Preliminarna rekonstrukcija

Preliminary reconstruction

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Nalaz brodske konstrukcije iz uvale Zambratija značajan je zbog više razloga. Datacija broda, stanje očuvanosti drva te posve jedinstvene značajke arhitekture i načina gradnje čine ga jednim od zanimljivijih i znanstveno izdašnijih nalaza s obzirom na tekuću problematiku i istraživanja na polju arheologije broda na Mediteranu.

Međutim, jedinstvenost njegovih karakteristika izuzetno je otežala rekonstrukciju izvornog izgleda broda. Nepostojanje arheoloških materijalnih paralela ili drugih usporedivih izvora (ikonografski prikazi, pisani izvori, etnografski primjeri) čini svaki pokušaj rekonstrukcije osobito zahtjevnim, a njegov krajnji rezultat izrazito hipotetskim. U ovom su kontekstu ostaci broda jedina osnova na kojoj se može bazirati preliminarna hipoteza rekonstrukcije njegove forme. Srećom, brod Zambratija s tog aspekta ima nekoliko bitnih prednosti, jer sačuvani ostaci uključuju i određene temeljne arhitektonske elemente uz gotovo 30 posto sačuvanih izvornih dijelova broda. Sačuvan je jedan od krajeva te završni voj koji definira visinu vodene linije. Osim toga, tri rebrenice omogućile su rekonstrukciju izvornih poprečnih presjeka. To predstavlja važnu informaciju u postupcima evaluacije i korekcije deformacija nastalih postdepozicijskim

The Zambratija wreck is remarkable for more than one reason. The dating, the exceptional state of preservation of the wood, and the unique construction of the boat and its assembly system make it one of the more interesting and rewarding finds in view of current paradigms and research perspectives within Mediterranean nautical archaeological research.

Nonetheless, the unique character of the vessel made the reconstruction of the original boat particularly difficult. The absence of archaeological parallels, or any comparable material of other sorts (iconography, written evidence, or similar ethnographic examples), make any attempt at reconstruction particularly demanding and the results distinctly hypothetical. In this context, the remains themselves constitute the only evidence on which to base a preliminary hypothetical reconstruction of the shape of the boat. Luckily, the Zambratija wreck also has considerable advantages in this respect. The remains include the boat's fundamental structural elements, and about 30% of the original boat is relatively well preserved. One of the ends is preserved, along with the sheerstrake, which defines the vessel's waterline. Moreover, the three floor-timbers gave the hull's



II.48
3D model ostataka
3D model of the remains
(izradili / made by: V. Dumas, P. Poveda)

procesima. Kao doprinos predmetnim pozitivnim činjenicama, možemo pridodati i metodu dokumentiranja primijenjenu prilikom istraživanja, koja je omogućila iscrtavanje vrlo preciznih planova, na osnovi kojih se obavljala rekonstrukcija izvornog plovila.

Metode rekonstrukcije

Cjelovito i iscrpno proučavanje nekog plovila zahtijeva ekstenzivna istraživanja, započevši od same olupine, a sve s ciljem izrade hipoteze rekonstrukcije izvornog plovila. Riječ je o složenom radu u kojem su poznata ograničenja u najmanju ruku jednako brojna koliko i nepoznata. Izrada rekonstrukcije uvjetovana je dugim i detaljnim istraživačkim protokolima i predstavlja važan izvor informacija kad je riječ o proučavanju plovidbenih karakteristika i mogućnosti te funkciji drevnih plovila.

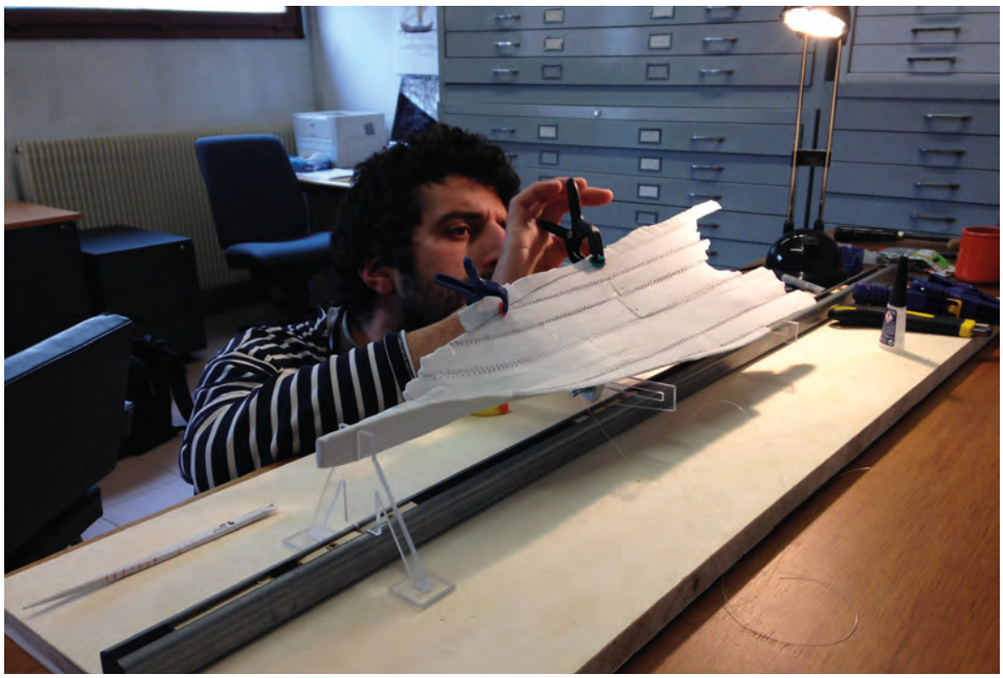
Različita istraživanja provedena od 1960-ih godina u Danskoj (Centar za pomorsku arheologiju, Roskilde), Sjedinjenim Američkim Državama (Sveučilište Texas

cross section. These are important indications used to evaluate and correct the deformations the wood has undergone during the long period it was buried. In addition to these positive points can be added the recording methods used at Zambratija that have allowed a very accurate plan to be drawn, which was used as the basis of the reconstruction of the original boat.

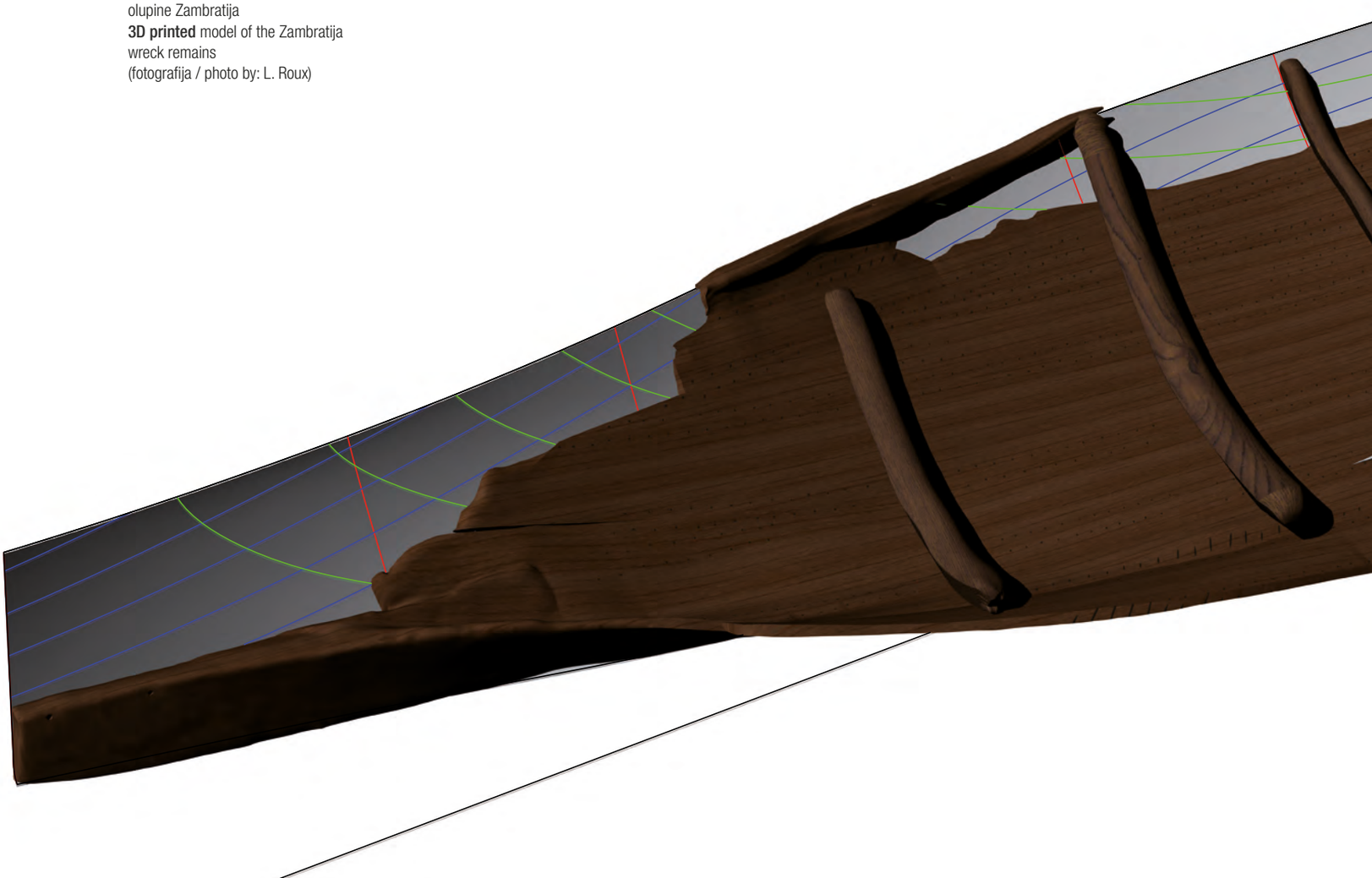
Reconstruction methods

A complete and exhaustive study of a vessel requires extensive research, starting from the wreck itself, with the objective of producing hypothetical reconstructions of the original boat. It is complex work in which the known constraints are at least as numerous as the unknown factors. Guided by long and meticulous research protocols, a reconstruction of an ancient ship is an important source of information used to examine the vessel's seaworthiness, sailing capabilities, and function.

The various experiments undertaken since the 1960s in Denmark (Centre for Maritime Archaeology, Roskilde), in America (Texas A&M University and the Institute for

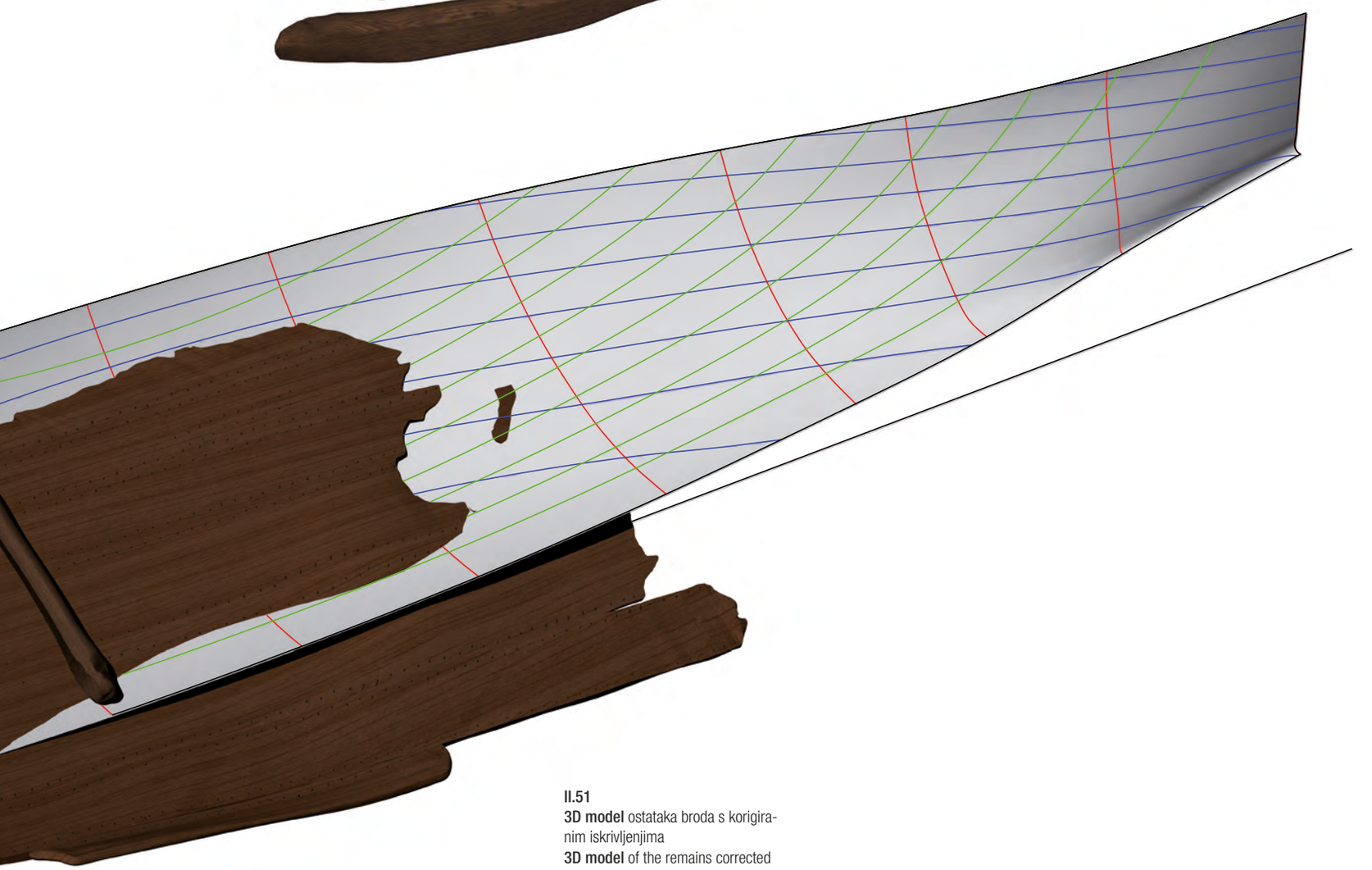


II.49
Isprintana 3D maketa ostataka olupine Zambratija
3D printed model of the Zambratija wreck remains
(fotografija / photo by: L. Roux)





II.50
3D model očuvanih rebara
3D model of the preserved frames
(izrada / made by: P. Poveda)



II.51
3D model ostataka broda s korigiranim iskrivljenjima
3D model of the remains corrected for distortions
(izrada / made by: P. Poveda)

A&M i Institut za nautičku arheologiju, College Station) ili Francuskoj (Centar Camille Jullian, Sveučilište Aix-Marseille, CNRS, Aix-en-Provence), omogućila su razvoj metoda rekonstrukcije koje su dobro prilagođene proučavanim plovilima (Steffy 1994; Pomey, Rieth 2005; Poveda 2012, 2015).

Kroz modeliranje brodskih ostataka *in situ*, izradu studijskih maketa (od drva ili drva i kartona) te hipotetskih rekonstrukcijskih modela razvijen je proces analize ostataka te rekonstrukcije nedostajućih dijelova brodova. Posljednjih petnaestak godina ovakva se vrsta istraživanja uvelike izmijenila, s obzirom da sve značajnije mjesto zauzima informatička oprema koja se koristi u različitim fazama pri postupku rekonstrukcije. Olupina Zambratija također nije iznimka te ovdje iznesena pretpostavka o rekonstrukciji predstavlja rezultat gotovo isključive upotrebe alata za trodimenzionalnu virtualizaciju.

Fotogrametrijsko snimanje broda isprva je omogućilo izradu prvog 3D modela, pokazujući vrlo jasno položaj svih brodskih ostataka u prostoru. Premda je riječ o pravoj trodimenzionalnoj fotografiji nalazišta, iz takvog prvog 3D modela ipak nije bilo moguće međusobno razlikovati pojedine arhitektonske dijelove. Stoga je bilo potrebno prethodno izvesti remodeliranje na osnovi kojeg su kasnije razlikovani različiti dijelovi arhitekture broda te je njima rukovano odvojeno i po želji. Na temelju tog drugog modela nastojali smo rekonstruirati izvornu formu broda (Sl. II.48).

Na olupini Zambratija istodobno su primijenjene dvije metode rekonstrukcije kako bi se mogao usporediti njihov rezultat. Jedna je tehnika posve računalna, dok se druga temelji na kombiniranoj upotrebi virtualnih i fizičkih modela. Međutim, ograničenja koja nameće vrsta plastičnog materijala, 3D ispisa sačuvanih ostataka broda u mjerilu 1:10 (Sl. II.49), nisu dopustila da ovo istraživanje urodi konkretnim rezultatom. Stoga smo svoju pretpostavku razvili isključivo putem računalno baziranog istraživanja (Sl. II.50, II.51).

Od olupine do broda

Detaljnim proučavanjem ostataka utvrđene su jedinstvene karakteristike plovila Zambratija. Oblik rebrenica, kao i njihov položaj u odnosu na središnji element, derivat monoksila (P2), omogućili su određivanje uzdužne osi broda (Sl. II.52). Ta os je također omogućila opažanje forme nalaza i kuta nalijeganja, kao i iskrivljenost brodske oplate koja se značajno otvorila u svom sjevernom dijelu. Vojevi P1 i P8 mogu se uspraviti kako bi se prilagodili obliku rebrenica, ne bi li se dobio kut jednak kutu oplate na suprotnom boku (P3 i P4). Stoga brod izgleda kako ima vrlo zaobljeni poprečni presjek.

Nadalje, produžavanjem sačuvanih vojeva prema krajevima broda omogućava se nekoliko rješenja.

Nautical Archaeology, College Station), or in France (Centre Camille Jullian, Aix-Marseille University, CNRS, Aix-en-Provence), have enabled reconstruction methods that are well suited to studying such vessels (Steffy 1994; Pomey, Rieth 2005; Poveda 2012, 2015).

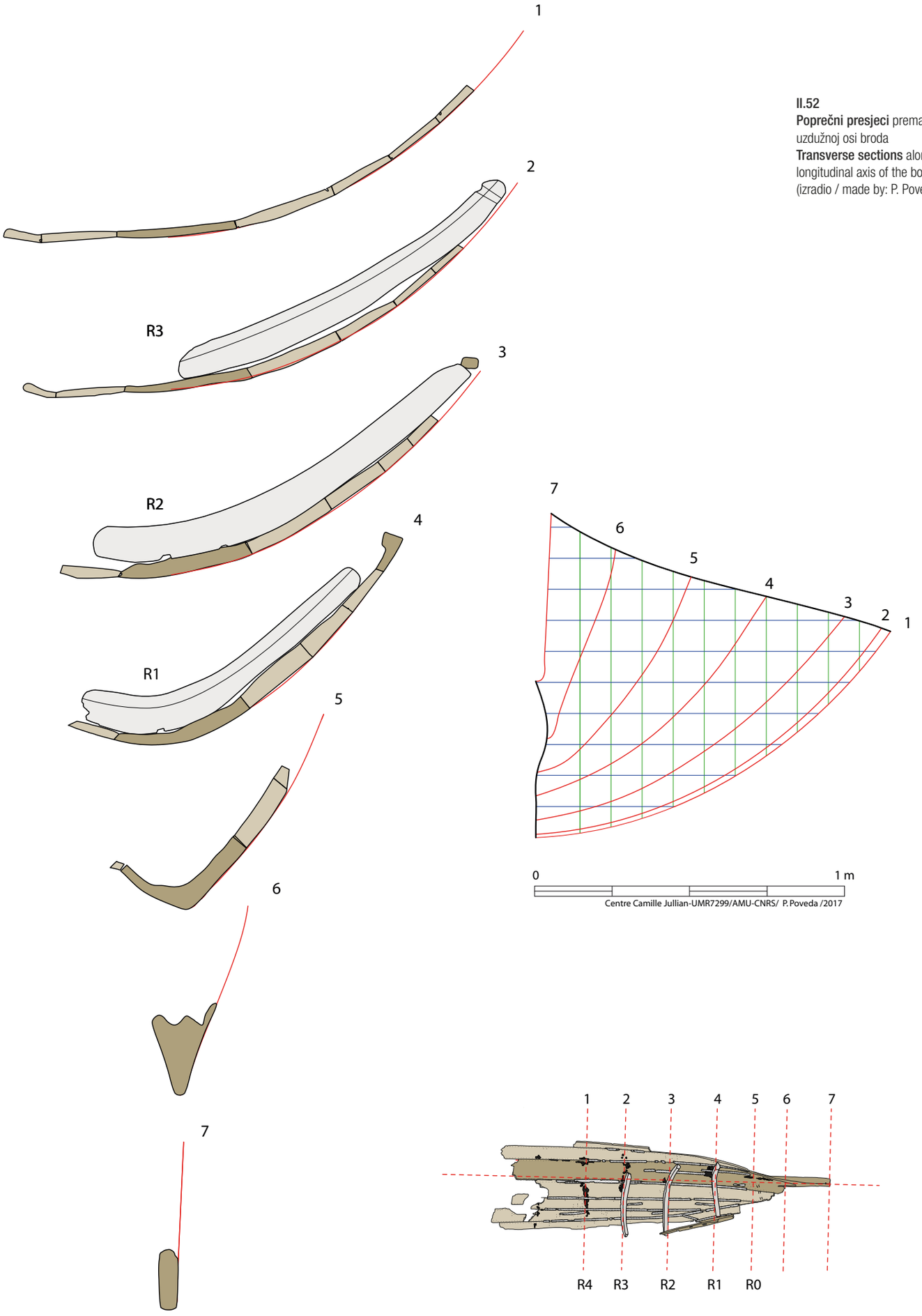
Through the use of models of the remains as found, study models (in wood, or wood and cardboard), and hypothetical reconstruction models, a process for analysing the remains and representing lost parts has been established. For the past 15 years or so, however, this type of study has been greatly modified by the increasing use of digital technology in the different steps in the reconstruction process. The Zambratija wreck is no exception and the hypothetical reconstruction presented here is the result of the almost exclusive use of 3D virtualization tools.

The photogrammetric record of the wreck initially allowed the creation of a preliminary 3D model that gave the precise position of the remains in space. The first model was a true 3D photographic image, but it did not allow individual timbers to be distinguished from each other. Remodelling was necessary to be able to separate and manipulate individual parts of the structure of the vessel at will. From the second model onwards the aim was to find the original shape of the boat (Fig II.48).

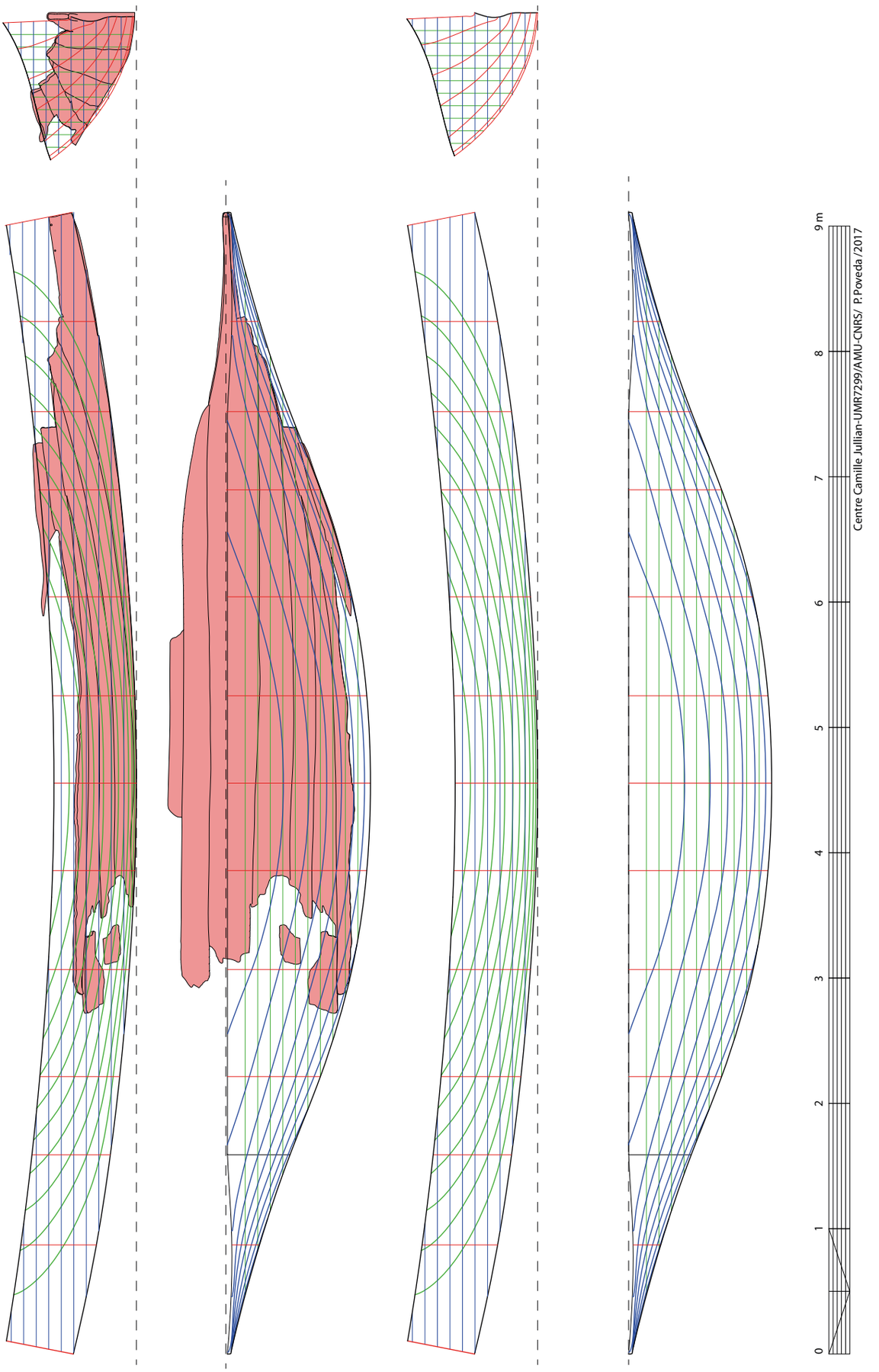
For the Zambratija wreck, two methods were employed simultaneously in order to compare results. One of the techniques is entirely digital, while the other is based on the combination of virtual and physical models. Constraints imposed by the plastic material used for the physical model, however, in this case the preserved parts of the wreck were 3D printed at 1/10th scale (Fig. II.49), did not permit this aspect of the research to produce conclusive results. Only the digital-based research was used for the reconstruction proposed here (Figs II.50, II.51).

From wreck to boat

Intensive study of the remains allows us to assess the unique characteristics of the Zambratija vessel. The shape of the floor-timbers and their position in relation to the central timber, a P2 logboat derivative, provides a coherent longitudinal axis (Fig. II.52). This axis also allows the form of the deposit and angle at which the wreck lay to be discerned, and thus the distortion of the planking that appears to have opened out on the northern side. Strakes P1 and P8 can be pulled up to match the shapes of the floor-timbers, forming an angle equal to that of the planking on the opposite side (P3 and P4). The boat can thus be seen to have a very rounded cross section.



II.52
Poprečni presjeci prema uzdužnoj osi broda
Transverse sections along the longitudinal axis of the boat
(izradio / made by: P. Poveda)



II.53
Prva hipoteza forme trupa
First hypothesis of the hull shape
(izradio / made by: P. Poveda)

Prije svega, što se tiče sjeverne strane, sa sigurnošću je moguće iscrtati koherentnu shemu oplate temeljenu na korištenju mrtvih vojeva za sužavanje forme broda prema njegovim krajevima, na mjestu nižih vojeva (P3, P4 i P5). Oni su s gornje strane povezani cjelovitim vojem (P6), koji je i sam okrunjen završnim vojem L-profila (P7). Nadalje, čini se da se najširа točka broda, glavno rebro, može smjestiti u dijelove očuvanog trupa, budući da je uočeno blago sužavanje vojeva od položaja rebra R5. Posljedično, možemo racionalno pretpostaviti da očuvani sjeveroistočni dio konstrukcije odgovara četvrtini cjelokupnog broda.

Prethodno navedeni elementi o jedinstvenim značajkama ovoga broda, kao i zaključci koji proizlaze iz analize njegovih ostataka, navode nas, dakle, na postavljanje hipoteze koja nam se učinila najjednostavnijom, tj. simetriji lijevog i desnog boka te simetriji jednog i drugog kraja broda od njegovog najšireg dijela. Slijedom navedenog, zrcalno simetrično smo prvo preslikali rekonstruiranu četvrtinu boka, a potom i nasuprotnih krajeva.

Zaključak

Rekonstruirano plovilo duljine je 9,11 m, širine 2,28 m te visine 0,66 m na središnjem dijelu trupa (Sl. II.53). Poprečni profili broda su vrlo oblog presjeka, s uskim krajevima koje čini masivan i vertikalni pramčani i krmeni dio. Uzdužno, brod ima vrlo izraženu krivulju ili luk, kojeg prati i linija završnog voja, što brodu daje uzdignuti izgled.

Zaključno, na ovom stupnju istraživanja ostaju otvorena različita pitanja, osobito kad je riječ o krajevima broda, tj. kako su vojevi spojeni za masivne krajnje drvene elemente te o načinu upravljanja i sustavu propulzije broda. Sva ta pitanja morat će biti predmetom neke naknadne studije.

Furthermore, extending the preserved strakes towards the ends allows a number of findings.

First, for the northern side it is possible to reconstruct with some certainty a coherent planking plan based on the use of drop strakes to narrow the shape of the boat towards the ends for the lowest strakes (P3, P4 and P5), that are topped by a complete strake (P6), in turn capped by the L-shaped sheerstrake, P7. A slight narrowing of the strakes from frame R5 suggests the widest point of the boat, the midship frame, is within the preserved part of the hull. Therefore, we reasoned that northeastern part of the wreck equates to a complete quarter of the boat.

The unique character of the vessel and the analysis of its remains led us to propose the simplest hypothesis: a boat that was symmetrical both to port and starboard and fore and aft of the widest part. We could, therefore, mirror the preserved quarter first to reconstruct the opposite side, and then the opposite end.

Conclusion

The reconstructed vessel is 9.11 m long, 2.28 m wide, and 0.66 m deep amidships (Fig. II.53). The transverse profile is very rounded with narrow ends formed by the massive vertical timber at the bow and the stern. The longitudinal profile has a pronounced curve or rocker, matched by the sheerline, giving the boat a crescent shape.

In conclusion, at present several questions remain open, like the ones regarding the unusual ends or precisely, how the strakes were fastened to the massive end timbers, as well as those concerning the boat's steering and propulsion systems. These questions should be looked at again in the future.