Sibe Mardešić započeo još 1976. Ovoga puta težište konferencije više nije bilo na teoriji oblika nego na geometrijskoj teoriji grupa, geometrijskoj topologiji i dinamičkim sustavima.

U lipnju 2016. u Zagrebu se održavao *6. kongres hrvatskih matematičara* na koji se prijavio i akademik Sibe Mardešić s predavanjem koje je bilo predviđeno za 17. lipnja. Nažalost, dva dana ranije pozlilo mu je, odmah je prebačen u bolnicu KBC Zagreb, gdje je preminuo od zatajenja rada srca 18. lipnja 2016., dva dana prije njegova 89. rođendana.

Evo posljednjih rečenica toga velika znanosti, matematike, posebice topologije i još posebnije teorije (jakog oblika i homologije, zaljubljenika u znanost, promišljanja i profesuru, koji je pokušavao razumjeti povijest, umjetnost i globalnu politiku, ali do posljednjega daha ipak znanost, a zadnje rečenice njegove impresivne knjige, **slika 13**, glase (1):

„Želja mi je bila da prije dovršetka ove knjige riješim problem produkta havajske naušnice i punktirane sume niza 1-sfera te da rezultat uključim u knjigu. Nažalost, usprkos svim nastojanjima to se nije dogodilo. U nekim mi se trenutcima činilo da sam blizu rješenja, pa sam čak o tome i govorio na seminarima u Splitu (5. i 6. svibnja 2016.) i Ljubljani (14. svibnja 2016.), ali do rješenja ipak nije došlo. Tako je to često u matematici.

He was pleased to hear from people involved in Scientology (the science of science), for example academician Vladimir Paar, that his [Sibe's] articles have been read and cited (up to 2016)



SLIKA 13. Naslovnica knjige Sibe Mardešića, *Kako sam postao i ostao matematičar* (1)

FIGURE 13. Cover of Sibe Mardešić's book, *How I became and remained a mathematician* (1)

about 2,040 times (of which about 450 times book with Segal), which is a lot for mathematics; if it is to be compared with citations in physics, these figures should be multiplied by four, and for medicine the factor is at least eight. Data from Google Scholars (including the year 2022) say that the total citation of Sibe Mardešić is about 3,900 times.

Jedna karika u lancu zaključivanja popusti i sve se ruši.“

Bilo mu je drago čuti od ljudi koji se bave *scientologijom* (znanost o znanosti), npr. akademika Vladimira Paara, da su njegovi [Sibini] članci čitani i citirani (do 2016.) oko 2 040 puta (od toga oko 450 puta knjiga sa Segalom), što je za matematiku puno; ako se to želi usporediti s citiranošću u fizici, te brojke treba pomnožiti s četiri, a za medicinu je faktor barem osam. Podatci iz Google Scholar (uključivši 2022. godinu) kažu da je ukupna citiranost Sibe Mardešića oko 3 900 puta.

Nadalje, kažu scijentolozi, akademik Sibe Mardešić održao je u karijeri 333 predavanja u 117 gradova u 22 zemlje (1, 2, 79). Pod njegovim je vodstvom izrađeno 9 doktorskih disertacija, 32 magistarska rada i više od 100 diplomskih radova.

Profesor Sibe Mardešić slovio je za izvrsnoga predavača (80), **slika 14**, generacije studenata hvalile su njegova predavanja, uz dobru koncepciju i dokaze teorema do zadnjega zareza, jasnu dikciju te lijep rukopis po ploči. Isto je tražio i od predavača na seminarima, studenata. To je iskusio i autor ovoga članka, na čemu je zahvalan profesoru Mardešiću.

Koliko je Sibe Mardešić volio svoj posao ocrta i sljedeća anegdota. Topološki su se seminari tradicijski održavali ponedjeljkom od 10 do 12 sati na Elektrotehničkom fakultetu u Zagrebu (današnji Fakultet elektrotehnike i računarstva, FER), pa bi se nakon seminara nas nekoliko laganom 10-minutnom šetnjom vraćali na PMF, čavrljajući o svemu i svačemu. Jed-

Furthermore, Scientologists say, academician Sibe Mardešić held 333 lectures in 117 cities in 22 countries during his career (1, 2, 79). Under his guidance, 9 doctoral dissertations, 32 master's theses and more than 100 undergraduate thesis were prepared.



SLIKA 14. **Profesor Sibe Mardešić kao predavač (80)**

FIGURE 14. **Professor Sibe Mardešić as a lecturer (80)**

Professor Sibe Mardešić was known as an excellent lecturer (80), **Figure 14**, generations of students praised his lectures, with a good concept and proofs of theorems down to the last comma, clear diction and beautiful handwriting on the blackboard. He asked the same from lecturers at seminars and students. The author of this article also experienced this, for which he is grateful to professor Mardešić.

How much Sibe Mardešić loved his job is illustrated by the following anecdote. Topological seminars were traditionally held on Mondays from 10 a.m. to 12 noon at the Faculty of Electrical Engineering in Zagreb (today's Faculty of Electrical Engineering and Computing, FER), so after the sem-

nom je prilikom Sibe rekao, šaleći se, da bismo zapravo mi trebali plaćati državi, a ne obrnuto, što nam omogućuje da se bavimo ovim poslom kojeg tako volimo.

Kako i sam Sibe Mardešić u svojoj autobiografiji (1) navodi, imao je „dug, sretan, ispunjen i lijep život“. U znak sjećanja posvećeni su mu članci u *Rad HAZU* (2), u *Glasnik mat.* (79) i čitav broj *Rad HAZU* (81). Također, posebni (virtualni) broj časopisa *Topology and its Applications* iz 2019., uredili su M. Bestvina, S. Dranishnikov, S. Ferry i Š. Ungar, ima 17 članaka uključujući i Mardešićev članak (82).

Zaključak

Popis svih radova akademika Sibe Mardešića u (79) može se sažeti ovako: 160 strogo znanstvenih radova, 51 stručni rad te 20 knjiga i skripata. Zaista zadivljujuće! Sve to ukazuje da je Sibe Mardešić bio ne samo izuzetno sposoban i oštrouman znanstvenik i znalac, nego i vrlo marljiv i radišan znanstveni pisac. Volio je i živu riječ, pa je osim brojnih predavanja i seminara na matičnom fakultetu u Zagrebu (i u Splitu i po Hrvatskoj) održao i oko 340 predavanja i seminara diljem svijeta. Imao je golemo znanje klasične matematike, dobar uvid u suvremenu matematiku i dubinsko poznavanje gotovo svih dijelova suvremene topologije. Bio je recenzent i ocjenjivač nebrojeno mnogo znanstvenih i stručnih radova te knjiga i član povjerenstava za napredovanje mnogih znanstvenika. Učio je i znanstveno razmišljao i predavao doslovce do posljednjeg dana života. Govorio je tečno i čitao engleski,

inar a few of us would take a leisurely 10-minute walk back to PMF, chatting about anything and everything. On one occasion Sibe said, jokingly, that we should actually be paying the state, not the other way around, which allows us to do this work that we love so much.

As Sibe Mardešić states in his autobiography (1), he had a „long, happy, fulfilling and beautiful life“. As a sign of his memory, articles were dedicated to him in *Rad HAZU* (2), in *Glasnik mat.* (79) and the entire number of *Rad HAZU* (81). Also, the special (virtual) issue of the journal *Topology and its Applications* from 2019, edited by M. Bestvina, S. Dranishnikov, S. Ferry and Š. Ungar, has 17 articles, including Mardešić's article (82).

Conclusion

The list of all academician Siba Mardešić's works in (79) can be summarized as follows: 160 strictly scientific works, 51 expert works and 20 books and scripts. Really stunning! All this indicates that Sibe Mardešić was not only an extremely capable and shrewd scientist and connoisseur, but also a very diligent scientific writer. He also loved the living word, so in addition to numerous lectures and seminars at his home university in Zagreb (and in Split and throughout Croatia), he also held around 340 lectures and seminars around the world. He had a vast knowledge of classical mathematics, a good insight into modern mathematics and in-depth knowledge of almost all parts of modern topology. He was a reviewer and evaluator of countless scientific and professional works and books and a member of commission for the advancement of many scientists. He studied and thought scientifically and taught literally until the last day of his life. He spoke fluently and read English, German,

njemački, francuski, talijanski, ruski, a donekle španjolski i japanski. Kao osoba, Sibe Mardešić bio je vrlo drag, susretljiv, nenametljiv i dobroćudan.

French, Italian and Russian, and to some extent Spanish and Japanese. As a person, Sibe Mardešić was very nice, accommodating, unobtrusive and good-natured.

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Opazanje i snimanje potpune pomrčine Sunca 15. II. 1961. na otocima Hvar i Brač te na Biokovu*

Observations and recordings of total solar eclipse on February 15, 1961 on the islands of Hvar and Brač and on Mt. Biokovo*

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SAŽETAK

U radu je analiziran rijedak događaj potpune pomrčine Sunca, vidljive u južnom dijelu Hrvatske, posebice na otocima Hvaru i Braču i uključivanje zagrebačke Zvezdarnice u uspješno opazanje i snimanje pomrčine i njezinih različitih efekata.

Brojnim uspješnim predavanjima, koja su pripremili i održali srednjoškolci i studenti sa Zvezdarnice, u 46 mjesta na otocima i priobalju, popularizirali su astronomiju, a time i Zvezdarnicu. Pripremni radovi započeli su još 1960., a mladi predavači upoznati su s pravilnim pristupom održavanju znanstveno-popularnih predavanja laicima svih dobni skupina. Kako je astronomija 1948./1949. izgubila status nastavnog predmeta u srednjim školama, koji je imala dugo

SUMMARY

The paper analyses the infrequent phenomenon of total solar eclipse, observed in southern Croatia, particularly on the islands of Hvar and Brač, as well as the involvement of Zagreb astronomical observatory in successful observation and recordings of the eclipse and its various effects.

Numerous successful lectures, prepared and given by high-school and university students from the Observatory, at 46 locations on the islands and at the coast, popularised astronomy, the Observatory included. Preparations started as early as 1960, when young lecturers got acquainted with the right approach to giving popular science lectures to laymen of all ages. As astronomy lost the position of subject taught in secondary schools in 1948/1949, which it had a long time before, the HPD Observatory was the only place open to astronomy fans.

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vremena, Zvezdarnica HPD-a bila je jedino mjesto otvoreno ljubiteljima astronomije, pa je putem seminara i tečajeva djelovala kao svojevrsna zvezdarnička astronomska škola. Posebno se skrbilo o stručnom radu i obuci s instrumentima za snimanje pomrčine. O tome najbolje govore prekrasne fotografije pomrčine koje su uspjeli snimiti, s puno kreativnosti uz skromne prijenosne teleskope Zvezdarnice. Ta je akcija detaljno opisana u časopisu *Zemlja i svemir* (ZIS) koji je Zvezdarnica osnovala 1957., također s brojnom mladeži zainteresiranom za učenje i promicanje astronomije. Uspješan rad dalje je nastavljen uporabom esperanta te osnivanjem prvoga međunarodnog astronomskeg kampa – Esperantsko-astronomskeg kampa prijatelja mira te drugih važnih aktivnosti. Zvezdarnicom je u to vrijeme, od 1954. upravljao dr. Gabrijel Divjanović, koji je usmjeravao sve primjerene akcije zvezdarničke mladeži i oduševljavao ih svojim vizijama prijateljstva sa svim narodima zagovaranjem mira. U godini prije potpune pomrčine značajnu je ulogu odigrala knjiga *Drama u svemiru*, svojevrsna znanstveno-popularna drama o mogućoj propasti zemaljske civilizacije uz uporabu atomskog oružja, koju je napisalo 25 mladih zvezdoznana.

KLJUČNE RIJEČI

potpuna pomrčina Sunca u Hrvatskoj

- esperantsko-astronomskeg Kamp prijatelja mira
- knjiga *Drama u svemiru*
- odabir lokacije
- opažanje i snimanje pomrčine
- otoci Brač i Hvar i tvrđava Španjola
- predavanja zvezdarničke mladeži o pomrčini Sunca
- zagrebačka Zvezdarnica

Through seminars and courses the Observatory acted as a kind of observatory astronomical school, taking special care of professional work and instruction in using the instruments for recording eclipse. This is best illustrated by beautiful photos of the eclipse taken, with much creativity in using modest portable telescopes belonging to the Observatory. This action was described in detail in the periodical *Earth and Space* (*Zemlja i svemir* – ZIS), which the observatory started in 1957, again with a number of young people interested in learning and promoting astronomy. Successful activities were continued by using Esperanto and establishing the first international astronomical camp – Esperanto-astronomical camp for the friends of world piece, as well as by numerous other important activities. The Observatory was at that time, since 1954, managed by dr. Gabrijel Divjaković, who directed all the adequate activities of the Observatory youth and delighted them with his visions of friendship with all the nation and promotion of world peace. The year prior to total eclipse was also marked by an important book – *Drama u svemiru* (*Drama in Space*), a kind of popular science drama dealing with possible downfall of Earth civilisation by the use of nuclear weapons, written by 25 young astronomers.

KEY WORDS

Total solar eclipse in Croatia

- Esperanto-astronomical Camp for friends of world piece
- the book *Drama u svemiru*
- selecting locations
- observing and recording eclipse
- the islands of Brač and Hvar and the fort of Španjola
- lectures by Observatory youth on solar eclipse
- Zagreb Observatory

*Primjer uspješne pripreme mladeži
na zagrebačkoj Zvezdarnici za
popularizaciju pomrčine predavanjima
te za stručni rad opažanja i snimanja
Sunca za vrijeme pomrčine.*

1. Uvod

1.1. Tama usred dana

Nijedna nebeska pojava ne izaziva kod ljudi takav dojam kao pomrčina Sunca. Kada usred bijela dana Sunčeva ploča počinje tamniti, to je nešto više od obične spoznaje da se dobro nam poznati Mjesec nakratko smješta između Zemlje i Sunca. Ta je nebeska predstava još dojmljivije izgledala našim drevnim pretcima, kojima je Sunce bilo božanstvo, a crna sjena što se preko njega prevlačila predstavljala je demona, zmaja koji namjerava prožderati Sunce i ostaviti Zemlju u mraku. Pomrčine Sunca nekoć su stoga sijale užas i strah, a kroz ljudski strah „nagoviještavale“ rat, glad, potres, potop i sve moguće nesreće. Veliku nedoumicu izazivale su i mnoge pojave vezane uz pomrčinu Sunca koje nisu mogli objasniti, od čudnih vatrenih izboja vidljivih tijekom pomrčine, zatim sjajnih planeta i zvijezda na tamnom nebu, pa sve do zatvaranja cvjetova i potpune sablasne tišine bez životinjskih zvukova. Mnogo se toga danas može znanstveno objasniti, ali čudesnost prizora nije ništa manje dojmljiva. I dakako, iz zemaljske perspektive još uvijek se ne može ništa učiniti da se pomrčinu Sunca spriječi, promijeni ili tome slično. Može se samo koristiti sve što nam ona nudi, od nezamjenjive ljepote do novih znanstvenih spoznaja.

*An example of a successful preparation of the
youth at Zagreb Observatory for the purpose of
popularisation of eclipse through lectures and for
professional observation and recording of the Sun
during eclipse.*

1. Introduction

1.1. Darkness in the middle of the day

No other celestial phenomenon can impress people as solar eclipse. When Sun's disk starts to turn dark in the middle of a bright day, it is something more than the mere realisation that a well-known Moon is positioned for a short while between the Earth and the Sun. This celestial show surely looked even more impressive to our ancient ancestors, for whom the Sun was a god, while the dark shadow creeping over it represented a demon, a dragon, whose intention was to swallow the Sun and leave the Earth in darkness. It is no wonder then that Solar eclipses used to sow terror and fear, through this fear „announcing“ war, famine, earthquake, flood and any other possible disaster. Great deal of confusion was also caused by various phenomena associated with solar eclipse that could not be explained, from curious bursts of fire that could be seen during eclipse, bright planets and stars in dark sky, to closing flowers and overwhelming and eery silence, deprived of any animal sounds. All of these phenomena can be scientifically explained today. However, the wonder of the scene is no less impressive. Obviously, from the Earth perspective, we can do exactly nothing to prevent solar eclipse, change it or do anything about it. We can only use everything it offers, from its irreplaceable beauty to some new piece of scientific knowledge. Total solar eclipse could be seen in Croatia, in its southern part, more than sixty years ago, in 1961, while the following one will be seen in as much as 190 years,

Iz Hrvatske, iz njena južnog dijela, potpuna pomrčina Sunca mogla se vidjeti prije više od šezdeset godina, 1961., a sljedeća potpuna, bit će vidljiva tek nakon 190 godina, odnosno 2151. Stoga se pomrčinu iz 1961. s pravom naziva povijesnom potpunom pomrčinom Sunca u Hrvatskoj.

1.2. Zašto dolazi do pomrčine Sunca vidljive sa Zemlje

Put do spoznaje kako nastaju pomrčine i kako ih se može predvidjeti bio je dug i naporan, no pojava je toliko čudesna, prelijepa i zastrašujuća da je od pamtivijeka s razlogom pobuđivala veliko zanimanje. Odgovor na pitanje zašto dolazi do pomrčine Sunca vezan je uz Zemlju, njezin prirodni satelit Mjesec i golemo Sunce, našu zvijezdu, oko koje se gibaju Zemlja i ostali planeti Sunčeva sustava. Sunce i Mjesec nalaze se na različitim udaljenostima od Zemlje. Srednja udaljenost Mjeseca je oko 380 000 kilometara. Srednja udaljenost Zemlje od Sunca ili jedna astronomska jedinica (A.J.) je oko 150 milijuna kilometara. Pritom je Mjesec promjerom oko 400 puta manji od Sunca i na našu sreću i oko 400 puta bliže Zemlji nego Sunce, pa nam stoga Sunce i Mjesec promjerom izgledaju približno jednaki. I tu je najvažnija tajna zašto je uopće moguća potpuna pomrčina Sunca. No, to naravno nije sve. Mjesec obiđe oko Zemlje za oko 29,5 dana, a Zemlja oko Sunca za oko 365,25 dana. Gibanje Zemlje oko Sunca nije jednostavno već zbog same činjenice da Zemljina zamišljena os, koja prolazi polovima nije okomita na ravninu gibanja Zemlje oko Sunca, koju nazivamo ravninom

in 2151. This is why the 1961 eclipse is rightfully called historic total solar eclipse in Croatia.

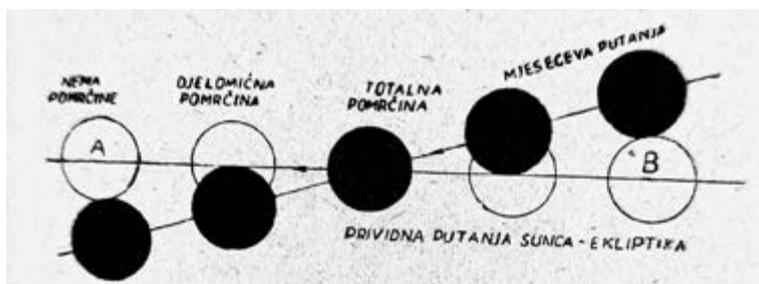
1.2. Why solar eclipses seen from the Earth occur

The road to understanding how eclipses occur and how they can be predicted was long and strenuous, but this phenomenon is so miraculous, beautiful and terrifying that has, with good reason, aroused great interest from the beginning of time. The answer to the question why solar eclipse connected to the Earth occurs is its natural satellite the Moon and huge Sun, our star, around which the Earth and other planets of the Solar system move. The Sun and the Moon are situated at different distances from the Earth. The moon is on average some 380 000 kilometres from the Earth, while the distance of the Earth from the Sun, or one astronomical unit (AU) is around 150 million kilometres. At the same time, the Moon has a diameter about 400 less than the Sun and, fortunately for us, it is about 400 times nearer to the Earth than the sun. As a result, the Sun and the Moon appear to us to be of approximately the same diameter. Here lies the secret of why total solar eclipse is possible at all. Of course, this is not all. The Moon circles the Earth in approximately 29.5 days, while the Earth circles the Sun in 365.25 days. The movement of the Earth around the Sun is not a simple one, if only for the fact that the Earth's imagined axis, which passes through the poles, is not perpendicular to the plan of the Earth's movement around the Sun, called the ecliptic plane, but is tilted, which causes the change of seasons on the Earth. This, of course, is not all as well. If the Moon would also move in the ecliptic plane, we would have, at the time of every new moon, when the Moon is between the Earth and the Sun and cannot be seen in the sky, solar eclipse. However, the plane in which the Moon

ekliptike, nego je nagnuta, pa se stoga na Zemlji izmjenjuju godišnja doba. No, ni to, naravno, nije sve. Kada bi se Mjesec također kretao točno u ravnini ekliptike, za svakoga Mlađaka, kada se Mjesec nađe između Zemlje i Sunca pa ga ne možemo vidjeti na nebu, imali bismo pomrčinu Sunca. Međutim, ravnina u kojoj se Mjesec giba oko Zemlje također je nagnuta prema ravnini ekliptike pa do pomrčine Sunca može doći samo kad se Mjesec nađe u sjecištima tih dviju ravnina, u tzv. čvorovima (slika 1), a Mjesec je u fazi Mlađaka.

travels around the Earth is also tilted to the ecliptic plane and solar eclipse can occur only when the Moon is positioned in the intersection of these two planes, in so called nodes (Figure 1), and the Moon is in the new moon phase.

If the Moon is not exactly in the node, a partial solar eclipse can be seen from the Earth, meaning the Moon passes between the Earth and the Sun in such a way as to overshadow only a part of the Sun's surface. Additionally, the path of the Earth around the Sun and of the Moon around the Earth are not circles but ellipses. When the Earth is nearest to the Sun, the distance between them is around 147 mil-



SLIKA 1. Prikaz čvorova te djelomične i potpune pomrčine Sunca

FIGURE 1. Representation of the nodes, together with partial and total solar eclipse

U slučaju da Mjesec nije točno u čvoru, može sa Zemlje biti vidljiva djelomična pomrčina Sunca, znači Mjesec tako prolazi između Zemlje i Sunca da zasjeni samo dio Sunčeve površine. Osim toga, Zemljina staza oko Sunca i Mjesečeva staza oko Zemlje nisu kružnice nego elipse. Kad je Zemlja najbliže Suncu ta je udaljenost oko 147 milijuna kilometara, a kada je najdalje, ta je udaljenost oko 152 milijuna kilometara. Mjesec u trenutku pomrčine može biti nešto bliže ili nešto dalje od Zemlje. Naime, kada je najbliže Zemlji,

lion kilometres, while the farthest it is 152 million kilometres. The moon, on the other hand, can be, at eclipse, somewhat nearer to or somewhat farther from the Earth. When nearest to the Earth, the distance is around 356 000 kilometres, when farthest, it is around 407 000 kilometres from the Earth. If it is farther, its apparent diameter is somewhat smaller than the Sun's and it does not cover the Sun completely, but a bright edge of the Sun around the dark Moon's disc can be seen from the earth in the area of total eclipse. Annular eclipse can be seen from the Earth in such a situation. Although it is interesting and marvellous, it cannot be compared with

udaljen je oko 356 000 kilometara, a kada je najdalje od Zemlje udaljen je oko 407 000 kilometara. Ako je dalje, njegov prividni promjer je malo manji od Sunčeva pa ne pokrije Sunce u cijelosti, nego se sa Zemlje, u području potpune pomrčine vidi svijetli rub Sunca oko tamne Mjesečeve ploče. Tada se sa Zemlje vidi prstenasta pomrčina Sunca i koliko god je i ona zanimljiva i lijepa, ne može se usporediti s potpunom pomrčinom Sunca, kada je Sunčeva ploča potpuno zakrivljena Mjesečevom, a vidi se samo izbrazdani rub Mjesečeve ploče, okružen veličanstvenom koronom i čudesnim zaigranim plamenovima odnosno prominencijama ili protuberancama. Usred dana tada nastane neobična plavkasto-siva pro hladna noć, praćena vjetroćem, a na nebu se mogu vidjeti najsjajnije zvijezde i planeti.

Već je grčki povjesničar i filozof Plutarh (živio je oko 50. do oko 125. godine) zapazio i opisao Sunčevu koronu, vidljivu prilikom potpune pomrčine Sunca, a to je zapravo vrlo rijetki najviši sloj Sunčeve atmosfere. Korona je jedan od uzročnika blage svjetlosti zbog koje prigodom pomrčine Sunca ne vlada potpuni mrak.¹

1.3. Područje totaliteta ili potpune pomrčine Sunca

Vrh stošca sjene kreće se po Zemljinoj površini i samo na tim područjima je potpuno tamna zona totaliteta. No, Zemlju zahvaća i polusjena, a u tom području je

total solar eclipse, when the Sun's disc is completely concealed by the Moon and only a puckered edge of the Moon's disc can be seen, surrounded by magnificent corona and magic playful flames, or prominences or protuberances. Unusual bluish-grey rather cold night occurs in the middle of the day, accompanied by a slight breeze, while the most brilliant stars and planets can be seen in the sky.

Greek historian and philosopher Plutarch (lived around 50 to around 125) observed and described solar corona, seen at the total solar eclipse, which is, in fact, a very rare highest level of solar atmosphere. Corona is one of the causes of soft light that prevents total darkness during solar eclipse.¹

1.3. The area of totality or total solar eclipse

The tip of the shadow cone travels over the surface of the Earth, resulting in totally dark totality zones only on the spots where it touches the surface. However, the Earth is also affected by a half-shade, where partial solar eclipse can be observed, with the Moon more or less covering the Sun's disc, the coverage expressed in percentages. During the last solar eclipse in the second millennium, in August 1999, a partial eclipse of the big phase could be seen in Croatia, meaning that the Moon covered minimum of 88.9% of the Sun's disc in Lastovo to maximum of 98.8% in Čakovec. Although people in Croatia could experience some unusual effects, such as weird colour of the day and coldness, and see-through protective glasses or some other appliance that only a bright arc remained of the Sun, it cannot even nearly match the impression by a total solar eclipse, which cannot be ignored, even if you try to. Precise calculations have only recently

¹ Koronograf, uređaj kojim se korona može promatrati svakodnevno, izumio je francuski astronom Bernard Ferdinand Lyot (1897. – 1952.) tek u dvadesetom stoljeću, 1930.

¹ Coronagraph, a device used for everyday observation of solar corona, invented by the French astronomer Bernard Ferdinand Lyot (1897–1952) in the twentieth century, 1930.

vidljiva djelomična pomrčina Sunca, pri kojoj Mjesec manje ili više prekriva Sunčevu ploču, što se izražava u postotcima. Tako je prilikom posljednje pomrčine Sunca u drugom tisućljeću, u kolovozu 1999., iz Hrvatske bila vidljiva djelomična pomrčina velike faze, što znači da je Mjesec prekrrio od najmanje 88,9 % Sunčeve ploče na Lastovu, do najviše 98,8 % Sunčeve ploče u Čakovcu. Pa premda su hrvatski građani mogli doživjeti neke neobične efekte kao čudnu boju dana i hladnoću i eventualno kroz zaštitne naočale ili drugo, vidjeti da je od Sunca ostao samo svijetli luk, to ne može ni približiti dojam koji na čovjeka ostavlja potpuno pomračeno Sunce, što čovjek ne može ignorirati čak ni kada bi to htio. Tek je u novije doba usavršeno točno računanje pomrčina Sunca (nakon što su točno izračunate Mjesečeva i Zemljina staza) te se pomrčine mogu precizno izračunati i predvidjeti ne samo za budućnost, nego i za prošlost. Za mnoge događaje iz prošlosti saznalo se vrijeme zbivanja zahvaljujući upravo proračunima pomrčina, a mnoge su i zabilježene u nekoj staroj kronici ili drugom spisu iz vremena kada je ta prirodna pojava bila još dojmljivija.

Potpuna pomrčina Sunca vidljiva je samo s određenog područja na Zemlji. Klizeći po Zemljinoj površini, vršak Mjesečeve sjene crta na njoj liniju potpune pomrčine Sunca, ne širu od 300 kilometara. Trajanje pomrčine je vrlo kratko, ponekad je riječ o jednoj jedinjoj minuti, a najdulje pomrčine mogu trajati oko 7,5 minuta. Zbog te kratkoće trajanja pomrčine, ekipe koje dolaze u zonu totaliteta

been made of solar eclipses (after the Moon's and the Earth's orbits have been precisely calculated), meaning eclipses can now be precisely calculated, not only in the future, but in the past as well. Numerous events in the past could be dated thanks to the calculations of eclipses, as many of them were recorded in an old chronicle or some other document at the time when this natural phenomenon impressed people even more than today.

Total solar eclipse can be seen only from a particular spot on the Earth's surface. Sliding along the surface, the tip of the Moon's shadow draws on it the line of total solar eclipse, not wider than 300 kilometres. Eclipse is of a very short duration, sometimes not more than a minute, while the longest eclipses could last around 7.5 minutes. This is why the teams coming into totality zone to observe, record and study the effects of the eclipse spend a long time preparing and training everything they plan to do during the eclipse. This is necessary not only because the eclipse is so short, but also because it is a „breath-taking“ phenomenon and simulation of the eclipse aims at preparing people who would otherwise, impressed by the unforgettable scene, when the sky is covered with bright stars in the middle of the day, get confused and would not be able to perform the planned tasks in time, and there is no opportunity to repeat it. (1; 2, pp. 127–131, 136–138; 3, pp. 81–125)

2. Observatory at Popov toranj in Zagreb

2.1. *Elitists* and misunderstood role of the Observatory as a burden to the HPD (Croatian Society of Natural Sciences)

Croatian Society of Natural Sciences (Hrvatsko naravoslovno društvo – HND) was founded at the assembly held on December 27th 1885 in the National Museum in Demetrova street 1, Zagreb Up-

da bi opažale, snimale i proučavale efekte pomrčine, dugi vremenski period vježbaju sve što će raditi u tijeku pomrčine. To je potrebno ne samo što totalitet kratko traje, već je to fenomen od kojega „staje dah“ pa se simulacijom pomrčine izbjegava mogućnost da se čovjek, zaokupljen nezaboravnim prizorom, kada se nebo usred dana kratkotrajno ospe sjajnim zvijezdama, ne uspije snaći i na vrijeme izvršiti povjerene zadatke, a prilika za ponavljanje ne postoji. (1) (2, str. 127–131, 136–138) (3, str. 81–125)

2. Zvezdarnica na Popovu tornju u Zagrebu

2.1. *Elitisti* i pogrešno shvaćena uloga Zvezdarnice kao tereta HPD-u

Na skupštini održanoj 27. prosinca 1885. u Narodnom muzeju u Demetrovoj ulici broj 1 na zagrebačkom Gornjem gradu, osnovano je Hrvatsko naravoslovno društvo (HND, od godine 1907. Hrvatsko prirodoslovno društvo – HPD). Osnivač Spiridion Brusina² rekao je tom prilikom da je to „*prvo društvo prirodnjaka u Hrvatskoj i u obće na slavenskom jugu*“. Društvo je imalo dvije sekcije: geografsku i ornitološku, ali je astronomija od samog početka bila zastupljena djelo-

per town. The Society changed its name (Hrvatsko prirodoslovno društvo – HPD) in 1907. The Society founder, Spiridion Brusina² said at the occasion that it was „*the first society of naturalists in Croatia and in Slavic south in general*“. The Society had two sections: geographical and ornithological. However, astronomy was present from the very beginnings through activities of some of the members, especially Oton Kučera.³ It was only seventeen years later, on Kučera's initiative, who was transferred to Real High School on Grič, Zagreb, in 1902, that astronomical section (*astronomska sekcija – AS*), with the main aim „*to organise an astronomical observatory for general public in Zagreb*“. Kučera's book *Naše nebo (Our Sky)*, published by Matica Hrvatska in 1895 (**Figure 2**) became a foundation on which astronomical knowledge was built and spread in Croatian provinces, as well as further into other Slavic regions.

Oton Kučera (4) was the driving force of the newly planned observatory. An interesting cultural circle was created at the beginning of the twentieth century around the idea of creating a public Croatian observatory within the aegis of the HPD, sensing the importance of such an institution. Con-

² Spiridion Brusina (1845. – 1908.), jedan od najpoznatijih hrvatskih prirodoslovaca u 19. st., bio je i utemeljitelj Hrvatskoga narodnog zoološkog muzeja i prvi sveučilišni profesor na katedri za zoologiju Mudroslovnog fakulteta Kraljevskoga sveučilišta Franje Josipa I. Bio je inicijator, suosnivač i prvi predsjednik HPD-a, 1885.

² Spiridion Brusina (1845–1908.), one of the most famous Croatian naturalists of the 19th century. He was the founder of the Croatian National Zoological Museum and the first university professor at the department of zoology of the Faculty of Philosophy, Royal University of Francis Joseph I. He was also the initiator, co-founder and the first president of Croatian Society of Natural Sciences (HPD) in 1885.

³ Dr. Oton Kučera (1857–1931), was an important Croatian naturalist, enlightener, educator, scientist, author of textbooks and popular science books, the president of Matica Hrvatska (1909–1916), co-founder and the first president of Radio club Zagreb, initiator of founding the HPD Observatory in Zagreb and its first head, and occupied numerous other important positions.

vanjem pojedinih članova, posebice Otona Kučere.³ Tek se sedamnaest godina kasnije, na Kučerinu inicijativu, koji je 1892. premješten u Zagreb na Visoku realku na Griču, 1902. tim dvjema sekcijama pridružila i „*astronomička (AS)*“, s glavnim zadatkom: „*urediti društveni opservatorij astronomički u Zagrebu*“. Kučerina knjiga *Naše nebo*, koju je Matica hrvatska tiskala 1895. (slika 2), postala je temelj na kojem se širilo astronomsko znanje u hrvatskim zemljama i dalje na slavenskim područjima.

Pokretačka je snaga osmišljene zvjezdarnice bio Oton Kučera (4). Oko te ideje stvaranja hrvatske građanske zvjezdarnice u okrilju HPD-a stvorio se početkom dvadesetog stoljeća zanimljiv kulturni krug koji je osjetio važnost takve ustanove. Unatoč tome, unutar HPD-a oformila se i snažna struja tzv. elitista, odnosno onih koji su osnivanje zvjezdarnice u siromašnom i malom hrvatskom narodu smatrali ludošću. Međutim, biskup Josip Juraj Strossmayer (1815. – 1905.) donacijom od 200 kruna pokrenuo je val imućnih darovatelja koji su potpomogli izgradnju zvjezdarnice, pa je u tisku objavljeno prikupljanje i skromnih donacija. Za Zvjezdarnicu su dio svojeg prihoda dali prirodoslovci, humanisti, političari, svećenici,

trary to this, a strong group, so called elitists, was formed within the HPD, who considered the foundation of an observatory in small and poor Croatia a folly. However, Croatian bishop Juraj Strossmayer (1815–1905) started a wave of wealthy donors with his donation of 200 krunas, which helped the construction of the observatory and the press announced collection of more modest donations. Naturalists, humanists, politicians, priests, military officers and soldiers, nobility, writers and other artists, craftsmen, people of various professions and of various wealth, as well as institutions and town administration throughout Croatia, all contributed a part of their income to build the Observatory in Zagreb.



SLIKA 2. Naslovnica Kučerine knjige *Naše nebo*

FIGURE 2. *Front page of Kučera's book Naše nebo*

³ Dr. Oton Kučera (1857. – 1931.), hrvatski je značajni prirodoslovac, prosvjetitelj, pedagog, profesor, znanstvenik, pisac udžbenika i popularnih znanstvenih knjiga, predsjednik Matice hrvatske (1909. – 1916.), suosnivač i prvi predsjednik Radio kluba Zagreb, inicijator osnivanja Zvjezdarnice HPD-a u Zagrebu i njezin prvi upravitelj i drugo.

Kučera chose Popov toranj as the site for the Observatory and the city of Zagreb gave it for a free three-year rent. The construction of the Observa-

časnici i vojnici, plemstvo, književnici i drugi umjetnici, obrtnici, ljudi različitih zanimanja i imovnog staleža kao i ustanove i gradski organi diljem Hrvatske.

Kučera je za Zvezdarnicu izabrao Popov toranj, kojega je grad Zagreb na tri godine ustupio na besplatno korištenje. Izgradnja zvezdarnice prikazana je ne samo kao utemeljenje znanstvene i kulturne ustanove, nego i kao rodoljubni čin. Za prvoga predstojnika izabran je dr. Oton Kučera, a sve do 1918. Zvezdarnica je dobivala godišnju vladinu potporu od 500 kruna, pa i više (sluke 3, 4).



SLIKA 3. Zvezdarnica na Popovu tornju 1904. godine

FIGURE 3. *Observatory at Popov toranj in 1904*

Uz stručni rad Zvezdarnica je ozbiljno krenula i s popularizacijom astronomije. Bila je otvorena tri puta tjedno navečer, a nedjeljom prije podne za opažanje Sunca, a posjećivale su je i skupine učenika.

Čini se da je Oton Kučera svojom knjigom *Naše nebo*, koja je izazvala veliko za-

tory was considered not only a foundation of a scientific and cultural institution but a patriotic act as well. The first head of the Observatory was d. Oton Kučera, and the Observatory received an annual support from the government of 500 krunas, and sometimes even more, up until 1918 (Figure 3, 4).



SLIKA 4. Oton Kučera u kupoli Zvezdarnice na Popovu tornju

FIGURE 4. *Oton Kučera in the dome of the Popov toranj Observatory*

Apart from its professional work, the Observatory invested a serious effort in popularising astronomy. It was open three evenings a week, on Sunday mornings to observe the Sun, and was also visited regularly by groups of school pupils.

It is possible that Oton Kučera, with his book *Naše nebo*, which aroused considerable interest

nimanje i popularnost te osnivanjem Zvezdarnice i Astronomijske sekcije u HPD-u 1902. kod nekih svojih moćnih kolega izazvao animozitet, zapravo prikriveni jal i ljubomoru. To je još više došlo do izražaja kad je Kučera na simpoziju u Heidelbergu uspješno inicirao ime *Croatia* asteroidu (**slika 5**) koji je 1906. otkrio njemački astronom August Kopff (1882. – 1960.) sa zvezdarnice u Heidelbergu, a njom je tada upravljao astronom Max Wolf (1863. – 1932.). Ime asteroidu bilo je zapravo odavanje počasti osnivanju Zvezdarnice HPD-a. (4)

Elitisti su i dalje Zvezdarnicu smatrali nepotrebnom velikom investicijom i promašajem, dapače teretom HPD-u. Željeli su društvenu Zvezdarnicu zatvorenog tipa, a Kučeru i njegove tzv. populiste optužili za laicizam. Ravnopravno sudjelovanje laika u HPD-u odredio je osnivač HPD-a Spiridon Brusina iz jednostavnog razloga što je u Hrvatskoj još bilo pre malo prirodoslovaca, a laici različitih struka pokazali su se velikim ljubiteljima astronomije i ostalih prirodoslovnih znanosti. Stoga je Zvezdarnica predavanjima i drugim aktivnostima dala priliku mladeži i građanima da steknu barem osnovna znanja iz astronomije, što bi trebalo biti i pitanje kulture svakoga barem donekle obrazovanog čovjeka.

Godine 1909. iskazana je Kučeri velika čast izborom za predsjednika Matice hrvatske, a asteroidu *Croatia* službeno je priznato ime. (5) Naredna godina, 1910. bila je za Kučeru izuzetno teška. *Elitisti* su ga na sve načine nastojali ukaljati, a prilika koju su čekali pružila im se kad je Ku-

and was quite popular, as well as with the foundation of the Observatory and the Astronomical section in the HPD in 1902, provoked animosity, better to say concealed envy and jealousy, on the part of some of some of his powerful colleagues. It was even more obvious when Kučera successfully proposed the name *Croatia* for an asteroid at a conference in Heidelberg (**Figure 5**). The asteroid was discovered by the German astronomer August Kopff (1882–1960) in 1906, from the observatory in Heidelberg, headed at that time by the astronomer Max Wolf (1863–1932). Giving the name to the asteroid was, in fact, an honour to the foundation of the HPD Observatory in Zagreb. (4)



SLIKA 5. Fotografiska ploča oznake G4164 na kojoj je A. Kopff otkrio asteroid 589 Croatia; položaj asteroida je obilježen strjelicom i oznakom „10“

FIGURE 5. Photographic plate designated G4164 on which A. Kopff discovered the asteroid 589 Croatia; the position of the asteroid is marked with the arrow and designation „10“

The *elitists* further insisted to consider the Observatory an unnecessary huge investment and a failure, furthermore, a burden on the HPD. They wanted a national Observatory of a closed type, while Kučera was accused of laicism. The founder of the HPD Spiridon Brusina defined equal participation of laymen in HPD, for the simple reason that the number of naturalists in Croatia was too

čera održao predavanje o spektralnoj analizi, koje je potom objavljeno u *Glasniku HPD-a*. Moćna grupa prirodoslovaca optužila ga je za tzv. plagijat. Unatoč ružnim napadima u hrvatskom tisku, pobijedio je na izborima za predsjednika HPD-a, ali zbog cijele nepodobne situacije tu čast nije prihvatio. Osim toga, dao je ostavku na mjesto predstojnika Zvezdarnice te je do 1913. bio v. d. predstojnik, a potom je sav inventar Zvezdarnice predao HPD-u. (3, str. 88–120)

Od važnih astronomskih događanja iz toga razdoblja upečatljivo je bilo opažanje Halleyeva kometa 1910. i brojni popularni članci u hrvatskom tisku posvećeni repaticama, u čemu je Kučera sudjelovao. Predstojnici Zvezdarnice birani nakon Kučere nisu imali prilike pokazati svoje vrline i sposobnosti jer je 1914. počeo Prvi svjetski rat, pa su neki bili i mobilizirani. Unatoč tome izabrani upravitelj Adam pl. Kugler⁴ je 1918. tiskao prvu vrteću kartu zvezdanog neba na hrvatskom području i slavonskom jugu, a u suradnji s Otonom Kučerom priredio je astronomski *Kalendar Bošković*. Rad na Zvezdarnici od 1914. do 1918. nadgledao je predsjednik HPD-a Fran Tučan.⁵ (6)

⁴ Adam pl. Kugler (1888. – 1918.) bio je astronomski motritelj i publicist. Od 1915. do 1918. bio je pročelnik Astronomijske sekcije HPD-a i predstojnik Zvezdarnice.

⁵ Fran Tučan bio je hrvatski mineralog i petrograf, predsjednik Hrvatskoga prirodoslovnog društva (1915. – 1921. i 1945. – 1954.) te predsjednik Matice hrvatske (1918. – 1920.). U njegovu je čast 1987. utemeljena Nagrada „Fran Tučan“ za popularizaciju znanosti.

small, and laymen of various professions proved to be great fans of astronomy and other natural sciences. This is why the Observatory offered an opportunity to the youth and other citizens, through lectures and other activities, to acquire at least basic knowledge in astronomy, which was considered to be an issue important for every at least minimally educated man in the country.

Kučera was greatly honoured in 1909 when he was elected as the president of Matica Hrvatska, and the name of the asteroid Croatia was officially recognised. (5) The following year, 1910, was very hard for Kučera. The *elitists* tried to defile him in any way possible, and the opportunity they were waiting for opened when Kučera had a lecture on spectral analysis, later published in the *HPD Glasnik*. A powerful group of naturalists accused him for plagiarism. Despite ugly attacks in Croatian press, Kučera won the election for the president of the HPD. However, due to the unacceptable situation, he declined the honour. Additionally, he resigned from the position of Observatory head and continued to be acting head until 1913, after which he handed the complete Observatory equipment to the HPD. (3, pp. 88–120)

One of the most important and memorable astronomical events of the time was the observation of Halley's comet in 1910, which resulted in a number of popular articles in Croatian press dedicated to comets, shooting stars, in which Kučera also participated. The heads of the Observatory elected after Kučera did not have the opportunity to show their virtues and abilities, as the World War I started in 1914, and some of them were even mobilised. Despite this, the elected head of the Observatory Adam pl. Kugler⁴ published the first rotating

⁴ Adam pl. Kugler (1888–1918.) was an astronomical observer and a publicist. He was the head of the HPD's

Bolja situacija sa Zvezdarnicom bila je od 1920. do 1925., kada je njome ponovo upravljao dr. Oton Kučera. Studentska mladež počela je obavljati zadatke demonstratora i aktivno volontirati na Zvezdarnici. Uz rad na popularizaciji astronomije zabilježeni su i pokušaji znanstvenog djelovanja. Nakon Kučerina odlaska 1925. počelo je stagniranje aktivnosti što je trajalo sve do završetka Drugoga svjetskog rata.

Na rad Zvezdarnice i dalje su negativno djelovali sukobi „populista“ i „elitista“ glede namjene i važnosti Zvezdarnice, pa je povremeno zabilježena i njena potpuna neaktivnost. Oni koji su imali svu vlast i mogli upravljati Zvezdarnicom, nisu imali ni sposobnosti niti želje da Zvezdarnica okuplja mladež, ali ni ljude svih dobnih skupina. Jedino se na Zvezdarnici sastajalo Hrvatsko prirodoslovno društvo.

Ostaje tek činjenica da je Zvezdarnica najbolje djelovala prvih deset godina od osnivanja, dok je njome upravljao dr. Oton Kučera te u vrijeme njegova drugoga predstojništva od 1920. do 1925.

U uvodnom govoru koji je zabilježen u Tajničkoj knjizi Astronomsko-geofizičke sekcije, prigodom ponovnog otvorenja Zvezdarnice 1945., nakon što je završio Drugi svjetski rat, tadašnji po drugi puta predsjednik HPD-a (1945. – 1954.) dr. Fran Tučan kritički se osvrnuo na cijelo opisano razdoblje, žaleći desetljeća prije rata „kada je Društvo stjecajem tadašnjih prilika i nesposobnosti uprave pošlo poves krivim putem i mjesto sve šireg populariteta, ono se svojim radom ograničava-

chart of the starry sky in Croatia and Slavic south in 1918, and in cooperation with Oton Kučera he prepared the astronomical and *Kalendar Bošković* (*Bošković Calendar*). The work at the Observatory from 1914 to 1918 was supervised by the HPD president Fran Tučan.⁵ (6)

Situation with the Observatory improved in the period from 1920 to 1925, when it was again managed by dr. Oton Kučera. Students started to perform the duties of demonstrator and volunteer actively at the Observatory. Together with the work on popularising astronomy, the first attempts of scientific work were recorded. After Kučera left in 1925, activities stagnated and stagnation lasted until the end of the World War II.

Negative impact on the work of the Observatory was continually exhibited by the conflicts of „populists“ and „elitists“, concerning with the purpose and importance of the Observatory, which resulted in its recorded complete inactivity at times. People with complete power and could manage the Observatory had neither capacity not wish to gather young people at the Observatory, or people of all ages for that matter. Only the Croatian Society for Natural Sciences used to meet at the Observatory.

The fact is that the observatory worked most efficiently during the first ten years from its foundation, when headed by dr. Oton Kučera, as well as during his second term as the head of the Observatory, from 1920 to 1925.

Astronomical section from 1915 to 1918, as well as the manager of the Observatory.

⁵ Fran Tučan was a Croatian mineralogist and petrographer, the president of the Croatian Society for Natural Sciences (HPD) (1915–1921 and 1945–1954), as well as the president of Matica hrvatska (1918–1920). The Award for the Popularisation of Science „Fran Tučan“ was established in his honour.

lo na uski krug učenjaka i par amatera“. (6) Da je postojalo veliko zanimanje za astronomiju i Zvezdarnicu među osobama različitih struka i to dobrim dijelom protivnika „elitističkog“ pristupa dotadašnje uprave, pokazuje i zanos kojim je 1945. obnovljeno HPD, ustrojena Astronomsko-geofizička sekcija, uređena Zvezdarnica i otvorena već 13. kolovoza 1945.

3. Preporod Zvezdarnice pod upravom dr. Gabrijela Divjanovića

Nakon Drugoga svjetskog rata nastaje novi uzlet Zvezdarnice kao ustanove za široku popularizaciju astronomije u svim dobnim skupinama, a vrhunac djelovanja nastupa u razdoblju upravljanja Zvezdarnicom dr. Gabrijela Divjanovića⁶ (slika 6).

Bez obzira na brojne aktivnosti u svezi s astronomijom, predmet astronomija je bez prihvatljiva obrazloženja 1948./1949. isključen iz srednjoškolske nastave, pa se godinama bezuspješno pokušavalo astro-

In his speech, recorded in the Secretary book of the Astronomical-geophysical section, on the occasion of re-opening the Observatory in 1945, after the end of the WW II, the president of the HPD



SLIKA 6. Dr. Gabrijel Divjanović
FIGURE 6. Dr. Gabrijel Divjanović

⁶ Gabrijel Divjanović rođen je 1913. u Našicama, a umro u Zagrebu 1991. Diplomirao je na Pravnom fakultetu u Zagrebu i doktorirao 1937. U Drugom svjetskom ratu se pridružio partizanima zajedno s više članova HPD-a. Iz ratnih dana brojne anegdote opisuju ga kao astronoma koji je u predahu učio o astrognoziji i osnovama astronomije. Tijekom rata napisao je knjižicu *Zemlja i svemir* koja je tiskana 1945. u Splitu te 1946. i 1947. u Zagrebu. U novoj državi unatoč ratnih zasluga završio na Golom otoku jer je bio tvrdoglavo uporan u onom što je smatrao istinom. Zahvaljujući ratnim drugovima na visokim položajima, zaposlio se u HPD-u, a 1954. su mu povjerovali upravljanje Zvezdarnicom.

in the second term (1945-1954) dr. Fran Tučan offered a critical insight of the whole period described above, expressing his regret for the decades before the war „when the Society, due to the circumstances of the time and the incompetence of the people in charge took completely wrong turn and, instead of spreading popularity, it limited through its work the activities to a narrow circle of scientist and a few amateurs“. (6) The fact that there was a great deal of interest for astronomy and the Observatory among the people of various professions, mostly opponents to the „elitistic“ approach of previous administrations, can be clearly seen in the enthusiasm ex-

nomiji vratiti njezin status u hrvatskom srednjoškolskom obrazovanju.

Godine 1954. HPD povjerava upravljanje Zvezdarnicom dr. Gabrijelu Divjanoviću, koji je neočekivano uspješno obilježio gotovo četvrt stoljeća njezina djelovanja. Zvezdarnica se kao primarnom zadatku posvetila radu na popularizaciji astronomije u narodu. Šezdesetih i sedamdesetih godina bilježi se svojevrsni preporod u djelovanju Zvezdarnice, a uz popularizatorski, počeo se jače razvijati i stručni rad, tj. rad na opažanjima i mjerenjima, koja su obavljali mladi sudionici astronomskih tečajeva za učenike srednjih škola. Djelujući uspješno izvan školskoga sustava, Zvezdarnica je koristila sve mogućnosti kako bi nadomjestila taj nedostatak i pomogla učenicima i nastavnicima po školama da steknu potrebna znanja iz astronomije.

Na Zvezdarnici je djelovalo više grupa odnosno sekcija, primjerice grupa za Sunce, za promjenljive zvijezde, za vidljivost, astronautička grupa i druge. Treba spomenuti i napore Grupe za radioastronomiju koja je izradila jednostavni radioteleskop SEA (*Sudden Enhancement of Atmosferics – Iznenadno pobuđivanje atmosfere*). Bio je to prijammnik s radnom frekvencijom od 27 kHz kod kojeg promatrač na osnovu varijacije nivoa izlaznoga signala zaključuje o promjenama u ionosferi, što znači neizravno i o promjenama na Suncu. Rad na SEA započeo je Baldo Jurišić, a nastavili su Robert Nađ, Bruno Šibl, Bojan Štajcar, Zdenko Mikšik, Krešimir Brandt i drugi. (2, str. 137) Zalaganjem G. Divjanovića, HPD-a i brojnih njegovih ratnih prijatelja koji su

hibited in restoring the HPD in 1945, organising the Astronomical-geophysical section, as well as in the activities aimed at re-organising the Observatory, which was opened again as early as August 13th 1945.

3. Revival of the Observatory under the management of dr. Gabrijela Divjanovića

New period of prosperity for the Observatory, as an institution for broad popularisation of astronomy in all age groups, started after the Second World War, while the peak of its activities occurred in the period when dr. Gabrijel Divjaković was leading the Observatory⁶ (Figure 6).

Regardless of numerous activities dealing with astronomy, the subject of astronomy was, with no acceptable explanation, removed from school curricula in 1948/1949, and years were spent in vain to try to return the status of astronomy in Croatian secondary education.

HPD entrusted dr. Gabrijel Divjaković with managing the Observatory in 1954, and his efforts, rather unexpectedly, resulted in successful functioning of the Observatory for almost quarter of a century afterwards. The Observatory defined

⁶ Gabrijel Divjanović was born in Našice in 1913 and died in Zagreb in 1991. He graduated from Law School in Zagreb and earned his doctor's degree in 1937. He joined the partisans in the World War II, together with a number of HPD members. Anecdotes from his war days describe him as an astronomer who taught himself bases of astronomy and astronomy. During the war he wrote a booklet entitled *The Earth and Space*, published in Split in 1945 and in Zagreb in 1946 and 1947. In the newly formed state, despite his war-time merits, he ended in the Goli otok concentration camp, because he was stubbornly consistent in what he saw as a truth. Thanks to his war companions as high positions, he was employed in the HPD, and in 1954 he was entrusted with the position of the head of the Observatory in Zagreb.

ga cijenili, astronomija je dobila svoje mjesto u školskim natjecanjima iz fizike, kemije i drugih predmeta, iako nije bila službeno uključena u nastavni program.

3.1. *Drama u svemiru (Tragedio en la Universo)*

Godine 1960., na 15. obljetnicu tragedije Hirošime i Nagasakija, iz zanimljive književne radionice na Zvezdarnici dovršena je i tiskana znanstveno-fantastična svemirska drama pod naslovom *Drama u svemiru* (slika 7). To je nevelika knjižica (93 stranice), koja je otvoreno progovorila o sudbini našega planeta ako ne pobijedi razum. Knjigu su napisala dvadeset petorica mladih astronoma amatera sa zagrebačke Zvezdarnice, vođena G. Divjanovićem. Premda u knjizi nigdje nije naveden kao duhovni otac i začetnik toga djela, sudionici pisanja knjige potvrdili su atmosferu u kojoj je stvarana *Drama u svemiru*, a označila je početak pohoda miroljubive i čovjekoljubive ideje s hrvatske Zvezdarnice u svijet.

its primary goal as popularisation of astronomy in the nation. During the sixties and seventies of the last century a kind of revival happens in the workings of the Observatory. Together with popularisation efforts, professional work was also encouraged, i.e., the work on observations and measurement, performed by young participants of astronomical courses for secondary school students. The Observatory worked successfully outside of the formal educational system, using all the opportunities do compensate for this disadvantage and help the students and teachers in schools to acquire necessary knowledge in astronomy.

A number of groups, or sections, were active at the Observatory, such as the group for the Sun, for variable stars, for visibility, astronautical group etc. Th efforts of the Group for radioastronomy should be mentioned, which constructed a simple radio-telescope SEA (*Sudden Enhancement of Atmospherics*). It was a receiver with the working frequency of 27 kHz, where the observer concludes, based on the output signal variation,

on the changes in ionosphere, meaning indirectly on the changes in the Sun as well. Baldo Jurišić started the work on SEA, to be continued by Robert Nađ, Bruno Šibl, Bojan Štajcar, Zdenko Mikšik,



SLIKA 7. Naslovnice knjiga *Drama u svemiru* i *Tragedio en la Universo* te *Felicigaj Ferioj* (*Sretni praznici*)

FIGURE 7. *Front pages of the books Drama u svemiru, Tragedio en la Universo and Felicigaj Ferioj (Happy Holidays)*

Knjiga je svojevrsan protest protiv sudbine Hirošime i Nagasakija i svih potencijalnih hirošima koje prijete ljudskome rodu. Godine 1956. zvezdarnička mladež i stariji suradnici te Gabrijel Divjanović pokrenuli su popularno znanstveni časopis *Zemlja i svemir (ZIS)*, gdje bi objavljivali različite članke vezane uz astronomiju i Zvezdarnicu. U njemu je uspješno reklamirana *Drama u svemiru*, a u esperantskom izdanju putovala je u brojne svjetske države i bila dobro prihvaćena. Posebice je apostrofirana poruka iz knjige „Mi hoćemo živjeti!“, upućena svima onima koji se neodgovorno „igraju“ atomskim oružjem koje može uništiti planet Zemlju. Naslov knjige i navedena poruka potaknule su Divjanovića na dokazivanje da planet Zemlja nema granica, osim onih umjetno stvorenih, koje su često kobne za ljude. Bilo je to doba hladnog rata i „željezne zavjese“, a on, kažnjnik s Golog otoka, nije smio imati putovnicu. Dapače, nije smio ni objavljivati članke niti knjige, pa je pisao pod pseudonimima. Tako je oduševljeni esperantist Gabrijel Divjanović i mladež okupljenu na Zvezdarnici inspirirao da uče esperanto, kao odskočnu dasku za druženje s ljudima iz cijeloga svijeta.

Pacifističko-humanističkim opredjeljenjem Zvezdarnice uz *Dramu u svemiru* i učenje esperanta, uspostavljene su brojne veze sa svjetskim esperantistima, što je iznjedrilo zajednički projekt *Kamp prijatelja mira u Primoštenu*, ljetno odredište hrvatske mladeži zagrebačke Zvezdarnice. U kampu se gradivo iz opće astronomije i astrognozije produbljiva-

Krešimir Brandt and others. (2, p. 137) Commitment of G. Divjanović, HPD and a number of his war friends who respected him, astronomy won its place in school competitions in physics, chemistry and other subjects, although it has never been included into secondary school curricula.

3.1. *Drama in Space (Tragedio en la Universo)*

In 1960, on the fifteenth anniversary of the tragedy in Hiroshima and Nagasaki, science-fiction space drama entitled „*Drama in Space*“ was completed and published from the intriguing literature workshop at the Observatory (Figure 7). This small booklet (93 pages) openly spoke of the destiny of our planet if reason did not prevail. Twenty-five young amateur astronomers from the Zagreb Observatory, led by G. Divjanović, authored the book. Although the book made no mention of Divjanović as a spiritual father and begetter of this work, the participants in writing the book clearly confirmed the atmosphere of creating it – the beginning of the idea of peace-loving and philanthropic campaign at the Observatory in Zagreb, and its global opening.

This book was a kind of a protest against the destiny of Hiroshima and Nagasaki, as well as against all the potential hiroshimas threatening humankind. Observatory youth and come older collaborators, together with Gabrijel Divjanović started in 1956 a popular science journal *Earth and Space (Zemlja i svemir, ZIS)*, where they published various articles connected with astronomy and the Observatory. The journal successfully promoted the book *Drama in Space*, which, in its Esperanto version, found readers in a number of countries worldwide and was quite well received. Special attention was paid to the message in the book „We want to live!“, sent to those who „played“ irresponsibly with nuclear weapons that could de-

lo i nastavilo dopisivanjem s esperantistima iz različitih zemalja. To je dovelo do uspješne pripreme za opažanje, snimanje i popularizaciju kasnije potpune pomrčine Sunca vidljive iz Hrvatske. Kad je Divjanović počeo na esperantu tiskati časopis *Zemlja i svemir*, pod naslovom *Homo kaj Kosmo* (*Čovjek i svemir*), doista su poništene zemaljske granice. Tako je *Homo kaj Kosmo* odlazio i u Kinu, otkud je godina ma stizao kineski časopis *El popola Cinio* (*Kineski narod*).

Osim toga, Divjanović je Zvezdarnicu 1967. učlanio u Hrvatski pagvaški pokret u suradnji s akademikom Ivanom Supekom (1915. – 2007.), koji mu je bio na čelu. Time je Zvezdarnica bila vezana i uz svjetski Pagvaški pokret iz 1962., kada su eminentni svjetski znanstvenici osnovali pokret protiv zlouporabe atomske energije. (7–9)

4. Primjer uspješne pripreme mladeži na Zvezdarnici HPD-a za popularizaciju i stručni rad u astronomiji u povodu potpune pomrčine Sunca vidljive iz Hrvatske 15. II. 1961.

4.1. Područje totaliteta pomrčine od 15. veljače 1961.

U broju 1/61 časopisa *Zemlja i svemir* objavljeni su zanimljivi članci povezani sa Suncem i „događajem stoljeća“, kako je nazivana potpuna pomrčina Sunca u Hrvatskoj. O tome je pisao Jerko Kirigin i prikazao uvjete za odabir najboljeg mjesta za opažanje pomrčine. Pojas potpune pomrčine Sunca 15. veljače 1961. počeo je u

stroy the Earth. The title of the book and this message prompted Divjanović to prove that there are no boundaries on the Earth, apart from those artificially created and often fatal for the people. It was the time of cold war and „iron curtain“ and he, a convict from Goli otok, could not get his passport. Moreover, he was not allowed to publish articles or books and was forced to use alias to publish. This is also why a devoted esperantist Gabrijel Divjanović inspire and prompted the youth gathered at the Observatory to learn Esperanto, as a kind of springboard for the chance to associate with the people worldwide.

Through pacifist and humanistic commitments, *Drama in Space* and learning Esperanto, the Observatory established numerous contacts with world esperantists, which resulted in a joint project *Friends of Piece Camp in Primošten* (*Kamp prijatelja mira u Primoštenu*), a summer destination for Croatian youth from the Observatory in Zagreb. The camp was dedicated to broadening the knowledge of general astronomy and astrognosy and continuing correspondence with esperantists from various countries. This enabled successful preparation for the observation, recording and popularisation of the solar eclipse seen from Croatia that was to come later. When Divjanović started publishing in Esperanto the publication *Earth and Space* (*Zemlja i svemir*), under the title *Homo kaj Kosmo* (*Man and Space*), it really meant abolishing borders on the Earth. For example, *Homo kaj Kosmo* went to China, from where a Chinese journal *El popola Cinio* (*Chinese people*) arrived to Zagreb.

Additionally, Divjanović enrolled the Observatory into the Croatian Pugwash movement in 1967, in cooperation with the academician Ivan Supek (1915–2007), who headed the Movement in Croatia. This is how the Observatory was connected with the global Pugwash movement from

Biskajskom zaljevu, oko 500 km zapadno od francuskoga grada Bordeauxa. Prelazio je francuskim područjem, zatim talijanskim gdje je središnja linija prolazila preko Genove i Ancone. U Hrvatskoj je pomrčina počela na jugozapadnom rtu otoka Brača u 8 h i 42 min, na Hvaru i Makarskoj, potom malo južnije od Mostara u Bosni i Hercegovini u 8 h i 44 min. Prešla je preko Pljevlja i Niša u Srbiji u 8 h i 48,5 min, a zatim bugarsku granicu oko 8 h 49 min i 30 s. Iz Bugarske je prešla u Sovjetski Savez, na poluotok Krim, gdje je bio najpogodniji položaj za opažanje. Linija totaliteta potom je zahvatila Sovjetski Savez do poluotoka Tajmira u sjevernom Sibiru. Pojas potpune pomrčine bio je širok oko 240 km pa su u pojasu bili gradovi Marseille, Genova, Rim, Sofija, Rostov, Staljingrad, a također i velika zvjezdarnica Pic du Midi na Pirinejima i jedna od najvećih zvjezdarnica na svijetu na poluotoku Krimu.

J. Kirigin je naveo da je za opažače sa Zvjezdarnice trebalo izabrati najpogodnija mjesta opažanja, koja se nalaze na samoj liniji totaliteta gdje totalitet traje najdulje i pritom imati na umu meteorološke prilike izabranog mjesta. Najbolje mjesto opažanja bio je Hvar s najmanjim brojem oblačnih dana u godini, zatim Brač, jugoistočni dio Šolte i okolica Makarske. Dogovoreno je stoga nekoliko opažačkih mjesta. (10) U časopisu je osim Kiriginove bilo još zanimljivih tema, pa je svaki čitatelj mogao pronaći najvažnije podatke o Suncu. (11–19) Objavljen je i članak *Pripreme talijanskih opservatorija za promatranje totalne pomrčine*.

1962, when eminent world scientists established a movement opposed to misuse of nuclear energy. (7–9)

4. Examples of successful preparation of youth at the HPB Observatory for popularisation and professional work in astronomy on the occasion of total solar eclipse seen in Croatia on February 15th 1961

4.1. Eclipse totality zone on February 15th 1961

Interesting articles on the Sun and „the event of the century“, as total solar eclipse in Croatia was called, were published in the issue 1/61 of the journal *Earth and Space (Zemlja i svemir)*. Jerko Kirigin also wrote on the topic, describing the conditions for the selection of the best spot to observe the eclipse. The zone of total solar eclipse on February 15th 1961 started in the Bay of Biscay, about 500 km west of the French city of Bordeaux. It passed through the territory of France, and then Italy, where the central line passed over Genoa and Ancona. The eclipse started in Croatia at the southwest headland of the island of Brač at 8 hours 42 minutes a.m., on Hvar and at Makarska, and then then a little bit southern of Mostar in Bosnia and Herzegovina at 8 h 44 min. It moved over Pljevlje and Niš in Serbia at 8 h 48.5 min, and then to Bulgarian border around 8 h 49 min 30 s. From Bulgaria it passed to the Soviet Union, to the peninsula of Crimea, where position was the for observing the phenomenon. The line of totality then reached the Soviet Union all through the Peninsula of Tajmir in the north of Siberia. Total eclipse zone was about 240 km wide and included the cities like Marseille, Genoa, Rome, Sofia, Rostov, Stalingrad, a big observatory Pic du midi on the Pyrenees and one of

4.2. Predavanja iz astronomije i priprema zvjezdarničke mladeži za ulogu predavača

Godina koja je slijedila nakon tiskanja *Drame u svemiru* bila je izrazito plodna u povijesti Zvjezdarnice. U očekivanju potpune pomrčine Sunca, mladi zvjezdarničari na Popovu tornju, puni entuzijazma željeli su iskoristiti rijetku prigodu za popularizaciju astronomije na jugu Hrvatske, posebice na otocima. Osim priprema za stručno opažanje i fotografiranje pomrčine, cilj je im bio putem zanimljivih i svakom čovjeku razumljivih i dostupnih predavanja ukazati mještanima da je riječ o prirodnoj pojavi koja će zahvatiti Hrvatsku tek nakon 190 godina. Te se pojave ne treba bojati nego iskoristiti rijetku privilegiju da je mogu opažati svi ljudi koji ili žive ili će doći u zonu totaliteta odnosno potpune pomrčine Sunca. Također je trebalo pojasniti slušateljima zašto i kako će zaštititi svoje oči. Ostvarenje svih tih ciljeva zahtijevalo je dugotrajnu pripremu koja je na Zvjezdarnici počela još 1960. Osim predavanja o tome kako nastaju pomrčine i što se sve može vidjeti u kratkom vremenu trajanja potpune pomrčine, mjesec dana prije pojave pomrčine obrađene su teme kao građa svemira, uvjeti za život, ima li života na drugim svemirskim tjelesima, što su nam otkrili umjetni sateliti te put u svemir. Osim toga, sudionici izabrani za popularizaciju astronomije predavanjima, morali su upoznati potrebne instrumente te veličine i jedinice mjerenja u astronomiji.

Na Zvjezdarnici su u okviru seminara obrađene sve dogovorene teme, provje-

the largest observatories in the world on the peninsula of Crimea.

J. Kirigin wrote that the observers from the Observatory were supposed to select the most favourable positions for observation, those on the very line of totality, where totality exhibits the longest duration, while at the same time considering meteorological conditions of the location. The most favourable observation location was Hvar, with the fewest cloudy days in a year, then Brač, south-east part of Šolta and the vicinity of Makarska. A number of observation posts were thus agreed upon. (10) Besides Kirigin's, there were some other interesting topics in the magazine, so every reader could find the most important data on the Sun. (11–19) The article *Preparations of Italian observatories for observing total solar eclipse* was also published in the issue.

4.2. Lectures in astronomy and Observatory youth preparations for the role of lecturers

The year that followed publishing *Drama in Space* was an extraordinary fruitful one in the history of the Observatory. Expecting total solar eclipse, young astronomers at the Popov toranj, bursting with enthusiasm, wished to use a rare opportunity to popularise astronomy at the south of Croatia, especially on the islands. Besides preparations for professional observation and photographing the eclipse, their aim was to use interesting, understandable and easily accessible lectures to show the local population that the eclipse was a natural phenomenon that will reach Croatia again only after 190 years. The phenomenon should not be afraid of, it should be used as a rare privilege, as it could be observed by all the people who lived or would come into the totality zone, the zone of total solar eclipse. The public should also be acquainted with the knowledge of why and how to protect their

ravana su ranije stečena i nova znanja kako bi predavači bili spremni ne samo za svoje predavanje nego i za svaku raspravu koja bi mogla uslijediti tijekom i nakon predavanja. Tek kad su predavači bili odlični u stručnom znanju, slijedio je novi pokus kako sve to popularnim i pristupačnim govorom prenijeti slušateljima različite dobi i naobrazbe. Svemirske udaljenosti i slično trebalo je predočiti živim i zanimljivim usporedbama, služiti se slikama, crtežima i modelima Sunčeva sustava. Pritom je valjalo pokazati i kreativnost na samom predavanju, jer nisu uvijek bili dostupni aparati za projekciju slika. Smatralo se korisnim ispričati i kakvu zanimljivu šalu ili anegdodu iz povijesti astronomije, ali se trebalo snaći i za slučaj da nestane struje. Konačno, predavanje ne bi smjelo trajati dulje od 35 do 45 min, a zatim je trebalo i potaknuti raspravu. Predavači su morali naučiti i rukovati s tehničkim pomagalima na predavanjima i znati se obratiti svakom pojedincu i prilagoditi se publici.

Nakon svega rečenoga izabrani predavači, njih 16, bili su svjesni da ne predstavljaju samo sebe nego i Zvezdarnicu. Na izabrana mjesta poslani su dopisi za držanje predavanja. Odziv je bio izvrstan te su predavači upućeni u 46 mjesta. Bojazan da zbog mladosti kao astronomi amateri ne će biti ozbiljno shvaćeni od starije publike, ubrzo se rasplinula. Ipak, najzahvalnija publika bila su školska djeca koja su postavljala brojna raznovrsna pitanja. Starija publika pokazala je veliku bojazan od mogućnosti gubitka vida. Bilo je potrebno uvjeriti ih da se to ne može dogoditi

eyes. Long-time preparations were required to realise all of this, and the preparations started at the Observatory as early as 1960. Apart from the lectures explaining how eclipses are created and what can be seen in the short duration of total eclipse, a month prior to the eclipse some other topics were presented, such as the structure of the universe, conditions for developing life, whether there is life on other bodies in space, what was discovered by artificial satellites and travel to space. Additionally, the participants selected to popularise astronomy through lectures had to get familiar with the measuring instrument, values and units in astronomy.

All the topics agreed upon were elaborated in the seminary at the Observatory, previous and new knowledge was checked again, so that the lecturers were not only ready for their assigned lecture, but also for any possible discussion that could start during and after the lecture. Only when the lecturers were excellent in their professional knowledge, could they be instructed, in a new trial, in how to transfer their knowledge to their listeners of various age and education in a popular and understandable words. Distances in space and similar notions should be presented by vivid and interesting comparisons and pictures, drawings and models of the Solar system were supposed to be used. Creativity was expected at giving the lecture itself as the devices for projecting pictures were not available everywhere. It was considered useful to tell an interesting joke or anecdote from the history of astronomy, and being ready for power failure was also one of the skills. Finally, the lecture was supposed not to last longer than 35 to 45 minutes, then discussion was to be encouraged. The lecturers were obliged to learn handling technical aids and device to be used in lectures, they should know how to address each individual and adapt their way to particular public.

ako slijede dane im upute. Unatoč tome, neki su izjavljivali da će se zatvoriti u kuću, zaključati vrata i staviti pokrivače na prozore. Teško ih je bilo uvjeriti da im se ništa loše ne može dogoditi jer se u svemirskom prostoru Mjesec nalazi na pravcu Zemlja – Sunce i njegova sjena uvjetuje pomrčini.

Tablica objavljena u navedenom članku najbolje govori o uspješnosti akcije popularizacije astronomije. Predavanja su održana u 46 mjesta, od jednog predavanja pa do rekordnih 16 predavanja u 6 dana u Visu, a na cijelom otoku Visu bilo je čak 26 predavanja. Pokazalo se da su osmišljena predavanja bila puni pogodak, uspješna i višestruko korisna, održana su od 5. do 11. veljače, u 7 dana 16 mladih predavača održalo je 111 predavanja za 30 940 slušatelja različitih dobi (slike 8, 9).

Bio je to veliki uspjeh Zvezdarnice na Popovu tornju i temelj na kojem je kasnije inicirano stvaranje astronomskih grupa u hrvatskim školama, a dio grupa je prerastao u astronomska društva u pojedinim mjestima. Svi su oni imali otvorenu mogućnost suradnje sa Zvezdarnicom bilo putem posjeta, čitanja uspješnog časopisa *Zemlja i svemir*, pisanja na adresu Zvezdarnice te uputa za osnivanje astronomskih grupa i pravih društava. Time je učinjen znatan korak u popularizaciji i razvoju astronomije u Hrvatskoj, a Zvezdarnica je tada bila jedina ustanova takve vrste.

Povremeno bi čitatelji u časopisu mogli naći obavijest o knjizi *Drama u svemiru* i kako je nabaviti. U br. 1/2 šk. god.

After all of the above, the selected lecturers, sixteen of them, well aware that they not only represented themselves but the observatory as well. Official memos were sent about planned lectures to the places to be held. The response was excellent and the lecturers were sent to 46 locations. The fear that, due to their youth and the fact they were amateur astronomers, they would not be taken serious by older listeners, proved to be unfounded. However, the most appreciative audience were school children who asked a number of questions of all kinds. The older audience exhibited considerable fear of the possibility of losing their eyesight. It was necessary to convince them it could not happen if they followed the instructions given. Despite all, some of them claimed they would close in their homes, lock the doors and put blankets on the windows. It was really difficult to convince them that nothing bad could happen as the Moon was situated directly on the direction the Earth – the Sun and its shadow caused the eclipse itself.

The table published in the article mentioned above is the best illustration of the successful astronomy popularisation action. Lectures were held in 46 places, from a single lecture to record 16 lectures in 6 days on the town of Vis, with as much as 26 lectures on the whole island of Vis. Obviously, planned lectures hit the spot, they were successful and useful in a multiple ways. They were held from February 5th to 11th. Sixteen young lecturers gave 111 lectures in 7 days, for 30 940 audience of various age groups (Figure 8, 9).

It was a great success of the Observatory at Popov toranj and the foundation upon which astronomical groups were initiated in Croatian schools, while some of these groups grew into astronomical societies in some towns. All of them had an open possibility of cooperating with the Observatory, through visits, reading the successful *Earth and*

Tema predavanja	Broj predavanja	Prisutno slušalaca		
		građana	učenika	vojnika
Pomrčina Sunca	90	18.680	5.340	1.950
Put u svemir	9	580	1.300	—
Što su nam otkrili Zemljini umjetni sateliti?	7	1.390	—	300
Ima li života na drugim svemirskim svjetovima?	3	800	—	—
Grada svemira	2	600	—	—
		22.050	6.640	2.250
SVEGA	111		30.940	

SLIKA 8. Teme predavanja i prisutno slušateljstvo
 FIGURE 8. Lecture topics and the audience present

Mjesto	Broj predavanja	Prisutno		
		građana	učenika	vojnika
1. Biograd na moru	1	200	—	—
2. Brlato na Korčuli	1	250	—	—
3. Bol (na Braču)	1	50	—	—
4. Budva	1	100	—	—
5. Crnica kod Šibenika (Tvornica ferolegura)	1	300	—	—
6. Dubrovnik	5	300	570	—
7. Dugopolje (kraj Solina)	1	200	—	—
8. Gračac	6	1800	270	—
9. Herceg Novi	1	600	—	—
10. Imotski	3	800	240	—
11. Kaštel Kambelovac	1	350	—	—
12. Klis	1	300	—	—
13. Knin	1	600	—	—
14. Kornič (otok Vis)	6	1500	1000	200
15. Korčula	2	650	—	—
16. Kotar	2	250	—	—
17. Krivodol	2	350	120	—
18. Lečevica	1	70	—	—
19. Lozovac (kod Šibenika) Tvornica aluminija	1	400	—	—
20. Malo Lošinj	1	150	—	—
21. Makarska	4	2000	—	—
22. Maringe Zemlje (otok Vis)	1	100	—	—
23. Milna (otok Brač)	1	400	—	—
24. Nikšić	3	1200	200	—
25. Petrovac na moru	1	100	—	—
26. Ploče	6	380	900	850
27. Podsolje (otok Vis)	1	50	—	—
28. Postire (otok Brač)	1	150	—	—
29. Potstranje (otok Vis)	1	100	—	—
30. Potpišlje (otok Vis)	1	400	—	—
31. Proložac	2	250	120	—
32. Pušića (otok Brač)	1	300	—	—
33. Ražine (kod Šibenika) Tvornica aluminija »Bois Kidrič«	1	500	—	—
34. Runovići	2	500	120	—
35. Selca (otok Brač)	2	400	—	—
36. Sinj	1	1000	—	—
37. Solin	1	400	—	—
38. Split	8	500	1500	—
39. Supetar (na Braču)	2	200	300	—
40. Šibenik	7	2.250	1050	—
41. Titograd	1	700	—	—
42. Třebinje	2	600	400	—
43. Vis (otok Vis)	16	1280	300	600
44. Vranjic	1	200	—	—
45. Zadar	4	700	—	600
46. Žrnovnica	1	200	—	—
Svega	111	22050	6640	2250
			30940	

SLIKA 9. Mjesta održanih predavanja i prisutno slušateljstvo
 FIGURE 9. Location where lecture was given and audience present

1967./1968. dana je obavijest o drugom, znatno dopunjenom izdanju poznate knjige *Drama u svemiru*. Upućena je poruka roditeljima i nastavnicima da nagrade dobre učenike tom knjigom te da je preporuča prijateljima i znancima i time učine nešto „za našu zajedničku stvar“.

Astronomska društva i školske grupe mogli su se obratiti Zvezdarnici kako bi dobili ogledni primjerak knjige. Saznajemo da je u SFRJ⁷ prvo izdanje prodano u nakladi većoj od 10 000 primjeraka, čime je postala jedna od najčitanijih knjiga u državi.

Akademik Žarko Dadić je o važnosti Zvezdarnice napisao: *Zvezdarnica Hrvatskoga prirodoslovnog društva je po početnoj zamisli trebala biti ustanova za popularizaciju astronomije i za znanstveno-istraživački rad. Istraživački rad na njoj nije uspio, ali je ipak njezina uloga za razvoj astronomije u Hrvatskoj bila znatna. Naime, ona je odigrala važnu ulogu popularizacije, a svojim izdanjima je širila astronomska znanja u narodu. Osim toga ona je bila jedina astronomska ustanova u Hrvatskoj prvih 20 godina 20. stoljeća, budući da nije uspjelo osnivanje katedre za astronomiju na Zagrebačkom sveučilištu. Zato se mora priznati njezina važna uloga u hrvatskom društvu i bez obzira što nije prerasla u znanstveno-istraživačku ustanovu.* (20)

⁷ Pod imenom Federativna Narodna Republika Jugoslavija trajala je od 1945. do 1963., a nadalje do 1991. bila je Socijalistička Federativna Republika Jugoslavija.

Space journal, writing to the Observatory and using instructions on how to establish astronomical groups and true societies. It was an important step in popularisation and development of astronomy in Croatia, at the time when the Observatory was the only institution of the kind in the country.

Readers could occasionally find the information on the book *Drama in Space* in the journal, as well as the instructions how to purchase it. The issue 1/2 academic year 1967/1968 offered an information of the second, significantly supplemented edition of the well-known book *Drama in Space*. A message was sent to parents and teachers to award good students with the book and to recommend it to their friends and acquaintances and in this was do something for „out common goal“.

Astronomical societies and school groups could contact the Observatory to get a sample copy of the book. Reports say that the first edition of the book was sold in Yugoslavia (SFRJ)⁷ in more than 10 000 copies, which made it one of the most widely read books in the country.

The academician Žarko Dadić wrote about the importance of the Observatory: *The Observatory of the Croatian Society of Natural Sciences was by initial intention supposed to be an institution aimed at popularising astronomy and organising scientific research in the field. Scientific research did not succeed, but its role in the development of astronomy in Croatia was still considerable. It played an important role in popularising, and their editions spread astronomic knowledge throughout the nation. Additionally, it was the only astronomic institution in Croatia during the first 20 years of the twentieth century, as the*

⁷ The country functioned under the name of Federal People's Republic of Yugoslavia from 1945 until 1963, to continue until 1991 under the name of Socialist Federal Republic of Yugoslavia.

4.3. Priprema zvjezdarničke mladeži za opažanje i snimanje potpune pomrčine Sunca 15. veljače 1961. i ekipe za opažanje i snimanje s Hvara, Brača i planine Biokovo kraj Makarske

Nakon održanih predavanja svi su predavači krenuli u Split, ugovoreno mjesto sastanka te su zajedno pošli na Hvar pripremiti sve potrebno za opažanje pomrčine.

Da bi opažanje i snimanje Sunca tijekom potpune pomrčine bilo uspješno, bilo je potrebno mlade astronome amateure upoznati s izazovima toga zadatka i na Zvjezdarnici uvježbati sve ključne momente da bi se u kratkih dvije minute totaliteta uspješno obavilo sve predviđeno. Najstručniji u tom pogledu da im prenesu svoja znanja bio je djelatnik Zvjezdarnice Zlatko Britvić, dipl. inž. geodezije (1928. – 1989.), i oni koji su imali iskustva s pravom pomrčinom, makar i djelomičnom.

Ekipa mladih opažaca morala je izvršiti svestrane pripreme i naučiti rukovati s instrumentima koji su postojali na Zvjezdarnici. U posljednjim mjesecima 1960. već su imali gotov opći plan opažanja, određen broj opažaca i raspoloživih instrumenata (slika 10). Zatim se prišlo sređivanju i uređivanju instrumentnog inventara. Namjera je bila opažati pomrčinu u više vidova. Grupe od po četiri opažaca bile su predviđene za crtanje korone odnosno vanjskoga plašta Sunca. Svaki je član trebao nacrtati jedan kvadrant korone te bi sva četvorica zabilježila njenu konačnu sliku, a potpuna pomrčina za koju su se pripremali trajala je samo dvije minute i u tom kratkom vremenu opažaci su morali nacrtati svoj kvadrant korone.

efforts to establish a department of astronomy at the University of Zagreb failed. This is why its important role in Croatian society should be recognised, regardless of the fact that it did not grow into a scientific research institution. (20)



SLIKA 10. Članovi ekipe zagrebačke Zvjezdarnice koji su promatrali totalnu pomrčinu Sunca 15. veljače 1961. u Hvaru
FIGURE 10. Members of the Zagreb Observatory team in charge of observing total solar eclipse on February 15th 1961 at Hvar

4.3. Preparation of the Observatory youth for observing and recording total solar eclipse on February 15th 1961 and preparation of the team in charge of recording from Hvar, Brač and Mt. Biokovo near Makarska

After having given their lectures, all the lecturers went to Split, meeting place previously arranged, and then went together to Hvar, to prepare everything necessary to observe the eclipse.

To ensure a successful observation and recording of the Sun during total eclipse, it was necessary to acquaint young amateur astronomers with all the challenges of this project and to practice at the Observatory all the key moments, so as to be able to do everything planned during the short two minutes

Vježbalo se s projekcijama na platno fotografija korone iz prijašnjih pomrčina. Značajnu ulogu u crtanju korone imao je suradnik Zvezdarnice Zlatko Berić, dobar poznavatelj boja i njihovih nijansi, koji je sređivao crteže i ukazivao na moguće nedostatke pri crtanju. Važan zadatak bilo je i određivanje doticaja između Mjesečeva i Sunčeva diska, a za tu kvalitetnu izvedbu trebalo je sedam dalekozora i to pet malih s povećanjem šest puta, koji su inače služili za opažanje i praćenje satelita, i dva Zeissova instrumenta s povećanjem od maksimalno 100 puta. U tu svrhu pripremljena su tamna stakla, s filterima od foto-ploče radi zaštite očiju opažачa. Zeissovi instrumenti rabljeni su na dva načina, jedan s filtrom, a drugi projekcijom slike Sunca na bijeli papir (metoda projekcije). Zeissovi instrumenti bili su predviđeni i za motrenje protuberanci ili prominencija odnosno velikih plameno-va vidljivih za vrijeme potpune pomrčine.

Opažачi su dobili štoperice kojima su određene korekcije prema kronometru odnosno preciznom satu koji je bio u inventaru Zvezdarnice. Vremenska služba određivala je i korekcije kronometra prema signalu Geofizičkog instituta u Zagrebu.

Od najatraktivnijih fotografija pomrčine očekivalo se najviše rezultata. Sredstvi- ma koja je Zvezdarnica dobila za praćenje pomrčine uređen je sav fotomaterijal i opremljeni svi fotoaparati. Tri su fotoaparata bila zadužena tijekom pomrčine bilježiti različite promjene kao što su osvjetljenje, faze pomrčine i drugo. U središtu pozornosti bila je teleskop-kamera za sni-

of totality. Zlatko Britvić (1928-1989), graduated engineer of geodesy and an employee of the Observatory, was most proficient and professional in order to transfer his knowledge, together with some other people who had any previous experience with real eclipse, partial at least if not total.

A teal of young observers was in charge of organising comprehensive preparation and learn to use the instrument at their disposal at the Observatory. They had a general plan of observation completed during the last months of 1960, number of observers defined and assortment of available instruments (**Figure 10**). The following step was listing and preparing the instruments to be used in the project. Their intention was to observe the eclipse by various means. Groups of four observers each were supposed to make drawings of the corona or outer mantle of the Sun. Each member had to draw a single quadrant of the corona, which meant the four of them would record its final picture. Total eclipse for which they prepared lasted only two short minutes and, in this time, and each observer had to draw precisely his own quadrant of the corona.

Practice was done using projecting corona photos from previous eclipses on screen. Collaborator of the Observatory, Zlatko Berić, expert on colours and their hues, played an important role in drawing the corona. He sorted out the drawings and pointed out possible imperfections in drawing. Important task was also to determine contacts between the Moon and Sun discs. To do it as perfectly as possible they needed seven binoculars, five of them small, with the magnification of six, usually used to observe and monitor satellites, and two Zeiss instruments with the magnification of maximum one hundred. Darkened pieces of glass were prepared for the purpose, with photo-plate filters to protect the observers' eyes. Zeiss instruments were used in

manje pomrčine, nabavljena neposredno prije pomrčine.

Mjesto gdje će opažači snimati pomrčinu izabrano je prema općim meteorološkim prilikama u zoni totaliteta u bivšoj Jugoslaviji. Izbor je pao na Hvar i staru tvrđavu Španjola (**slika 11**) zbog pogodnog smještaja nad okolinom i brojnih terasa koje su poslužile kao izvrstan teren za postavljanje instrumenata. Na Hvaru su



SLIKA 11. Jedno od promatračkih mjesta na tvrđavi Španjola u Hvaru

FIGURE 11. One of the observation posts at the fortress of Španjola in Hvar

poslovi raspoređeni po skupinama. Još su jednom prije pomrčine očišćeni i montirani instrumenti, obavljeno sve potrebno te izvršene korekcije satova. U ponedjeljak 13. veljače svi su instrumenti preneseni na Španjolu i postavljeni na predviđena mjesta. Opažači su obavili i pokusne vježbe s rukovanjem instrumentima. Idućeg dana posjećena su opažačka mjesta ostalih astronomskih skupina, smještenih u neposrednoj blizini Hvara. Disciplina je svugdje bila na visini, jer je bila riječ o pojavi koju se imalo sreću vidjeti jednom u životu.

two manners, one with a filter and the other with a projection of the Sun on white paper (projection method). Zeiss instruments were also intended for observing protuberances or prominences, huge bursts of fire that could be seen during total eclipse.

Observers were also given stop-watches, used to make corrections according to a chronometer, a highly precise clock possessed by the Observatory. Observatory time service also determined chronometer corrections following the signal emitted by the Institute of Geophysics in Zagreb.

The best results were expected from most attractive eclipse photos. All the photographic material and cameras were bought and equipped by the finances acquired for the purpose of monitoring the eclipse. The task of three cameras was to record various changes occurring during the eclipse, such as luminous intensity, eclipse phases etc. A telescopic camera used to record the eclipse, purchased immediately before it, was in the centre of attention.

Exact location where the observers would record the eclipse was selected following the meteorological conditions in the totality zone in former Yugoslavia. The island of Hvar was selected and its old fortress of Španjola (**Figure 11**), primarily due to its favourable location above the immediate environment and numerous terraces that were used as an excellent ground to mount various instruments. Tasks were divided by groups on Hvar. The instruments were once again cleaned and mounted prior to the eclipse, everything necessary was done and clocks corrected. All the instruments were transported to Španjola on Monday, February 13th and mounted the predetermined spots. Observers also organised a trial exercise regarding necessary work with the instruments. Observing posts of the other astronomical groups were visited the following day, situated in the vicinity of the town of Hvar. Disci-

Opažači su fotografirali faze pomrčine i njene različite efekte. Crtanje korone i protuberanci bilo je veoma važno, trebalo ih je crtati na posebnim karticama s kvadrantima označenim rimskim brojem, imenom opažača u gornjem desnom kutu. Kartice je trebalo položiti tako da je njezin donji rub paralelan s obzorom. U crtanje korone bili su uključeni Emil Babić, Jadranka Gomerčić, Jasmina Hadžibašcaušević, Sonja Jermaniš, Marko Kuprešanin, Branka Mihelčić, Nada Mihelčić, Ratko Roušal, Marijan Ručević, Nikola Sabioncello, Blanka Šranc i Jurica Vuković. S pomoću ruskih dalekozora za promatranje satelita finiju strukturu korone zabilježili su Stjepan Malović, Zdenko Marković, Neven Megušar i Miro Pećnik.

Opažanje protuberanci obavljeno je s dva Zeissova teleskopa, povećanja 100 puta. Protuberance su crtali Ernest Mihalek i Petar Römer. Nacrtano je 40 kartica na Hvaru, a na Biokovu 10. Iz svih crteža bilo je moguće rekonstruirati potpuni prikaz korone.

5. Događaj stoljeća: Potpuna pomrčina Sunca vidljiva iz Hrvatske 15. veljače 1961.

U br. 3/60 časopisa *Zemlja i svemir*, u rubrici *Naša Zvezdarnica* čitatelji su upoznati s pripremama za opažanje potpune pomrčine Sunca 15. veljače 1961., „koja će se osobito dobro vidjeti u našoj zemlji, a naročito na području našeg Jadrana“. Za broj 1/61 najavljeno je da će biti posvećen isključivo pomrčini, a „ *cjelokupan rad oko*

pline was high everywhere, as it was a phenomenon one could be lucky to see during his lifetime.

The observers took photos of eclipse phases and its various effects. Drawing corona and protuberances was of extreme importance, they were drawn on special cards with squares marked with Roman numerals and name of the observer in the upper right corner. The card was supposed to be positioned so that its lower edge was parallel with horizon. The following people were included in drawing the corona: Emil Babić, Jadranka Gomerčić, Jasmina Hadžibašcaušević, Sonja Jermaniš, Marko Kuprešanin, Branka Mihelčić, Nada Mihelčić, Ratko Roušal, Marijan Ručević, Nikola Sabioncello, Blanka Šranc and Jurica Vuković. Stjepan Malović, Zdenko Marković, Neven Megušar and Miro Pećnik used Russian-made binoculars, intended for observation of satellites, to observe fine structure of the corona.

Protuberances were observed using two Zeiss telescopes with the magnification of one hundred. Ernest Mihalek and Petar Römer were in charge of drawing protuberances. Forty cards were drawn on Hvar and ten on Mt. Biokovo. Using all of these drawings enabled reconstructing complete representation of the corona.

5. Event of the century: Total solar eclipse seen from Croatia on February 15th 1961

The issue 3/60 of the journal *Earth and Space*, in its column *Our Observatory*, tried to prepare the readers for the observation of total solar eclipse on February 15th 1961 „which will be particularly well seen in our country, and especially at the region of our Adriatic“. It was announced that the issue 1/61 will be dedicated to the eclipse only, and „*complete work on the organisation of observation by foreign and national scientific teams and tourists,*

organizacije promatranja stranih i domaćih naučnih ekipa i turista, boravak i djelatnost na terenu kao i rezultati radova, popraćeno mnogobrojnim ilustracijama, bit će prikazano u drugom posebnom izdanju br. 2. našeg časopisa“.

5.1. Originalna kamera za snimanje korone

U broju 2/61 Ranko Gradečak je u članku *Fotografiranje korone* opisao nastojanje mladih entuzijasta da se i kamerom najbolje moguće pripreme za snimanje korone. Gradečak piše da se kvalitetnu fotografiju korone može dobiti samo ako je slika korone odnosno diska Mjeseca na negativu dovoljno velika. Zbog toga astronomi za snimanje korone rabe objektivne s veoma velikom žarišnom daljinom, čak do 10 metara. Međutim, kod takve je kamere slika korone na negativu slaba sjaja. Da bi se to izbjeglo potrebno je uzeti duge ekspozicije, čak po nekoliko desetaka sekundi, a u tom je slučaju neophodno potrebno tzv. praćenje Sunca. Uređaji koji automatski slijede dnevni put Sunca moraju biti precizno izrađeni i različitih su konstrukcija. Za snimanje korone čak je prema vlastitim nacrtima izrađena kamera za snimanje korone. Geofizički institut u Zagrebu imao je mehaničku radionicu pa je njima povjerena kompletna izrada kamere. Kamera je postavljena na ekvatorijalnu montažu jednog od dalekozora, a sve zajedno je postavljeno na specijalno napravljen drveni stalak. Snimatelji korone bili su Vesna Kolarić, Maja Grgić, Stanko Vidmar i Ranko Gradečak. Snimljene

their stay and activities on the field, as well as the results achieved, accompanied by numerous illustrations, will be presented in the second and special edition of issue 2 of our journal“.

5.1. Original camera for recording the corona

Ranko Gradečak described in the issue 2/61, in the article entitled *Taking photos of the corona*, the efforts of young enthusiasts to prepare in the best possible way for recording the corona with their camera. Gradečak claimed that a high-quality photo of a corona could be obtained only if its picture, or picture of the disc of the Moon, was large enough. This is why astronomers when recording a corona use camera lenses with highly increased focal length, up to 10 metres. However, the picture of a corona is of considerably lower brightness when such a camera is used. To avoid this disadvantage, it is necessary to use long exposures, as long as a few dozens of seconds sometimes, which means observers have to the procedure of so called following the Sun. Devices that automatically follow daily path of the Sun should be extremely precise and can be of various constructions. A camera for recording corona was constructed by original blueprints for this occasion. Institute for Geophysics in Zagreb had a mechanical workshop and they were entrusted to construct complete camera for the purpose. The camera was assembled on the equatorial mounting of one of the binoculars, while the whole structure was mounted on a specially constructed wooden stand. Corona was recorded by Vesna Kolarić, Maja Grgić, Stanko Vidmar and Ranko Gradečak. The photos taken exceeded all expectations (**Figure 12**).

Gradečak described how the HPD Observatory team had a very much efficient camera made for the purpose of recording corona. The lens had 12.5 cm diameter, focal length was 65 cm and shorter expo-

fotografije premašile su očekivanja (slika 12).

Gradečak opisuje kako je ekipa Zvezdarnice HPD-a prema vlastitim nacrtima dala izraditi vrlo uspješnu kameru za snimanje korone. Objektiv je bio promjera 12,5 cm, žarišna daljina 65 cm te je bilo moguće koristiti kraće ekspozicije. Objektiv je bio montiran u prstenu s tri para vijaka kako bi se lako pratio smjer optičke osi objektiva. Pred objektiv je stavljen iris zastor odnosno blenda te je bilo moguće re-

gulirati količinu svjetlosti koja dolazi na objektiv. Prije snimanja korone izravno, s pomoću slike Sunca na mutnom staklu, orijentirala se dio kamere u smjer istok – zapad koji služi kao vodilica za umetanje kazeta s fotoografskim pločama. Cijev kamere je izrađena od lakoga

i čvrstog metala svinutog u široku cijev, u koju ulazi jedna manja cijev, kojom se cijeli stražnji dio kamere može vijcima uvlačiti i izvlačiti. Time je omogućeno točno fokusiranje. Zapor jedne stare velike kamere s veoma širokim objektivom poslužio je kao zapor kamere, a bio je smješten neposredno uz fotografsku ploču. Na vanjskoj strani bio je montiran mali pomoćni dalekozor kojim se namještala čitava kamera u smjeru Sunca. U vidnom polju pomoć-

situations could be used. The lens was mounted on a ring with three pairs of screws so as to make it easier to follow the lens optical axis direction. An iris curtain, or shutter, was mounted in front of the lens making it possible to regulate the amount of light to come onto the lens. A part of the camera used as a guide for inserting cartridges with photographic plates was oriented in the direction east-west prior to direct recording of corona, using the image of the sun on frosted glass. Camera barrel was made of a light and strong metal, bent into a broad tube, into which a smaller tube is inserted. This is used to



SLIKA 12. Korona snimljena specijalnom kamerom

FIGURE 12. Corona recorded using a special camera

retract and draw out the whole back assembly of the camera, employing special screws. This action allows for precise focusing. A shutter of another old big camera with a very wide lens was used as the diaphragm for the new one and was positioned immediately with the photographic plate. A small auxiliary binocular was mounted on the outer

side and used to set the whole of the came in the direction of the Sun. A cross of thin threads was situated in the field of view of the auxiliary binoculars. The picture of the Sun was supposed to be brought at the crossing of the threads, meaning exactly in the centre of the field of view. One of the binoculars of equatorial mounting owned by the Observatory was carrying the camera described above, and the whole assembly was mounted on a specially constructed wooden stand. Camera movement was controlled with screws for fine adjustment, po-

nog dalekozora nalazio se križ od tankih niti. Slika Sunca trebala se dovesti na presjek niti, kad je točno u središtu vidnog polja. Jedan od dalekozora ekvatorijalne montaže u posjedu Zvezdarnice, nosio je opisanu kameru, a sve zajedno stavljeno je na specijalno napravljen drveni stalak. Kretanje kamere obavljalo se vijcima za fino pomicanje koji se nalaze na ekvatorijalno montiranim osima te je kamera mogla biti točno usmjerena u bilo kojem smjeru neba.

Gradečak je potanko opisao rad na pripremanju i snimanju korone. Nakon što su stativ i osovine ekvatorijalne montaže smještene u točno određeni položaj, montirana je kamera sa svim dijelovima. S pomoću blende pred objektivom smanjen je sjaj slike Sunca, a da bi sjaj bio još više smanjen pred objektiv je postavljena jedna srednje zacrnjena fotografska ploča. Smjer sjevera na ploči dobiven je izravnim slikom Sunca hvatanom na mutno staklo kamere. Na njemu je ucrtan križ. Čitavo ležište mutnog stakla moglo se okretati oko osi okomite na mutnu ploču. Sunce je praćeno okretanjem ležišta mutne ploče u smjeru istok-zapad. Izabrano je da slika Sunca pri nepokretnoj kameri stalno prolazi uz jednu crtu križa, što je fiksiralo ležište mutnog stakla. Tim je načinom osigurana i orijentacija svih fotografskih ploča. Moralo se paziti pri umećanju foto-ploča u kazete da njihova ivica dobro priljege uz rub kazete.

Za uspješno snimanje korone zaslužno je četvero ljudi: Vesna Kolarić, Maja Grgić, Stanko Vidmar i Ranko Gradečak. Stanko Vidmar je vijcima za fino pomica-

sitioned on the equatorially mounted axes, which made possible for the camera to be precisely directed in any required direction in the sky.

Gradečak described in detail the work on preparations and recording the corona. After the stand and the axes of equatorial mounting were fixed in a precisely defined position, the camera and all of its parts were mounted. Brightness of the picture of the Sun was reduced using a diaphragm in front of the camera lens, and to reduce it even further, a medium darkened photographic plate was positioned in front of the lens. Northern direction on the plate was obtained through a direct picture of the Sun caught onto the dimmed camera glass. It has a cross drawn on it. The whole frosted glass bearing could be rotated around the axis perpendicular to the dimmed plate. The sun was followed by rotating the dimmed plate bearing in the direction east-west. Construction required that the picture of the Sun with stationary camera passes constantly by one line of the cross, which fixed the bearing of frosted glass. Orientation of all the photographic plates was also ensured in this way. Operators had to take care that the edge of the plate had to fit tightly with the edge of the cartridge when inserting the photographic plates into cartridges.

Four people should be given credit for successful recording of the corona: Vesna Kolarić, Maja Grgić, Stanko Vidmar and Ranko Gradečak. Stanko Vidmar used the screws for fine adjustment to keep continuously the picture of the Sun at the crossing of the threads, with the help of a binoculars. Vesna Kolarić adjusted exposition times, wound the shutter and exposed. Maja Grgić and Ranko Gradečak inserted cartridges into the camera, opened and closed their covers and extracted cartridges with exposed plates. It could be seen how important were the exercises and practice done at the Observatory, aimed at coordination of the movements and high-

nje neprekidno držao sliku Sunca u presjeku nitnog križa u pomoćnom dalekozoru. Vesna Kolarić je namještala vremena ekspozicije, napinjala zapor i eksponirala. Maja Grgić i Ranko Gradečak stavljali su kazete u kameru, otvarali i zatvarali njihove poklopce i vadili kazete s eksponiranim pločama. Pokazalo se koliko su važne bile na Zvezdarnici odrađene vježbe usklađivanja pokreta i što veće brzine snimanja. Snimanje je izvršeno na osam fotografskih ploča. Dvije ploče bile su s ekspozicijom jedne sekunde, dvije ploče s pola sekunde te po jedna ploča s ekspozicijom 1/5, 1/10, 1/25 i 1/50 sekunde. Ploče su bile odlične kvalitete, a razvijач je bio Atomal F. Ekipa je bila potpuno zadovoljna rezultatom snimanja jer su fotografije nadmašile njihova očekivanja. Skromna vlastita konstrukcija izvrsno je obavila svoj zadatak s dobro uhodanim četvero snimatelja.

5.2. Precizni opisi u časopisu *Zemlja i svemir*

Kao što je i najavljeno, brojevi 1/61 i 2/61 časopisa *Zemlja i svemir* u cijelosti su posvećeni pomrčini 15. II. 1961. Ukazana prilika izvrsno je iskorištena za popularizaciju astronomije i promociju AS HPD-a i Zvezdarnice HPD-a i izvan Hrvatske i SFRJ. Pomrčina je ocijenjena kao događaj stoljeća, s napomenom da se iz „naše zemlje“ može vidjeti samo tri puta u tisuću godina. U prvom broju dani su teorijski članci o kojima je pisano ranije. U br. 2 prikazana je totalna pomrčina Sunca 15. II. 1961. u iznimno zanimljivim člancima: B. Damjanić: *Astronomске večeri u zoni totaliteta*, E. Mihalek: *Organizacija*

est possible recording speed. Recording was done on eight photographic plates. Two of them were exposed for one second, two for half a second and one had the exposition of 1/5, 1/10, 1/25 and 1/50 seconds. The plates were of top quality, and the developer used was Atomal F. The team was completely satisfied with the results of recording as the photos surpassed all of their expectations. Their modest self-made construction performed the task in an excellent way, with the help of four trained and coordinated cameramen.

5.2. Precise descriptions in the *Earth and Space journal*

As had been announced, the issue 1/61 and 2/61 of the *Earth and Space journal* were completely dedicated to the eclipse of February 15th 1961. The opportunity was perfectly used to popularise astronomy and to promote the AS HPD and the HPD Observatory outside Croatia and Yugoslavia. The eclipse was rated as the event of the century, with a special note that „from our country“ it could be seen only three times in thousand years. The first issue contained theoretical article mentioned before. The issue 2 presented total solar eclipse of February 15th 1961 in the following very interesting articles: B. Damjanić: *Astronomical evening in the totality zone*, E. Mihalek: *Organisation of eclipse observation*, Z. Klobučar: *Taking photos of eclipse phases*, R. Gradečak: *Taking corona photos*, P. Römer: *Drawing corona and protuberances*, Z. Klobučar: *Corona*, T. Breider: *Measuring contacts and Flying shadows*, dr. B. Makjanić: *Geophysical measurement during eclipse*.

Branka Damjanić, the author of the text on astronomical evenings in totality zone, reported that the Observatory sent three specially trained and equipped teams into totality zone: one team of 16 lecturers that visited all the important towns in to-

promatranja pomrčine, Z. Klobučar: Fotografiranje faza pomrčine, R. Gradečak: Fotografiranje korone, P. Römer: *Crtanje korone i protuberanaca*, Z. Klobučar: *Korona*, T. Breider: *Mjerenje kontakata i Leteće sjene*, dr. B. Makjanić: *Geofizička mjerenja za vrijeme pomrčine*.

Od Branke Damjanić, autorice teksta o astronomskim večerima u zoni totaliteta, saznajemo da je Zvezdarnica u zonu totaliteta uputila tri specijalno izučene i opremljene ekipe: jednu ekipu predavača (16 članova), koja je obišla sva važnija mjesta u zoni totaliteta, od Malog Lošinja do Titograda u Crnoj Gori (ukupno 46 mjesta); drugu ekipu od 40 promatrača na otok Hvar, na tvrđavu Španjola; i treću od šest promatrača na planinu Biokovo kraj Makarske, na koti od 1 700 m nadmorske visine. Predavači, većinom studenti i srednjoškolci koji su za predavanja i rasprave pripremljeni na seminarima na Zvezdarnici prije pomrčine, od 111 održanih predavanja, 90 se odnosilo na pomrčinu, a ostale teme bile su: *Put u svemir*, *Što su otkrili Zemljini umjetni sateliti*, *Ima li života na drugim svemirskim svjetovima* i *Grada svemira*. Predavanja o pomrčini Sunca slušalo je 18 680 građana, od toga 5 340 učenika i 1 950 vojnika (slika 8).

Slično kao s predavačima bilo je i s odabranim opažačima, koji su prošli stručne pripreme. Već krajem 1960. napravljen je opći plan opažanja s brojem opažača i brojem iskoristivih instrumenata. U pripreme radove ubraja se i odabiranje mjesta opažanja. Kao najpogodnije mjesto izabran je otok Hvar i stara tvrđava Španjola.

tality zone, from Mali Lošinj to Titograd in Monte Negro (46 towns totally); the other team of 40 observers sent to the island of Hvar, Španjol fortress; and finally the third team of six observers to the Mt. Biokovo near Makarska, at the elevation of 1700 m above the sea level. The lecturers were mostly university or high-school students prepared prior to the eclipse for the lectures and discussions at seminars organised by the Observatory. Exactly 111 lectures were given, 90 concerned with the eclipse, while the other topics were: *Travel to space*, *What have Earth's artificial satellites discovered*, *Is there life on other celestial bodies* and *The structure of the Universe*. The lectures on eclipse were attended by 18 680 people, 5340 pupils and 1950 soldiers (Figure 8).

Just like the lecturers, selected observers also passed professional training. As early as the end of 1960, a general plan of observation was made, including the number of observers and the number of instruments to be used. Preparations also included selecting the location for observation. The island of Hvar was selected as the most favourable one, with its fortress of Španjola. All the instruments were transported to the fortress and mounted to be tested at their predetermined points. The observers performed the last training and tests in working with the instruments.

The entire team was highly successful and the Croatian Society of Natural Sciences published an interesting booklet entitled *ABC Solar Eclipse on February 15th 1961*. The author was Milan Butorac. The expedition to Hvar was evaluated as successful (Figure 13, 14), while the Observatory published a nicely furnished booklet *Total Solar Eclipse on February 15th 1961 (Totala suneklipso 15. 02. 1961)* written in Croatian, Esperanto, English and German (Figure 15). Prof. dr. Leo Randić was the editor. The booklet was also used to send

U ponedjeljak 13. veljače 1961. svi su instrumenti preneseni na tvrđavu i postavljeni za probu na svoja predviđena mjesta. Opažači su obavljali zadnje vježbe u rukovanju instrumentima.

Uspjeh cjelokupne ekipe bio je izvrstan te je Hrvatsko prirodoslovno društvo objavilo zanimljivu knjižicu *ABC Pomrčina Sunca 15. veljače 1961.* Autor je bio Milan Butorac. Ekspedicija na Hvar ocijenjena je uspješnom (slike 13, 14), a Zvezdarnica je tiskala lijepo opremljenu knjižicu *Potpuna pomrčina Sunca 15. II. 1961. (Totala suneklipso 15. II. 1961.)* napisanu na hrvatskom, esperantu te engleskom i njemačkom jeziku (slika 15). Urednik je bio prof. dr. Leo Randić. Knjižica je iskorištena i za slanje u svijet informacija o prijevodu na esperanto *Drame u svemiru (Tragedio en la Universo)*, ljepota Hrvatske i Međunarodnoga kampa prijatelja mira u Primoštenu te astronomske esperantske radiostanice. Naime, nešto više od mjesec dana nakon pomrčine Sunca, nastupanje proljeća 1961. godine obilježeno je u noći s 20. na 21. ožujka uključivanjem s Popova tornja astronomske esperantske radiostanice, članice Radio-kluba Zagreb, jedine takve vrste na svijetu.

Publikacija *Totala suneklipso 15. II. 1961.* slana je esperantskim organizacijama diljem svijeta. Navedeno je da svim radovima oko organizacije promatranja te svemirske pojave rukovodi Koordinacioni odbor astronomskih društava i opservatorija FNRJ, u koji su učlanjene sve astronomske organizacije u državi.

Dr. Zlatan Sremec, predsjednik Republičkoga vijeća Sabora Narodne Re-

information globally on the Esperanto translation of *Drama in Space (Tragedio en la Universo)*, of the natural beauties of Croatia and of the International camp for the friends of world piece in Primošten as



SLIKA 13. Pojava dijamantnog prstena prigodom potpune pomrčine Sunca na Hvaru

FIGURE 13. Diamond ring appearing during the total solar eclipse on Hvar



SLIKA 14. Kromosfera i protuberance na zapadnom rubu Sunca

FIGURE 14. Chromosphere and protuberance at the western edge of the Sun

well as of the astronomical Esperanto radio station. Namely, the astronomical Esperanto radio station, a member of the Zagreb radio club and the only one at that time in the world, started broadcasting

publike Hrvatske, također i predsjednik HPD-a, u sklopu ekipe sa Zvezdarnice također je promatrao otpunu pomrčinu Sunca na Hvaru.

Posebna ekipa, koja je pomrčinu opažala s Biokova, također je dala svoj opsežan opis opažanja pomrčine s vrha Vošac na Biokovu (**slika 16**), u snježnim uvjetima mjeseca veljače. I oni su uspješno obavili postavljene zadatke, kao i stručna ekipa koja je pomrčinu opažala iz Vrboske, s terase tvrđave.

U toj su ekipi bili stručnjaci Astronomskog zavoda Tehničkog fakulteta iz Zagreba: prof. dr. Leo Randić, prof. ing. Predrag Terzić, tehničar Slavko Marof, Zlatko Britvić, dipl. ing. i skupina mladih astronoma amatera. Grčka ekipa je također mjerila kontakte te je zanimljiva bila usporedba najboljih rezultata izmjenog vremena kontakata obju ekipa. Za vrijeme I. kontakta grčka je ekipa dobila rezultat 7 h 33 min i 55,5 s, a hrvatska 7 h 33 min i 49 s. Za IV. kontakt grčka je ekipa dobila vrijeme 9 h 54 min 39,6 s, a hrvatska ekipa izmjerila je vrijeme IV. kontakta u 9 h 54 min 39,9 s.

S terase tvrđave iz Vrboske mjerena je i temperatura tijekom pomrčine.

in the night between March 20th and 21st 1961, a month after the solar eclipse.

The publication *Totala suneklipso 15. 02 1961* was sent to Esperanto organisations worldwide. It stressed that all the activities on the organisation of observing the phenomenon were directed by the Coordination Committee of the astronomical societies and observatories in Yugoslavia, a body the

members of which were all the astronomical organisations in the country.

Dr. Zlatan Sremec, the president of the Sabor's (Parliament's) Republic Council of the People's Republic of Croatia, also the president of the HPD, was also a member of the Observatory team observing the total solar eclipse on Hvar.

Special team that observed the eclipse from Mt. Biokovo contributed considerably to the description of the observations from the peak of Vošac on Mt. Biokovo (**Figure 16**), under heavy snow conditions in February. They also successfully

performed all of their planned tasks, as did the expert team that observed the eclipse from the fortress terrace at Vrboska.

The team included the experts from the Astronomical Department, Technical Faculty in Zagreb: Prof. dr. Leo Randić, Prof. ing. Predrag Terzić, technician Slavko Marof, Zlatko Britvić, graduated ing. Together with a group of young amateur astronomers. A team from Greece was also involved in measuring contacts and it was interesting to compare the best



SLIKA 15. Naslovnica knjižice *Totala Suneklipso 15. II 1961.*

FIGURE 15. *Front page of the booklet Totala Suneklipso 15 02 1961*



SLIKA 16. Posebna ekipa zagrebačke Zvezdarnice koja je opažala i snimala pomrčinu Sunca na planini Biokovo kraj Makarske

FIGURE 16. *Special team from Zagreb Observatory that monitored and recorded solar eclipse at Mt. Biokovo, near Makarska*

5.3. Događanja s Vidove gore na otoku Braču

Na Vidovoj gori na otoku Braču bilo je organizirano opažanje različitih ekipa iz Hrvatske i inozemstva. Sudjelovala je i Astronomska grupa Narodne osmogodišnje škole iz Selske ceste II uz profesora Branka Margetića (?), a utisci učenika objavljeni su u časopisu. Jedna od zanimljivih epizoda vezanih uz pomrčinu Sunca je i ona s astronomom don Nikom Miličevićem, s otoka. U *Prirodoslovlju* je objavljen članak (21) o njemu te su

results of the contact time measured for both teams. For the time of the first contact, the Greek team reached the result of 7 h 33 min and 55,5 s, while the Croatian team recorded 7 h 33 min and 49 s. For the fourth contact, the Greek team recorded the time of 9 h 54 min 39,6 s, while the Croatian team measured the time of 9 h 54 min 39,9 s for the same contact.

Temperature during the eclipse was also measured from the terrace of Vrboska fortress.

5.3. Events at Vidova gora on the island of Brač

Observation for various teams, both from Croatia and abroad, was also organised at Vidova go-

prikazani život i djelo don Nike Miličevića, ml. (1877. –1963.), svjetski poznatog astronoma iz Pustinje Blaca na otoku Braču. Nikola Miličević rođen je 1887. u Zvečanju, u Poljicama. Kao dječak došao je u Pustinju Blaca gdje je upravitelj bio njegov stric Nikola Miličević, st. (1869. –1923.). Pod njegovim je patronatom odgajan za svećenika i njegova nasljednika. Zareden je 1910. i postao župskim pomoćnikom na Braču. Tijekom školovanja oduševio se astronomijom te je stric ishodio dozvolu od hvarskog biskupa za njegov studij astronomije u Beču. Nakon završenog studija i preuzimanja 1923. uprave nad Pustinjom Blaca, godine 1926. uspio je kupiti veliki Brennerov teleskop iz bivše privatne zvjezdarnice Manora na Malom Lošinju te osnovao Zvjezdarnicu Blaca. Bavio se znanstvenim radom iz nebeske mehanike, praktične primjene na izračun pojedinih putanja nebeskih tijela te teorije i prakse raznih astronomskih instrumenata i drugo. (21)

Godine 1961. nalazimo starog i boleznog don Niku kojeg su svi htjeli upoznati, a on unatoč bolesti nije želio propustiti potpunu pomrčinu Sunca koja je za hrvatske i druge astronome i ljubitelje astronomije bila najvažniji astronomski događaj, a vidljiva iz južnog dijela Hrvatske. Linija totaliteta prelazila je otocima Hvar, Brač i Vis. U svom dnevniku don Niko opisuje svoj doživljaj potpune pomrčina Sunca. Imao je tada 74 godine i bio u dosta lošem zdravstvenom stanju, stacioniran u bolnici. Uoči pomrčine 11. 2. 1961. posjetili su ga Željko Polanšćak sa zagrebačke Radio-televizije i Virgil Kurbel, urednik Večer-

ra on the island of Brač. One of the participants was the Astronomical group from the elementary school (Narodna osmogodišnja škola) II in Zagreb, with their teacher Branko Margetić (?), and the pupils' impressions were published in a journal. An interesting episode connected with solar eclipse and an astronomer from the island, don Niko Miličević was recorded. An article (21) was published about him in the magazine *Natural History (Prirodoslovlje)*, presenting his life and work. Niko Miličević jr. (1877-1963), globally known astronomer from Pustinja Blaca on the island of Brač was born in Zvečanj, Poljice. As a boy he came to Pustinja Blaca, to live with his uncle Nikola Miličević, sr. (1869-1923), who was the administrator there. Under his protection, he was educated to become a priest and his uncle's heir there. He was ordained in 1910 and became parish assistant on Brač. During his education he was fascinated by astronomy and his uncle got the permission from the Brač bishop for him to study astronomy in Wien. After graduating and taking over the administration of Pustinja Blaca in 1923, he managed to purchase a big Brenner telescope from the former private observatory Manora at Mali Lošinj in 1926, and establish the Blaca Observatory. He was involved in the scientific work in the field of celestial mechanics, practical application of the theory on the calculation of the orbits of individual celestial bodies, as well as in theory and practice of various astronomical instruments and in other relate topics. (21)

In 1961, don Niko was old and ill, but everybody wanted to meet him. Despite his illness he did not want to miss the total solar eclipse, which was the most important astronomical event for Croatian and other astronomers and fans of astronomy, and which could be seen from the southern part of Croatia. The totality line passed over the islands of Hvar, Brač and Vis. Don Niko described in his di-

njeg lista te su s njim obavili zanimljiv razgovor zabilježen na magnetofonu. (21)

Nakon smrti Otona Kučere (1931.), kojeg je don Niko veoma cijenio, kasnije je bio u doticaju s njegovim sinom Vlahom Kučerom⁸ te je postao i članom Astronomskog društva Oton Kučera⁹ (2, str. 210–213) Članovi toga društva bili su u dogovoru s grupom ljubitelja astronomije iz Austrije te su zajedno stigli 13. 2. 1961. u Supetar. Don Niko ih je dočekaao, navodi da je u ekipi stiglo 78 ljudi i da su se svi smjestili u hotel Jadran, a za mjesto opažanja bila je odabrana Vidova gora. Srijeda, 15. veljače 1961. bila je Pepelnica. Pomrčina je počinjala u 7.34 i trajala do 9.50 te je trebalo na vrijeme stići na Vidovu goru. Don Niko je ustao u pet i trideset te su on, domaćica Katica, i još neki Bračani stigli na Vidovu goru bolničkim automobilom u 7 h 15 min. Zabilježio je da je temperatura bila 8°. U dnevniku je don Niko zapisao: „*Gore je hladno i ima još ostataka starog snijega, a i mraza. Već je gore dosta svijeta i velika navala na specijalne marke. U 7.34 prvi kontakt i već polako napred, u 8.41 drugi kontakt, počeo*

ary his impressions of total solar eclipse. He was 74 at the time and his health was deteriorating, spending most of his time in a hospital. On the eve of the eclipse, on February 11th 1961, he was visited by Željko Polanšćak from Zagreb Radio-Television and Virgil Kurbel, the editor of *Večernji list*, and they had an interesting conversation with him, recorded on a tape-recorder. (21)

After Oton Kučera died (1931), and don Niko appreciated him very much, don Niko was in contact with his son, Vlaho Kučera⁸ and became a member of the Astronomical Society Oton Kučera⁹ (2, pp. 210–213) The members of this society had an arrangement with a group of astronomy fans from Austria, and came to Supetar on Brač on February 13th 1961. Don Niko welcomed them, said in his diary that the team consisted of 78 people and they were all accommodated in the hotel Jadran, selecting Vidova gora as the observation site. Wednesday, February 15th 1961 was Ash Wednesday. The eclipse began at 7.34 and lasted until 9.50 and it was necessary to come to Vidova gora on time. Don Niko got up at 5.30 and he, together with his housekeeper Katica and some other people from Brač, arrived at Vidova gora by an ambulance at 7 h 15 min. He noted that the temperature was 8°. In his diary don Niko wrote: „*It*

⁸ Vlaho Kučera (1898. – 1983.) bio je astronom amater i bavio se izumima. Suradnik Zvezdarnice HPD-a, a 1954. suosnivač Astronomskog društva Hrvatske „Oton Kučera“. Objavio je knjigu *Praktični astronom* (1959.).

⁹ Astronomsko društvo „Oton Kučera“, osnovano 1954., bilo je samostalno astronomsko društvo koje je imalo svoju izdavačku djelatnost, predavanja i druge aktivnosti. Među članovima Društva bili su Stjepan Mohorovičić, don Niko Miličević, Juraj Golubić, Slavko Rozgaj, Zlatko Britvić, Dragan Bach, Mladen Hegedušić i drugi.

⁸ Vlaho Kučera (1898– 1983) was an amateur astronomer and inventor. He was a collaborator of the HPB Observatory and co-founder of the Astronomical Societa of Croatia „Oton Kučera“ in 1954. He published the book *Practical astronomer* (1959.).

⁹ Astronomical Society „Oton Kučera“, founded in 1954, was an independent astronomical society with its own publishing activities, organised lectures and other activities. Members of the Society were, among others, Stjepan Mohorovičić, don Niko Miličević, Juraj Golubić, Slavko Rozgaj, Zlatko Britvić, Dragan Bach, Mladen Hegedušić and others.

tak totaliteta. Veoma lijepo se vidi fotosfera pak jasna moćna kromosfera i lijepo razvijena korona sa nekoliko lijepih pramenova i dvije jake crvene protuberance lijevo i desno. Nastup crne mjesечеve sjene na moru, i poslije odstup, lijepo se vide planeti Jupiter i Saturn u konjunkciji prema zapadu, a prema istoku Merkur i Venera, i još nekoliko zvijezda oko zenita. Nakon 2 ¼ minute III. Kontakt i Sunce se pomalja. – Idemo zatim u Dom, crnu kavu, pak dijelim čitavo vrijeme autogramme. Vlaho Kučera upravi mi javni pozdrav, a ja mu odgovorim. Prof. Dr. Eisner, Dr. Haupt, Dr. Pyrhinger, Dr. Esih, ing. Hegedušić itd. Već je pomrčina davno svršila, pak idemo k našem autu, i u 11 krećemo natrag. Katica se iskrca i ostane u Nerežišću, a ja i Tomislava u bolnicu. Šoferu Stevi 500. D. (...).“ U rujnu je u Supetru boravio Vlaho Kučera te mu je donio naručene fotografije pomrčine, za koje je don Niko platio 1 000 dinara. (21)

Astronomska sekcija Prirodoslovnog društva iz Ljubljane poslala je na Brač 25 promatrača. U članku profesora Pavla Kunavera koji je organizirao i vodio slovensku ekspediciju razvidno je da su bili u doticaju s don Nikom Miličevićem i od njega su tražili savjet o mjestu promatranja na Braču. Preporučio im je Bol ili Selce. Izabrali su Selce i uspješno obavili opažanja za vrijeme pomrčine. Don Niko i prof. Kunaver bili su u vezi niz godina. Pavel Kunaver (1889. – 1988.), bio je slovenski profesor zemljopisa. Osnovao je 1929. školsku zvezdarnicu na terasi škole u Zgornjoj Šiški. Imao je jednostavan reflektor objektiva 11 cm vlastite izrade. Desetljećima je pratio Sunčevu aktivnost

was cold up there, there were residues of old snow, and frost as well. There were a lot of people up there and a great rush for special stamps. The first contact was at 7.34, then slowly forwards, the second contact at 8.41, the beginning of totality. Photosphere could be nicely seen, together with clear and powerful chromosphere and well-developed corona, with a few beautiful strands and two strong red protuberances left and right. Black lunar shadow advanced at the sea, then retreated. The planets Jupiter and Saturn could be clearly seen in conjunction westward, Mercure and Venus eastward, and some other stars around the zenith. After 2 ¼ minutes third contact occurred and the Sun appeared – We went to the Mountain Hut, black coffee, then autographs for a long time. Vlaho Kučera greeted me in front of the public and I greeted him back. Prof. dr. Eisner, dr. Haupt, dr. Pyrhinger, dr. Esih, ing. Hegedušić and some others were there. The eclipse had long ended, we went for our car and started back at 11 o'clock. Katica went out and stayed in Nerežišće, Tomislav and me went to the hospital. Gave 500 D to driver Stevo (...).“ Vlaho Kučera stayed in Supetar in September and brought the photos of the eclipse don Niko had asked for and paid 1000 dinars for them. (21)

Astronomical section of the Society of Natural Sciences from Ljubljana sent 25 observers to Brač. Prof. Pavel Kunavera, who organised and led the Slovenian expedition, notes in his article that they were in contact with don Niko Miličević and asked for his advice regarding the location on Brač favourable for the observation. He recommended Bol or Selce and they choose Selce, successfully accomplishing observation during the eclipse. Don Niko and Prof. Kunaver had contacts for a number of years. Pavel Kunaver (1889– 1988) was a Slovenian professor of geography. He established a school observatory at the school terrace in Zgornja Šiška in 1929. He had a simple reflector of his

i slao svoja opažanja u Centar za opažanje Sunca u Zürichu. Napisao je nekoliko knjiga iz astronomije i tiskao vrteću kartu neba. Suradivao je i sa Zvezdarnicom na Popovu tornju.

6. Zaključak

Moto članka *Primjer uspješne pripreme mladeži na zagrebačkoj Zvezdarnici za popularizaciju pomrčine predavanjima te za stručni rad opažanja i snimanja Sunca za vrijeme pomrčine*, nije slučajna. Moguće ga je iščitati i u različitim drugim djelovanjima Zvezdarnice na Popovu tornju. Izuzevši nekoliko neplodnih razdoblja, kada vrsni hrvatski intelektualci i znanstvenici nisu shvaćali kakvu priliku imaju da pospješe razvitak hrvatske astronomije, sve ostalo vrvi aktivnošću i velikim rezultatima, o kojima će više biti rečeno sljedeće godine na 120. obljetnici osnivanja Zvezdarnice na Popovu tornju.

Oton Kučera je začetnik Zvezdarnice u koju je nesebično uložio svoje vrijeme i svoju zamisao, imajući viziju zvezdarnice za popularizaciju astronomije, ali i za stručni i znanstveni rad. Drugi velikan s osebujnim načinom rada, Gabrijel Divjanović, svoju je energiju također nesebično dijelio usmjeravajući brojnu mladež na različite vidove popularizacije astronomije te preko njih pridonio razvitku profesionalne astronomije u Hrvatskoj. Uspio je biti i „drugi otac“ i prijatelj učenicima i studentima koji su dolazili i družili se na Zvezdarnici. Bilo je tu i pjesama i sviranja violine i sličnih manifestacija obiteljsko-

own design with the lens of 11 cm and monitored solar activity for years, sending his observations to the Centre for solar observations in Zürich. He also wrote a few books in astronomy and published a rotating map of the sky. He also collaborated with the Observatory at Popov toranj.

6. Conclusion

The motif of the article *An example of a successful preparation of the youth at Zagreb Observatory for the purpose of popularisation of eclipse through lectures and for professional observation and recording of the Sun during eclipse*, is not random or haphazard one. It can also be seen in various other activities of the Observatory at Popov toranj. Barring a few unfruitful periods, when prominent Croatian intellectuals and scientists did not comprehend the opportunity to advance the development of Croatian astronomy, the rest of the history of the Observatory abounds in activity and high results, which will be discussed in more detail next year, at the 120 anniversary of the Observatory at Popov toranj.

Oton Kučera was the founder of the Observatory and he invested selflessly his time and his ideas, having the vision of an observatory with the purpose of popularising astronomy, but also as a place of professional and scientific work. Another great man with a peculiar style of work, Gabrijel Divjanović, also shared his energy selflessly, directing a number of young people to various modes of popularising astronomy, thus contributing to the development of professional astronomy in Croatia. He also managed to be a „second father“ and a friend to pupils and students who came to the Observatory and hanged out there. There was a lot of songs and playing violins there, as well as many other similar manifestations of family unity. However, as-

ga zajedništva, ali uvijek je na pijedestalu bila astronomija i što se još može učiniti za njenu dobrobit kad već nije nastavni predmet u školama. Gledamo li s odmakom vremena, čini se da je što narod kaže „svako zlo za neko dobro“ pa je i ta apsurdna odluka pridonijela ubrzanom razvitku amaterske i profesionalne astronomije u Hrvatskoj s ishodištem na Zvezdarnici HPD-a, a potom samostalnoj Zvezdarnici koja je prolazila kroz različite „Scile i Haribde“¹⁰ i uspješno odolijevala ugrozama.

tronomy was always at the pedestal, as was the question what else could be done for its benefit, when it never made it as a subject to school curricula. If we consider it from contemporary perspective, with a time delay, it seems that the proverbial „every cloud has a silver lining“ could be applied here, meaning this absurd decision has contributed to the accelerated development of amateur and professional astronomy in Croatia, with the starting point in the HPD Observaory, and later completely independent Observatory, which has passed through various „Scyllas and Charibdes“¹⁰ and has successfully resisted various menaces and threats.

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3. Tatjana Kren i Branko Hanžek: *Oton Kučera (1857. – 1931.), Per aspera ad astra (Kroz trnje do zvijezda)*, Gimnazija Matije Antuna Reljkovića, Vinkovci, 2013., str 81–125., 88–116).
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6. Tatjana Kren: *Članovi astronomske sekcije i astronomskeg društva te ostali suradnici Zvezdarnice od 1903. do 2003. godine* (G. Kren, ur.), *Bolid XXX(1-2) (2003) 94–95.*

¹⁰ Scila i Haribda (grč. *Σκύλλα, Skýlla* i *Χάρυβδις, Khárybdis*), po antičkome vjerovanju dvije opasne nemani koje su pomorci morali izbjeći ako su se htjeli spasiti za plovidbe kroz Messinski tjesnac (između Italije i Sicilije).

¹⁰ Scyllas and Charibdis (Greek *Σκύλλα, Skýlla* and *Χάρυβδις, Khárybdis*), according to the ancient Greek belief were two dangerous monsters that sailors had to avoid if they wished to sail through the strait of Messina successfully (between Italy and Sicily).

7. Tatjana Kren i Kruno Poljak: *Velika ideja prijateljstva i mira – Pacifizam i esperanto na zagrebačkoj Zvezdarnici*, u: *Spomenica Zvezdarnice Zagreb 1903. –2003., Povodom stote obljetnice*, Zagrebački astronomski savez – Zvezdarnica Zagreb, 2003., str. 92–98).
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Znanstveni doprinosi Armina Pallaora (1955.–2020.) u ihtiologiji i ornitologiji

Scientific contributions of Armin Pallaor (1955–2020) in ichthyology and ornithology

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SAŽETAK

U Zagrebu je 27. siječnja 2020. u dobi od 65 godina prerano preminuo dr. sc. Armin Pallaoro, znanstveni savjetnik Instituta za oceanografiju i ribarstvo u Splitu, i u tom trenutku je hrvatsko prirodoslovlje ostalo bez vrsnoga znanstvenika iz područja biologije mora, ihtiologije, ornitologije, ribarstvene biologije i morskoga ribarstva. Napisao je 104 znanstvena rada iz navedenih područja. Bio je strastveni prirodoslovac u pravom smislu riječi. Čitav svoj životni vijek posvetio je moru i njegovim tajnama, o kojima je mnogo znao. Svoje je spoznaje o moru i životu u njemu nesebično dijelio svojim mlađim kolegama. Bio je suautor u tri poglavlja u knjigama te suautor

SUMMARY

In Zagreb, on January 27, 2020, at the age of 65, Dr. Armin Pallaoro passed away, scientific advisor of the Institute of Oceanography and Fisheries in Split, and at that moment Croatian natural history was left without an excellent scientist in fields of marine biology, ichthyology, ornithology, fisheries biology and marine fisheries. He wrote 104 scientific papers on the above-mentioned issue. He was a passionate naturalist in the true sense of the word. He devoted his entire life to the sea and its secrets, about which he knew a lot, and selflessly shared his knowledge about the sea and life in it with great ease with younger colleagues. He was a co-author in 3 chapters of books and a co-author in the book „Crvena knjiga morskih riba Hrvatske“. The newly described species *Zebrus*

* Članak je djelomice referiran na znanstvenom skupu *Hrvatski prirodoslovci 31*, Split, 25. – 26. studenoga 2022.

* *The paper was partially referred at the scientific meeting Croatian naturalists 31, Split, Croatia, November 25–26, 2022.*

u knjizi *Crvena knjiga morskih riba Hrvatske. Novoopisana vrsta glavoča Zebrus pallaoroi* (M. Kovačić, R. Šanda, K. Čekovská, T. Soukupová and J. Vukić, godine 2021.) nazvana je u čast dr. sc. Armina Pallaora.

KLJUČNE RIJEČI

Armin Pallaoro

- ihtiologija
- ornitologija
- scientist

Kratki životopis

Dr. sc. Armin Pallaoro (**slika 1**), znanstveni savjetnik Instituta za oceanografiju i ribarstvo u Splitu, rođen je 28. lipnja 1955. godine u Splitu, u kojem je završio osnovnu i srednju školu. Diplomirao je na Prirodoslovno-matematičkom fakultetu (smjer: Biologija) Sveučilišta u Zagrebu 1983. godine. U Zagrebu završava i poslijediplomski studij Oceanologije na istom fakultetu te stječe titulu magistra znanosti (polje: biologija) 1988. godine, kada je i obranio magistarsku radnju pod naslovom: *Biometrijske, biološke i neke ekološke značajke Lipophrys pavo (Risso, 1810) (Pisces, Perciformes, Blenniidae) u Jadranskom moru*. Od godine 1985. do 1986. radio je kao znanstveni asistent na Prirodoslovno-matematičkom fakultetu, Sveučilišta u Splitu. Od 1986. do kraja života kontinuirano je radio u Laboratoriju za ihtiologiju i priobalni ribolov Instituta za oceanografiju i ribarstvo u Splitu. U Zagrebu je godine 1996. obranio i svoju doktorsku disertaciju pod naslovom *Dinamika populacije, ribarstveni značaj i zaštita ušate Oblada melanura (Linnae-*

pallaoroi Kovačić, Šanda, Čekovská, Soukupová & Vukić, 2021 is named in honor of Ph.D. Armin Pallaoro.

KEYWORDS

Armin Pallaoro

- ichthyology
- ornithology
- scientist

Short biography

Dr. Armin Pallaoro (**Figure 1**), the scientific advisor of the Institute of Oceanography and Fisheries in Split, was born on June 28, 1955, in Split, where he completed primary and secondary school. He graduated from the Faculty of Sciences (Departments: Biology) of the University of Zagreb in 1983. In Zagreb, he also completed postgraduate studies in Oceanology at the same Faculty and obtained a master's degree (field: biology) in 1988, when he defended his master's thesis under the title: *Biometrijske, biološke i neke ekološke značajke Lipophrys pavo (Risso, 1810) (Pisces, Perciformes, Blenniidae) u Jadranskom moru* (Biometric, biological and some ecological features of *Lipophrys pavo* (Risso, 1810) (Pisces, Perciformes, Blenniidae) in the Adriatic Sea).

From 1985 to 1986, he worked as a research assistant at the Faculty of Science, University of Split. From 1986 until the end of his life, he worked continuously in the Laboratory of Ichthyology and Coastal Fishing of the Institute of Oceanography and Fisheries in Split. In 1996, he defended his doctoral dissertation in Zagreb under the title: *Dinamika populaci-*

us, 1758) *uzduž istočne obale Jadranskoga mora.*

U razdoblju 1985. – 1986. radio je kao znanstveni asistent na Splitskom sveučilištu (Prirodoslovno-matematički fakultet), a od tada je neprekidno radio u Laboratoriju za ihtiologiju i priobalni ribolov u Institutu za oceanografiju i ribarstvo u Splitu.

Bio je član Soci t  Franaise d’Ichtyologie (Francuskoga ihtiološkog društva), Hrvatskoga ihtiološkog društva te Hrvatskoga biološkog društva. Objavio je 104 izvorna znanstvena rada te je sudjelovao u izradi oko 50 studija i izvješt a.

itav svoj  ivotni vijek posvetio je moru i njegovim tajnama, o kojima je mnogo znao, i svoje je spoznaje o moru i  ivotu u njemu nesebino i s lakoom dijelio svojim mladim kolegama. Bio je strastveni prirodoslovac u pravom smislu rijei. Bio je suautor u tri poglavlja u knjigama te suautor u knjizi *Crvena knjiga morskih riba Hrvatske* (slika 2).

Dr. Armin Pallaor je prerano preminuo u Zagrebu, 27. sijenja 2020., u dobi od 65 godina. U tom je trenutku hrvatsko prirodoslovlje ostalo bez vrsnoga znanstvenika iz podruja biologije mora, ihtiologije, ornitologije, ribarstvene biologije i morskog ribarstva.

Znanstveni i struni rad

U znanstvenom i strunom radu uglavnom se bavio biologijom mora i to poglavito u znanstvenim granama ihtiologija, ribarstvena biologija, sistematika riba i rakova, morfologija, biologija i ekologija riba, dugorone promjene u populacijama riba i rakova, te utjecaj ribolov-



SLIKA 1. Dr. sc. Armin Pallaoro
FIGURE 1. Armin Pallaoro, Ph.D.



SLIKA 2. Naslovnica *Crvene knjige morskih riba Hrvatske* (1)
FIGURE 2. The cover of the book *Red book of marine fishes of Croatia* (1)

je, ribarstveni znaaj i zaštita ušate Oblada melanura (Linnaeus, 1758) *uzduž istone obale Jadranskoga mora* (Population dynamics, fisheries significance and protection of the abalone *Oblada melanura* (Linna-

nih alata na stanje populacija riba, rakova i glavonožaca.

Svoj znanstveni rad započinje u ihtiologiji, već od samog početka odabirom teme diplomskog rada u kojem razmatra biometrijske, biološke i ekološke značajke babilice kukmašice *Lipophrys pavo* te kasnije odabirom svoje doktorske disertacije u kojoj je bio posvećen dinamici populacija ušate *Oblada melanura*.

Bio je i suautor jedne vrlo vrijedne knjige (slika 2): Jardas, I., Pallaora, A., Vrgoč, N., Jukić-Peladić (2008): *Crvena knjiga morskih riba Hrvatske*. (1) Ta je knjiga posvećena mnogim generacijama hrvatskih oceanografa koji su predano izučavali biološka svojstva istočnoga Jadrana i radili na razumnom iskorištavanju obnovljivih bioloških bogatstava i njihovoj zaštiti.

Na slici 3 je prikazana novoopisana vrsta glavoča koja je nazvana u čast dr. sc. Armina Pallaora. U radu Kovačić *et al.* (2021) stoji (2):

„*Etimologija. Nazvan u čast Armina Pallaora, velikog ihtiologa s Instituta za oceanografiju i ribarstvo Split, Hrvatska, koji je nažalost preminuo u siječnju 2020. Armin je svoje znanje te svoje terenske i laboratorijske vještine o ribama nesebično dijelio s generacijama mladih hrvatskih kolega na njihovim počecima, među kojima je i jedan od autora (MK).*“

Popis znanstvenih radova – ihtiološki doprinosi

U ovom potpoglavlju kronološki su prikazani znanstveni radovi s ihtiološkim doprinosima dr. sc. Armina Pallaora. Sveukupno je publicirao 104 znanstvena rada.

eus, 1758) along the eastern coast of the Adriatic Sea).



SLIKA 3. *Zebrus pallaoroi* (Kovačić *et. al.*) (2)

FIGURE 3. *Zebrus pallaoroi* (Kovačić *et. al.*) (2)

He was a member of the Société Française d'Ichthyologie (French Ichthyological Society), the Croatian Ichthyological Society and the Croatian Biological Society. He published 104 original scientific papers and participated in the creation of around 50 studies and reports.

He devoted his entire life to the sea and its secrets, about which he knew a lot, and he selflessly and easily shared his knowledge about the sea and life in it with his younger colleagues. He was a passionate naturalist in the true sense of the word. He was a co-author in three chapters of books and a co-author in the book (Figure 2) *Crvena knjiga morskih riba Hrvatske* (The Red Book of Marine Fishes of Croatia).

Dr. Armin Pallaora died prematurely in Zagreb, on January 27, 2020, at the age of 65. At that moment, Croatian natural history was left without an excellent scientist in the fields of marine biology, ichthyology, ornithology, fisheries biology and marine fisheries.

1. TUTMAN, P., K. KAPIRIS, M. KIRIN-ČIĆ & A. PALLAORO. 2017. Floating marine litter as a raft for drifting voyages for *Planes minutus* Crustacea: Decapoda: Grapsidae) and *Liocarcinus navigator* (Crustacea: Decapoda: Polybiidae). Marine Pollution Bulletin, 120, ½: 217-221. doi:10.1016/j.marpolbul.2017.04.063
2. ŠANTIĆ, M., A. PALLAORO, M. MARKOV & I. JARDAS. 2017. Morphometric and meristic traits of megrim, *Lepidorhombus whiffiagonis* (Walbaum, 1792) from the eastern central Adriatic Sea. Archives of Biological Sciences, 69, 4: 665-670. doi:10.2298/ABS170214012S
3. ZORICA, B., V. ČIKEŠ KEČ, A. PALLAORO, K. ZANKI, G. BRZULJA & V. KRALJEVIĆ. 2016. First record of agujon needlefish, *Tylosurus acus imperialis* (RAFINESQUE, 1810) (Osteichthyes: Belonidae) in the Croatian part of the Adriatic Sea. Acta Adriatica, 57, 1: 183-186.
4. ŠANTIĆ, M., A. PALLAORO, B. RAĐA & I. JARDAS. 2016. Diet composition of greater weever, *Trachinus draco* (Linnaeus, 1758) captured in the eastern-central Adriatic Sea in relation to fish size, season and sampling area. Journal of Applied Ichthyology, 32, 4: 675-681. doi:10.1111/jai.13081
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6. ŠANTIĆ, M., A. PALLAORO, I. MIKULANDRA, B. RAĐA & I. JARDAS.

Scientific and professional work

In his scientific and professional work, he mainly dealt with marine biology, mainly in the scientific branches of ichthyology, fisheries biology, systematics of fish and crustaceans, morphology, biology and ecology of fish, long-term changes in fish and crustacean populations, and the influence of fishing tools on the condition of fish populations, crustaceans and cephalopods.

He began his scientific work in ichthyology, already from the very beginning by choosing the topic of his diploma thesis in which he considered the biometric, biological and ecological features of the midwife *Lipophrys pavo*, and later by choosing his doctoral dissertation which he devoted to the population dynamics of the abalone *Oblada melanura*.

He was also the co-author of a very valuable book (**Figure 2**): Jardas, I., Pallaoro, A., Vrgoč, N., Jukić-Peladić (2008): *Crvena knjiga morskih riba Hrvatske* (Red book of marine fishes of Croatia). (1) This book is dedicated to many generations of Croatian oceanographers who devotedly studied the biological properties of the eastern Adriatic and worked on the reasonable exploitation of renewable biological resources and their protection.

Figure 3 shows a newly described species of cephalopod, which was named in honor of Dr. Armin Pallaora. In the work of Kovačić *et al.* (2021) write (2): „Etymology. Named in honour of Armin Pallaoro, a great ichthyologist from the Institute of Oceanography and Fishery Split, Croatia, who sadly passed away in January 2020.

2015. Age, growth and mortality of poor cod (*Trisopterus minutus* L.) from the eastern Adriatic Sea. Archives of Biological Sciences, 67, 3: 921-927 doi:10.2298/ABS141106053S

7. GRATI, F., M. COBANI, D. BOJANIĆ VAREZIĆ, B. DRAGIČEVIĆ, J. DULČIĆ, M. GAMBINO, O. GIOVANNARDI, R. GRGIČEVIĆ, Z. IKICA, A. JOKSIMOVIĆ, J. KOLITARI, M. KRALJEVIĆ, B. MARČETA, S. MATIĆ-SKOKO, **A. PALLAORO**, E. SABATELLA, N. STAGLIČIĆ, J. ŠVAB, P. TUTMAN, N. VRGOČ, E. ARNERI, L. CERIOLA & N. MILONE. 2015. Small-scale fisheries in the Adriatic Sea: information gaps at the biological, socio-economic and environmental level. FAO Fisheries and Aquaculture Proceedings, 39: 71-82.
8. ŠANTIĆ, M., **A. PALLAORO** & BILJANA RAĐA. 2013. Diet composition of Young-of-the-Year Mediterranean horse mackerel, *Trachurus mediterraneus* (Carangidae), from the eastern central Adriatic Sea. Cahiers de Biologie Marine, 54, 1: 41-48.
9. MATIĆ-SKOKO, S., D. BOJANIĆ VAREZIĆ, J. ŠILJIĆ, P. TUTMAN & **A. PALLAORO**. 2013. The cuckoo wrasse, *Labrus mixtus* (Pisces: Labridae): biological indices for life history and conservation. Scientia Marina, 77, 4: 595-605 doi:10.3989/scimar.03884.07A
10. ŠANTIĆ, M., N. STAGLIČIĆ, **A. PALLAORO**, M. MARKOV & I. JARDAS. 2013. Age and growth of megrim *Lepidorhombus whiffiagonis* (Scophthalmidae) from eastern central Adriatic Sea. Cybium, 37, 4: 255-261.

Armin unselfishly shared his knowledge and his fieldwork and laboratory skills on fishes with generations of younger Croatian colleagues at their beginnings, including one of the authors (MK).“

List of scientific papers – ichthyological contributions

In this sub-chapter, scientific papers with the ichthyological contributions of Dr. Armin Pallaoro are presented chronologically. He published a total of 104 scientific papers.

1. TUTMAN, P., K. KAPIRIS, M. KIRINČIĆ & **A. PALLAORO**. 2017. Floating marine litter as a raft for drifting voyages for *Planes minutus* Crustacea: Decapoda: Grapsidae) and *Liocarcinus navigator* (Crustacea: Decapoda: Polybiidae). Marine Pollution Bulletin, 120, ½: 217-221. doi:10.1016/j.marpolbul.2017.04.063
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Ornithological contributions

Armin Pallaoro ringed birds in Croatia in the period from 1985 to 1993. He ringed a total of 880 birds (Mužinić and Purger, 2009) (3). According to data from the Bird Ringing Archive of the Institute of Ornithology, HAZU, in the period from 1985 to 1991 (a total of seven years on the island of Šolta), he ringed a total of 287 birds, members of 39 species, in 4 settlements (Grohote, Nečujam, Donje Selo, Srednje Selo) (Mužinić and Purger, 2009).

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Proizvodnja cementa u Splitu: cementara Gilardi & Bettiza*

Cement production in the City of Split, Croatia: Cement plant Gilardi & Bettiza*

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SAŽETAK

Tvornica cementa u zapadnom dijelu Splitske luke, u Dražancu, Prva dalmatinska tvornica cementa portland Gilardi & Bettiza – Split, osnovana je 1865. U početku je (od 1870.) proizvodila roman-cement, a od godine 1880. portland-cement; prestaje s radom 1933. godine. Tehnologija se temeljila na vertikalnim Dietzschovim pećima, a sirovinu je osiguravalo nalazište vapnenca i kvalitetnog lapora pokraj tvornice, na obroncima Marjana. U ovom je radu povijest prve splitske tvornice cementa obrađena s kemijske, geološke, tehnološke, ekonomske, političke i kulturološke strane – navođenjem sjećanja Enza Bettize (1927. – 2017.), sina posljednjega vlasnika tvornice iz obitelji Bettiza.

SUMMARY

The cement plant at the west end of the Split Port, at Dražanac, The First Dalmatian Plant of Portland Cement Gilardi & Bettiza – Split, was founded in 1865. At the beginning (from 1870) it produced roman cement and after that, from 1880 to 1933, its chief product was portland cement. It used vertical Dietzsch kilns and marl of high quality mined at the close vicinity of the plant, on the slopes of Mt. Marjan. In this paper, the history of the first plant of portland cement in Dalmatia is discussed, from chemical, geological, technological, economic, political and cultural viewpoints, last based on the memories of Enzo Bettiza (1927–2017), the son of the last owner of the cement plant in Bettiza family.

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* *The paper was partially referred at the scientific meeting* Croatian naturalists 31, Split, Croatia, November 25–26, 2022.

** Sada u miru. / ** Now retired.

KLJUČNE RIJEČI

proizvodnja cementa u Dalmaciji

- Dietzschova peć
- Enzo Bettiza
- portland-cement

Uvod

Razvoj industrije u Dalmaciji uvjetovan je dvjema pogodnostima. Prva pogodnost je blizina mora, što je u početnom razdoblju industrijalizacije, sredinom 19. stoljeća, bilo presudno jer još nije postojala cestovna infrastruktura (prve su ceste građene u Dalmaciji za vrijeme francuske okupacije, 1809. – 1815., često po trasama rimskih putova). Druga je pogodnost obilje mineralnih sirovina, vapnenca i lapora. Dok je prva stijena služila za proizvodnju vapna, nalazišta druge stijene, lapora, bila su nužna za proizvodnju cementa. Cement je naime smjesa kalcijevih silikata i aluminata (**tablica 1**), dok je lapor (*tupina*, lokalno ime za lapor) poglavito smjesa kalcita (CaCO_3) i minerala gline (alumosilikata).¹ Toplinskom obradom („pečenjem“) lapora dobiva se klincker (1), od kojeg se potom proizvodi cement, na isti način kao što se živo vapno (CaO) dobiva od vapnenca (stijena koja se poglavito sastoji od kalcita, CaCO_3 , s malim udjelom magnezita, MgCO_3).

¹ Lapor pogodan za proizvodnju cementa (cementni lapor) mora imati hidraulični modul $w(\text{CaO})/[w(\text{SiO}_2) + w(\text{Al}_2\text{O}_3) + w(\text{Fe}_2\text{O}_3)] = 1,8 - 2,2$, gdje je w maseni udio (postotak) odgovarajuće komponente. Lapor se nalazi u flišu (njem. Flysch), seriji sedimentata u kojima se izmjenjuju slojevi lapora, glinenih škriljevaca i pješčenjaka (v. sliku 4).

KEYWORDS

Cement production in Dalmatia

- Dietzsch kiln
- Enzo Bettiza
- Portland cement

Introduction

The development of industry in Dalmatia was closely related to two beneficial factors. The first one was proximity of the sea, which was, at the initial steps of industrialisation in the mid-19th century, of utmost importance, as no road infrastructure was available at the time (the first roads in Dalmatia were built during the French occupation, 1809–1815, quite often on the routes of ancient Roman roads). The second advantage was the abundance of mineral raw materials, primarily limestone and marl. While limestone was used to manufacture lime, the deposits of marl were essential for the production of cement. Cement is in principle a mixture of calcium silicates and aluminates (**Table 1**), while marl (*tupina*, the local name for marl) is primarily a mixture of calcite (CaCO_3) and mineral clay (alumosilicate).¹ Thermal treatment („firing“) of marl results in cement clinker (1), which is the starting material for cement production, in the same way as quicklime (CaO) is obtained from limestone (rock consisting mostly of calcite, CaCO_3 , accompanied by a small portion of magnesite, MgCO_3).

Italian capital was primarily present in the initial industrialisation phases in Dalmatia. It can

¹ The marl adequate for cement production (cement marl) should have hydraulic modul $w(\text{CaO})/[w(\text{SiO}_2) + w(\text{Al}_2\text{O}_3) + w(\text{Fe}_2\text{O}_3)] = 1.8-2.2$, where w is mass proportion (percentage) of the component in question. Marl is contained in flysch (German Flysch), a series of sediments where layers of marl, clay slate and sandstone alternate (see Figure 4).

TABLICA 1. Kemijski sastav klinkera^a
 TABLE 1. *The chemical constitution of clinker^a*

Sastojak (faza) <i>Constituent (phase)</i>	Molekulska formula <i>Molecular formula</i>	Temperatura nastajanja / °C <i>Formation temperature / °C</i>	Nastaje od <i>Formed from</i>
Živo vapno <i>Quick lime</i>	CaO	900–1000	CaCO ₃
Belit <i>Belite</i>	Ca ₂ SiO ₄	700–750	CaO + Al ₂ Si ₂ O ₅ (OH) ₄ ^b
Kalcijev ortoaluminat <i>Calcium orthoaluminate</i>	Ca ₃ (AlO ₃) ₂	1000	CaO + Al ₂ Si ₂ O ₅ (OH) ₄ ^b
Alit <i>Alite</i>	Ca ₃ SiO ₄	1350	CaO + Ca ₂ SiO ₄
Ferit <i>Ferrite</i>	Ca ₂ (Al,Fe)O ₅	1400–1450 ^c	CaO + Fe ₂ O ₃ + Al ₂ Si ₂ O ₅ (OH) ₄ ^b

^a Klinker se sastavom razlikuje od cementa, jer mu se nakon mljevenja dodaju dodatci, posebice gips.
^a *Clinker is not chemically identical to cement, because of the additives added after grinding, e.g. gypsum.*
^b Kaolinit, no mogu biti i drugi minerali gline (montmorilonit, ilit) sličnog sastava.
^b *Kaolinite, but also other chemically similar clay minerals (montmorillonite, illite).*
^c Talište ferita u smjesi s ostalim sastojcima; funkcija ferita je snižavanje tališta klinkera.
^c *Melting point of ferrite in the mixture of other constituents; its function is to decrease the melting point of clinker.*

U primarnoj industrijalizaciji Dalmacije prednjačio je talijanski kapital. To se vidi između ostalog i po tvornicama kalcijeva karbida (CaC₂) u Šibeniku te u Dugom ratu kod Omiša (2). Prva je tvornica počela s radom godine 1897., a druga 1914. Obje su bile početno u vlasništvu dioničarskog društva SUFID² iz Trsta, koje je osnovano radi iskorištavanja prirodnih, prije svega hidroenergetskih potencijala Dalmacije. Kalcijev karbid se na-

be seen, among others, in the case of calcium carbide (CaC₂) plant in Šibenik and in Dugi Rat near Omiš (2). The plant in Šibenik started its work in 1897, and the other one in 1914. Both were initially owned by SUFID², a joint-stock company from Trieste, founded with the aim of exploiting primarily the hydropower potentials of Dalmatia. As calcium carbide is produced from coal (coke) and quicklime in electric arc furnaces, it was necessary to establish a quarry and build a hydroelectric power plant in the vicinity of the carbide factory. The

² SUFID, Società anonima per l'utilizzazione delle forze idrauliche della Dalmazia.

² SUFID, Società anonima per l'utilizzazione delle forze idrauliche della Dalmazia.

ime proizvodi od ugljena (koksa) i živog vapna u električnim lučnim pećima, pa je u blizini tvornice karbida trebalo otvoriti kamenolom te izgraditi hidroelektranu. Stoga je proizvodnja karbida postala moguća istom kada je društvo SUFID izgradilo hidroelektrane HE Krka kod Šibenika (1895.) te HE Kraljevac kod Splita (1912.). Bitna je bila i blizina mora koja je omogućavala brodsku dopremu druge sirovine za proizvodnju kalcijeva karbida, ugljena.

Isti obrazac nalazimo i pri proizvodnji cementa u Dalmaciji i primorskoj Hrvatskoj (3-5) (**tablica 2**). S te je strane zanimljiva povijest pogona za proizvodnju vapna i cementa na tako opskurnom mjestu kao što je Križna luka na Hvaru, udaljena 700 metara od središta grada Hvara (**slika 1**). I tu je bila bitna dostupnost mora.

Osnovnu je sirovinu za proizvodnju vapna, vapnenac, davao stotinjak metara udaljeni kamenolom (koji je otvoren još u 18. stoljeću), ali se lapor – potreban za proizvodnju cementa – morao dopremiti iz Stobreča. U malom je zaljevu, tik uz morsku obalu, godine 1895. podignuta tvornica koje su vlasnici bili talijanski kemičar Cesare Zamboni i splitski poduzetnik Emil Stock (3). Tvornica je prestala raditi već 1906., da bi zbog nesuglasja s razvojem turizma bila uklonjena 1926. i zamijenjena tvornicom sardina. Danas na tom mjestu stoji hotel Galeb (izgrađen 1967.), a malo podalje je, na mjestu bivšeg kamenoloma, 1968. izgrađen hotel Bodul.

Cement se proizvodio na tri načina, u tri vrste peći. Prve, najjednostavnije peći



SLIKA 1. Mala tvornica cementa u Križnoj luci u Hvaru proizvodila je vapno i cement od 1898. do 1906.

FIGURE 1. A small cement plant in Križna Luka (the city of Hvar, Hvar Island) produced cement and lime in the period 1898–1906

manufacture of carbide became thus possible only when the company of SUFID built the hydroelectric power plant HE Krka near Šibenik (1895) and HE Kraljevac near Split (1912). The proximity of the sea was also essential, as it enabled the transportation and procurement by ship of the other raw material necessary to manufacture calcium carbide, primarily coal.

The same pattern can be seen in the production of cement in Dalmatia and coastal Croatia (3-5) (**Table 2**). An interesting example is in this context the history of the lime and cement manufacturing plant at an obscure location of Križna luka, at the island of Hvar, some 700 meters away from the centre of the town of Hvar (**Figure 1**). The access to the sea was also a deciding factor here.

Basic raw material for the manufacture of lime, limestone, was obtained in a quarry, some hundred meters away (established as early as the 18th century). However, marl, necessary to manufacture cement, had to be transported from Stobreč. The plant was built in a small bay in 1895 and the owners were an Italian chemist, Cesare Zamboni, and a

TABLICA 2. Proizvodne karakteristike cementara na području Hrvatske do godine 1941.
 TABLE 2. *Production capacities of cement plants in Croatia until the year 1941*

Cementara <i>Cement plant</i>	Osno-vana (zatvo-rena) <i>Found-ed (closed)</i>	Kapacitet u tisućama tona <i>Production capacity in 1000 tons</i>			Broj peći (1920. – 1941.) <i>Number of kilns (1920– 1941)</i>	
		1913.	1918.	1932. – 1940.	Vertikalne <i>Vertical</i>	Rotacijske <i>Rotational</i>
Gilardi & Bettiza (Dražanac, Split)	1865. (1933.)	27	27	27	12	0
Escher Heinrich (Rovinj)	1852.					
Tvornica cementa Jauske (Rovinj)	1895.					
Emil Stock (Hvar)	1898. (1906.)					
Jadransko d.d. (Solin)	1904.	80	79,5	175	18	2
Split d. d. – Majdan (Solin)	1908.	150	150	336	62	2
Cement d. s. o. (Omiš)	1908.	18				
Tvornica cementa (Bakar)	1910.	25				
Croatia d. d. (Podsused)	1908.	40	40	95	0	4
Dalmatia d. d. (K. Sućurac)	1912.	120	120	222	35 ^c	1
Societa istriana del cemento (Pula) ^a	1926.	17 ^b		60–90	2	1
Sprema – Giuseppe Conigliaro (Koromačno) ^a	1928.	62 ^b		62	0	1

^a U međuratnom razdoblju (1918. – 1941.) nisu bile na području Kraljevine Jugoslavije nego Kraljevine Italije.

^a *During the period between the two world wars (1918–1941) they were not in the territory of the Kingdom of Yugoslavia, but in the Kingdom of Italy.*

^b Proizvodnja u godini osnivanja.

^b *Production in the year of foundation.*

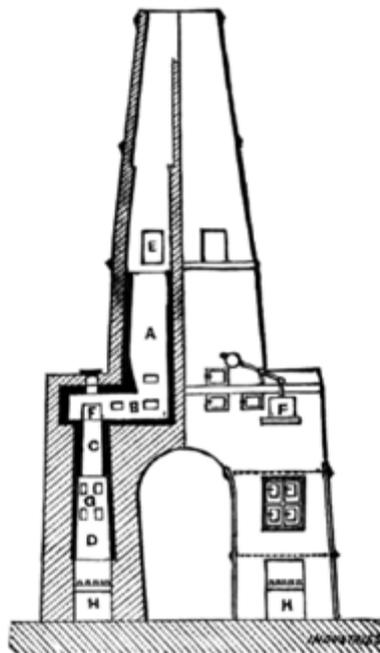
^c Uz osam četverostrukih grupa peći tipa Dietzsch, 1926. su sagrađene još tri vertikalne peći šahtnog tipa.

^c *Besides eight four-membered groups of Dietzsch kilns, three vertical shaft kilns were mounted in 1926.*

bile su jamaste peći. One se u bitnom nisu razlikovale od peći za proizvodnju drvenog ugljena. Bile su to jame promjera četiri metra, obložene šamotnom opekom koje su se punile naizmjenično slojevima goriva (kombinacijom drva i ugljena) i lapora te puštale da gore dva do četiri dana, no radni je ciklus – koji je uključivao punjenje, gorenje, hlađenje i razgradnju peći – trajao tjedan dana. Napredniji oblik peći bile su vertikalne (Dietzsch) peći, izumljene 1884. godine (6). One su bile slične visokim pećima za proizvodnju željeza (slika 2). Odozgo su punjene laporom, u sredini peći bi se osušeni lapor gurao željeznim šipkama uz dodavanje ugljena ili koksa. Dotok zraka kroz otvore u nižim dijelovima peći podržavao je vatra potrebnu za pečenje klinkera koji bi se na kraju takvog, kontinuiranog postupka vadio s njezina dna. Proizvodnja cementa (klinkera) u vertikalnim pećima trošila je dva do tri puta manje goriva nego u jamastima, no zahtijevala je više manualnog rada, pa je jeftina radna snaga također bila razlogom razvoja cementne industrije u Dalmaciji.

Na kraju treba spomenuti i modernu tehnologiju, tehnologiju rotacijskih peći (7), koja se danas jedina koristi u proizvodnji cementa. Postupak je sličan postupku u Dietzschovim pećima: sirovina za proizvodnju cementa se suši, a potom peče sve dok se pri temperaturi od 1 400–1 500 °C ne stvrdne u klinker. I ovdje se sirovina unosi na vrh peći, no peć nije postavljena okomito nego koso, okreće se, a toplinu potrebnu za tehnološki postupak ne daje gorivo izmiješano sa sirovinom,

businessman from Split, Emil Stock. (3). The plant soon closed, in 1906, and was removed completely in 1926, being in disagreement with tourism, to be replaced by a sardine factory. Hotel Galeb (built 1967) occupies the location today, while a bit further, on the location of a former quarry, hotel Bodul was built in 1968.



SLIKA 2. Shema vertikalne Dietzschove peći za kontinuiranu proizvodnju cementa (6)

FIGURE 2. Scheme of a vertical Dietzsch kiln for continuous cement production (6)

Cement was manufactured in three ways, in three types of kilns. The first and least sophisticated were pitfire kilns. They differed principally in no essential detail from charcoal pits and had a form of a pit in the ground, four meters in diameter, lined with firebrick, and filled alternately by layers of fuel (combination of wood and coal) and

nego plamen ugljene prašine, mazuta ili zemnog plina koji gori s dna peći.

Prva dalmatinska tvornica cementa

Reći za tvornicu cementa koja je šezdeset godina (1870. – 1933.)³ proizvodila cement u Splitu na obroncima Marjana (8) da je prva dalmatinska tvornica cementa, kao što sugerira njezino ime u posljednje četiri godine (1929. – 1933.) njezina postojanja, Prva dalmatinska tvornica cementa Portland M. Ferić & Comp., nije posve točno. Prvu proizvodnju cementa („pečenja lapora“) pokrenula su godine 1867. dva Prusa, Heinrich Enrico Hartung i Enrico Höfling, u Vinišću (zapadni dio Trogirskog zaljeva), na mjestu gdje se još od 1628. iskapao i pređivao bitumen (a Hartung je tu imao svoj pogon). No već 1868. na tom mjestu, zbog razmirica suvlasnika prestaje proizvodnja cementa, pa Höfling traži bolje mjesto za svoju tvornicu, dok Hartung nastavlja s proizvodnjom bitumena na staroj lokaciji (8).

Nova lokacija za tvornicu cementa odabrana je na zapadnoj splitkoj obali, u predjelu Dražanac (**slika 3**) na obroncima Marjana, gdje je pronađen izuzetno kvalitetan lapor morskoga podrijetla i eocenske starosti. Područje oko Splita je flišni bazen (**slika 4**) (9, 10), pa se tu početkom 20. stoljeća grade mnoge tvornice (**tablica 2**). Tvornica godišnje proizvodi 2 000 tona roman-cementa tehnologijom jamastih peći. Sve se još radilo ručno,

³ Tvornica je formalno osnovana godine 1865., no počela je s radom istom 1870.

marl. They burned continually for two to four days, while the working cycle, which included filling, burning, cooling and decomposition, lasted for a week. The most advanced type of kilns were vertical (Dietzsch) kilns, invented in 1884. (6) They were quite similar to blast furnaces for the production of iron (**Figure 2**). The kilns were filled with marl from above, while the dried marl was pushed using iron bars and adding coal and coke. Airflow through the openings in lower parts of the kiln supported the fire necessary to burn the clinker, which was then, at the end of this continuous process, extracted from the kiln bottom. The manufacture of cement (clinker) in vertical kilns required two to three times less fuel than in pitfire ones, but asked for more manual work. This is the reason why cheap labour was one of the key factors in developing the cement industry in Dalmatia.

Modern technology of rotary kilns (7) should also be mentioned, as it is the only one used today in cement production. The process is similar to that used in Dietzsch kilns – the raw material for cement production is dried and then baked until it solidifies at the temperature of 1400–1500 °C in the clinker. The raw material is here also fed from the top of the kiln. However, the kiln is not vertical but slanted, it rotates, while the heat necessary for the process is not obtained from the fuel mixed with raw material, but from the coal-dust flame, fuel oil, or natural gas burning from the bottom of the kiln.

The first cement plant in Dalmatia

It is not quite accurate to say for the cement plant which used to produce cement in Split, on the slopes of Mt. Marjan for sixty years (1870–1933)³

³ The factory was officially founded in 1865, but it started working only in 1870.

a proizvod usitnjavao žrvnjem na konjski pogon, postupkom kao za proizvodnju maslinova ulja.

Godine 1871. pogon za proizvodnju cementa od bivšeg vlasnika kupuju splitski poduzetnici Marino Bettiza (1814. – 1901.) i Lorenzo Gilardi (1822. – 1899.), pa od tada tvornica radi pod imenom Gilardi & Bettiza. No na periferiji Splita, u Dujmovači počinje 1876. godine s radom druga tvornica za proizvodnju cementa, pa novi vlasnici čine sve kako bi se oduprli konkurenciji. Stoga iste godine podižu novu peć za proizvodnju živog vapna dok konjski pogon zamjenju parnim.

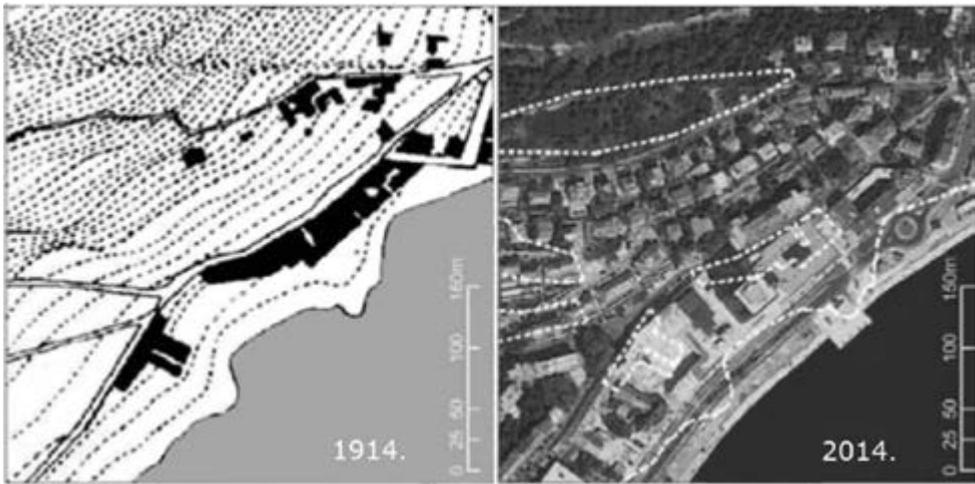
Četiri godine nakon toga, 1880., tvornica u vlasništvu obitelji Gilardi i Bettiza prelazi na proizvodnju portland-cementa.⁴ Tvornica zapošljava 50 radnika i proizvodi 4 000 tona cementa godišnje. Godine 1889. vlasnici kupuju od splitske općine tupinolom na Marjanu, a 1893. i zemljište na kojem se nalazila tvornica, što je dotad korišteno na koncesiju. Tvornica uskoro mijenja svoje vlasnike, jer 1899. umire Lorenzo Gilardi, a 1901. Marino Bettiza, pa njihove udjele preuzimaju zakoniti nasljednici. Marina Bettizu nasljeđuju sinovi Giovanni (1834. – 1930.) i Pietro (1856. – 1928.), dok Gilardijeva sina Lorenza II. (1880. – 1929.), budući da je bio maloljetan, zastupa majka Lucia Gilardi, r. Tossich (1831. – 1914.) i rođak Doimo Savo.

⁴ Portland-cement se peče s višim udjelom vapnenca (idealno 76 %) i manjim udjelom gline te pri višoj temperaturi od roman-cementa (koji se peče pri 1 200 °C). Stoga kod portland-cementa dolazi do sinteriranja i nastajanja alita, koji betonu daje čvrstoću.

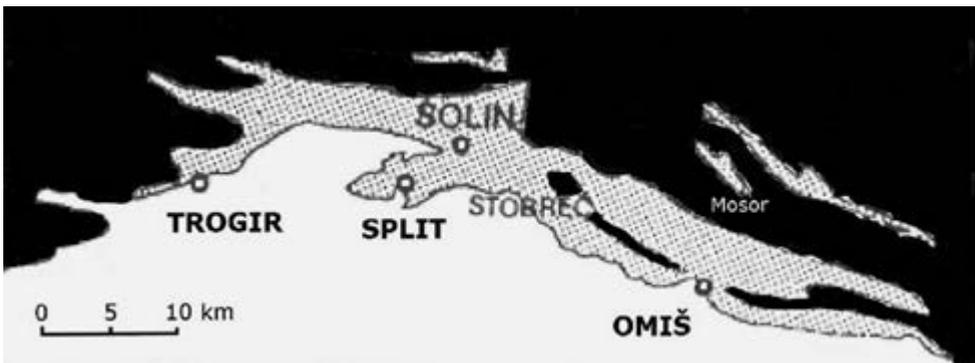
(8) that it was the first cement factory in Dalmatia, as the name of the company suggests for the last four years of its operation (1929–1933), namely „The first portland cement plant in Dalmatia M. Ferić & Comp“. The first cement manufacture („marl firing“) was started in 1867 by two Prussians – Heinrich Enrico Hartung and Enrico Höfling, in Vinišće (western part of the Trogir bay), on the location where pitch had been mined and processed from 1628 (Hartung had his plant there). Due to the conflicts between the owners, cement production was terminated on the location as soon as 1868 and Höfling searched for a more proper location for his factory, while Hartung continued his bitumen production at the old site (8).

A new location for the cement factory was selected at the western coast of Split, at the location of Dražanac (**Figure 3**) on the slopes of Mt. Marjan, where top quality marl of maritime origin from the ecocen age was found. The area round Split is a flysch basin (**Figure 4**) (9, 10), which was the reason why a number of factories were built at the location at the beginning of the 20th century (Table 2). The new factory produced 2000 tons of roman cement a year, using the technology of pitfire kilns. The process was manual at the time and the product was ground using millstones turned by horses, in a manner similar to olive oil production.

Businessmen from Split Marino Bettiza (1814–1901) and Lorenzo Gilardi (1822–1899) bought the cement manufacturing plant from the former owner in 1871, and the company operated under the name Gilardi & Bettiza from that time on. However, in 1876, another cement factory was started on the outskirts of Split, at Dujmovača, and the new owners of the first factory were doing their best to resist the competitors. They built a new kiln for the manufacture of quicklime, while horses as the source of power were replaced by steam.



SLIKA 3. Karta Dražanac (Split) 1924. i njegova zračna fotografija 2014. godine (3)
FIGURE 3. The map of Dražanac (Split), 1924, and its aerial photography, 2014 (3)



SLIKA 4. Vrlo pojednostavnjena geološka karta Splita i okolice: crnim su označena područja vapnenca, a sivo područja u kojima preteže fliš (9, 10)
FIGURE 4. A very simplified geological map of Split and its surroundings: limestone zones are marked in black, and flysch zones in gray (9, 10)

Nakon smrti prvih vlasnika, 1905. proizvodnja se modernizira izgradnjom prvih peći tipa Dietzsch. Peći su građene u grupi po četiri kako bi se lakše punile i praznile te dijelile isti dimnjak. Godine 1906. i 1909. izgrađeno je još osam

Four years afterwards, in 1880, the plant owned by the families of Gilardi and Bettiza shifted to the production of portland-cement.⁴ The plant em-

⁴ Portland-cement is baked with a higher content of limestone (ideally 76 %), lower content of clay, and

takvih peći, pa je uoči Prvoga svjetskog rata tvornica podno Marjana imala tri dimnjaka i dvanaest peći, no u planu je bila izgradnja još jednog kompleksa. Sve je to bilo popraćeno opsežnim građevinskim radovima u armiranom betonu. U tim godinama tvornica dobiva i novi uređaj za mljevenje klinkera, kuglični horizontalni mlin dužine 10 metara. Zahvaljujući novim pećima proizvodnja cementa raste na 27 000 tona, uz zapošljavanje tek malog broja novih radnika (sada ih je u tvornici bilo 70). Usto, tvornica 1906. mijenja ime u Prva dalmatinska tvornica cementa portland Gilardi & Bettiza – Split (**slika 5**).

No uspostavom nove države, Kraljevine SHS, mijenjaju se prilike u Splitu. Godine 1920. splitska općina poduzima opsežne komunalne radove radi urbanizacije zapadne obale splitske luke, a 1925. zabranjuje eksploataciju lapa na Marjanu. Stari vlasnici prodaju 1929. svoje udjele obitelji Ferić koja nastavlja proizvodnju, da bi već godine 1933. tvornica prestala s proizvodnjom cementa. Po nalogu talijanskih okupacijskih vlasti 1941. ruše se tvornički dimnjaci, da bi nakon završetka rata tvornica nastavila proizvodnju, no samo betonskih odljevaka. Tvornica se nacionalizira te pod imenom Voljak i Jadranka djeluje sve do 1978., kada prestaje svaka industrijska djelatnost u zapadnom dijelu splitske luke.

Proizvodnja betonskih odljevaka

Pojava umjetnih materijala, kao zamjena (imitacija) za prirodne, karakteristična je za 19. stoljeće. Jedan od razloga te poja-

ployed 50 workers and the output was some 4000 t of cement a year. In 1889, the owners bought a tupina mine on Mt. Marjan from the commune of Split, as well as the land where the factory was situated (in 1893), which had been leased until then. The factory changed owners soon, as Lorenzo Gilardi died in 1899, Marino Bettiza in 1901, and their lawful heirs took over their shares. Marin Bettiza was succeeded by his sons Giovanni (1834–1930) and Pietro (1856–1928), while Gilardi's son Lorenzo II. (1880–1929), being under age, was represented by his mother Lucia Gilardi, born Tossich (1831–1914) and his cousin Doimo Savo.

After the death of the original owners, in 1905, the production was modernised by building the first Dietzsch-type kilns. The kilns were constructed in groups of four, in order to facilitate filling and emptying, while the stack was common for all of them. Eight more kilns were built in 1906 and 1909, thus the factory at the slopes of Mt. Marjan had three stacks on the eve of WWI, and consisted of twelve kilns, with plans of building an additional complex in near future. This was all accompanied by comprehensive reinforced-concrete constructions. The factory was equipped with new machinery for milling clinker during these years, in the form of a horizontal ball mill 10 meters long. Due to new kilns, cement production grew to 27 000 tons, while the number of workers increased only slightly (there were 70 workers in the factory at the time). Additionally, the company changed its name in 1906 to „The first portland cement factory in Dalmatia Gilardi & Bettiza – Split“ (**Figure 5**).

at higher temperature than roman cement (which is fired at 1200 °C). This is why sintering occurs in manufacturing portland cement and alites are formed, which gives concrete additional strength.



SLIKA 5. Razglednica koja prikazuje pogled na tvornicu Gilardi & Bettiza 1905.

FIGURE 5. Postcard (1905) depicting the Gilardi & Bettiza cement plant

ve je uspon građanstva koje je htjelo oponašati životni stil plemstva, za što njegovi pripadnici nisu imali dovoljno novca, a često ni ukusa. Prvi surogat bio je papir, koji je u obliku papirmašea (*papiermaché*) zamjenjivao drvo, a počesto i metal. Riječ je namime o kaši priređenoj razmuljivanjem papira u vodi, koja otvrdnjava sušenjem. Kaši se radi pojačavanja tvrdoće i čvrstoće dodavalo škrobno ljepilo ili vodeno staklo te se oblikovala u sobni namještaj, pa i „metalne“ svjetiljke, ako bi se u papirnu masu umiješala zlatna boja ili metalna prašina.

Među takve surogate pripada i beton. Riječ je dakako o zamjeni za kamen, od davnina poznat građevni i dekorativni materijal, posebice u sredozemnim ze-

However, circumstances in Split were changed with the founding of the new state, the Kingdom of SHS. The municipality of Split undertook comprehensive communal activities in 1920, with the aim of urbanising the west coast of Split port. Marl exploitation on Mt. Marjan was banned in 1925. The initial owners sold their shares in the cement plant to the family of Ferić, who continued production until 1933, when the factory ceased producing cement at all. Italian occupying power ordered factory stacks to be demolished in 1941. Still, the factory continued working after the war, but only in the field of concrete castings. It was nationalised and was working under the names of Vuljak and Jadranka until 1978, when all the industrial activities were discontinued at the west coast of the Split port.

mljama. Beton se, kao i papirmaše, mogao lako oblikovati u kalupu, pa su se dekoracije od betona mogle proizvoditi ne samo masovno nego i jeftino. Betonske se skulpture i ukrasi pojavljuju u splitskoj arhitekturi u doba secesije pod utjecajem arhitekata koji su studirali u Pragu i Beču. „Logično je da sva ta ostvarenja u arhitekturi u većini slučajeva ne predstavljaju nikakva vrijedna arhitektonska ostvarenja, već po samoj činjenici što cement ne ostavlja baš ‚uzorit‘ dojam koji bi trebalo svakako respektirati“, piše Ante Sapunar, pa nastavlja: „Osim toga svi su ti betonski ukrasi kratka vijeka jer se s vremenom odvajaju i pucaju željezna ojačanja pa i to uzrokuje brzo propadanje.“(11) No unatoč nepriličnosti betona, Sapunar se potrudio popisati i opisati sve takve ukrase koje je još mogao pronaći u Splitu. Kao što se moglo očekivati, većina se betonskih ukrasa nalazi na području ondašnje gradske periferije, jer je plemstvo i bogatije građanstvo, koje je živjelo bliže gradskom središtu, radije koristilo skuplji, no otmjeniji materijal, građevinski kamen.

Svi su ti predmeti potjecali iz proizvodnje tvornice podno Marjana, koja je uz pogon za proizvodnju cementa od 1885. imala i radionicu za izradu betonskih proizvoda. O bogatstvu njihove proizvodnje najbolje govori četverodijelni prodajni katalog tvrke Gilardi & Bettiza iz 1909. U prvom dijelu kataloga nalaze se slike 55 vrsta podnih pločica i rubnjaka, u drugom dijelu su četiri vrste dimnjaka te kupaće kade, zahodske školjke i cijevi raznih dimenzija. U trećem dijelu čitatelj katalo-

Production of concrete castings

Nineteenth century was characterised by the emergence of artificial materials as replacements for or imitations of natural materials. One of the reasons for this is the development of building and construction, which was aimed at imitating the life style of nobility, for which the middle classes did not have enough money, and often lacked good taste. The first such substitute was paper which, in the form of *papier-mâché*, replaced wood, and often metal as well. It is a pulp prepared by mixing, or slurping, paper in water, to be hardened by drying. To enhance hardness and strength, size glue or water glass was often added to the pulp. Such material was often shaped into room furniture and even „metal“ lamps, for which purpose golden dye or metal dust was added to the paper mass.

Concrete also belongs among such substitutes. Obviously, it is a substitute for stone, a historical renown building and decorative material, especially in Mediterranean countries. Concrete can be, similarly to *papier-mâché*, easily shaped in moulds, meaning concrete ornaments could be produced not only large-scale, but at low prices as well. Concrete sculptures and ornaments appeared in the architecture of Split during the period of the Vienna Secession, under the influence of the architects who studied in Prague and Vienna. Ante Sapunar wrote: „It is quite logical that these pieces of architecture in most cases could not be regarded as valuable architectural achievements, if only by the fact that concrete itself does not give a „fine“ impression, which should be respected by all means“, and continued: „Besides, all of these concrete ornaments are only short lived, as in time they come-off and iron reinforcements break, which also leads to rapid deterioration.“(11) Still, apart from the inadequacy of concrete, Sapunar invested an effort in listing

ga nalazi nadgrobnne spomenike, križeve, grobne vaze i škropionice, dok četvrti dio donosi asortiman vrtnih dekoracija. Tu se nalaze vaze za cvijeće, ukrasni nadvratci za vrata i prozore, vrtnne fontane i stolovi, alegorijske skulpture, a među skulpturama je i poprsje Franje Josipa (12). Zanimljivo je da, iako su se dekoracije proizvodile u vrijeme secesije, u njima se ne očituje stil toga umjetničkog razdoblja nego onog prethodnog, naime historicizma, poglavito neobaroka. Tome se ne treba čuditi jer su avangardni pokreti, kakav je u to doba bila secesija (*art nouveau*), pobuna protiv starih, ustaljenih umjetničkih pravaca koji su iscrpli svoju stvaralačku snagu te degenerirali u kič.

Naročito su bili traženi proizvodi iz prvog dijela kataloga, pa je ostalo zabilježeno da je tvornica 1889. proizvela čak 2,5 milijuna pločica u 60 modela (8). Za njihovu je kvalitetu tvornica dobila priznanja u Trstu (1882.), Zagrebu (1891.) i Madridu (1897.) te na drugim izložbama diljem Austro-Ugarske Monarhije i Europe.

Sjećanje na splitsku tvornicu u kronici Enza Bettize

„Putniku koji se nekada približavao brodom splitskim lukobranima i gatovima, odmah bi udarila u oči dva prva kršna elementa pejzaža: tvornica cementa Gilardi & Bettiza, koja se sa svoja četiri pušća i siva tvornička dimnjaka gotovo naginjala nad morem, a malo dalje, slijeva, stjenovit pramac Svetog Stjepana porinut sa svojim grobovima, svojim čempresima, agavama i tamarisima da skladno obgrli grad-

and describing all the concrete ornamentations he could find in Split. As could be expected, most of the concrete ornaments were situated in the suburbs of the city at the time, as the nobility and rich citizens, who lived nearer to the city center, preferred to use more expensive, but also more stylish material, building stone.

All of these artefacts came from the production halls of the plant at the slopes of Mt. Marjan, which had, from 1885, apart from the cement producing plant, a workshop for the manufacture of concrete products. The scope and richness of its production is best illustrated by a four-part sales catalog of the company Gilardi & Bettiza from 1909. The first part of the catalogue consisted of 55 pictures of floor tile types and kerbstones, the second part depicted four types of chimneys and bathtubs, toilet bowls and tubes of various dimensions. The third part contained gravestones, crosses, grave vases and fonts, while the fourth part contained an assortment of garden ornaments. Among them were flower vases, decorative lintels for doors and windows, garden fountains and tables, allegorical sculptures, and among them Francis Joseph's bust (12). It is interesting to note that, although the decorations and ornaments were manufactured during the period of the Vienna Secession, they exhibited the characteristics not of this artistic style but of the one preceding it, meaning historicism, primarily neo-baroque. It was quite logical, as the avant-garde movements, which Vienna Secession (*art nouveau*), was at that time, were a rebellion against the old, established artistic styles, which had exhausted its creative power and degenerated into kitsch.

Demand was highest for the products in the first part of the catalogue, so it was noted that the plant manufactured as many as 2.5 million tiles in 60 models in 1889 only (8). The company was awarded for its high quality in Trieste (1882), Zagreb

sku luku u obliku potkove“,⁵ piše u sjećanjima na stari Split i svoje djetinjstvo u njemu (13, str. 108) književnik, publicist i političar Enzo Bettiza (1927. – 2017.) (14, 15), praukun prvoga vlasnika tvornice, Marina Bettize (1814. – 1901.), unuk Pietra Bettize (1856. – 1928.) i sin „šjora Vice“, Vicenza Bettize (1861. – 1946.)⁶, splitskoga odvjetnika, Talijana, i Marije Vušković (1896. –?), Hrvatice (16) (**slike 6, 7**).

„Tvornica je iz prošlog stoljeća, nadvita i ona nad morem, a sa skladištima odostrag oslonjena na prve padine brda Marjan, nalazila se kao što spomenuh, u neposrednoj blizini sustipanskih hridi“, nastavlja opis Bettiza. „Groblje je danas još golo i pusto, još uvijek bez hotela, dok se na mjestu tvornice cementa diže vrlo visoka i otužna zelenkasta kocka hotela od devet ili možda dvanaest katova.“⁷ (13, str. 109) Uz tu ga tvornicu, u obiteljskom vlasništvu, vežu najživlje uspomene iz djetinjstva: „Posebno se sjećam tih vreća boje pijeska, tvrdih, nabreklih, hrapavih na dodir, koje nisu bile od kartona nego od indijske jute, s gustim plavkastim pečatom koji je zanosno javljao: *Split – Gilardi & Bettiza – Prva dalmatinska tvornica cementa Portland – Osnovana 1865.*“ (13, str. 169)

⁵ Tvornicu podno Marjana ovekovečio je i splitski slikar Emanuel Vidović (1870. – 1953.) u veduti iz 1919. godine (23).

⁶ Nesigurna godina smrti, procijenjena – kao i godina smrti njegova sina Marina – prema sjećanjima Enza Bettize (12, str. 235).

⁷ Enzo Bettiza ovdje misli na hotel Marjan, izgrađen 1963. na mjestu bivše tvornice.

(1891) and Madrid (1897), as well as on numerous other exhibitions throughout the Austro-Hungarian Monarchy and other European countries.

A Memory of the Split cement plant in Enzo Bettiza's chronicle

„The first sight that caught the eye of a traveler coming near Split breakwaters and piers by ship at that time would be two robust elements of the landscape: cement plant Gilardi & Bettiza, which, with four of its smoking and grey factory stacks, almost leaned over the sea, and the other, a little bit to the left, the rocky bow of Sustipan (Saint Stephen), launched with its graves, its cypresses, agaves and tamarisks, both of them harmoniously embracing the city port as a kind of a horseshoe“,⁵ as a writer, publicist and politician Enzo Bettiza (1927–2017) (14, 15), a great grandson of the first plant owner Marino Bettiza (1814–1901), grandson of Pietro Bettiza (1856–1928) and son of „šjor Vice“, Vicenzo Bettiza (1861–946)⁶ a lawyer from Split, an Italian and Marija Vušković (1896–?) a Croat, wrote in his memories of the old Split (16) (**Figures 6, 7**).

„The plant comes from the last century, overhanging the sea, with warehouses in the back, leaning on the first slopes of Mt. Marjan, it was situated, as I said, in the immediate vicinity of Sustipan rocks“ Bettiza continued his description. „The graveyard is even today naked and deserted, still with no hotel there, while a tall and sad greenish

⁵ The plant below Marjan was also immortalised by the painter from Split Emanuel Vidović (1870 – 1953) in a veduta from 1919 (23).

⁶ Uncertain year of death, estimated – also year of death of his son Marin – according to recollection of Enzo Bettiza (12, p. 235).



SLIKA 6. Pogled na cementaru Gilardi & Bettiza (1926.) iz gradske luke, Zbirka Muzeja grada Splita (8)

FIGURE 6. *View of the Gilardi & Bettiza cement plant (1926) from the city port, Collection of the Split City Museum (8)*

Iz pozamašne knjige, svojevrsnog autobiografskog romana sina posljednjega vlasnika tvornice iz obitelji Bettiza, saznajemo malo ili ništa o obiteljskoj tvornici, o njezinoj proizvodnji i tehnologiji, ali se tvornica provlači kroz knjigu kao lajtmotiv obiteljskog života i zbivanja u „velom mistu“ – u vrijeme kada je „velo“ još bilo malo: 1910. godine Split je imao oko 22 000, a 1930. 35 000 stanovnika. Činjenica da je tvornica bila izgrađena tik uz gradsko, „sustipansko“ groblje, dala joj je posebno obilježje jer je svaka pogrobna povorka trebala pokraj nje proći i, još više, ceremonijalno se zadržati pred njezinim željeznim vratima:

Najposlije iznenađenje. Kao nekim neočekivanim poremećajem, rekao bih gotovo čarolijom ili nepredvidivim svetogrđem povorka bi se zaustavila pred ogromnim željeznim vratima tvornice cementa. I tu kao



SLIKA 7. Enzo Bettiza (1927. – 2017.), sin posljednjega vlasnika tvornice iz obitelji Bettiza (15)

FIGURE 7. *Enzo Bettiza (1927–2017), the son of the last owner of the cement plant from the Bettiza family (15)*

cube of a hotel, of nine or maybe twelve floors.⁷ (13, p. 109) The most vivid memories from child-

⁷ Enzo Bettiza speaks here of the hotel Marjan, built in 1963 on the location of the former plant.

da bi nastao preokret i poremećaj polaganog i urednog ritma svetog pogrebničkog čina. Pred vratima tvornice uvijek se odjednom upletao neodoljivom fizičkom silom, energičan i okosit obiteljski pogrebnik. To odlučno ali i sračunato tehničko uplitanje Bepa Mitrovića, koji je sav bio glas i pokret, sav napregnut da organizacijskom obredu pokopa dade pretposljednji zamah, a zapravo je dotad strogoj pogrebnoj svečanosti pridodavao iznenadno i malo neočekivano ubrzanje. Liturgijska čednost i sredenost obreda odjednom se raspadala, u sve više pomamnom, vrtložnom, bučnom gotovo zagušujućem gibanju... Nehotična vis comica, izazvana mušičavom ličnosti patuljastog ali oštrog pogrebnika, iz nutrine kojega je strujio fluid tajanstvene i zarazne zvonke energije, sručila bi se poput užarene dijabolične ludosti nad općom tugom za pokojnikom i odmah je narušila i razbila u tisuću komadića. (13, str. 110)

„Nehotična vis comica“ obiteljskog pogrebnika, koju spominje Enzo Bettiza u citiranom odlomku, proživljala je u to vrijeme život u Splitu, pa i život u samoj tvornici. Na str. 168–169 autor opisuje „splitskog Caruza“, možda najpoznatijeg splitskog *ridikula*. Kada se jednog jutra taj nesuđeni operni pjevač pojavio među brojnim skupljačima milostinje pred uretima tvornice, Enzijeve ga je otac pozvao hrvatskim dalmatinskim dijalektom (inače je „šjor Vice“ govorio talijanski, venecijanskim dijalektom) pružajući mu slušalicu crnog telefona: „Caruso moj lipi, evo ti u telefon direkcija milanske Skale. Ajde zapivaj ‚lucean le stelle‘. Ako im zapiš ariju kako treba, oni će te sigurno po-

hood tied him to this family-owned factory: „I remember particularly those sand-colored bags, hard, bulging, coarse to touch, not of cardboard but of Indian jute, with a compact bluish seal which glamorously proclaimed: *Split – Gilardi & Bettiza – Prva dalmatinska tvornica cementa Portland – Osnovana 1865.*“ (13, str. 169)

This sizable book, a kind of autobiographical novel written by the son of the last plant owner from the Bettiza family, tells us little or nothing about the family plant, its production and technology. However, the plant sweeps through the book as a leitmotif of family life and events in „Velo Misto“ („big town“) – at the time when big was still small: Split had some 22 000 inhabitants in 1910, and around 35 000 in 1930. The fact that the factory was built in the immediate vicinity of the town „Sustipan“ graveyard gave it a special mark as every funeral procession passed by its fence and, even more significantly, stopped ceremonially by its iron gate.

Finally a surprise. As by some unexpected disturbance, by magic, I would say, or unpredictable sacrilege, the procession would stop at the enormous iron gates of the cement plant. This is the spot where a slow and tidy rhythm of the holy funeral rite would be disturbed. Energetic and brusque family undertaker would suddenly interfere using unstoppable physical force at the factory gate. This determined, but also calculated, technical interference of Bepo Mitrović, who was transformed completely into a voice and movement, was strenuously aimed at giving the organisation of funeral rites a penultimate swing, while in reality the funeral ceremony, previously quite strict, was given a sudden and unexpected small push. Liturgical purity and neatness of the ceremony would suddenly disintegrate in a more and more frantic, turbulent, noisy, almost deafening movement... Unintentional vis comica, caused by the

zvati odma u Milano“. Ridikul se odmah prihvatio posla uz „razonodan smijeh moga oca, strica Giannija, arheologa Bulića, ukopnika Mitrovića i činovnika koji su se tiskali oko njega.“ Neočekivanoj predstavi pridružilo se i mnoštvo pred tvornicom jer su „vani skupljači milostinje zviždali i pljeskali, dok su cigani udarajući u doboše natjeravali svoga nezgrapnog medvjeda da pleše u laganom ritmu bolne pučinijevske melodije.“ (13, str. 169) O tome piše i Inoslav Bešker, „Šjor Vice Bettiza bio je veseljak, glendižav u privatnom životu (on je organizirao putovanje splitskog ‘Karuzá’ u Metropolitan), bio je ozbiljan i pošten industrijalac austrijskog kova, navikao na zadanu riječ“, pa nije jasno je li smisaoENZOVA oca za šalu išla tako daleko da je splitskom ridikulu priuštio putovanje preko oceana ili je, vjerojatnije, tu zgodu Inoslav Bešker čuo iz treće ruke, u njezinoj iskrivljenoj verziji.

Taj ležerni mediteranski, pravo rečeno starosplitski život očitovao se i u radu tvornice. Tvornica cementa podno Marjana nije funkcionirala po strogom načelu poduzeća, radnici u njoj nisu bili, kao u drugim dalmatinskim tvornicama, „pretežnim dijelom regrutirani sa sela, pa su i dalje nastavljali živjeti na selu“ (4, str. 114) zadržavajući seoski („vlaški“) način života i odijevanja. Radnici obitelji Bettiza bili su većinom Splićani,⁸ a obitelj je vodila

impulsive personality of the dwarfish but harsh undertaker, who emitted from his inner self a fluid of mysterious and contagious reverberant energy, would crash like a flaming diabolical madness onto the feeling of grief for the deceased, and would immediately undermine it and break it into a thousand tiny pieces. (13, p. 110)

„Unintentional vis comica“ arranged by the family undertaker, mentioned by Enzo Bettiza in the chapter quoted above, used to permeate the life in Split, as well as the life in the plant. On pages 168–169 the author described „Split’s Caruzo“, probably the most famous Split *ridicule*. When, one morning, this would-be opera singer appeared among numerous charity collectors in front of the plant offices, Enzo’s father called him in the Croatian Dalmatian dialect (otherwise „šjor Vice“ was speaking Italian, Venice dialect), handing him the black handset of his office phone: „My dear Caruso, here is the management of Scala in Milan. Sing for them, lucean le stelle. If you sing it properly, they will certainly at once invite you to Milan“. The *ridicule* got down to the assigned work immediately, accompanied by „merry laughter from my father, uncle Gianni, the archaeologist Bulić, undertaker Mitrović and the clerks who crowded around him.“ The unexpected performance was readily joined by the crowd in front of the plant, as „charity collectors outside whistled and applauded, while Gypsies were beating their drums and forcing their clumsy bear to dance in the easy rhythm of the poignant Puccini’s melody.“ (13, p. 169) Inoslav Bešker also writes of the same: „Šjor Vice Bettiza was a jolly man, a prankster in private life (he was the one who organised the trip of Split’s „Caruzo“ to Metropolitan). Otherwise, he was a serious and honest businessman of the Austrian sort, always keeping his word“, From all of this, it is not quite clear whether his sense of hu-

⁸ Radnici tvrtke Gilardi & Bettiza bili su i dobro plaćeni. Ovisno o radnom mjestu i kvalifikaciji imali su 1920. nadnicu od 26,25 do 28,75 kruna, dok su u drugim dalmatinskim cementarama i rudnicima lapora primali 15 do

tvornicu kao seljačku zadrugu ili, bolje, živjela je i radila slično kako su nekoć radili i živjeli obrtnici (pod istim krovom sa svojom radionicom i radnicima):

I u nas, upravo kao u Buddenbrookovih, kuća u kojoj smo živjeli fiziološki se proizvodila u urede, u spremišta, u konjušnice, u sveta stovarišta i skladišta robe. I u nas institucija otkaza praktično nije postojala. I radnici i posluga gotovo su uvijek ostajali doživotno vezani za gospodarevu obitelj. Cehovski duh bio je slabo razvijen ili sasvim odsutan. Ograde između vlasnika, radnika, kočijaša, šofera i posluge bijahu prilično giblijive i probodne; ako bi skladištar, načinivši nekoliko koraka, prešao iz skladišta u kuću, mogao je ponekad pomoći u nekom iznenadnom kućnom poslu; u drugom je slučaju sluga mogao zamijeniti oboljelog radnika ... Umjesto da ih umirove često su pojedine privržene radnike, koji zbog starosti više nisu mogli obavljati teške fizičke poslove u tvornici ili građevinskom poduzeću, premještali na lakše kućanske poslove.“ (13, str. 166)

O samoj tvornici, Enzo Bettiza piše malo. „Građevina koju opisujem predstavljala je samo dio posjeda, onaj najstariji i najosobniji“, piše autor o svojoj obiteljskoj kući. „Drugi su važni dijelovi, velika tvornica cementa sa svoja četiri dimnjaka nadvita nad lukom, zatim odmah do nje manja tvornica specijalizirana za izradu opeka i proizvoda od cementa (cijevi, pločice, mozaici, ukrasni predmeti), najzad majdani tupine koji su snabdije-

20 kruna. U to je vrijeme kilogram crnog kruha stajao 10, a odijelo 3 000 kruna (4, str. 118).

mour went so far as to pay the *ridicule* a transatlantic trip, or, which is more probable, Inoslav Bešek heard the anecdote from a third person, in its distorted version.

This relaxed Mediterranean, better to say old Split, way of life was reflected in the workings of the plant as well. The cement plant at the slopes of Mt. Marjan did not operate according to the strict corporation rules. The workers were not, unlike many other Dalmatian factories, „mostly recruited from rural parts, continuing to live in their villages“ (4, p. 114) maintaining their rural („vlaški“) way of life and clothing. The workers employed by the family Bettiza were mostly citizens of Split,⁸ while the family managed the plant as a peasant cooperative, or, better to say, the plant lived and worked in the manner craftsmen used to live and work before (under the same roof with their workshops and workers):

In our family, just like with the Buddenbrooks, the house where we lived physiologically grew into offices, storages, stables, into holy warehouses with goods. The Institute of dismissal was practically unknown in our plant as well. Both workers and servants were almost always connected to the master family for life. Guild spirit was poorly developed or not present at all. Barriers between owners on one side and workers, coachmen, drivers and servants were rather flexible and passable; if a storekeeper, making just a few steps, crossed from his storage to the house, he could sometimes help with unexpected housework; alternatively, a servant could replace a worker on sick leave...

⁸ The workers in the company of Gilardi & Bettiza were well paid, as well. Depending on the position and skills, their daily wage was from 26.25 to 28.76 krunas in 1920, while the other Dalmatian cement plants and marl mines paid their worker from 15 to 20 krunas. A kilo of black bread cost 10 krunas at the time, and men's suit 3000 krunas (4, p. 118).

vali sirovinom, moderno opremljeni wagonetima i kolosijecima, čime se upravljalo u suvlasništvu, koje ponekad bijaše i konfliktno, s obitelji Gilardi.“ (13, str. 166–167)

O tom drugom suvlasniku, obitelji Gilardi (17), saznajemo iz knjige malo. Čitamo samo da je Protasio Gilardi (1869. – 1917.), bio svadljivac i „čangrizalo“ (13, str. 167), „čudan, nikad zadovoljan ortak“ (13, str. 137), dok je njegov brat Lorenzo bio „čovjek više odan lovu i ribolovu nego poslovima.“ (13, str. 114)

Iz knjige na kraju saznajemo i o prodaji tvornice novom vlasniku, Marinu Feriću (1859. – 1936.) godine 1929. Takva je odluka uzrokovana privrednom krizom, „smrću Gilardija i nestankom njihove dinastije“, te „teškom nedorečenošću oporuka koje su ostavili djed i stric Nane.“ (13, str. 198) Propasti tvornice kumovao je i sin Marin (1922. – 1946.), vlasnik tvornice tjestenine „Marino Bettiza“ koja je bila vezana s cementarom, pa kad ju je Marin, inače nesklon poslovima, upropastio, morala je kao hipoteka otići i cementara: „Moralna sramota, propast bez ostatka; Split još nije vidio sličnu i tako naglu ekonomsku katastrofu.“ (13, str. 234)

Zaključak

Iako se tvornica cementa Gilardi & Bettiza nalazila u današnjem gradskom centru, u samoj gradskoj luci, kilometar udaljena od Dioklecijanove palače, za njezino postojanje mnogi Splitsani nisu čuli, pa o njoj ne znaju ni studenti koji su došli studirati na tamošnjem Tehnološ-

Instead of retiring individual loyal workers who were too old to work on heavy physical jobs in the plant or building company, the owners transferred them to lighter housework.“ (13, p. 166)

Enzo Bettiza did not write much of the plant itself. „The building I am describing represents only a part of the estate, the oldest and the most personal one“, the author wrote of his family house. „The other important parts were the big cement plant with its four stacks overhanging the port, then, right beside it, a smaller plant specialised for brick and cement articles production (pipes, tiles, mosaics, decorative articles), and, finally marl mines which fed raw material to the plant, equipped with modern wagonettes and rails. All of this was managed in a co-ownership with the family of Gilardi, sometimes resulting in conflicts.“ (13, p. 166–167)

The book tells us a little about the other co-owner, the family Gilardi. (17) We can only read that Protasio Gilardi (1869–1917) was a quarreller and grumpy (13, p. 167), „a strange, never satisfied partner“ (13, p. 137), while his brother Lorenzo was „a man fonder of hunting and fishing than business.“ (13, p. 114)

The book finally tells us of selling the plant to the new owner, Marin Ferić (1859–1936) in 1929. The decision to sell was caused by the economic crisis, „the death of Gilardi and disappearance of their dynasty“, as well as by „extreme vagueness of the will left by the grandfather and uncle Nane.“ (13, p. 198) The son Marin (1922–1946), the owner of the pasta factory „Marino Bettiza“, linked with the cement plant, also contributed to the ruin of the company. Marin, quite inapt for business, ruined his company and the cement plant went with it as a mortgage guarantee. „moral disgrace, ruin with no remainder; Split has not seen similar and so sudden economic catastrophe ever.“ (13, p. 234)

kom fakultetu (18). O vlasnicima tvornice, članovima obitelji Bettiza, ne bi se pak ništa znalo da jedan njezin izdanak, spomenuti Enzo Bettiza nije napisao knjigu (13). U *Hrvatskom bibliografskom leksikonu* nalazimo samo jednog člana te obitelji, slikara Petra Beticu (Bettiza), rođenog u Splitu 1891. godine s nepoznatim mjestom i godinom smrti (19), dok *Jugoslavenska enciklopedija* tvornicu Gilardi – Bettiza spominje samo u jednoj rečenici pet stranica dugog članka o Splitu (20). Istina je da su Talijani prednjačili u industrijalizaciji Dalmacije, no tvornice uz hrvatsku obalu Jadrana sigurno su više utjecale na hrvatsku nego na talijansku sredinu.

Više se o tvornici i o obiteljima njezinih vlasnika (Gilardi, Bettiza, Ferić) može saznati iz talijanskih izvora (12, 16, 17)⁹, čemu je uzrok i nemarni odnos prema industrijskoj baštini. Prema uskom shvaćanju, povijest bi trebalo učiti radi razvoja nacionalne svijesti, pa bi se historiografija trebala baviti samo kulturom, umjetnošću i nacionalnom politikom („borbom za državnost“), dok bi povijest znanosti i industrije, posebice ako je u njoj očit utjecaj stranaca, trebalo prepustiti stručnjacima – ako bi oni imali volje da se bave povijesnim istraživanjima (21, 22). Takav odnos

⁹ Tijekom talijanske okupacije Dalmacije (1941. – 1944.) opljačkani su muzeji, zbirke umjetnina i arhivi, temelj proučavanja povijesti. Talijani su odnijeli stare dokumente i rukopise, opustošili korčulanski, lastovski, trogirski i splitski arhiv; samo je u rujnu 1943. iz Zadra prebačeno 157 sanduka punih arhivskoga materijala (24) (*op. ur.*).

Conclusions

Although the cement plant Gilardi & Bettiza was situated in what is today the town center, in the town port itself, only a single kilometer away from the Diocletian palace, many inhabitants of Split have never heard of it, including the students who come to study there at the Faculty of Technology (18). Plant owners, members of the Bettiza family, would not be remembered at all unless one of their offspring, Enzo Bettiza, had not written a book (13). *Croatian Bibliographical Lexicon* mentions only one member of the family, painter Petar Betica (Bettiza), born in Split in 1891, with an unknown place and year of death (19), while the *Yugoslav Encyclopaedia* mentions the factory Gilardi–Bettiza in one sentence only in the article on Split, five pages long (20). The truth is that although Italians were the pioneers of industrialisation in Dalmatia, factories at the Croatian shore of the Adriatic had a more profound impact on the Croatian than the Italian social environment.

Italian sources offer more information on the plant and on the families of its owners (Gilardi, Bettiza, Ferić) (12, 16, 17)⁹, a sloppy approach to the industrial heritage being of paramount importance here. To a narrow-minded view, history should be studied exclusively as a tool in developing national awareness, thus historiography is supposed to deal only with culture, art and national politics („struggle for statehood“), while the history of science and industry, especially if the impact of foreigners is obvious in them, should be left to experts

⁹ During the Italian occupation of Dalmatia (1941–1944) museums, collections of artworks and archives, bases in studying history, were looted. The Italians took away old documents and manuscripts, devastate archives in Korčula, Lastovo, Trogir and Split. In September 1943 only, the Italians carried away 157 crates full of archive material from Zadar (24) (*editor's note*).

prema povijesti na kraju dovodi da „zaboravljamo mnogo toga što nikako ne bismo smjeli zaboraviti“, no danas – zahvaljujući duhu liberalizma – živimo samo u sadašnjosti, „u svijetu u kojem je amnezija poželjno stanje“ (18).

– provided they were in the mood to deal with historical research (21, 22). Such an approach to history finally results in that „we forget a lot of things we should never forget“. However, due to the spirit of liberalism, we live in present only, „in the world where amnesia is a desirable state of affairs“ (18).

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Devedeset godina znanstvenog časopisa *Acta Adriatica* (1932. – 2022.)*

Ninety years of the scientific journal *Acta Adriatica* (1932–2022)*

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SAŽETAK

Acta Adriatica je primarna znanstvena publikacija s međunarodnom recenzijom, duge tradicije, koju Institut za oceanografiju i ribarstvo u Splitu neprekidno izdaje od 1932. U početku je časopis bio interno glasilo institucije, a danas je to ugledni znanstveni časopis u kojem svoje radove objavljuju znanstvenici i stručnjaci iz gotovo cijelog svijeta. Do kraja 2022. objavljena su ukupno 62 sveska s ukupno 1 048 znanstvena rada u čijem je pisanju sudjelovalo oko tisuću autora. Uključivanje časopisa u svjetske znanstvene tijekove zahtijevalo je i međunarodnu vidljivost i prepoznatljivost, stoga je uredništvo ulagalo i dalje ulaže velike napore da se časopis uključi u gotovo sve svjetske baze podataka, kako bi objavljeni radovi postali što dostupniji širokoj znanstvenoj zajednici. Unatoč svim pro-

SUMMARY

Acta Adriatica is the primary scientific publication with an international review, a long tradition, which the Institute of Oceanography and Fisheries in Split has been publishing continuously since 1932. In the very beginning, the journal was an internal journal of the institution, and today it is a reputable scientific journal in which scientists and experts from almost all over the world publish their works. By the end of 2021, a total of 62 volumes with a total of 1,048 scientific papers were published, in the writing of which about 1,000 authors participated. The inclusion of the journal in the world scientific trends required both international visibility and recognition, so the Editorial Board has made and continues to make great efforts to include the journal in almost all global databases, as published papers become more accessible to the general scientific community. Despite all the changes and future

* Članak je djelomice referiran na znanstvenom skupu *Hrvatski prirodoslovci* 31, Split, 25. – 26. studeni 2022.

* *The paper was partially referred at the scientific meeting Croatian naturalists* 31, Split, Croatia, November 25–26, 2022.

mjenama i budućim težnjama, glavni je cilj izdavanja časopisa *Acta Adriatica* ostaje nepromijenjen: objavljivati kvalitetne izvorne znanstvene i pregledne radove na multidisciplinarnoj razini koji će pomoći još boljem razumijevanju Jadranskoga i Sredozemnog mora i tako postati još bogatija riznica znanja o njima. *Acta Adriatica* je časopis u otvorenom pristupu, što znači da je sadržaj časopisa u cijelosti besplatno dostupan.

KLJUČNE RIJEČI

Acta Adriatica

– Institut za oceanografiju i ribarstvo Split
– 90 godina izlaza (1932. – 2022.)

Sadržaj znanstvenih članaka

Od ukupno dosad objavljenih radova oko 70 % ih je iz područja biologije (**biologija mora**, i to uglavnom biologija i ekologija riba u Jadranskom i Sredozemnom moru). Od toga se 11 % članaka bavi temama važnim za gospodarski ribolov, procjena biomase riba izravnim i neizravnim metodama, marikultura, lagunarno ribarstvo i uzgoj školjkaša), 10 % su teme iz **fizike mora** (fizička oceanografija, optika mora, geostrofička strujanja, „jadranske ingresije“ i ostalo), a 10 % je iz **kemije mora** i zagađenja mora (količina i raspodjela hranjivih tvari, eutrofikacija, teški metali u morskoj vodi i sedimentima, utjecaj čovjeka i njegovih aktivnosti na morski ekosustav, sadržaj polutanata: ulja, deterdženta i pesticida). Preostalih oko 10 % članaka su prilozi iz raznih područja – geologija mora, alati i tehnike ribolova, povijest istraživanja mora, interdisciplinarnosti i drugo.

aspirations, the main goal of *Acta Adriatica* remains unchanged: to publish quality scientific original and review papers at a multidisciplinary level that will help to better understand the Adriatic and Mediterranean Seas and thus become an even richer treasure trove of knowledge about them. *Acta Adriatica* is an open access journal, the content of the journal is available free of charge.

KEYWORDS

Acta Adriatica, journal

– Institute of Oceanography and Fisheries
Split
– 90 years of publication (1932–2022)

Content of scientific papers

Of the total papers published so far, about 70% are from the field of **biology** (marine biology, mainly the biology and ecology of fish in the Adriatic and Mediterranean Seas). Of these, 11% of articles deal with topics important for commercial fishing, estimation of fish biomass by direct and indirect methods, mariculture, lagoon fisheries and shellfish farming), and 10% are topics from **marine physics** (physical oceanography, marine optics, geostrophic currents, „Adriatic ingressions“ and others), and 10% is from **marine chemistry** and marine pollution (amount and distribution of nutrients, eutrophication, heavy metals in seawater and sediments, the impact of man and the impact of man and his activities on the marine ecosystem, the content of pollutants: oil, detergents and pesticides). The remaining 10% of the articles are contributions from various fields – marine geology, fish-

Bilo bi vrlo zahtjevno i preopširno predstaviti sadržaj svih objavljenih članaka pojedinačno pa je stoga prikazan pregled najvažnijih tema s naznakom nekih važnih rezultata. Članci iz znanstvenog polja biologija (područje prirodnih znanosti) (poglavito iz sistematike i ekologije) od samog početka imali moderan i multidisciplinarn pristup,

U seriji *Monografija* do sada je objavljeno pet priloga: *Ecology of plankton stages of the anchovy in the central Adriatic; Ecological study of Prosobranchiata in the eastern part of the Adriatic sea; The taxonomy, distribution, and ecology of Adriatic Foraminifera; Biology, population dynamics and fisheries case study of anchovy; Tintinnids (Tintinnida, Choerotruchia, Ciliata) in the Adriatic Sea, Mediterranean, Part I Taxonomy and Part II Ecology.*

Istraživanja flore i faune Jadranskoga i Sredozemnog mora bila su predmet brojnih radova, uključivala su inventarizaciju, katalogizaciju, revizije te ključeve za određivanje različitih taksonomskih kategorija. Istraživane su neke nove ili slabo poznate vrste bentoskih algi uz revizije nekih obitelji i opisane posve nove vrste. Na osnovi florističkih i ekoloških istraživanja litoralni pojas Jadranskoga mora je podijeljen u nekoliko bionomskih stepenica. U neposrednoj blizini nekih većih gradova uočene su promjene u sastavu i raspodjeli bentoskih algi kao posljedica intenzivnih zagađenja. Objavljena su i istraživanja epifitskih algi u naseljima cvjetnice *Posidonia oceanica* u nekim dijelovima Jadranskoga mora. Također su objavljeni rezultati istraživanja prehrane ribe salpe *Sarpa salpa*, inače herbivorne vrste, kao i

ing tools and techniques, history of marine research, interdisciplinary sciences and others.

It would be very demanding and too extensive to present the content of all published papers individually, so an overview of the most important topics with an indication of some important results is presented. Papers from the scientific field of biology (field of natural sciences) (mainly from systematics and ecology) had a modern and multidisciplinary approach from the very beginning,

So far, five articles have been published in the *Monograph* series: *Ecology of plankton stages of the anchovy in the central Adriatic; Ecological study of Prosobranchiata in the eastern part of the Adriatic sea; The taxonomy, distribution, and ecology of Adriatic Foraminifera; Biology, population dynamics and fisheries case study of anchovy; Tintinnids (Tintinnida, Choerotruchia, Ciliata) in the Adriatic Sea, Mediterranean, Part I Taxonomy and Part II Ecology.*

Investigations of the flora and fauna of the Adriatic and Mediterranean Seas were the subject of numerous papers, including inventory, cataloging, revisions and keys for determining different taxonomic categories. Some new or poorly known species of benthic algae were investigated, along with revisions of some families and completely new species were described. On the basis of floristic and ecological research, the littoral zone of the Adriatic Sea is divided into several bionomic steps. In the immediate vicinity of some larger cities, changes in the composition and distribution of benthic algae have been observed as a result of intense pollution. Research on epiphytic algae in the settlements

utjecaja kaveznog uzgoja riba na makroben-toske zajednice.

Od ukupno dosad objavljenih rado-va oko 70 % članaka je iz područja bio-logije (**biologija mora**, i to uglavnom biologija i ekologija riba u Jadranskom i Sre-dozemnom moru), od toga se 11 % člana-ka unutar biologije bavi temama važnim za gospodarski ribolov, procjena biomase riba izravnim i neizravnim metodama, marikul-tura, lagunarno ribarstvo i uzgoj školjkaša), 10 % su teme iz **fizike mora** (fizička ocea-nografija, optika mora, geostrofička stru-janja, „jadranske ingresije“ i ostalo), a 10 % je iz **kemije mora** i zagađenja mora (količi-na i raspodjela hranjivih tvari, eutrofikacija, teški metali u morskoj vodi i sedimentima, utjecaj čovjeka i njegovih aktivnosti na mor-ski ekosustav, sadržaj polutanata: ulja, de-terdženta i pesticida). Preostalih oko 10 % članaka su prilozi iz raznih područja – geo-logija mora, alati i tehnike ribolova, povijest istraživanja mora, interdisciplinarni znanosti i drugo.

Bilo bi vrlo zahtjevno i preopširno pred-staviti sadržaj svih objavljenih članaka po-jedinačno pa je stoga prikazan pregled naj-važnijih tema s naznakom nekih važnih rezultata. Članci iz znanstvenog polja bio-logija (područje prirodnih znanosti) (pogla-vito iz sistematike i ekologije) od samog su početka imali moderan i multidisciplinarni pristup,

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of the flowering plant *Posidonia oceanica* in some parts of the Adriatic Sea has also been published. Also published were the results of research into the feeding of salpa fish *Sarpa salpa*, otherwise a herbivorous species, as well as the impact of cage farming of fish on macrobenthic communities. Original scientific works on the biochemical composition of some Adriatic algae and flower-ing plants have also been published.

In volume 46, appendix 1, from 2005, the re-sults of a long-term study (1947–1971) of the morphology, systematics and ecology of the ge-nus *Sargassum* collected along the eastern coast of the Adriatic sea were presented (The genus *Sargassum* in the Adriatic sea: Morphology, sys-tematics and ecology), while the results of the benthos survey in the Senj Archipelago area were published in the second issue of the journal in the same year (*A benthos survey of the Senj Archi-pelago*).

A significant number of works are devo-ted to phytoplankton research, primarily to re-search on the relationship between different species and groups, biomass and primary pro-duction. The results are based on constant sam-pling at certain control stations in the middle Adriatic, along with monitoring the fluctuations of the phytoplankton community in space and time. Papers were also published on the results of research into the structure and size of phyto-plankton in relation to density, biomass and pri-mary production, with the aim of better under-standing food chains in the marine ecosystem. Such research enables the calculation of the den-sity, biomass and production of phytoplankton during the process of eutrophication, as well as

ology, population dynamics and fisheries case study of anchovy; Tintinnids (Tintinnida, Choerotruchia, Ciliata) in the Adriatic Sea, Mediterranean, Part I Taxonomy and Part II Ecology.

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Objavljeni su i originalni znanstveni radovi o biokemijskom sastavu nekih jadranskih algi i cvjetnica. Objavljeni su i originalni znanstveni radovi o biokemijskom sastavu nekih jadranskih algi i cvjetnica. U svesku 46., dodatku 1, iz 2005. izneseni su rezultati dugoročne studije (1947. – 1971.) morfologije, sistematike i ekologije svoje *Sargassum* sakupljene uzduž istočne obale Jadranskoga mora (*The genus Sargassum in the Adriatic sea: Morphology, systematics and ecology*), dok su drugom broju časopisa iste godine objavljeni rezultati istraživanja

the occurrence of characteristic species in coastal waters. A little later, such research was also carried out in the open waters of the Adriatic Sea. The results of research into the impact of the Suez Canal on phytoplankton communities in Egyptian waters and the impact of Black Sea water in the coastal zone along the Greek coast are also significant.

The early developmental stages of fish were also a very frequent topic of scientific papers published in the journal *Acta Adriatica*, as well as the taxonomic composition and seasonal and long-term fluctuations of zooplankton biomass under the influence of the environment. One of the most important zooplankton groups Copepoda is also significantly represented in published works. Most of the works on zooplankton refer to the Adriatic Sea, but we should not ignore the works relating to the Eastern Mediterranean and the Aegean Sea.

Various aspects of microbiological research are described in more than twenty original scientific papers. The daily, seasonal, horizontal and vertical distributions of heterotrophic bacteria and their role in the sulfur and nitrogen cycle in the central and southern Adriatic were investigated. There are also papers presenting the results of the relationship between heterotrophic bacteria, phytoplankton and zooplankton. The presence of *Rhodospseudomonas* sp. (which contains a red pigment of carotenoid nature) explains the appearance of the „red tide“ phenomenon in the upper layers of the „sea lakes“ on the island of Mljet. In 2013, a paper was published on the structure of the microbial community in anchialine caves on the island of Mljet. There are

bentosa na području Senjskog arhipelaga (*A benthos survey of the Senj Archipelago*).

Značajan broj radova posvećen je istraživanjima fitoplanktona, prije svega istraživanju odnosa između različitih vrsta i skupina, biomase i primarne proizvodnje. Rezultati se temelje na stalnom uzorkovanju na određenim kontrolnim postajama u srednjem Jadranu uz praćenje kolebanja fitoplanktonske zajednice u prostoru i vremenu. Također su tiskani i radovi o rezultatima istraživanja strukture i veličine fitoplanktona u odnosu na gustoću, biomasu i primarnu proizvodnju, a u svrhu boljšeg poznavanja hranidbenih lanaca u morskom ekosustavu. Takva istraživanja omogućuju izračun gustoće, biomase i proizvodnje fitoplanktona tijekom procesa eutrofikacije, kao i pojave karakterističnih vrsta u priobalnim vodama. Nešto kasnije takva su istraživanja obavljena i u otvorenim vodama Jadranskog mora. Značajni su i rezultati istraživanja utjecaja Sueskog kanala na fitoplanktonske zajednice u egipatskim vodama te utjecaja crnomorske vode na priobalni pojas uzduž grčke obale.

Rani razvojni stadiji riba također su bili vrlo česta tema znanstvenih radova tiskanih u časopisu *Acta Adriatica*, kao i taksonomski sastav te sezonska i dugoročna kolebanja biomase zooplanktona pod utjecajem okoliša. Jedna od najvažnijih zooplanktonskih skupina Copepoda također je značajno zastupljena u objavljenim radovima. Većina radova o zooplanktonu se odnosi na Jadransko more, no ne treba zanemariti ni radove koji se odnose na istočno Sredozemlje i Egejsko more.

Različiti aspekti mikrobioloških istraživanja opisani su u više od dvadeset origi-

more and more works on the quality of seawater and shellfish in relation to the presence of bacteria, as well as those that indicate the influence of various factors on the dispersion and duration of fecal pollution.

There are also numerous works on the biology and ecology of pelagic and demersal fish species, those in the Adriatic Sea, and those in the waters of Italy, Israel, Egypt, North Africa, the Aegean Sea, and the Senegalese coast. Some species, such as mackerel, pilchard, mullet, some crustaceans and the crab shrimp *Neprophs norvegicus*, have been investigated in more detail. In 26 papers, it was written about the nutrition of fish in almost all parts of the Adriatic, in the eastern Mediterranean and along the coast of the northern part of Africa. In these papers, there are also those on the estimation of fish biomass indirect and direct methods used in fisheries biology. Works from the fields of mariculture, shellfish farming and lagoon fisheries have also been published.

Volume 40 (issue 3) 2005 is dedicated to the famous Croatian ichthyologist Juraj Kolombatović, who is noted in world ichthyological science for the first description of seven species of fish. In the same issue, a paper titled *Evolutionary steps in ichthyology and new challenges* was published, one of the few in the field of history of science that provides a brief overview of the development of ichthyology.

Numerous investigation of benthos has been published for almost all areas of the Adriatic and some parts of the Mediterranean. Volume 37 (issue 1/2) published the results of interdisciplinary research in the northern Adriatic, where

nalnih znanstvenih radova. Istraživane su dnevne, sezonske, horizontalne i vertikalne distribucije heterotrofnih bakterija i njihove uloge u ciklusu sumpora i dušika u srednjem i južnom Jadranu. Također su zastupljeni radovi u kojima se iznose rezultati odnosa između heterotrofnih bakterija, fitoplanktona i zooplanktona. Prisutnošću vrste *Rhodospseudomonas* sp. (koja sadrži crveni pigment karotenoidne prirode) objašnjava se pojava fenomena „red tide“ u gornjim slojevima „morskih jezera“ na otoku Mljetu. Godine 2013. objavljen je rad o strukturi mikrobnе zajednice u anhialinim špiljama na otoku Mljetu. Sve su brojniji radovi o kvaliteti morske vode i školjkaša u odnosu na prisutnost bakterija, kao i onih koji ukazuju na utjecaj različitih čimbenika na disperziju i trajanje fekalnih onečišćenja.

Također su brojni i radovi o biologiji i ekologiji pelagičkih i demersalnih vrsta riba, onih u Jadranskom moru, i onih u vodama Italije, Izraela, Egipta, Sjeverne Afrike, Egejskog mora i Senegalske obale. Neke vrste, kao što su skuša, srdela, cipli, neke hrskavičnjače te rak škamp *Neprophs norvegicus*, su detaljnije istraživane. U 26 radova pisano je o prehrani riba u gotovo svim dijelovima Jadrana, u istočnom Sredozemlju te uzduž obale sjevernog dijela Afrike. U tim radovima ima onih o procjeni biomase riba neizravnim i izravnim metodama koje se koriste u ribarstvenoj biologiji. Također su objavljeni i radovi iz područja marikulture, uzgoja školjkaša te lagunarnog ribarstva.

Svezak 40 (sveščić 3) iz 2005. posvećen je znamenitom hrvatskom ihtiologu Juraju Kolombatoviću koji je zabilježen u svjetskoj ihtiološkoj znanosti zbog prvog opisa sedam

the IKA and IVANA oil platforms were installed. Papers were also published on the results of ecological research within the framework of certain projects, for example, the Vir-Konavli project.

Numerous works on physical oceanography from the area of the entire Adriatic and parts of the Mediterranean (Egypt, Greece, Turkey) have also been published, which include the influence of the intermediate Levantine water („Adriatic ingression“) on the hydrographic properties of the Adriatic Sea. One whole issue (Vol. 47, Supplement, 2006) is devoted to physical oceanography („The ADRICOSM Pilot Project: I ADRICOSM Pilot Project: a coastal and river basin prediction system for the Adriatic Sea, Variations of thermal conditions in the southern Adriatic from XBT measurements in the period October 2002 – June 2003, South Adriatic phenomena observable through VOS XBT and other ADRICOSM data, The large scale observing system component of ADRICOSM: the satellite system, The Northern Adriatic Sea hydrographic conditions from October 2002 – September 2003, including the climatic heating anomaly of summer 2003 coastal scale observing system component of ADRICOSM: Gulf of Trieste network, Surface fluxes and thermohaline variability over the ADRICOSM polygon Pelješac–Vis–Drvenik, The S1 buoy station, Po River delta: data handling and presentation, Automatic meteo-ocean station (AMOS): real-time data acquisition, validation, archiving and numerical modeling; Nested modeling of the east Adriatic coastal waters...“).

vrsta riba. U istom broju objavljen je i rad pod naslovom *Evolutionary steps in ichthyology and new challenges*, jedan od rijetkih iz područja povijesti znanosti koji iznosi kratki pregled razvoja ihtiologije.

Objavljena su i brojna istraživanja bentosa u gotovo svim područjima Jadrana i nekim dijelovima Sredozemlja. U svesku 37 (sveščić 1/2) objavljeni su rezultati interdisciplinarnih istraživanja u sjevernom Jadranu, gdje su bile postavljane naftne platforme IKA i IVANA. Tiskani su i radovi o rezultatima ekoloških istraživanja u okviru određenih projekata, npr. Projekt Vir-Konavli.

Objavljeni su i brojni radovi iz fizičke oceanografije s područja cijeloga Jadrana i dijelova Sredozemlja (Egipat, Grčka, Turska), koji obuhvaćaju utjecaj intermedijarne levantinske vode („jadranske ingresije“) na hidrografska svojstva Jadranskog mora. Jedan cijeli broj (Vol. 47, Supplement, 2006) posvećen je fizičkoj oceanografiji (The ADRI-COSM Pilot Project: I ADRI-COSM Pilot Project: a coastal and river basin prediction system for the Adriatic Sea, Variations of thermal conditions in the southern Adriatic from XBT measurements in the period October 2002 – June 2003, South Adriatic phenomena observable through VOS XBT and other ADRI-COSM data, The large scale observing system component of ADRI-COSM: the satellite system, The Northern Adriatic Sea hydrographic conditions from October 2002 – September 2003, including the climatic heating anomaly of summer 2003 coastal scale observing system component of ADRI-COSM: Gulf of Trieste network, Surface fluxes and thermohaline variability over the ADRI-COSM po-

In 2017, a paper on Lagrangian coherent structures of the current field in the Rijeka Bay was published, and in 2018, a paper on eutrophication monitoring using Landsat 8 in the Boka Kotor Bay.

There are more and more works of a multidisciplinary nature that include long-term fluctuations of salinity, transparency and chlorophyll in relation to „Adriatic ingressions“. A certain number of works refer to the optics of the sea in the area of the central and southern Adriatic and to the fluctuations of optical properties over time. Investigation of the dynamics of water masses is represented in more than 25 issues of the journal. The whole area of the Adriatic is spatially covered, from the Gulf of Trieste all the way to the Otranto Gate. Calculations of geostrophic currents in the Adriatic and the eastern Mediterranean have been published for the first time. A paper was also published that shows the impact of the construction of the Aswan Dam on the oceanographic and fishing characteristics of the waters of the Nile River Delta and its somewhat wider surroundings.

Papers in marine chemistry primarily include discussions on the amount and distribution of nutrients and their role in biological cycles. During the last two decades, published results indicate the eutrophication of some areas in the Adriatic, often coastal areas, primarily near larger cities. At the same time, various biochemical entities were investigated, and the pollution process in some areas was also determined. Some studies have established the existence of heavy metals in the sea, in water and sediment, and in organisms. The content of some other pollutants

lygon Pelješac–Vis–Drvenik, The S1 buoy station, Po River delta: data handling and presentation, Automatic meteo-ocean station (AMOS): real-time data acquisition, validation, archiving and numerical modeling; Nested modeling of the east Adriatic coastal waters...).

Godine 2017. objavljen je rad o Lagrangevim koherentnim strukturama strujnog polja u Riječkom zaljevu, a 2018. rad o monitoringu eutrofikacije primjenom Landsat 8 u Bokotorskom zaljevu.

Sve su zastupljeniji radovi multidisciplinarnog karaktera koji obuhvaćaju dugoročnu fluktuaciju saliniteta, transparentnosti i klorofila u odnosu na „jadranske ingresije“. Određeni se broj radova odnosi na optiku mora u području srednjeg i južnog Jadrana te na kolebanja optičkih svojstava u vremenu. Istraživanje dinamike vodenih masa zastupljeno je u više od 25 svezaka časopisa. Prostorno je pokriveno cijelo područje Jadrana, od Tišćanskoga zaljeva pa sve do Otrantskih vrata. Po prvi puta su objavljeni izračuni geostrofičkih strujanja u Jadranu i istočnom Sredozemlju. Objavljen je i rad koji prikazuje utjecaj izgradnje Asuanske brane na oceanografske i ribarstvene značajke voda u delti rijeke Nil i nešto šire okolice.

Radovi iz kemije mora ponajprije obuhvaćaju rasprave o količini i raspodjeli hranjivih tvari te njihovoj ulozi u biološkim ciklusima. Tijekom posljednja dva desetljeća objavljeni rezultati ukazuju na eutrofikaciju nekih područja u Jadranu, često je to obalno područje, primarno u blizini većih gradova. Istodobno su istraživani i različiti biokemijski subjekti, a utvrđen je i proces zagađenja u nekim područjima. Neke su studije utvrđi-

such as oil, detergents and pesticides was also determined. In most of the works, the fact that man is increasingly affecting the marine ecosystem is highlighted.

Marine geology is represented in works related to sedimentation (lakes on the island of Mljet, the channel area of the eastern coast of the Adriatic, Kaštela Bay), hydrogeology (fresh water sources), as well as chalk-foraminifera (Adriatic, waters of Lebanon and Yemen). In 2016, a paper was published on the characterization of the fine-grained surface sediment fraction in the channel area of the eastern side of the Adriatic Sea.

In the last five or six years, a number of very interesting review papers and original scientific articles have been published, such as: *Concentrations and origin of polycyclic aromatic hydrocarbons in sediments of the Middle Adriatic Sea; To what extent the size fraction affects an interpretation of planktonic foraminiferal assemblages – case study from Southern Adriatic; A long term (1949–2010) study of catch and effort in Israeli trawl fishery, Eastern Mediterranean Sea; The abundance, distribution and speciation of mercury in waters and sediments of the Adriatic Sea – a review; Wind storminess in the Adriatic Sea in a climate change scenario; The presence of Tetradontidae species in the Central Mediterranean: an update from the southern Adriatic Sea; Progress in Mediterranean bioinvasions two years after the Suez Canal enlargement, The abundance and speciation of mercury in the Adriatic plankton, bivalves and fish – a review; Setting-up a billboard of marine invasive species in the ESENAS area: current situation and future expectancies; A*

le postojanje teških metala u moru, u vodi i sedimentu i organizmima. Također je utvrđen i sadržaj nekih drugih zagađivača poput ulja, deterdženata i pesticida. U većini radova istaknuta je činjenica kako čovjek sve više utječe na morski ekosustav.

Geologija mora je zastupljena u radovima vezanim uz sedimentaciju (jezera na otoku Mljetu, kanalsko područje istočne obale Jadrana, Kaštelanski zaljev), hidrogeologiju (izvori slatke vode), kao i krednjake-foraminifere (Jadran, vode Libanona i Jemena). Godine 2016. objavljen je i rad o karakterizaciji sitno-zrnaste frakcije površinskog sedimenta u kanalskom području istočne strane Jadranskog mora.

Posljednjih pet-šest godina objavljen je niz vrlo zanimljivih preglednih radova i originalnih znanstvenih članaka, kao što su: *Concentrations and origin of polycyclic aromatic hydrocarbons in sediments of the Middle Adriatic Sea; To what extent the size fraction affects an interpretation of planktonic foraminiferal assemblages – case study from Southern Adriatic; A long term (1949–2010) study of catch and effort in Israeli trawl fishery, Eastern Mediterranean Sea; The abundance, distribution and speciation of mercury in waters and sediments of the Adriatic Sea – a review; Wind storminess in the Adriatic Sea in a climate change scenario; The presence of Tetraodontidae species in the Central Mediterranean: an update from the southern Adriatic Sea; Progress in Mediterranean bio-invasions two years after the Suez Canal enlargement, The abundance and speciation of mercury in the Adriatic plankton, bivalves and fish – a review; Setting-up a billboard of marine invasive species in the ESENIAS*

comparative approach to the Croatian and Montenegrin small-scale fisheries (SSF) in the coastal eastern Adriatic Sea: fishing gears and target species; Seaweeds of the Greek coasts: Rhodophyta excluding Ceramiales; Oil seeps detection and mapping by SAR imagery in the Adriatic Sea; A review of reproduction biology and spawning /nursery grounds of the most important Adriatic commercial fish species in the last two decades and Reproductive traits of the European hake, Merluccius merluccius (L. 1758), in the Adriatic Sea.

Languages in the journal *Acta Adriatica*

The language of the papers published in the journal changed in different periods. At the beginning, the works were printed in the then accepted world languages (French, English, German). Around the 1960s and 1970s, politics required articles in the Croatian language (or Serbo-Croatian). Since the 1980s, English has been the predominant language with a few exceptions, and today only works in English are published. In total, more than 60% of works have been published in English so far. In the earlier period, the titles of articles were printed in the language of the article and in Croatian. Later, the papers were printed only in the language of the journal, and the Croatian title and Croatian summary were printed at the end of the article. Since 2000, the only official language of the journal is English.

Although foreign authors have also published works in *Acta Adriatica* from the very beginning, their share is growing, especially in recent times when it reaches almost more than 50% of works. In the beginning, in most cases,

area: current situation and future expectancies; A comparative approach to the Croatian and Montenegrin small-scale fisheries (SSF) in the coastal eastern Adriatic Sea: fishing gears and target species; Seaweeds of the Greek coasts: Rhodophyta excluding Ceramiales; Oil seeps detection and mapping by SAR imagery in the Adriatic Sea; A review of reproduction biology and spawning/nursery grounds of the most important Adriatic commercial fish species in the last two decades i Reproductive traits of the European hake, Merluccius merluccius (L. 1758), in the Adriatic Sea.

Jezici u časopisu *Acta Adriatica*

Jezik objavljenih radova u časopisu mijenjao se u različitim razdobljima. U početku su radovi tiskani na tada prihvaćenim svjetskim jezicima (francuski, engleski, njemački). Oko 1960-ih i 1970-ih politika je zahtijevala članke na hrvatskom jeziku (ili pak srpsko-hrvatskom). Od 1980-ih engleski jezik je prevladavajući uz nekoliko iznimki, a danas se objavljuju isključivo radovi na engleskom jeziku. Ukupno je do sada na engleskom jeziku objavljeno više od 60 % radova. U ranijem razdoblju su naslovi članaka bili tiskani na jeziku članka i na hrvatskom jeziku. Kasnije su radovi tiskani samo na jeziku časopisa, a hrvatski naslov i hrvatski sažetak tiskani su na kraju članka. Od 2000. godine jedini službeni jezik časopisa je engleski jezik.

Premda su strani autori od samog početka objavljivali radove u *Acta Adriatica*, njihov udjel raste, osobito u novije vrijeme kada doseže gotovo više od 50 % radova. Na početku to su u većini slučajeva bili domaći autori.

these were domestic authors. However, the journal is gradually growing towards international authors, even though they are mostly from the Mediterranean (Egypt, Greece, Italy, Israel, France, Turkey, Malta, Lebanon, Spain, Tunisia), but there are also authors from other countries (Great Britain, Poland, Sweden, Norway, Denmark, Romania, Hungary, USA, India, Senegal, Japan, UAE).

Editorial Office

Since 1932, the editor-in-chief of the journal usually has been the director of the Institute of Oceanography and Fisheries (**Figure 1**). At the beginning of 1973, in addition to the *Editor-in-Chief*, the function of *Technical Editor* was introduced. Already in 1979, the *Editorial Board* was introduced, and in 1992, the *Publishing Board* was introduced, which was united in 1999 into a single *Editorial Board*.

Today, the Editorial Board is divided into three parts (Senior Associate Editors – higher assistant editors, Associate Editors – assistant editor, and Subject Editors – contributions editors in the sections).

World databases

The processing a journal *Acta Adriatica* in the world scientific publications also required international recognition. Therefore, the Editorial Board also strives to include the journal in the world's databases in order to make the published works as accessible as possible to the wider scientific community. Since 2007, works published in *Acta Adriatica* have been indexed in a number

Međutim, časopis postupno prerasta prema međunarodnim autorima, iako su i oni pretežito iz Sredozemlja (Egipat, Grčka, Italija, Izrael, Francuska, Turska, Malta, Libanon, Španjolska, Tunis), no tu su i autori iz drugih zemalja (Velika Britanija, Poljska, Švedska, Norveška, Danska, Rumunjska, Mađarska, USA, Indija, Senegal, Japan, UAE).

Uredništvo

Od godine 1932. glavni i odgovorni urednik časopisa u pravilu je bio ravnatelj Instituta za oceanografiju i ribarstvo (**slika 1**). Početkom 1973. pored glavnoga i odgovornog urednika (*Editor-in-Chief*) uvodi se i funkcija tehničkog urednika (*Technical Editor*). Već od 1979. godine uvodi se i Urednički odbor (*Editorial Board*), a 1992. se uvodi Savjetodavni odbor (*Advisory Board*), koji se 1999. objedinjuje u jedinstveni Uređivački odbor (*Editorial Board*).

Uređivački odbor je danas podijeljen na tri dijela (*Senior Associate Editors* – viši suradnici urednika, *Associate Editors* – suradnici urednika, *Subject Editors* – urednici tema).

Svjetske baze podataka

Uključivanje časopisa *Acta Adriatica* u svjetske znanstvene publikacije zahtijevalo je međunarodnu prepoznatljivost. Stoga Urednički odbor nastoji uključiti časopis u svjetske baze podataka kako bi objavljeni radovi postali što dostupniji široj znanstvenoj zajednici. Od 2007. su radovi objavljeni u *Acta Adriatica* indeksirani u nizu baza podataka: Agricola, ASFA (CSA) – Aquatic Science & Fisheries Abstracts CSA, CAB

of databases: Agricola, ASFA (CSA) – Aquatic Science & Fisheries Abstracts CSA, CAB Abstracts, CNRS – INIST, Dialog, DOAJ, EBSCOhost, Fish & Fisheries Worldwide produced by NICS, South Africa, Georeference, HRČAK, ISI Web of Knowledge, Oceanic Abstracts, Pollution Abstracts, Referativnij Zhurnal, SCI Expanded (WoS-Web of Science), SCOPUS, Water Resources Abstracts and Zoological Record. *Acta Adriatica* got its first impact factor (Impact Factor) in 2009, which was 0.459, and already in 2011 it was 0.500. The last value of the impact factor (IF) is 0.739.

In addition, the number of citations of articles from the journal *Acta Adriatica* in SCI (Science Citation Index) was analyzed for the period between 1975 and 2001 (1). Compared to 119 Croatian scientific journals dealing with all fields, except medicine, *Acta Adriatica* ranked second based on data on the number of citations in the SCI database, and including medical journals, it ranked sixth among 142 scientific journals. Today, in relation to all Croatian scientific journals, *Acta Adriatica* ranks fourth, based on the criteria of the Ministry of Science and Education of the Republic of Croatia (Silobričić, oral communication).

Conclusion

In addition to technological modernization, scientific publishing is characterized by a relatively large increase in the number of scientific journals in the world, which also increases the number of competitors. The *Acta Adriatica* journal, which is celebrating 90 years of continuous

Abstracts, CNRS – INIST, Dialog, DOAJ, EBSCOhost, Fish & Fisheries Worldwide produced by NICS, South Africa, Georeference, HRČAK, ISI Web of Knowledge, Oceanic Abstracts, Pollution Abstracts, Referativnij Zhurnal, SCI Expanded (WoS-Web of Science), SCOPUS, Water Resources Abstracts i Zoological Record. *Acta Adriatica* dobiva svoj prvi čimbenik odjeka (Impact Factor) 2009. godine koji je iznosio 0.459, a već 2011. bio je 0.500). Zadnja vrijednost čimbenika odjeka (Impact Factor – IF) je 0.739.

Osim toga, broj citata članka iz časopisa *Acta Adriatica* u SCI (Science Citation Index) je analiziran za razdoblje između 1975. i 2001. godine (1). U usporedbi sa 119 hrvatskih znanstvenih časopisa koji se bave svim poljima, osim medicine, *Acta Adriatica* je zauzimala drugo mjesto na temelju podataka o broju citata u bazi SCI, a uključivo časopise iz područja medicine zauzimala je šesto mjesto među 142 znanstvena časopisa. Danas, u odnosu na sve hrvatske znanstvene časopise *Acta Adriatica* zauzima četvrto mjesto, na temelju kriterija Ministarstva znanosti i obrazovanja Republike Hrvatske (Silobričić, usmeno priopćenje).

Zaključak

Osim tehnološke modernizacije, znanstveno izdavaštvo obilježava



SLIKA 1. Izgled naslovnica časopisa *Acta Adriatica* od godine 1930. do danas (šesta po redu)

FIGURE 1. The layout of *Acta Adriatica* journal covers from 1930 to today (sixth in order)

va razmjerno velik porast broja znanstvenih časopisa u svijetu, čime raste i broj konkurenata. S nadolazećom konkurencijom časopis *Acta Adriatica*, koji slavi 90 godina neprekidnog izlaza, moći će se takmičiti jedino s poboljšanjem kvalitete objavljenih radova i samog izdavačkog procesa. Samo tako časopis može računati s porastom scijentometrijskih pokazatelja, koji časopis čine atraktivnijim, osigurava veći priljev radova, njihovu bolju selekciju i kvalitetu. Jedino tako časopis može očekivati nove uspjehe u budućnosti i sljedeće velike obljetnice.

publishing, will be able to compete with the upcoming competition only by improving the quality of published works and the publishing process itself.

This is the only way the journal can count on an increase in scientometric indicators, which make the journal more attractive, and ensure a greater influx of papers, their better selection and quality. This is the only way the journal can expect new successes in the future and the next big anniversaries.

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Predstavljamo vam ogranke Matice hrvatske / *Introducing the branches of Matica Hrvatska*

Ogranak Matice hrvatske u Splitu / *The branch of Matica Hrvatska in Split*

Od ilegale do svjetala pozornice

From the illegal to the lights of the stage

Matica hrvatska u Splitu slavi 70. rođendan!

Matica Hrvatska in Split is celebrating its 70th birthday!

Kako nam je samo proletjelo tih sedam desetljeća! Kad se skupina hrvatskih domoljuba okupila godine 1952. imala je za cilj samo jednu misao – očuvanje hrvatskoga identiteta, naše baštine, našeg hrvatskoga jezika. Tek što su postali punoljetni, stigla je 1971. i Matica hrvatska je zabranjena. Sve što je hrvatski disalo postalo je ne samo politički, nego i životno nepodobno. Matičari su doslovce pometeni jednako kao i hrvatski proljećari na svim razinama, osobito na hrvatskim sveučilištima. Za hrvatske proljećare od kojih su mnogi bili i članovi Matice hrvatske nije bilo mjesta u državnim, pa ni u kakvim drugim pravim službama iako su bili najobrazovaniji. Jedva su se mogli zaposliti i na marginalnim poslovima. Njihova je egzistencija bila nemoguća u uvjetima kad je sve hrvatsko označeno neprijateljskim u tom jugoslavenskom režimu u kojem nije bilo mjesta za hrvatske domoljube. Tako se kroz sudbinu Hrvata i njihovo političko smaknuće godine 1971. može pratiti i sudbina Matice hrvatske i njezinih članova.

Dvadeset godina Matica hrvatska nije smjela postojati u Hrvatskoj, ali to nije ugasio hrvatski duh ma koliko su se jugo-

How those seven decades flew by! When a group of Croatian patriots gathered in 1952, they had only one goal in mind – the preservation of Croatian identity, our heritage, and our Croatian language. As soon as they came of age, 1971 arrived and Matica Hrvatska was banned. Everything that breathed Croatian became not only politically, but also unfit for life. The registrars have literally swept away just like the Croatian springers at all levels, especially at Croatian universities. There was no place for the Croatian spring workers, many of whom were also members of Matica Hrvatska, in the state, or even in any other real services, even though they were the most educated. They could hardly find employment even in marginal jobs. Their existence was impossible in the conditions when everything Croatian was labeled as hostile in that Yugoslav regime in which there was no place for Croatian patriots. Thus, through the destiny of the Croats and their political execution in 1971, the destiny of Matica Hrvatska and its members can be traced.

For twenty years Matica Hrvatska was not allowed to exist in Croatia, but that did not extinguish the Croatian spirit, no matter how hard Yugoslav spies and murderers tried to hunt them down and kill them around the world. Matica Hrvatska in exile, outside the borders of our beautiful homeland Lijepa

slavenski špijuni i ubojice trudili ganjati ih i ubijati po svijetu. Matica hrvatska u izbjeglištvu, izvan granica Lijepe naše domovine sjala je svim svojim sjajem a hrvatska misao nikada nije prestala postojati u srcima Hrvata koji su sanjali svoju državu.

A onda je došla godina 1991. I ostvarenje svih hrvatskih snova o modernoj hrvatskoj državi. Dugo potiskivana ljubav prema Domovini silom otjeranih Hrvata buknila je svom svojom snagom, a iseljena Hrvatska stala je u obranu hrvatske Domovine.

Srušen je Berlinski zid kao uvertira u rušenje zločinačkog komunističkog režima, a na tom je tragu pao i komunistički režim na jugoslavenskom prostoru. Padajući, htjeli su uništiti sve hrvatsko – naše katoličke crkve, naša groblja, naše gradove, našu kulturu, naš identitet, našu baštinu, naše sinove, našu braću, naše muževe, momke, prijatelje, naše djevojke i majke, sve što je disalo hrvatski. Nije im dosta bilo zločina svih godina dotad.

Ali Hrvatska je ustala i obranila se. Uz veliku žrtvu hrvatskih branitelja, uz najveću moguću potporu hrvatskog iseljništva, onoga istog koje je proglašeno nepodobnim. Onog koje je podrugljivo desetljećima nazivano hrvatskom emigracijom. Ta je hrvatska emigracija ljubavlju pobijedila svoje progonitelje.

U emigraciji su djelovali i naši matičari, a novine koje su objavljivali potajno su se čitale i u Hrvatskoj. Zabranjeno štivo uvijek je bilo najdraže.

Na krilima jedne velike ljubavi stvorena je samostalna hrvatska država koja je 15. siječnja 1992. i međunarodno priznata, a sa stvaranjem naše države obnovljena je i Matica hrvatska. Jako dobro pamtim taj zarazni en-

Naša, shone with all its splendor and the Croatian thought never stopped to exist in the hearts of Croats who dreamed of their own state.

And then came the year 1991. And the realization of all Croatian dreams about a modern Croatian state. The long-suppressed love for the Motherland contrary to his will impelled Croats to flare up with all their might, and the evicted Croatia stood in defence of the Croatian Motherland.

The Berlin Wall was destroyed as a prelude to the overthrow of the criminal communist regime, and the communist regime in Yugoslavia also blows down on that trail. Falling, they wanted to destroy everything Croatian – our Catholic churches, our cemeteries, our cities, our culture, our identity, our heritage, our sons, our brothers, our husbands, boyfriends, friends, our girlfriends and mothers, everything that breathed Croatian. They hadn't had enough of crime in all the years up to that point.

But Croatia stood up and defended itself. With the great sacrifice of Croatian veterans, with the greatest possible support of the Croatian emigration, the same one that was declared unacceptable. The one that was derisively called Croatian emigration for decades. That Croatian emigration defeated its persecutors with love.

Our „Matičari“ also worked in emigration, and the newspapers, they published were secretly read in Croatia as well. Banned reading was always a favorite.

On the wings of one great love, an independent Croatian state was instituted, which was internationally recognized on January 15, 1992, and with the creation of our state, the Croatian Motherland was also renewed. I remember very well the infectious enthusiasm that carried us in the 90s, even though I was only a student in Zagreb at the time.

With the establishment and creation of the Croatian state, Matica Hrvatska also spread in Croatia. That is how her work was renewed in Split, and all the most important things that happened in culture

tuzijazam koji nas je nosio 90-ih godina, iako sam tada bila samo studentica u Zagrebu.

Sa stvaranjem hrvatske države prodisala je i Matica hrvatska u Hrvatskoj. Tako je i u Splitu obnovljen njezin rad, a sve najvažnije što se događalo u kulturi i znanosti u našem gradu, potjecalo je iz Matice hrvatske. Sve je imalo hrvatski predznak. I svima je to bilo normalno. Matica hrvatska u gradu svetoga Dujma, mučenika i zaštitnika Splita i Splitsko-makarske nadbiskupije disala je napokon punim plućima. U gradu oca hrvatske književnosti Marka Marulića objavljivale su se knjige koje su u bivšem režimu bile zabranjivane, na tribinama su gostovali Hrvati koji su bili proganjeni i nepoželjni, hrvatski se časopisi više nisu morali skrivati ni čitati u tajnosti.

Ogranak Matice hrvatske (OMH) u Splitu baštini danas sve što su prošli naši pretci, živimo i radimo na temeljima koje su nam oni ostavili.

Već 30 godina uspijevamo redovito održavati *Dane Matice hrvatske* na kojima gostuju ugledni hrvatski umjetnici, znanstvenici, i osobito povjesničari – sve redom hrvatski domoljubi. Tako smo ovogodišnje, jubilarne, 30. *dane Matice hrvatske* u Splitu otvorili satom povijesti dr. sc. Blanke Matković (slika 1), mlade povjesničarke koja živi i radi u Londonu, a koja je, istražujući brojne komunističke arhive u Hrvatskoj i izvan nje, pokazala kako je jugoslavenški režim, ma koliko se i danas u Hrvatskoj šutjelo o tome, držao logor u Jasenovcu čitavih deset godina nakon završetka Drugoga svjetskog rata, od 1945. do 1955. Možete samo zamisliti čemu je služio!

Potom je u organizaciji našega splitskoga Ogranaka Matice hrvatske prikazan do-

and science in our city came from Matica Hrvatska. Everything had a Croatian sign.

And it was normal for everyone. The motherland of Croatia in the city of St. Dujmo, martyr and protector of Split and the Split-Maker Archdiocese, was finally breathing fully. In the city of the father of Croatian literature, Marko Marulić, the published books that were banned in the former regime, Croats who were persecuted and unwanted were guests in the stands, and Croatian magazines no longer had to be hidden or read in secret.



SLIKA 1. Mlada hrvatska povjesničarka dr. sc. Blanka Matković u Ogranku Matice hrvatske u Splitu

FIGURE 1. Young Croatian historian Ph.D. Blanka Matković, at the Matica Hrvatska Branch in Split

Today, the branch of Matica Hrvatska (OMH) in Split inherits everything that our ancestors went through, we live and work on the ground they left us.

For 30 years, we have succeeded in regularly holding *Days of the Matica Hrvatska*, which are participating eminent Croatian artists, scientists, and especially historians – all in turn Croatian patriots.

kumentarni film proslavljenoga hrvatskog redatelja Jakova Sedlara (inače vršnjaka našeg Ogranka) „*Hrvatski pravednici*“, posvećen Hrvatima koji su spašavali Židove u doba NDH (**slika 2**).

This is how we opened this year's jubilee, 30th Days of Matica Hrvatska in Split with a history lecture by Dr. Blanka Matković (**Figure 1**), a young historian who lives and works in London, who, researching numerous communist archives in Croatia and abroad, showed



SLIKA 2. Publika na projekciji filma „*Hrvatski pravednici*“ u Splitu; foto OMH Split
FIGURE 2. *The public at the screening of the film „The Righteous of Croatia“ in Split; photo by OMH Split*

Film je premijerno prikazan 12. kolovoza u Starom Gradu na Hvaru jer je upravo tamo pokopan Ratimir Deletis, Hrvat koji je spasio najviše, više od stotinu, Židova, a njegov sin, danas ugledni liječnik u New Yorku dr. Vedran Deletis sa suprugom i kćerkom Katarinom, počastio nas je svojim dolaskom na splitsku projekciju (**slika 3**).

Otvaramo teme o kojima se i danas šuti a koje zanimaju naše ljude.

Već ranije doveli smo članicu Akademije znanosti i umjetnosti u Argentini Carmen Veljićak koja nam je predstavila „*Hrvatsku povijest*“ na španjolskom jeziku. Priredili smo i predstavljanje gotovo autobiografske knjige „*Vrijeme u meni i ja u vremenu*“ kulturnoga urednika Slobodne Dalmacije, gos-

that the Yugoslav regime, no matter how silent it is in Croatia today, kept a camp in Jasenovac for ten whole years after the end of the World War II, from 1945 to 1955. You can only imagine what it was used for!

Then in the organization of our Split branch of Matica Hrvatska, a documentary film by the well-known Croatian director Jakov Sedlar (otherwise a coeval of our branch) “Croatian Righteous” was shown, dedicated to the Croats who saved the Jews during the NDH (**Figure 2**).

The film premiered on August 12 in Stari Grad on Hvar, because Ratimir Deletis, a Croat who saved the most, more than a hundred, Jews, and his son, today a respected doctor in New York, Dr. Vedran Deletis, was there with his wife and daughter Katarina, honored us with his appearance at the screening in Split (**Figure 3**).

podina Josipa Jovića u čije se vrijeme novina prodavala u tiraži o kojoj sve dnevne novine zajedno danas mogu samo sanjati.

Matici hrvatskoj u čast, u povodu 180. godišnjice osnutka, njezinom Ulicom, prvi put organizirali smo revijalnu utrku za djecu iz vrtića, majke, bake, ali i svjetsku maratonku Anu Piplicu (65), koja uživa u trčanju maratona po cijelom svijetu. Upravo se bila vratila iz Chicaga gdje je za pet sati istrčala 42 kilometra dugu maratonsku dionicu. Bilo je to 15. listopada na *Dan početka Mjeseca hrvatske knjige*, pa smo svim sudionicima darovali knjige – izdanja naše Matice hrvatske, želeći time knjigu učiniti dostupnijom svima koji žele čitati.

I ove godine duž Vukovarske ulice gorjet će svijeće u znak sjećanja na nemjerljivu žrtvu grada Vukovara i njegovih branitelja kojima nikada ne možemo dovoljno zahvaliti za slobodu koju su nam podarili. To je s godinama postao svehrvatski projekt pod nazivom „*I u mom gradu Vukovar svijetli*“, a potekao je upravo iz Splita. Svake godine cijela Hrvatska 17. studenoga, dan uoči godišnjice pada grada Vukovara u četničke ruke 1991., paljenjem svijeća duž Vu-

We open up topics that are still silent today and that are of interest to our people.

We already brought Carmen Vrljičak, a member of the Academy of Sciences and Arts in Argentina, who presented „Croatian history“ in Spanish. We also organized the presentation of the almost autobiographical book „Vrijeme u meni i ja u vremenu“ (*Time in me and me in time*) by the famous editor of Slobodna Dalmacija, Mr. Josip Jović, in whose time the newspaper was sold in a circulation that all daily newspapers together can only dream of today.

In honor of Matica Hrvatska, on the occasion of the 180th anniversary of its foundation, on her street, for the first time, we organized a show race for kindergarten children, mothers, grandmothers, as well as world marathon runner Ana Piplica (65), who enjoys running marathons all over the world. She had just returned from Chicago, where she ran a 42-kilometer marathon section in five hours.

It was on October 15, the day of the beginning of the „Croatian Book Month“ (*Mjesec hrvatske knjige*), so we gave all participants books – editions of our Matica Hrvatska, wanting to make the book more accessible to everyone who wants to read.

This year too, candles will burn along Vukovarska Street in memory of the immeasurable sacrifice of the city of Vukovar and its defenders, whom we can nev-



SLIKA 3. Dr. Vedran Deletis sa suprugom i kćerkom Katarinom na splitskoj projekciji filma „Hrvatski pravедnici“, redatelja Jakova Sedlara i Mire Wolf; foto OMH Split

FIGURE 3. Dr. Vedran Deletis with his wife and daughter Katarina at the Split screening of the film „Croatian Righteous“, directed by Jakov Sedlar and Mira Wolf; photo by OMH Split

kovarske ulice i u svojim prozorima, odaje počast hrvatskim braniteljima na višemjesečnom herojskom otporu neprijateljima koji su uništili naš hrvatski grad Vukovar.

Čast nama u Splitu iskazuje i naš, Matičin Odjel za prirodoslovlje i matematiku iz Zagreba, organizacijom znanstvenog skupa *Hrvatski prirodoslovci*, koji se s časopisom „*Prirodoslovlje*“, posvećenom našim znamenitim sugrađanima prirodoslovcima, pridružuju našim *Danima Matice hrvatske* u Splitu.

A nije da mi nemamo naših poznatih sugrađana. Kao malo tko, splitski se ogranak može pohvaliti znamenitim članovima iz svih sfera društva. Primjerice, predsjednik je našeg Nadzornog odbora prof. dr. Ivica Škarić, hrvatski proljećar ‘pometen’ 1971. na Pravnom fakultetu u Splitu, a u hrvatskoj državi bio je i splitski gradonačelnik. U Matici su još dvojica nekadašnjih splitskih gradonačelnika – dr. Petar Slapničar i Andro Krstulović Opara. S nama su i naši umjetnici svjetskoga glasa – Josip Botteri Dini (**slika 4**), čija se djela nalaze i u Vatikanskom muzeju, Matko Trebotić koji je, među ostalim, za kazališta u Splitu, Dubrovniku, Rijeci i Šibeniku oslikao svečane zastore kao jedinstveni projekt nazvan „*Jadranski poliptih*“, potom kreator naše kune akademik Kuzma Kovačić... a to su samo neki iz garde naših umjetnika.

Svima je nama naša Matica na srcu. Svi smo mi samo volonteri u njoj. Zaljubljenici u svoju kulturu, baštinu, identitet. Naša je Matica hrvatska danas kao uspavana ljepotica kojoj je, kao i svemu, potrebna naša ljubav za istinsko buđenje i život. Kao i našoj državi Hrvatskoj. Jer sudbina naše Matice neodvojivo je vezana uz sudbinu hr-

er thank enough for the freedom they gave us. Over the years, this became an all-Croatian project called „Even in my city Vukovar shines“ (*I u mom gradu Vukovar svijetli*), and it originated from Split.

Every year, on November 17, the day before the anniversary of the fall of the city of Vukovar to the Chetniks in 1991, the whole of Croatia honors the Croatian defenders by lighting candles along Vukovarska street and in their windows for months of heroic resistance to the enemies who destroyed our Croatian city of Vukovar.

Our Matica Hrvatska, Division of Natural Sciences and Mathematics from Zagreb also honors us in Split by organizing a scientific meeting „Croatian naturalists“ (*Hrvatski prirodoslovci*), who, together with the journal „*Prirodoslovlje*“, dedicated to our famous fellow citizen naturalists, join our Matica Hrvatska Days in Split.

And it's not that we don't have our famous fellow citizens. Like a few others, the Split branch can boast of notable members from all spheres of society. For example, the president of our Supervisory Board is professor Ivica Škarić, Ph.D., the Croatian Springer ‚swept out‘ in 1971 at the Faculty of Law in Split, and was the mayor of Split in the Croatian state. There are two more former mayors of Split in Matica – Dr. Petar Slapničar and Andro Krstulović Opara. With us are also our world-renowned artist – Josip Botteri Dini (**Figure 4**), whose works are also in the Vatican Museum, Matko Trebotić who, among others, painted festive curtains for theaters in Split, Dubrovnik, Rijeka and Šibenik as a unique project called „*Adriatic Polyptych*“ (*Jadranski poliptih*), then the creator of our kuna, academician Kuzma Kovačić... and these are just some of the guard of our artists.

We all have our Matica close to our hearts. We are all just volunteers in it. Beloved of their culture, heritage and identity. Today, our Matica is like a sleeping beauty that, like everything, needs our love for true awakening and life. As well as our country Croatia. Because the destiny of our Matica is insepara-

vatske države. I kroz govor o stvaranju naše države govorimo i o životu naše Matice hrvatske. Na tragu one antologijske Matoše-

bly linked to the destiny of the Croatian state. And through the speech about the creation of our state, we are also talking about the life of our Matica Hrvatska.



SLIKA 4. Pozivnica Ogranka Matice hrvatske u Splitu, koju je izradio Josip Botteri Dini
SLIKA 4. Invitation card of the Matica Hrvatska branch in Split, made by Josip Botteri Dini

ve domoljubne pjesme „Pri svetom kralju“, koja završava stihovima: „...I dok je srca, bit će i Krocije!“, znamo, dok je srca bit će i Matice hrvatske.

On the trail of that anthology Matoš's patriotic poem „Pri svetom kralju“, which ends with the lines: „...And as long as there is a heart, there will be Croatia!“ (*...i dok je srca, bit će i Krocije!*), we know, as long as there is a heart, there will be a Matica Hrvatska.

Snježana Šetka

Predsjednica Ogranka Matice hrvatske (OMH) u Splitu
President of The Branch of Matica Hrvatska in Split

Tradicionalni dalmatinski pripravci i proizvodi od samoniklih i kultiviranih biljaka

Traditional Dalmatian preparations and products from wild and cultivated plants

Boris Dorbić, Zdenka Bilušić

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Autori su knjižicu objavili kao dio projekta koji uključuje obilježavanje 180. obljetnice knjige *Flora dalmatica*, priznanoga hrvatskog botaničara Roberta Visianija, s ciljem upoznavanja šire javnosti o značenju naše znanstvene baštine kao i vrijednosti dalmatinskog bilja koje se nalazi u recepturama raznovrsnih tradicijskih dalmatinskih proizvoda.

Posebnost je knjižice izvornost opisanih recepata, prikupljenih usmenom predajom, koji ostaju zabilježeni i trajno sačuvani od zaborava.

Knjižica je podijeljena u deset poglavlja. Uprvim su poglavljima autori na jednostavan i informativan način opisali postupak sakupljanja, sušenja i čuvanja ljekovitog bilja, vrste i pripremu biljnih pripravaka, istaknuli osnovne aktivne tvari sadržane u



The authors published the booklet as part of a project that includes marking the 180th anniversary of the book *Flora dalmatica*, by the well-known Croatian botanist Robert Visiani, with the aim of introducing the wider public to the meaning of our scientific heritage as well as the value of Dalmatian herbs found in the recipes of various traditional Dalmatian products.

The special feature of the booklet is the originality of the described recipes, collected through oral tradition, which remain recorded and permanently preserved from oblivion. The booklet is divided into ten chapters.

ljekovitim biljkama te naveli popis biljnih sirovina prema njihovu djelovanju.

U šestom i sedmom poglavlju ukratko je prikazan kemijski sastav voća te vrste proizvoda od voća i njihova priprava. U osmom, najopširnijem poglavlju, zapsani su recepti tradicijskih dalmatinskih pripravaka i proizvoda od samoniklih i kultiviranih biljaka na temelju usmenog kazivanja uz tablični pregled biljnih vrsta koje se navode u receptima.

Zadnja poglavlja knjige sadrže nagrađene učeničke recepte prema usmenoj predaji te popis literature i usmenih kazivanja ispitanika.

Ta zbirka izvornih tradicijskih dalmatinskih recepeta za pripravu biljnih pripravaka i proizvoda svojim jednostavnim pristupom može pobuditi interes šire čitateljske publike i pridonijeti njihovoj promociji i valorizaciji kao i čuvanju od zaborava.

In the first chapters, the authors described in a simple and informative way the process of collecting, drying and preserving medicinal plants, the types and preparing of herbal formulation, highlighted the basic active substances contained in medicinal plants and provided a list of herbal raw materials according to their effects.

In the sixth and seventh chapters, the chemical composition of fruits and types of fruit products and their preparation are briefly presented. In the eighth, the most extensive chapter, recipes for traditional Dalmatian preparations and products from wild and cultivated plants are written down based on word of mouth with a tabular overview of the plant species mentioned in the recipes.

The last chapters of the book contain award-winning student recipes according to oral tradition, as well as a list of literature and oral accounts of respondents.

This collection of original traditional Dalmatian recipes for the preparing of herbal preparations and products, with its simple approach, can arouse the interest of a wider readership and contribute to their promotion and valorization as well as preservation from oblivion.

Suzana Inić,

Farmaceutsko-biokemijski fakultet Sveučilišta u Zagrebu

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Svim recenzentima zahvaljujemo na obavljenoj prosudbi radova, na uloženom trudu i spremnosti na suradnji s Uredništvom časopisa i autorima članaka.

Uredništvo

We thank all the reviewers for their evaluation of the papers, and for their effort and willingness to cooperate with the Editorial Board of the journal and the authors of the articles.

Editorial

Dosad održani znanstveni skupovi *Odjela za prirodoslovlje i matematiku* Matice hrvatske / *Scientific meetings of the Division of Natural Sciences and Mathematics of Matica Hrvatska held so far*

1) HRVATSKI PRIRODOSLOVCI

- *Hrvatski prirodoslovci 1* Zagreb, 7. veljače 1992.
- *Hrvatski prirodoslovci 2* Zagreb, 17. i 18. lipnja 1993.
- *Hrvatski prirodoslovci 3* Zagreb, 7. listopada 1994.
- *Hrvatski prirodoslovci 4* Zagreb, 6. listopada 1995.
- *Hrvatski prirodoslovci 5* Zagreb, 4. listopada 1996.
- *Hrvatski prirodoslovci 6* Zagreb, 3. listopada 1997.
- *Hrvatski prirodoslovci 7* Osijek, 2. listopada 1998.
- *Hrvatski prirodoslovci 8* Rijeka, 8. listopada 1999.
- *Hrvatski prirodoslovci 9* Zadar, 6. listopada 2000.
- *Hrvatski prirodoslovci 10* Dubrovnik, 25. i 26. listopada 2001.
- *Hrvatski prirodoslovci 11* Požega, 11. i 12. listopada 2002.
- *Hrvatski prirodoslovci 12* Pazin, 17. i 18. listopada 2003.
- *Hrvatski prirodoslovci 13* Gospić, 15. i 16. listopada 2004.
- *Hrvatski prirodoslovci 14* Knin, 14. i 15. listopada 2005.
- *Hrvatski prirodoslovci 15* Koprivnica, 13. i 14. listopada 2006.
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- *Hrvatski prirodoslovci 18* Vukovar, 16. i 17. listopada 2009.
- *Hrvatski prirodoslovci 19* Vis, 22. i 23. listopada 2010.
- *Hrvatski prirodoslovci 20* Sinj, 14. i 15. listopada 2011.
- *Hrvatski prirodoslovci 21* Imotski, 19. i 20. listopada 2012.
- *Hrvatski prirodoslovci 22* Križevci, 18. i 19. listopada 2013.
- *Hrvatski prirodoslovci 23* Vinkovci, 10. i 11. listopada 2014.
- *Hrvatski prirodoslovci 24* Sarajevo, 23. i 24. listopada 2015.
- *Hrvatski prirodoslovci 25* Karlovac, 21. listopada 2016.
- *Hrvatski prirodoslovci 26* Zabok, 20. i 21. listopada 2017.
- *Hrvatski prirodoslovci 27* Senj, 19. – 20. listopada 2018.
- *Hrvatski prirodoslovci 28* Rovinj, 10. – 11. listopada 2019.
- *Hrvatski prirodoslovci 29* Klanjec, 20. listopada 2020.
- *Hrvatski prirodoslovci 30* Čakovec, 16. prosinca 2021.
- *Hrvatski prirodoslovci 31* Split, 25. – 26. studeni 2022.

2) HRVATSKI PRIRODOSLOVCI U AMERICI

- *Istaknuti hrvatski znanstvenici u Americi* Zagreb, 21. lipnja 1996.
- *Istaknuti hrvatski znanstvenici u Americi* Zagreb, 19. lipnja 1998.

Naputci autorima

Časopis *Prirodoslovlje* izdaje Odjel za prirodoslovlje i matematiku Matice hrvatske, a namijenjen je popularizaciji i promicanju svih polja prirodoslovlja (fizike, kemije, biologije, geografije, astronomije i dr.) i matematike.

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