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# Okostje brazdastega kita v Prirodoslovnem muzeju Slovenije

## *Fin Whale Skeleton in the Slovenian Museum of Natural History*

Mojca JERNEJC KODRIČ<sup>1</sup>,

Staša TOME<sup>1</sup>,

Boris KRYŠTUFEK<sup>1,2</sup>

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### Izvleček

Marca 2003 je Prirodoslovni muzej Slovenije prevzel 13,2 m dolgo samico brazdastega kita (*Balaenoptera physalus*), ki je bila najdena kot plavajoče truplo v Piranskem zalivu na slovenski obali. Opisujemo postopke, povezane s pridobitvijo formalnih dovoljenj za prevzem trupla, in njegov potop na globino približno 20 m, kjer smo ga prepustili naravnemu razkroju. Kosti smo dvignili na površje, razsolili, iz njih odstranili maščobo s kemijsko ekstrakcijo z organskim topilom diklormetan in jih utrdili. Leta 2011 smo posamezne kosti sestavili in povezali v skelet. Na ogled smo ga postavili 15. septembra istega leta v okviru praznovanja 190-letnice Kranjskega deželne muzeja, katerega neposredni naslednik je Prirodoslovni muzej Slovenije. V članku opisujemo posamezne kosti, ki so tudi predstavljene s fotografijami. Zadnje poglavje opisuje načrtovanje in izvedbo razstave v kontekstu interpretacije naravne dediščine, spremljevalne programe, promocijo in vrednotenje razstave.

**Ključne besede:** *Balaenoptera physalus*, Jadransko morje, skeletiranje, osteologija, muzeologija, muzejska razstava, interpretacija

<sup>1</sup> Prirodoslovni muzej Slovenije / Slovenian Museum of Natural History/, Prešernova 20, 1000 Ljubljana, Slovenija, mjernejc@pms-lj.si, stome@pms-lj.si

<sup>2</sup> Znanstveno-raziskovalno središče Koper, Univerza na Primorskem / Science and Research Centre Koper, University of Primorska, boris.krystufek@zrc.upr.si

## Abstract

In March 2003, the Slovenian Museum of Natural History acquired a 13.2 m long female Fin Whale (*Balaenoptera physalus*), which had been found as a floating carcass in Piran Bay, Slovenia. The procedures associated with the acquisition of formal permits for the adoption of the carcass are described, as well as for its immersion to a depth of about 20 metres, where left to its natural decomposition. Thereupon, its bones were lifted to the surface, desalinated, fat removed from them through chemical extraction with organic dichloromethane solvent, and consolidated. In 2011, the whale's skeleton was assembled from individual bones. On September 15th of the same year, it was finally exhibited within the framework of the 190th anniversary of the Provincial Museum of Carniola, direct predecessor of the Slovenian Museum of Natural History. The article describes and photographically presents the Fin Whale's individual bones. The last chapter is dedicated to the planning and implementation of the exhibition in the context of natural heritage interpretation, the accompanying programmes, promotion and evaluation of the exhibition.

**Key words:** *Balaenoptera physalus*, Adriatic Sea, maceration, osteology, museology, museum exhibition, interpretation

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## Predgovor

Boris KRYŠTUFEK

Obvestilo o najdenem truplu brazdastega kita, ki ga je Prirodoslovni muzej Slovenije prejel 10. marca 2003, je v naslednjih letih močno vplivalo na dejavnost institucije. Ker je muzej razmeroma majhna ustanova, z vsega 26 zaposlenimi, so prevzem trupla, prepariranje skeleta in njegova priprava za razstavo pomenili veliko obremenitev, predvsem za Kustodiat za vretenčarje, Tehnično službo muzeja in Oddelek za stike z javnostjo. Dejavnosti smo zaokrožili jeseni 2011 z odprtjem razstave »Skrivnostna smrt mlade Leonore« in s spremnim katalogom (Jernejc Kodrič, 2011). Razstava je bila osrednji dogodek v okviru praznovanja 190-letnice ustanovitve Kranjskega deželnega muzeja v Ljubljani. Simbolni pomen dogodka je bil dvojen. Prirodoslovni muzej Slovenije namreč izhaja neposredno iz Kranjskega deželnega muzeja, ki je bil v začetku sicer kompleksen muzej, v katerem pa je imelo vodilno vlogo naravoslovje. Henrik Freyer (1802-1866), prvi kustos Kranjskega deželnega muzeja, je ob raznovrstnem delu, ki ga je opravljal v času svojega službovanja v muzeju (1832-1954), pripravil tudi seznam vretenčarjev Kranjske (Freyer, 1842), ki je temeljil na primerkih, shranjenih v muzejski zbirki. S pridobitvijo brazdastega kita je Kustodiat za vretenčarje Prirodoslovnega muzeja Slovenije samo nadaljeval delo, ki je bilo vgrajeno v njegov začetek: zbiranje, hranjenje in preučevanje favne ter posredovanje sporočila javnosti.

Ko smo se v muzeju odločali, kako se odzvati na obvestilo, smo bili pod velikimi pritiski. Nihče ni imel nobenih izkušenj s preparacijo tako velikega trupla. Jasno smo se zavedali, da preparatorskega dela ne bo mogoče opraviti v muzejski stavbi sredi Ljubljane. Vedeli smo tudi, da bodo za delo potrebna finančna sredstva, ki pa jih nismo imeli. Približno v istem času smo od Veterinarske službe izvedeli, da načrtuje sežig trupla. Ker je vodstvo Prirodoslovnega muzeja brez

## Preface

by Boris KRYŠTUFEK

In the ensuing years, the notice regarding the Fin Whale carcass, which was acquired by the Slovenian Museum of Natural History on March 10th, 2003, had a great impact on the activities of this institution. Given that the Museum is a fairly small establishment, employing no more than 26 people, the preparation of the skeleton and all the work necessary for its exhibiting was highly burdensome for the Museum, particularly its Vertebrate Department, Technical Service and PR Department. The activities were rounded up in the autumn 2011 with the opening of the exhibition entitled *The Mysterious Death of Young Leonora* and its accompanying catalogue (Jernejc Kodrič, 2011). The exhibition was the main event within the framework of the 190th anniversary of the founding of the Provincial Museum of Carniola (former province of the Habsburg Empire, now part of Slovenia) in Ljubljana. The symbolic meaning of the event was twofold. Specifically, the Slovenian Museum of Natural History stems directly from the Provincial Museum of Carniola, which was initially a complex museum, with the leading role in it played by natural history. Henrik Freyer (1802-1866), the first Museum's curator, also prepared, along with very diverse work carried out by him during his service for the Museum, the list of vertebrates of Carniola (Freyer, 1842), which was based on the specimens kept in the Museum's collection. With the acquisition of the Fin Whale, the Department of Vertebrate Zoology merely continued the work incorporated into its beginning: fauna collecting, preserving and studying, and conveying information to the public.

When deliberating on how to respond to the notice on a dead whale, we were under immense pressure. Nobody had any experience with the preparation of such a huge carcass. On the other hand, we were well aware that financial means would be necessary for this particular

odlašanja prevzelo finančno jamstvo, smo se odločili, da se lotimo dejavnosti za prevzem trupla. V državi, katere morska obala meri v dolžino samo 43 km, je najdba 13-metrskega kita v javnosti seveda zbudila veliko zanimanja. Danes, ko je delo za nami, smo kajpak prepričani, da smo se pravilno odločili.

V tistih prvih dneh, 10. in 11. marca 2003, ni bilo časa za natančnejše analize. Vedeli smo, da zaradi lastne verodostojnosti ne moremo začeti s postopkom prevzema trupla, kasneje pa od njega odstopiti, ker bi pač ocenili, da dela ne bomo mogli opraviti. V prvih urah pa tudi še nismo vedeli, kako bomo skeletiranje sploh izpeljali. Medmrežje je ponujalo veliko manj informacij, kot jih danes, zato smo se morali zanesti predvsem na lastno znanje. Morali smo tudi prehiteti predvideno uničenje trupla. Stvari so se dobro iztekle, ves čas pa smo morali reševati dokaj specifične probleme. Ti so zadevali pridobivanje dovoljenj za prevzem kita in za delo na morju, skeletiranje, ekstrakcijo maščob, sestavljanje posameznih kosti v skelet in njegovo končno predstavitev javnosti. Odločili smo se, da svoje izkušnje iztrgamo pozabi in jih objavimo. Morda bodo zanimive še za koga.

Dejstva, kako izjemno prirodno smo rešili pred propadom, smo se v polni meri zavedeli šele pozneje, ko smo našli čas za iskanje po literaturi. Vosati kiti so redki v Jadranskem morju, zlasti v njegovem severnem delu; redki so tudi v naravoslovnih muzejih na vzhodni jadranski obali (npr. Marčič, 1927). Naša najdba je bila časovno dokaj presenetljiva. Največ opažanj (75 %) brazdastih kitov v Sredozemlju je namreč iz poletnih mesecev (julij-september), naš primer pa je bil najden marca. Kot opisujemo v spodnjem poglavju, so najdbe plavajočih trupel brazdastega kita izjemno redke; po letu 1728 so v severnem Jadranu poleg našega zabeležili samo še en takšen primer. Večina podatkov o brazdastem kitu temelji na opažanjih, ko je pogosto težko preveriti zanesljivost klasifikacije. Le redko se zoologom ponudi priložnost, da pridejo do verodostojne vrstne determinacije na osnovi preučevanja trupla. Iz skrajnega severnega Jadrana so

purpose, but we simply did not have them. At about the same time we learned from the Veterinary Service that they were planning to incinerate the carcass. As the Natural History Museum's management immediately assumed the financial guarantee, we decided to embark upon activities for the actual acquisition of the carcass. In the country with mere 43 km long coast, the find of a 13 m long whale attracted much attention. Today, when the work has been accomplished, we are of course convinced that a right decision was made by us.

In those first days, March 10th and 11th, 2003, there was no time for any accurate analyses. We knew that for the sake of our own credibility we could not start the procedure of the carcass acquisition and then withdraw from the whole matter on the assessment that we would be incapable of carrying out the work. And in the first few hours we had no idea of how to carry out the preparation of bones. Since the Internet offered much less information on the matter than today, we simply had to rely upon our own knowledge. At the same time, we had to prevent the planned destruction of the body. Although we had to solve fairly specific problems, all ended to our satisfaction. The problems concerned a permit for the acquisition of the carcass and work at sea, exposure of the animal to decomposition, fat extraction, assembly of bones into a skeleton, and its final presentation to the public. Now we decided to save our gained experience from oblivion and publish it all. Perhaps it will be of interest to somebody else as well.

We became fully aware of the fact that a truly exceptional find was rescued from ruin only later, when finding some time for browsing through literature. Baleen whales are rare in the Adriatic Sea, especially in its northern part; they are also scarce in natural history museums on the eastern Adriatic coast (e.g. Marčič, 1927). In terms of time, our find was surprising indeed. Specifically, most sightings (75%) of Fin Whales come from summer months (July-September), while our specimen was found in March. As described in the last chapter, the finds of floating Fin Whale

doslej imeli takšno priložnost samo dvakrat. V nadaljnjem besedilu navajamo, da je bila najzgodnejša najdba iz leta 1831 (Milje pri Trstu) napačno interpretirana kot sinji kit, z dolgoročnimi posledicami. V drugem primeru je šlo za samico, nekoliko manjšo od naše, ki je nasedla leta 1976 v tržaškem pristanišču. Tudi s tega vidika je bila ohranitev okostja vredna napora in stroškov. Rezultati zoološkega preučevanja sodijo v domeno preverljive znanosti, to preverljivost pa omogoča material, shranjen v naravoslovnih muzejih. Med takšen material sodi tudi okostje brazdastega kita, ki si ga lahko ogledamo v Prirodoslovnem muzeju v Ljubljani. Izjemno je po svoji redkosti in dimenzijah, v samem bistvu pa se ne razlikuje od 170.572 drugih muzealij (toliko jih je bilo na seznamu ob izteku leta 2011), ki dokumentirajo favno, floro in geo, shranjeni pa so v muzejskih zbirkah.

carcasses are extremely rare; after 1728, only one Fin Whale was recorded in the Northern Adriatic apart from ours. The majority of Fin Whale data are based on sightings, when it is difficult to check the classification reliability. Zoologists get very few opportunities to acquire reliable species determination on the basis of carcass study. In the extreme Northern Adriatic, they have had only two such opportunities. In further text we state that the first find from 1831 (Muggia near Trieste) was falsely interpreted as a Blue Whale, with long-term consequences, of course. The second case refers to a Fin Whale female, somewhat smaller than ours, which was found stranded in 1976 in Port of Trieste. From this aspect, too, the preservation of the skeleton was worth the effort and costs. Results of the zoological studies fall within the domain of verifiable science, where this verifiability is enabled by material kept in natural history museums. Material of this kind is also the Fin Whale skeleton, which can be viewed in the Museum of Natural History in Ljubljana. It is exceptional on the account of its dimensions, while in its essence it does not differ from the 170,572 vouchers (as listed at the end of 2011), which document fauna, flora and geological components on the Earth's surface and are kept in museum collections.

## Uvod

Boris KRYŠTUFEK,  
Mojca JERNEJC KODRIČ

Brazdasti (hrbtopluti) kit *Balaenoptera physalus* (Linnaeus, 1758) je ena od petih (Nowak, 1999) ali šestih vrst rodu *Balaenoptera* Lacépède, 1804 (Wilson & Reeder, 2005). Razširjen je po vseh svetovnih morjih in oceanih, najbolj pa mu ustrezajo zmerne in subpolarne vode z globino nad 1.000 m. Čeprav pretežno pelaška vrsta, se pojavlja tudi v prehransko bogatih obalnih vodah (Cagnolaro, Di Natale & Notarbartolo di Sciarra, 1983), vendar le izjemoma v morjih z globino manj kot 200 m (Nowak, 1999). Znani sta dve podvrsti, nominotipska, ki je manjša in živi na severni polobli, ter *B. p. quoyi* Fischer, 1829 z južne poloble, ki je večja (Wilson & Reeder, 2005). Brazdasti kiti se spomladi in poleti selijo v hladne polarne vode, kjer se hranijo, jeseni pa plavajo v zmerna in tropska morja. Selitve sicer niso tako izražene kot pri drugih vrstah, kar velja še posebej za severne populacije. Zaradi razlik v sezoni se podvrsti ob ekvatorju ne srečujeta (Nowak, 1999). V Sredozemskem morju živi stalna populacija, ki se ne seli. Sredozemski kiti se v genskih markerjih ločijo od živali iz severnega Atlantika (Notarbartolo di Sciarra *et al.*, 2003).

Brazdasti kit je druga največja živalska vrsta na planetu; od njega je večji edinole sinji kit *Balaenoptera musculus* (Linnaeus, 1758). Ko doseže spolno zrelost, je brazdasti kit dolg približno 17,7 m (samci) oz. 18,3 m (samice). Največja zabeležena dolžina je bila 25 m pri samcih in 27 m pri samicah. Masa 25-metrške živali dosega približno 70 ton (Nowak, 1999). Velikost ni konstantna med območji. Tako je podvrsta *B. p. quoyi* (60-80 ton) težja od *B. p. physalus* (40-50 ton; Perrin, Wursig & Thewissen, 2009). Populacija iz Sredozemskega morja doseže manjše dimenzije; samice (povprečna dolžina 14,7 m) so nekoliko daljše od samcev (13,4 m), vendar razlika ni statistično značilna (Notarbartolo di Sciarra *et al.*, 2003).

## Introduction

by Boris KRYŠTUFEK &  
Mojca JERNEJC KODRIČ

Fin Whale *Balaenoptera physalus* (Linnaeus, 1758) is one of the five (Nowak, 1999) or six species of the genus *Balaenoptera* Lacépède, 1804 (Wilson & Reeder, 2005). It is distributed in all world's seas and oceans, with over a thousand metres deep temperate and sub-polar waters best suited for its habitat. Although predominantly pelagic species, it also occurs in food-rich coastal waters (Cagnolaro, Di Natale & Notarbartolo di Sciarra, 1983), but only exceptionally in seas with depths of less than 200 metres (Nowak, 1999). Two subspecies are known: nominotypical, which is smaller and inhabits the northern hemisphere, and the larger *B. p. quoyi* Fischer, 1829 from the southern hemisphere (Wilson & Reeder, 2005). In spring and summer, Fin Whales migrate to cold polar waters where they feed, while in autumn they move to temperate and tropical seas. Their migration, however, is not as distinct as in other species, particularly the whale's northern population. Owing to the seasonal differences, the two subspecies do not meet at the Equator (Nowak, 1999). The Mediterranean Sea is home to a non-migrating permanent population. In their genetic markers, the Mediterranean whales differ from their Northern Atlantic counterparts (Notarbartolo di Sciarra *et al.*, 2003).

Fin Whale is the second largest animal species on the planet, surpassed only by the Blue Whale, *Balaenoptera musculus* (Linnaeus, 1758). When reaching maturity, male Fin Whales reach about 17.7 metres in length and females about 18.3 metres. The greatest recorded length remains 25 metres in males and 27 metres in females. The mass of a 5 metres long animal reaches approximately 70 tons (Nowak, 1999). Size is not constant between different areas. The subspecies *B. p. quoyi* (60-80 tons) is heavier than *B. p. physalus* (40-50 tons; Perrin, Wursig &

Globalna populacija brazdastega kita je bila pred približno stoletjem ocenjena na 470.000 osebkov, od katerih jih je večina (400.000) živel na južni polobli. Po zlomu populacij sinjega kita je postal brazdasti kit pomembna lovna vrsta kitolovne industrije. V sezoni 1937-38 so jih ujeli 28.000, kar je bilo dvakrat več, kot je znašal ulov sinjih kitov. V obdobju 1946-1965 je ulov stalno presegal 10.000 osebkov. Vrh je bil dosežen v letih 1952-1962 s približno 30.000 živalmi letno, čemur je sledil zlom populacije in padec ulova, najprej na 5.320 živali v sezoni 1968/69 in na 743 osebkov v sezoni 1978/79 (Nowak, 1999). V Sredozemskem morju so brazdastega kita največ lovili okrog Gibraltarskega preliva. V letih 1921-1927 je bilo na španski strani preliva ubitih 6.250 velikih kitov, od tega več kot 90 % brazdastih. Kitolov je trajal vse do osemdesetih let 20. stoletja, kar je močno vplivalo na populacijo brazdastega kita v Sredozemskem morju, ob samih Gibraltarskih vratih pa je bila vrsta v šestdesetih letih 20. stoletja iztrebljena (Notarbartolo di Sciara *et al.*, 2003).

Brazdastega kita obravnava niz mednarodnih dokumentov, med njimi Konvencija o trgovini z ogroženimi vrstami (CITES), Konvencija o migratornih vrstah (CMS), Konvencija ACCOBAMS (Sporazum o ohranjanju kitov in delfinov Črnega morja, Sredozemskega morja in sosednjega atlantskega območja) in Rdeči seznam Mednarodne zveze za varstvo narave (IUCN), v katerem je brazdasti kit uvrščen v kategorijo »ogrožen« (En); pred letom 1996 je bil v nižji kategoriji »ranljiv« (Vu). Globalna populacija je ocenjena na približno 90.000 osebkov, od katerih jih je največ v severnem Atlantiku (Reilly *et al.*, 2008).

V Sredozemlju so brazdasti kiti najpogostejši v njegovem zahodnem delu, proti vzhodu pa njihovo število hitro pojema (Notarbartolo di Sciara *et al.*, 2003). V italijanskih vodah je bilo npr. v letih 1978-1982 zabeleženih kar 112 opažanj brazdastih kitov, velika večina pa jih je bila iz Tirenskega in Ligurijskega morja (Di Natale & Mangano, 1983). Glavna prehranjevalna območja so ob francoski obali, kjer se v poletnih mesecih zaradi velike primarne

Thewissen, 2009). The Mediterranean Sea population reaches smaller dimensions, with females (average length 14.7 metres) a little longer than males (13.4 m), although this difference is not statistically significant (Notarbartolo di Sciara *et al.*, 2003).

About a century ago, the global Fin Whale population was estimated at 470,000 individuals, the majority (400,000) of which inhabited the southern hemisphere. After the collapse of the Blue Whale's populations, the Fin Whale became a significant target of the whaling industry. In the 1937-1938 period, no less than 28,000 individuals were killed, which was twice as much as the Blue Whale catch. In the 1946-1965, the catch was constantly surpassing 10,000 individuals. The peak was reached in the years 1952-1962 with about 30,000 killed animals per year; this was followed by the population crash and cull reduction, at first to 5,320 animals in the 1968/1969 season and to 743 individuals in the 1978/1979 season (Nowak, 1999). In the Mediterranean Sea, most Fin Whales were speared around the Strait of Gibraltar. In the 1921-1927, 6,250 large whales were caught on the Spanish side of the Strait, a good 90% of which were Fin Whales. Whaling lasted until the 1980s, which grossly affected Fin Whale population in the Mediterranean Sea, while at the Strait of Gibraltar alone the species was exterminated in the 1960s (Notarbartolo di Sciara *et al.*, 2003).

Fin Whale is subject to a number of international documents, such as the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), the Convention the Conservation of Migratory Species of Wild Animals (CMS), the Agreement on the Conservation of Cetaceans of the Black and Mediterranean Seas (ACCOBAMS) and the Red List of the International Union for Conservation of Nature (IUCN), which placed the Fin Whale into the Endangered (En) category; prior to 1996, it was listed in the lower Vulnerable (Vu) category. The global population is estimated at approximately 90,000 individuals, most of them inhabiting the Northern Atlantic (Reilly *et al.*, 2008).



produkcije močno namnožijo svetleče kozice vrste *Meganyctiphanes norvegica*. Edino znano zimsko prehranjevalno območje v Sredozemskem morju je v okolici otoka Lampedusa med Sicilijo in Tunizijo, kjer se hranijo v plitvejših obalnih vodah s svetlečimi kozicami vrste *Nyctiphanes cuochi* (Canese *et al.*, 2006). Danes živi v Sredozemlju manj kot 10.000 brazdastih kitov (Reilly *et al.*, 2008).

Identiteta kitov rodu *Balaenoptera* v Sredozemlju in Jadranu je bila vse do nedavna negotova. Sredozemska populacija so v preteklosti pogosto obravnavali kot endemičen takson in jo navajali z različnimi imeni: *Balaenoptera rorqual*, *B. mediterraneus*, *B. antiquorum* ali *B. aragonus* (Notarbartolo di Sciarra *et al.*, 2003). Po drugi strani so zgodnejši avtorji primerke *Balaenoptera physalus* determinirali kot *B. musculus*, ki pa v Sredozemlju ne živi (Wilson & Reeder, 2005). Pa vendar so se navedbe sinjega kita za Jadran v literaturi trdovratno obdržale vse do konca prejšnjega stoletja. Dulić & Tortić (1960), Đulić & Mirić (1967) in Mirić (1970) so tako navedli za Jadran brazdastega in sinjega kita kot naključni oz. zelo redki vrsti. Podobno je tudi Toschi (1965) navedel sinjega kita kot naključno vrsto za italijanska morja. Mirić (1970) za Jadran omenja še tretjo vrsto, ščukastega kita *Balaenoptera acutorostrata* Lacépède, 1804. Verjetno ta navedba temelji na lobanji mlade živali, pridobljeni leta 1771 z bolonjske tržnice, ki je še vedno shranjena v Muzeju primerjalne anatomije v Bologni (Bearzi *et al.*, 2004).

Kryštufek (1991) je sinjega kita v seznamu sesalcev Slovenije navedel »na osnovi Brusinove navedbe za Milje«. Kot takšno sta to vrsto obravnavala tudi Kryštufek & Lipej (1985). Popravek vrstne določitve v *B. physalus* sta prva opravila Kryštufek & Lipej (1993), čemur so sledili tudi novejši viri (Kryštufek & Janžekovič 1999, Genov 2011).

V Jadranu severno od črte Zadar – Ancona je bilo v letih 1728-2003 samo 23 opazanj skupno 26 osebkov brazdastega kita, od tega štirih mladičev. Verjetno je šlo za občasne klateže, ki so zašli iz prehranjevalnih območij v Jonskem morju. Največ brazdastih kitov (11) je

in the Mediterranean, Fin Whales are most abundant in its western part; towards the east, their numbers decrease rapidly (Notarbartolo di Sciarra *et al.*, 2003). In Italian waters, no less than 112 sightings were made in the 1978-1982 period, the vast majority of them in the Tyrrhenian and Ligurian Seas (Di Natale & Mangano, 1983). The main feeding areas are located along the French coast, where krill *Meganyctiphanes norvegica* reproduces at a fast rate in the summer months owing to the area's high primary production. The only known winter feeding area in the Mediterranean Sea is situated in the vicinity of Lampedusa Island between Sicily and Tunisia, where whales feed in shallow coastal waters on krill *Nyctiphanes cuochi* (Canese *et al.*, 2006). Today, less than 10,000 Fin Whales inhabit the Mediterranean Sea.

Until recently, the identity of whales of the genus *Balaenoptera* was uncertain in the Mediterranean and Adriatic Seas. In the past, the Mediterranean population was often dealt with as an endemic taxon, referred to with different names: *Balaenoptera rorqual*, *B. mediterraneus*, *B. antiquorum* or *B. aragonus* (Notarbartolo di Sciarra *et al.*, 2003). Earlier authors, on the other hand, determined specimens of *Balaenoptera physalus* as *B. musculus* which, however, does not live in the Mediterranean Sea (Wilson & Reeder, 2005). Still, reports of the Blue Whale for the Adriatic stubbornly continued to appear in literature until the end of the 20th century. Dulić & Tortić (1960), Đulić & Mirić (1967) and Mirić (1970), for example, cite for the Adriatic Sea the Fin and Blue Whales as random and very rare species, respectively. Similarly, Toschi (1965) cited the Blue Whale as a random species for Italy. For the Adriatic, Mirić (1970) cites yet the third species, i.e. Common Minke Whale *Balaenoptera acutorostrata* Lacépède, 1804. This report is most probably based on the find of a skull of a young animal acquired in 1771 at Bologna fish market; the skull is still kept in the Museum of Comparative Anatomy in Bologna (Bearzi *et al.*, 2004).

Kryštufek (1991) included the Blue Whale in the list of mammals of Slovenia »on the basis of Brusina's report for Muggia«. As such, this

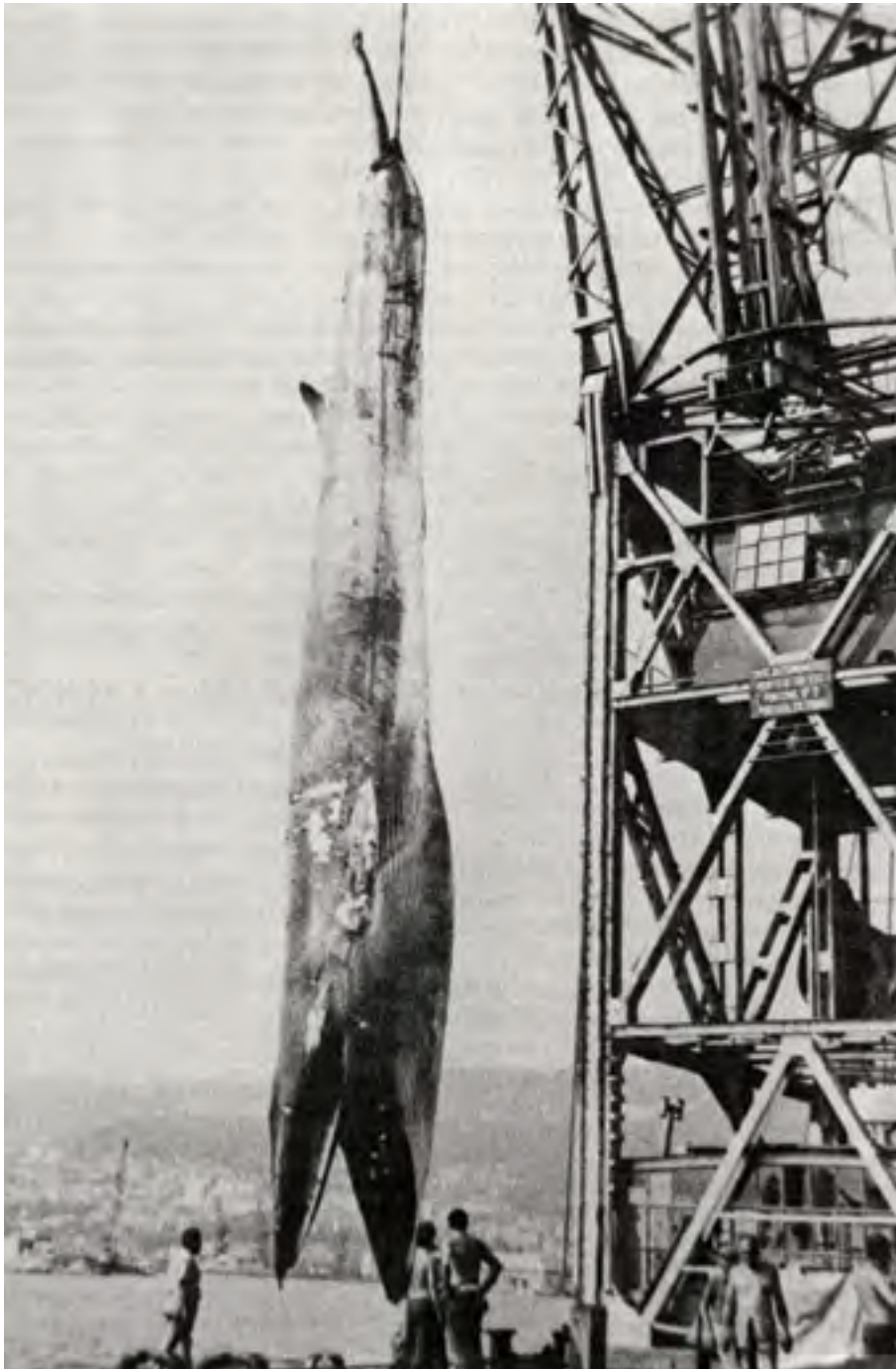
bilo zabeleženih z opazovanjem živih osebkov, v osmih primerih je šlo za nasedle kite in samo v dveh primerih za plavajoči trupli. Večina opažanj je iz zadnjih desetletij, kar je morda posledica sprememb v količini zooplanktona (Lipej *et al.*, 2004). Dejansko starejši popisi sesalcev hrvaškega morja navadno omenjajo samo zobate kite (npr. Depoli 1899, Korljevič, 1902). Brazdasti kit je v severnem Jadranu v zadnjih letih občasen gost, povprečno zabeležimo enega na vsaki dve ali tri leta (Genov, 2011).

V skrajnem severnem delu Jadranu je dokumentiranih zapisov o brazdastem kitu izjemno malo. Primerek, ki je leta 1831 nasedel v Miljah pri Trstu (Brusina, 1888), so dolgo časa navajali kot sinjega kita (glej zgoraj). Dne 22. junija 1976 je v tržaškem pristanišču nasedla samica, dolga 9,8 m in težka 4 tone. Od 6. do 8. junija 1979 so v delti reke Pad opazovali samico z mladičem. Šest ribiških ladij je tedaj preprečilo, da bi kita nasedla, in ju nato usmerilo v globlje vode, 20 milj od obale (Kryštufek & Lipej, 1993). Di Natale & Mangano (1983) navajata opažanja v severnem Jadranu tudi v letih 1978 – 1982. V slovenskih vodah smo dva osebkova nazadnje opažali avgusta 2011 v Piranskem zalivu (Jernejc Kodrič, 2011).

species was also dealt with by Kryštufek & Lipej (1985). The species determination was first changed to *B. physalus* by Kryštufek & Lipej (1993); the correction was followed by more recent sources as well (Kryštufek & Janžekovič 1999, Genov 2011).

In the 1728-2003 period, only 23 records of a total of 26 Fin Whale individuals (including four calves) were made in the Adriatic north of the Zadar - Ancona line. These were probably occasional vagrants straying from their feeding areas in the Ionian Sea. Most Fin Whales (11) were sighted live, in eight cases they were stranded, and only in two cases the whales were recorded as floating carcasses. The majority of records date to the last few decades, which may be the result of changes in the quantity of zooplankton (Lipej *et al.*, 2004). Older surveys of the mammals of Croatia indeed include toothed whales only (e.g. Depoli 1899, Korljevič, 1902). In the last few years, the Fin Whale has been an occasional visitor to the Northern Adriatic, as only one has been recorded every two or three years (Genov, 2011).

Extremely few documented Fin Whale records are at hand for the extreme northern part of the Adriatic Sea. The specimen found stranded in 1831 at Muggia near Trieste (Brusina, 1888) was for years cited as Blue Whale (see above). On June 22nd, 1976, a 9.8 metres long female weighing 4 tons was found stranded in the Port of Trieste. From June 6th to 8th, 1979, a female and her calf were observed in the Po delta. On that occasion, six fishing vessels prevented the whales from stranding by directing them into deeper waters some 20 miles from the coast (Kryštufek & Lipej, 1993). Di Natale & Mangano (1983) write about records of Fin Whales in the Northern Adriatic in the 1978-1982 period as well. In Slovenian waters, two individuals were observed for the last time in August 2011 in Piran Bay (Jernejc Kodrič, 2011).



**Slika 1.** Samica brazdastega kita, ki je leta 1976 nasedla v tržaškem pristanišču . (Vir: Kryštufek & Lipej, 1993)

**Figure 1.** A female Fin Whale found stranded in the Port of Trieste in 1976. (Kryštufek & Lipej, 1993).

## Najdba in potop trupla brazdastega kita

Boris KRYŠTUFEK,  
Mojca JERNEJC KODRIČ

Prirodoslovni muzej Slovenije (PMS) je 10. marca 2003 prejel obvestilo, da so v Piranskem zalivu odkrili truplo mlade samice brazdastega kita. Dnevnik Večer z dne 11. marca 2003 je dolžino trupla ocenil na približno 12 m, kasnejše meritve pa so pokazale na 13,2 m; repna plavut je bila široka 3,2 m, dolžina prsne plavuti pa je bila 1,55 m. Vzrok smrti mlade samice ni znan. Truplo je že kazalo znake razpadanja, torej je bila žival že dalj časa mrtva. Dnevnik Delo je že 3. januarja 2003 poročal, da so ob slovenski obali opazili brazdastega kita. Ker so veliki kiti v slovenskem morju izjemna redkost, se je sama po sebi ponujala domneva, da gre za isto žival.

Služba za varovanje obalnega morja pri Agenciji RS za okolje (ARSO, pri Ministrstvu za okolje, prostor in energijo – MOPE) je že razkrajajoče se truplo prepeljala v koprsko luko.

PMS je takoj po prejemu obvestila, ob približno 12. uri istega dne, Veterinarski fakulteti Univerze v Ljubljani (VFUL) sporočil interes, da po veterinarskih pregledih prevzame truplo in ga skeletira. V naglici smo pripravili okvirni načrt dela, ob približno 14. uri pa sta bila uslužbenca PMS pripravljena, da odpotujeta v Koper in organizirata delo. Zavedali smo se, da skeletiranja tako velike živali ne moremo opraviti v stavbi PMS na Prešernovi cesti 20 v Ljubljani, zato smo kot najboljšo možnost predvideli potopitev trupla in razkroj na morskem dnu. Prvega dne se veterinarska služba ni odločila, kaj bo s truplom. Omenjala je prepolovitev živali in prevoz v secirnico VFUL. V tem primeru bi bil primerek za PMS verjetno izgubljen. Kot skrajno rešitev smo predlagali zakop trupla, kar pa ni bilo sprejemljivo za veterinarsko službo.

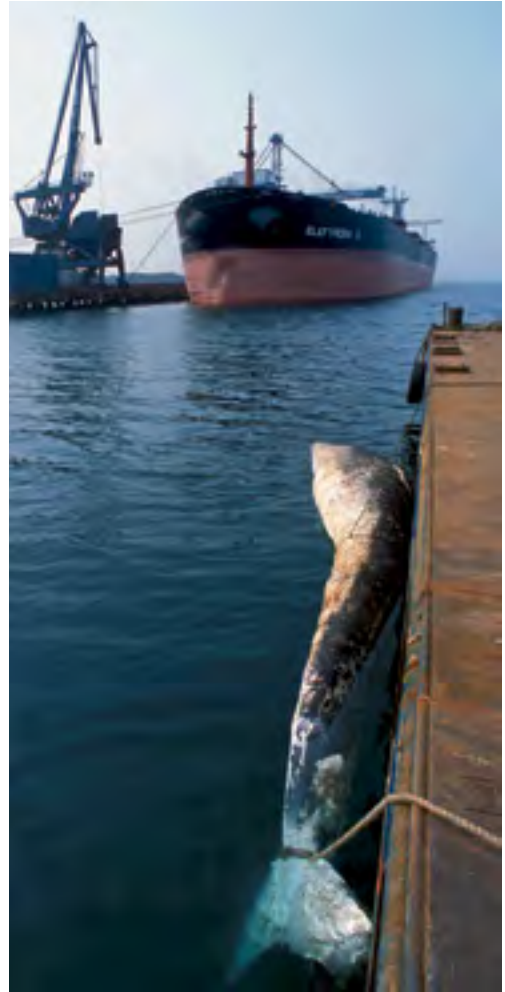
## Acquisition of the carcass and first stages in its preparation

by Boris KRYŠTUFEK &  
Mojca JERNEJC KODRIČ

On March 10th, 2003, the Slovenian Museum of Natural History received information on carcass of a young Fin Whale female being found in Piran Bay, Slovenia. The Večer daily, issued on March 11th, estimated the length of the carcass at approximately 12 metres, while eventual measurements raised the length to 13.2 metres; the whale's fluke was 3.2 metres wide, pectoral fin 1.55 metres long. The cause of the young female's death remains unknown. The carcass already showed signs of decay, hence the animal had been dead for some time. The Delo daily reported on a Fin Whale observation along the Slovenian coast as early as on January 3rd, 2003. Given that whales are exceptionally rare in the Slovenian sea, a presumption was offered by itself that the sightings concerned the same animal.

The Coastal Sea Protection Service of the Slovenian Environment Agency (functioning within the framework of the Ministry of the Environment, Spatial Planning and Energy) transported the decaying carcass to the Port of Koper.

Immediately after receiving the information, at about noon of the same day, the Slovenian Museum of Natural History conveyed interest to the Veterinary Faculty of the University of Ljubljana to assume the carcass after veterinary inspection and carry out the preparation of a skeleton. In a hurry we prepared an indicative work plan, and at about 14.00 hrs two Museum's employees were ready to travel to Koper to organize the work. As we were well aware that preparation of such a huge animal could not be implemented in the Museum's building at Prešernova cesta 20 in



**Sliki 2 in 3.** Truplo samice brazdastega kita, najdene 10. marca 2003 v Piranskem zalivu. Fotografija: Ciril Mlinar

**Figures 2 & 3.** Carcass of the female Fin Whale, found on March 10th, 2003, in Piran Bay. Photo: Ciril Mlinar

Torek 11. marca je minil v nenehnih pogovorih s štirimi ministrstvi – Ministrstvom za kmetijstvo, gozdarstvo in prehrano, MOPE, Ministrstvom za zdravstvo in Ministrstvom za promet (MP). Zaradi številnih zapletov se je vodstvo PMS proti koncu delovnega dne obrnilo na Ministrstvo za kulturo (MK) s prošnjo za posredovanje. Skupaj s podporo MOPE se je proti koncu dneva jeziček na tehtnici prevesil na stran PMS. MOPE je menilo, da mrtvi

Ljubljana, we believed that the best solution would be to sink the carcass and leave it to decompose on the sea floor. On the first day, the Veterinary Service did not make a decision as to what to do with the carcass, although contemplating about cutting the animal in half and transporting it to the Veterinary Faculty's dissection room. In this case, the specimen would be most probably lost. As a last resort, we suggested the carcass to be buried, but

brazdasti kit ni odpadek v smislu določil Protokola o preprečevanju onesnaževanja Sredozemskega morja (Ur.L. SFRJ – MP, št. 12/77 in Ur. l. RS 102/02 – MP), ampak del biomase v morju in se razgrajuje v svojem življenjskem okolju. Takšna interpretacija zakonskih določil je bila ključna za nadaljnji razplet dogodkov. Istega dne je tudi MP, ki je pristojno za izdajo dovoljenj za vse dejavnosti na morju, dovolilo potop živali na območju izlita piranske kanalizacije. V sredo dopoldne se je PMS dogovoril z izvajalcem del Ugom SUB, Ugom Fondo, univ. dipl. biol., samostojnim podjetnikom, da pripravi vse potrebno za potopitev živali. Dogovorjen je bil potop ob izpustih piranske kanalizacije približno 3,5 km od obale v globini okrog 20 m. Po načrtu je bilo treba okrog trupla sestaviti mrežasto vrečo (velikost okenc 15 mm), da se kasneje ne bi izgubili manjše kosti. To delo je trajalo vse do petka 14. marca, ko je zapihala močna burja in preprečila prevoz na kraj potopitve.

V soboto 15. marca je izvajalec prepeljal kita do Pirana in ga privezal na plovec pred Morsko biološko postajo. Vetrovno vreme se je nadaljevalo tudi v nedeljo, tako da so truplo lahko potopili šele v ponedeljek, 17. marca, teden dni po tem, ko so ga tokovi zanesli v Piranski zaliv. Za premagovanje sile vzgona je bilo truplo treba obtežiti s štirimi tonami betonskih blokov. Pred potopom smo odstranili nekaj vosov, ki so kot roževinasta tvorba izpostavljeni organskemu razkroju. Shranili smo jih v 10-odstotni nevtralizirani raztopini formaldehida in kasneje posušili na zraku. Zaradi tehničnih omejitev in velike časovne stiske PMS ni bil v stanju, da ohrani vse vose. Potek del na potopu trupla sta opisala izvajalec Ugo Fonda in uslužbenec PMS Ciril Mlinar, ki je delo fotografsko dokumentiral.

Dogodki so pritegnili izjemno pozornost medijev. O njih so dnevno poročali TV Slovenija, POP TV, nekatere radijske postaje in dnevni tisk Delo, Večer, Dnevnik, Primorske novice, Slovenske novice in Gorenjski glas. Ni manjkalo tudi očitkov zaradi počasnih del: »Stroka ne ve, kako ravnati s poginulim kitom«, smo lahko prebrali v Dnevniku,

this was not acceptable by the Veterinary Service. Tuesday March 11th passed in the midst of ongoing discussions with four ministries – Ministry of Agriculture, Forestry and Food, Ministry of the Environment, Spatial Planning and Energy, Ministry of Health, and Ministry of Traffic. Due to the numerous complications, the Museum of Natural History contacted the Ministry of Culture at the end of the day, requesting them to mediate in the matter. With the aid of the Ministry of the Environment, Spatial Planning and Energy, the scales finally turned to the Museum's side. The Ministry of the Environment pointed out that the Fin Whale carcass is not a waste in the sense of provisions stipulated by the Protocol for the prevention of pollution of the Mediterranean Sea (Official Gazette of the Republic of the Socialist Federative Republic of Yugoslavia – Ministry of Traffic, No. 12/77, and Official Gazette of the Republic of Slovenia – Ministry of Traffic), but part of biomass in the sea that decomposes in its natural environment. Such interpretation of the statutory provisions was of key significance for the events' further outcome. On the same day the Ministry of Transport, which is responsible for issuing permits for all activities carried out at sea, allowed the corpse to be sunk in the area of Piran sewage spill. On Wednesday morning, the Museum of Natural History made an agreement with the contractor UNIC SUB led by Ugo Fonda (BSc in Biology) to prepare a plan for the whale's immersion in the sea. It was agreed that this was to be done some 3.5 km from the shore (at a depth of approximately 20 metres) near the spot where the Piran sewage flows into the sea. According to the plan, a mesh bag (with 15 mm openings) was to be set up around the carcass to avoid eventual loss of smaller bones. This work lasted until Friday 14th March, when a strong northerly wind began to blow, preventing transportation of the carcass to the place of immersion.

On Saturday March 15th, the contractor towed the carcass to Piran and tied it to a buoy in front of the Marine Biology Station. As the





**Sliki 4 in 5.** Potapljaška ekipa v koprski luki ovija kitovo truplo v mrežasto vrečo. Fotografija: Ciril Mlinar

**Figures 4 & 5.** Diving team wrapping the whale carcass in mesh bag in the Port of Koper. Photo: Ciril Mlinar



**Slika 6.** Na mestu potopa so potapljači truplo obtežili s štirimi tonami betonskih blokov. Poltonske uteži je do mesta potopa nosilo osem velikih balonov. Fotografija: Ciril Mlinar

**Figure 6.** At the immersion site, the carcass was laden by divers with four tons of concrete blocks. The half-ton weights were carried to the site by eight large balloons. Photo: Ciril Mlinar



**Slika 7.** Del vosov, ki so bili odstranjeni pred potopom trupla. Fotografija: Ciril Mlinar

**Figure 7.** Part of baleen plates, removed before the carcass was immersed. Photo: Ciril Mlinar

in »Kitovka smrdi od sramu« v Slovenskih novicah 12. marca 2003. Administrativno reševanje je vzelo dva dni časa, sama izvedba del nadaljnja dva dneva, trije dnevi pa so bili izgubljeni zaradi slabega vremena. Zapleti na administrativni ravni so v veliki meri razumljivi, če upoštevamo izjemnost in enkratnost dogodka. S takšno problematiko nima izkušenj noben državni resor, primanjkovalo je tudi informacij. Vendar je bilo na vseh ravneh veliko razumevanja in pripravljenosti, da se stvari uredijo na razumen in sprejemljiv način.

wind did not abate and persisted through the whole of Sunday, the carcass could be sunk no earlier than on Monday March 17th, a week after being driven by currents into Piran Bay. To overcome the buoyancy, the carcass had to be laden with four tons of concrete blocks. Prior to the immersion, some baleen plates had to be removed; as hornified structure, they are subjected to organic decomposition. We fixed them in 10% buffered formaldehyde solution and had them air dried later on. Owing to the technical restrictions and great time constraints, the Museum was not in a position to preserve all baleens. The progress of the work carried out during the immersion of the carcass was described in detail by the contractor Ugo Fonda and the Museum's employee Ciril Mlinar, who photographically documented the activities.

The events taking place at Piran attracted great attention of the media. Reports on them were daily presented by the national (TV Slovenia) and a commercial (POP TV) TV stations, few radio stations and newspapers such as *Delo*, *Večer*, *Dnevnik*, *Primorske novice*, *Slovenske novice* and *Gorenjski glas*. We were, however, also reproached for our slow work: »*The experts do not know how to handle a dead whale*« could be read in the *Dnevnik* daily, and »*The female whale stinks of shame*« in *Slovenske novice* on March 12th, 2003. The administrative work took us two days, its actual implementation further two days, while three days were lost due to the bad weather conditions. The complications at the administrative level are to a great extent understandable, if considering the fact that the event was truly exceptional and unique. With the issues of this kind, no state services had had any experience, and there was certain lack of information as well. In spite of it all, there was much understanding at all levels as well as readiness for the matter to be solved in a reasonable and acceptable manner.



## Pravni status brazdastega kita

Uredba o zavarovanju ogroženih živalskih vrst iz leta 1993 (zdaj Uredba o zavarovanih prosto živečih živalskih vrstah) je uvrščala na seznam tudi vse vrste kitov. Kot ustanovo v Republiki Sloveniji, pooblaščen za prevzem in hranjenje živali z omenjenega seznama, navaja uredba edino PMS. Občina Piran je 13. marca 2003 naslovila na PMS dopis za prevzem okostja najdenega kita. Interes je utemeljevala z dejstvom, da je bil kit najden v Piranskem zalivu, torej na območju občine. Razstavljeno okostje bi bila velika atrakcija, ki bi vidno obogatila turistično ponudbo kraja. Kot možna mesta na slovenski obali, kjer bi bilo okostje možno razstaviti, so se omenjale prenovljena stavba Morske biološke postaje, Piranski akvarij in načrtovani ribiški muzej. Čeprav so mediji o pobudi Občine Piran objektivno poročali, se je v javnosti ustvaril vtis, da »lastništvo mrtvega kita ni znano«. MK je zato kot pogoj za dodeljevanje dodatnih finančnih sredstev za skeletiranje kita zahtevalo ureditev pravnih vidikov. PMS se je 18. marca obrnil na MOPE s prošnjo za tolmačenje Uredbe o zavarovanju ogroženih živalskih vrst. MOPE je v dopisu št. 354-09-772003 z dne 7. aprila posredovalo sledeče stališče:

»Z uredbo o zavarovanju ogroženih živalskih vrst so določena pravila ravnanja z osebki zavarovanih vrst, vključno z mrtvimi. Namen določitve ravnanja z mrtvimi osebki je bil omogočiti znanstveno in muzejsko delo z živalmi, ki jih je sicer zaradi varstvenega režima težko pridobiti. ... S sprejemom uredbe je bila naloga v zvezi z ravnanjem z mrtvimi živalmi zavarovanih vrst dana Prirodoslovnemu muzeju Slovenije, in sicer iz razloga, ker je osrednja nacionalna naravoslovna muzejska inštitucija, pooblaščen za strokovno obdelavo in hranjenje eksponatov, obenem pa tudi omogoča dostop do materiala drugim znanstveno-raziskovalnim inštitucijam. Ne nazadnje je osrednji muzej tudi inštitucija, v kateri sta ogled in spoznavanje živali omogočena širši javnosti. ... V desetletni praksi je tako Prirodoslovni muzej prevzemal trupla živali,

## The Fin Whale's legal status

The Decree on protection of endangered animal species from 1993 (now Decree on protected free-living animal species) listed all whale species as well. As an institution in the Republic of Slovenia, authorized to assume and keep animals from the above mentioned list, only the Slovenian Museum of Natural History is stated by the Decree. On March 13th, 2003, however, the Piran Council sent a letter to the Museum of Natural History about its intention to take possession of the whale's skeleton. Its interest in the carcass was justified with the fact that the whale had been found in Piran Bay, therefore in the area of the Piran Council. The exhibited skeleton would be a great attraction that could greatly enrich the town's tourist supply. Among the possible places on the Slovenian coast, where the skeleton could be exhibited, were the reconstructed building of the Marine Biology Station, the Piran Aquarium, and the planned Fisheries Museum. Although the media reported on the Piran Council's initiative quite correctly, the impression was created in the public that »the ownership of the dead whale is not known«. The Ministry of Culture thus demanded, as a condition for the allocation of financial resources for the whale's preparation, all legal aspects to be solved. On March 18th, the Slovenian Museum of Natural History requested the Ministry of the Environment, Spatial Planning and Energy to interpret the Decree on protection of endangered animal species, and on April 7th the Ministry issued the following observation in its communication No. 354-09-772003:

»The Decree on protection of endangered animal species stipulates the rules of handling with individuals of protected species, including their carcasses. The purpose of stipulating the actual handling with dead individuals was to enable scientific and museum work with animals, which are otherwise difficult to obtain owing to the valid conservation regime ... By adopting the Decree, the task relating to handling with dead animals of protected species was assigned to the Slovenian Museum of Natural History, i.e. on the grounds that the Museum is a central national

če je za to izrazil interes, v obratnem primeru so bila trupla uničena v skladu z veterinarskimi predpisi. ... Menimo, da je za prevzem trupla oz. okostja zavarovanega brazdastega kita, skladno z uredbo, pristojen Prirodoslovni muzej Slovenije.«

Navedeni dopis je odstranil pomisleke, tako da je MK odobrilo dodatna sredstva za skletiranje. Podrobnejšo informacijo je objavil dnevnik Delo, v katerem je T. Švagelj 8. aprila 2003 med drugim zapisal:

»Po uredbi o vzpostavitvi mreže za izvajanje javne službe na področju varstva premične kulturne dediščine in določitvi državnih muzejev je Prirodoslovni muzej Slovenije državni muzej, ki opravlja javno službo – varovanje premične dediščine in matičnost – za tovrstno premično dediščino. Najdba brazdastega kita zagotovo sodi v premično dediščino naravnega izvora, torej je očitno, da primerek sodi edinole v zbirko Prirodoslovnega muzeja.«

## Preparacija okostja

Ko je bilo truplo najdeno, je že razpadalo, zato je bilo mogoče ohraniti samo okostje. Čeprav muzeološki priročniki natančno opisujejo postopke za shranjevanje in preparacijo sesalcev, ne dajejo navodil za živali, večjih od slona. Brusina (1888) opisuje preprosto metodo, po kateri je skletiral okrogloglavega delfina

*natural history institution, authorized to professionally treat and keep vouchers and, at the same time, to enable access to the material to other scientific research institutions. Last but not least, the central natural museum is also an institution, in which viewing of animals and learning about them is enabled to the wider public ... During its decades long practice, the Slovenian Museum of Natural History acquired carcasses of animals if expressing interest in them, otherwise the carcasses were destroyed in accordance with the veterinary regulations ... In compliance with the Decree we thus believe that the Slovenian Museum of Natural History is competent for the acquisition of the carcass (skeleton) of the protected Fin Whale.«*

The stated communication eliminated any doubts in this matter, and the Ministry of Culture approved allocation of additional financial means for the whale's preparation. A more detailed information was published by the Delo daily on April 8th, 2003, in which T. Švagelj wrote the following, inter alia:

*According to the Decree on setting up a network for the public service implementation in the sphere of movable cultural heritage and according to the stipulation of national museums, the Slovenian Natural History Museum is a national museum carrying out a public service – conservation of movable heritage and parentage – for the movable heritage of this kind. The Fin Whale carcass recovery is indubitably part of movable heritage of natural origin, and it is therefore obvious that the specimen should belong solely to the collection of the Slovenian Natural History Museum.«*

## Preparation of the skeleton

At the time when found, the carcass was already in the state of decay, which was the reason why only the skeleton could be preserved. Although museological manuals present detailed procedures for the preparation of mammals, no instructions for animals larger than elephant are given. Brusina (1888)

(*Grampus griseus*), ki ga je 1873 dobil v Zadru. Za primerek ne navaja nobenih dimenzij, vrsta pa zraste v dolžino do 4 m in tehta do 700 kg. S trupla je odstranil maščobo in mišičje, prepolvljeno žival pa dal v dve vrši. Dodal je voleke (*Murex* sp.) in vse skupaj potopil v morje. Žal ne navaja časa, v katerem se je truplo razkrojilo. Z rezultati je bil v glavnem zadovoljen. Edina težava je bila v tem, da izvajalec ni natančno upošteval vseh navodil (tako Brusina), zato so se nekatere manjše kosti izgubile.

Zoološki muzej v Zagrebu (danes Hrvaški prirodoslovni muzej) je leta 1990 sketiral okostje brazdastega kita, nasedlega na otoku Silbi. Kita, ki je bil deloma v vodi, deloma na kopnem, so preprosto prepustili razpadu, po približno letu dni pa pobrali ostanke. Nekaj kosti se je pri tem izgubilo, bodisi da so jih raznesli tokovi ali ljudje, bodisi so izginile iz neznanih vzrokov. Vezivno tkivo in hrustanec nista razpadla, pač pa sta se na zraku posušila. Kostje je bilo treba še kuhati v vodi z dodatkom detergenta in povsem očistiti organskih snovi. Magerle (1962) je opisal preparacijo samice brazdastega kita, dolge 11,5 m in težke približno 7 t, ki so jo dobili v paški luki. Truplo so »po nekaj dneh« prepeljali v Zagreb, kjer so se odločili, da primerek ohranijo kot okostje in kot dermoplastični preparat. Ker muzej ni imel na voljo potrebnih zmogljivosti, jim je prostore odstopila mestna klavnica. Truplo je ležalo na tovarnjaku s prikolico, na kateri so ga tudi pripeljali. S pomočjo premičnega ročnega dvigala so najprej dvignili repno plavut in z nje odstranili kožo v dolžini 80-100 cm. Nato so z drugim dvigalom dvignili del živali pred plavutjo. Takšen postopek so večkrat ponovili. Trup je ostal na tovarnjaku, sproščeno kožo pa so dvignili z dodatnimi dvigali. Dermoplastični preparat so izdelali na muzejskem dvorišču, kjer so postavili delovno mizo s površino 12 x 5 m. Kožo so čistili in sprosti preparirali z boraksom in arsenikom. Mišičje so mehansko odstranili z okostja, ki so ga nato razstavili na manjše dele. Manjše kosti so najprej izpirali v vodi, jih nato počasi kuhali in naposled prepustili maceraciji. Posamezne kosti so macerirali ločeno, pri čemer so menjali vodo, ki so ji

describes a simple method, according to which he prepared a skeleton of a Risso's Dolphin (*Grampus griseus*), acquired by him in 1873 in Zadar, Croatia. He states no dimensions for this specimen of the dolphin, which reaches 4 metres in length and 700 kilograms in weight. He removed fat and muscles from the carcass, cut it in half and put the pieces in two fish traps. He also put murexes (*Murex* sp.) inside and had them immersed into the sea. Unfortunately he does not state the time in which the carcass was decomposed. He was generally satisfied with the results, the only problem lying in the fact that the contractor had not fully followed all of the instructions given to him (as stated by Brusina), hence some of the smaller bones were lost.

In 1990, the Zoological Museum in Zagreb (presently Croatian Natural History Museum) prepared skeleton of the Fin Whale stranded on the island of Silba. The whale, which lay partially in the water and partially on land, was simply left to decompose. After about a year, its remains were collected. Some of the bones were lost in the meanwhile; they were either scattered around by currents or people or disappeared for unknown reasons. The connective tissue and cartilage did not dilapidate but merely dried up in the sun. In the end, the bones had to be cooked in water with the addition of detergent and utterly cleaned of organic matter. Magerle (1962) described preparation of a Fin Whale female (11.5 metres long, weighing approximately 7 tons) acquired from the Port of Pag. The carcass was transported to Zagreb »after a few days«, where they decided to preserve the specimen as skeleton and dermoplastic sample. As the Museum had no suitable spatial capacities, the place needed was offered by the city slaughterhouse. The carcass lay on a trailer truck, by which actually transported. With the aid of a movable manual hoist they first lifted its tail and removed the skin from it at a length of 80-100 cm. Then they lifted, with another hoist, a part of the animal in front of the fluke. This procedure was repeated several times. The body remained on the truck, while the released skin was lifted with additional hoists. Dermoplastic sample was made in the Museum's yard,

dodali lug. Magerle navaja, da posebnih težav ni bilo, da pa so bile kosti kljub velikosti zelo občutljive. Velike skeletne dele – lobanjo, večja vretenca, lopatico – so obdelali v velikih lesenih kadeh. Počasnemu kuhanju je sledila maceracija. Nazadnje so kosti obelili in razmastili v 2-odstotni raztopini luga, s klorovim apnom in bencinom. Zaradi prostorske stiske muzeja je preparat še vedno »začasno« shranjen na podstrežju muzeja.

Ko je PMS prejel sporočilo o mrtvem brazdastem kitu v Piranskem zalivu, je bil opisani postopek vse, kar smo imeli na voljo, zelo omejen čas pa ni dopuščal veliko manevrskega prostora. Ker je na začetku obstajala možnost, da kita prepeljejo v Ljubljano na veterinarske preiskave, smo razmišljali, da bi v tem primeru poginulo žival zakopali. Veterinarski službi se taka rešitev ni zdela sprejemljiva, tako da za pokop očitno ne bi mogli dobiti dovoljenja. Ostala je samo ena možnost: potop. Koliko časa bo truplo ležalo v globini, preden bodo od njega ostale samo kosti, marca 2003 še nismo vedeli. Javnost je ta podatek zelo zanimal, večinoma pa smo ugibali o času od šestih mesecev do dveh let. Izvajalec del je za razpad mehkih tkiv predvidel vsaj 8 do 12 mesecev. Ko je bil kit enkrat potopljen, je PMS spremljal njegov razkroj in začel zbirati informacije za kasnejše prepariranje in restavriranje okostja.

where a table with the surface of 12 × 5 metres was set up. The skin was cleaned and simultaneously prepared with borax powder and arsenic. The muscles were mechanically removed from the skeleton, which was then disassembled into smaller parts. Smaller bones were initially washed with water, then boiled slowly and finally left to macerate. Individual bones were macerated separately, when water was changed several times, with lye added to it. Magerle states that there were no specific problems, except that the bones were sensitive in spite of their great size. Large skeleton parts – the skull, larger vertebrae, shoulder blade – were treated in large wooden tubs. Slow boiling was followed by maceration. In the end the bones were bleached and defatted in 2% solution of lye, chlorine lime and petrol. Due to the lack of space, the sample is still »temporarily« kept in the Museum's attic.

When the Slovenian Museum of Natural History was informed about the dead Fin Whale in Piran Bay, the described procedure was all that was available to us, but the very limited time did not give us much room for manoeuvre. Given that a chance existed at the beginning for the whale to be transported to Ljubljana for veterinary investigation, we even considered that in this case it would be best to have the dead animal buried. Such solution, however, was not acceptable to the Veterinary Service, which meant that no permit could be obtained for the whale's burial. Hence, only one possibility remained: sinking of the carcass into the sea. How long the carcass will lie in the sea before only bones will remain of it was not yet known to us in March 2003. The public was very interested in this particular matter, but most of us guessed that the time needed for the carcass to disintegrate would be from six to twenty-four months. The work contractor envisaged at least 8 to 12 months for the soft tissues to decay. Once the whale was immersed, the Slovenian Museum of Natural History monitored its decomposition and began to gather information for the skeleton's later preparation and restoration.

## Razkroj kitovega trupla in dvig kosti z morskega dna

Boris KRYŠTUFEK,  
Mojca Jernejc KODRIČ

Ekipa Uga Fonde si je od aprila do septembra 2003 enkrat mesečno ogledala kitovo truplo. Vsak ogled so dokumentirali z video kamero in napisali poročilo. Dokumentacija je shranjena v PMS. Ogledi so bili opravljeni 21. aprila, 24. maja, 25. junija, 14. julija, 21. avgusta in 27. septembra 2003. Aprila je kit ležal na desnem boku na betonskih utežeh, maja pa so se v spodnjem predelu trebušne votline nabrali plini, tako da se je srednji del trupa dvignil od dna in v tem položaju ostal tudi junija in julija. Čeprav se nismo bali, da bi truplo splavalo na površje, saj so betonske uteži še vedno ležale na tleh, vrvi pa so bile obremenjene le z nekaj sto kilogrami sile vzgona, je Fonda v dodatnem kontrolnem potopu preluknjal trup in sprostil pline. Mreža, v katero je bilo truplo zavito, je bila ves čas v brezhibnem stanju.

Temperature morja so navedene v spodnji tabeli. Aprila 2003 so bili biološki procesi, ki so osnova razkroja organske snovi, zaradi nizkih temperatur počasni. Truplo je bilo še vedno kompaktno. Koža je odpadala v kosmih, velikih približno kvadratni centimeter, tako da je bilo že vidno vlaknasto podkožje. Razpad je bil najhitrejši na glavi, vosi pa so že popadali na dno. Vidna sta bila del lobanje in večina spodnje čeljustnice. V maju je koža odpadala v kosmih že pri dotiku. Poleg vlaknastega podkožja je bilo na nekaterih mestih vidno tudi mišično tkivo. Kitova glava je razpadla do te mere, da je bil viden velik del lobanje in zgornje čeljustnice, spodnji čeljustnici pa sta bili že povsem izpostavljeni. Tudi desna plavut je že močno razpadla, tako da so bile vidne vse kosti, leva plavut pa je bila še kompaktna. V juniju je truplo razpadalo

## The whale's carcass decomposition and lifting of its bones from the sea floor

by Boris KRYŠTUFEK &  
Mojca Jernejc KODRIČ

The team of Ugo Fonda inspected the whale's carcass once a month between April and September 2003. Every inspection was documented with video camera and written report. The documentation is kept in the Slovenian Museum of Natural History. Inspection dives were carried out on April 21st, May 24th, June 25th, July 14th, August 21st and September 27th, 2003. In April, the whale lay on its right side on concrete weights, while in May gases accumulated in the bottom part of its abdominal cavity, owing to which the middle part of the body rose from the bottom and remained in this position throughout June and July. Although we were not afraid of the carcass rising to the surface, the concrete blocks were still lying on the sea floor, with ropes laden only by a few hundred kilograms of buoyancy force. Ugo Fonda pierced the body during additional inspection dive, releasing the gases. The mesh surrounding the carcass was all the time in perfect condition.

Sea temperatures are given in the table below. In April 2003, the biological processes, which are the basis of organic matter decomposition, were slow due to the sea's low temperatures. The carcass was still compact. The skin was falling off in about 1 square centimetre large fragments and the fibrous subcutaneum could already be seen. The disintegration was fastest on the head, with baleen plates already resting on the bottom of the mesh. Part of the skull and the major part of the mandible were visible. In May, parts of the remaining skin were falling off if merely touched. Apart from fibrous subcutaneum, muscle tissue could be seen in some places. The whale's head disintegrated to such

hitreje. Koža se je že povsem razkrojila, na površju je bilo vidno tako mišičje kot vezivno tkivo. Lobanja je bila v glavnem že gola, samo v predelu vratu je še ostalo mehko tkivo. Spodnji čeljustnici sta bili že povsem prosti. Desna plavut je v mesecu dni dokončno razpadla, v levi so bile že vidne kosti. V repnem predelu so se pokazala vretenca, ki pa so bila med seboj še čvrsto povezana. Julija so bila vsa tkiva, razen hrustanca in tetiv, na otip mehka in so se ob pritisku trgala. Prsni plavuti sta že povsem razpadli, njune kosti so ležale v mreži nad tlemi. V bližini repa in v predelu trebuha so bila vidna vretenca. Vosi so začeli vidno propadati in se razkrajati na lamele. Avgusta so od kita ostale skoraj samo še kosti z vezivi in hrustancem. Vretenca so bila vidna vzdolž celotnega hrbta. Lobanja je bila že povsem očiščena, v vratnem predelu pa je bilo še vedno mehko tkivo. Rebra so že popadala v mrežasto vrečo. Septembra so potapljači opozorili na veliko krhkost okostja in na dejstvo, da lobanjske kosti še niso čvrsto zrasle v kranij. Količina mehkih tkiv je bila ocenjena na nekaj sto kilogramov.

Po oceni Uga Fonda je bila večina razkroja mikrobna. V premeru približno 20 m okrog trupla so morske živali (ribe, raki, glavonožci)

**Tabela 1.** Temperature morja (v °C) v obdobju april–avgust 2003 v Piranskem zalivu na površini in v globini približno 20 m, kje je ležalo truplo brazdastega kita (po meritvah Uga Fonda)

**Table 1.** Sea temperatures (in °C) during the April–August 2003 period in Piran Bay at the surface and at a depth of about 20 metres, where the whale carcass was lying (according to the measurements made by Ugo Fonda).

	T (0 m)	T (20 m)
april / April	11,5	10,0
maj / May	20,0	12,0
junij / June	25,0	16,0
julij / July	26,0	16,0
avgust / August	28,5	18,0
september / September	20,5	18,0

an extent that a large part of the skull and the maxilla could be seen, whereas the mandibles were already fully exposed. The right flipper, too, disintegrated a great deal, which means that all bones were already visible, while the left flipper was still compact. In June, the carcass began to disintegrate at a faster rate. The skin was now totally decomposed, and on the surface the whale's muscles and connective tissue could be seen. The skull was more or less already bare of organic matter, with only soft tissue remaining in the neck area. The mandibles were already completely free. Within a month, the right flipper finally disintegrated, making all its bones visible, while the bones of the left flipper were already visible. In the whale's tail area, vertebrae that were still firmly connected with each other began to be visible. In June, all the tissues, with the exception of cartilage and tendons, felt soft and tore when pressed. Pectoral fins had fully disintegrated, with their bones lying on the bottom of the mesh bag. Near the whale's tail and in belly area, vertebrae could be seen. Baleen plates began to decompose visibly and disintegrate into lamellae. In August, only a few bones with connective tissues and cartilage remained of the whole whale. Vertebrae were visible along the entire animal's back. The skull was almost entirely bare, while in the neck area the soft tissue could still be seen. The vertebrae had already fallen into the mesh. In September, divers called attention to the great fragility of the skeleton and the fact that skull bones had not yet firmly grown into cranium. The quantity of soft tissues was estimated at a few hundred kilos.

Ugo Fonda judged the body's decomposition was primarily microbial. In diameter of about 20 metres around the carcass, animals (fishes, crustaceans, cephalopods) lived their normal lives. On the body that was covered by white filamentary structures in March, colonies of parasitic copepods *Penella balenopterae* became more and more visible. Under the whale, hermit crabs that tend to be numerous at sewer outfalls, were seen. In May, Fonda no longer noticed any copepod colonies, while under the whale and on



**Slika 8.** Srednji del kitovega trupa se je zaradi nabranih plinov dvignil z dna. Fotografija: Ciril Mlinar

**Figure 8.** Owing to the accumulated gases, the middle section of the whale's body rose from the sea floor.  
Photo: Ciril Mlinar

živele običajno življenje. Na truplu, ki so ga v marcu prekrivale bele nitaste strukture, so postajale vse bolj očitne kolonije zajedavskih ceponožcev *Penella balenopterae*. Pod kitom so se zadrževali raki samotarci, ki so ob izlivu kanalizacije številni. V maju Fonda ni več opazil kolonij ceponožcev, pod kitom in na njem pa so bili raki samotarci. Na mrežo pod kitom so lignji v velikem številu odložili jajčeca. Od rib so se pod truplom in ob njem zadrževali številni glavači, okoli njega pa so plavale menule (*Spicara flexuosa*) in druge ribe, ki so se hranile z drobnimi kosmičastimi koščki tkiva. Ribe so tudi trgale koščke mesa z mrtvega kita. Avgusta je pod kitovim truplom ležalo večje število morskih brizgačev. Tudi v poletnih mesecih je bila večina razkroja še naprej mikrobna. Visoke poletne temperature so vidno pospešile razpad.

it hermit crabs were present. On the mesh under the carcass, squid had laid numerous eggs. As far as fishes are concerned, a number of gobies were observed under the whale and its sides; around it, Blotched Pickerels (*Spicara flexuosa*) and other fishes that fed on flaked pieces of tissue were swimming. The fishes also tore pieces of flesh from the dead whale. In August, a high number of sea cucumbers were lying under the carcass. In the summer months, the whale's decomposition continued to be mostly microbic, with high summer temperatures clearly hastening the decay.

The decaying carcass showed no negative impact on the environment. The whale's immediate vicinity was inhabited by fishes (conger, goby, etc.), crustaceans (hermit crab, lobster) and cephalopods (squid, cuttlefish, musky octopus). The same applies to sessile animals.

Razkrajajoče se truplo ni kazalo nobenega negativnega vpliva na okolico. V neposredni bližini trupla so živele ribe (ugor, lep, glavač idr.), raki (samotarci, jastogi) in glavonožci (lignji, sipe in moškadne hobotnice). Enako velja tudi za pritrjene (sesilne) živali. Nekatera bitja so truplo uporabljala kot trdno podlago in skrivališče.

Ker sta bili obe spodnji čeljustnici v juniju že brez vidnega mehkega tkiva, je vzniknil predlog, da bi ju dvignili na površje in prepeljali v Ljubljano. Ugo Fonda se je namreč bal, da bi ju kdo ukradel. Obe kosti, ki sta se belili na temnem truplu, sta bili namreč videti zelo lepi in zato kljub svoji velikosti mamljivi za morebitne zbiralce tovrstnih predmetov. Vodstvo PMS se je odločilo, da predlog sprejme. Bali smo se sicer, da razpad mehkih tkiv, predvsem ligamentov in hrustanca, v proksimalnem delu čeljusti še ni končan, kar bi utegnilo povzročiti težave pri nadaljnjem prepariranju. Kljub temu je ekipa PMS skupaj z izvajalcem 7. julija čeljusti dvignila na čoln. Tudi ta dogodek je pritegnil pozornost medijev, npr. Dela, ki je 8. julija 2003 zapisal »Prvi kitovi kosti že iz morja«, in Dnevnika, v katerem smo 9. julija 2003 lahko prebrali »Kitove kosti že pri strokovnjakih«. Pomisleki so se pokazali za utemeljene. Razkroj v območju spodnječeljustnične sklepa namreč še ni bil končan. Izurjena potapljača sta zato drug za drugim delala v globini 22 m celo uro, preden sta kosti ločila od trupa. Razpadajoče mehko tkivo smo na čolnu odstranili. Kostni smo na obali zavili v podloženo plastiko in ju z manjšim tovornjakom prepeljali v muzejske depojske prostore v Ljubljani. Posamezna spodnja čeljustnica je dolga po obodu 3,2 m, maso pa smo ocenili na nekaj manj kot 150 kg. Kljub velikosti je bilo kostno tkivo presenetljivo mehko in krhko.

Dne 15. julija so potapljači zašili rez, narejen dober teden prej, ko so iz mreže potegnili čeljustnici. Izkušnje ob dviganju spodnjih čeljustnic so pokazale, da je pri drugih kosteh smiselno počakati do konca razpada. V naslednjem mesecu se je zaradi visokih temperatur truplo hitro razkrajalo, zato je potapljaška ekipa ocenila, da bo oktobra od živali ostalo

Some of the marine creatures used the carcass as a solid platform and a hiding place.

Given that in June both mandibles were already without visible soft tissue, a proposition was made to have them lifted to the surface and transported to Ljubljana. Specifically, Ugo Fonda was afraid that somebody could steal them. Both bones, which seemed snow white on the dark carcass, were very attractive and in spite of their great size very tempting to potential collectors. The management of the Slovenian Museum of Natural History thus decided to accept the proposal, for it was feared that the decay of soft tissues, particularly ligaments and cartilage, was not completed in the proximal part of the jaw, which could cause problems during further preparation. In spite of it all, our Museum's team lifted, with the aid of Ugo Fonda, the jawbones into the boat. This event, too, attracted much attention of the media, e.g. Delo daily, which on July 8th, 2003, reported: »The first whale's bones already out of the sea«, and Dnevnik daily which on July 9th, 2003, announced: »The whale's bones already in the experts' hands.« The concern turned out to be justified, for the decay in the mandibular joint area had not been completed as yet. Two trained divers thus had to work, one after another, at a depth of 22 metres a whole hour, before separating the bones from the body. The disintegrating soft tissue was removed in the boat. On the shore, the bones were wrapped in lined plastic and transported with a small lorry to the Museum's depot in Ljubljana. Each mandible measured 3.2 metres around the perimeter, while its mass was estimated at a little less than 150 kilos. In spite of its great size, the bone tissue was surprisingly soft and fragile.

On July 15th, the divers stitched the cut made a good week earlier, when the mandibles were taken from the mesh bag. The experience gained during the lifting showed that it would be reasonable to wait until the carcass was fully dilapidated when dealing with other bones. Due to high temperatures at that time, the body was quickly decomposing, and the divers estimated that by October only the skeleton would remain of the entire animal.



samo še okostje. Tako so 14. oktobra 2003 dvignili nekaj reber in vretenc. Čez približno pol leta, 4. in 17. marca 2004, so z morskega dna dvignili še preostalo okostje. Kot zadnjo so potapljači 26. maja 2004 na površje dvignili lobanjo.

On October 14th, 2003, they lifted a few ribs and vertebrae, while after about half a year, on March 17th, 2004, they brought the rest of the bones to the surface. The last remaining part of the whale was its skull, which was lifted from the sea floor on May 26th, 2004.



**Slika 9.** Po slabih štirih mesecih so potapljači na površje dvignili spodnji čeljustnici. V predelu spodnječeljustnične glave je bilo še veliko mehkega tkiva. Fotografija: Dare Šere

**Figure 9.** The mandibles were lifted to the surface after a little less than four months. The mandibular head section was still full of soft tissue. Photo: Dare Šere



**Slika 10.** Dvig vretenc z morskega dna. Fotografija: Ciril Mlinar

**Figure 10.** Lifting of vertebrae from the sea floor.  
Photo: Ciril Mlinar



**Slika 11.** Pokojni potapljač, biolog in samostojni podjetnik Ugo Fonda. Fotografija: Ciril Mlinar

**Figure 11.** The late diver, biologist and independent entrepreneur Ugo Fonda. Photo: Ciril Mlinar



**Slika 12.** Dvig reber z morskega dna, marca 2004. Fotografija: Ivo Božič

**Figure 12.** Lifting of ribs from the sea floor, March 2004. Photo: Ivo Božič



**Slika 13.** Dvig lobanje z morskega dna. Fotografija: Ciril Mlinar

**Figure 13.** Lifting of the skull from the sea floor. Photo: Ciril Mlinar



**Slika 14.** Zadnji kostni element brazdastega kita, ki so ga potapljači dvignili na površje, je bila lobanja.  
Fotografija: arhiv Cirila Mlinarja

**Figure 14.** The Fin Whale's last structure lifted by divers to the surface was the skull. Photo: Ciril Mlinar's archive



Slika 15. Poročilo o ogledu trupla brazdastega kita z dne 24.5.2003, ki ga je podalo podjetje UNIC SUB, Ugo Fonda, s. p.

Figure 15. The report on the examination of the Fin Whale's carcass from May 24th, 2003, made by the firm UNIC SUB, Ugo Fonda, s. p.



11 **SOBOTA** zgodbe 22. marca 2003 **3**

# Dnevnik Uga Fonde, potapljača, ki je pred Piranom »pokopal«» trinajstmetskega kita

## Počivaj v miru, veliki prijatelj!

**PIRAN** : «Če bi mi nekdo pred meseci rekel, da bom kdaj potapljal, bi se smejal. Toda (še) danje primarne oaze premoženja» pravi Ugo Fonda, potapljač prirodnega muzeja, ki je v skupini potapljačev v ponedeljek v morju pred Piranom »pokopal«» mrtvega kita. In dodaja, da teburno in udajno se kile nič bolj zabavna, kot kiti, ko se potapljači spuščajo ali vzpenjajo po stenah kile. Bilo je to zadnje srečanje potapljačev za Soboto je Ugo Fonda napisal dnevnik v potapljaški sestavi kile.

**Ponedeljek, 16. marec: Največji doslej**

Spredelno so je spoznal, da je v Pircanovih vodah kit. Zaprta so morja so pomislil, da bi si ga bil takoj ogledal. Škafi razdeljeni so po vrstah, morja? Vseeno sklonilo na tisto in bil nekaj minut samo zabava. Bilo je kot in kad je vna je vna nekaj dni struje in bili so kiti, tako da se kape videli bal brezdomni svetlobi. Kitovi kiti so izgubili pri 14 urah, deljega od 17. marca, in se nato spustila črna, nepo-

pril. Najbolje, da je najprej videl, ko se je spuščal, da je kit videl in da sta videla kitovo oči in bal svetlobe. Črna svetloba se je pojavila pred potapljači. Potapljači so se spuščali po vodni kile, kar je bilo videti in vili obkroži, kar je bilo videti in vili obkroži. Potapljači so se spuščali po vodni kile, kar je bilo videti in vili obkroži. Potapljači so se spuščali po vodni kile, kar je bilo videti in vili obkroži.

**Torek, 17. marec: Kako do kile?**

Številni so se spuščali v potapljaški kile. Zaprta, da je bilo obkroži, da je obkroži, vna kile. Zaprta, da je bilo obkroži, da je obkroži, vna kile. Zaprta, da je bilo obkroži, da je obkroži, vna kile.

**Četrtek, 19. marec: Strano**

Ze spoznal je kitove strano svetlo, vendar je videla nekaj strano, saj je za morja kile. Potapljači so se spuščali po vodni kile, kar je bilo videti in vili obkroži. Potapljači so se spuščali po vodni kile, kar je bilo videti in vili obkroži.

**Subota, 22. marec: Mirno za »pokop«**

Odkrili so, da se vna kile. Zaprta, da je bilo obkroži, da je obkroži, vna kile. Zaprta, da je bilo obkroži, da je obkroži, vna kile. Zaprta, da je bilo obkroži, da je obkroži, vna kile.

**Sobota, 15. marec: Spet v Pircan**

Vseeno so se kile potapljači in nekaj minut. Ze kile potapljači in nekaj minut. Ze kile potapljači in nekaj minut. Ze kile potapljači in nekaj minut. Ze kile potapljači in nekaj minut.

**Nedelja, 16. marec: Prijazni kile**

Spoznal je se kile potapljači in nekaj minut. Ze kile potapljači in nekaj minut. Ze kile potapljači in nekaj minut. Ze kile potapljači in nekaj minut. Ze kile potapljači in nekaj minut.

**Petek, 14. marec: Razbrskano morje**

Potapljači so se spuščali po vodni kile, kar je bilo videti in vili obkroži. Potapljači so se spuščali po vodni kile, kar je bilo videti in vili obkroži.

**Ponedeljek, 17. marec: Potapljači**

Vseeno so se kile potapljači in nekaj minut. Ze kile potapljači in nekaj minut. Ze kile potapljači in nekaj minut. Ze kile potapljači in nekaj minut. Ze kile potapljači in nekaj minut.



Ze potapljači spustila kitovi in potapljači odšel na morje vna.



Potapljači so kitove strano svetlo in kile potapljači in nekaj minut. Ze kile potapljači in nekaj minut. Ze kile potapljači in nekaj minut.

**Slika 16.** Dnevnik potapljača Uga Fonde, ki je za Prirodoslovni muzej Slovenije pred Piranom »pokopal«» trinajstmetskega kita. Primorske novice, 22. 3. 2003

**Figure 16.** The diary of Ugo Fonda, who “buried” the 13 metres long whale off Piran for the Slovenian Museum of Natural History. Primorske novice, March 22nd, 2003.

## Prepariranje kosti

Mojca JERNEJC KODRIČ,  
Boris KRYŠTUFEK

Po dvigu kosti z morskega dna je bilo najprej na vrsti njihovo razsoljevanje. Ker je sol higroskopna, veže atmosfersko vlago, ta pa kasneje lahko pripelje do plesnenja ali bakterijskega razkroja kostnega materiala. Muzejska tehnična služba je kosti prepeljala v depojske prostore PMS in jih namestila v bazene s sladko vodo, ki ji je bila dodana majhna količina natrijevega hipoklorita ( $\text{NaClO}$ ) za preprečevanje rasti mikroorganizmov in alg. Vodo so menjali enkrat tedensko, pri čemer so tudi odstranili maščobo, ki se je nabrala na površini. Kostni so

## Preparation of bones

by Mojca JERNEJC KODRIČ &  
Boris KRYŠTUFEK

The lifting of bones from the sea floor was followed by their desalination. As salt is hygroscopic, it binds atmospheric moisture which, however, can eventually cause moulding or bacterial decomposition of bone tissue. The Museum's technical service transported the bones to the Museum of Natural History's depot, where placed into reservoirs with fresh water, to which a small quantity of sodium hypochlorite ( $\text{NaClO}$ ) was added to prevent the microorganisms and algae growth. Water was changed once a week, when fat gathered on the



**Slika 17.** V muzejskih depojskih prostorih so lobanjo namestili v plastičen bazen, kjer se je nato približno tri mesece namakala v sladki vodi. Fotografija: Ciril Mlinar

**Figure 17.** In the Museum depot, the skull was carefully placed in the plastic pool, where left to soak in fresh water for about three months. Photo: Ciril Mlinar



**Slika 18.** Razsoljevanje kosti v bazenu s sladko vodo. Fotografija: Ivo Božič

**Figure 18.** Desalination of bones in the pool filled with fresh water. Photo: Ivo Božič

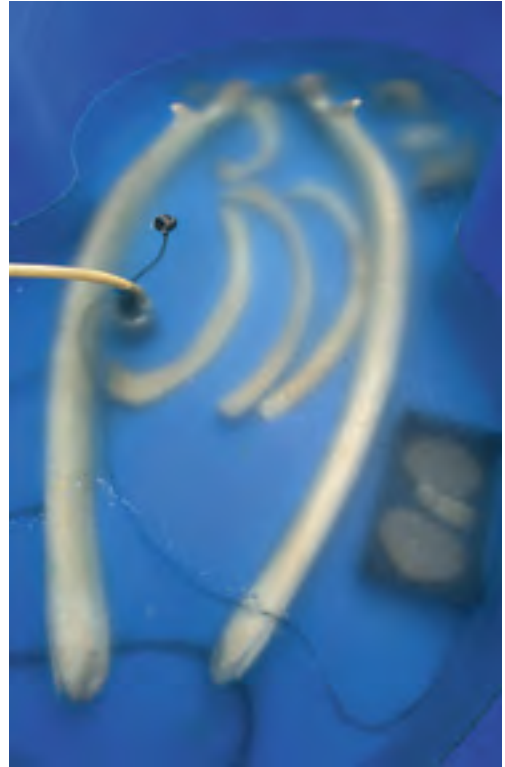
ostale v vodi približno tri mesece, potem pa so jih posušili na zraku.

Kosti kitov pogosto vsebujejo večjo količino maščobe (Cagnolaro, Di Natale & Notarbartolo di Sciara, 1983), ki pomeni energetsko zalogo, omogoča pa tudi večjo plovnost telesa. Maščobo je treba odstraniti, sicer sčasoma pronica na površje kosti in oksidira. Slednje povzroča neprijeten vonj, spremeni barvo kosti, predvsem pa zaradi znižane pH-vrednosti raztaplja apnenec. Za postopek ekstrakcije maščob iz kitovih kosti se je PMS leta 2003 povezal s podjetjem Kemis (KEMIS kemični izdelki, predelava in odstranjevanje odpadkov, d.o.o.), ki je pooblaščen za ravnanje z nevarnimi odpadki. Ker pri iskanju ustreznega postopka niso mogli dobiti referenčnega primera, so najprej določili ključne zahteve

surface was also removed. The bones remained in the water for about three months and then left to air dry.

Whale bones often contain a large amount of fat (Cagnolaro, Di Natale & Notarbartolo di Sciara, 1983), which presents an energy supply and at the same time enables a greater body buoyancy. The fat must be removed, or it gradually penetrates to the surface and oxidizes. The latter causes an unpleasant odour, changes the colour of bones and dissolves limestone mainly owing to the lowered pH level. For the purpose of fat extraction from the whale's bones, the Slovenian Museum of Natural History hired, in 2003, the firm Kemis (KEMIS Chemical Products, Processing and Removal of Waste, d.o.o.), authorised for handling with hazardous waste.





**Sliki 19 in 20.** Vodo v bazenih so menjali enkrat tedensko. Fotografija: Ciril Mlinar

**Figures 19 & 20.** The water was changed once a week. Photo: Ciril Mlinar

za izbiro topila. To je moralo čim boljše raztapljati živalske maščobe, ni smelo vplivati na mehansko zgradbo kosti in moralo je dobro prodirati v notranjost kosti. Topilo je moralo biti tudi lahko hlapno, da ne bi zastajalo v kosteh in se kasneje izcejalo iz njih. Naslednji zaželeni lastnosti sta bili, da topilo ne bi bilo gorljivo in korozivno, kar bi olajšalo izbiro materialov za izdelavo razmaščevalnih kadi. Tem zahtevam je najbolje ustrezalo organsko topilo diklormetan ( $\text{CH}_2\text{Cl}_2$ ). Gre za majhno molekulo, ki omogoča dobro penetracijo, odlično topi maščobe in ni vnetljiva ali korozivna. Topilo je možno regenerirati in ga ponovno uporabiti, kar zmanjšuje stroške dela. Februarja 2004 je Kemis poskusno razmastil vretence in rebro, na tej osnovi pa je določil standarde nadaljnjega dela. Potrebne so bile

Considering that no reference case could have been obtained during the search for a suitable procedure, the key requirements for the selection of suitable solvent were stipulated. It had to dissolve animal fats well, should not affect the mechanical structure of bones, and should well penetrate into the bones' interior. The solvent also had to be easily volatile, lest it should congest in the bones and later trickle from them. Next desirable characteristics were that the solvent was not combustible and corrosive, which would mitigate the selection of materials for the making of degreasing tubs. These requirements were best met by the organic dichloromethane solvent ( $\text{CH}_2\text{Cl}_2$ ). This is to do with a small molecule, which enables good penetration, dissolves fats very well, and is not combustible and corrosive. The

tri zaporedne ekstrakcije, vsaka v trajanju od 4 do 10 dni. Zaradi izjemnih dimenzij posameznih kosti je izvajalec pripravil posebne kadi in mrežasto košaro. Kljub temu celotne lobanje ni bilo moč potopiti v topilo. Anteriorni del rostruma, ki je segal nad gladino topila, so zato razmaščevali s prelivanjem. Dinamika dela je bila usklajena z dostavljanjem kosti, ekstrakcije pa so bile opravljene vsakokrat s svežim topilom. V analitskem laboratoriju Tovarne barv, lakov in umetnih smol d.o.o. »Helios« v Domžalah so opravili kemično analizo vzorca topila po končani obdelavi lobanje. Vzorec ni bil homogen in se je razsložil v zgornjo (vodno) frakcijo in spodnjo (metilenkloridno) frakcijo. V vodni frakciji vzorca so z metodo plinske kromatografije določili sledeče hlapne organske komponente (v utežnih odstotkih):

solvent can be regenerated and reused, which reduces work costs. In February 2004, Kemis experimentally removed fat from a vertebra and a rib and, on this basis, stipulated standards of further work. Three sequential extractions were necessary, each lasting from 4 to 10 days. Due to the extreme dimensions of separate bones, the contractor prepared special tubs and a mesh basket. In spite of it all, the skull could not have been fully immersed into the solvent. The anterior part of the rostrum that reached over the surface of the solvent thus had to be treated by the solvent being poured over it. The dynamics of this work was coordinated with delivery of bones, while extractions were carried out each time with a fresh solvent. In the Analytical Laboratory of the firm Helios (Production of Paints, Lacquers and Synthetic



**Slika 21.** Razmaščevanje spodnjih čeljustnic v podjetju Kemis. Fotografija: Ivo Božič

**Figure 21.** Extraction of fats from mandibles in the firm Kemis. Photo: Ivo Božič

0,1 % perkloroetilen (PER, imenovanega tudi tetrakloreten), 0,07 % toluena, 0,01 % ksilena in <0,01 % (v sledovih) trikloroetilen (TKE) ter izopropilacetata. Preostanek vzorca sta tvorila voda in metilenklorid. Nehlapni del vzorca vodne plasti je vseboval 0,2 utežnega odstotka suhe snovi. Iz FTIR-spektra nehlapnega dela vzorca je bil razviden obstoj stearatov (maščob) in tereftalnih funkcionalnih skupin. V metilenkloridni plasti vzorca so z metodo plinske kromatografije določili sledeče hlapne organske komponente (v utežnih odstotkih): 0,2 % PER, 0,1 % toluena, 0,02 % ksilena in <0,01 % (v sledovih) TKE ter izopropilacetata. Preostanek je bil metilenklorid. Nehlapni del vzorca metilenkloridne plasti je vseboval 0,005 utežnega odstotka suhe snovi. Iz FTIR- spektra nehlapnega dela vzorca je bila

Resin, d.o.o) in Domžale, chemical analysis of a solvent sample was made after the completed skull's treatment. The sample was not homogenous and polarised into the upper (water) fraction and lower (methylene chloride) fraction. In the water fraction of the sample, the following volatile organic components (in weight percent) were determined with the gas chromatography method: 0.1% of perchlorethylene (PER, also called tetrachlorethene), 0.07% toluene, 0.01% xylene and <0.01% (in traces) trichloroethylene (TCE) and isopropyl acetate. The rest of the sample was composed of water and methylene chloride. The non-volatile part of the sample of water layer contained 0.2 weight percent of dry matter. From FTIR spectre of the non-volatile part of the sample, presence of stearates (fats) and terephthalic



**Slika 22.** Razmaščevanje lobanje je delno potekalo s prelivanjem, saj je zaradi velikosti ni bilo mogoče popolnoma potopiti v topilo. Fotografija: Ivo Božič

**Figure 22.** Extraction of fats from the skull partially took place by the solvent being poured over it, as the skull could not be fully immersed into it owing to its huge size. Photo: Ivo Božič



**Slika 23.** Površinsko utrjevanje lobanje z emulzijo. Fotografija: Ciril Mlinar

**Figure 23.** Surface consolidation of the skull with emulsion. Photo: Ciril Mlinar

razvidna zastopnost stearatov (maščob) in tereftalnih funkcionalnih skupin.

Vzorec topila po opravljeni ekstrakciji je torej vseboval vodno in organsko fazo, ki sta bili medsebojno delno pomešani (emulgirani). Voda je ostala v kostnem tkivu tudi po sušenju zaradi njegove porozne zgradbe. Primesi drugih topil (toluen, ksilen, PER, TKE, izopropilacetat) so bile minimalne in posledica regeneracije metilenklorida. Našeta topila so lahko še prispevala k izboljšanju topilnih sposobnosti diklormetana. V ekstraktu (nehlapni del vzorca) so bile zabeležene funkcionalne skupine, značilne za živalske maščobe (stearate), vendar ni bilo mogoče ugotoviti, za katere stearate natančno gre. Količina vodne plasti v kadi je bila približno 15 litrov, količina metilenkloridne plasti pa 6 m<sup>3</sup> oziroma 6.000 kg. Količina 0,2 % suhe snovi v vodni plasti pomeni, da je 15 litrov vodne faze vsebovalo približno 30 g maščobe. Podobno pomeni 0,005 % suhe snovi v metilenkloridni plasti, da je 6.000 kg topila po opravljenih vseh treh ekstrahiranjih vsebovalo približno 300 g maščobe. Koncentracija maščobe v organskem sloju je bila torej izredno nizka, tako da diklormetan kot topilo še zdaleč ni bil nasičen. Obstoj maščob v vodnem sloju je bil verjetno posledica umiljenja (pretvorba estra v sol stearinove kisline).

Kosti so bile postopoma razmaščene med februarjem 2004 in junijem 2005, potem pa smo jih shranili v depojskih prostorih, kjer so ostale do leta 2011. Določene kosti oziroma njihovi deli so bili zelo krhki, zato smo jih površinsko utrdili z emulzijo Primal WS 24 (Samson Kamnik d.o.o.).

functional groups was evident. In the sample's methylene chloride layer, the following organic components (in weight percent) were determined with the gas chromatography method: 0.2% PER, 0.1% toluene, 0.02% xylene and <0.01% (in traces) TCE and isopropyl acetate. The rest was methylene chloride. The non-volatile part of the sample of the methylene chloride layer contained 0.005 weight percent of dry matter. From FTIR spectre of the non-volatile part of the sample, presence of stearamates (fats) and terephthalic functional groups was evident.

After the extraction, the solvent sample therefore contained water and organic phases, which were partially blended (emulgated) with each other. Water remained in the bone tissue even after being dried owing to its porous structure. Admixtures of other solvents (toluene, xylene, PER, TCE, isopropyl acetate) were minimal and resulted from the methylene chloride regeneration. The listed solvents could further contribute to the improvement of dichloromethane's solving capacities. In the extract (non-volatile part of the sample), functional groups characteristic of animal fats (stearates) were present, but it could not be established which particular stearamates were at stake. The quantity of water in the tub was approximately 15 litres, while the quantity of methylene chloride layer was 6 m<sup>3</sup> or 6,000 kg. The quantity of 0.2% of dry matter in the water layer means that 15 litres of water contained about 30 g of fat; 0.005% of dry matter in the methylene chloride similarly means that 6,000 kg of solvent contained about 300 g of fat after the three extractions. The concentration of fat in the organic layer was thus extremely low, which indicates that dichloromethane, as solvent, was far from saturated. The presence of fats in the water layer was probably a result of ester conversion into stearin acid salt.

The bones were gradually processed between February 2004 and June 2005, then stored in the Museum depot, where left until 2011. As certain bones or their parts were very fragile, they were surface-consolidated with Primal WS 24 emulsion (Samson Kamnik d.o.o.).



**Slika 24.** Preparirane kosti so bile v letih 2005–2011 shranjene v muzejskem depoju. Fotografija: Ivo Božič  
**Figure 24.** The prepared bones were stored in the Museum depot from 2005 to 2011. Photo: Ivo Božič



## Osteologija

Mojca JERNEJC KODRIČ,  
Boris Kryštufek

Javno predstavitev kitovega okostja smo načrtovali v novi muzejski stavbi v Biološkem središču pod Rožnikom in se je po zaključku tehničnih del zdela povsem realna. Toda leta 2007 je postalo jasno, da je postavitev velikokrat obljubljene nove muzejske stavbe ponovno odmaknjena v neznano prihodnost. Ker je bilo zanimanje javnosti za okostje veliko, smo se vendarle odločili, da ga v letu 2011 razstavimo ob praznovanju 190-letnice ustanovitve Kranjskega deželnega muzeja kot najstarejše kulturne, znanstveno-raziskovalne in izobraževalne ustanove na slovenskem etičnem ozemlju z neprekinjeno tradicijo. Kot edini primerni prostor nam je bila na voljo dvorana, namenjena občasnim razstavam

## Osteology

by Mojca JERNEJC KODRIČ &  
Boris Kryštufek

The Fin Whale's skeleton was planned to be publicly presented in the new museum building within the Biology Centre below Rožnik Hill (suburb of Ljubljana), and after the initial technical jobs were completed on the carcass, the plan seemed totally realistic. In 2007, however, it became clear that the construction of the museum buildings, which was promised so many times by the authorities, was once again postponed to an unknown future. Since the public interest in the skeleton was rising, we decided, in spite of it all, to exhibit it in 2011 on the 190th anniversary of the Carniolan Provincial Museum as of the oldest cultural scientific-research and educational institution with continuous tradition in Slovenian ethnic territory. As the only suitable place,



**Slika 25.** Določanje anatomskega položaja posameznih kosti v okostju. Fotografija: Ciril Mlinar

**Figure 25.** Determination of anatomical position of individual bones of the Fin Whale's skeleton.  
Photo: Ciril Mlinar

v muzejski stavbi na Prešernovi ulici. Odločitev je bila sprejeta šele januarja in februarja, ko so bila znana finančna sredstva za tekoče leto. Spomladi 2011 smo se lotili določanja posameznih kosti in njihovega anatomskega položaja v okostju. Pri tem smo si pomagali s sledečimi viri: Lonnberg (1931), Perrin, Wursig & Thewissen (2009), Cagnolaro, Di Natale & Notarbartolo di Sciara (1983) in Van Beneden & Gervais (1868). V pomoč so nam bile fotografije okostij brazdastih kitov, razstavljenih v naravoslovnih muzejih na Dunaju (Naturhistorisches Museum Wien), Benetkah (Museo di Storia Naturale di Venezia) in Budimpešti (Magyar Természettudományi Múzeum). Pri delu z okostjem je bila potrebna precejšna previdnost, saj so bili nekateri deli, zlasti odrastki vretenc, izjemno krhki. Posamezne kosti smo fotografirali in stehali (priloge).

Zaradi ekstremnih prilagoditev življenju v vodi se okostje kitov močno razlikuje od splošnega gradbenega plana sesalcev in sploh tetrapodov. Ker vodni vzgon nosi kitovo telo, so kosti lahke, pretežno spužvaste in brez ovoja kompaktnega kostnega tkiva. Zadnje okončine so povsem zakrnele, ohranil se je le ostanek okolčja, ki pa ni povezan z osnim skeletom, tako da križnica ni razvita. Na začetku repne regije hrbtenice obstajajo na ventralni strani vretenc hemalni loki. Sprednje okončine so preobražene v prsne plavuti. Prsni koš je velik in prožen (Cozzi *et al.*, 2009). Močno spremenjena je tudi lobanja. Spremembe v položaju, velikosti in obliki posameznih lobanjskih kosti so posledica prilagoditev, povezanih z dihanjem, načinom prehranjevanja in sluhom (Mead & Fordyce, 2009).

## Lobanja

Lobanja (*cranium*) našega primerka je bila v dorzalni (enako tudi ventralni) perspektivi trikotna struktura. Podaljšan rostrum se je proti vrhu postopno zoževal, na vrhu pa

the hall intended for occasional exhibitions in the museum building in Prešernova Street was available to us. The decision was made as late as in January and February, when the Museum's funds became known for the current year. In spring 2011, we began to identify separate bones and their anatomic position in the skeleton. Here we were aided by the following sources: Lonnberg (1931), Perrin, Wursig & Thewissen (2009), Cagnolaro, Di Natale & Notarbartolo di Sciara (1983) and Van Beneden & Gervais (1868). A great help were also the photographs of Fin Whale skeletons exhibited in natural history museums in Vienna (Naturhistorisches Museum Wien), Venice (Museo di Storia Naturale di Venezia) and Budapest (Magyar Természettudományi Múzeum). Working with the skeleton demanded considerable caution, considering that certain parts, particularly vertebral processes, were extremely fragile. Individual bones were photographed and weighed (Annexes).

Owing to the extreme adaption to life in water, the skeleton of whales greatly deviates from the general building plan of mammals, and tetrapods in general. As water buoyancy carries the whale's body, its bones are light, predominantly spongy and without compact (cortical) bone tissue. Hindlimbs are totally atrophied, with only remnants of pelvic girdle left; the latter, however, is not connected to the axial skeleton, which means that the sacrum does not develop. At the beginning of the backbone caudal region, chevrons are present on the ventral side of the vertebrae. Forelimbs are transformed into pectoral fins. The thorax is large and flexible (Cozzi *et al.*, 2009). The skull, too, is greatly altered. The changes in the position, size and form of separate cranial bones are the consequence of adaptations associated with breathing, manner of feeding and acoustic senses (Mead & Fordyce, 2009).

## Skull

The skull (*cranium*) of our specimen was a triangular structure in dorsal (as well as ventral) view. The extended rostrum narrowed down gradually towards the top, while at the

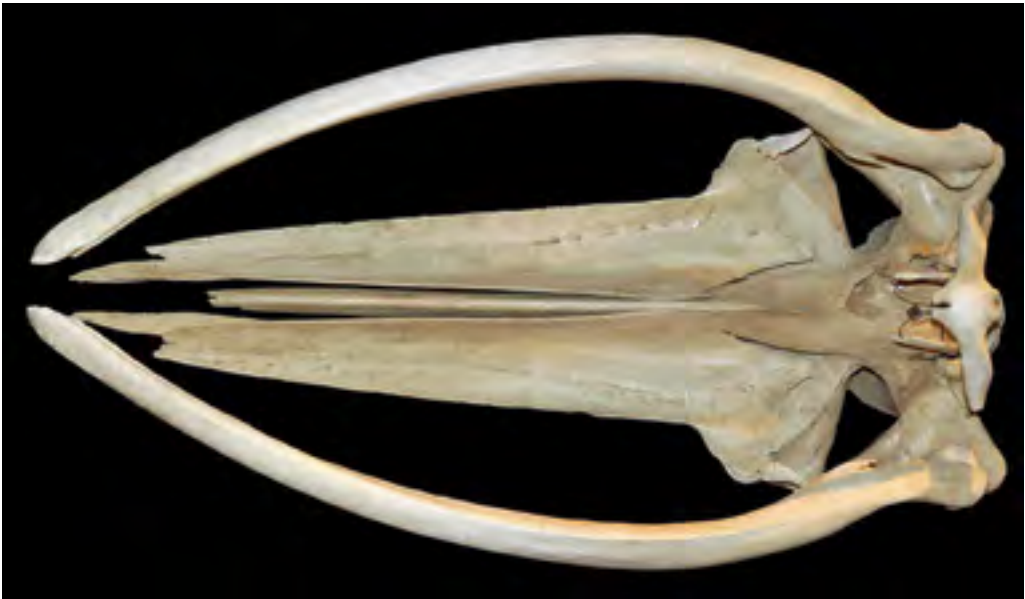
je bil koničast, medtem ko je pri sinjem kitu medialno zaobljen (Perrin, Wursig & Thewissen, 2009). Zelo dolgi zgornji čeljustnici (*os maxilla*) na posteriornem robu nebnihi podaljškovi (*maxilla, processus palatinus*) tvorita izraziti štrlini, medtem ko pri sinjem kitu teh ni (Sokolov & Arsen'ev, 2006). Nadočesna odrastka čelnice (*os frontale, processus supraorbitalis*) sta bila široka in obsežna. Velika

top itself it was pointed; in Blue Whale, it is medially rounded (Perrin, Wursig & Thewissen, 2009). The very long maxillae (*os maxilla*) on the posterior edge of palatine processes (*maxilla, processus palatinus*) form two distinct projections, which are absent in Blue Whale (Sokolov & Arsen'ev, 2006). Supraorbital processes of the frontal bone (*os frontale, processus supraorbitalis*) were wide



**Slika 26.** Lobanja lateralno, desna stran. Fotografija: Ciril Mlinar

**Figure 26.** The skull in lateral view, right side. Photo: Ciril Mlinar



**Slika 27.** Lobanja ventralno. Fotografija: Ciril Mlinar

**Figure 27.** The skull in ventral view. Photo: Ciril Mlinar



zatilnica (*os occipitale*) je bila na dorzalni strani lobanje zožena v smeri lobanjskega vrha. Luskasti del senčnice (*os temporale, pars squamosa*) in njen lični podaljšek (*processus zygomaticus*) sta bila masivna.

Za lobanje kitov je značilna teleskopija. Pojem je leta 1918 vpeljal Winge, opisuje pa teleskopsko prekrivanje nekaterih sosednjih lobanjskih kosti. Posteriorni deli zgornjih

and extensive. On dorsal side, the large occipital bone (*os occipitale*) was narrowed anteriorly. The squamosal part of temporal bone (*os temporale, pars squamosa*) and its zygomatic process (*processus zygomaticus*) were massive.

One of the characteristics of whale skull is its telescoping. The term was introduced in 1918 by Winge and describes the telescopic



**Slika 28.** Medčeljustnica (*os incisivum*). Fotografija: Ivo Božič

**Figure 28.** Premaxilla (*os incisivum*). Photo: Ivo Božič



**Slika 29.** Nosnici (*os nasale*). Fotografija: Ivo Božič

**Figure 29.** Nasal bones (*os nasale*). Photo: Ivo Božič



**Slika 30.** Ličnica (*os zygomaticum*).

Fotografija: Ciril Mlinar

**Figure 30.** Zygomatic bone (*os zygomaticum*).

Photo: Ciril Mlinar



**Slika 31.** Solznica (*os lacrimale*).

Fotografija: Ciril Mlinar

**Figure 31.** Lachrymal bone (*os lacrimale*).

Photo: Ciril Mlinar

čeljustnic in medčeljustnic prekrivajo majhen del čelnice, obdržijo pa lego glede na nosnici (*os nasale*) (Perrin, Wursig & Thewissen, 2009). Zatilnica je močno pomaknjena anteriorno in prekriva temenico (*os parietale*) (Mead & Fordyce, 2009). Posledica teleskopije je med drugim tudi posterodorzalni premik zunanjih nosnic (Perrin, Wursig & Thewissen, 2009).

## Spodnja čeljustnica

Spodnja čeljustnica (*mandibula*) je bila iz dveh masivnih, dolgih in usločenih kosti. Anteriorno se njuni konici ne stikata, nista združeni v spodnječeljustnični zrasti (*symphysis mandibulae*), sta pa povezani z ligamenti (Perrin, Wursig & Thewissen, 2009). Sklepni ali kondilarni odrastek (*processus condylaris*) oziroma spodnječeljustnična glava (*caput mandibulae*) tvori čeljustni sklep z lobanjo. Anteriorno od sklepnega odrastka leži kavljasti podaljšek (*processus coronoideus*) (Mead & Fordyce, 2009). Desna polovica spodnje čeljustnice je v ravni liniji merila 2,95 m.

overlapping of some neighbouring skull bones. The posterior parts of maxillae and premaxillae overlap a minor part of the frontal bones, but retain the position with regard to the nasal bones (*os nasale*) (Perrin, Wursig & Thewissen, 2009). The occipital bone is strongly shifted anteriorly and overlaps the parietal bone (*os parietale*) (Mead & Fordyce, 2009). The consequence of telescoping is, inter alia, posterior displacement of the external bony nares (Perrin, Wursig, Thewissen, 2009).

## Mandible

The mandible (*mandibula*) was composed of paired massive, long and curved bones. Anteriorly, their tips did not articulate in the mandibular symphysis (*symphysis mandibulae*), but were instead connected with ligaments (Perrin, Wursig & Thewissen, 2009). The articular process (*processus condylaris*) of mandibular ramus formed the temporo-mandibular joint with the skull. Anteriorly from the articular process, the coronoid process (*processus coronoideus*) is situated (Mead & Fordyce, 2009). The length of the mandible's right side was 2.95 m in a straight line.



**Slika 32.** Desna polovica spodnje čeljustnice (*mandibula*), dorzalno, dolžina v ravni liniji je 2,95 m.  
Fotografija: Ciril Mlinar

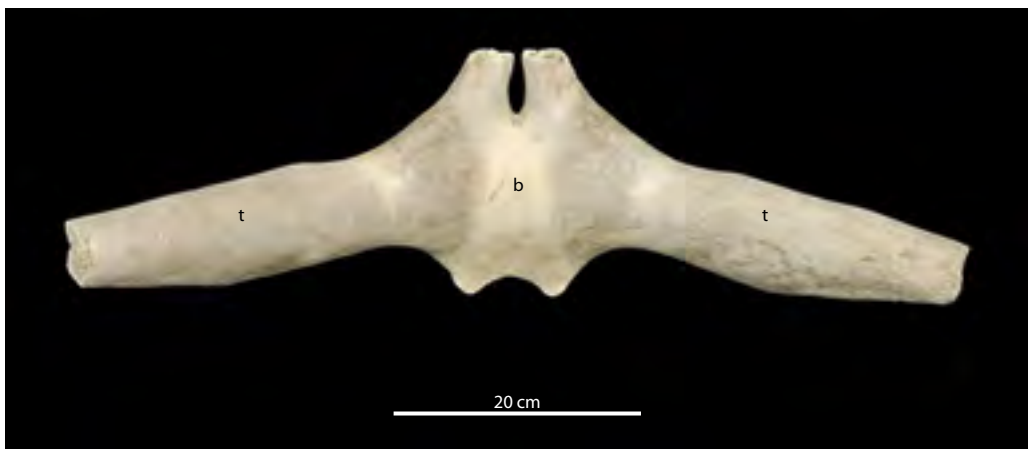
**Figure 32.** Right side of the mandible in dorsal view; length in a straight line is 2.95 m.  
Photo: Ciril Mlinar

## Podjezična kost ali podjezičnica

Podjezično kost (*os hyoideum*) tvori telo podjezičnice (*basihyoideum, corpus*), ki je zlito s stranskima, posteriorno usmerjenima velikima rogovoma podjezičnice (*thyrohyoideum; cornu majus*) (Mead & Fordyce, 2009). Telo je na anteriornem robu razcepljeno v dva

## Hyoid bone

The hyoid bone (*os hyoideum*) is composed of the basihyal body (*basihyoideum, corpus*), which is merged with the posteriorly oriented lateral horns of the hyoid bone (*thyrohyoideum; cornu majus*) (Mead & Fordyce, 2009). On the anterior margin, the body is split into



**Slika 33.** Podjezična kost, dorzalno (b – *basihyoideum*, t – *thyrohyoideum*). Fotografija: Ciril Mlinar

**Figure 33.** Hyoid bone in dorsal view (b – *basihyoideum*, t – *thyrohyoideum*). Photo: Ciril Mlinar



**Slika 34.** Podjezična kost, ventralno (b – *basihyoideum*, t - *thyrohyoideum*). Fotografija: Ciril Mlinar

**Figure 34.** Hyoid bone in ventral view (b – *basihyoideum*, t - *thyrohyoideum*). Photo: Ciril Mlinar



**Slika 35.** Mala rogova podjezičnice (*stylohyoideum*).

Fotografija: Ciril Mlinar

**Figure 35.** Hyoid bone's stylohyoid processes (*stylohyoideum*). Photo: Ciril Mlinar

simetrična odrastka. Njima nasproti ležita dva manjša in zaobljena posteriorna odrastka (Lonnberg, 1931). Dorzalno od podjezične kosti sta parna, cilindrična in ukrivljena mala rogova podjezičnice (*stylohyoideum*). Anteriorno se s hrustancem vežeta na telo podjezične kosti, posteriorno pa na zatilnico (Mead & Fordyce, 2009).

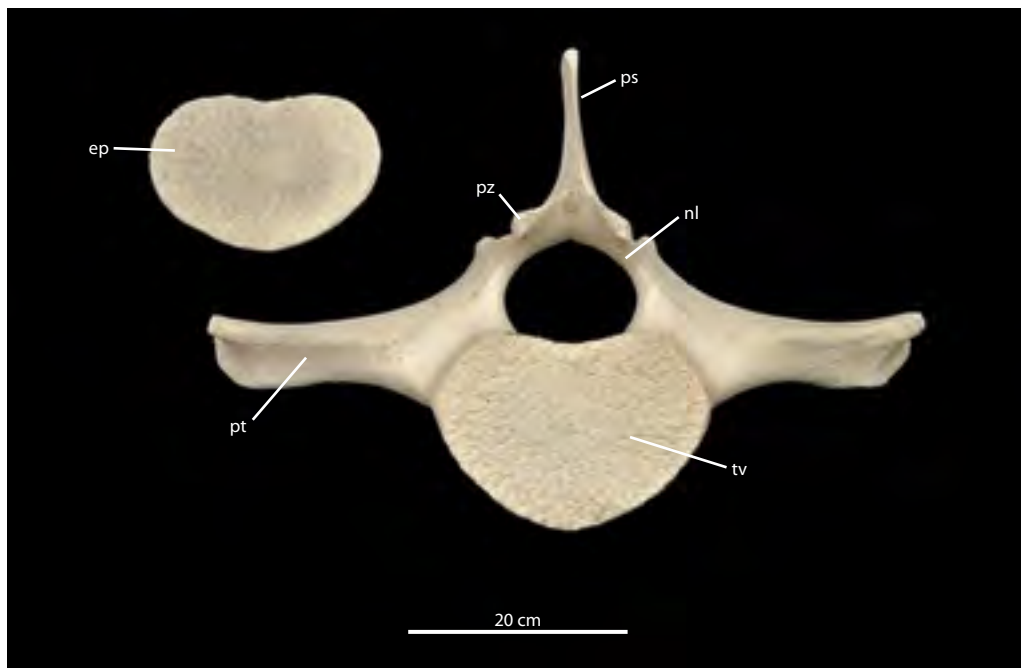
## Vretenca

Telesa vretenc tvorijo osnovno mehansko podporo hrbtenice. Iz telesa izhajata dva prečna odrastka (*processus transversus*) in trnasti (nevralni) odrastek (*processus spinosus*), ki je dorzalno na nevralnem loku. Zigapofize so mesta povezave

two symmetric processes. Opposite them, two smaller and rounded posterior processes are located (Lonnberg, 1931). Dorsally from the hyoid bone, there is a pair of cylindrical and curved processes of the hyoid bone (*stylohyoideum*). Anteriorly they are connected with the cartilage to the basihyal body, and posteriorly to the occipital bone (Mead & Fordyce, 2009).

## Vertebrae

The vertebrae constitute the vertebral column's basic mechanical support. Each body carries two transverse processes (*processus transversus*), as well as the spinous process (*processus spinosus*) which is located dorsally on the neural arch. Zygapophyses are



**Slika 36.** Peto prsno vretenca (D5) posteriorno (pt - prečni odrastek (*processus transversus*), tv - telo vretenca, pc - nevralni odrastek (*processus spinosus*), nl - nevralni lok, pz - postzigapofize) in posteriorna epifizna plošča. Fotografija: Ciril Mlinar

**Figure 36.** Fifth thoracic vertebra (D5) in posterior view (pt – transverse process (*processus transversus*), tv – centrum of vertebra, pc – neural process (*processus spinosus*), nl – neural arch, pz - postzygapophyses) and posterior vertebral epiphysis. Photo: Ciril Mlinar

med sosednjimi vretenci (Perrin, Wursig & Thewissen, 2009).

Hrbtenico kitov sestavljajo vratna (C), prsna (D), ledvena (L) in repna (Ca) regija. Zaradi zakrnele medenice križna regija ni prepoznavna. Vratna vretenca sestavljajo približno 4 %, prsna 21 %, ledvena 34 % in repna 41 % dolžine hrbtenice brazdastega kita (Cagnolaro, Di Natale & Notarbartolo di Sciara, 1983).

Pri obravnavanem osebku smo identificirali 57 vretenc. Formula je sledeča: C7, D15, L15, Ca20. Cagnolaro *et al.* (1983) in Perrin *et al.* (2009) navajajo za brazdaste kite 60 - 63 vretenc in formulo C7, D15 (16), L14 (13 - 16) in Ca25 (24 - 27). Možno je, da so se pri našem primerku posteriorna repna vretenca izgubila, ko je bilo truplo še potopljeno v morju.

Ker je bila naša žival mlada, epifizne (končne) plošče vretenc niso bile zraščene s telesi vretenc. Vsako vretenca je imelo na

the articulation surfaces between the neighbouring vertebrae (Perrin, Wursig & Thewissen, 2009).

The whales' vertebral column consists of the cervical region (C), thoracic region (D), lumbar region (L) and caudal region (Ca). Owing to the rudimentary pelvic girdle, the sacral region is not recognizable. Cervical vertebrae constitute about 4%, thoracic vertebrae 21%, lumbar vertebrae 34% and caudal vertebrae 41% of the Fin Whale vertebral column length (Cagnolaro, Di Natale & Notarbartolo di Sciara, 1983).

In our specimen, 57 vertebrae were identified: C7, D15, L15, Ca20. For Fin Whales, Cagnolaro *et al.* (1983) and Perrin *et al.* (2009) report 60-63 vertebrae: C7, D15 (16), L14 (13 - 16) and Ca25 (24 - 27). It is possible that the caudal vertebrae were lost in our specimen, when the carcass was still immersed in the sea.



**Slika 37.** Tretje vratno vretenca (C3), anteriorno, in anteriorna epifizna plošča. Fotografija: Ciril Mlinar

**Figure 37.** Third cervical vertebra (C3) in anterior view, and the anterior vertebral epiphysis. Photo: Ciril Mlinar

anteriorni in posteriorni strani telesa po eno epifizno ploščo. Izjemi sta bila atlas, ki je bil brez epifiznih plošč, in axis, ki je imel epifizno ploščo le na posteriorni strani. Epifizne plošče smo zlepili na telesa ustreznih vretenc s poliestrskim kitom.

Med lobanjo in prvim prsnim vretencem smo identificirali sedem **vratnih vretenc** (C). Njihova telesa so bila sploščena v anteriorno – posteriorni smeri; bila so opazno ožja od teles drugih vretenc. Ležala so tesno skupaj, vendar niso bila zrasla. Nevralni odrastki vratnih vretenc so bili zelo kratki. Prvi dve vretenci, nosač ali atlas (*atlas*) in okretač ali axis (*axis*), sta se po obliki močno razlikovali od drugih vratnih vretenc. Atlas je bil dokaj velik in je imel obsežen nevralni kanal. Prečna odrastka atlasa sta bila kratka, koničasta in odebeljena. Anteriorno je bila sklepna površina za zatilnična čvrša (*condylus occipitalis*), posteriorno pa za vezavo z axisom. Axis je bil največje vratno vretenca, z zelo širokimi, posteriorno usmerjenimi prečnimi odrastki, ki so tvorili sklenjen lok. Nevralni lok je bil masiven. Telo axisa je bilo podaljšano v zob (*dens, odontoid process*). Vratna vretenca C3 - C7 so imela velika in ozka ovalna telesa. Vretenca C3 - C6 so se razlikovala po dveh prečnih odrastkih na vsaki strani; dorzalni odrastek je bil bolj gracilen in tanjši od ventralnega. V nasprotju s C2 se prečna odrastka na vretencih C3 - C6 lateralno nista stikala, tako da nista tvorila obroča. Na C6 je bil ventralni prečni odrastek močno skrajšan, C7 pa je bil brez njega; dorzalni odrastek je bil masivnejši pri C7 kot pri drugih vratnih vretencih. Med delom s skeletom so nastale poškodbe dorzalnih prečnih odrastkov na vretencih C3 in C4. Na axisu in C2 so bili prečni odrastki usmerjeni posteriorno, na C3 in C4 so bili približno lateralni, na C5, C6 in C7 pa so bili usmerjeni anteriorno.

Since our animal was still immature, the vertebral epiphyses still did not fuse with vertebral bodies. Each body had one epiphysis both on the anterior and posterior sides; the only exception was the atlas, which was without epiphyses, and the axis, which had vertebral epiphysis on the posterior side only. We bonded the vertebral epiphyses to the bodies of appropriate vertebrae with polyester putty.

Between the skull and the first thoracic vertebra, seven **cervical vertebrae** were identified. Their bodies were flattened in the anterior-posterior direction and visibly narrower than the bodies of other vertebrae. They lay close together, but were unfused. The cervical vertebrae's neural processes were very short. The first two vertebrae, the atlas (*atlas*) and the axis (*axis*), differed a great deal in shape from other vertebrae. The atlas was fairly large and equipped with extensive neural canal. The atlas's transverse processes were short, pointed and inflated. Anteriorly, there was articular surface for occipital condyles (*condylus occipitalis*), and posteriorly for articulation with the axis. The latter was the largest cervical vertebra, with very wide, posteriorly oriented transverse processes that formed complete rings. The neural arch was massive. The body of the axis extended into odontoid process (*dens, odontoid process*). The cervical vertebrae C3-C7 had large and narrow oval bodies. The vertebrae C3-C6 differed in two transverse processes on each side; the dorsal process was more delicate and thinner than the ventral process. In contrast to C2, the transverse processes on vertebrae C3-C6 were not contiguous and therefore formed no arch. On C6, the ventral transverse process was much shorter, while C7 lacked it entirely; the dorsal process was more massive in C7 than in other cervical vertebrae. While we were working on the skeleton, the dorsal transverse processes were damaged on vertebrae C3 and C4. On the axis, the transverse processes were oriented posteriorly, on C3 and C4 they were approximately in lateral position, while on C5, C6 and C7 they were oriented anteriorly.



**Slika 38.** Anteriorna (ant.) in posteriorna (post.) površina prvega vratnega vretenca C1. Fotografija: Ciril Mlinar  
**Figure 38.** Anterior (ant.) and posterior (post.) surfaces of the 1st cervical vertebra C1. Photo: Ciril Mlinar





**Slika 39** . Dorzalna (dorz.) in ventralna (ventr.) stran prvega vratnega vretenca C1. Fotografija: Ciril Mlinar  
**Figure 39.** Dorsal (dors.) and ventral (ventr.) sides of the 1st cervical vertebra C1. Photo: Ciril Mlinar



**Slika 40.** Anteriorna (ant.) in posteriorna (post.) površina drugega vratnega vretenca C2. Fotografija: Ciril Mlinar  
**Figure 40.** Anterior (ant.) and posterior (post.) surfaces of the 2nd cervical vertebra C2. Photo: Ciril Mlinar



**Slika 41.** Dorzalna (dorz.) in ventralna (ventr.) stran prvega vratnega vretenca C2. Fotografija: Ciril Mlinar  
**Figure 41.** Dorsal (dors.) and ventral (ventr.) sides of the 2nd cervical vertebra C2. Photo: Ciril Mlinar



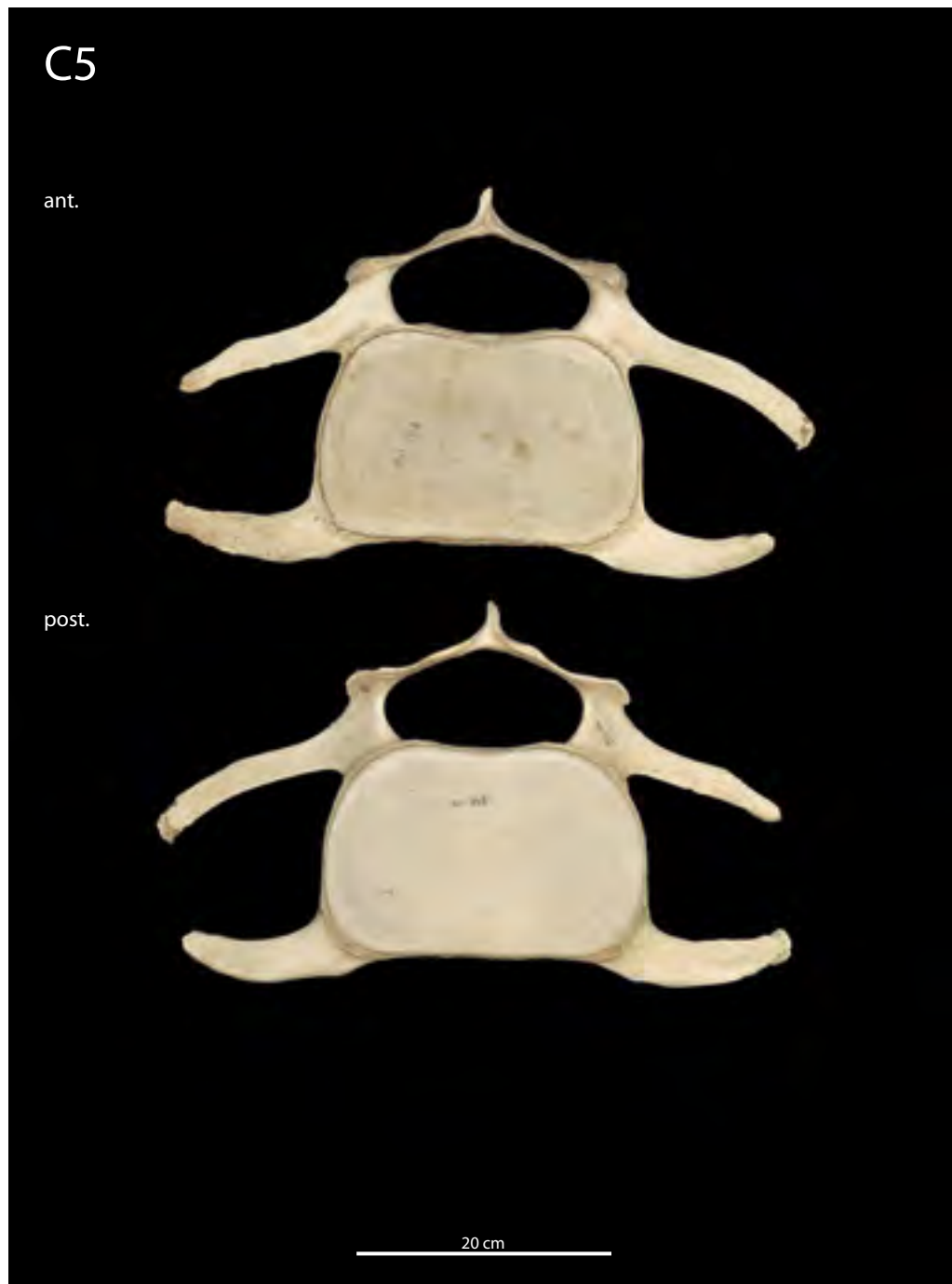
**Slika 42.** Anteriorna (ant.) in posteriorna (post.) površina tretjega vratnega vretenca C3. Dorzalni prečni odrastek je v distalnem delu odlomljen. Fotografija: Ciril Mlinar

**Figure 42.** Anterior (ant.) and posterior (post.) surfaces of the 3rd cervical vertebra C3. In distal part, the dorsal transverse process is broken off. Photo: Ciril Mlinar

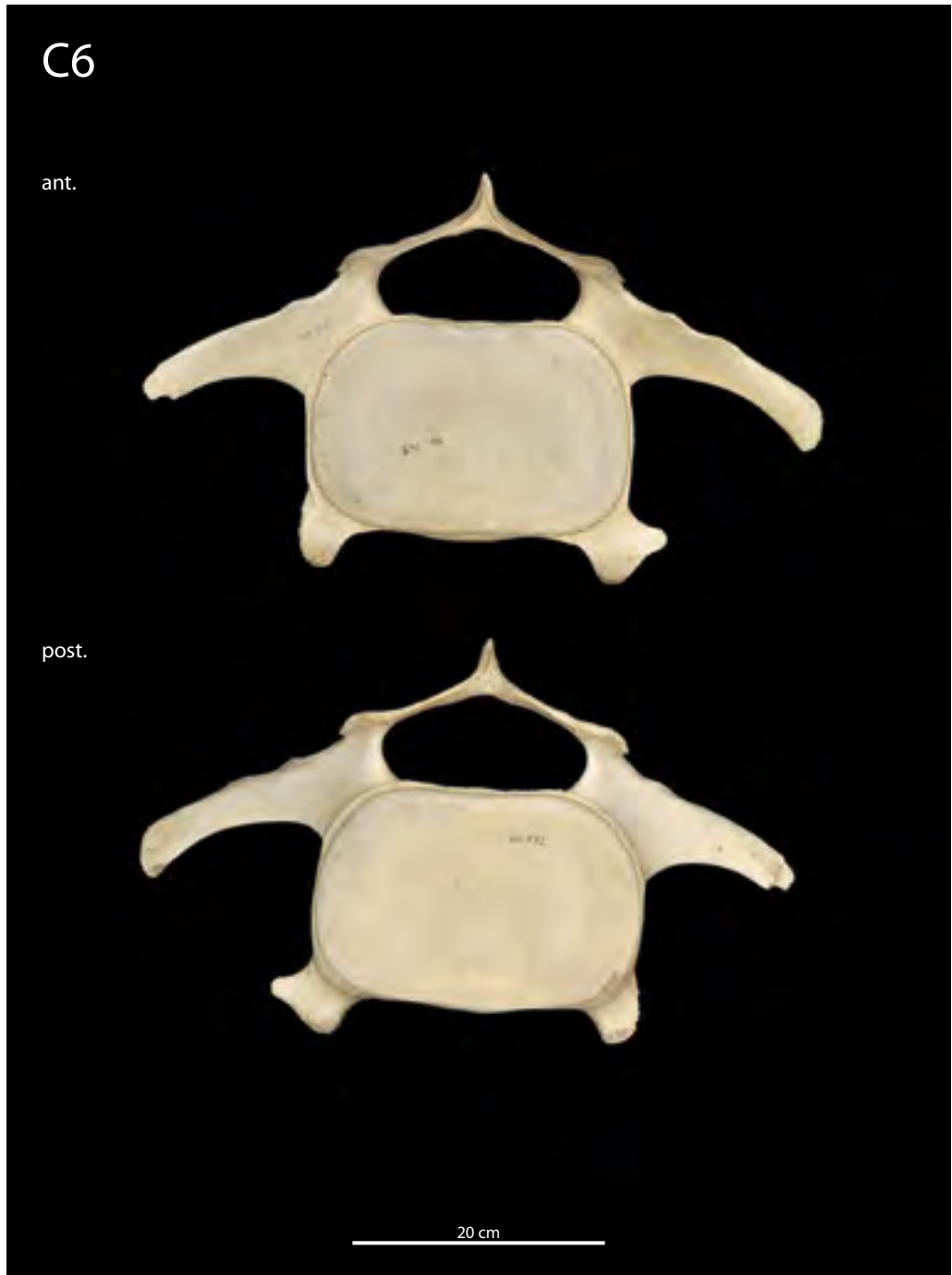


**Slika 43.** Anteriorna (ant.) in posteriorna (post.) površina četrtega vratnega vretenca C4. Dorsalni prečni odrastek je v distalnem delu odlomljen. Fotografija: Ciril Mlinar

**Figure 43:** Anterior (ant.) and posterior (post.) surfaces of the 4th cervical vertebra C4. In distal part, the dorsal transverse process is broken off. Photo: Ciril Mlinar



**Slika 44.** Anteriorna (ant.) in posteriorna (post.) površina petega vratnega vretenca C5. Fotografija: Ciril Mlinar  
**Figure 44:** Anterior (ant.) and posterior (post.) surfaces of the 5th cervical vertebra C5. Photo: Ciril Mlinar



**Slika 45.** Anteriorna (ant.) in posteriorna (post.) površina šestega vratnega vretenca C6. Fotografija: Ciril Mlinar  
**Figure 45.** Anterior (ant.) and posterior (post.) surfaces of the 6th cervical vertebra C6. Photo: Ciril Mlinar



**Slika 46.** Anteriorna (ant.) in posteriorna (post.) površina sedmega vratnega vretenca C7. Fotografija: Ciril Mlinar  
**Figure 46.** Anterior (ant.) and posterior (post.) surfaces of the 7th cervical vertebra C7. Photo: Ciril Mlinar



**Prsnih vretenc (D)** je bilo 15; prvih 14 vretenc (D1 - D14) je nosilo po par reber, petnajsto (D15) pa je pripadalo zadnjemu, enojnemu rebri. Telesa anteriornih prsnih vretenc so bila ozka, v posteriorni smeri pa so postajala vse daljša in cilindrična. Nevralna odrastka prvih dveh prsnih vretenc (D1 - D2) sta bila nizka in proti vrhu zožena. Pri drugih vretencih so bili nevralni odrastki visoki in izraziti, s širokim, oglatim vrhom. Med obdelavo je prišlo do manjših poškodb dorzalne površine nevrlnih odrastkov nekaterih prsnih vretenc. Na D7 - D14 so bili nevrlni odrastki usmerjeni posteriorno. Nevralni kanal prvih prsnih vretenc je bil ovalen, na vretencu D5 skoraj okrogel, od vretenca D8 naprej pa ozek in visok. Prečni odrastki prsnih vretenc so imeli na lateralni strani zadebelitve za vezavo z rebri. Prezigapofize so bile pri prvih petih prsnih vretencih majhne in vodoravne, ležale pa so na nevrlnem loku blizu osnove prečnega odrastka. Od vretenca D6 naprej so bile prezigapofize večje, zaokrožene in usmerjene izrazito anteriorno; ležale so na nevrlnem loku ali pa anteriornem robu nevrlnega odrastka. Postzigapofize so bile vidne le na prvih petih prsnih vretencih.

There were 15 **thoracic vertebrae (D)**; the first 14 (D1 - D14) carried a pair of ribs each, while the 15th vertebra (D15) belonged to the last, odd rib. The bodies of anterior thoracic vertebrae were narrow, while in the posterior direction they were increasingly longer and more cylindrical. Neural processes of the first two thoracic vertebrae (D1 - D2) were low and narrowed towards the top. In other vertebrae, the neural processes were high and distinct, with wide and angular tops. While working on the skeleton, dorsal surfaces of the neural processes on several thoracic vertebrae were slightly damaged. On D7 - D14, the neural processes were oriented posteriorly. The neural canal of the first thoracic vertebrae was oval, on vertebra D5 almost round, while narrow and high on D8 and posteriorly situated vertebrae. The transverse processes of thoracic vertebrae were inflated on the lateral side to connect to the ribs. In the first five thoracic vertebrae, the prezygapophyses were small and in horizontal position, lying on the neural arch near the basis of the transverse process. From vertebra D6 on, the prezygapophyses were larger, rounded and oriented distinctly anteriorly; they were situated on the neural arch or on anterior edge of the neural process. The postzygapophyses were present only on the first five thoracic vertebrae.



**Slika 47.** Anteriorna (ant.) in posteriorna (post.) površina prvega prsnega vretenca D1. Fotografija: Ciril Mlinar  
**Figure 47.** Anterior (ant.) and posterior (post.) surfaces of the 1st thoracic vertebra D1. Photo: Ciril Mlinar



**Slika 48.** Anteriorna (ant.) in posteriorna (post.) površina drugega prsnega vretenca D2. Fotografija: Ciril Mlinar  
**Figure 48.** Anterior (ant.) and posterior (post.) surfaces of the 2nd thoracic vertebra D2. Photo: Ciril Mlinar



**Slika 49.** Anteriorna (ant.) in posteriorna (post.) površina tretjega prsnega vretenca D3. Fotografija: Ciril Mlinar  
**Figure 49:** Anterior (ant.) and posterior (post.) surfaces of the 3rd thoracic vertebra D3. Photo: Ciril Mlinar



**Slika 50.** Anteriorna (ant.) in posteriorna (post.) površina četrtega prsnega vretenca D4. Fotografija: Ciril Mlinar  
**Figure 50.** Anterior (ant.) and posterior (post.) surfaces of the 4th thoracic vertebra D4. Photo: Ciril Mlinar



**Slika 51.** Anteriorna (ant.) in posteriorna (post.) površina petega prsnega vretenca D5. Fotografija: Ciril Mlinar  
**Figure 51:** Anterior (ant.) and posterior (post.) surfaces of the 5th thoracic vertebra D5. Photo: Ciril Mlinar





**Slika 52.** Anteriorna (ant.) in posteriorna (post.) površina šestega prsnega vretenca D6. Fotografija: Ciril Mlinar  
**Figure 52.** Anterior (ant.) and posterior (post.) surfaces of the 6th thoracic vertebra D6. Photo: Ciril Mlinar



**Slika 53.** Anteriorna (ant.) in posteriorna (post.) površina sedmega prsnega vretenca D7. Fotografija: Ciril Mlinar  
**Figure 53.** Anterior (ant.) and posterior (post.) surfaces of the 7th thoracic vertebra D7. Photo: Ciril Mlinar



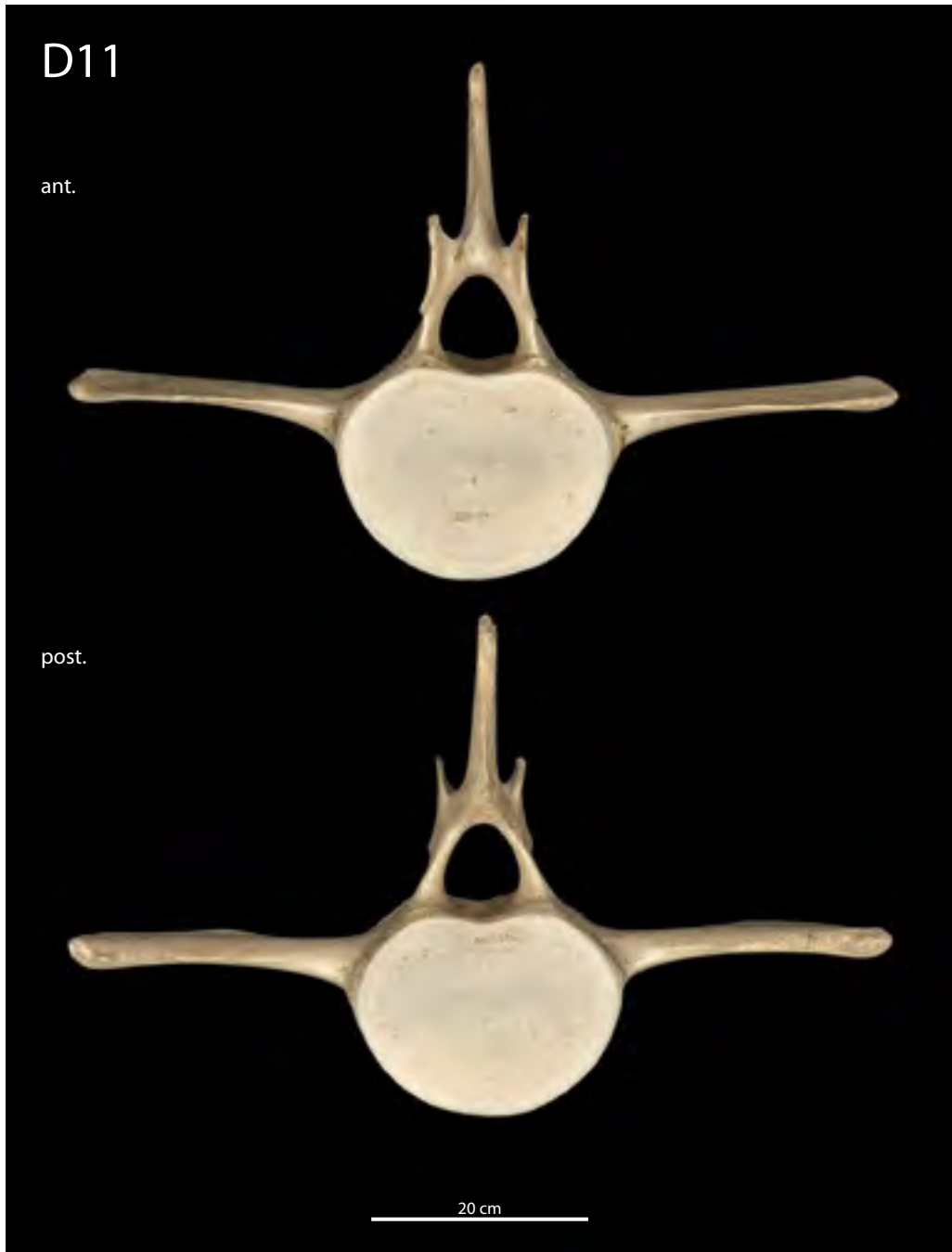
**Slika 54.** Anteriorna (ant.) in posteriorna (post.) površina osmega prsnega vretenca D8. Fotografija: Ciril Mlinar  
**Figure 54.** Anterior (ant.) and posterior (post.) surfaces of the 8th thoracic vertebra D8. Photo: Ciril Mlinar



**Slika 55.** Anteriorna (ant.) in posteriorna (post.) površina devetega prsnega vretenca D9. Fotografija: Ciril Mlinar  
**Figure 55.** Anterior (ant.) and posterior (post.) surfaces of the 9th thoracic vertebra D9. Photo: Ciril Mlinar



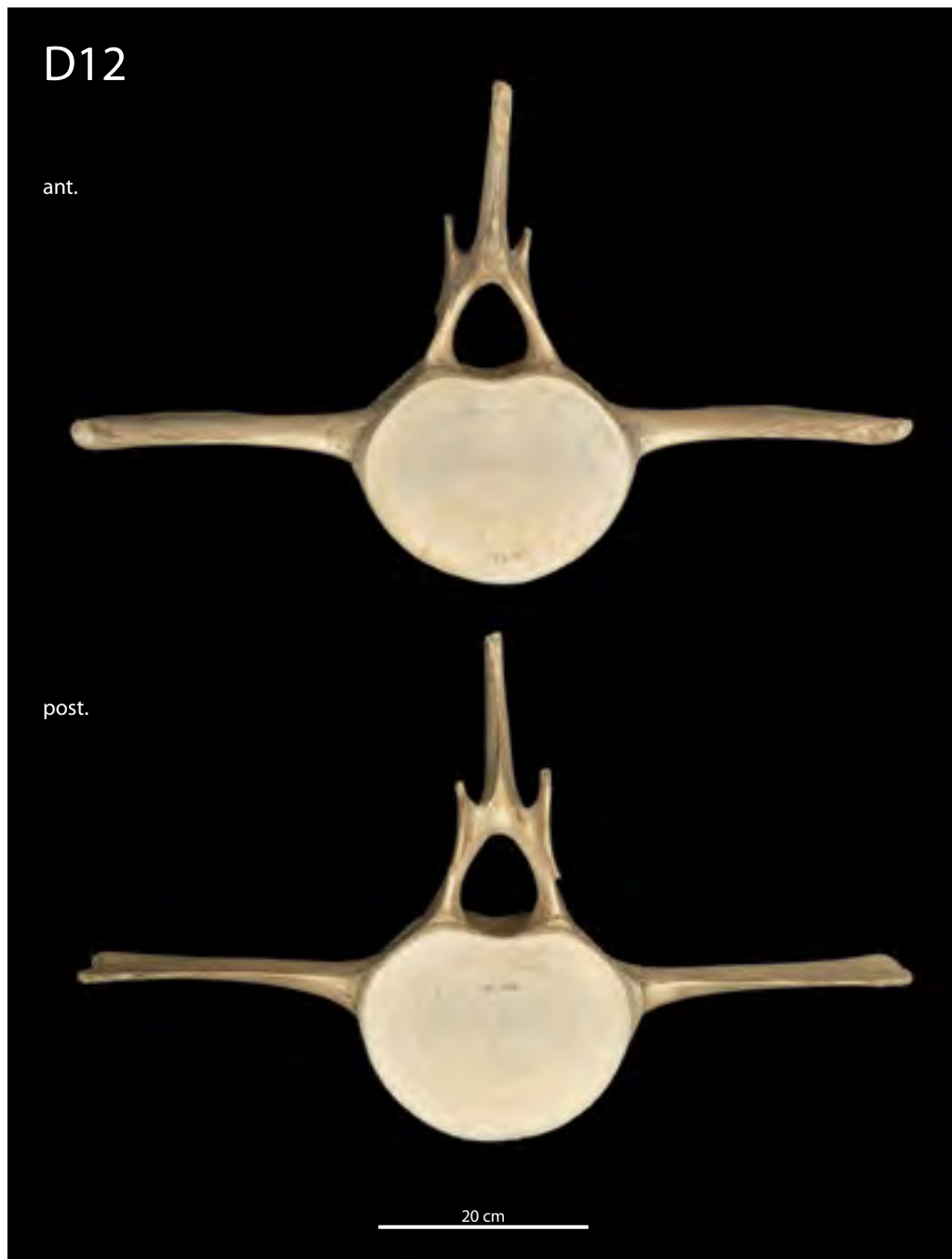
**Slika 56.** Anteriorna (ant.) in posteriorna (post.) površina desetega prsnega vretenca D10. Fotografija: Ciril Mlinar  
**Figure 56.** Anterior (ant.) and posterior (post.) surfaces of the 10th thoracic vertebra D10. Photo: Ciril Mlinar



**Slika 57.** Anteriorna (ant.) in posteriorna (post.) površina enajstega prsnega vretenca D11. Fotografija: Ciril Mlinar

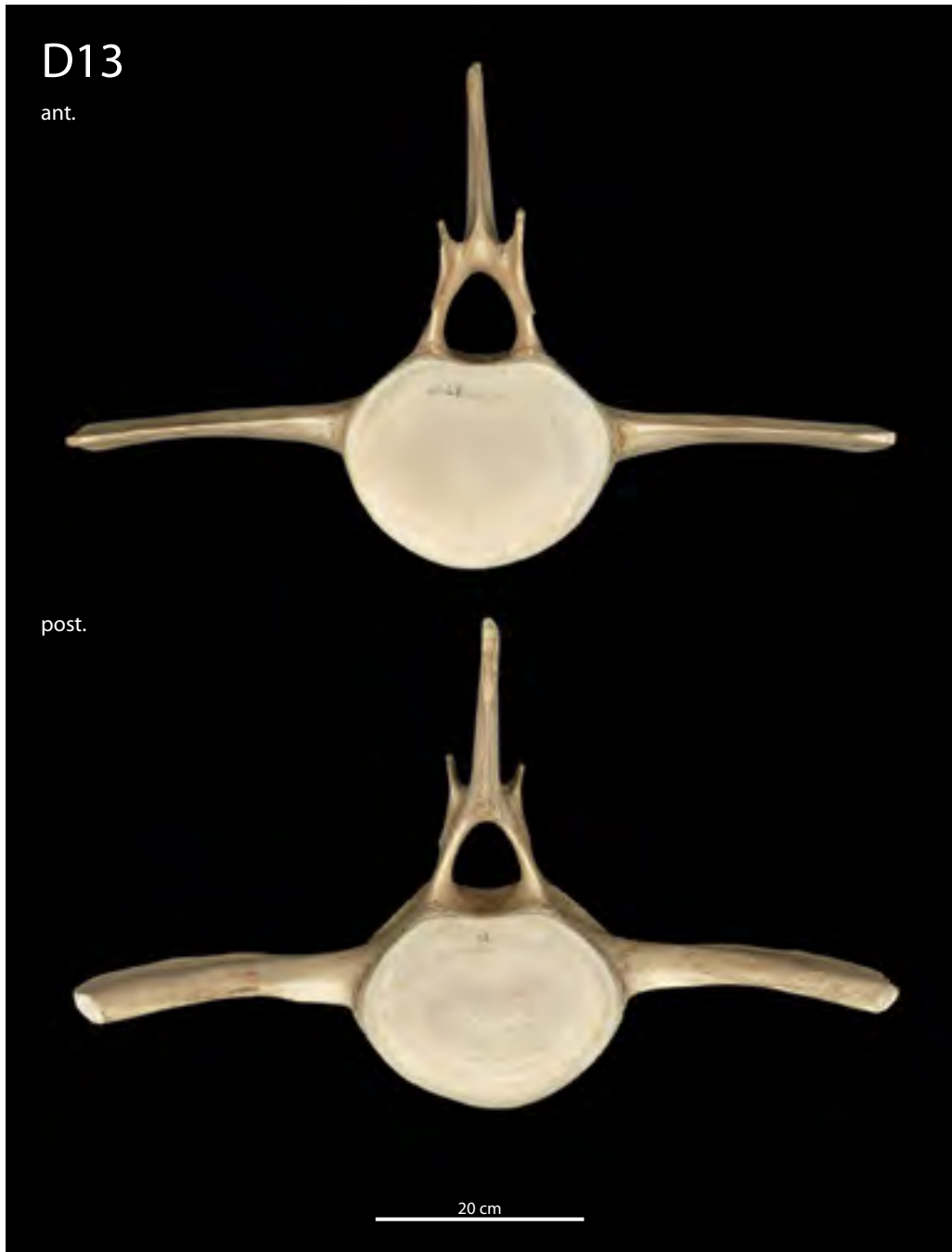
**Figure 57.** Anterior (ant.) and posterior (post.) surfaces of the 11th thoracic vertebra D11. Photo: Ciril Mlinar





**Slika 58.** Anteriorna (ant.) in posteriorna (post.) površina dvanajstega prsnega vretenca D12.  
Fotografija: Ciril Mlinar

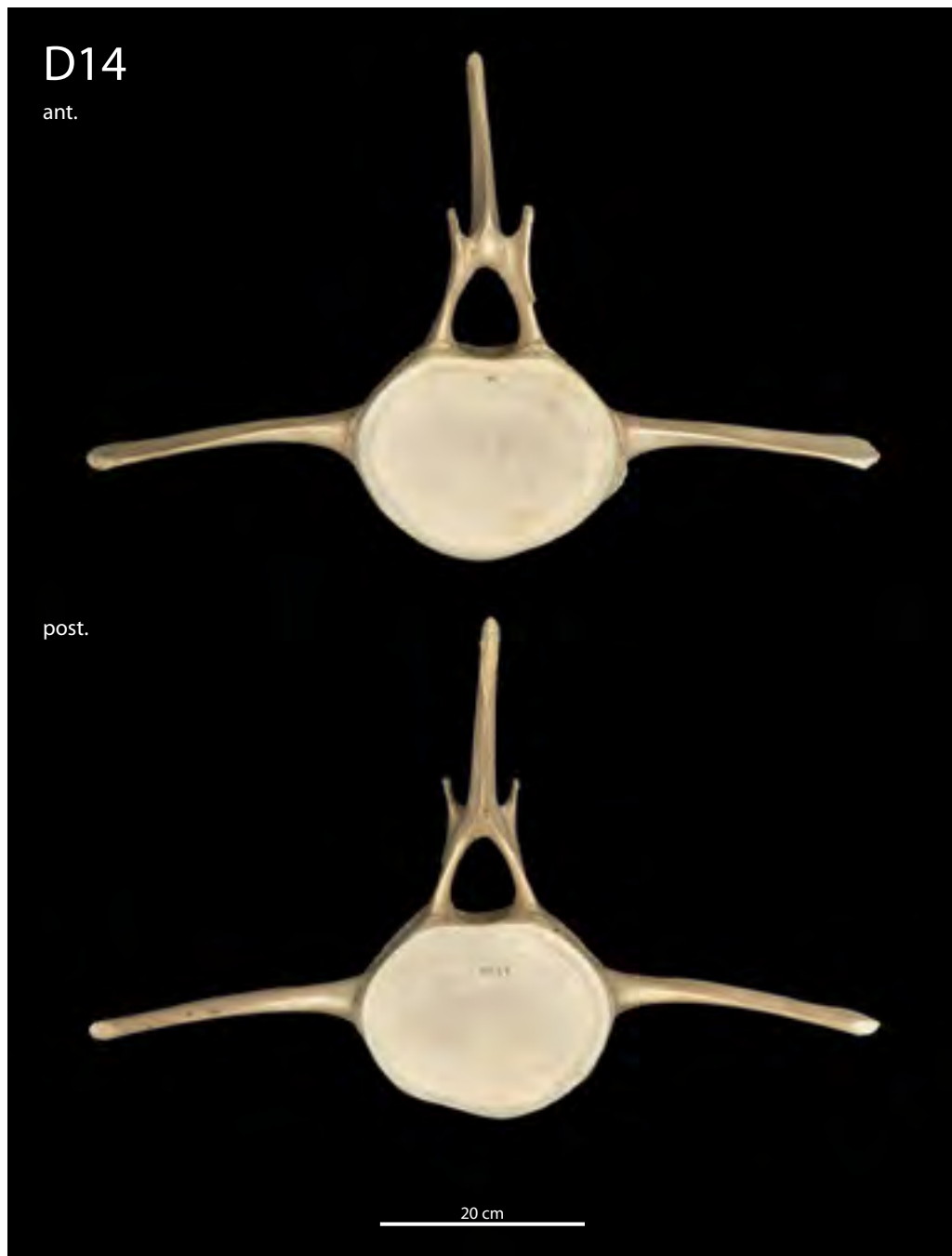
**Figure 58.** Anterior (ant.) and posterior (post.) surfaces of the 12th thoracic vertebra D12. Photo: Ciril Mlinar



**Slika 59.** Anteriorna (ant.) in posteriorna (post.) površina trinajstega prsnega vretenca D13.

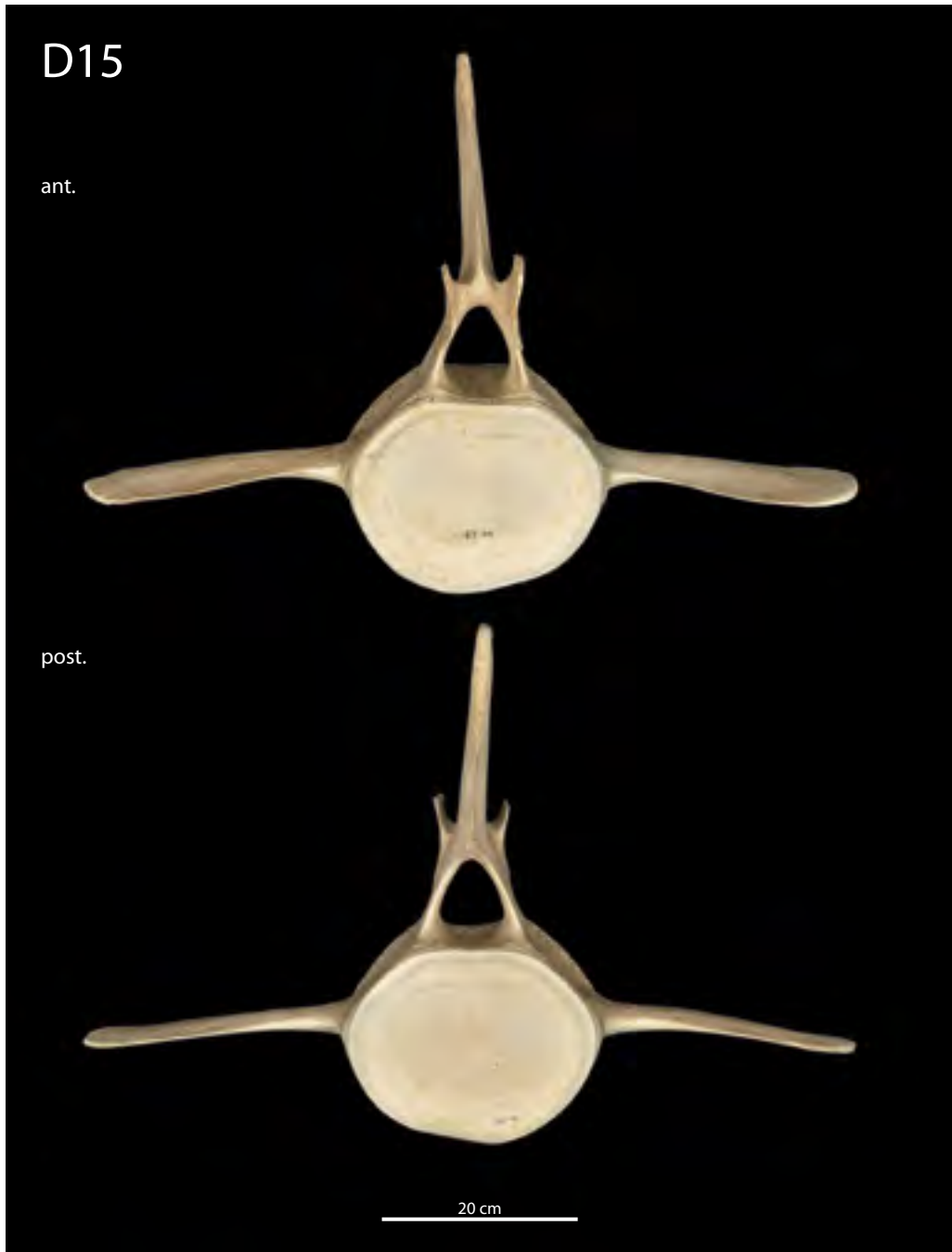
Fotografija: Ciril Mlinar

**Figure 59.** Anterior (ant.) and posterior (post.) surfaces of the 13th thoracic vertebra D13. Photo: Ciril Mlinar



**Slika 60.** Anteriorna (ant.) in posteriorna (post.) površina štirinajstega prsnega vretenca D14.  
Fotografija: Ciril Mlinar

**Figure 60.** Anterior (ant.) and posterior (post.) surfaces of the 14th thoracic vertebra D14. Photo: Ciril Mlinar



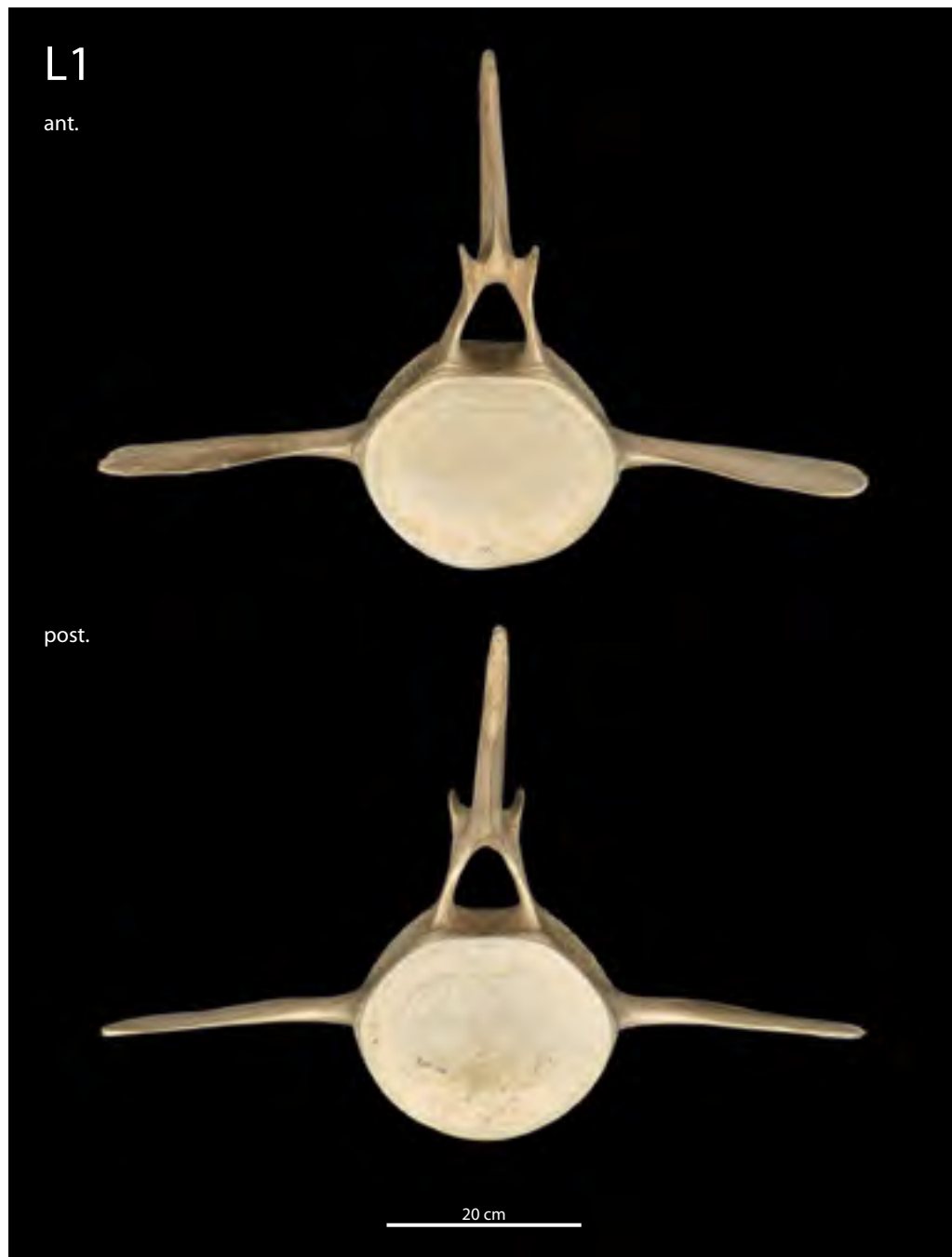
**Slika 61.** Anteriorna (ant.) in posteriorna (post.) površina petnajstega prsnega vretenca D15.

Fotografija: Ciril Mlinar

**Figure 61.** Anterior (ant.) and posterior (post.) surfaces of the 15th thoracic vertebra D15. Photo: Ciril Mlinar

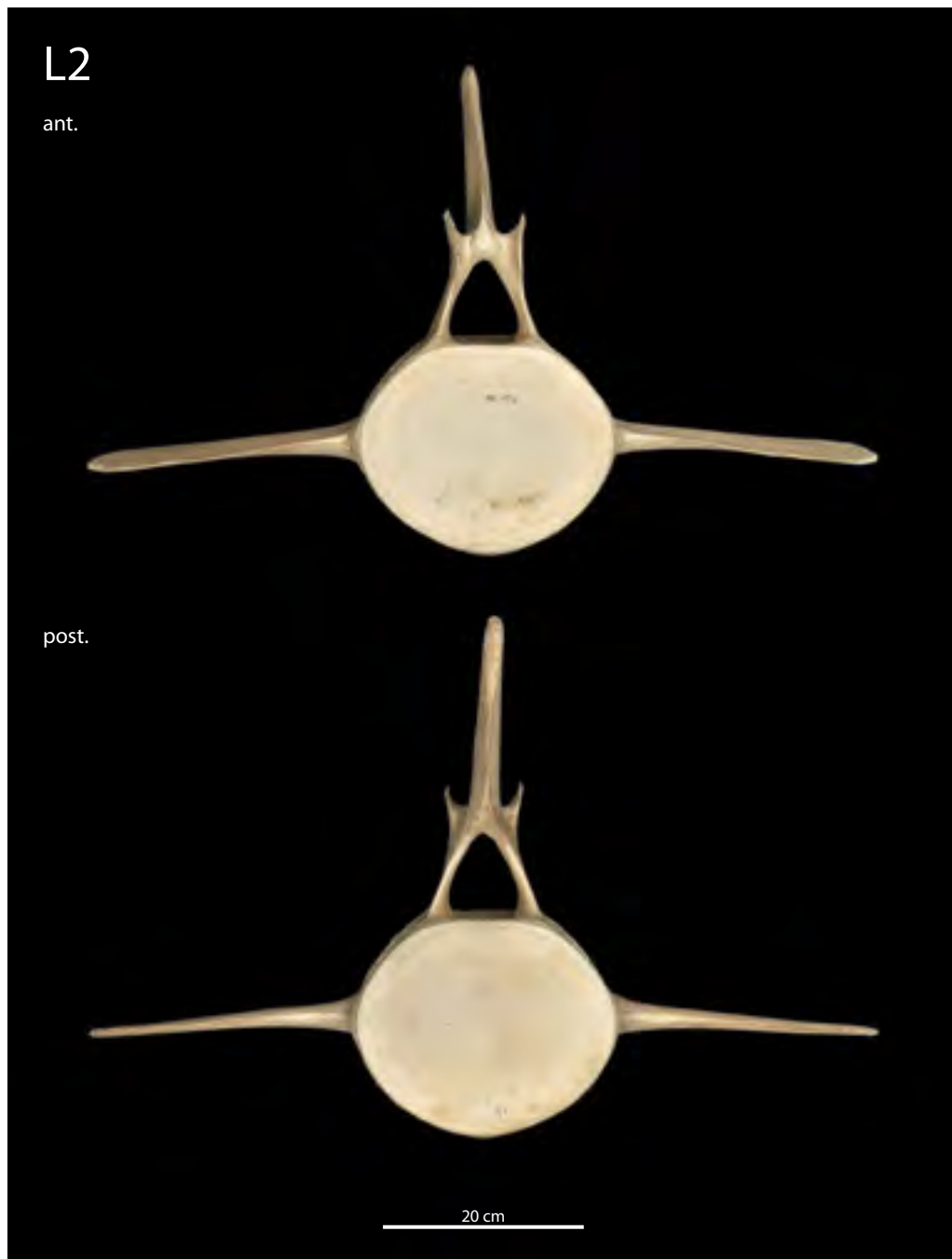
**Ledvenih vretenc** (L) je bilo 15. Od anteriorno ležečih prsnih vretenc so se razlikovala po tem, da niso nosila reber. Težje je bilo določiti mejo med zadnjim ledvenim in prvim repnim vretencem. Razlikovalni znak so bili ventralno ležeči hemalni loki in pripadajoči greben na telesu vretenca. Ledvena vretenca so bila brez hemalnega loka, na ventralni površini pa je bil neparen greben. Prvo repno vretenca (Ca1) je imelo parni greben, na katerega je bil vezan hemalni lok. Ledvena vretenca so bila precej enotne oblike, njihova telesa pa so bila največja. Nevralni odrastki so bili dolgi in posteriorno usmerjeni, prečni odrastki in prezygapofize pa izraziti.

The whale's skeleton had 15 **lumbar vertebrae** (L). From the anteriorly positioned thoracic vertebrae they differed by not carrying any ribs. The boundary between the last lumbar vertebra and the first caudal vertebra was much harder to determine. The marks of distinction were the ventral chevrons and the associated articular facet on the vertebra body. Lumbar vertebrae were with a ventral crest but lacked a chevron. Contrary to this, the first caudal vertebra (Ca1) had a paired crest carrying the chevron. Lumbar vertebrae were of a pretty uniform size, and their bodies were the largest in spine. The neural processes were long and posteriorly oriented, whereas the transverse processes and prezygapophyses were pronounced.



**Slika 62.** Anteriorna (ant.) in posteriorna (post.) površina prvega ledvenega vretenca L1.  
Fotografija: Ciril Mlinar

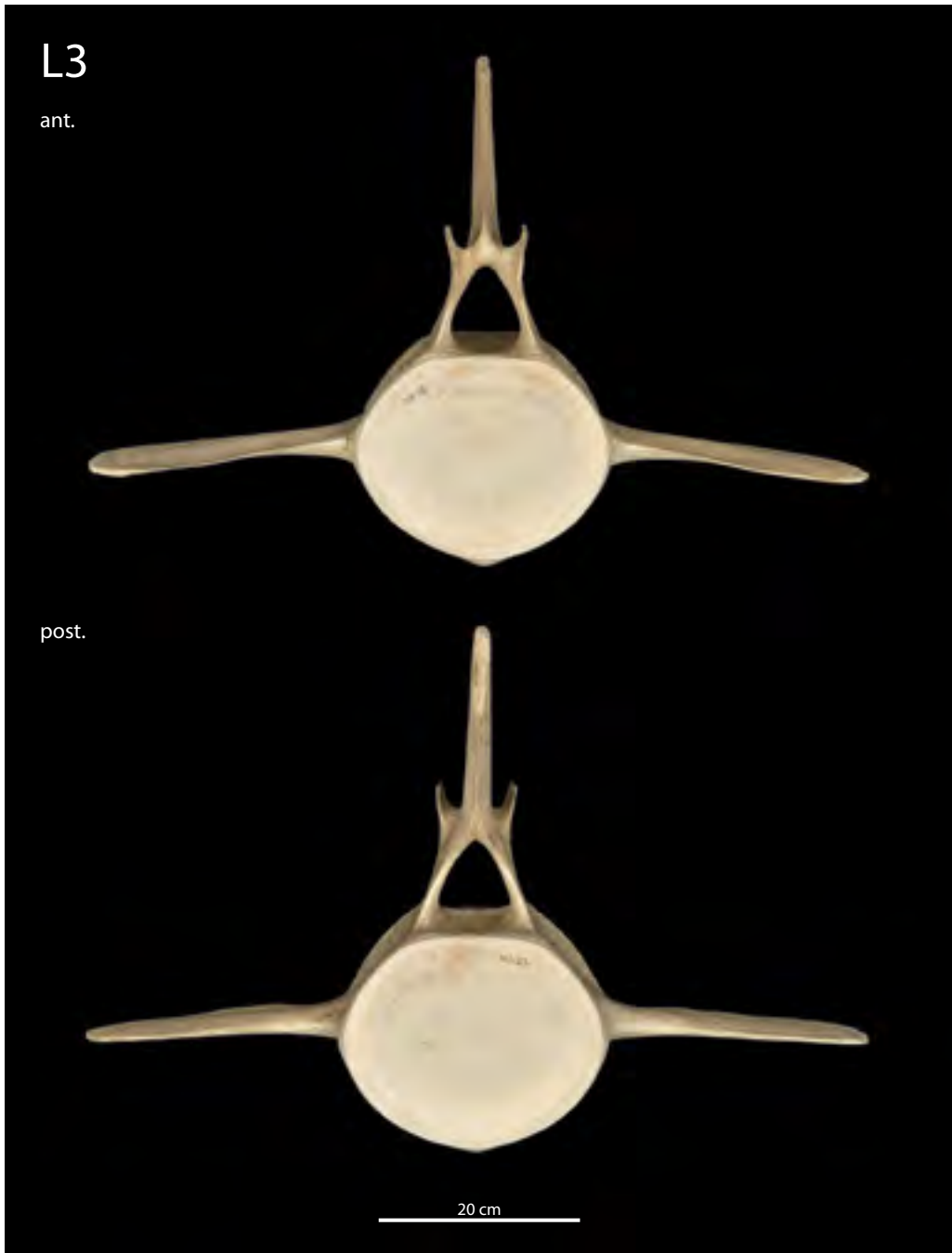
**Figure 62.** Anterior (ant.) and posterior (post.) surfaces of the 1st lumbar vertebra L1. Photo: Ciril Mlinar



**Slika 63.** Anteriorna (ant.) in posteriorna (post.) površina drugega ledvenega vretenca L2.  
Fotografija: Ciril Mlinar

**Figure 63.** Anterior (ant.) and posterior (post.) surfaces of the 2nd lumbar vertebra L2. Photo: Ciril Mlinar

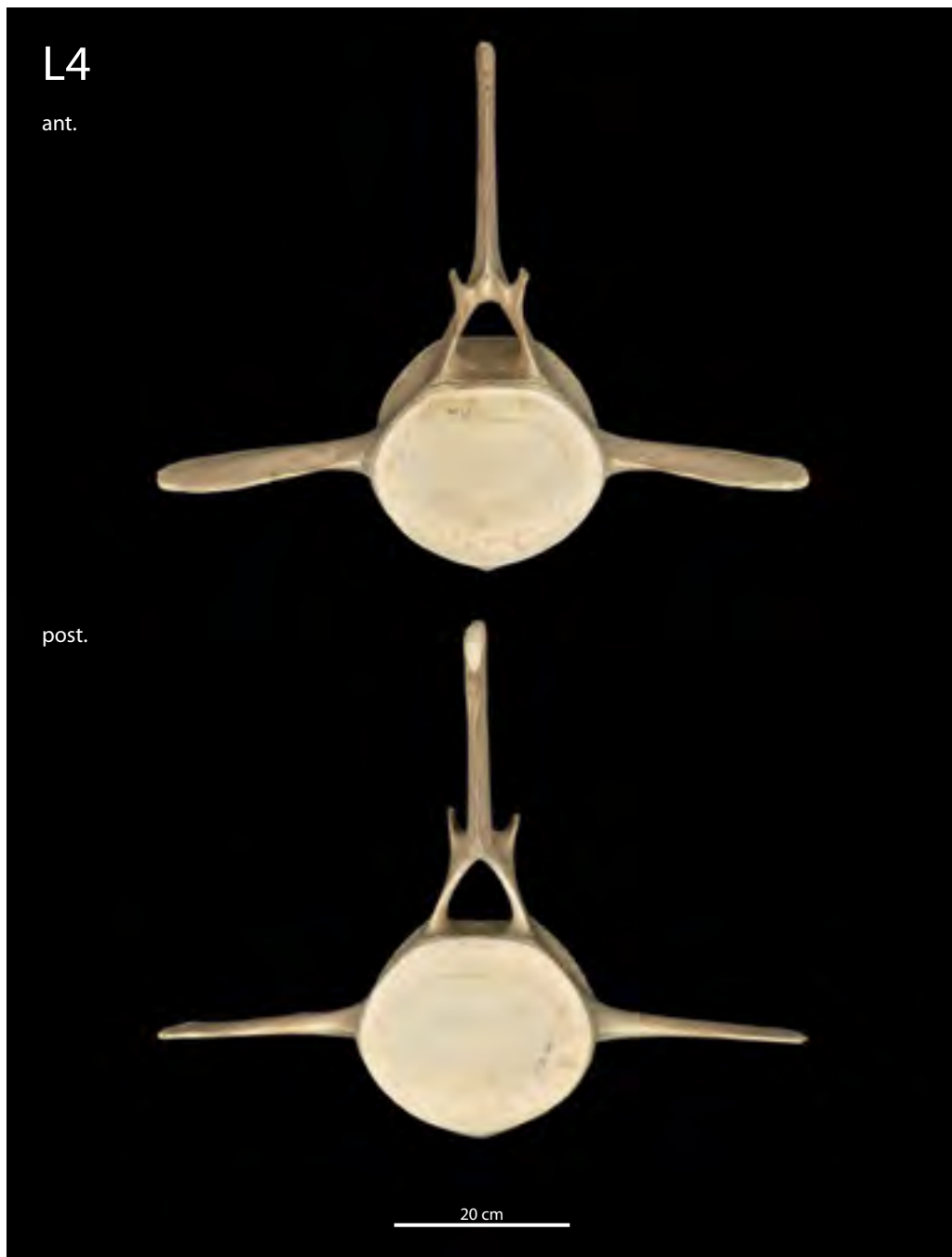




**Slika 64.** Anteriorna (ant.) in posteriorna (post.) površina tretjega ledvenega vretenca L3.

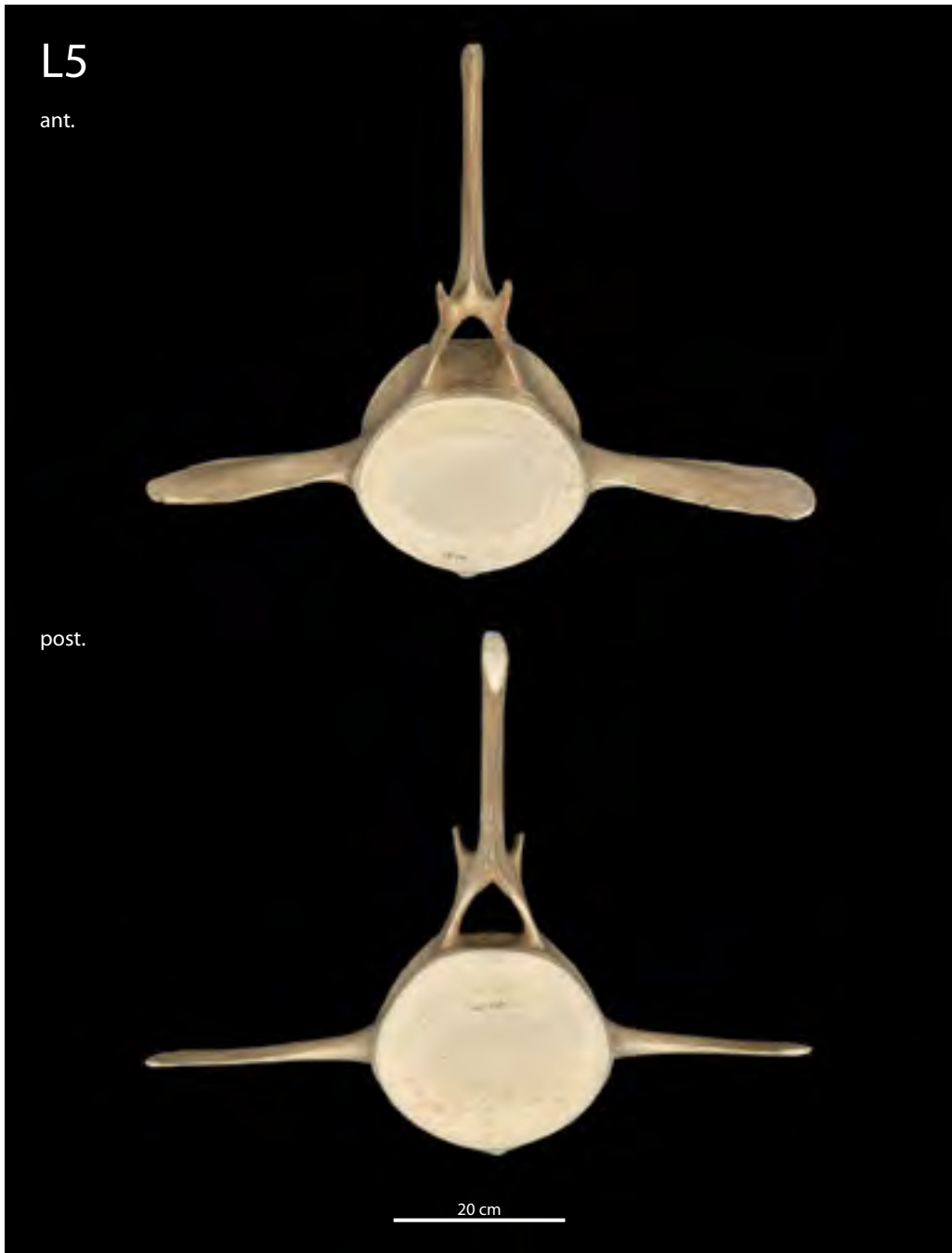
Fotografija: Ciril Mlinar

**Figure 64.** Anterior (ant.) and posterior (post.) surfaces of the 3rd lumbar vertebra L3. Photo: Ciril Mlinar



**Slika 65.** Anteriorna (ant.) in posteriorna (post.) površina četrtega ledvenega vretenca L4.  
Fotografija: Ciril Mlinar

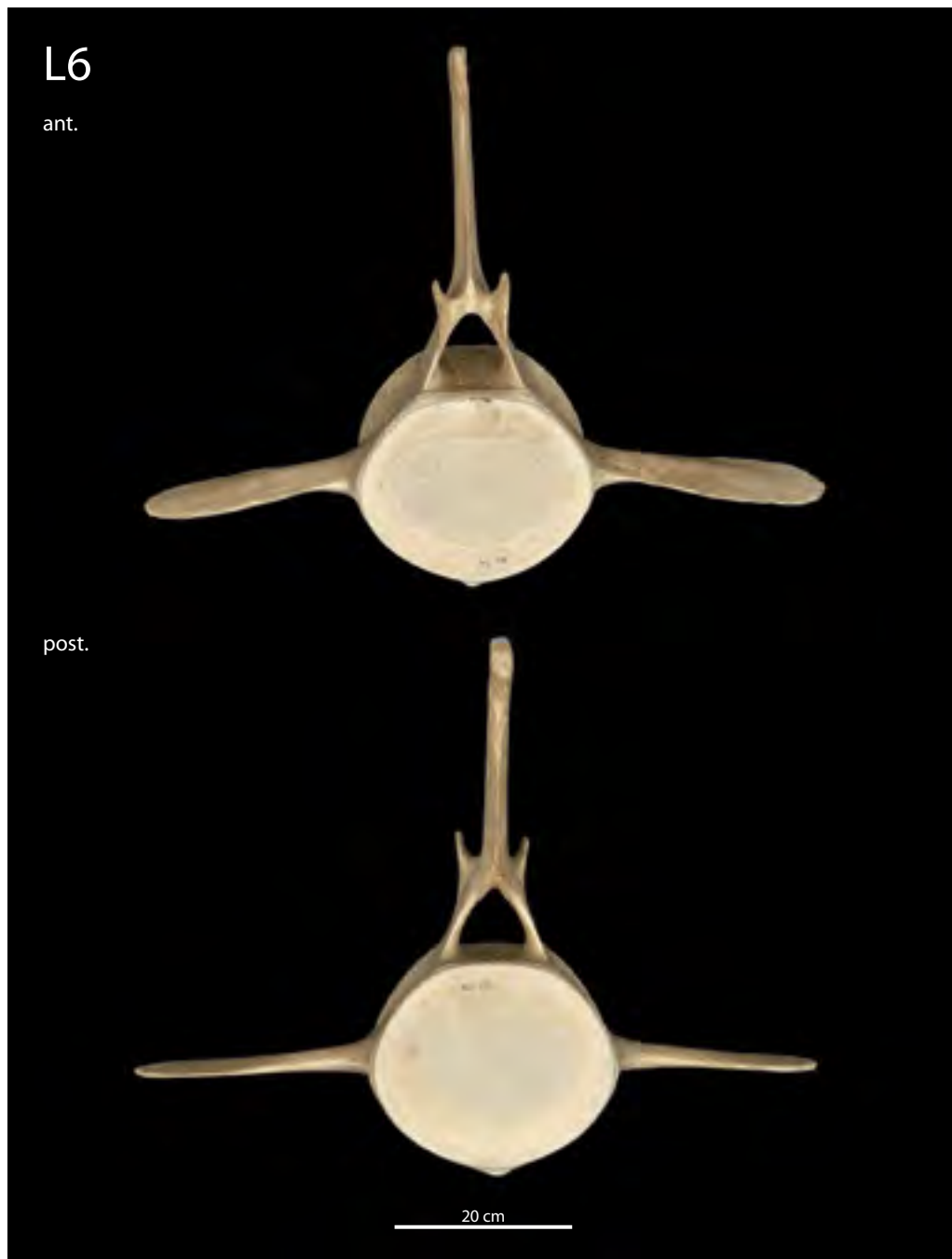
**Figure 65.** Anterior (ant.) and posterior (post.) surfaces of the 4th lumbar vertebra L4. Photo: Ciril Mlinar



**Slika 66.** Anteriorna (ant.) in posteriorna (post.) površina petega ledvenega vretenca L5.

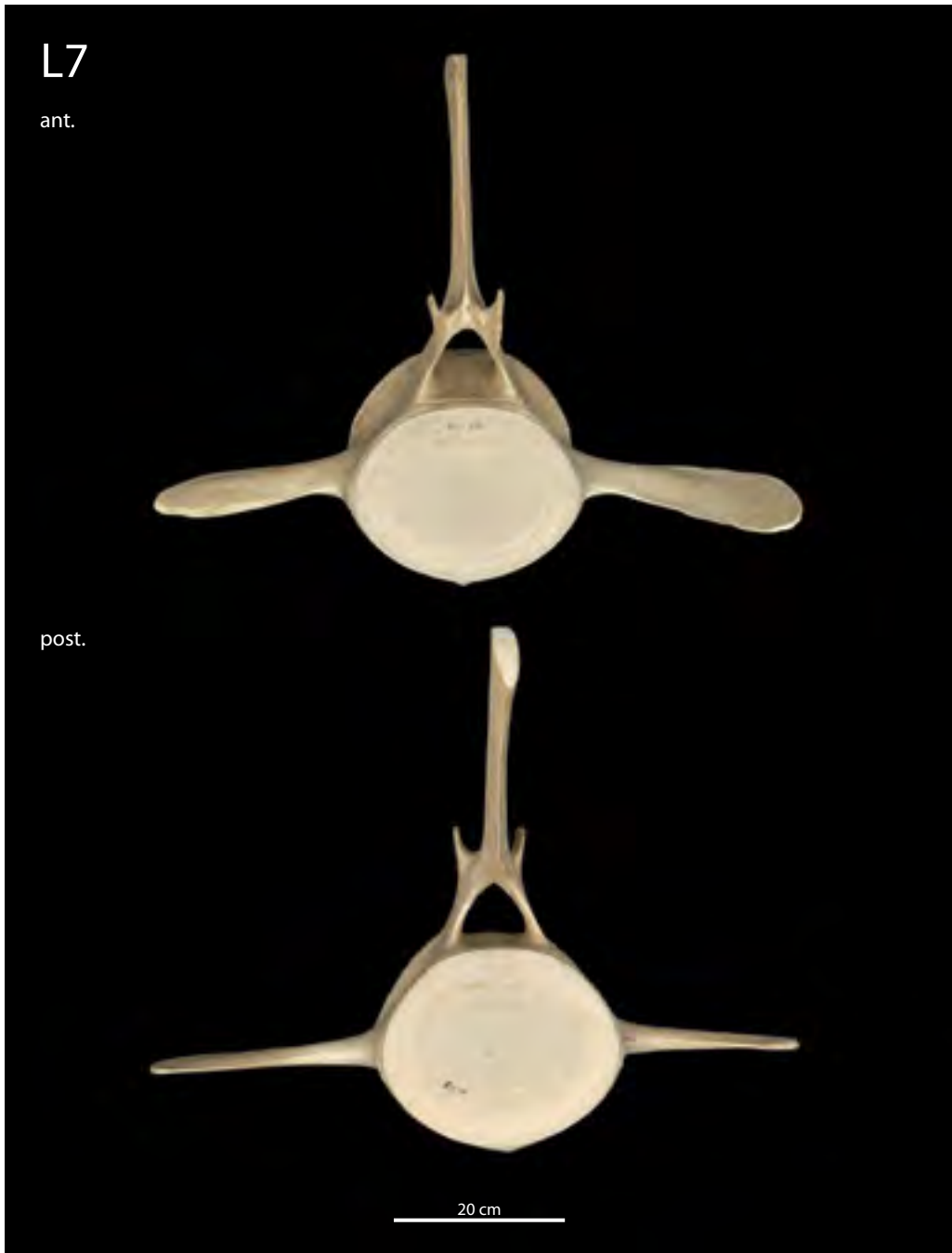
Fotografija: Ciril Mlinar

**Figure 66.** Anterior (ant.) and posterior (post.) surfaces of the 5th lumbar vertebra L5. Photo: Ciril Mlinar



**Slika 67.** Anteriorna (ant.) in posteriorna (post.) površina šestega ledvenega vretenca L6.  
Fotografija: Ciril Mlinar

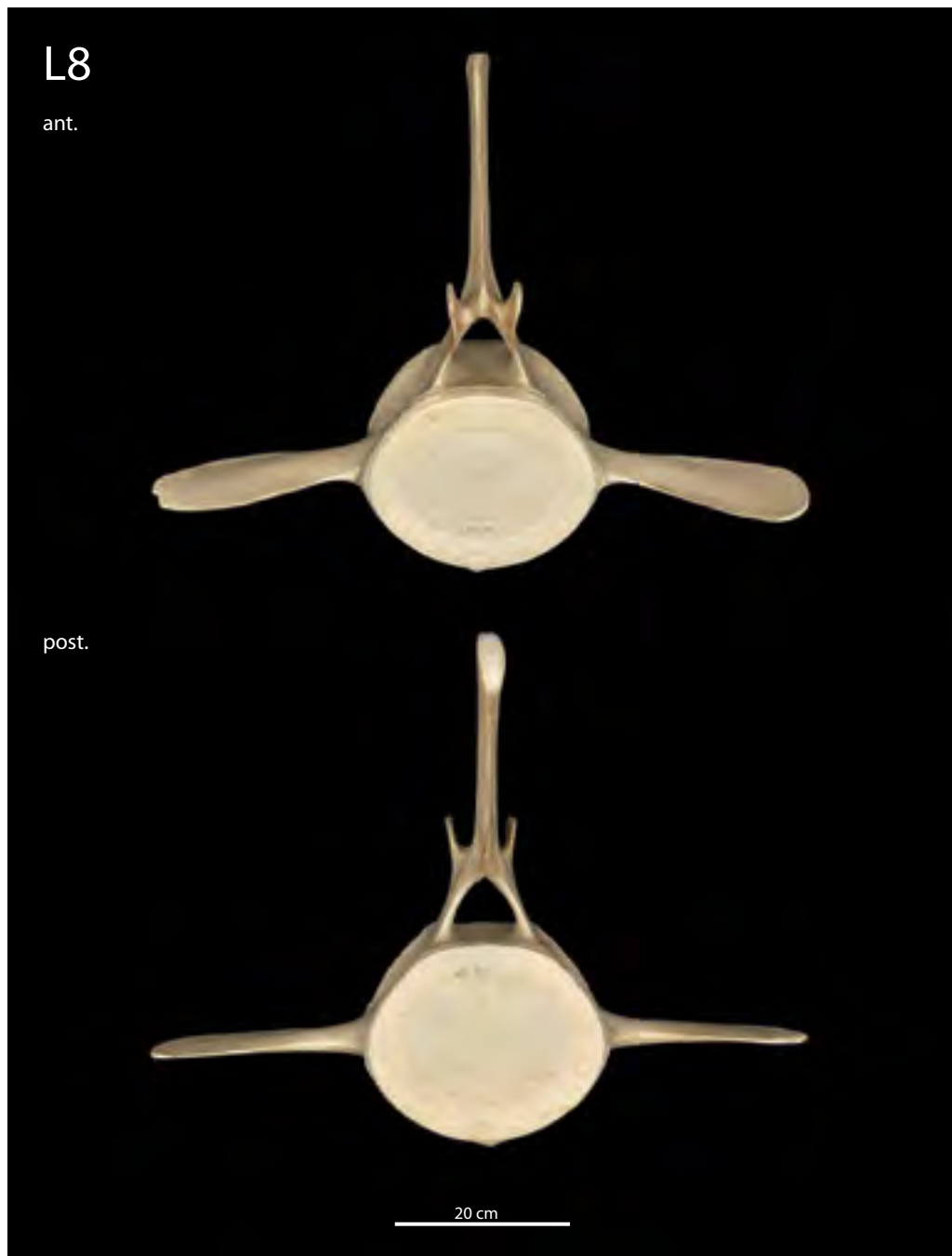
**Figure 67.** Anterior (ant.) and posterior (post.) surfaces of the 6th lumbar vertebra L6. Photo: Ciril Mlinar



**Slika 68.** Anteriorna (ant.) in posteriorna (post.) površina sedmega ledvenega vretenca L7.

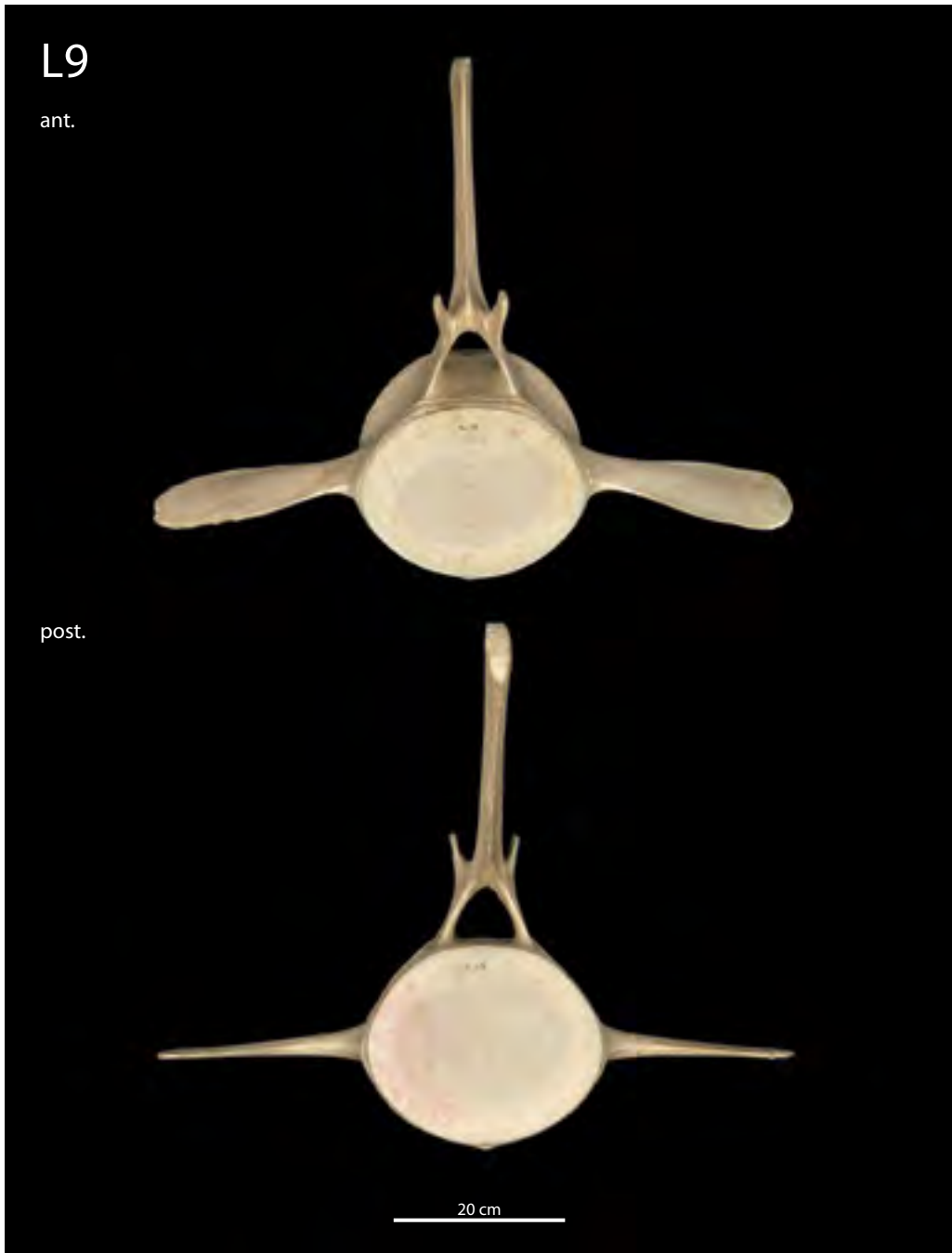
Fotografija: Ciril Mlinar

**Figure 68.** Anterior (ant.) and posterior (post.) surfaces of the 7th lumbar vertebra L7. Photo: Ciril Mlinar



**Slika 69.** Anteriorna (ant.) in posteriorna (post.) površina osmega ledvenega vretenca L8.  
Fotografija: Ciril Mlinar

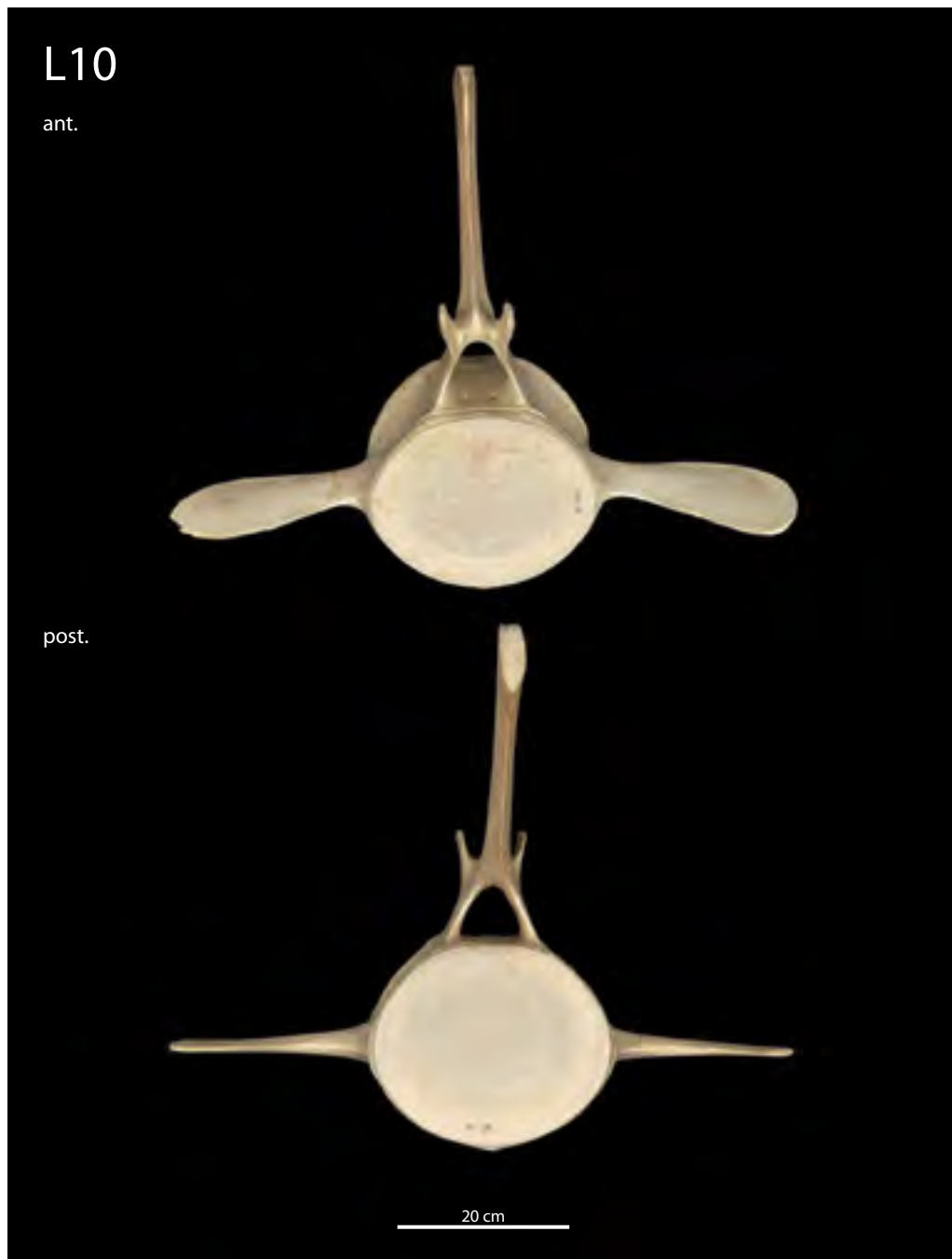
**Figure 69.** Anterior (ant.) and posterior (post.) surfaces of the 8th lumbar vertebra L8. Photo: Ciril Mlinar



**Slika 70.** Anteriorna (ant.) in posteriorna (post.) površina devetega ledvenega vretenca L9.  
Fotografija: Ciril Mlinar

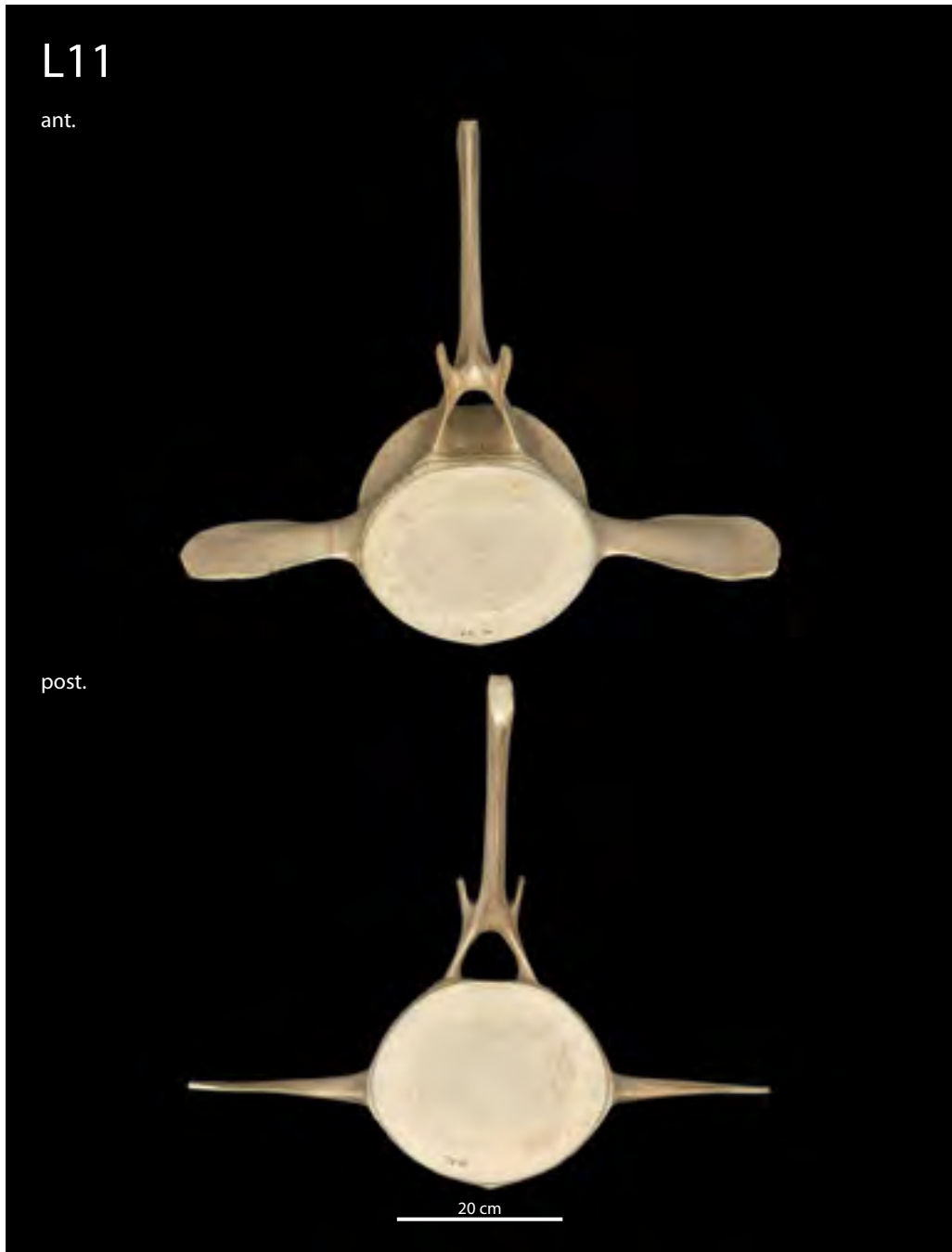
**Figure 70:** Anterior (ant.) and posterior (post.) surfaces of the 9th lumbar vertebra L9. Photo: Ciril Mlinar





**Slika 71.** Anteriorna (ant.) in posteriorna (post.) površina desetega ledvenega vretenca L10.  
Fotografija: Ciril Mlinar

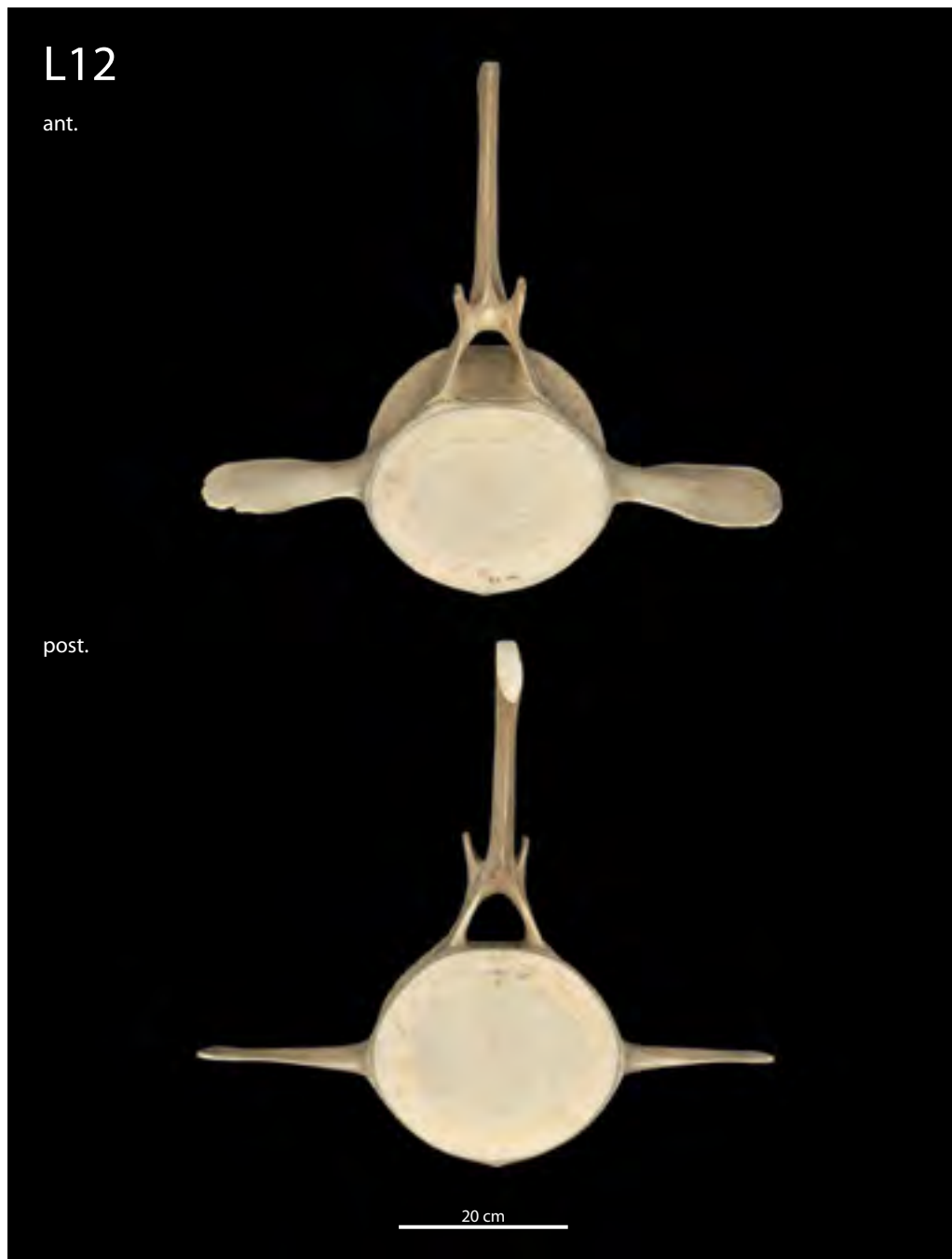
**Figure 71.** Anterior (ant.) and posterior (post.) surfaces of the 10th lumbar vertebra L10. Photo: Ciril Mlinar



**Slika 72.** Anteriorna (ant.) in posteriorna (post.) površina enajstega ledvenega vretenca L11.

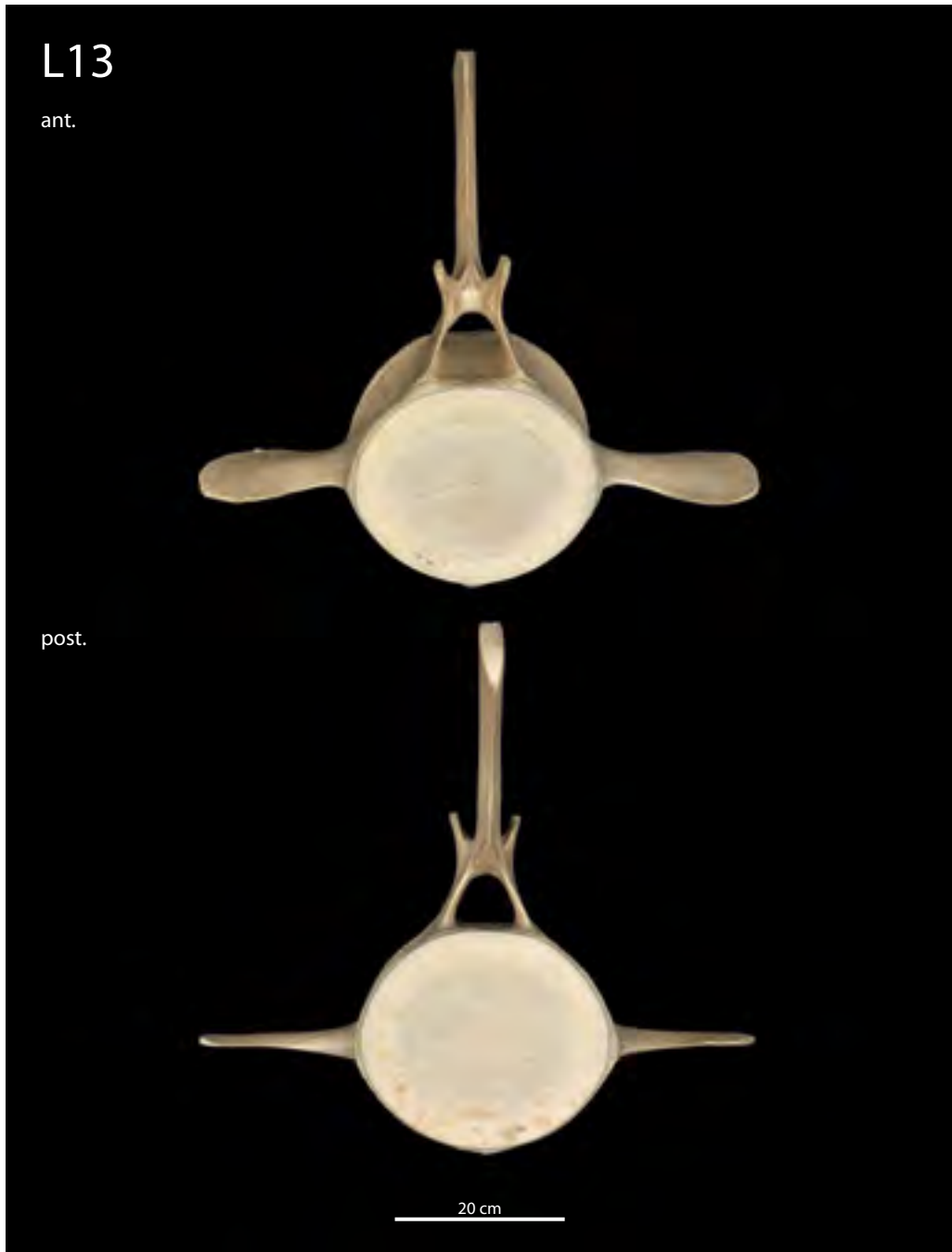
Fotografija: Ciril Mlinar

**Figure 72.** Anterior (ant.) and posterior (post.) surfaces of the 11th lumbar vertebra L11. Photo: Ciril Mlinar



**Slika 73.** Anteriorna (ant.) in posteriorna (post.) površina dvanajstega ledvenega vretenca L12.  
Fotografija: Ciril Mlinar

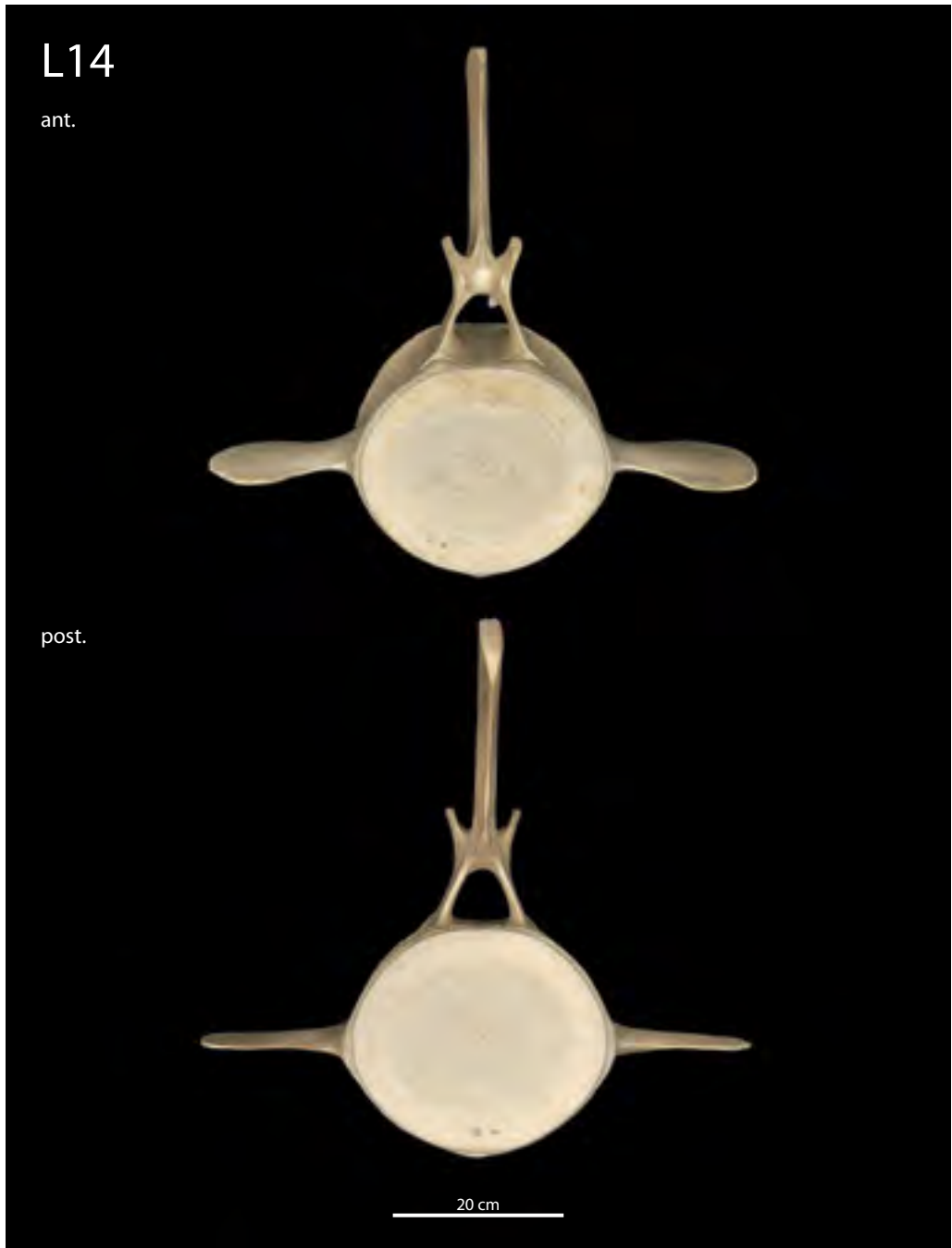
**Figure 73.** Anterior (ant.) and posterior (post.) surfaces of the 12th lumbar vertebra L12. Photo: Ciril Mlinar



**Slika 74.** Anteriorna (ant.) in posteriorna (post.) površina trinajstega ledvenega vretenca L13.

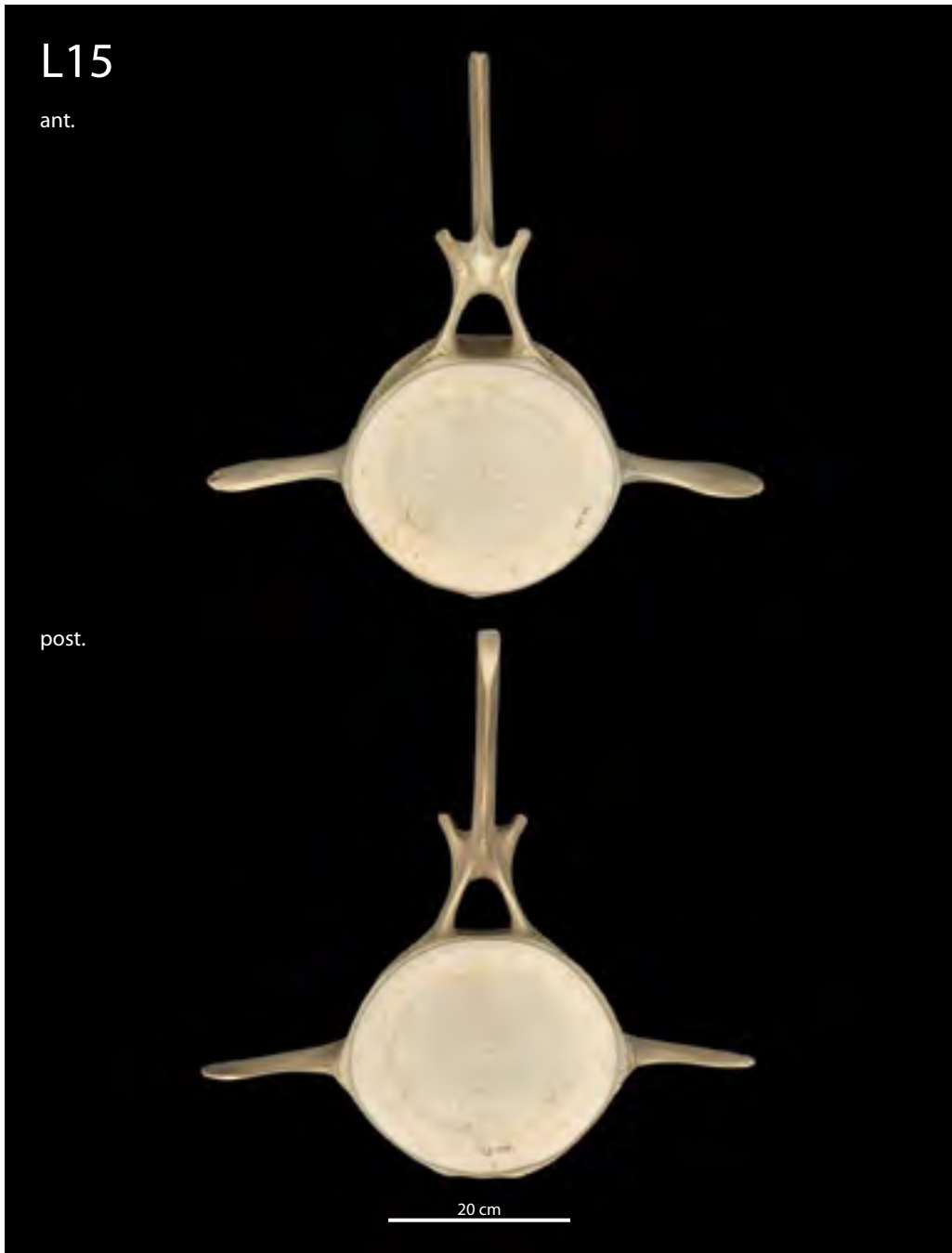
Fotografija: Ciril Mlinar

**Figure 74.** Anterior (ant.) and posterior (post.) surfaces of the 13th lumbar vertebra L13. Photo: Ciril Mlinar



**Slika 75.** Anteriorna (ant.) in posteriorna (post.) površina štirinajstega ledvenega vretenca L14.  
Fotografija: Ciril Mlinar

**Figure 75.** Anterior (ant.) and posterior (post.) surfaces of the 14th lumbar vertebra L14. Photo: Ciril Mlinar



**Slika 76.** Anteriorna (ant.) in posteriorna (post.) površina petnajstega ledvenega vretenca L15.  
Fotografija: Ciril Mlinar

**Figure 76.** Anterior (ant.) and posterior (post.) surfaces of the 15th lumbar vertebra L15. Photo: Ciril Mlinar

**Repnih vretenc** (Ca) smo identificirali 20. Kot smo že omenili, smo prvo repno vretence določili na osnovi dvojnega grebena na ventralni strani vretenca in hemalnega loka. Hemalni lok je bil koščen element v obliki črke V oziroma Y na ventralni strani repnih vretenc. Repna vretenca so bila izmed vseh najbolj raznolika. Anteriorna so imela izražene še vse odrastke, ki pa so se posteriorno vse bolj izgubljali. Pri našem osebku so prečni odrastki popolnoma izginili na vretencu Ca14; Ca13 je imel na osnovi prečnega odrastka še majhen nastavek. Prezigapofize, nevralni odrastki in nevralni loki so izginili na vretencu Ca15. Zadnja repna vretenca so imela le telesa, brez vseh odrastkov. Hemalni loki so obstajali na vretencih Ca1 - Ca14. Največji hemalni lok je nosilo vretence Ca2; velikost posteriorno ležečih lokov je postopno upadala. Na hemalne loke so pritrjene repne mišice, ki pomagajo pri gibanju repa (Perrin, Wursig & Thewissen, 2009).

We identified 20 **caudal vertebrae** (Ca). As already mentioned, the first caudal vertebra was determined on the basis of the paired ventral crest and the associated chevron. The latter was a V-shaped, or Y-shaped bony element situated on the ventral side of the vertebra. Caudal vertebrae were more diverse than other. While all processes were well expressed in anterior vertebrae, these were increasingly disappearing in a posterior direction. In our specimen, the transverse processes disappeared altogether on the vertebra Ca14; Ca13 still had a small projection. The prezygapophyses, neural processes and neural arches disappeared on the vertebra Ca15 and the posterior-most caudal vertebrae had only bodies without processes. The chevrons were present on the vertebrae Ca1 - Ca14. The largest chevron was carried by the vertebra C2; the size of posteriorly lying chevrons gradually decreased. To the hemal arches caudal muscles are fixed, which aid the tail's movements (Perrin, Wursig & Thewissen, 2009).





**Slika 77.** Anteriorna (ant.) in posteriorna (post.) površina prvega repnega vretenca Ca1. Fotografija: Ciril Mlinar  
**Figure 77.** Anterior (ant.) and posterior (post.) surfaces of the 1st caudal vertebra Ca1. Photo: Ciril Mlinar



**Slika 78.** Anteriorna (ant.) in posteriorna (post.) površina drugega repnega vretenca Ca2. Fotografija: Ciril Mlinar  
**Figure 78.** Anterior (ant.) and posterior (post.) surfaces of the 2nd caudal vertebra Ca2. Photo: Ciril Mlinar



**Slika 79.** Anteriorna (ant.) in posteriorna (post.) površina tretjega repnega vretenca Ca3. Fotografija: Ciril Mlinar  
**Figure 79.** Anterior (ant.) and posterior (post.) surfaces of the 3rd caudal vertebra Ca3. Photo: Ciril Mlinar



**Slika 80.** Anteriorna (ant.) in posteriorna (post.) površina četrtega repnega vretenca Ca4. Fotografija: Ciril Mlinar  
**Figure 80.** Anterior (ant.) and posterior (post.) surfaces of the 4th caudal vertebra Ca4. Photo: Ciril Mlinar



**Slika 81.** Anteriorna (ant.) in posteriorna (post.) površina petega vretenca Ca5. Fotografija: Ciril Mlinar  
**Figure 81.** Anterior (ant.) and posterior (post.) surfaces of the 5th caudal vertebra Ca5. Photo: Ciril Mlinar



**Slika 82.** Anteriorna (ant.) in posteriorna (post.) površina šestega repnega vretenca Ca6. Fotografija: Ciril Mlinar  
**Figure 82.** Anterior (ant.) and posterior (post.) surfaces of the 6th caudal vertebra C6. Photo: Ciril Mlinar



**Slika 83.** Anteriorna (ant.) in posteriorna (post.) površina sedmega repnega vretenca Ca7. Fotografija: Ciril Mlinar  
**Figure 83.** Anterior (ant.) and posterior (post.) surfaces of the 7th caudal vertebra Ca7. Photo: Ciril Mlinar

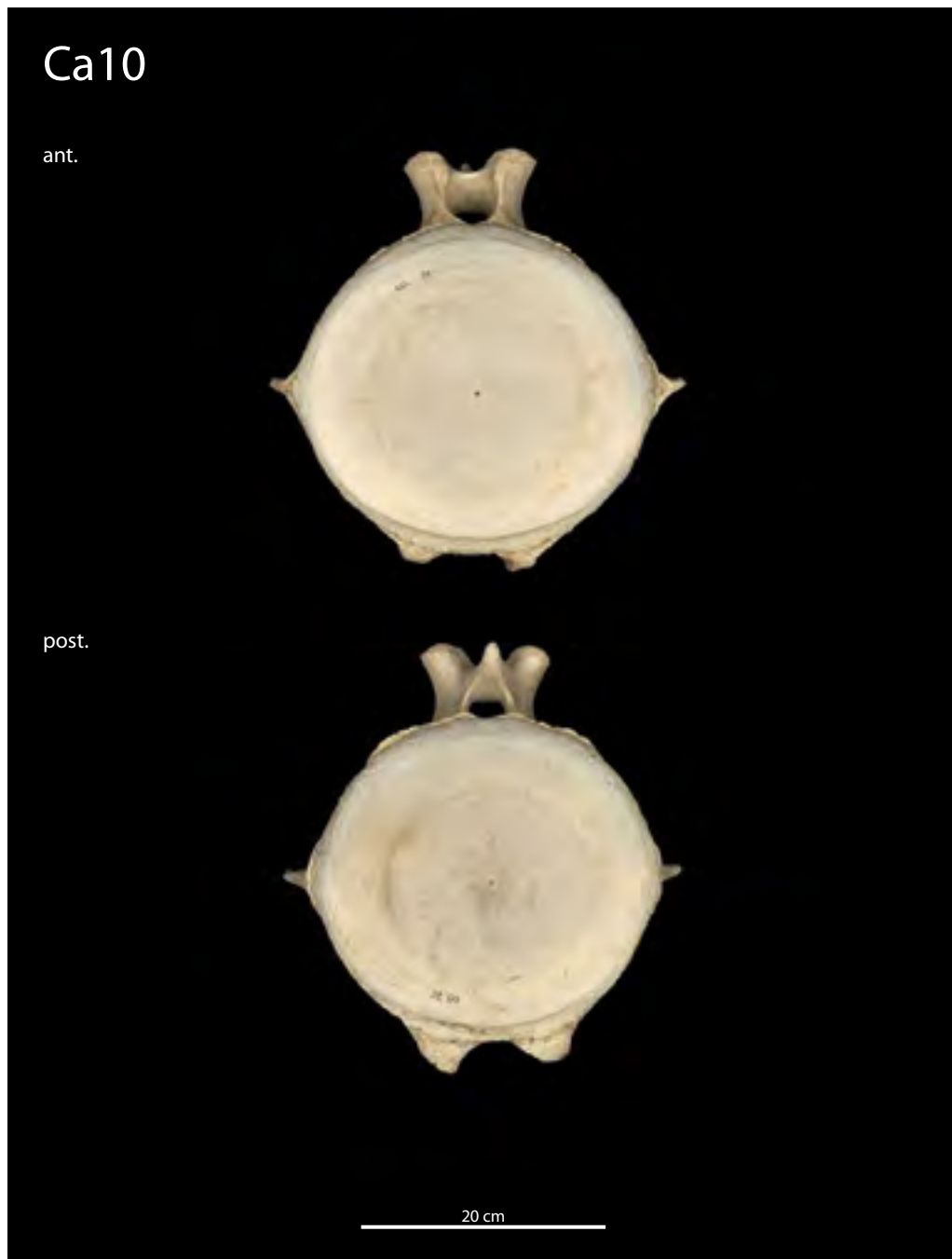




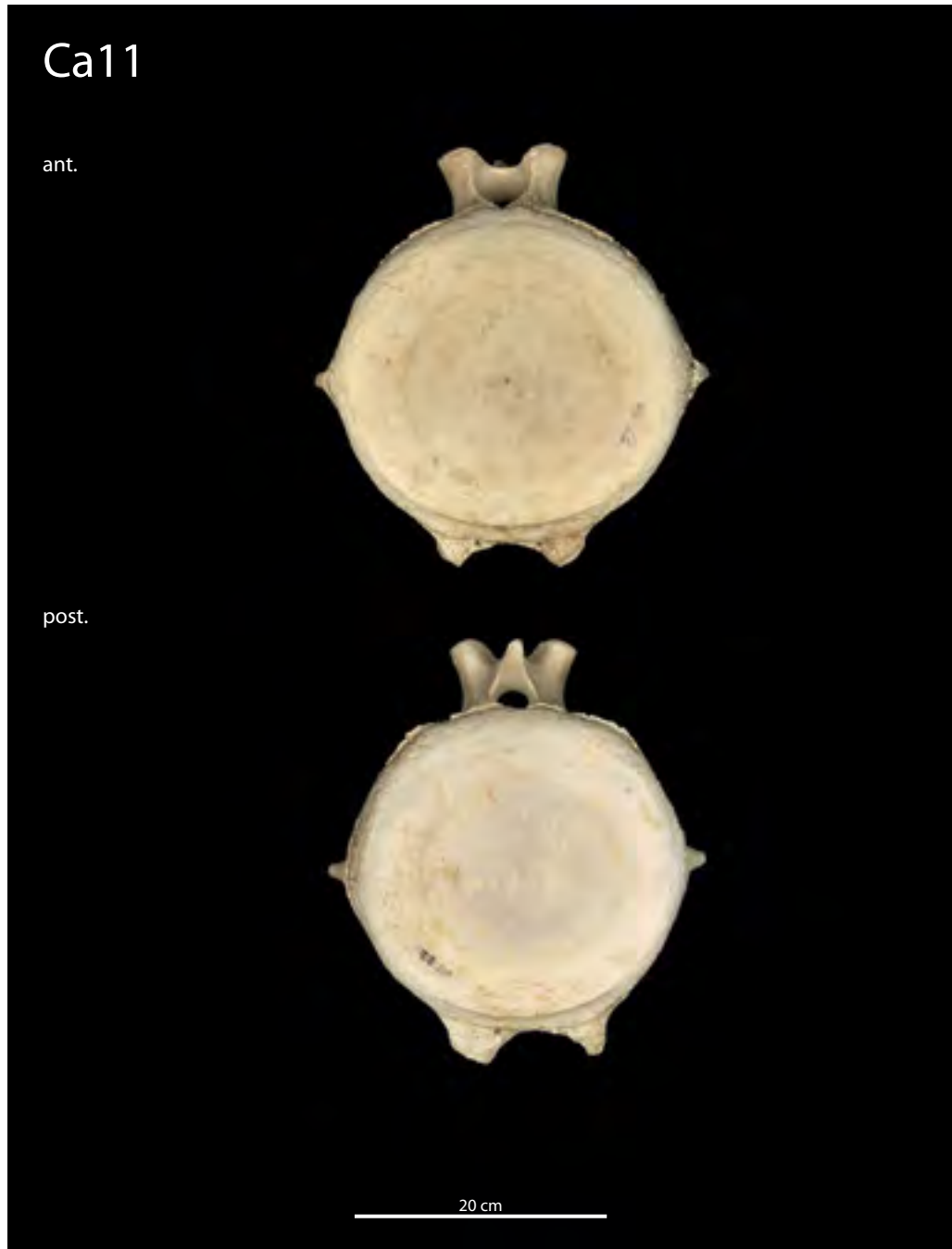
**Slika 84.** Anteriorna (ant.) in posteriorna (post.) površina osmega repnega vretenca Ca8. Fotografija: Ciril Mlinar  
**Figure 84.** Anterior (ant.) and posterior (post.) surfaces of the 8th caudal vertebra Ca8. Photo: Ciril Mlinar



**Slika 85.** Anteriorna (ant.) in posteriorna (post.) površina devetega repnega vretenca Ca9. Fotografija: Ciril Mlinar  
**Figure 85.** Anterior (ant.) and posterior (post.) surfaces of the 9th caudal vertebra Ca9. Photo: Ciril Mlinar



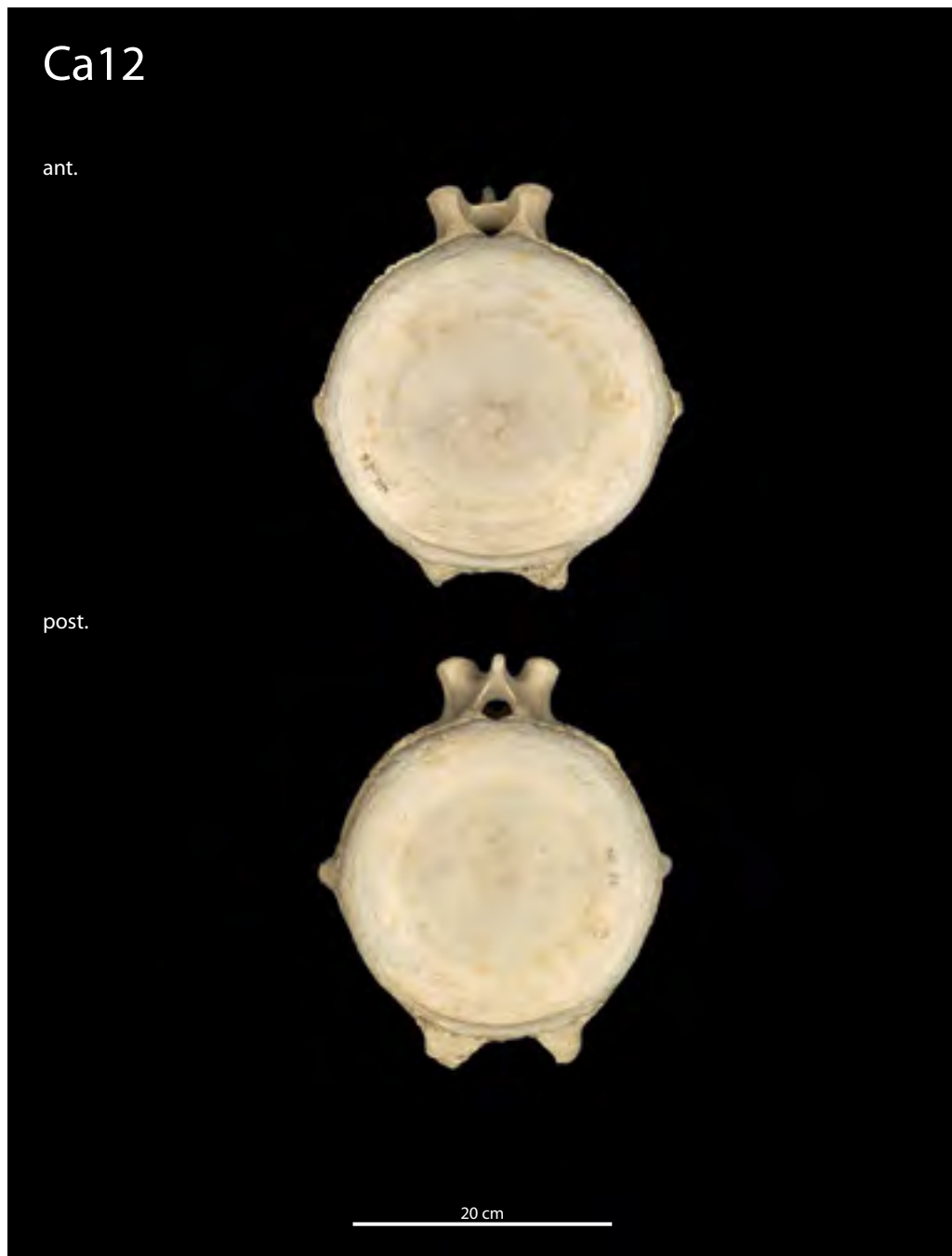
**Slika 86.** Anteriorna (ant.) in posteriorna (post.) površina desetega repnega vretenca Ca10. Fotografija: Ciril Mlinar  
**Figure 86.** Anterior (ant.) and posterior (post.) surfaces of the 10th caudal vertebra Ca10. Photo: Ciril Mlinar



**Slika 87.** Anteriorna (ant.) in posteriorna (post.) površina enajstega repnega vretenca Ca11.

Fotografija: Ciril Mlinar

**Figure 87.** Anterior (ant.) and posterior (post.) surfaces of the 11th caudal vertebra Ca11. Photo: Ciril Mlinar



**Slika 88.** Anteriorna (ant.) in posteriorna (post.) površina dvanajstega repnega vretenca Ca12.  
Fotografija: Ciril Mlinar

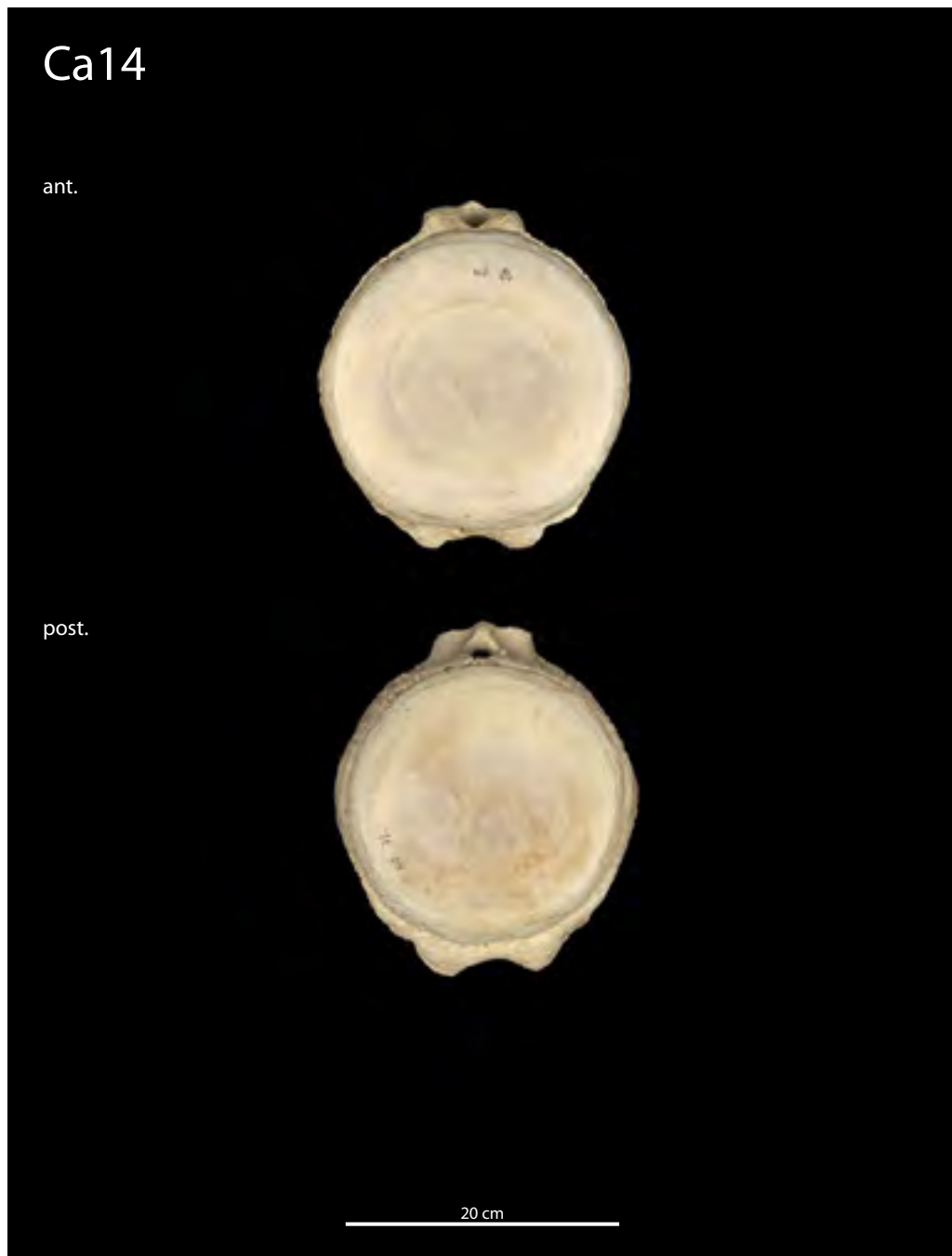
**Figure 88.** Anterior (ant.) and posterior (post.) surfaces of the 12th caudal vertebra Ca12. Photo: Ciril Mlinar



**Slika 89.** Anteriorna (ant.) in posteriorna (post.) površina trinajstega repnega vretenca Ca13.

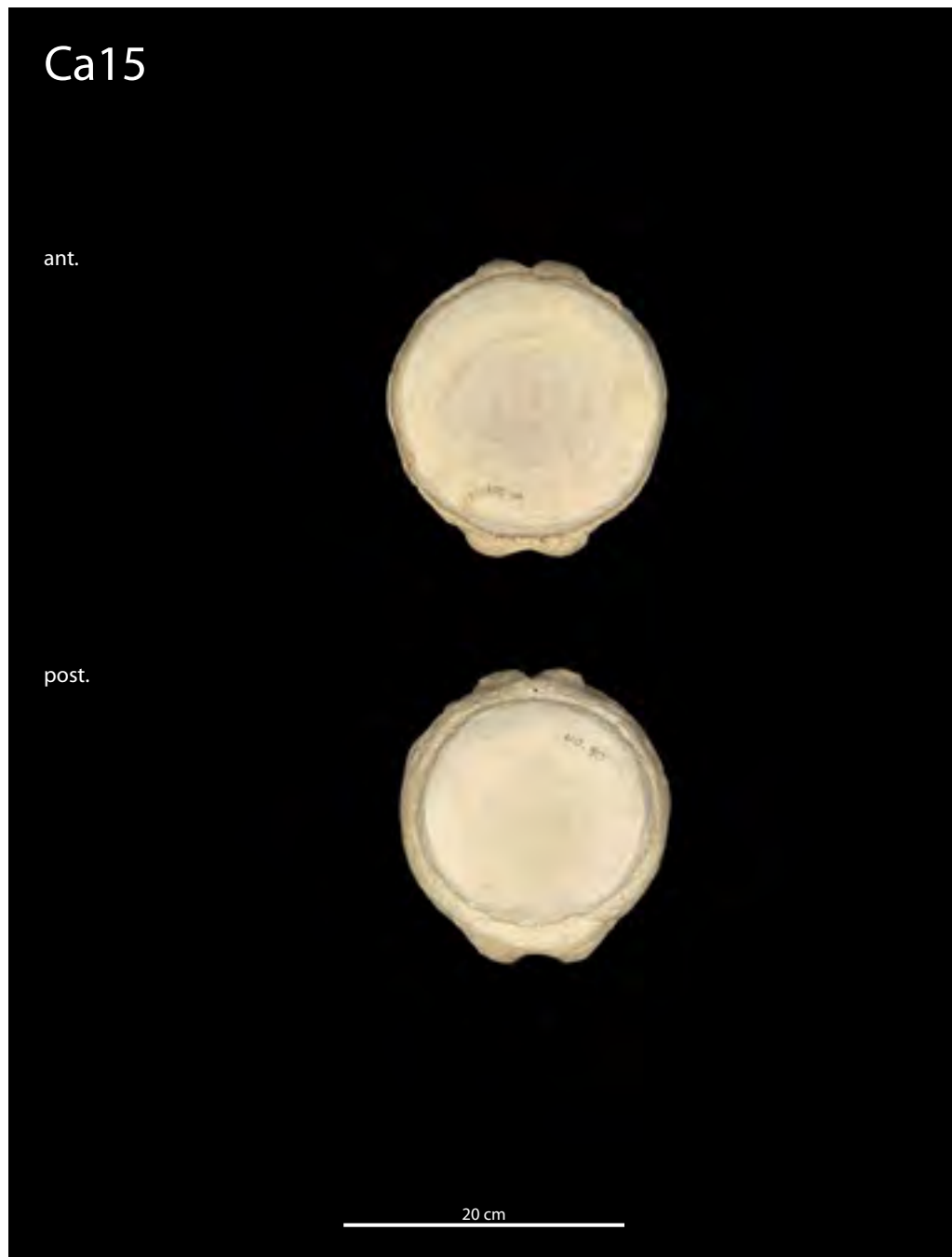
Fotografija: Ciril Mlinar

**Figure 89.** Anterior (ant.) and posterior (post.) surfaces of the 13th caudal vertebra Ca13. Photo: Ciril Mlinar



**Slika 90.** Anteriorna (ant.) in posteriorna (post.) površina štirinajstega repnega vretenca Ca14.  
Fotografija: Ciril Mlinar

**Figure 90.** Anterior (ant.) and posterior (post.) surfaces of the 14th caudal vertebra Ca14. Photo: Ciril Mlinar



**Slika 91.** Anteriorna (ant.) in posteriorna (post.) površina petnajstega repnega vretenca Ca15.  
Fotografija: Ciril Mlinar

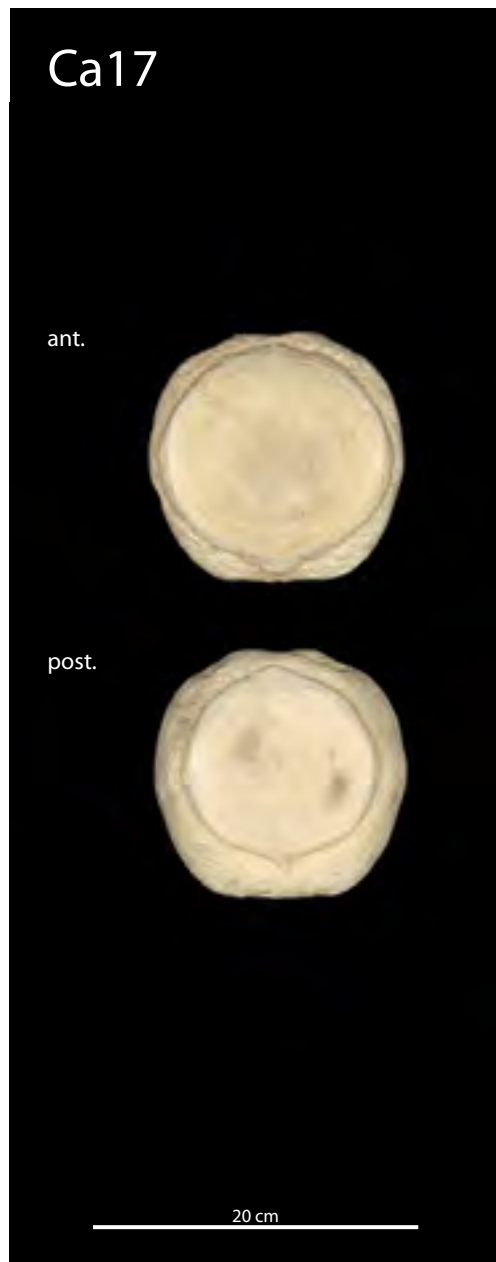
**Figure 91.** Anterior (ant.) and posterior (post.) surfaces of the 15th caudal vertebra Ca15. Photo: Ciril Mlinar





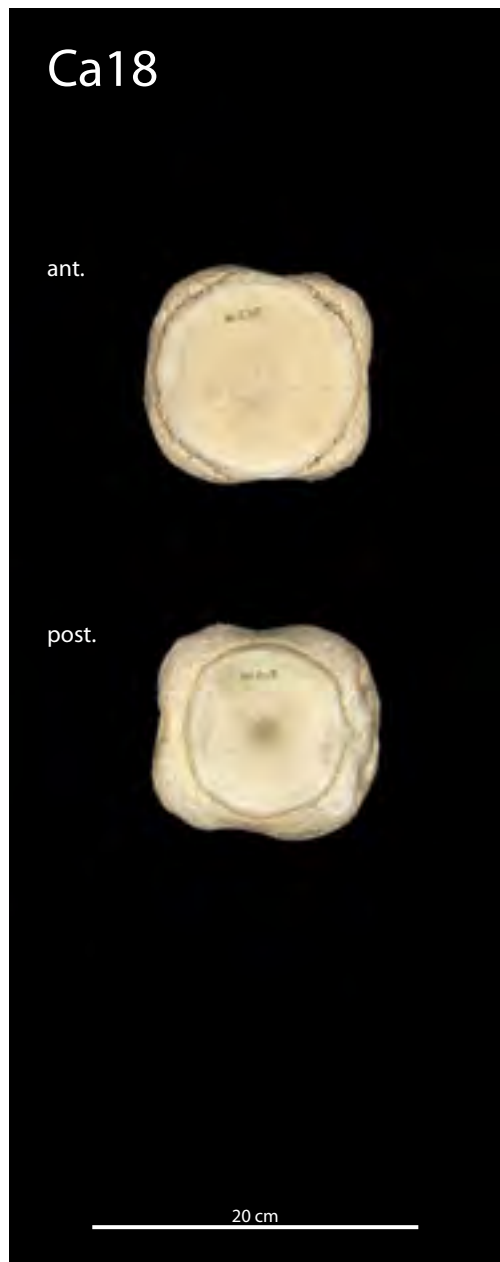
**Slika 92.** Anteriorna (ant.) in posteriorna (post.) površina šestnajstega repnega vretenca Ca16.  
Fotografija: Ciril Mlinar

**Figure 92.** Anterior (ant.) and posterior (post.) surfaces of the 16th caudal vertebra Ca16.  
Photo: Ciril Mlinar



**Slika 93.** Anteriorna (ant.) in posteriorna (post.) površina sedemnajstega repnega vretenca Ca17.  
Fotografija: Ciril Mlinar

**Figure 93.** Anterior (ant.) and posterior (post.) surfaces of the 17th caudal vertebra Ca17.  
Photo: Ciril Mlinar



**Slika 94.** Anteriorna (ant.) in posteriorna (post.) površina osemnajstega repnega vretenca Ca18. Fotografija: Ciril Mlinar

**Figure 94.** Anterior (ant.) and posterior (post.) surfaces of the 18th caudal vertebra Ca18. Photo: Ciril Mlinar



**Slika 95.** Anteriorna (ant.) in posteriorna (post.) površina devetnajstega repnega vretenca Ca19. Fotografija: Ciril Mlinar

**Figure 95.** Anterior (ant.) and posterior (post.) surfaces of the 19th caudal vertebra Ca19. Photo: Ciril Mlinar



**Slika 96.** Anteriorna (ant.) in posteriorna (post.) površina dvajsetega repnega vretenca Ca20.  
Fotografija: Ciril Mlinar

**Figure 96.** Anterior (ant.) and posterior (post.) surfaces of the 20th caudal vertebra Ca20.  
Photo: Ciril Mlinar



**Slika 97.** Hemalni loki na ventralni strani repnih vretenc. Anteriorno je levo. Fotografija: Ciril Mlinar

**Figure 97.** Hemal arches on the ventral side of the caudal vertebrae. Anterior is to the left. Photo: Ciril Mlinar

## Prsnica

Največja širina prsnice ali grodnice (*sternum*) je znašala 34,5 cm, največja dolžina pa 26 cm. Prsnica se pri vseh vosatih kitih veže samo na prvi par reber. Pri zobatih kitih je

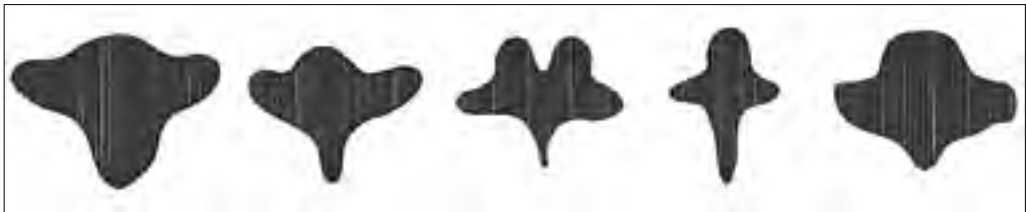
## Sternum

The sternum was 34.5 cm wide and 26 cm long. In all baleen whales, the sternum connects only to the first pair of ribs. In toothed whales, the sternum is segmented, while in



**Slika 98.** Dorzalna stran prsnice. Fotografija: Ciril Mlinar

**Figure 98.** Sternum in dorsal view. Photo: Ciril Mlinar



**Slika 99.** Različne oblike prsnice pri vrstah brazdastih kitov (Balaenopteridae). Od leve si sledijo prsnice sinjega kita (*Balaenoptera musculus*), brazdastega kita (*Balaenoptera physalus*), zajvala (*Balaenoptera borealis*), ščukastega kita (*Balaenoptera acutorostrata*) in grbavca (*Megaptera novaenliae*). (Vir: prirejeno po Sokolov & Arsen'ev, 2006)

**Figure 99.** Shape of sternum in different species of rorquals (Balaenopteridae). From left to right: Blue Whale (*Balaenoptera musculus*), Fin Whale (*Balaenoptera physalus*), Sei Whale (*Balaenoptera borealis*), Minke Whale (*Balaenoptera acutorostrata*) and Humpback Whale (*Megaptera novaenliae*). (Modified from Sokolov & Arsen'ev, 2006)

prsnica segmentirana, pri vosatih pa je enotna kost (Perrin, Wursig & Thewissen, 2009). Prsnica se po obliki razlikuje med vrstami družine Balaenopteridae. Pri našem primerku je kazala vse bistvene značilnosti vrste *B. physalus*.

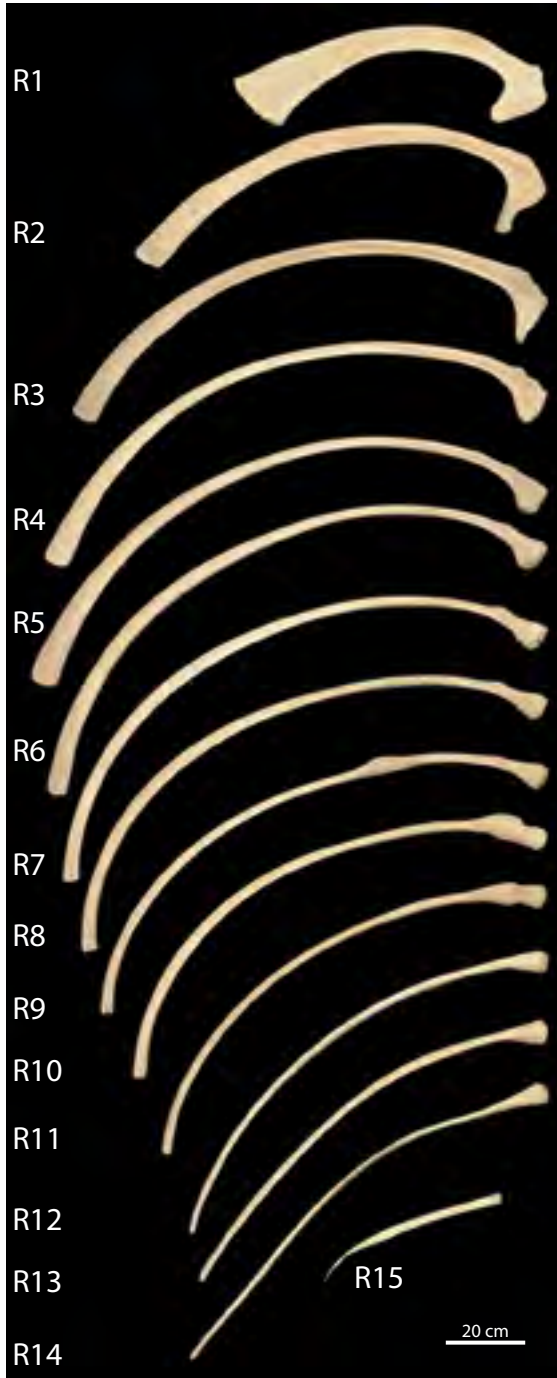
baleen whales it is composed of a single bone (Perrin, Wursig & Thewissen, 2009). Regarding its shape, the sternum differs between the species of the family Balaenopteridae. In our specimen, it showed all characteristics of the species *B. physalus*.

## Rebra

Naš osebek je imel 14 parov reber (*costae*) in neparno petnajsto rebro. To zadnje rebro je bilo znatno krajše in tanjše od drugih. Rebra so se v posteriorni smeri postopoma daljšala, najdaljši je bil šesti par, posteriorno ležeča rebra pa so bila postopno vse krajša. Prvi par reber je bil sploščen in širok. Kot je značilno za vse vosate kite, je bil s prsnico povezan le prvi par reber. Preostala rebra imajo proste distalne konce. (Cagnolaro, Di Natale & Notarbartolo di Sciara, 1983). Tri rebra na levi strani (R9, R10 in R11) so imela v zgornji tretjini vidne deformacije v obliki odebeljene kosti.

## Ribs

Our individual had 14 pairs of ribs (*costae*), with the odd fifteenth rib present as well. This last rib was considerably shorter and thinner than the rest. In posterior direction, the ribs were gradually becoming longer (the longest was the sixth pair), whereas the posteriorly lying ribs were gradually becoming shorter. The first pair was flat and wide. As characteristic of all baleen whales, only the first pair was connected to the sternum. The remaining ribs have free distal ends (Cagnolaro, Di Natale & Notarbartolo di Sciara, 1983). Three ribs on the left side (R9, R10 and R11) had visible deformations in the form of thickened bone in their proximal third.



**Slika 100.** Leva rebra R1 – R15, rebra R9, R10 in R11 kažejo abnormalne odebelitve. Fotografija: Ciril Mlinar  
**Figure 100.** Left ribs R1 – R15, ribs R9, R10 and R11 with abnormal thickening. Photo: Ciril Mlinar

## Plečnica ali lopatica

Od kosti plečnega obroča je pri kitih ohranjena parna plečnica, korakoidna kost pa le kot korakoidni odrastek plečnice, ključnice ni. Glenoidna vdolbina (*cavitas glenoidalis*) ali sklepna ponvica plečnice tvori z glavo nadlahtnice (*caput humeri*) zelo gibljiv ramenski sklep. Hkrati je to tudi edini gibljivi sklep v prsni plavuti kitov (Perrin, Wursig & Thewissen, 2009). Kot je značilno za brazdstega kita, je bila plečnica (lopatica, *scapula*) našega primerka široka, ploščata in pahljačasta. Zgornji rob je bil konveksen. Anteriorno je imela dva koščena odrastka: akromij (*acromion*) in korakoidni odrastek (*processus coracoideus*). Akromij je bil močnejše razvit kot korakoidni odrastek.

## Scapula

Of the pectoral girdle, only the scapula is present in whales, while the coracoid bone is reduced to the scapular coracoid process. There is no clavicle. The glenoid fossa of the scapula forms a highly flexible shoulder joint with humeral head. At the same time, it is also the only flexible joint in the whales' pectoral fin (Perrin, Wursig & Thewissen, 2009). As characteristic of the Fin Whale, the scapula of our specimen was wide, flat and fan-shaped, with a convex upper edge. Anteriorly, it had two processes: the acromion and coracoid process, with the former more strongly developed than the latter.





**Slika 101.** Lateralna površina desne lopatice (a-akromij, k-korakoidni odrastek, gv-glenoidna vdolbina). Fotografija: Ciril Mlinar

**Figure 101.** Lateral surface of the right scapula (a - acromion, k – coracoid process, gv – glenoid fossa). Photo: Ciril Mlinar



**Slika 102.** Medialna površina desne lopatice, (a-akromij, k-korakoidni odrastek, gv-glenoidna vdolbina). Fotografija: Ciril Mlinar

**Figure 102.** Medial surface of the right scapula (a - acromion, k – coracoid process, gv – glenoid fossa). Photo: Ciril Mlinar

## Kosti prsne plavuti

Sprednje okončine so pri kitih preobražene v prsne plavuti. Okostje prsne plavuti sestavljajo nadlahtnica (*humerus*), koželjnica (*radius*), podlahtnica (*ulna*), zapestne koščice ali zapestnice (*carpales*), dlančnice (*metacarpales*) in prstnice (*phalanges*).

Pri brazdastem kitu je nadlahtnica kratka in široka kost. Njena glava (*caput humeri*) je polkrogle oblike, velika in skoraj vzporedna z osjo kosti. Proksimalno je sklepno povezana s sklepno ponvico (glenoidno votlino) lopatice v zelo gibljiv sklep. Na distalnem koncu ima sklepno ploskev v obliki črke V, ki se tesno in negibljivo stika s proksimalnima površinama

## Pectoral fin bones

In whales, the pectoral limbs are modified as flippers. The fin skeleton consists of the humerus, radius, ulna, carpals (*carpales*), metacarpals (*metacarpales*) and phalanges (*phalanges*).

In Fin Whales, the humerus is a short and broad bone. Its head (*caput humeri*) is semi-circular, large and almost parallel to the bone axis. Proximally, it articulates with the glenoid fossa of the scapula into a very flexible joint. At the distal end, it has V-shaped joint surface, which is in a close and solid-state articulation with the proximal surfaces of the ulna and the radius (Perrin, Wursig & Thewissen, 2009). The head of the humerus and its distal part



**Slika 103.** Nadlahtnica, lateralno (pe-proksimalna epifiza, de-distalna epifiza). Fotografija: Ciril Mlinar

**Figure 103.** Humerus in lateral view (pe – proximal epiphysis, de – distal epiphysis). Photo: Ciril Mlinar



**Slika 104.** Kosti v negibnem komolcu.

Nadlahtnica distalno (zgoraj), podlahtnica proksimalno (levo spodaj), koželjnica proksimalno (desno spodaj). Puščice označujejo epifize, ki pri našem osebku še niso bile zraščene z diafizami.

Fotografija: Ciril Mlinar

**Figure 104.** Bones in the immobile elbow. Distal part of humerus (above), proximal ulna (below left), and proximal radius (below right), with arrows indicating epiphyses, which had not yet been ossified with diaphyses. Photo: Ciril Mlinar

podlahtnice in koželjnice (Perrin, Wursig & Thewissen, 2009). Glava humerusa in njegov distalni del sta razvita kot epifizi. Pri našem osebkju epifizi še nista bili zraščeni z diafizo nadlahtnice.

Koželjica leži dorzalno od podlahtnice. Na proksimalnem in distalnem koncu sta širši, v sredini pa najožji; koželjnica je širša od podlahtnice. Olecranon ali komolčni podaljšek (*processus olecrani*) je proksimalen podaljšek podlahtnice (Perrin, Wursig & Thewissen, 2009).

Pet zapestnic ali karpalnih kosti brazdastih kitov je razporejenih v dve vrsti. V proksimalni vrsti vzdolž distalnega konca koželjnice in podlahtnice so tri karpalne koščice, v

develop during the ontogeny as epiphyses. In our specimen, the epiphyses were not yet ossified with the humerus's diaphyses.

In Fin Whale the ulna and radius are parallel, long and flat bones. The ulna is situated dorsally from the radius. Both bones are the widest at their proximal and distal ends, and the narrowest in the middle; the radius is wider than the ulna. The olecranon (*processus olecrani*) is a proximal extension of the ulna (Perrin, Wursig & Thewissen, 2009).

The five carpal bones of the Fin Whale are arranged in two rows. In the proximal row along the distal end of the radius and the ulna, three small carpals are situated; in the parallel distal row, there are two of them. These are small



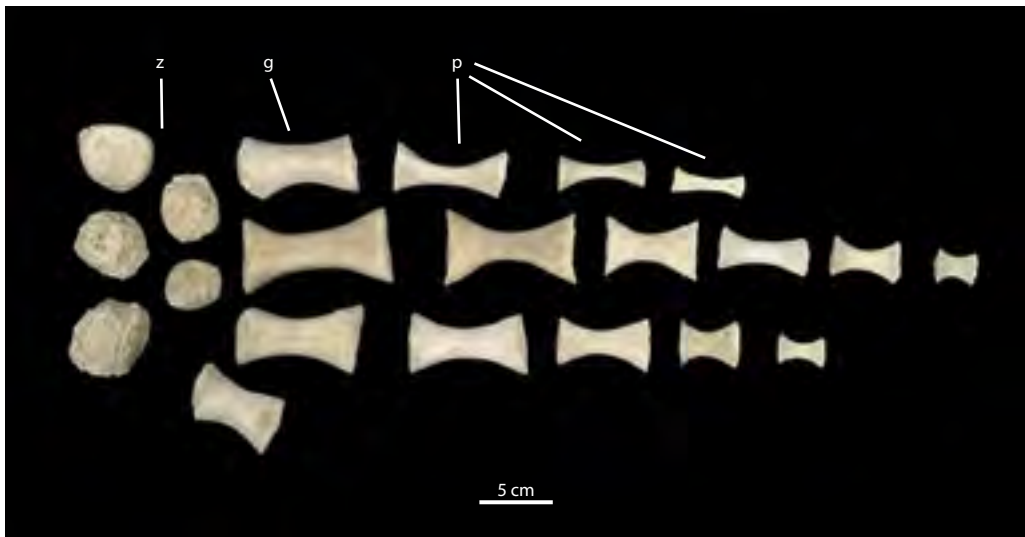
**Slika 105.** Desna koželjnica in podlahtnica (o- olecranon, pe- proksimalna epifiza).

Fotografija: Ciril Mlinar

**Figure 105.** Right radius and ulna (o - olecranon, pe – proximal epiphysis). Photo: Ciril Mlinar

vzporedni distalni vrsti sta dve. To so majhne in kratke kosti, nepravilne, približno kroglaste oblike. So brez sklepnih površin in potopljene v hrustanec. Imajo hrapavo, luknjičasto površino. Tako dlančnice kot prstnice imajo obliko peščene ure. Brazdastim kitom manjka tretji prst (Perrin, Wursig & Thewissen, 2009). Kiti imajo v prstih večje število prstnic, kot je običajno za sesalce (hiperfalangija; Perrin, Wursig & Thewissen, 2009), največ jih imata srednja dva prsta (II. in IV.). Število prstnic v vsakem od štirih prstov variira, npr. I: 3-4; II: 6; IV: 5-6; V: 3-4 (= 17-20; Perrin, Wursig & Thewissen, 2009), ali I: 3-4; II: 5-7; IV: 5-7; V: 3-4 (= 16-22; Cagnolaro, Di Natale & Notarbartolo di Sciara, 1983). Pri našem primerku je bilo v celoti ohranjenih 21 prstnic, tako da nobena od prsnih plavuti ni bila v tem pogledu popolna. Glede na zgoraj navedene prstne formule za brazdastega kita smo izdelali 7 odlitkov prstnic (2 odlitka za levo plavut in 5 za desno). Hrustančno tkivo med karpalnimi kostmi in med prstnicami vsakega od prstov smo nadomestili z modelirno maso.

and short bones of irregular spherical form. Dipped in the cartilage they are without articulation facets. Their surface is rough and porous. Both metacarpals and phalanges are hourglass-shaped. Fin Whales are missing their third digits (Perrin, Wursig & Thewissen, 2009). In general, whales have more phalanges in their digits than the usual number in mammals (hyperphalangy; Perrin, Wursig & Thewissen, 2009); most of them are in middle two digits (II and IV). The number of phalanges varies in each of the four digits, e.g. I: 3-4; II: 6; IV: 5-6; V: 3-4 (= 17-20; Perrin, Wursig & Thewissen, 2009), or I: 3-4; II: 5-7; IV: 5-7; V: 3-4 (= 16-22; Cagnolaro, Di Natale & Notarbartolo di Sciara, 1983). In our specimen, 21 phalanges were fully preserved, which means that none of the sets was complete in this respect. In view of the Fin Whale digit numbers stated above, 7 casts of phalanges were made (2 casts for the left and 5 for the right fins) to reconstruct the skeleton. The cartilage tissue between the carpals and the phalanges of each digit were substituted in the model with the modelling putty.



**Slika 106.** Zapestnice (z), dlančnice (d) in ohranjene prstnice (p) leve prsne plavuti. Manjkajoči prstnici palca sta bili naknadno nadomeščeni z mavčnima odlitkoma. Fotografija: Ciril Mlinar

**Figure 106.** Carpals (z), metacarpals (d) and phalanges (p) of the left pectoral fin. The missing thumb phalanges were later replaced with plaster casts. Photo: Ciril Mlinar

## Medenica

Pri našem primerku je bila ohranjena samo leva stran zakrnelega ostanka medenice (*pelvis*), desno stran pa smo nadomestili z odlitkom iz mavca. Pri brazdastih kitih leži okoljce prosto v mišičju, brez povezave z osnim skeletom. Leva in desna stran sta pomaknjeni lateralno od linije hrbtenice in sta z njo skoraj vzporedni. Zakrneli ostanek medenice rabi za pritrdišče mišic reproduktivnih organov in je navadno večji pri samcih (Perrin, Wursig & Thewissen, 2009). Dolžina, ki jo za odrasle osebe te vrste navajata Cagnolaro *et al.* (1983) in Sokolov (2006), znaša približno 40 cm. Pri naši samici je bila medenica dolga slabih 12 cm.

Daljši del zakrnelega ostanka medenice tvori črevnico (*ilium*) in je usmerjen kranialno, posteriorno usmerjeni del tvori sednico (*ischium*), trikotna lateralna razširitev pa dimeljnico oziroma sramnico (*pubis*) (Lonnberg, 1931).

## Pelvis

In our specimen, only the left side of the pelvic vestige was preserved; the right side was replaced with a plaster cast. In Fin Whales, the pelvis is lying freely in the muscular tissue, with no connection with the axial skeleton. The left and right sides are shifted laterally from the backbone line and lie almost parallel to it. The pelvic vestige serves for fixing muscles of the reproductive organs and is normally larger in males (Perrin, Wursig & Thewissen, 2009). The length reported for mature individuals of this species by Cagnolaro *et al.* (1983) and Sokolov (2006) is up to about 40 cm. In our female, the pelvis was a little less than 12 cm long.

The longer part of the pelvic vestige represents the ilium and is oriented cranially, the posteriorly oriented part is the ischium, whereas the triangular lateral widening delineates the pubis (Lonnberg, 1931).



**Slika 107.** Medenica. Kranialno je desno, ventralno spodaj. Fotografija: Ciril Mlinar

**Figure 107.** Pelvis, cranial is to the right, ventral is at the bottom. Photo: Ciril Mlinar

## Montiranje okostja

Mojca JERNEJC KODRIČ,  
Boris KRYŠTUFEK

Naravoslovni muzeji pogosto razstavljajo okostja kitov, kljub temu pa je literatura, ki opisuje pripravo okostja za razstavo, dokaj skromna. Podrobnosti postopkov navadno niso dokumentirane in so ohranjene le v osebnem vedenju muzejskega osebja. V našem primeru je montažo okostja in njegovo namestitve na stropno konstrukcijo dvorane opravil samostojni podjetnik Jure Malovič. Z njim si je osebje PMS ogledalo tri v predhodnem poglavju omenjena okostja brazdastih kitov, razstavljena v naravoslovnih muzejih. Pri delu sta nam bila v največjo pomoč priročnik *The Sperm Whale Engineering Manual or Building a Big Whale Skeleton* (Post, 2009) in informacija, skupaj z obsežno fotodokumentacijo, ki jo je prijazno posredoval naravoslovni muzej v Budimpešti.

Pred začetkom dela je podjetje Piring (Projektiranje, tehnično svetovanje, Vojko Pirjevec

## Articulation of the skeleton

Mojca JERNEJC KODRIČ &  
Boris KRYŠTUFEK

Although natural history museums often put whale skeletons on display, the literature describing skeleton preparation for exhibition purposes is fairly modest. The details of this procedure are normally not documented and therefore preserved only in personal knowledge of the museum staff. In our case, the articulation of the skeleton and its installation was carried out by the independent entrepreneur Jure Malovič. In his company, the staff of our Museum inspected three Fin Whale skeletons exhibited in natural history museums abroad. During our work we were aided particularly by the manual *The Sperm Whale Engineering Manual or Building a Big Whale Skeleton* (Post, 2009) and information, together with extensive photographic documentation, kindly supplied by the Natural History Museum in Budapest.

Prior to the planned works, the firm Piring (Architectural Engineering and Technical



**Slika 108.** Vrtanje vretenc.  
Fotografija: Ivo Božič

**Figure 108.** Drilling holes into vertebrae. Photo: Ivo Božič



s.p.) opravilo analize gradbene konstrukcije in pripravilo statični načrt namestitve okostja pod strop dvorane.

Prva faza povezovanja kosti se je začela v dislociranih depojskih prostorih junija 2011. Ekipa zunanjega izvajalca je v vsako vretenca izvrtala po dve luknji in jih nanizala na palici iz nerjavečega jekla. V prvi fazi je bila celotna hrbtenica razdeljena na pet odsekov. Vretenca je izvajalec pritrdil v primerni medsebojni oddaljenosti z jeklenimi maticami in podložkami. V naslednji stopnji je izvajalec v dolge kosti sprednjih okončin vstavil jeklene palice, fiksirane z epoksidno maso. Delno povezane sklope okostja smo iz depojskih prostorov prepeljali v muzejsko zgradbo na Prešernovi cesti, kjer so sledila nadaljnja dela.

V muzejski dvorani je ekipa izvajalca postavila cevni oder. Na obstoječe etažne jeklene nosilce so privarili okrogla jeklena sidra. Najprej so z jeklenimi pletenicami pod strop obesili zadnji repni segment hrbtenice. Postopno so dodajali naslednje elemente in jih medsebojno povezali. Primerno ukrivljenost hrbtenice so dosegli z natezanjem jeklenih pletenic. Kostni lobanje so pred dvigovanjem

Counselling, Vojko Pirjevec s.p.) analysed building construction and the statics for hanging the skeleton under the ceiling of the Museum hall.

The first phase of bone mounting started in June 2011 in the Museum's nonresidential depots. The team of external contractor bored two holes in each vertebra and strung them on a rod made of stainless steel. In this phase, the entire vertebral column was divided in five sections. The contractor fixed the vertebrae at suitable distances with steel nuts and washers. During the ensuing phase, steel rods were inserted into long bones of the forelimbs and fixed with epoxy putty. Partially linked sections of the skeleton were then transported from the depot to the Museum building at Prešernova Street, where other works followed shortly.

The contractor's team set up tubular scaffolding in the Museum hall. Afterwards, round steel anchors were welded on to the existing floor steel beams. At first, the last backbone's tail segment was hung under the ceiling with braided steel cables. Step by step, the ensuing elements were added and connected with



**Sliki 109 in 110.** Povezovanje vretenc.

Fotografija: Ciril Mlinar

**Figures 109 and 110.** Linking of vertebrae.

Photo: Ciril Mlinar

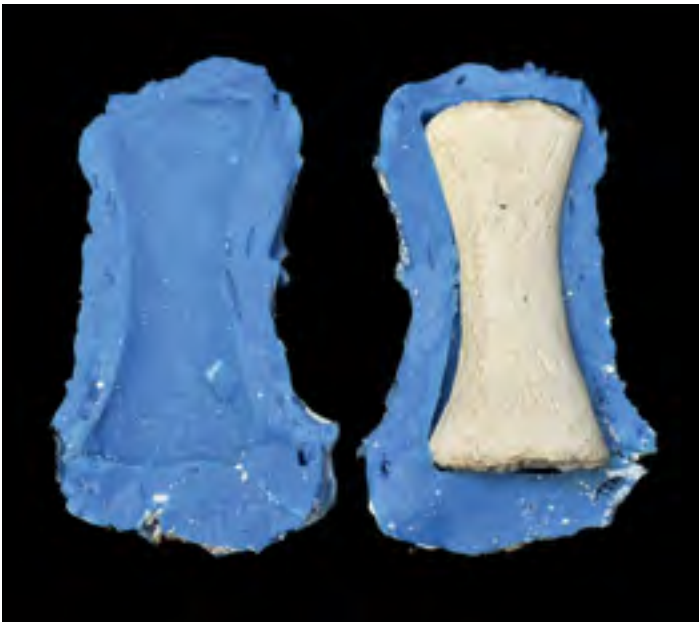


povezali z močnimi jeklenimi elementi. Nato so lobanjo s pomočjo škripca in jeklenih pletenic dvignili pod strop, jo pritrdili s pletenicami na stropna sidrišča in povezali z dvema jeklenima palicama, ki sta potekali skozi vretenca. Spodnječeljustnični glavi obeh čeljustnic so predhodno prevrtali v dorzo-ventralni smeri, pod stropom pa so ju v ustrezen položaj pritrdili z dvema dolgima navojnima palicama. Med seboj so ju prečno povezali z jekleno navojno palico. Rebra so s pomočjo vdelenih navojnih palic povezali s prsnimi vretenci. Medsebojno so jih povezali na mestih lateralnih usločenj; skupaj so speli rebra od prvega do petega, in od petega do petnajstega. Že povezano okostje prsne plavuti so z jekleno pletenico, ki je obkrožala podlahtnico, obesili na stropna sidrišča. Plečnici so dodatno pritrdili na rebra na dveh mestih.

Tehnična služba PMS je izdelala mavčne odlitke manjkajočih prstnic in desne strani zakrnelega ostanka medenice, ki jih je izvajalec vstavil v okostje. Na jeklene navojne palice je nanizal navrtane prstnice, dlančnice in zapestnice, jih fiksiral ter povezal s distalnim delom podlahtnice in koželjnice. Hrustančno tkivo med prstnicami in hrustanec, v katerem

each other. The appropriate curvature of the spine was attained by straining the braided steel cables. Prior to being lifted, the skull bones were linked together with strong steel elements. Then the skull was lifted with the aid of pulley and braided steel cables under the ceiling, fastened with braided cables to the ceiling anchors and connected with two steel rods that ran through the vertebrae. The mandibular heads of both jawbones were drilled in advance in the dorso-ventral direction and then fixed in a suitable position under the ceiling with two long threaded rods. They were linked with each other transversally with a threaded steel rod. The ribs were joined with thoracic vertebrae with the aid of built-in threaded rods. They were joined with each other on the spots of lateral warps; the ribs were tied together from the first to the fifth, and from the fifth to the fifteenth. The already mounted skeleton of the pectoral fin was hung under the ceiling with a braided steel cable that surrounded the ulna. The scapulas were additionally fixed to the ribs at two places.

The Museum's Technical Service made plaster casts of the missing phalanges and



**Slika 111.** Izdelava mavčnega odlitka prstnice. Fotografija: Ciril Mlinar

**Figure 111.** Modelling of the plaster cast of the whale's phalange. Photo: Ciril Mlinar



so potopljene zappestnice, smo nadomestili z modelirno maso. Nazadnje je izvajalec z jeklenimi palicami na okostje pritrdili manjše kosti (prsnico, jezično kost, hemalne loke in medenico). Celotno okostje je z jeklenimi pletenicami obešeno na skupno 13 sidriščnih točkah (ušesih), privarjenih na etažne prečne nosilce.

Konec avgusta 2011 je okostje brazdastega kita (Leonore, kot so jo poimenovali uslužbeneci PMS) viselo pod stropom razstavne dvorane. Redno v letnih presledkih bo treba pregledovati stanje pritrdilnih delov konstrukcije in s tem njeno stabilnost in varnost. Prav slednja je bila najpomembnejša zahteva pri povezovanju in obešanju okostja. Hkrati smo si prizadevali, da bi bili uporabljeni jekleni elementi estetsko čim manj moteči.

Okostje je nameščeno razmeroma visoko. Čeprav to zmanjša preglednost eksponata, pa zagotavlja potreben prostor za obiskovalce in bodoče postavitve občasnih razstav v dvorani. Izvajalec je predvidel demontažo okostja po posameznih sklopih in prenos na morebitno novo lokacijo.

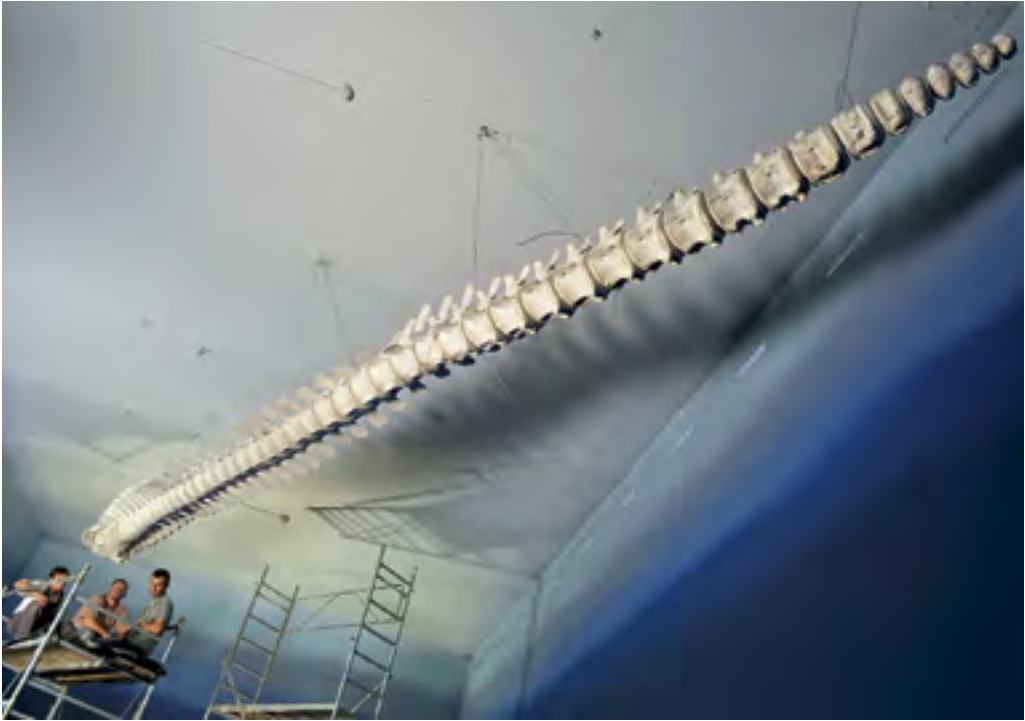
Ker je šlo pri tem skeletu za največji eksponat, kar jih je muzej pridobil v svoji zgodovini, je bil najprimernejši razstavni objekt za počastitev 190. obletnice ustanovitve Kranjskega deželnega muzeja, katerega neposredni naslednik je PMS. Razstavo z naslovom »Skrivnostna smrt mlade Leonore« smo odprli za javnost 15. septembra 2011, opisana pa je v naslednjem poglavju.

the right side of the pelvic vestige, which were then added to the skeleton by the contractor. He strung bored phalanges, metacarpals and carpals on the threaded steel rods, fixed them and finally linked them with distal parts of the ulna and the radius. The cartilage tissue between the phalanges and the cartilage in which carpals are dipped, were replaced with modelling putty. In the end, the contractor fixed smaller bones (sternum, hyoid bone, chevrons and pelvic bones). The entire skeleton was hung with threaded steel cables at a total of 13 anchor points that were welded to the floor transverse struts.

In the end of August 2011, the skeleton of the Fin Whale (Leonora, as named by the employees of the Slovenian Museum of Natural History) was finally hanging under the ceiling of the exhibition hall. The state of the construction's fastened parts will have to be checked regularly at yearly intervals and, concurrently, its stability and safety. The very latter was the major demand in the assembly of the skeleton. At the same time we did our best to make the used steel elements as little aesthetically disturbing as possible.

The skeleton is installed relatively high. Although this reduces the visualization of the exhibit, it provides the necessary place for visitors and the future setups of occasional exhibitions in the hall. The contractor envisaged the skeleton's dismantling per separate sections, as well as transfer to a potential new location.

As this skeleton was the largest exhibit acquired by the Museum in its history, it seemed the most suitable display object for the celebration of the 190th anniversary of the Carniolan Provincial Museum, direct predecessor of the Slovenian Museum of Natural History. The exhibition entitled *The Mysterious Death of Young Leonora* was opened to the public on September 15th, 2011, and is described in the subsequent chapter.





**Slika 112 – Slika 118.** Montaža posameznih delov okostja. Fotografija: Ciril Mlinar

**Figure 112 – Figure 118.** Mounting of the skeleton's separate parts. Photo: Ciril Mlinar



**Slika 119.** Konec avgusta 2011 je okostje brazdastega kita viselo v razstavnih dvorani Prirodoslovnega muzeja Slovenije. Fotografija: Ciril Mlinar  
**Figure 119.** At the end of August 2011, the Fin Whale's skeleton was already hanging in the exhibition hall of the Slovenian Natural History Museum.  
Photo: Ciril Mlinar

## Interpretacija na razstavi »Skrivnostna smrt mlade Leonore«

Staša TOME

### Uvod

Pridobitev okostja mlade samice brazdastega kita za zbirko Prirodoslovnega muzeja Slovenije ni pomembna le s stališča evidentiranja, dokumentiranja, ohranjanja in preučevanja naravne dediščine, pač pa tudi v kontekstu predstavljanja dediščine javnosti. Čeprav ima vsak muzejski eksponat znanstveno in dokumentarno vrednost, so primerki, kot je okostje kita, izjemno pomembni za ozaveščanje in izobraževanje javnosti, saj pritegnejo pozornost že zaradi svojih izjemnih dimenzij in nenavadnosti. Z učinkovito interpretacijo smo tako ob velikanskem okostju, ki bi bilo brez spremljajočih vsebin sicer le atrakcija brez prave pedagoško-andragoške vrednosti, obiskovalcem na inovativen način predstavili pridobitev okostja za muzejsko zbirko, brazdastega kita kot predstavnika morskih sesalcev, in dejstva o ustroju in življenju kitov, obiskovalce pa smo opozorili na dejavnike, ki ogrožajo te velike morske sesalce in celoten morski ekosistem ter vlogo človeka pri spreminjanju okolja. Tako je Leonora, kot smo poimenovali samico, ki ji je pripadalo razstavljeno okostje, dobila pomembno vlogo pri izpolnjevanju enega glavnih poslanstev našega muzeja.

Verjamemo, da smo nalogo dobro opravili, o čemer pričča tudi Valvasorjeva nagrada za leto 2011, najvišje stanovsko priznanje, ki ga podeljuje Slovensko muzejsko društvo za enkratne izjemne dosežke v muzejstvu.

V omejenih razmerah, v katerih deluje Prirodoslovni muzej Slovenije, nikakor ni bilo preprosto postaviti na ogled več kot 13 metrov dolgega eksponata in ob tem pripraviti še zanimivo in poučno razstavo. V času pridobivanja okostja je kazalo, da bo prostorska

## The Mysterious Death of Young Leonora - the exhibition interpretation

by Staša TOME

### Introduction

The acquisition of the young female Fin Whale's skeleton by the Slovenian Museum of Natural History is highly significant not only from the aspect of recording, documenting, preserving and studying our natural heritage, but also in the context of its presentation to the public. Although every museum exhibit has a scientific and documentary value, the specimens such as whale skeleton are of exceptional significance for the public awareness building and education, as they attract attention already due to their exceptional dimensions and remarkableness. With effective interpretations we thus innovatively presented to visitors, at the actual side of this huge skeleton that would without the accompanying topics be just an attraction void of a true pedagogical-andragogical value, the acquisition of the skeleton for the museum collection – the Fin Whale as a representative of marine mammals, together with the facts about the structure and life of whales. At the same time, we drew the visitors' attention to the factors threatening these massive marine animals and their entire ecosystem, as well as to the role of man in the degrading of our environment. Leonora – as the female to which the exhibited skeleton belonged was named – acquired an important role in the fulfillment of one of the main missions and commitments of our museum.

We believe that our job was well done, as evidenced by the Valvasor Award received in 2001 – the highest recognition granted by the Slovenian Museum Society for exceptional achievements in museum profession.

In the space-limited conditions, in which the Slovenian Museum of Natural History is functioning, it was certainly far from easy to

stiska, s katero se že desetletja spopada edini nacionalni naravoslovni muzej, kmalu rešena z novim poslopljem v Biološkem središču. Okostje Leonore naj bi bilo razstavljeno v vhodni avli nove stavbe, kjer bi si prostor delilo z okostjem neveljskega mamuta, prepoznanim simbolom našega muzeja. Žal je bil projekt prekinjen tik pred začetkom graditve in odložen za nedoločen čas. Ko so bile dobro leto po odkritju trupla kitove kosti že spravljene v muzejskem depozitu, smo še upali, da bomo svojo dejavnost preselili v nove prostore in tam okostje v doglednem času dostojno predstavili. Po sedmih letih čakanja smo se odločili, da Leonoro ob 190. obletnici ustanovitve Kranjskega deželnega muzeja, iz katerega izhaja tudi naša ustanova, predstavimo javnosti v obstoječih prostorih. Zavedamo se namreč, da mora muzej svoje poslanstvo izpolnjevati vsak trenutek svojega obstoja, ne glede na trenutne težave in načrte za prihodnost.

Prirodoslovni muzej Slovenije si v zgodovinski stavbi na Prešernovi ulici v Ljubljani deli prostore z Narodnim muzejem Slovenije. Razstavni prostori merijo zgolj dobrih 700 m<sup>2</sup>, ob čemer je izkoriščen vsak prostorček petih razstavnih dvoran in tudi hodnika. Dodatnih prostorov, namenjenih obiskovalcem, kot so učilnica, kavarna in prostor za počitek, ki so nujni del vsakega sodobnega muzeja, Prirodoslovni muzej Slovenije nima, zasilno trgovino in garderobo pa si deli z Narodnim muzejem Slovenije.

Edini prostor, kjer je bilo mogoče razstaviti okostje velikih dimenzij, je bila dvorana, namenjena občasnim razstavam, ki so na ogled le leto ali dve. Okostje smo obesili pod strop in ga vsebinsko dopolnili z razstavo »Skrivnostna smrt mlade Leonore«. Tudi po zaprtju razstave bo okostje ostalo na svojem mestu vse do selitve v novo zgradbo. Sestavljanje in pritrjevanje pod strop je bilo namreč zelo zahtevno in drago, ta naš največji eksponat pa mora biti na ogled javnosti. V že tako težavnih prostorskih razmerah to pomeni dodatno omejitev pri izboru vsebin za nadaljnje občasne razstave, ki morajo biti z okostjem logično, vsebinsko in oblikovno povezane. Kljub izjemno

put on display about 13 metres long exhibit and to prepare an interesting and instructive exhibition at the same time. When the procedure of skeleton acquisition was under way, it looked that the lack of space, the problem the only national natural history museum has been coping with for decades, would be shortly solved with a new building constructed in the Biology Centre. Leonora's skeleton was to be exhibited in the new building's entrance hall, where the space would be shared with the skeleton of the woolly mammoth from Nevlje, the recognisable symbol of our museum. The project was, unfortunately, stopped just prior to the start of construction and suspended indefinitely. When a good year after the discovery of the carcass the whale's bones were already stored in the Museum depot, we still hoped to move to new premises and decently exhibit the skeleton within a reasonable time there. After waiting for seven years, however, we decided to exhibit Leonora to the public on the existing premises at the 190th anniversary of the Carniolan Provincial Museum, the actual predecessor of our institution. We are of course aware that a museum must fulfil its mission in every moment of its existence, irrespective of the momentary problems and plans for the future.

The Slovenian Museum of Natural History shares the premises in the historic building at d Prešernova ulica in Ljubljana with the National Museum of Slovenia. The showrooms cover no more than 700 m<sup>2</sup>, meaning that even the tiniest space in the building's five exhibition halls and corridor is made good use of. The Museum of Natural History has no additional rooms intended for visitors, such as classroom, coffee room and place to rest, while the provisional shop and the wardrobe are shared with the National Museum of Slovenia.

The only place where the huge skeleton could be exhibited was the hall intended for temporary exhibitions in duration of a year or two. The skeleton suspended under the ceiling was the central object of the exhibition entitled *The Mysterious Death of Young Leonora*. The skeleton will remain in its place after the exhibition closure as well, until we move to the new



premišljenemu izboru tem in ustrezni interpretaciji je to dejavnik, ki bo v prihodnosti bistveno omejeval uresničevanje poslanstva Prirodoslovnega muzeja Slovenije. Zato seveda upamo, da bo novo poslopje čim prej realizirano in bo lahko Leonora, tako kot neveljski mamut in druga slovenska naravna dediščina, predstavljena v ustreznih razmerah na sodoben, celosten in za obiskovalce še bolj zanimiv in poučen način.

## **Načrtovanje razstave in zastavljeni cilji**

Tako kot so za trdnost hiše potrebni dobri temelji, je za dobro razstavo pomembno skrbno in premišljeno načrtovanje (Ham, 1992; Veverka, 2001, 1998; Knudson *et al.* 2003). Toda, kakšna je »dobra razstava«?

Eno izmed meril za dobro razstavo je nedvomno število obiskovalcev. Da razstava ne sme samevati in biti sebi namen, postaja vse bolj jasno tudi v slovenskih muzejih. Nekateri se po liniji najmanjšega odpora zato zatekajo k najemanju privlačnih populističnih gostujočih razstav iz tujine. Stroški takšnih razstav so navadno zelo visoki, tuje razstave pa ne predstavljajo slovenske kulturne dediščine, kar naj bi bila glavna vsebina naših muzejev. Tudi če je razstava v tujini požela uspeh, ni nikakršnega zagotovila, da bo pri nas dobro obiskana, saj sta struktura obiskovalcev muzejev in splošna kultura obiskovanja kulturnih ustanov v Sloveniji precej drugačni kot v tujini. Ne gre niti prezreti dejstva, da sporočilo in glavne cilje gostujočih razstav določijo avtorji po svoji presoji

building. To wit, the skeleton's mounting and fixing under the ceiling was a demanding and costly job, but our largest exhibit simply had to be put on display to the public. Under the already difficult spatial conditions this meant an additional limitation in the selection of contents for further occasional exhibitions that must be, quite logically, closely associated with the skeleton in terms of contents and form. In spite of the exceptionally thoughtful selection of topics and their suitable interpretation, this is the factor that will significantly limit the implementation of the Museum of Natural History's vocation in the future. We sincerely hope, therefore, that the new building will be constructed in the shortest possible time and that Leonora will be exhibited, the same as the mammoth from Nevlje and other Slovenian natural heritage, under suitable conditions in a modern, integrated and to visitors even more interesting and educative way.

## **The exhibition planning and the set up objectives**

The same as a solid foundation is necessary for a strong house, so is a careful and thoughtful planning significant for a successful exhibition (Ham, 1992; Veverka, 2001, 1998; Knudson *et al.* 2003). But what is »a successful exhibition«?

One of the criteria is no doubt the number of visitors. The fact that an exhibition should not live a solitary life and merely serve its own purpose is becoming increasingly clear in Slovenian museums as well. This is why some of them resort, along the line of least resistance, to hiring attractive and populist exhibitions from abroad. The costs of foreign exhibitions of this kind are usually very high and, apart from it, do not deal with Slovenian cultural heritage that is the main topic of our museums. Even if an exhibition was highly successful abroad, there is no guarantee that it will be well visited in our country as well, given that the structure of museum visitors and the general attitude towards visiting cultural institutions greatly

in (pogosto prevladujočih komercialnih) interesih. Koliko s takšnimi razstavami pridobijo obiskovalci, ni mogoče razbrati iz števila obiskovalcev razstave. Ali zapustijo razstavo z novim znanjem, obogateni za nova občutja in ali so predana sporočila skladna s poslanstvom in politiko muzeja? Je bil denar davkoplačevalcev torej smiselno porabljen? To lahko pokaže le sistematično in metodološko preiščeno vrednotenje (evalvacija) projekta (Veverka, 1998; National Association for Interpretation, 1990). Razstava »Skrivnostna smrt mlade Leonore« je v celoti plod domačega znanja in je zato tudi s tega stališča presežek na področju interpretacije slovenske kulturne dediščine.

»Dobro« obiskana razstava zato ni nujno res kakovostna in usklajena z kulturnimi interesi okolja. Tega smo se zavedali tudi pri pripravi razstave »Skrivnostna smrt mlade Leonore«, zato smo se preiščeno lotili načrtovanja. Nekdaj je bilo načrtovanje razstav podrejeno predvsem predmetom (muzealijam) in prostoru, ki je bil na voljo. Glavno in pogosto tudi edino vlogo pri tem sta odigrala pristojni kustos in oblikovalec razstave, navadno arhitekt po izobrazbi. Muzejski delavci, ki se ukvarjajo z obiskovalci, kot so muzejski pedagogi, tržniki, tisti, ki skrbijo za stike z javnostjo, so pri projektu večinoma začeli sodelovati šele tedaj, ko je bila razstava že postavljena. Danes je načrtovanje razstav, ki upoštevajo načela sodobne interpretacije, usmerjeno predvsem v obiskovalca, njegove potrebe, želje in zmožnosti (Tavčar, 2009; van Mensch in Meijer-van Mensch, 2011). Zato je priporočeno, da je vodja projekta strokovnjak, ki dobro pozna načela dobre interpretacije (Veverka, 1998). Po tem smo se ravnali tudi pri pripravi naše razstave. Ožjo projektno skupino so sestavljali trije kustosi Kustodiata za vretenčarje, vodenje projekta pa je bilo zaupano sodelavki, ki se ukvarja predvsem z izobraževanjem, komuniciranjem z javnostjo in interpretacijo kulturne dediščine. V pripravo razstave je bila ves čas projekta vključena tudi muzejska pedagoginja. Ob poglobljenem strokovnem znanju s področja biologije smo tako pri pripravi razstave uporabili tudi znanje in

differ from those abroad. Neither should we ignore the fact that the basic message and the main objectives of such visiting exhibitions are stipulated by the authors at their discretion and according to their (often prevailing commercial) interests. How much is gained by visitors at the exhibitions of this kind cannot be discerned from the number of people visiting such exhibitions. Do they leave with new knowledge and insights, enriched with new sensations, and are the conveyed messages in compliance with the museum's vocation and policy? Was the tax payers' money wisely used? This can be answered only by the project's deliberate, systematic and methodological evaluation (Veverka, 1998; National Association for Interpretation, 1990)? The exhibition *The Mysterious Death of Young Leonora* is entirely the result of own knowledge and therefore an authentic achievement in the sphere of cultural heritage interpretation.

A »well« visited exhibition is therefore not necessarily good and in compliance with the cultural interests of the environment. As we were aware of this fact also prior to the preparation of the exhibition *The Mysterious Death of Young Leonora*, we thoughtfully embarked on its planning. Years ago, the exhibition planning was mostly subjected to objects and the available space. The main and often only role was played by the exhibition's competent curator and designer, usually an architect. The museum workers dealing with visitors, such as museum pedagogues, marketing researchers and PR officers, mostly joined the project when the exhibition had already been set up. Today, the planning of exhibitions that pay regard to the modern interpretation principles is directed predominantly towards visitors, their needs, desires and possibilities (Tavčar, 2009; van Mensch and Meijer-van Mensch, 2011). It is advisable, therefore, that the project leader is an expert who is well acquainted with the good interpretation principles (Veverka, 1998). This is what we conformed to during the preparation of our exhibition as well. The core project team was comprised of three curators from the Department of Vertebrate Zoology, while the project leadership





**Slika 120.** Ožjo projektno skupino so sestavljali strokovnjaki s področja biologije in interpretacije dediščine. Od leve proti desni: dr. Staša Tome, Ivo A. Božič, Mojca Jernejc Kodrič in prof. dr. Boris Kryštufek. Fotografija: Ciril Mlinar

**Figure 120:** The core project team comprised experts from the spheres of biology and heritage interpretation. From left to right: Dr Staša Tome, Ivo A. Božič, Mojca Jernejc Kodrič and Prof Dr Boris Kryštufek. Photo: Ciril Mlinar

več kot desetletne izkušnje s področja pedagogike, neformalnega izobraževanja otrok in odraslih, psihologije učenja, potreb muzejskih obiskovalcev, marketinga in interpretacije kulturne dediščine. V drugi fazi načrtovanja se je skupini pridružila še oblikovalka razstave.

Pomembno je, da ob načrtovanju razstave po načelih dobre interpretacije poleg drugih dejavnikov, kot so na npr. razpoložljiv prostor, stroški, čas odprtja razstave, trajanje razstave, ciljna publika itd., že na samem začetku projekta jasno definiramo tudi namen, temo in cilje projekta. To olajša premišljen izbor in strukturiranje vsebin, ki podpirajo glavno sporočilo, kar zagotavlja, da ga obiskovalci lažje razumejo (Veverka, 1998).

itself was entrusted to our female colleague who is engaged largely in education, communication with the public, and cultural heritage interpretation. During the preparation of the exhibition, the museum pedagogue permanently participated in the project. Apart from biological expertise, the knowledge and more than ten years of experience in pedagogy, informal education of children and adults, psychology of learning, needs of museum visitors, marketing and cultural heritage interpretation were used in the preparation of the exhibition. In the second planning phase, the team was joined by the exhibition designer.

It is important that during the exhibition planning the project's purpose, theme and

Namen razstave pove, katere segmente svojega poslanstva bomo z njo uresničevali. Namen razstave »Skrivnostna smrt mlade Leonore« je bil večplasten:

- javnosti predstaviti okostje brazdastega kita, izviren način pridobitve in prepariranja okostja ter s tem zagotovili dostopnost dediščine javnosti ter promocijo lastnega strokovnega znanja in ustanove,
- javnosti predstaviti brazdastega kita kot zanimivo živalsko vrsto, druge predstavnike kitov, ki se pojavljajo v Jadranu, opozoriti na ogroženost teh velikih sesalcev in vpliv človeka na naravno okolje in s tem zagotoviti naravoslovno in naravovarstveno izobraževanje javnosti,
- pripraviti odmevno razstavo, ki bo dosegla čim večje število ljudi in bo tudi medijsko odmevna, in s tem zagotoviti dostopnost dediščine najširši javnosti, promocijo ustanove in njenega poslanstva.

Tema razstave je glavno sporočilo, ki ga želimo posredovati obiskovalcem. Biti mora kratko in čim bolj koncizno. Obiskovalec (ob načrtovanju razstave pa tudi snovalci razstave) ga lahko po ogledu razstave izrazi z eno samo povedjo.

Ciljev ne smemo zamenjati s temo, ki ni merljiva. Jasno definirani in merljivi cilji pomagajo snovalcem razstave, da se lažje držijo izbrane teme, hkrati pa omogočajo realno in natančno evalvacijo. Tema razstave »Skrivnostna smrt mlade Leonore« je bila: Kiti so ogroženi morski sesalci, ki zaidejo tudi v slovensko morje. Okoli tega sporočila smo nanizali vsebine o pridobitvi okostja, o predstavitvi kitov kot skupini sesalcev, o njihovi razširjenosti, drugih vrstah kitov, ki zaidejo v Jadran, in dejavnih, ki jih ogrožajo. Vse vsebine so podpirale glavno sporočilo (temo) z različnih vidikov in ga dopolnjevale z dodatnimi informacijami.

Cilji morajo predvideti vpliv na treh ravneh (Veverka, 1998): (1) kaj se bo obiskovalec naučil (učni cilji), (2) kako bo razstava vplivala na njegovo čustvovanje (čustveni cilji) in (3) kako bo razstava vplivala na ravnanje

objectives are clearly defined already at the project's beginning in accordance with good interpretation principles, apart from other factors, e.g. the available space, costs, time of the exhibition opening, duration of the exhibition, target public, etc. This of course facilitates thoughtful selection and structuring of topics that support the basic exhibition's message, which ensures that it is easier understood by visitors (Veverka 1998).

The purpose of the exhibition tells us which segments of our vocation we shall implement through it. The purpose of the exhibition *The Mysterious Death of Young Leonora* was multifold:

- to present to the public the Fin Whale skeleton, the original manner of the bones' acquisition and preparation, and thus to provide for the accessibility of heritage as well as promotion of our own and the institution's expert knowledge;
- to present to the public the Fin Whale as an interesting animal species, other whale representatives occurring in the Adriatic Sea, to call attention to the threat status of these huge marine mammals and to the human impact on the natural environment, and thus to provide for naturalist and nature conservation education of the public;
- to prepare an acclaimed exhibition, which will reach as many people as possible and will be, at the same time, of interest to the media, and thus to provide for the accessibility of natural heritage to the widest public, as well as for promotion of our institution and its mission.

The exhibition's is the main message we wish to render to our visitors. It must be short and as concise as possible. A visitor (as well as the exhibition's authors during its planning) can express it with a single sentence after visiting the exhibition.

The objectives are not to be confused with the topic, which is not measurable. The clearly defined and measurable objectives help the exhibition's creators to make it easier for them to stick to the selected theme, but at the same

obiskovalca (vedenjski cilji). Ob načrtovanju razstave »Skrivnostna smrt mlade Leonore« smo definirali naslednje cilje:

#### 1. Učni cilji

Obiskovalec bo po ogledu razstave:

- znal opisati, kako je Prirodoslovni muzej Slovenije pridobil razstavljeni okostje,
- vedel, da so kiti sesalci, in znal naštet vsaj tri lastnosti, ki to dokazujejo,
- vedel, da kite delimo na vosate in zobate, in znal opisati razliko med obema skupinama,
- vedel, da so kiti v Jadranu redki, vendar se občasno pojavljajo,
- vedel, da so kiti ogroženi, in znal naštet vsaj tri dejavnike, ki jih danes ogrožajo.

#### 2. Čustveni cilji

Obiskovalec bo po ogledu razstave:

- prepoznal muzej kot ustanovo, ki ponuja priložnost za kvalitetno (poučno in zabavno) preživljanje časa,
- cenil strokovnjake, ki so predlagali izviren način prepariranja okostja in njihovo delo, in podpiral dejavnost muzejev,
- občudoval naravo in morske sesalce ter sposobnost prilagoditve organizmov okolju,
- obsojal kitolov,
- zaskrbljen zaradi poseganja človeka v naravo.

#### 3. Vedenjski cilji

Obiskovalec bo po ogledu razstave:

- ponovno obiskal muzej,
- moralno in materialno podpiral dejavnost muzeja ter v svojem okolju promoviral muzej,
- ravnal okolju prijazneje,
- iskal nadaljnje informacije o predstavljeni temi, tudi z nakupom kataloga in stripa,
- kupil kakšen spominek v muzejski trgovini.

time enable a real and exact evaluation. The theme of the exhibition *The Mysterious Death of Young Leonora* was the following: Whales are endangered marine mammals that occasionally stray into the Slovenian Sea. Around this message, we presented information about the acquisition of the skeleton, about the presentation of whales as of a group of mammals, about their distribution, other whale species straying into the Adriatic, and the factors that make them endangered. All topics have supported the main message (theme) from different aspects and supplemented it with additional information.

The objectives must influence a visitor at the following three levels (Veverka 1998): (1) what shall a visitor learn (learning objectives), (2) how will the exhibition affect his or her emotions (emotional objectives), and (3) how will the exhibition affect the visitor's conduct (behavioural objectives). When planning the exhibition *The Mysterious Death of Young Leonora*, we defined the following objectives:

#### 1. Learning objectives

After visiting the exhibition, a visitor will:

- be able to describe how the Slovenian Museum of Natural History acquired the exhibited skeleton,
- know that whales are mammals and will be able to list at least three characteristics demonstrating this fact,
- know that whales are divided into baleen and toothed whales, and will be able to describe the difference between the two groups,
- know that whales are rare in the Adriatic, occurring only occasionally,
- know that whales are endangered, and will be able to enumerate at least three factors due to which they are currently endangered.

#### 2. Emotional objectives

After visiting the exhibition, a visitor will:

- recognize the museum as an institution that offers a possibility for good (educational and amusing) spending of time,



**Slika 121.** Naslov razstave je provokativen, a v mejah dobrega okusa. Fotografija: Ciril Mlinar

**Figure 121.** The exhibition title is provocative, but still within the limits of good taste.  
Photo: Ciril Mlinar

## Leonora in načela dobre interpretacije

Interpretacijo bi poenostavljeno lahko opisali kot posredovanje strokovnih informacij na razumljiv in obiskovalcu dojemljiv način. Načela dobre interpretacije je že pred več kot petdesetimi leti zasnoval Tilden (1957) in se do danes niso dosti spremenila. Veverka (1998) jih v nekoliko skrajšani obliki navaja kot Tildnovi namigi. Za dobro interpretacijo je pomembno, da naslavlja celoto in da si prizadeva za enotnost sporočila - z vsemi predstavivtvmi eno, izbrano temo osvetljuje z različnih stališč. Dobra interpretacija namesto podajanja golih dejstev podaja informacijo skozi proces, ki bi ga lahko imenovali PRR (angl. provoke – relate - reveal): izziv (provokacija) – povezava

- respect the experts who proposed an original manner of skeleton preparation and their work, and support the museums' activities;
- admire nature and marine mammals, as well as the ability of organisms to adapt to the environment,
- become concerned about human encroachment upon nature.

### 3. Behavioural objectives

After visiting the exhibition, a visitor will:

- visit the museum again,
- morally and materially support the museum's activities, and promote the institution in his/her social environment,
- act more environmentally-friendly,
- search for further information on the presented theme, also by purchasing the catalogue and the comic strip,
- buy a souvenir in the museum shop.

## Leonora and good interpretation principle

In simple terms, interpretation could be described as communication of expert information in a comprehensive and intuitive manner. Good interpretation principles were conceived more than fifty years ago by Tilden (1957), and have not changed much since. In somewhat shortened form, Veverka (1998) describes them as Tilden's tips. For a good interpretation it is significant that it addresses the whole and strives for unity of the message – with all presentations it throws light upon, from different aspects, a single, selected theme. Instead of bare facts, good interpretation relates information through a process, which could be called PRR (provoke – relate – reveal): with

informacije z lastnimi izkušnjami – razkritje. Z izzivom pritegnemo obiskovalčevo pozornost, z uporabo analogij, metafor ipd. pa mu omogočimo, da informacije poveže s svojimi izkušnjami. Na podlagi tako ustvarjenega »učnega potenciala« na neobičajen, svojstven način razkrijemo odgovor.

Pri načrtovanju razstave »Skrivnostna smrt mlade Leonore« smo se skušali kar najbolj držati teh načel. Tema razstave je bila skrbno izbrana in definirana že v prvi fazi načrtovanja razstave. Z različnih stališč jo osvetljuje pet sklopov in zaključek, ki naslavljajo celoto in podajajo enotno sporočilo. Proces PRR je v konceptu, naslovu in vsebinskem delu razstave.

Koncept razstave je zasnovan kot detektivska zgodba. Podpirajo ga naslov razstave in naslovi posameznih sklopov. Prvi sklop z naslovom »Najdeno je bilo orjaško truplo« sproži niz vprašanj: »Kdo je bila mlada Leonora?«, »Videna je bila živa!«, »Kaj pa njeno sorodstvo?«, »Jo je pogubila lakota, ali je postala žrtev človeka?«. Na koncu zaključimo, da »Uganka ostaja nerešena«.

Naslov razstave je ključnega pomena predvsem za njeno promocijo. Pritegniti mora pozornost obiskovalcev in medijev. Ob oblikovanju naslova, tako kot pri izboru in interpretaciji vseh vsebin na razstavi, se je vedno koristno vprašati: Zakaj bi ljudi to sploh zanimalo? Odgovor se nikakor ne sme glasiti: »Ker se nam (strokovnjakom) to zdi pomembno!« ali »Ker bi obiskovalci to morali vedeti!« Koristno, če je naslov provokativen, seveda v mejah dobrega okusa. Ljudi najbolj pritegnejo informacije, ki jih lahko povežejo s sabo in svojimi izkušnjami. Takšne informacije si tudi najlaže zapomnijo. Ob načrtovanju interpretacije smo, po precej burni debati in skrbnem premisleku, delovni naslov razstave *Brazdasti kit v slovenskem morju* zato spremenili v »Skrivnostna smrt mlade Leonore«.

S poimenovanjem je Leonora dobila v zavesti obiskovalcev poseben položaj. Nič več ni bila le eden izmed mnogih kitov, ki jih nismo nikoli videli in ki plavajo nekje tam v morskih globinah. Postala je nekaj, kar poznajo in do česar lahko izoblikujejo čustven odnos.

provocation we attract the visitor's attention, while with the use of analogies, metaphors etc. we enable it to integrate information with his or her experience. On the basis of thus created »learning potential« in an unusual, original way, the answer is revealed.

While planning the exhibition entitled *The Mysterious Death of Young Leonora*, we attempted to stick to these principles. The exhibition theme was carefully selected and defined as early as in the first phase of the exhibition planning. From different aspects it is illuminated by five thematic blocks and a conclusion, which jointly addresses the whole and relates a uniform message. The PRR process is present in the concept, title and in the exhibits.

The exhibition concept is designed like a detective story, supported by the exhibition title and the titles of separate thematic blocks. The first among them, titled »A huge carcass was found in the sea« raised a number of questions: »Who was the young Leonora?«, »She was seen alive!«, »And what about her relatives?«, »Was she a victim of hunger or perhaps man?« In the end we conclude that »The mystery remains unsolved«.

The exhibition title is of key importance for its promotion. It is to attract attention of the visitors as well as the media. While selecting the title, it is always useful to ask ourselves, the same as in the selection and interpretation of all exhibition themes: »Why should people want to know this at all?« The answer should in no way read: »Because it seems important to us (the experts)!« or »«Because the visitors should know this.« Useful, if the title is provocative – within the limits of good taste, of course. People are particularly attracted by information, which they can associate with themselves and their own experience. Information of this kind is best remembered as well. While planning the interpretation we therefore changed, after a heated debate and careful consideration, the provisional title *Fin Whale in the Slovenian Sea* into *The Mysterious Death of Young Leonora*.

By naming the exhibited whale, Leonora acquired a special status in the visitors' minds.

Ta pa je pri zagotavljanju izpolnjevanja ciljev razstave bistvenega pomena. Ker nihče ne ve, zakaj je mlada samica poginila, je besedica »skrivnostna« v naslovu informativna, hkrati pa se ujema s konceptom razstave in vzbuja zanimanje.

Da bi pritegnili pozornost, smo tudi na razstavi uporabili mnoge izzive. Izzivalni so bili naslovi vsebinskih sklopov. Na razstavi o kitu smo razstavili ženski steznik (nekdaj so v steznikih uporabljali »kitovo kost« - vose), provokativne so bile tudi nekatere fotografije (npr. mrtev kit v mlaki krvi). Informacije smo skušali povezati z obiskovalčevimi izkušnjami (npr. »brazdasti kit lahko mahoma zajame

She was no longer just one of the numerous whales, which we have never seen and just swim there somewhere, deep in the sea. She became something they are acquainted with and can create an emotional relationship with. And this is of key importance in the attempts to fulfil the objectives of an exhibition. As nobody knows why the young female died, the word »mysterious« in the title is informative, but consistent with the exhibition concept and interest-arousing at the same time.

In order to arouse interest, we opted for several challenges to be applied at the exhibition. The titles of thematic blocks were certainly provoking. During the exhibition, a



**Slika 122.** Tildnove namige smo uporabili za posredovanje informacije o teži brazdastih kitov. S provokativnim naslovom (vprašanjem) smo zbudili obiskovalčevo zanimanje. Za mersko enoto smo kot analogijo uporabili slona. Naloga (postavi slone na črto) je pomenila nov izziv, izpolnitev naloge pa je prinesla razkritje informacije. Fotografija: Ciril Mlinar

**Figure 122.** Tilden's tips were used for providing information on the Fin Whales' body mass. With a provocative title (question), the visitors' interest was aroused. As analogy, elephant was used as the unit of measurement. The task (to place elephants on the line) presented a new challenge, while task fulfilment brought disclosure of the information. Photo: Ciril Mlinar





**Slika 123.** Le kaj počne ženski steznik na razstavi o kitih?

Fotografija: Ciril Mlinar

**Figure 123.** What on earth is doing this female corset at the exhibition about whales? Photo: Ciril Mlinar

količino vode, ki bi napolnila velik avtobus«, ali »plen se ujame na vosih kot na situ«).

## Intelektualna in fizična dostopnost

Za doseganje zastavljenih ciljev smo morali poskrbeti za intelektualno in fizično dostopnost vsebine razstave. Čeprav je na tem področju v zadnjem času v naših muzejih zaznati velik napredek, je še vse preveč razstav, na katerih so besedila dolga, nerazumljiva in napisana v strokovnem jeziku. Razlog za to leži v dejstvu, da besedila za razstave pišejo kustosi, ki so strokovnjaki na svojem področju in dobri poznavalci teme, vendar so jim pričakovanja in potrebe obiskovalcev povsem tuja. Ob pripravi razstave »Skrivnostna smrt mlade Leonore« smo se zato zadeve lotili drugače. Kustosi pristojnega kustodiata so pripravili strokovne osnove, na podlagi katerih je sodelavka, ki se ukvarja z interpretacijo in komuniciranjem dediščine, oblikovala scenarij in osnutek besedil

female corset was on display (because »whale bones«, i.e. baleen plates, were used in corsets decades ago). Some photographs (such as of a dead whale in a pool of blood) were also provocative. We tried to link information with the visitors' experience (e.g. a Fin Whale can scoop up, at a time, such a huge amount of water that a school bus could be filled with« or »prey is caught on baleen plates like on a sieve«).

## Intellectual and physical accessibility

To attain the planned objectives, we had to provide for intellectual and physical accessibility of the exhibition topics. Although a significant progress has been noted lately in Slovenian museums in this particular sphere, there are just too many exhibitions on display, the texts of which are too long and written in hardly comprehensible scientific language. The reason for this lies in the fact that exhibition texts are written by curators who are indeed experts in their fields of expertise and in topics under consideration, but unaware of the visitors' expectations and needs. While preparing the exhibition *The Mysterious Death of Young Leonora* we thus embarked on the matter in a different way. The Museum's Vertebrate Department prepared scientific foundations, on the basis



**Slika 124.** Z vrtenjem ročice simuliramo količino hrane, ki jo v enem dnevu poje brazdasti kit. Manj zahteven obiskovalec dobi le vtis, da je te hrane zelo veliko, zahtevnejši obiskovalci pa lahko s preprostim računom (10 x 100 kg) ugotovijo težo dnevno zaužite hrane oz. kolikokrat mora kit zajeti in precediti vodo, da zadovolji dnevno potrebo po hrani. Fotografija: Ciril Mlinar

**Figure 124.** By rotating the handle, the quantity of food eaten by a Fin Whale in a single day is simulated. A less demanding visitor gets merely an impression that this amount is indeed great, while more demanding visitors can determine, with a simple calculation (10 x 100 kg), the weight of daily consumed food or how many times a whale must scoop up and filter the water in order to satisfy its daily food requirements. Photo: Ciril Mlinar

za razstavo. Besedilo je moralo biti koncizno, napisano v laikom razumljivem jeziku, hkrati pa strokovno neoporečno in informativno, kar smo dosegli s ponovnim strokovnim pregledom in usklajevanjem.

Besedila na naši razstavi so kratka in strukturirana. Osnovna besedila posameznega sklopa ne presegajo 50 besed, dopolnjujejo pa jih podnapisi k slikam. Slikovnega gradiva je veliko. Obiskovalci si namreč zapomnijo 30 % tistega, kar preberejo, 50 % tistega, kar vidijo, in 90% tistega, kar ugotovijo s poskusom. Prav zato smo v razstavo vključili tudi nekaj interaktivnih elementov. Največji notranji interes pri obiskovalcih vzbudijo interakcije, kjer aktivnost obiskovalca povzroči odziv na predstavitvi. Na razstavi »Skrivnostna smrt mlade Leonore« je nekaj takšnih elementov, od bolj zapletenih, kot je na primer prikaz količine hrane, ki jo v enem dnevu poje brazdasti kit,

of which the employee responsible for heritage interpretation and communication prepared a scenario and draft texts for the exhibition. The latter had to be concise and understandable, but professionally irreproachable and informative, which was in fact achieved with a repeated peer review and coordination.

Our exhibition texts were short and structured, with the basic text of each thematic block not exceeding 50 words, but supplemented with figure captions. There was a great deal of pictorial material. Visitors remember, quite specifically, 30% of what they read, 50% of what they see, and 90% of what they try. This is why we included a few interactive elements as well. The greatest inner interest is aroused by interactions, where the visitors' activity is provoked by the presentation response. At the exhibition *The Mysterious Death of Young Leonora* there are some elements of this kind,



do bolj preprostih, kot je prikaz zvočnega one-snaženja pod morjem.

Nekoliko nižjo notranjo motivacijsko moč imajo predstavitve, kjer je aktiven le obiskovalec ali je aktiven del razstave, obiskovalec pa to aktivnost le pasivno opazuje. Najpreprostejši primer takšne interakcije so ploščice, pod katerimi se skriva informacija, izvlečni panoji ali film, ki prikazuje pridobitev okostja.

Najnižjo notranjo motivacijsko moč imajo predstavitve, kjer obiskovalec pasivno opazuje razstavo, na kateri se nič ne dogaja. Takšen primer so panoji z besedili in slikami. Pomanjkanje notranje motivacijske moči je treba v teh primerih nadomestiti z ustreznim oblikovanjem in dobro interpretacijo, ki sledi procesu PRR.

Na vsaki razstavi so potrebni vsi trije načini komuniciranja z obiskovalcem, saj učenje poteka na različne načine in pri vsakem človeku nekoliko drugače (Roberts, 1997). Strokovnjaki priporočajo, da je 20 % interakcij, kjer sta aktivna razstava in obiskovalec, 60 % predstavitev, kjer je aktiven bodisi obiskovalec bodisi razstava, in 20 % predstavitev, kjer sta obiskovalec in razstava pasivna. To razmerje

from more complex ones, such as presentation of the quantity of food eaten by a Fin Whale in a single day, to more simple elements, such as depiction of noise pollution under the sea.

Somewhat lower inner power of motivation is asserted by the presentations, where only visitors are active, or where part of the exhibition is active, with visitors just passively observing this activity. The simplest example of such interaction are tablets under which information is hidden, pull-out panels, or film showing the skeleton acquisition.

The lowest inner power of motivation is asserted by the presentations where visitors passively observe the exhibition at which nothing is happening at all. Such are panels with texts and pictures. In such cases, the lack of inner motivation power is to be replaced with suitable design and solid interpretation, which follows the PRR process.

At every exhibition, all three manners of communicating with visitors are necessary, given that learning takes place in different ways and slightly differently in each individual (Roberts, 1997). Experts recommend 20% of interactions where exhibition and visitors



**Slika 125.** Preprosta akcija-reakcija: s pritiskom na gumb se oglasi podvodni hrup. Fotografija: Ciril Mlinar

**Figure 125.** A simple action-reaction: by pushing the button, underwater noise of ship engines is heard. Photo: Ciril Mlinar



**Slika 126.** Da bi prišli do informacije, se je treba malo potruditi. Fotografija: Ciril Mlinar

**Figure 126.** In order to get information, a little effort is needed. Photo: Ciril Mlinar

obiskovalcu omogoča, da se po aktivnem učenju ob interakcijah med pasivnim opazovanjem razstave mentalno nekoliko sprosti in vsebine sprejema na drug način (Veverka, 2001).

Ker se zavedamo, da obiskovalci informacije iz okolja sprejemajo z vsemi čuti, smo dodali zvočne učinke (oglašanje kita, podmorski hrup), tipne izkušnje (odlitki nekaterih kosti, obiskovalci pa so lahko uporabili celo voh (vonj posušeni rakcev, s katerimi se hranijo kiti).

are active, 60% of presentations where either exhibition or visitors are active, and 20% of presentations where visitors and exhibition are passive. This ratio enables visitors to mentally relax a little after the active learning along with interactions and passive observation of the exhibition and to adopt the presented themes in a different way (Veverka, 2001).

As we are aware that visitors receive information from the environment with all their senses, we supplemented the exhibition



**Slika 127.** Ob ogledu filma o pridobitvi okostja obiskovalec pasivno opazuje dogajanje na ekranu. Fotografija: Ciril Mlinar

**Figure 127.** While watching the film about the skeleton acquisition, visitors passively observe the events on the screen. Photo: Ciril Mlinar



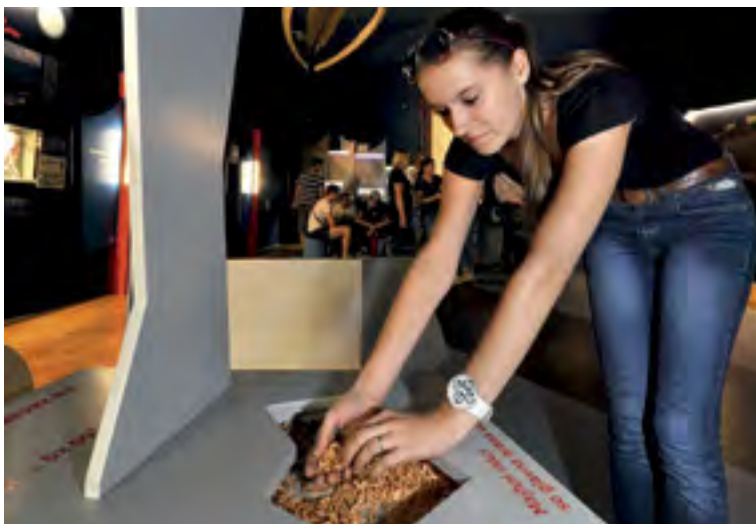
**Slika 128.** Panoji z besedili in slikami imajo najnižjo notranjo motivacijsko moč, zato je koristno, da obiskovalca pritegne provokativen naslov. Fotografija: Ciril Mlinar

**Figure 128.** Given that panels with texts and pictures have the lowest inner power of motivation, it is useful to attract visitors by a provocative title: Photo: Ciril Mlinar

Navadno govorimo o fizični dostopnosti, kadar želimo omogočiti dostopnost osebam s posebnimi potrebami, ob čemer pogosto pozabljam, da imajo »posebne« potrebe vsi obiskovalci. Fizična dostopnost ne pomeni le možnosti dostopa in gibanja po razstavnem prostoru, pač pa tudi fizično dostopnost vsebin. Da bodo obiskovalci sploh lahko vstopili v proces učenja, morajo besedila prebrati. Da bi jim to olajšali, mora biti vsebina predstavljena na ustrezni višini, pisava dovolj velika

with sound effects (whale sounds, underwater noise), tactile experience (casts of some bones) and even the possibility of visitors using their sense of smell (the smell of dried krill whales feed on).

When wishing to enable access to persons with special needs, we usually speak of physical access, but then we often forget that all visitors have some kind of »special« needs, too. Physical accessibility does not mean only possibility of access and shifting around



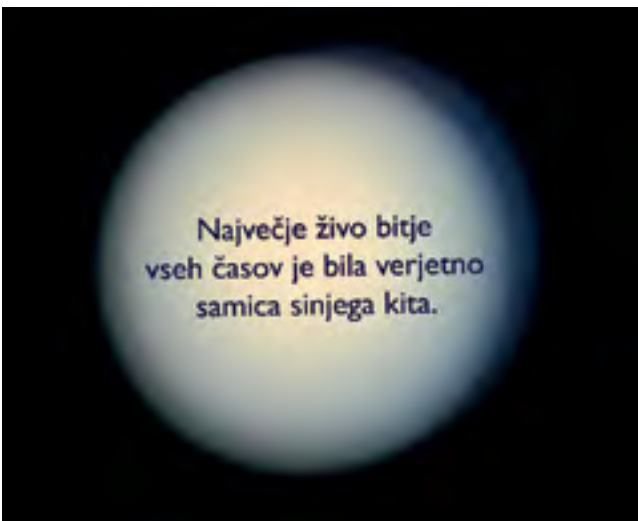
**Slika 129.** Drobi rakci, imenovani kril, so glavna hrana brazdastega kita. Obiskovalci so jih lahko prijeli in povohali. Fotografija: Ciril Mlinar

**Figure 129.** Krill are the Fin Whale's main food. Visitors were able to put their hands on them and smell them. Photo: Ciril Mlinar



**Slika 130.** Različna velikost pisave v naslovih, uvodnih v besedilih, ter besedilih ob slikah in fotografijah strukturira besedilo, a omogoča dobro berljivost tudi osebam s slabšim vidom. Fotografija: Ciril Mlinar

**Figure 130.** The different size of fonts of wording in titles, introductory texts as well as in figure and photo captions indeed structure the texts, but make it easier to be read by people with visual impairments as well. Photo: Ciril Mlinar



**Slika 131.** Za dobro berljivost je pomemben dober kontrast med barvo črk in podlago. Besedila v mehurčkih, ki so bila prvotno svetlo modra, smo spremenili v temno modra. Fotografija: Ciril Mlinar

**Figure 131.** For good readability, high contrast between the colour of letters and the background should be created. The wording in bubbles, which was originally very light, was changed into dark blue. Photo: Ciril Mlinar





**Slika 132.** Diskretna svetloba, ki jo oddaja niz svetilnih led-diod, osvetljuje vsebine na panojih, ne pa prostora, ki naj bi bil temačen, tako kot podmorski svet. Fotografija: Ciril Mlinar

**Figure 132.** Discrete light emitted by a series of diodes illuminates the topics presented on the panels and not the exhibition space, which should be dark, similarly as the underwater world. Photo: Ciril Mlinar



**Slika 133.** Vsebine, ki so nameščene pod nivojem pasu odraslega človeka, so pod pokrovi, ki jih mora obiskovalec odstraniti, da jih odkrije. Vrednotenje razstave bo pokazalo, v kolikšni meri smo bili uspešni pri prenosu teh informacij. Fotografija: Ciril Mlinar

**Figure 133.** The topics presented below the belt of an adult person are under round covers, which have to be shifted in order for the contents to be disclosed. Evaluation of the exhibition will show how successful we were in the transfer of these pieces of information. Photo: Ciril Mlinar



**Slika 134.** Strip *Skrivnostna smrt mlade Leonore*. Ljubezenska zgodba s primesmi kriminalke, ki temelji na resničnih dogodkih (z rahlo zavajajočo naslovnico) je slepim in slabovidnim na voljo tudi v brajlici. Zahvala za to gre predvsem Zavodu za slepo in slabovidno mladino in gospe Damijani Dušak.

**Figure 134.** Comic strip *The Mysterious Death of Young Leonora*. This love story with admixture of a thriller, which is based on true events (with slightly misleading title), is available to the blind and partially sighted in Braille language as well. Thanks for this are due to the Institute for the Blind and Partially Sighted Children and the teacher Damijana Dušak.

in osvetljenost primerna (npr. Serrell, 1996). Mnogi snovalci razstav v želji predstaviti čim več vsebin zanemarijo zlato pravilo »Manj je več!«. Zato pripravijo preveč gradiva, ki ga je na vedno omejen prostor mogoče umestiti le na račun velikosti pisave in slik. Takšna razstava

the exhibition room, but physical access to the topics as well. If visitors are to enter the learning process at all, they are compelled to read the texts. To make this easier for them, a topic must be presented at a suitable height, with big enough and adequately illuminated text (e.g. Serrell, 1996). In their wish to present as many themes as possible, many experts simply ignore the rule »Less is more!« Thus they usually prepare too much material, which can be placed in permanently limited space only on the account of the size of letters and pictures. Such exhibition turns out overcrowded, which is highly unpleasant, with visitors avoiding reading the unsuitably illuminated texts written with small fonts, while small pictures do not attract any attention and remain unnoticed. Everything that is presented too low (below the belt), or too high, will attract very little attention.

When designing the exhibition, we attempted to limit ourselves, already in the context of topic unity, by taking into consideration the quantity of presented topics. Notwithstanding, there was much material piled up, and in cooperation with our exhibition designer we began to search for solutions that would not adversely affect the exhibition accessibility. The texts are therefore written with suitably large fonts in view of the anticipated reader's distance and text structure. In the dusky place they are illuminated with beams of rays. If necessary, however, the illumination of the entire place can be increased, e.g. when school groups need more light in order to solve their worksheets. The topics that had to be presented outside the area of the visitors' greatest attention (below the belt) are displayed mainly with pictorial material or with presentations that provide greater inner motivation power.

As far as persons with special needs are concerned, we attempted to bring the content nearer to them with the aid of audio guides (for the blind and visually impaired) and subtitles on all audio-visual presentations. We were extremely pleased to hear about the initiative by the Institute for the Blind and Partially Sighted Children to have the comic strip *The*

je prenatrpana, kar deluje odbijajoče, obiskovalci se izogibajo branju drobno napisanih in neustrezno osvetljenih besedil, majhne slike pa ne pritegnejo pozornosti in ostanejo neopazene. Vse kar je predstavljeno prenizko (pod višino pasu) ali previsoko, bo deležno le malo pozornosti.

Pri snovanju razstave o Leonori smo se že v kontekstu enovitosti teme skušali omejiti glede količine predstavljenih vsebin. Gradiva je bilo kljub vsemu precej. Zato smo v sodelovanju z oblikovalko razstave iskali rešitve, ki ne krnijo dostopnosti razstave. Besedila so tako napisana z ustrežno veliko pisavo glede na predvideno oddaljenost bralca in strukturo besedila. Kljub temačnosti prostora so usmerjeno osvetljena, po potrebi pa osvetljenost celotnega prostora lahko povečamo, npr. kadar šolske skupine za reševanju učnih listov potrebujejo več svetlobe. Vsebine, ki smo jih morali predstaviti zunaj območja največje pozornosti obiskovalcev, so predstavljene predvsem s slikovnim gradivom ali s predstavitvami, ki imajo večjo notranjo motivacijsko moč.

Osebam s posebnimi potrebami smo skušali vsebine približati s pomočjo zvočnih vodnikov (za slepe in slabovidne) ter podnapisi na vseh avdio-vizualnih predstavitvah. Izjemno nas je razveselila pobuda Zavoda za slepo in slabovidno mladino, ki je v okviru izobraževanja mladih predlagala prevod stripa *Skrivnostna smrt mlade Leonore*. Ljubezenska zgodba s primesmi kriminalke, ki temelji na resničnih dogodkih (z rahlo zavajajočo naslovnico) v brajlico. Prirodoslovni muzej Slovenije in avtorji stripa so v ta namen z veseljem dovolili uporabo gradiva in tisk stripa v brajlici. Otroci so tako spoznavali Leonoro in se ob tem učili tudi branja in pisanja v brajlici. Zavod za slepo in slabovidno mladino je strip, prilagojen slepim, natisnil v dveh izvodih, od katerih je enega podaril Prirodoslovnemu muzeju Slovenije. Varovanci zavoda so v času trajanja razstave prebirali tudi zgodbe Leonora pripoveduje, ki so bile ob delavnicah za otroke vsak mesec objavljene na spletu. Dogovorjeno je, da bomo v sodelovanju z njimi v brajlici natisnili tudi teh deset zgodb.

*Mysterious Death of Young Leonora*” translated, within the children’s education framework, into Braille language. The Slovenian Museum of Natural History and the authors were pleased to allow the material of this publication to be freely used for this purpose. In this way, children were able to get acquainted with Leonora as well as to learn to read and write in Braille. The Institute for the Blind and Partially Sighted Children printed the comic strip, adapted for the blind, in two copies and donated one of them to the Slovenian Museum of Natural History. During the exhibition, the Institute’s protégés also read the stories Leonora Narrates published every month on the Internet. It has also been agreed that we shall print, in cooperation with them, these ten stories in Braille.

## Razmerje med elektronskimi in mehanskimi predstavitvami

Sodobna elektronska tehnologija ponuja veliko novih možnosti za predstavitev vsebin na muzejskih razstavah. Predvsem mlajši obiskovalci si na razstavah želijo in tudi pričakujejo posredovanje informacij prek računalnikov, avdio-vizualnih naprav, telefonov... Vendar imajo elektronske naprave kar nekaj slabosti. V slovenskih muzejih, kjer proračuni razstav ne dosegajo niti desetine zneskov podobnih razstav v tujini, ni zanemarljivo, da so sodobne elektronske naprave razmeroma drage. Zahtevno je tudi njihovo vzdrževanje, saj se ob množični uporabi pogosto kvarijo. Popravilo je zamudno, za kar lahko navadno poskrbi le serviser, kar ni poceni. Medtem

## Balance between electronic and mechanical presentations

Modern electronic technology offers a number of new possibilities for the presentation of topics displayed at museum exhibitions, where younger visitors in particular wish for and expect to receive information via computers, audio-visual appliances, telephones ... Electronic devices of this kind, however, have a number of impediments. In Slovenian museums, where exhibition budgets do not reach even one tenth of the amounts of similar exhibitions abroad, it is not negligible that modern electronic appliances are relatively expensive and therefore not easily accessible at all. Their maintenance is demanding, too, considering the fact that they often break



**Slika 135.** Preprosta računalniška animacija predstavi selitve kitov na preprost, hitro dojemljiv način. Fotografija: Ciril Mlinar

**Figure 135.** A simple computer animation presents migration of whales in a simplified and quickly comprehensive manner. Photo: Ciril Mlinar



predstavitev na razstavi ne deluje, kar pri obiskovalcih pušča zelo slab vtis in povzroča nejevoljo.

Predvsem pri mladih obiskovalcih je notranja motivacijska moč elektronskih naprav precejšnja, kar je dobro izkoristiti. Vendar če z njimi pretiravamo, druge predstavitve ostanejo neopazene in tako je možnost za različne načine učenja zamujena. Ob odločitvi med elektronsko ali mehanično predstavitvijo pa moramo upoštevati tudi cilj predstavitve – nekatere vsebine je primerneje ali lažje prikazati z elektronsko napravo, druge pa z mehanskimi interakcijami.

Na razstavi »Skrivnostna smrt mlade Leonore« smo skušali zagotoviti pravo razmerje med elektronskimi in mehanskimi interakcijami, pri čemer smo bili omejeni tudi z razpoložljivimi finančnimi sredstvi. Veliki ekran, ki smo ga kupili že pred leti,

down owing to their widespread use. Their repair is time-consuming and can usually be carried out only by experts, which is of course not cheap. While in the process of repair, the presentation is at a standstill, which leaves a very bad impression and causes frustration at the same time.

The inner motivation power of electronic devices is great especially as far as young visitors are concerned, which should be put to good use, of course. If used too often, however, other presentations remain unnoticed, which means that the possibility of a different manner of learning is missed. When choosing between electronic and mechanical presentations, the exhibition's objective must thus be taken into account – some topics are easier and more appropriately presented with electronic devices, others through mechanical interactions.



**Slika 136.** Poučna računalniška igrca s prof. dr. Florjanom Umkom je vedno deležna veliko pozornosti. Fotografija: Ciril Mlinar

**Figure 136.** The instructive computer game with Professor Umek always attracts much attention among junior visitors. Photo: Ciril Mlinar

smo uporabili za predstavitev dveh filmov. V enominutnem intervjuju strokovnjak, prof. dr. Boris Kryštufek, predstavi dogajanje takoj po odkritju trupla, kar je bilo ključnega pomena za pridobitev našega največjega eksponata, drugi prikazuje celoten postopek pridobitve okostja. Ker je nekoliko daljši (4 min.), smo pred ekran postavili tabureje, da si ga lahko obiskovalci ogledajo sede. Otroci se lahko poigrajo s prof. dr. Florjanom Umkom, ki jih ob poučni računalniški igrici nauči nekaj dejstev o kitih in Leonori. Tudi za predstavitev selitve kitov je bila interaktivna računalniška animacija najboljša rešitev, saj le s preprostim pritiskom na ekran nazorno pokaže, kar bi bilo z besedami težko opisati na kratko in razumljivo.

## Oblikovanje razstave

Večina ameriških strokovnjakov na področju interpretacije poudarja, da ima dostopnost vsebin prednost pred obliko, zato grafičnemu oblikovanju in oblikovanju prostora ne posvečajo veliko pozornosti (Ham, 1992; Veverka, 1996). V Evropi je estetski videz razstave še vedno zelo pomemben, zato muzeji v vse večje projekte vključijo tudi oblikovalca. Žal se je v preteklosti pogosto dogajalo, da oblikovalci muzejskih razstav, večinoma arhitekti, pogosto niso poznali ne osnov interpretacije ne potreb in zahtev obiskovalcev. Danes v Sloveniji deluje nekaj arhitektov, ki so specializirani tudi na tem področju, vendar je zagotavljanje dostopnosti vsebin razstave kljub vsemu naloga in odgovornost muzejskih delavcev. Vendar vloge dobrega oblikovalca ne gre zanemariti. Znano je namreč, da obiskovalci razstavo dojemajo z vsemi čuti, tudi intuitivno. Ustvarjanje pravega

At the exhibition *The Mysterious Death of Young Leonora* we did our best to choose the proper balance between electronic and mechanical interactions, although we were limited by the available funds. The large screen, purchased a few years earlier, was used for the presentation of two films. In a minute long interview, head of the Vertebrate Department presents the events taking place immediately after the carcass's discovery, which was of key importance for the acquisition of our largest exhibit, while the second film presents the entire procedure of the skeleton acquisition. As the latter is somewhat longer (4 minutes), ottomans were placed in front of the screen to enable the visitors to watch it sitting down. Children can »play« with Florjan Umek, who tells them, through an instructive computer game, a few facts about Leonora and whales in general. An interactive computer animation was the best solution for the presentation of whale migration, since it clearly shows, simply by touching the screen, everything that would be difficult to describe with words in a short and intelligible way.

## The exhibition design

The majority of American interpretation experts underline that the accessibility of topics takes precedence over form, which is the reason why they devote very little attention to graphic and space design (Ham, 1992; Veverka, 1996). As the aesthetic appearance is still very important in Europe, museums include designers into the increasingly large projects as well. In the past, unfortunately, museum exhibition designers, predominantly architects, were frequently acquainted neither with the basics of interpretation nor with the visitors' needs and requirements. Although several architects with museum interpretation skills are present on the Slovenian market, the accessibility of exhibition topics is still the task and responsibility of museum employees. On the other hand, the role of good designers should not be neglected either, for it is well known that visitors

ozračja v prostoru je zato lahko bistvenega pomena za komuniciranje sporočila.

Tudi pri načrtovanju razstave »Skrivnostna smrt mlade Leonore« je bilo pogosto treba iskati kompromis med estetsko sprejemljivimi rešitvami in zahtevami muzejske projektne skupine. Kljub temu je profesionalno

comprehend exhibition with all senses, as well as intuitively. Creation of appropriate atmosphere in the exhibition hall can therefore be of key significance for message communication.

During the exhibition planning, a compromise had to be found between aesthetically acceptable solutions on the one hand, and



**Slika 137.** Odlična oblikovalska rešitev: izvlečne fotografije na panojih v obliki valov so omogočile prihranek prostora in hkrati obiskovalca spodbudile, da je dejavno iskal informacije. Fotografija: Ciril Mlinar

**Figure 137.** A design solution: the pull-out photos on the panels in the form of waves enabled space-saving and stimulated the visitors at the same time to actively look for information. Photo: Ciril Mlinar



**Slika 138.** Celotno oblikovanje razstave je zasnovano tako, da bi obiskovalec dobil občutek, da je pod morsko gladino. Fotografija: Ciril Mlinar

**Figure 138.** The entire design of the exhibition is conceived in a manner that the visitor gets the feeling as if hovering under the sea surface. Photo: Ciril Mlinar

oblikovanje razstave bistveno prispevalo k učinkovitosti interpretacije. Temna modrina prostora, ki proti stropu prehaja v svetlejši tone, ustvarja občutek, da vstopamo v podvodni svet. Migotanje morske gladina na stropu ta občutek še podkrepi. V daljavi je slišati oglašanje brazdastega kita. Nekje nad obiskovalci lebdi okostje Leonore. Nevpadljiva svetloba zadošča za branje besedil, vendar ohranja podmorsko ozračje. Panoji, ki spominjajo na obliko rib, kitov, čeri in valov, ga estetsko podpirajo. Občutje, ki prevzame obiskovalca, ko stopi v razstavni prostor, je tako skladno z naslovom, temo in konceptom razstave, zato je prenos sporočila razstave bolj učinkovit. Vloga oblikovalke je bila neprecenljiva tudi pri iskanju rešitev, kako čim boljje izkoristiti prostor, ter pri načrtovanju in izvedbi različnih interaktivnih predstavitev in pri sami izvedbi razstave.

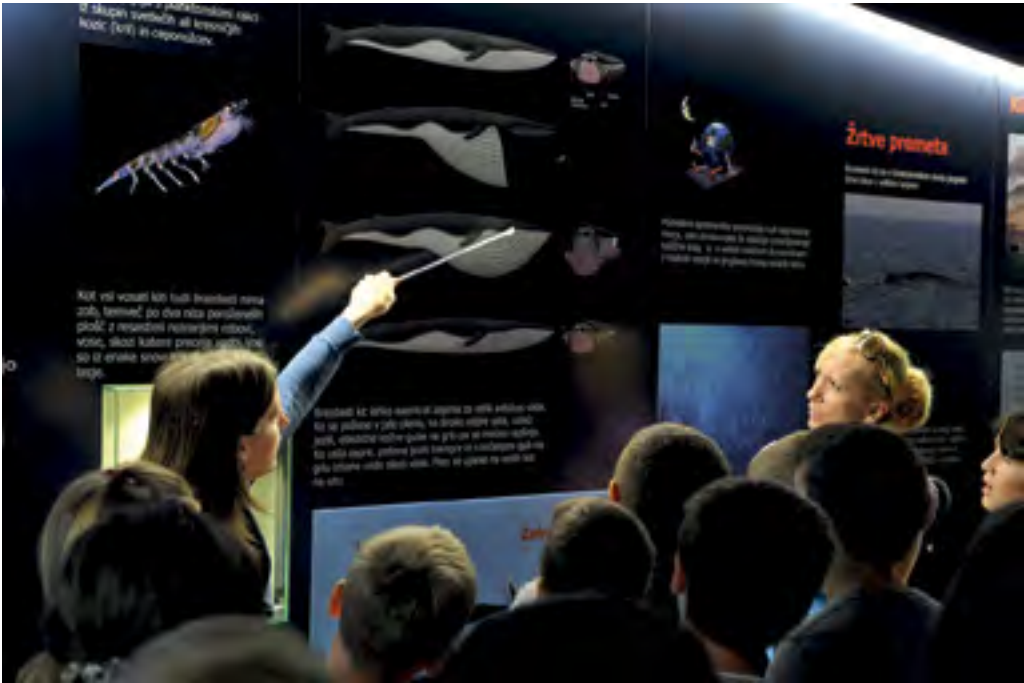


**Slika 139.** Učna ura z delovnimi listi.  
Fotografija: Ciril Mlinar

**Figure 139.** Lesson with worksheets.  
Photo: Ciril Mlinar

demands of the museum project group on the other. Nonetheless, the professional design of the exhibition greatly contributed to the interpretation's effectiveness. The dark blue colour of the exhibition hall that gradually transforms into lighter shades towards the ceiling creates the sensation of entering the underwater world. The flickering of the sea surface on the ceiling further substantiates this sensation. In the distance, the Fin Whale's calls are heard. Somewhere above the visitors, Leonora's skeleton is hovering. The inconspicuous light suffices for the reading of texts, but retains the underwater atmosphere. The panels that remind us of the shape of fishes, whales, rocks and waves aesthetically support the skeleton. The feeling that seizes the visitors when entering the exhibition hall is thus fully consistent with the exhibition title, theme and concept, which makes the transfer of the message even more effective. The designer's role was invaluable also in the search for the solution of how to exploit the space in the best possible way, as well as in the planning and implementation of various interactive presentations and in the implementation of the exhibition itself.





Slika 140. Strokovno vodstvo po razstavi je prilagojeno starosti otrok. Fotografija: Ciril Mlinar

Figure 140. Guidance at the exhibition is adapted to the children's age. Photo: Ciril Mlinar

## Spremljajoči programi in publikacije

Več kot polovico obiskovalcev Prirodoslovnega muzeja Slovenije običajno sestavljajo otroci, ki muzej obiščejo v organiziranih skupinah vrtcev, osnovnih in srednjih šol. Ob razstavi »Skrivnostna smrt mlade Leonore« smo jim ponudili strokovna vodstva ali učne ure z delovnimi listi, prilagojene starosti obiskovalcev. Za skupine vrtcev smo pripravili tudi različne delavnice.

V ciklu delavnic za otroke z naslovom Leonora pripoveduje smo vsako drugo soboto (razen med poletnimi počitnicami) skozi zgodbi otrokom predstavili različne vsebine o brazdastih kitih in drugih morskih prebivalcih. Ob vsaki zgodbi so otroci ustvarjali na različne načine: iz nogavic so izdelovali mehke igračke, ki so ponazarjale brazdastega kita, pripravili so

## Accompanying programmes and publications

More than half of visitors in the Slovenian Museum of Natural History are children and the young who visit the Museum within groups organised by kindergartens, primary schools and secondary schools. During the exhibition *The Mysterious Death of Young Leonora*, we offered them professional guidance or lessons with worksheets adapted to the visitors' age. For kindergarten groups, various workshops were also prepared.

Within the cycle of children's workshops, entitled *Leonora Narrates*, we presented to the youngsters – every second Saturday (except during the summer holidays) – various topics concerning Fin Whales and other marine inhabitants. During each of the stories, children were creative in different ways: they made soft



**Slika 141.** Na delavnicah so se otroci zabavali, ustvarjali in se učili. Fotografija: Ciril Mlinar

**Figure 141.** At workshops, children create, learn and have fun. Photo: Ciril Mlinar

dišeča mila iz naravnih sestavin z upodobljenim delfinom, izdelali so vsak svojo morsko diorama, izdelovali so origamije morskih prebivalcev, upodobili razlitje nafte z likovno tehniko praskanka itd. Otroci, ki so obiskali pet delavnic, so prejeli priznanje in drobno darilce. Delavnice so bile zelo dobro obiskane, večkrat so bile celo razprodane več dni vnaprej. Zgodbice smo sproti objavljali na muzejskih spletnih straneh in ob tem pozvali obiskovalce in druge otroke, da jih upodobijo ter sodelujejo na likovnem natečaju. Na začetku leta 2013 bodo najboljši izdelki nagrajeni in predstavljeni na priložnostni razstavi v muzeju.

Za odrasle obiskovalce smo pripravili cikel predavanj, ki so potekala vsak drugi četrtek v mesecu, razen med poletnimi počitnicami. Predavali so ugledni slovenski strokovnjaki, ki so obiskovalcem predstavili pridobitev okostja, brazdastega kita kot živalsko vrsto, druge kite,

toys representing Fin Whale from old stockings, scented soaps in the shape of dolphins from natural ingredients, visited dioramas and origamis of marine creatures, portrayed oil spill in scratchboard technique, etc. The children who visited five workshops received a special recognition and a small present. The workshops were well attended (usually sold out several days in advance). The stories were simultaneously published on the Museum's website, summoning the visitors and other children to make drawings for them and to take part at the envisaged art contest. In the beginning of 2013, the best works will be awarded and put on a special display in the Museum.

For adult visitors, we prepared a cycle of lectures that took place every second Thursday in the month, throughout the year except for summer holidays. The lecturers were renowned national experts, who presented to



**Slika 142.** Na razstavi »Nazaj v morje« smo obravnavali tudi kite. Fotografija: Ciril Mlinar

**Figure 142.** At the exhibition *Back to the Sea*, whales were also dealt with. Photo: Ciril Mlinar

visitors the acquisition of the whale skeleton, the Fin Whale itself as an animal species, other whales straying into the Adriatic, the issues surrounding the captivity of dolphins, the impacts of global warming on marine life, and other interesting themes. Admission was free. In agreement with Videolectures, all presentations were recorded and are publicly accessible at <http://videolectures.net/pms/>

Twice a month as well as every first Sunday in the month, when admission to the Museum is free, visitors were invited to a guided tour through the exhibition.

During the exhibition, audio guides in the Slovenian and English languages were also prepared; they were intended for domestic visitors, persons with special needs, and foreign tourists, as all texts at the exhibition are written only in the Slovenian language.

Throughout the academic year during the exhibition *The Mysterious Death of Young Leonora*, the pensioners attending the course



**Slika 143.** Katalog razstave za zahtevnejše obiskovalce in strip za najstnike. Fotografija: Ciril Mlinar

**Figure 143.** The exhibition catalogue for more demanding visitors and comic strip for teenagers. Photo: Ciril Mlinar .



ki zahajajo v Jadran, problematiko ujetništva delfinov, vpliv globalnega segrevanja na življenje v morju in še druge zanimive vsebine. Vstop je bil brezplačen. V dogovoru z Videolectures so bila vsa predavanja posneta in javno dostopna na njihovi spletni strani <http://videolectures.net/pms/>

Dvakrat mesečno, med drugim tudi vsako prvo nedeljo v mesecu, ko je vstop v muzej prost, smo obiskovalce povabili na javno vodstvo po razstavi.

Ob razstavi smo pripravili tudi zvočne vodnike v slovenskem in angleškem jeziku, namenjene domačim obiskovalcem, osebam s posebnimi potrebami, kot tudi tujim turistom, saj so vsa besedila na razstavi le v slovenskem jeziku.

Tudi slušatelji študijskega krožka Narava – znana neznanka so ob razstavi »Skrivnostna smrt mlade Leonore« pod mentorstvom muzejske uslužbenke vse študijsko leto spoznavali kite in druga morska bitja. Rezultat njihovega dela je bila občasna razstava »Nazaj v morje«, na kateri so predstavili nekatere nekdanje kopenske vretenčarje, ki so se ponovno prilagodili življenju v morju.

Ker se zavedamo, da na razstavi lahko učinkovito predstavimo le omejeno količino informacij, smo za zahtevnejše obiskovalce pripravili katalog, ki poglobljeno obravnava vsebine, ki so na razstavi le bežno predstavljene. V miru in udobju domačega naslanjača lahko tako obiskovalec izve še veliko več o kitih, njihovi ogroženosti, evoluciji, kitih v severnem Jadranu, načinu pridobitve in prepariranja okostja ter kitih v zbirki Prirodoslovnega muzeja Slovenije.

Najstnikom je namenjen strip z enakim naslovom, kot ga nosi razstava, in podnaslovom: Ljubezenska zgodba s primesmi kriminalke, ki temelji na resničnih dogodkih (z rahlo zavajajočo naslovnico). Na humoren način, včasih malo romantično, drugič napeto, bralcu predstavi vsa najpomembnejša dejstva, ki jih obravnava tudi razstava.

Tako smo z različnimi pristopi in ob uporabi različnih žanrov vsebino razstave približali najširši publiki, od otrok v vrtcu do upokojenec ter tudi tujim turistom.

*Nature – the Known Unknown* were getting acquainted with whales and other marine beings under the mentorship of the museum employee. The result of their work was an occasional exhibition *Back to the Sea*, at which some former land vertebrates that adapted to marine life once more were presented.

As we are well aware that only a limited amount of information can be effectively presented at the exhibition, a catalogue was prepared for more demanding visitors with in-depth description of the topics only briefly presented at the exhibition. In the peace and comfort of armchair at home, the visitors can thus learn much more about whales, their threat status, evolution, whales occurring in the Adriatic Sea, manner of acquisition and preparation of the skeleton, and whales kept in the collection of the Slovenian Museum of Natural History.

For teenagers, the comic strip carrying the same name as the exhibition and the subtitle *Love story with admixture of a thriller, which is based on true events (with slightly misleading title)* is intended. In a humorous way, at times slightly romantically, then again thrillingly, it presents to the reader the most important facts dealt with at the exhibition.

With various approaches and use of different genres, the exhibition topics were thus brought nearer to the widest audience, from kindergarten children to retired people and foreign tourists.

## Promocija

Prirodoslovni muzej Slovenije ima za promocijo svoje dejavnosti na voljo zelo omejena finančna sredstva. Za promocijo razstave smo zato uporabili predvsem brezplačne možnosti, kot je brezplačno oglaševanje v različnih tiskanih medijih, odziv medijev na tiskovno konferenco in poslano jim gradivo, brezplačno spletno oglaševanje, elektronska pošta in podobno. Največji strošek promocije je bila izdelava velikega plakata na pročelju muzejske hiše. V promocijske namene smo izdelali tudi plakat, razglednico in kazalko za knjigo.

Razstava je bila deležna precejšnje medijske pozornosti, tako na radiu in televiziji kot v tiskanih medijih. Avtorji razstave so bili na Valu 202 Radia Slovenija celo nominirani za ime tedna.

Za promocijo smo poskrbeli tudi s spremljajočimi programi, ki smo jih brezplačno oglaševali v radijskih oddajah, tiskanih medijih, napovednikih v muzejski hiši in z vabili, poslanimi prek elektronske pošte.

Ponovno smo ugotovili, da je v Sloveniji najboljša promocija »dober glas, ki seže v deveto vas«.

## Promotion

The Slovenian Museum of Natural History has very limited funds available for the promotion of its activities. For the exhibition promotion, mostly unpayable options were therefore used, such as free advertising in various print media, media's response to the press conference and material sent to them, free Internet advertising, e-mail, etc. The highest cost of the exhibition promotion was accounted for the production of the large poster displayed on the facade of the Museum building. For promotion purposes, a postcard, poster and bookmark were also made.

The exhibition received much attention of the media – radio, TV and press. The authors of the exhibition were nominated for »The Name of the Week« on the national Radio Slovenia's Val 202 programme.

The exhibition was further promoted with accompanying programmes freely advertised in radio broadcasts, print media, trailers in the Museum building, and invitations sent via e-mail.

We could ascertain once more that the best promotion is »Good reputation can reach the 9th village«, as the saying goes in Slovenian.



**Slika 144.** Vabilo na razstavo je povablencem prineslo trajen spomin – iz vezane plošče izrezljano okostje kita.

**Figure 144.** Invitation to the exhibition brought a lasting memory to our guests – whale skeleton made of plywood.



Slika 146. Plakat prikazuje vrste kitov, ki so bili doslej zabeleženi v Jadranu.

Figure 146. The poster depicts the species of whales so far recorded in the Adriatic Sea.



Slika 145. Oblikovalka razstave je poskrbela za celotno podobo celotnega projekta. Fotografija: Ciril Mlinar

Figure 145. The exhibition designer took care of the entire project's corporate identity. Photo: Ciril Mlinar.



**Slika 148.** Otroci so ob obisku delavnic iz cikla Leonora pripoveduje prejeli štampiljko. Pet štampiljk jim je prineslo priznanje in nagrado. Ta tržni prijem se je izkazal kot izjemno učinkovit, saj so bile delavnice skorajda vedno razprodane. Fotografija: Ciril Mlinar

**Figure 148.** Children visiting workshops organized within the Leonora Narrates cycle received a stamp for each attendance. Five stamps brought them a recognition and award. This marketing approach turned out to be highly effective, given that workshops were almost always sold out. Photo: Ciril Mlinar.



**Slika 147.** Leonoro so predstavili med drugim tudi v Slovenskih novicah. Fotografija: Ciril Mlinar

**Figure 147.** Leonora was also presented in press. Above is a clip from the Slovenske novice daily. Photo: Ciril Mlinar.

## Vrednotenje

V Prirodoslovnem muzeju Slovenije kontinuirano vrednotimo svoje delo z obiskovalci. Redno beležimo število in strukturo obiskovalcev, občasno pa preverjamo tudi njihovo splošno mnenje o muzeju, razstavah in programih ter njihova pričakovanja. Ob večjih razstavah ugotavljamo, v kolikšni meri smo izpolnili cilje, ki smo si jih zastavili ob načrtovanju.

Razstava »Skrivnostna smrt mlade Leonore« je bila v enem letu, odkar je na ogled (od začetka oktobra 2011 do konca septembra 2012), dobro obiskana. V tem obdobju smo zabeležili 31.858 obiskovalcev, kar je glede na povprečje zadnjega desetletja (2001 do 2010: povprečno 22.250 obiskovalcev letno) dober rezultat. Tudi če primerjamo število obiskovalcev v letu 2011, ko je bila razstava o Leonori na ogled le zadnje tri mesece in pol (30.521), z letom pred tem (26.239), smo lahko zadovoljni z obiskom.

## Evaluation

The Slovenian Museum of Natural History continually evaluates its relations with visitors. We regularly record the number and structure of visitors and occasionally ascertain their general opinion about the Museum, exhibitions and programmes, as well as their expectations. After major exhibitions, we attempt to assess to what extent the planned objectives have been fulfilled.

In a year while on display (from early October 2011 to the end of September 2012), the exhibition about Leonora was well attended. In this period, 31,858 visitors were recorded, which is highly above the average for the last decade (2001 to 2010: 22,250 visitors per year on average). Also in 2011, when the exhibition was on display only for the last three months and a half, we recorded more visitors (30,521) than in 2010 (26,239).

**Tabela 2.** Pregled števila obiskovalcev različnih demografskih skupin, ki so obiskali razstavo »Skrivnostna smrt mlade Leonore« v obdobju enega leta (oktober 2011 – september 2012).

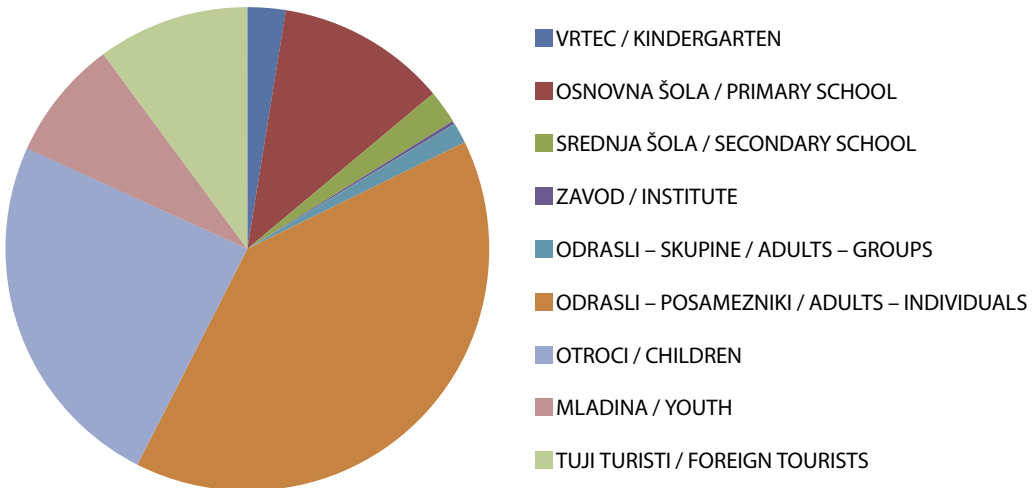
**Table 2.** Number of visitors according to demographic group in the period of one year (October 2011 – September 2012).

MESEC	VRTEC	OSNOVNA ŠOLA	SREDNJA ŠOLA	ZAVOD	ODRASLI - PO-SAMEZNIKI	ODRASLI - SKUPINE	MLADINA	OTROCI	TUJI TURISTI	SKUPAJ	OD TEGA DRUŽIN
oktober 2011	94	268	82	13	1059	32	185	644	249	<b>2626</b>	324
november 2011	110	327	0	8	556	60	82	440	123	<b>1706</b>	253
december 2011	16	415	27	5	1606	21	461	1062	198	<b>3811</b>	479
januar 2012	60	228	201	0	391	93	68	264	70	<b>1375</b>	147
februar 2012	40	519	39	0	3587	29	998	1956	205	<b>7373</b>	1022
marec 2012	120	411	31	38	1036	39	112	350	135	<b>2272</b>	183
april 2012	221	255	49	0	706	61	35	390	243	<b>1960</b>	230
maj 2012	75	393	197	0	799	102	176	381	276	<b>2399</b>	199
junij 2012	53	447	67	0	1735	6	294	873	338	<b>3813</b>	739
julij 2012	7	0	0	8	408	0	41	701	398	<b>1563</b>	207
avgust 2012	0	0	0	0	352	0	79	447	630	<b>1508</b>	230
september 2012	15	359	13	0	431	0	31	237	366	<b>1452</b>	160
<b>SKUPAJ</b>	<b>811</b>	<b>3622</b>	<b>706</b>	<b>72</b>	<b>12666</b>	<b>443</b>	<b>2562</b>	<b>7745</b>	<b>3231</b>	<b>31858</b>	<b>4173</b>

V kategoriji »zavod« je zajeto število obiskovalcev iz različnih ustanov za osebe s posebnimi potrebami, domov za starejše ipd.

Razstavo si je ogledalo 18 % obiskovalcev v organiziranih skupinah (vrtni, šole, zavodi, organizirane skupine odraslih), 82 % je bilo individualnih obiskovalcev. Največji obisk slednjih smo zabeležili v mesecih, ko muzej v okviru različnih promocijskih akcij ponuja prost vstop (Ta veseli dan kulture - 3. december; slovenski kulturni praznik Prešernov dan - 8. februar in Poletna muzejska noč - druga sobota v juniju). V počitniških mesecih, ko beležimo izpad organiziranih skupin izobraževalnih organizacij, so znaten delež obiskovalcev sestavljali tuji turisti in otroci, ki so se udeležili poletnih naravoslovnih delavnic. Julija so prevladovali otroci (45 % vseh obiskovalcev), avgusta pa tuji turisti (41 % vseh obiskovalcev). Delež odraslih obiskovalcev je bil v tem času približno enak (julij 26 %, avgust 23 %). To ni naključje, temveč rezultat premišljene programske politike, ki temelji na večletnem vrednotenju potreb naših potencialnih obiskovalcev in si prizadeva za maksimalno izkoriščanje potencialnih kapacitet.

Of all visitors, 18% were in organised groups (kindergartens, schools, institutes, organised groups of adults), and the remaining 82% were individual visitors. The highest attendance by the latter was recorded in the months when the Museum offers free admission within the framework of different promotional campaigns (This Merry Day of Culture – December 3rd; Slovenian Cultural Holiday Prešeren Day – February 8th; and Museum Night – second Saturday in June). During the summer holiday months, when no organized groups from various educational organisations visit the Museum, a significant proportion of visitors went on the account of foreign tourists and children who took part at the summer natural history workshops. In July 2012, children prevailed (45% of all visitors), while in August foreign tourists were prevalent (41% of all visitors). The share of adult visitors at this time was approximately the same (26% in July, 23% in August). We assume this is no coincidence but a result of a well considered programme policy, which is based on long-lasting evaluation of the potential visitors' needs and strives towards maximum exploitation of our capacities.



**Slika 149.** Deleži različnih demografskih skupin obiskovalcev, ki so razstavo »Skrivnostna smrt mlade Leonore« obiskali od začetka oktobra 2011 do konca septembra 2012.

**Figure 149.** Pie diagram of demographic groups of visitors to the exhibition The Mysterious Death of Young Leonora, from early October 2011 to the beginning of September 2012.





**Slika 150.** Opazovanje obiskovalcev na razstavi mora biti diskretno, ob vstopu pa morajo biti obiskovalci opozorjeni, da na razstavi poteka vrednotenje in zakaj je to potrebno. Fotografija: Ciril Mlinar

**Figure 150.** Monitoring of the visitors must be discreet, but when entering the exhibition they must be told that evaluation is taking place at the exhibition and why this is necessary. Photo: Ciril Mlinar



**Slika 151.** Valvasorjeva nagrada, ki so jo prejeli vodja razstavnega projekta in kustosi razstave, je na razstavi na ogled obiskovalcem. Fotografija: Ciril Mlinar

**Figure 151.** The Valvasor Award, received by the head of exhibition project and exhibition curators, is on display to the museum visitors.

Z metodo opazovanja in anketiranjem bomo ovrednotili doseganje ciljev razstave. V času priprave tega prispevka smo šele začeli zbirati podatke, saj smo morali dinamiko naših dejavnosti ob razstavi, zaradi mnogih nalog, ki smo si jih zadali, razporediti skozi celotno obdobje, ko bo razstava odprta. Kljub temu bomo z vrednotenjem zajeli več kot eno leto in tako preverili doseganje ciljev pod različnimi pogoji. Po koncu razstave bomo podatke statistično obdelali in vsebinsko ovrednotili ter jih objavili v strokovni literaturi. Ob tej priložnosti zato predstavljamo le metodologijo in navajamo nekatere preliminarne ugotovitve.

Z metodo opazovanja bomo ugotovili, kako naključno izbrani obiskovalci uporabljajo razstavo. Zanima nas, kako se obiskovalci gibljejo po razstavi, katere predstavitve jih najbolj pritegnejo, katere interaktivne predstavitve preizkusijo, koliko časa se zadržijo pri posamezni predstavitvi itd. V ta namen smo izdelali obrazec s tlorisom razstave, na katerem opazovalci označijo pot obiskovalca, beležijo njegove različne dejavnosti in čas, ki jim ga nameni. V splošnem lahko že v tej fazi ugotovimo, da so po pričakovanjih največ pozornosti, predvsem mlajših obiskovalcev, deležne interaktivne predstavitve, določena besedila pa so bila pogosto povsem pregledana.

Z anketiranjem naključno izbranih posameznikov bomo ugotovili, ali so obiskovalci sprejeli sporočilo, ki smo ga želeli prenesti, ali so besedila razumljiva, kaj so se obiskovalci naučili, kakšno sled je pustila razstava v njihovem čustvovanju, in kako bo razstava vplivala na njihovo ravnanje. Anketa je sestavljena na osnovi ciljev, ki smo jih zastavili že v fazi načrtovanja razstave, kar močno olajša vrednotenje. Anketa beleži tudi želje in potrebe obiskovalcev, kar je v veliko pomoč pri načrtovanju nadaljnjih razstav in programov.

Razstavo bomo vrednotili ob različnih priložnostih. Zanima nas, ali obiskovalci drugače uporabljajo razstavo ob dnevih odprtih vrat, ko je vstop brezplačen in je na razstavi precejšnja gneča, kot v času, ko je za ogled razstave treba plačati (sicer skromno) vstopnino, a je kvaliteta ogleda bistveno višja. Zajeli bomo različne

With the observation method and questionnaires, we shall evaluate to what extent the exhibition's objectives were achieved. At the time of preparing this paper, the data-gathering had only just begun, as we were forced to distribute the dynamics of our activities parallel to the exhibition, owing to the numerous tasks we had set out, through the entire period when the exhibition was to be open to the public. Notwithstanding, we shall embrace more than a year with our evaluation and thus ascertain the objectives' attainment under different conditions. After the exhibition's closure we shall statistically process and evaluate the data and publish them in relevant literature. On this occasion we therefore present only the methodology and some preliminary findings.

With the observation method, we shall further ascertain how the exhibition is utilized by randomly selected visitors. Specifically, we are interested in how visitors move through the exhibition, which presentations attract their attention most, which interactive presentations they put to the test, how long they linger at separate presentations, etc. For this very purpose we prepared a form with the exhibition floor plan, on which the observers mark the path of a visitor, note down his/her different activities and the time dedicated to them. In general, it is already in this phase that we can ascertain, as we actually anticipated in advance, that most attention is paid particularly by younger visitors to the interactive presentations, while certain texts are often totally ignored.

Through questioning the randomly chosen individuals we shall be able to assess whether the visitors received the message we wished to convey to them, whether the texts were intelligible, what the visitors have learned, what traces were left by the exhibition in their emotions, and how the exhibition influenced their conduct. The questionnaire is constructed on the basis of objectives set already in the phase of the exhibition planning, which greatly mitigates the evaluation. The questionnaire also records the visitors' wishes and needs, which is of great help in the planning of further exhibitions and museum programmes.



demografske skupine obiskovalcev, posebej pa bomo ovrednotili predstavitve, namenjene otrokom, ter vpliv spremljajočih dejavnosti (npr. delavnic) na doseganje zastavljenih ciljev.

## Zahvale

Prirodoslovni muzej Slovenije se zahvaljuje vsem posameznikom in ustanovam za njihova prizadevanja, da se enkratni primerek brazdastega kita shrani in razstavi v osrednjem narodnem naravoslovnem muzeju. Celotni seznam je naveden v kolofonu razstave v Prilogah (Tabela 2).

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The exhibition will be evaluated on various occasions. We are interested whether the visitors utilise the exhibition differently during the »Open Days«, when the admission is free and the exhibition hall happens to be pretty crowded, than at the time when admission has to be paid, but the quality of the tour is significantly greater. We shall embrace different demographic groups of visitors and dedicate special attention to the evaluation of presentations intended for children and of the impact of the accompanying activities (e.g. workshops) on the attainment of the set out objectives.

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## Priloge /Annexes

**Tabela 1.** Masa posameznih kosti okostja samice brazdastega kita; po sušenju in opravljenih preparatorskih postopkih, (R1 – R14; leva rebra (R15 ni bilo stehtano), C1 – C7; vratna vretenca, D1 – D15: prsna vretenca, L1 – L15; ledvena vretenca, Ca1 – Ca20; repna vretenca, h.l. – hemalni loki). Vretenca so bila tehtana po lepljenju epifiznih plošč na telesa posameznih vretenc.

\* **Nevalni** odrastek deloma odlomljen.

\*\* **Maso** lobanje smo določili iz razlike med praznim in z lobanjo naloženim vozilom. Razlika je znašala 200 kg, od te teže smo odšteli 10 kg (paleta), natančnost tehtanja je bila +/- 20 kg.

**Table 1.** Mass of dry bones of the Fin Whale female's skeleton after preparation procedures (R1 – R14; left ribs (R15 was not weighed), C1 – C7; cervical vertebrae, D1 – D15: thoracic vertebrae, L1 – L15; lumbar vertebrae, Ca1 – Ca20; caudal vertebrae, ch. – chevrons). The vertebrae were weighed together with the vertebral epiphyses.

\* **Neural** process partially broken off.

\*\* **The skull** mass was determined from the difference between empty vehicle and vehicle loaded with the skull. The difference was 200 kg, of which 10 kg (pallet) were deducted. The accuracy of weighing was +/- 20 kg.

kost / bone	masa / mass (kg)	kost / bone	masa / mass (kg)
R1	1.64	D8	2.66
R2	1.9	D9	2.74
R3	1.88	D10	2.84
R4	1.8	D11	2.92
R5	2.14	D12	2.92
R6	1.88	D13	3.21
R7	1.53	D14	3.26
R8	1.35	D15	3.12
R9	1.19	L1	3.18
R10	1.12	L2	3.22
R11	0.9	L3	3.38
R12	0.68	L4	3.49
R13	0.59	L5	3.68
R14	0.48	L6	3.54*
C1	2.17	L7	3.76
C2	2.54	L8	3.84
C3	0.88	L9	3.98
C4	0.76	L10	4.06
C5	0.83	L11	4.1
C6	0.94	L12	4.15
C7	1.12	L13	4.28
D1	1.38	L14	4.38
D2	1.66	L15	4.4
D3	2.18	Ca1	4.36
D4	2.47	Ca2	4.35
D5	2.52	Ca3	4.48
D6	2.51	Ca4	4.55
D7	2.56	Ca5	4.49

kost / bone	masa / mass (kg)	kost / bone	masa / mass (kg)
Ca6	4.4	h. l. na / ch. on Ca5	0.22
Ca7	4.23	h. l. na / ch. on Ca6	0.24
Ca8	4.06	h. l. na / ch. on Ca7	0.25
Ca9	3.91	h. l. na / ch. on Ca8	0.2
Ca10	3.68	h. l. na / ch. on Ca9	0.18
Ca11	3.53	h. l. na / ch. on Ca10	0.14
Ca12	3.31	h. l. na / ch. on Ca11	0.11
Ca13	2.99	h. l. na / ch. on Ca12	0.081
Ca14	2.3	h. l. na / ch. on Ca13	0.062
Ca15	1.38	h. l. na / ch. on Ca14	0.031
Ca16	0.79	prsnica / sternum	0.45
Ca17	0.55	lopatica / scapula	3.25
Ca18	0.43	nadlahtnica / humerus	2.32
Ca19	0.22	podlahtnica / ulna	1.01
Ca20	0.11	koželjnica / radius	1.73
h.l. na / ch. on Ca1	0.11	podjezična kost / hyoid bone	0.98
h. l. na / ch. on Ca2	0.16	desna spodnja čeljustnica / right mandible	47.75
h. l. na / ch. on Ca3	0.19	lobanja in spodnji čeljustnici / skull and mandibles	190+/- 20**
h. l. na / ch. on Ca4	0.2		

**Tabela 2.** Kolofon razstave »Skrivnostna smrt mlade Leonore«.

**Table 2.** Colophon of the exhibition *The Mysterious Death of Young Leonora*

**Vodja razstavnega projekta:** Staša Tome

**Vodji pridobitve in prepariranja okostja:** Boris Kryštufek, Ivo Božič

**Kustosi razstave:** Boris Kryštufek Ivo Božič, Mojca Jernejc Kodrič

**Scenarij razstave:** Staša Tome

**Interpretacija:** Staša Tome, Mojca Jernejc Kodrič, Sonja Ifko

**Fotografije:** Ivo Božič, Tilen Genov, Uwe Kils, Ciril Mlinar, Dare Šere, Simone Panigada, Alessia Scuderi, Mark Votier

**Risbe:** Vladimir Leben

**Oblikovanje razstave:** Sonja Ifko

**Lektoriranje:** Goran Schmidt

**Film Brazdasti kit v Slovenskem morju:** Ivo Božič, Ciril Mlinar, Jure Longyka, Gianni Pavan, Tomi Trilar, Henrik Ciglič

**IZobraževalna igra Sestavi kita in mamuta:** Staša Tome, Breda Činč Juhant, Mojca Jernejc Kodrič, Matija Križnar, Dušan Kastelic, Igor Šinkovec, Ciril Mlinar, Jože Pečnik, Brane Solce

**Računalniški prikaz selitve kitov:** Dušan Kastelic

**Zvočni posnetki:** Tilen Genov, Gianni Pavan, Tomi Trilar

**Priredba besedil za zvočne vodnike:** Staša Tome

**Pedagoški programi:** Ljerka Trampuž (vodstva, učne ure z delovnimi listi, Staša Tome (programi za samostojno uporabo - Skrivnosti poln nahrbtnik)

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Prirodoslovni muzej Slovenije se zahvaljuje posameznikom in ustanovam za njihova prizadevanja, ki so omogočila, da je enkratni primerek brazdastega kita shranjen in razstavljen v osrednjem nacionalnem naravoslovnem muzeju.

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- <http://www.nps.gov/index.htm>
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**Head of the exhibition project:** Staša Tome

**Heads of the skeleton acquisition and preparation project :** Boris Kryštufek, Ivo Božič

**Curators:** Boris Kryštufek, Ivo Božič, Mojca Jernejc Kodrič

**Exhibition scenario:** Staša Tome

**Interpretation:** Staša Tome, Mojca Jernejc Kodrič, Sonja Ifko

**Photos:** Ivo Božič, Tilen Genov, Uwe Kils, Ciril Mlinar, Dare Šere, Simone Panigada, Alessia Scuderi, Mark Votier

**Drawings:** Vladimir Leben

**Exhibition design:** Sonja Ifko

**Language editing:** Goran Schmidt

**Film *Fin Whale in the Slovenian Sea*:** Ivo Božič, Ciril Mlinar, Jure Longyka, Gianni Pavan, Tomi Trilar, Henrik Ciglič

**Educational game *Compose a Whale and a Mammoth*:** Staša Tome, Breda Činč Juhant, Mojca Jernejc Kodrič, Matija Križnar, Dušan Kastelic, Igor Šinkovec, Ciril Mlinar, Jože Pečnik, Brane Solce

**Whale migration computer display:** Dušan Kastelic

**Sound recordings:** Tilen Genov, Gianni Pavan, Tomi Trilar

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