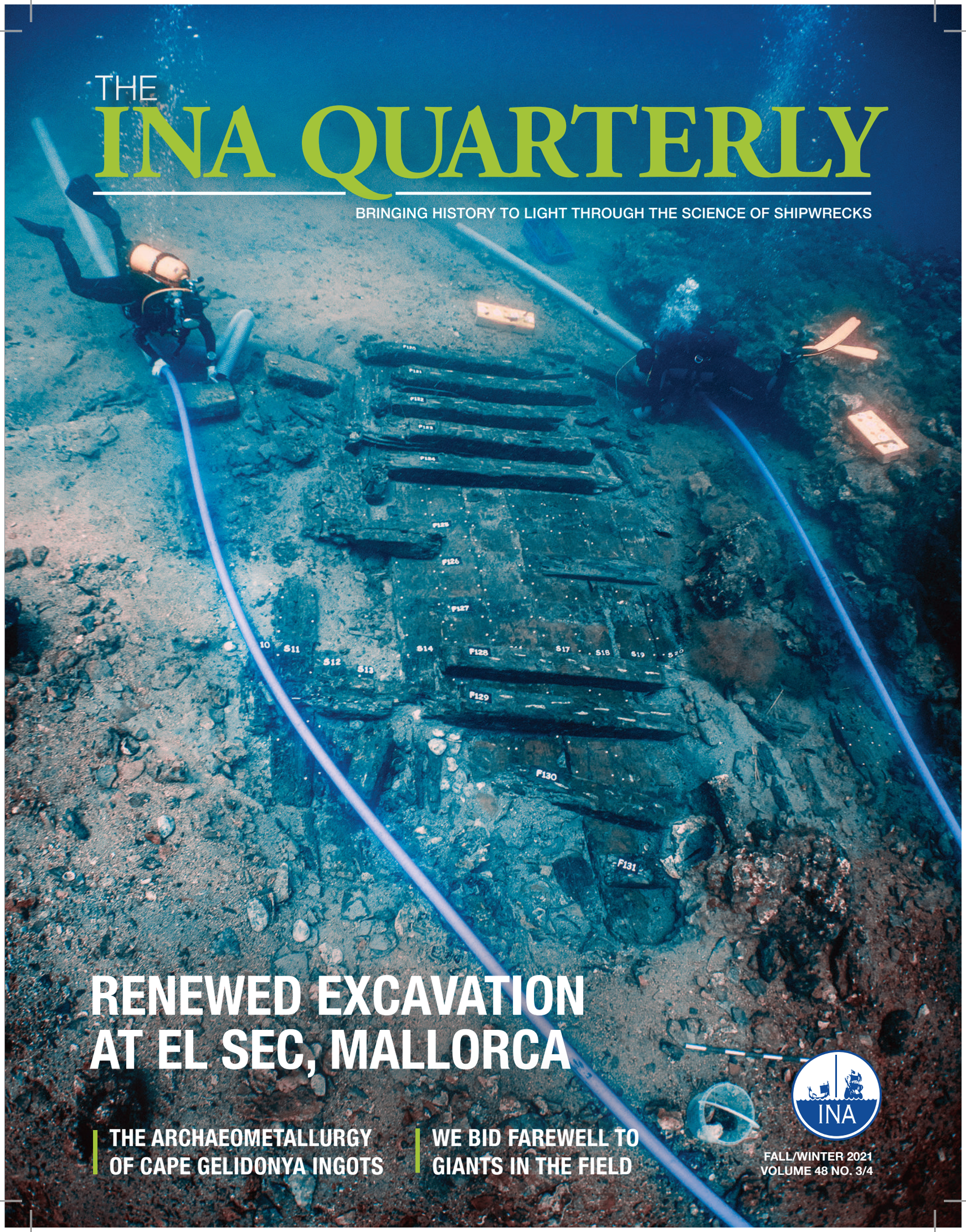
THE
INA QUARTERLY
BRINGING HISTORY TO LIGHT THROUGH THE SCIENCE OF SHIPWRECKS
RENEWED EXCAVATION AT EL SEC, MALLORCA
THE ARCHAEOMETALLURGY OF CAPE GELIDONYA INGOTS
WE BID FAREWELL TO GIANTS IN THE FIELD
INA
FALL/WINTER 2021
VOLUME 48 NO. 3/4

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ON THE COVER: Two divers excavate the hull remains of the El Sec wreck. Photo by Pedro Riera Llompart.

The Institute of Nautical Archaeology is a non-profit organization whose mission is to advance the search for the history of civilization by fostering excellence in underwater archaeology

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INA

— 2022 —

GEORGE AND ANN BASS PUBLICATION GRANT RECIPIENT

The **George and Ann Bass Endowment for Nautical Archaeology Publications**, established in 2018, honors two of INA's founders and supports a cause very close to their hearts: the final publication of archaeological material excavated by INA.

The 2022 Bass Publication Grant was awarded to INA Research Associate and NAP alumna **Dr. Cheryl Ward** in support of her efforts to publish the results of archaeological fieldwork conducted by INA-Egypt between 1994 and 1998 on the Sadana Island shipwreck, an 18th-century *markab* located near Safaga, Egypt on the Red Sea coast. The Sadana Island ship opens doors to understanding a previously undocumented method of ship construction.

Practically the first words George Bass said to new students in 1982 were the keys to his success: do good work with a good team and publish promptly. As I open up the Sadana Island catalogs and unroll the plans and drawings, memories flood in. Not just of dedicated Egyptian and international archaeologists and students, but also riding camels at the pyramids with George after a conference in Alexandria, convivial meals and laughter, and George's constant reminder to do better and aim higher. Bringing the Sadana Island ship to publication with the aid of INA's George and Ann Bass Endowment for Nautical Archaeology Publications is a joy and a privilege.

- CHERYL WARD

www.nauticalarch.org

INA

— 2022 —

CLAUDE DUTHUIT ARCHAEOLOGY GRANT RECIPIENT

Every year since 2014 INA has awarded the $30,000 **Claude Duthuit Archaeology Grant** to a single underwater archaeological project that captures the innovative, bold, and dedicated spirit of Claude Duthuit. Claude was a pioneer in the field of nautical archaeology and INA Director for three decades who valued innovation and a willingness to take risks. The 2022 Claude Duthuit Archaeology Grant winner is **Deborah Cvikel** (University of Haifa, Israel) who will continue the excavation and reconstruction of the 7th-8th century **Ma'agan Mikhael B shipwreck**, discovered in 2005 off the Carmel coast of Israel. Congratulations to Cvikel and her team!

"The Ma'agan Mikhael B shipwreck's timbers are elegantly worked and assembled, and the quantity and quality of the diverse artifacts is overwhelming. The ship was a well-built lateen-rigged merchantman, and her cargo of amphorae hails from multiple eastern Mediterranean nodes of commerce. I am honored and excited that INA's Claude Duthuit Archaeology Grant will support the 2022 excavation season as well as the continued study and conservation of the shipwreck and finds."

-DEBORAH CVIKEL

www.nauticalarch.org

THE LOSS OF GIANTS

Who Shaped Maritime Archaeology

2021 was a devastating year for the maritime archaeology community, owing to the deaths of prominent scholars and exceptional colleagues. Following the loss of INA Founder George Bass on March 2, 2021, whom we honored in *INA Quarterly* 48.1/2, the field of maritime archaeology also said goodbye to Patrice Pomey, Thijs Maarleveld, Simon Keay, and Seán McGrail.

PATRICE POMEY

(15 August 1943 – 7 March 2021)

Patrice Pomey began his education as an engineer but changed direction to study Art History and Archaeology at the Sorbonne in Paris. Pomey's master's thesis focused on Roman ship construction as well as ancient ship iconography. His excavation of two ancient shipwrecks, Planier 3 (1970) and La Madrague de Giens (1972-1982), were foundational for the history of underwater archaeology in France. Pomey served in a number of leadership roles, including Director of Recherches Archéologiques Sous-Marines (1984-1991) and Director of Le Centre national de la recherche scientifique (CNRS) to oversee the Centre Camille Jullian (formerly the Institut d'Archéologie Méditerranéenne) from 2000 to 2007. His excavation and study of nine ancient ships at Place Jules-Verne (including two laced Greek boats) and the subsequent construction of replica *Gyptis* constitute additional major contributions to the field of nautical archaeology. Among his many meaningful publications are *La navigation dans l'antiquité* (1997), *L'archéologie navale* (2005), and dozens of definitive and thought-provoking articles about ancient Mediterranean ship construction.

THIJS MAARLEVELD

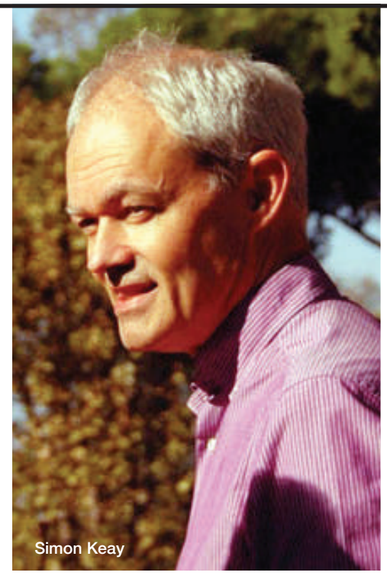
(21 October 1953 – 11 March 2021)

Thijs Maarleveld was born in Amsterdam and is best known for his work on underwater cultural heritage, particularly in the Netherlands. While still a student, he was appointed by the Dutch government to focus on the protection of shipwrecks, which would be the focus of his professional life for over four decades. In 1991, Maarleveld was one of the founders of the International Committee on the Underwater Cultural Heritage (ICUCH), and he served as president from 2008 to 2013. He received his Ph.D. from the University of Leiden, and in 2005 he was appointed Professor in the Maritime Archaeology Program at the University of Southern Denmark. This program flourished under Maarleveld's direction until its closure in 2019. Maarleveld was known for his ardent support of the 1996 ICOMOS Charter and 2001 UNESCO Convention on the Protection of the Underwater Cultural Heritage. Of his many publications and manuals, some of his best-known works are *Archeologie in Troebel Water* (1984), *Archaeological Heritage Management in Dutch Waters* (1998), "The 2001 UNESCO-Convention on the Protection of the Underwater Cultural Heritage: Origin and Consequences" (2007), and "What matters in underwater archaeology is the thinking, not the sinking" (2020, in *Our Blue Planet*).

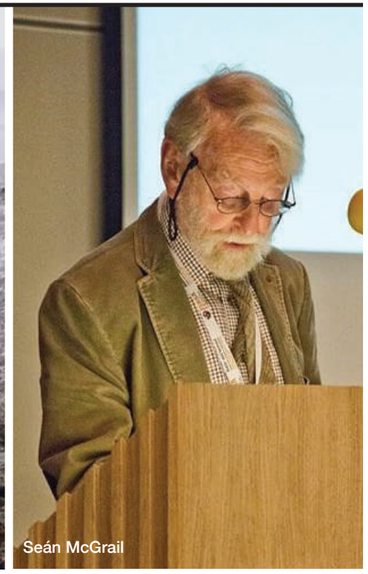

Patrice Pomey


Patrice Pomey (right)


Thijs Maarleveld


Simon Keay


Seán McGrail


Seán McGrail

SIMON KEAY

(21 May 1954 – 7 April 2021)

Simon Keay was born in London and received his bachelor's (1977) and doctoral (1983) degrees in archaeology from the University of London. His dissertation dealt with Late Roman trade in the western Mediterranean, with a focus on the chronology and typology of amphoras, an established work in the field after its publication (1984). Keay served on the Archaeology faculty of Southampton University from 1985 until his retirement in 2020. Keay spent much of his early career at Southampton engaged in Iberian archaeology before returning to Roman Italy in the late 1990s. Keay undertook a number of field projects over the years, such as the Ager Tarraconensis Survey (1985-1990), the Roman Towns in the Middle and Lower Tiber Valley, the Portus Project (1998-2004, 2007-2021), and the Roman Mediterranean Ports (PortusLimen) project (2014-2019). Keay authored or co-authored a number of publications, including *Roman Spain* (1988), *The Archaeology of Early Roman Baetica* (1998), *Portus: An Archaeological Survey of the Port of Imperial Rome* (2006), *Portus and its Hinterland* (2011), *Rome, Portus and the Mediterranean* (2013), and *Roman Port Societies: The Evidence of Inscriptions* (anticipated in 2022).

SEÁN MCGRAIL

(5 May 1928 – 28 June 2021)

Seán McGrail served 22 years in the Royal Navy as a pilot in the Fleet Air Arm and as a Master Mariner. Between 1968 and 1971 he earned a combined degree in mathematics, economics, and medieval history from Bristol University. In 1972, McGrail was appointed Assistant Keeper in the Ships Department of the National Maritime Museum. He earned a Ph.D. from University College London in 1978 with a dissertation entitled "Logboats of England and Wales." Throughout his career, McGrail held academic positions at Oxford University (1986-1993) and Southampton University (1991), and was a visiting chair at Roskilde, Denmark (1994) and Haifa, Israel (1995). In addition to these many achievements, McGrail was a prolific author, publishing *Ancient Boats* (1983), *Ancient Boats in North-West Europe* (1987), *Boats of the World* (2001), and his last volume pair *Early Ships and Seafaring* (2015).

RENEWED EXCAVATION AT EL SEC, MALLORCA

Preliminary results from the 2021 season

BY CARLOS DE JUAN, AGUSTIN DIEZ CASTILLO, AND SEBASTIÀ MUNAR

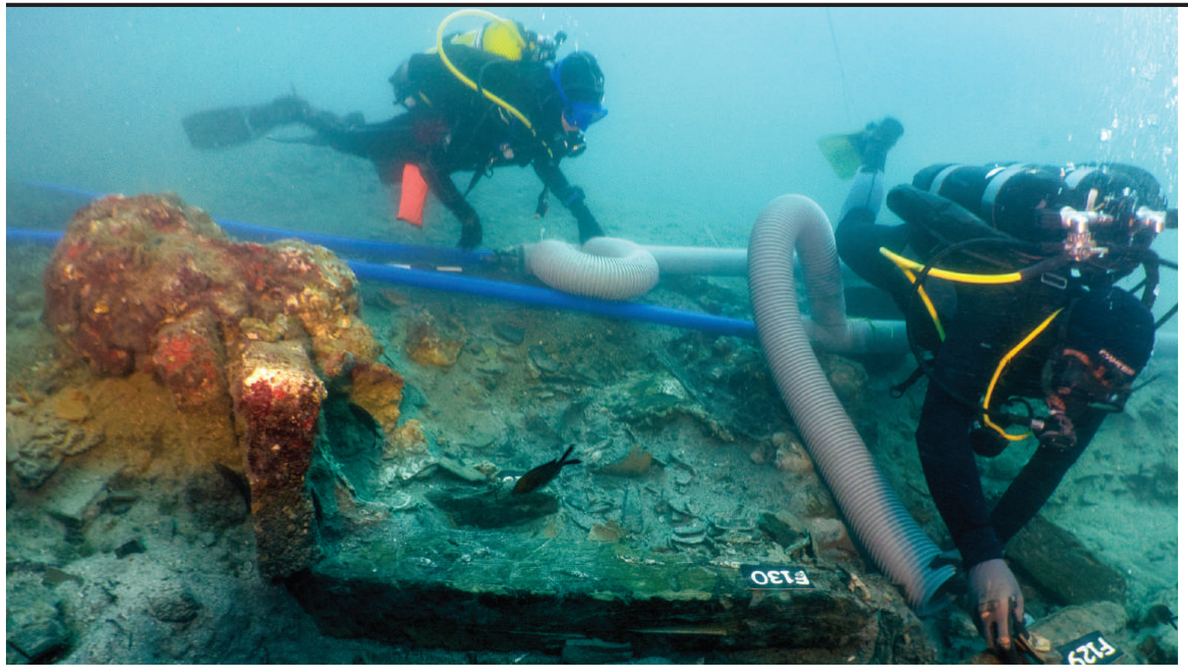
The fourth-century B.C. (375-350 B.C.) shipwreck at El Sec is located close to the islet of the same name in northwest Palma Bay on the island of Mallorca in Spain's Balearic Islands. Located at a depth of 33 m (108 ft), the wreck was first discovered in the 1940s. It was in the late 1960s when Spanish archaeologist and cartographer Josep Mascaró Pasarius published a study about an assemblage of Attic black-glazed pottery from the wreck, suggesting that this was the first ancient Greek ship found in Spain. The pottery was recovered by amateurs, fueling an interest in nautical archaeology and underwater heritage protection. In 1970, the foundation of the first Balearic institution sponsored the first archaeological mission at El Sec. Navy divers, who had no training in underwater archaeology, worked from the Spanish navy vessel *Poseidon* for three days with the aid of explosives to recover 530 artifacts without any record-keeping. The explosives were designed to 'recover' anything that was hidden beneath a layer of bronze *lebes* (cauldrons), which had formed a concreted mound over time. According to Francesca Pallarés (1972), those explosions damaged the archaeological remains and also facilitated looting of the site.

In the context of that urgent scenario, a deal was signed between Spanish Dirección General de Bellas Artes and Italian Istituto di Studi Liguri with its Centro Sperimentale di Archeologia Sottomarina di Albenga. The archaeological mission directed by Nino Lamboglia started in September 1970, at the south edge of the cauldron mound, where a group of rectangular millstones were visible *in situ*. Lamboglia applied terrestrial archaeological methods at El Sec, never diving on the site himself but relying on Navy divers, and mapped the site and recorded the position of 751 pieces. Underneath the cargo in the southern sector, hull remains appeared, including 12 planks and ten frames. In those early days, divers briefly described the pieces, took some measurements, and sketched a drawing.

In March and April of 1971, Spanish Navy divers recovered more artifacts from the seabed at El Sec, discovering a trench previously made by looters. That find led to another archaeological mission in August, directed from the surface by Cristobal Veny, using dredges and recovering 124 artifacts. The last mission at El Sec was in September 1972 when Catalina Enseñat, also from the surface, directed divers who recovered metallic concretions from the mound, using, in her words, 'blunt methods.' Between three and four tons of cauldron fragments, nails, necklace beads, almonds,

PHOTO: PEDRO RIERA LLOMPART

Opposite page: Two divers use dredges to clear around the hull of the wreck at El Sec.



PHOTOS: THIS PAGE AND OPPOSITE PAGE: PEDRO RIERA LLOMPART

Could the El Sec ship help to clarify the shipbuilding evolution of the fourth century B.C.? Did this evolution follow different paths like tree branches?

hazelnuts, pine nuts, wild olives, vines, and brambles were raised to the surface. Antonio Arribas' 1987 monograph is the best summary of the El Sec ship's cargo, most of which was recovered without proper archaeological recording and consideration of context (with the exception of Lamboglia's mission), some finds even being mixed with other artifacts of unknown provenance.

A PUNIC VESSEL OF THE CLASSICAL PERIOD

Most of the artifacts recovered were Aegean amphoras, Grecoitalic Will A2 amphoras, and Punic Central Mediterranean amphoras. Also, a small group of Punic amphoras from Ebusus (Ibiza Island) was identified (Ramon 1991). The Attic red figure and black-glazed ware showed graffiti, probably to be understood as numerals. Punic ware, bronze *lebes,* and volcanic millstones were also identified.

Despite the initial interpretation of the ship as a Greek vessel, the El Sec ship is now considered a Punic vessel with a heterogeneous cargo that sank while heading to the emporion of Ebusus (Asensio 2010).

In the intervening half-century, the study of ancient shipbuilding and its evolution in the Classical period has brought renewed scientific interest in the El Sec ship. The absence of evidence between the Ma'agan Mikhael shipwreck (ca. 400 B.C.) and the Kyrenia shipwreck (310 B.C.) brought about research of the hull at Mazotos, Cyprus (375 B.C.) that is still ongoing. In February 2019, after academic discussions with Cemal Pulak and Deborah Carlson at Texas A&M University in College Station, a new plan to revisit the El Sec shipwreck was put into place.

The El Sec ship's framing pattern, recorded in Lamboglia's excavation, did not seem to fit Patrice Pomey's family of transitional Greek framing characterized by floor timbers and futtocks joined by Z-scarves alternating with top timbers. The strong differences between the Hellenistic shipbuilding standard which the Kyrenia ship represents at the end of the fourth century B.C. and the aforementioned wrecks associated with the Greek tradition of ship construction raised the possibility of Punic influence in the Kyrenia ship's construction. Could the El Sec ship help to clarify the shipbuilding evolution of the fourth century B.C.? Did this evolution follow different paths like tree branches?

THE 21st-CENTURY MISSION

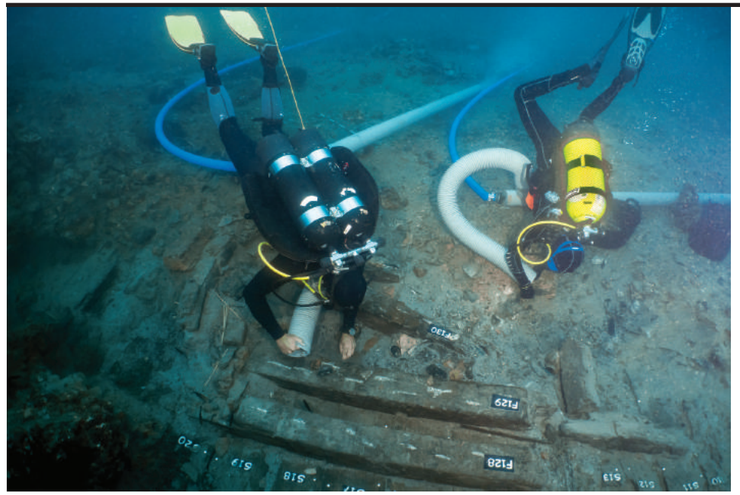
Looking for answers, a survey was done in spring 2019 by Munar and de Juan, thanks to the support of the regional government of Mallorca (Consell Insular de Mallorca-Departament de Cultura, Patrimoni i Politica Lingüistica) and the Spanish Navy. The wreck was relocated, and the team recorded some hull remains and two rectangular millstones in the area south of the concreted mound, which suggested that renewed excavation may provide new data about the framing pattern and fastening technique. These elements could help corroborate the hypothesis that shipbuilding techniques of Phoenician origin were transferred to Greeks between the end of the sixth century B.C. and the beginning of the third century B.C.

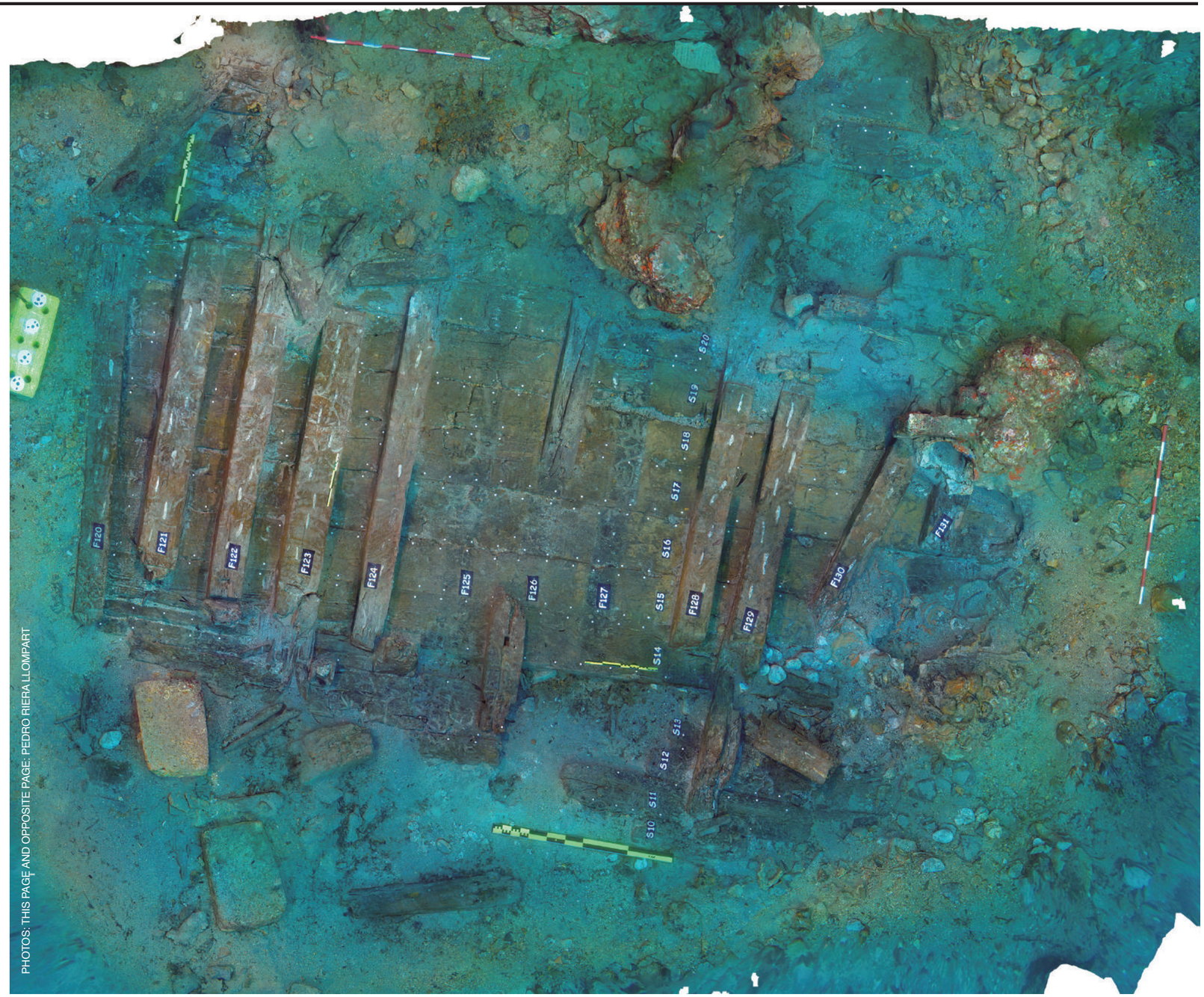
In 2021, after some delay due to the global COVID-19 pandemic, the first archaeological excavation of the 21st century was undertaken at El Sec. This research was conducted by the University of Valencia (Department de Prehistòria, Arqueologia i Història Antiga) through a three-year (2020-2022) Mallorca Regional Government program to promote the maritime heritage research along with invaluable financial assistance and scientific advice from the Institute of Nautical Archaeology (INA). The 2021 team was made up of university professor Agustín Diez Castillo, researchers Sebastià Munar, Miguel San Claudio, Franca Cibecchini, Professor José Antonio Moya, and INA Research Associate Carlos de Juan.

The work started with photogrammetric coverage of the mound's south sector; a few tests with water dredges were performed in order to relocate the hull explored by Lamboglia in the 1970s. Despite some confusion from old mapping positions, some frames appeared underneath a layer of sand 30 cm thick. The presence of loose sand, small pebbles and shells, and the absence of any pottery sherds, suggested that this area had been previously excavated. In other words, this was the spot for which we were looking.

The excavation limits of the 2021 mission were an area 6 x 4 m (20 x 13 ft), and during those days some dives were allocated to checking the mound (ca. 12 x 9 x 2.5 m, or 39 x 29.5 x 8 ft) which, according to Pallarés' reports, had an upper layer of bronze cauldrons. Today there is nothing left of that layer. It looked like there was either a large rock or group of stones inhabited by marine flora and fauna, but rocks of that kind were rare in that environment. The proposal that these unexpected stones were ballast seemed

This page: Two divers excavate around frames F129 and F130. **Opposite page:** A mass of broken pottery resting on the frames.





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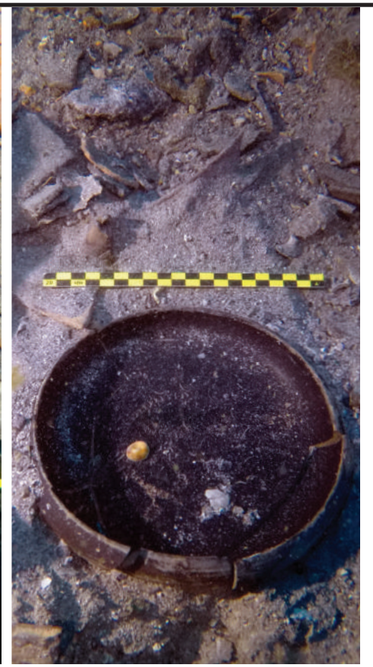
Today there is nothing left of that [bronze cauldron] layer. It looked like there was either a large rock or group of stones inhabited by marine flora and fauna, but rocks of that kind were rare in that environment.

to be correct, but a more in-depth study allowed us to identify within the mound other rectangular millstones, cauldron fragments, unclassified lithic artifacts, and pottery sherds (all of which were part of the original large concretion). There appeared, furthermore, what looked like more raw minerals, still unknown, that could be the main cargo of the El Sec ship, placed in the lower part of the hold.

The excavation of the hull portion, known from the 1970s, went quickly and well, discovering some planks and attached frames. Unfortunately, we witnessed the damage brought about by looters who had dug a hole in the hull, displacing and damaging some of the strakes (numbers 11, 12, and 13) and also frames that had disappeared completely (numbers 125, 126, and 127).

The excavation of the hull followed the strakes heading west to east. Also, the southern edge of the hull revealed some carpentry marks which deserve further study. To the north, we were able to determine that the timbers continued beneath the mound. The frames were tagged with a corresponding number, and planks and all pegs from the mortise-and-tenon joints were marked with white pins. In this sector, nine frames were excavated but, as previously mentioned, three of them became eroded and disappeared in the seabed close to the mound. Some were square in section, 16 cm sided and 16 cm molded, while others were slightly rectangular, 20 cm sided and 16 cm molded, with average frame-to-frame spacing of 20 cm. The joining technique was clenched nails without treenails, made probably in copper, but further analysis will be needed because some of the

This page: Two divers work to clear under the frames of the wreck. **Opposite page:** An orthographic image of the hull remains.



Could we stablish a clear relationship between the ship, the heterogeneous cargo, and the sailors on board? Was the El Sec ship built according to a Punic tradition? Ultimately, could the answers to these questions provide a better understanding of the Kyrenia vessel's shipbuilding tradition?

isolated nails found on the seabed looked like iron. Associated with the frames, two heads of a beam were recorded *in situ*, which allow us to propose that the portion of the hull under excavation corresponded to the side, including the deck and the bulwark; this suggests that the vessel's keel may be under the mound, which would comprise the main cargo.

As the excavation continued, we observed a change in the sediment while digging to the east. The sand was not as loose, and sherds of black-glazed pottery started to appear in this sector (near Frame 128), some with graffiti; more relevant, the sediment was compact with little branches. A (silver?) ring and a few beads (of carnelian and glass paste?) appeared. A large sediment sample was collected. The analysis already done by Dr. Pérez Jordá (University of Valencia) showed a representative quantity of *Vitis vinifera, Ficus carica,* and mostly coriander within the sample. Also, there appeared some branches of vines, not just wine shoots as dunnage, but real branches which are currently under DNA study. Are we faced with archaeological evidence for the trade in plants, which were conspicuously absent from the Iberian Peninsula?

After the authorities were informed about this unexpected discovery, the project directors had a slight change in plans: this mission was no longer only a shipbuilding study without artifact recovery. When the excavation continued towards Frame 129, the suspicions of a never-excavated lower level proved correct. A group of small river stones appeared, likely all rolled together in that spot after the wrecking. More necklace beads, one of gold with a flower motif, appeared in the area, but many in different forms and sizes and quantities that suggest a trade in raw materials.

The excavation of the eastern sector between Frames 129, 130, and 131 revealed in the upper layers many heavy small bowls and fragments of an Attic black-glazed pot with joining sherds, suggesting that these could have been stored in a now-lost wooden crate. A collection of small finds appeared, bone and other materials, a few with engraved motifs which deserve more study, and and Punic pottery of sufficient quantity to exceed galley or sailors' wares, perhaps representing trade goods. Also, more millstones of different sizes, parts of bronze cauldrons, the base of an Attic krater, lamps, unknown concreted pieces, and more elements of the ship including a possible wale, a kind of stringer, and more planks.

With this incredible scenario we concluded the 2021 mission by sampling the hull for wood species identification and burying the site with sand.

This page: Miscellaneous small finds from the wreck including a hinge, seeds, and carnelian beads. **Opposite page, from left:** A Punic pot; a Greek black-glazed dish.

PHOTOS: THIS PAGE AND OPPOSITE PAGE: PEDRO RIERA LLOMPART

FUTURE RESEARCH

The goal of the 2021 season was to record the remains of a previously excavated, looted, and dynamited wreck while trying to get answers about the evolution of shipbuilding in the Classical period. At this time, we hope to accomplish that goal in 2022, but there are more hull remains than Lamboglia´s excavation showed, and these deserve future archaeological excavation. Will we be able to reach the keel and garboard strakes underneath the mound? Could we stablish a clear relationship between the ship, the heterogeneous cargo, and the sailors on board? Was the El Sec ship built according to a Punic tradition? Ultimately, could the answers to these questions provide a better understanding of the Kyrenia vessel's shipbuilding tradition?

This research is expected to continue in 2022 under the auspices of the University of Valencia; Consell Insular de Mallorca Departament de Cultura, Patrimoni i Politica Lingüistica; and INA.

ACKNOWLEDGMENTS

We would like to thank Ms. Coll Borràs and Mr. Cardell for their support of nautical archeology research on Mallorca Island, Calvià City Hall for providing archeological storage, Ms. Aguiló Fiol for her help with the El Sec collection in the Palma Museum, and INA for believing in and supporting this project.

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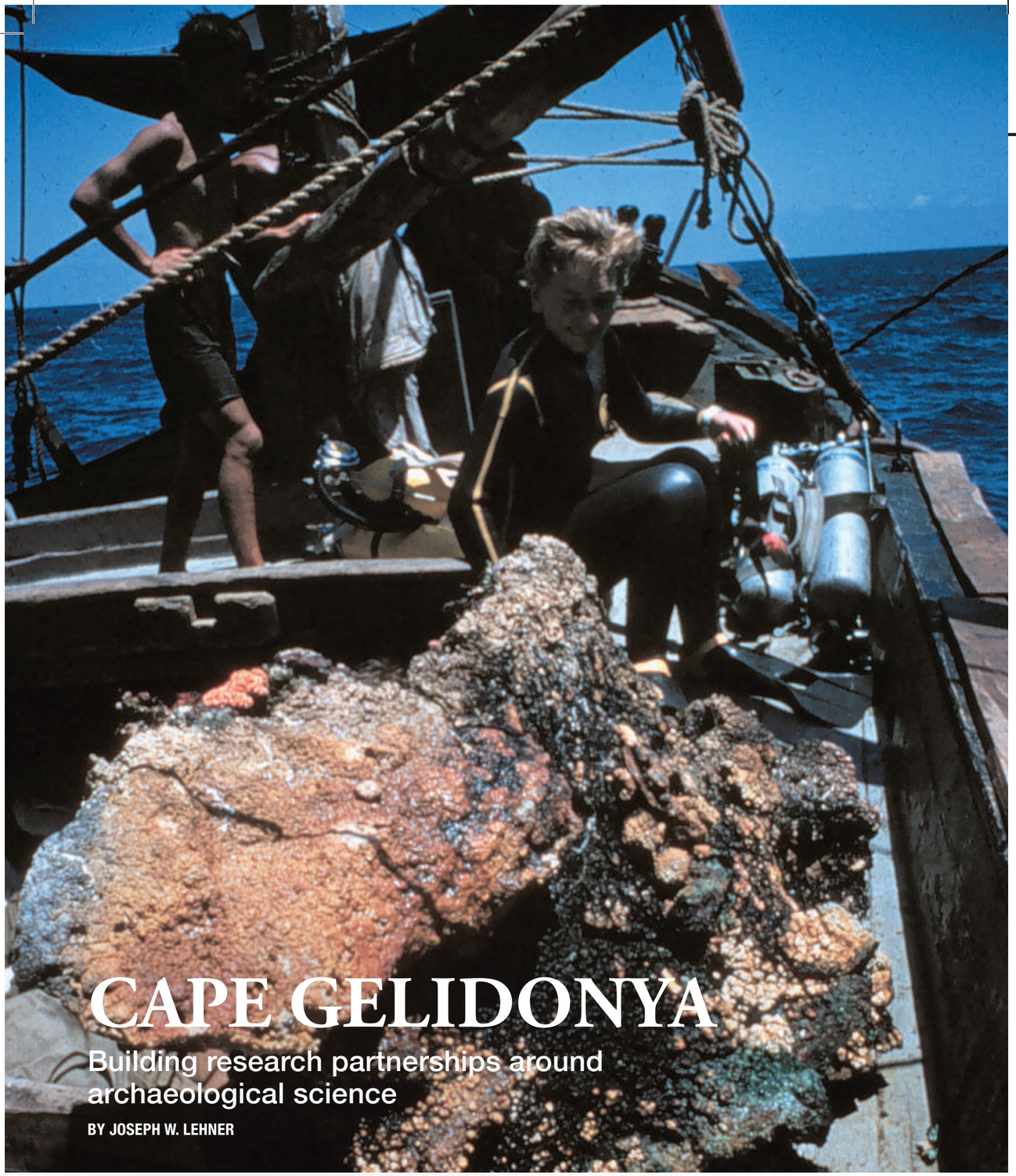

CAPE GELIDONYA

Building research partnerships around archaeological science

BY JOSEPH W. LEHNER

INA Quarterly readers are well aware of the fundamental importance of George F. Bass' excavations in 1960 at Cape Gelidonya (Turkey) to the development of underwater archaeology as a discipline. Less appreciated, because they are not well known, are Bass' contributions to the origins of archaeometry, the application of scientific methods and technology to archaeological artifacts.

EARLY COLLABORATIONS

In many ways Bass' forward thinking may have been catalyzed by his connections with the Penn Museum (then the University Museum), the establishment there of the Museum Applied Science Center for Archaeology (MASCA) in 1961, and the scientific expertise this attracted. Physicist Elizabeth Ralph, associate director of MASCA (1961 – 1982) and a true pioneer of radiocarbon dating and methods, conducted the first and only analysis of twig dunnage from the Cape Gelidonya shipwreck. She deduced a calendar age of 1200±50 B.C. for the dunnage, firmly placing it at the end of the Late Bronze Age and providing Bass with an absolute date for the shipwreck. Ralph would go on to collaborate with Henry Michael, a pioneer in the field of dendrochronology (tree-ring dating), to produce one of the first radiocarbon calibration curves. If Ralph's data are compared to the most recent IntCal20 calibration, one arrives at a mean date of 1189±84 cal B.C. (1383 – 1017 B.C., 95.4% confidence), demonstrating how well she anticipated and understood problems in radiocarbon analysis.

Robert Brill of the Corning Museum of Glass together with Jesse Wampler of the Brookhaven National Laboratory produced some of the first measurements of lead isotope ratios on archaeological metal, including a sample of metallic lead from the Cape Gelidonya wreck. This work united nautical archaeology and isotope geochemistry in a wholly novel way. Brill, in many ways like Ralph, anticipated problems associated with this method, principally in the use of isotope ratios to determine provenance. While the lead sample 'matched' the famed lead and silver deposits of Laurion in mainland Greece, it was also already apparent that it was consistent with 'geologically similar' sources in Turkey and Iran. We now know that then mutually indistinguishable geochemical fingerprints are related in part to errors associated with early mass spectrometry, but more fundamentally that many geographically distinct metal sources cannot be distinguished by means of their lead isotopes because of their overlapping geological ages and conditions of formation.

ARCHAEOMETALLURGY, ISOTOPES, AND ANCIENT TRADE NETWORKS

The Cape Gelidonya shipwreck played an important role in the development of archaeometallurgy as a discipline. Archaeometallurgy, which examines the physical, cultural, and social dimensions of metallurgy in deep time, was previously a curiosity or highly specialized science outside of mainstream archaeology. With the discovery of the copper ingot and scrap bronze cargo at Cape Gelidonya, however, it became immediately clear that in-depth study was necessary to infer the

This page, from left: Moritz Jansen prepares samples for analysis at the Deutsches Bergbau-Museum Bochum; Asu Selen Özcan documents the desalination process; Emre Kuruçayırlı collects XRF data at INA's BRC. **Opposite page:** Honor Frost examines a concreted mass of ingots at Cape Gelidonya, Turkey (1960).

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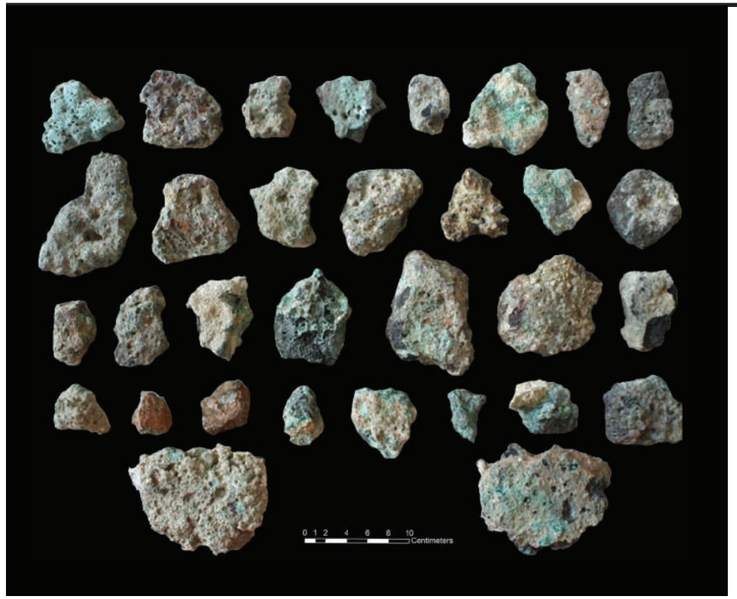

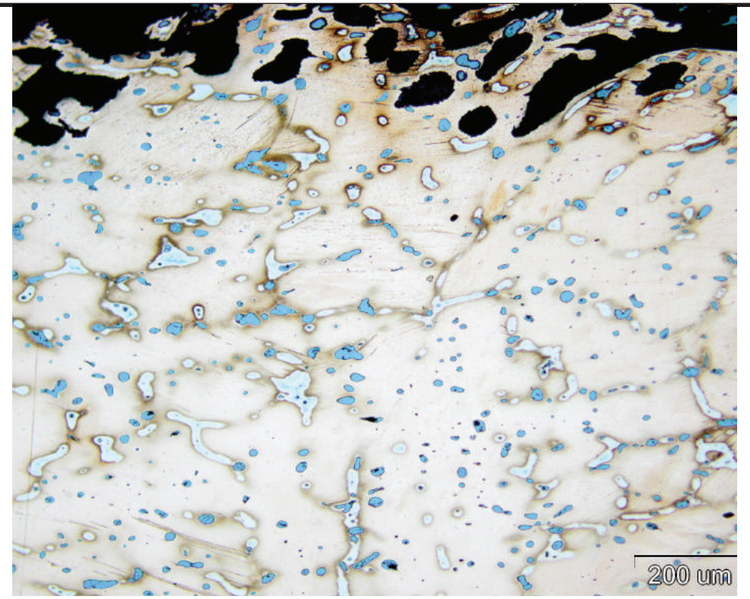

PHOTOS: THIS PAGE: L. VAN BREMPT; J. LEHNER: OPPOSITE PAGE: J. LEHNER AND E. KURUÇAYIRLI

This page: Photomicrograph of a polished section of an ingot fragment. **Opposite page, from left:** A selection of ingot fragments from Cape Gelidonya; 3D model of ingot IN25 showing colorized texture and grayscale to highlight topography and sign impression.

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While the larger objects recovered by Bass still comprise the bulk of the cargo, the new finds add diversity and depth...ongoing work integrates novel approaches in documentation, materials science, and digital archaeology to test new hypotheses about the nature of the wreck.

origins of the metals and how they fit into the Late Bronze Age trade networks. From the 1970s until the 1990s, analyses of the copper and tin ingots from the shipwrecks at Cape Gelidonya and also Uluburun would add, on an unprecedented scale, completely new knowledge to our understanding of Bronze Age metallurgy, interregional trade networks, and political economy.

In the early 1970s, James Muhly, Robert Maddin, and Tamara Stech-Wheeler conducted the first archaeometallurgical studies of the Cape Gelidonya metal cargo. Using the Laboratory for Research on the Structure of Matter at the University of Pennsylvania, their analyses of ingots from the Cape Gelidonya shipwreck and others found at terrestrial sites on Crete confirmed that the ingots were pure copper products with diagnostic impurities that solidified as non-metallic phases of copper oxides, sulfides, and slag. These results also demonstrated that the ingots were technologically very close to the original smelting stages.

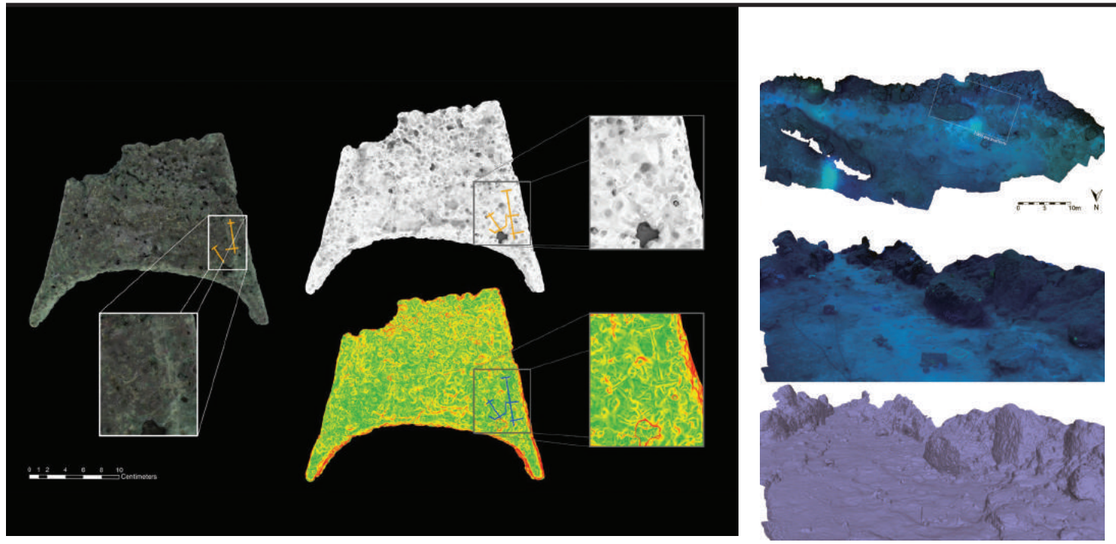
The conclusions of these early studies catalyzed later, large-scale archaeometallurgical research programs in the United Kingdom and Europe. The question of provenance would not be formally tested until the monumental efforts of Zofia Stos and Noël Gale starting in the 1980s. Their work at the Isotrace Laboratory at the University of Oxford focused on improving methods of lead isotope analysis and the examination of hundreds of ore and metal samples from across the Mediterranean. Eventually, their work put to rest debates about where oxhide ingots were produced. Theories had ranged from Anatolia to Sardinia, and the implications of each had dramatic consequences for understanding Bronze Age trade. Stos and Gale conclusively demonstrated that most oxhide ingots were produced on Cyprus, excepting only the earliest known oxhide or pillow-shaped ingots from Crete.

AT THE FRONTIER OF GEOCHEMISTRY AND DIGITAL ARCHAEOLOGY

Four surveys at Cape Gelidonya between 1987 and 1994, an excavation season in 2010, and the rediscovery of unpublished material in the storerooms of the Bodrum Museum of Underwater Archaeology have added over 1,000 ingot fragments and another 227 non-ingot copper alloy objects to the inventory published by Bass in 1967. While the larger objects recovered by Bass still comprise the bulk of the cargo, the new finds add diversity and depth. Our team's ongoing work integrates novel approaches in documentation, materials science, and digital archaeology to test new hypotheses about the nature of the wreck, the ship's cargo, and personal effects recovered during excavation and survey.

Emre Kuruçayırlı (Department of Chemistry, Boğaziçi University) is leading efforts both in Bodrum and in Istanbul to provide the project with an entirely new dataset on the composition and microstructures of the ingot assemblage. Kuruçayırlı compared elemental analysis of the ingots against the well-characterized Uluburun ingots and discovered that the ingots from the two wrecks have different chemical 'fingerprints.' Microscopic views into the metal reveal a pattern observable in nearly all the samples analyzed so far, including a preponderance of well-distributed copper sulfide droplets. The near ubiquitous presence of sulfide inclusions in the metal and the absence of slag distinguish the Cape Gelidonya ingots from the earlier Uluburun assemblage, suggesting that in the intervening century there was a substantial technological shift in the production methods of ancient copper smelters on Cyprus. Details newly observed both on the ingot surfaces and in the microstructures of the metal give insights into how the ingots were handled, including indications of intentional breaking and hammering.

The patterns observed through elemental analysis and microscopy led to a crucial question that could be tested using new methods in isotope geochemistry. Where Brill and Stos and Gale earlier innovated the adaptation of lead isotope analysis to determine provenance, our collaborator Moritz Jansen of the Deutsches Bergbau-Museum Bochum, Germany (Leibniz Research Museum for Geo-Resources) is using subtle isotopic differences to track the shift from using copper oxides to copper sulfides in the eastern Mediterranean. This new branch of research, copper isotope analysis, has enormous potential, and data from the Cape Gelidonya shipwreck have assumed an important role in this rapidly growing field. Already Jansen's work has independently corroborated Kuruçayırlı's research in Istanbul, showing a pattern



Serendipity defines scientific revolutions, yet it is the necessities of inquiry such as those which Bass and his colleagues undertook in studying the Cape Gelidonya shipwreck that helped shape the field of archaeological science.

that is linked to an early innovation in industrial sulfide metallurgy – a terrestrial phenomenon that is at present best documented in underwater contexts from submerged shipwreck cargos.

Moving from the microscopic to the macroscopic, we have endeavored to incorporate new technologies in high resolution 3D scanning and photogrammetry to record over 350 Cape Gelidonya objects. Graduate students Dominique Langis-Barsetti (University of Toronto) and Samuel Martin (University of Arkansas) are collaborating in this digital effort. At its most basic, 3D documentation serves remote study and dissemination and provides a means to both increase reproducibility and enrich publication by presenting findings in novel spaces. From an analytical point of view, data derived from this work also provide new ways to observe archaeological materials. Three-dimensional surfaces, which are accurate to ca. 0.1mm, provide a means for studying textural differences, volumes and densities, and morphology.

In many ways, serendipity defines scientific revolutions, yet it is the necessities of inquiry such as those which Bass and his colleagues undertook in studying the Cape Gelidonya shipwreck that helped shape the field of archaeological science. Now, as we aim to publish the wreck in its entirety, we are compelled to reckon with and build on that foundational work and take on the delightful and exciting burden of knowledge that remains buried within the Cape Gelidonya shipwreck's cargo.

This page, from left: 3D model of half-ingot IN36; 3D model of the Gelidonya wrecksite, created from photographs taken during 2010.

ACKNOWLEDGMENTS

The long list of the many universities, foundations, and private donors who have supported the various scientific studies described above will be explicitly recognized in the final publication. Here the author would like to acknowledge in particular the generous support of INA and the use of the facilities at the Bodrum Research Center. We are grateful for the expert efforts of BRC conservators, especially Esra Altınanıt Kirik and Selen Özcan, and the drawing skills of Bilge Güneşdoğdu. The stabilization, monitoring, and documentation of this large artifact assemblage is the basis upon which our later analytical work rests.

AUTHOR

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2021 INA BOARD MEETING

Directors and Officers meet in Williamsburg, Virginia

Every autumn, INA's Board of Directors comes together to discuss the status of current INA projects and plan for upcoming surveys, excavations, conservation, and publications. In October 2021, the INA Board traveled to Colonial Williamsburg, Virginia, at the suggestion of INA Associate Director and longtime Williamsburg resident John Broadwater. Highlights of the weekend included guided tours of Colonial Williamsburg and Historic Jamestown; Museum President Howard Hoege welcomed us to The Mariners' Museum, where we received a behind-the-scenes tour of the laboratory in which the turret of the USS *Monitor* is being conserved. The INA Board heard presentations by John Broadwater, Art Cohn, Chris Dostal, Tuba Ekmekçi, and George Schwarz. In addition, we honored some key figures we lost in 2021, with illustrated tributes presented by Gordon Bass (for George Bass), Shelley Wachsmann (for Lucy Darden), and Sheila Matthews (for Faith Hentschel). Sincere thanks to the dozens of people who helped make the 2021 meeting a success and especially to the INA Board for your continued support!

1. **Front row, from left:** Orkan Köyağasıoğlu, Jennifer Steffy, Howard Hoege, Sheila Matthews, Shanna Daniel, Ginny Klein, Kevin Crisman, Debbie Carlson, Tüba Ekmekçi, Kroum Batchvarov, Ginny West, Carolyn Kennedy, Lucija Aydemir, John De Lapa. **Middle row, from left:** Tracy Culp, Bill Culp, Roger Williamson, Lynn Baird Shaw, Dave Steffy, Anne Self, Dana McGinnis, Kenan Yılmaz, Ann Bass, Jeff Hakko. **Back row, from left:** Robert Self, Cemal Pulak, George Schwarz, Josh Daniel, Shelley Wachsmann, Charlie Steinmetz, Olya Batchvarov, Dot Finnegan, John Broadwater, Cora and Chris Dostal, Oğuz Aydemir, Diane Langworthy, Keith Langworthy.

2. John Broadwater and Dot Finnegan 3. Elaine Chan and Dana McGinnis 4. Betsey Boshell Todd and Ann Bass 5. **From left:** Jeff Hakko, Cemal Pulak, Barbara Duthuit, Lucija Ratkovic Aydemir, Oğuz Aydemir, Sheila Matthews 6. Ned Boshell, David Todd, and Betsey Boshell Todd 7. Dave Steffy and Debbie Carlson

8. Lynn Baird Shaw and Shelley Wachsmann 9. John De Lapa, Lucija Aydemir, Oğuz Aydemir 10. Art Cohn 11. **Front row, left to right:** Unknown, Roger Williamson. **Middle row, left to right:** Kenan Yılmaz, Barbara Duthuit, Ann Bass, Lynn Baird Shaw, Debbie Carlson, Sheila Matthews. **Back row, left to right:** Dana McGinnis, Elaine Chan, Oğuz Aydemir, Lucija Aydemir, Jeff Hakko 12. Gordon Bass and Barbara Duthuit

LUCY DARDEN (1930–2021)

TRIBUTE

Lucy Glenn Jackson was born on October 30, 1930, in Odessa, Texas. In 1951, she met petroleum engineer Frank Darden, and the couple married shortly after. Their first child Toby was born in 1953, and their second son Glenn in 1955. After a brief time in Colombia for Frank's work, the Dardens moved back to Texas and settled in Fort Worth where they welcomed their third child and first daughter, Anne. In 1983, Frank, an avid yachtsman, read an article about INA and telephoned George Bass to learn more. Frank became an INA Director in 1984 and he and Lucy visited several INA excavations over the years, including Uluburun and Tektaş Burnu. After Frank passed away in 2001, Lucy remained an enthusiastic INA Director, serving on the Executive, Archaeological, and Nominating Committees. Beyond her dedication to INA, Lucy was actively involved in numerous charitable and cultural pursuits in the Fort Worth area. In 2018, Lucy endowed the INA Discovery Fund, which provides grants of $5,000-$25,000 to worthy INA survey, fieldwork, and research projects. Following Lucy's death on April 9, 2021, her many admirers donated close to $100,000 to the INA Discovery Fund. Lucy was a loyal and fervent supporter of INA but always refused any publicity or recognition for her initiatives; in the words of one INA Director "she epitomized the American gentle lady."

Lucy was blessed with a keen mind, quick wit, and an abundance of common sense. She was a dear friend and for years was an invaluable INA director. She was also an enthusiastic supporter of the Fort Worth Opera, and since she knew that George too was an opera lover, she often invited us to attend the annual Fort Worth Opera Festival with her for a few days. This gala event was held in the spring, usually with four operas presented multiple times over a two- or three-week period. The productions were first rate, and occasionally we were even treated to the world premiere of a contemporary work. Between and after performances there were gatherings where we could chat with singers, directors, and guest artists, and sometimes festive dinners that might include impromptu arias between courses! And at the end of each evening Lucy, George, and I retreated to Lucy's sunroom, nightcap in hand, to critique the singing or the staging, and from there we might move on to books, INA projects, politics, or any of a dozen other topics. We each had strong opinions about everything, so the discussions were always lively, and in the end, we generally agreed on our perfect solutions to all the world's problems!

Lucy's company was simply the best, always. George and I loved those visits, and they remain my favorite memories of her.

-ANN BASS

Lucy became active with INA shortly after her husband, Frank passed away. Lucy was a strong, confident woman and yet almost as a contradiction, gregarious and humble as well. When she called me about endowing a new fund for supporting archaeological projects, she wanted to continue the discovery theme that Frank started many years before. She was firm that she didn't want the endowment named after her. At the next INA Board Meeting after forming the Discovery Fund within INA, President Deborah Carlson had prepared a tribute to Lucy to present after dinner. Although no one told her about it, Lucy suspected something. Seconds before Debbie rose, Lucy asked me if Debbie had planned to talk about her, which I affirmed. With dread in her voice, Lucy asked me to stop Debbie. Much to Debbie's disappointment, I did.

Many years ago, when new ideas were being floated to promote and enlarge INA, there was a presentation at a board meeting by a man who wanted to make television shows about INA projects. The idea threatened to take INA away from being an academic institute and promote adventure. Lucy, who was sitting in the front row was obviously unimpressed as she said loudly and for all to hear, "Get rid of the salesman!" That put an end to that idea then and there. He was lucky she didn't throw him out, which I am sure she could have done. Lucy's comment also gave us the confidence to maintain our high standards and stay academically focused.

It didn't take long to know where you stood with Lucy. If she was behind you, you could be sure you were doing something right. To better understand her interesting personality I had wanted to ask Lucy to tell me stories of her early days. I never got that opportunity but would venture to say she encountered difficult times more than once and overcame them each time.

-JOHN DE LAPA

Lucy was family. Not just to her own biological family, whom she loved dearly and deeply, but also to the INA family. Lucy was incredibly nurturing.

I got to know Frank, Lucy's husband, shortly before his death. After Frank's passing in 2001, Lucy and I continued that friendship. I think that in one sense, Lucy saw INA as a continuation of Frank's passion for the sea and sailing, and a way to remember him. But it was more than that. Lucy truly had a love of INA and deeply cared about it.

Over the years I made a point of calling Lucy whenever I was in-between planes at D/FW. One time when I called her she told me, "Oh, I can't talk now. I'm in the middle of a bridge game with my friends."

Lucy *did* take her bridge seriously.

Through the years Lucy remained a dedicated supporter of all things INA. Frank and Lucy visited numerous INA projects including Uluburun, a trip on which her daughter Anne participated also. After Frank's passing, she continued on as an INA Board Member and served on the Executive, Archaeological, and Nominating committees.

In 2018 Lucy endowed the INA Discovery Fund, which now provides $35,000 to support worthy nautical archaeologists, many of whom are students, or graduates, of Texas A&M University's Nautical Archaeology Program. These funds permit them to carry out groundbreaking work around the world. In creating the Fund Lucy was furthering George's original vision in affiliating INA with Texas A&M University—to "preach the gospel" of nautical archaeology.

Lucy will be dearly missed.

-SHELLEY WACHSMANN

This page, from left: Lucy and Ann Bass, 2019; Grace Darden, Kate Darden, Shelley Wachsmann, and Lucy at the Board Meeting in Vancouver, 2018. **Opposite page:** Ann Darden Self and Lucy visit the Uluburun excavation.

BERTA LLEDÓ (1971–2021)

TRIBUTE

Berta Maria Lledó Solbes was born on February 24, 1971 in Alicante, Spain. Berta was always interested in archaeology and when she entered the history program at the University of Alicante in 1989, she chose to study archaeology, participating in fieldwork at sites ranging in date from the Paleolithic to the medieval period. Ultimately Berta chose to specialize in medieval Islamic glass and she first collaborated with INA in 1993 when George Bass sought volunteers to assist with the publication of the Serçe Limanı medieval "Glass Wreck." Berta was completely at home in Bodrum and made friends immediately. In 1999, she married Tufan Turanlı, and in 2002 their daughter Ada was born. Two years later son Bora was born. Berta participated in several INA shipwreck surveys and INA's excavation of the Classical Greek shipwreck at Tektaş Burnu (1999-2001). In 2007, Berta and Tufan began work on the Turkish Ottoman frigate Ertuğrul that sank in Japan in 1890. They excavated the wreck from 2008 to 2010 and again in 2015 while constantly conducting lab work and international outreach. Berta was a co-author of the 2009 publication of Serçe Limanı Volume II. Her 2016 doctoral dissertation at the University of Alicante focused on the excavation, artifacts, and history of Ertuğrul. Berta passed away on July 27, 2021, after a heroic battle against cancer, but her memory and legacy endure in her beautiful children and the many friends and colleagues who adored her and deeply respected her work.

Berta's journey from the coasts of Spain to the coasts of Turkey in 1993, to study the glass from the Serçe Limanı shipwreck, set in motion a sea of change. Quickly, Berta proved essential to the research and publication of the eleventh-century shipwreck, and vital to the lives of Tufan and those fortunate to love her. In Bodrum, Berta became the beating heart of what is often termed the "INA Family," one who radiated warmth and effortless intelligence, and without an ounce of arrogance. I first met Berta at Tektaş Burnu in 2000, and it was Berta who welcomed me –an outsider– with open arms, ears, and mind. Berta was never shy to share her insights, experiences, and her trials with those she wrapped in her embrace, and she listened to others with depth and sincerity. Over the decades, as she worked with Tufan on the *Ertuğrul* shipwreck and her own dissertation in Bodrum, Berta remained the heart of the Bodrum INA family, and the home and garden she cultivated was an oasis of beauty and conviviality on Sualtı Sokak. Much like the *Ertuğrul* ship herself, Berta connected people and cultures in enduring friendship. Her friendship recognized no boundaries laid by time or geography. Berta was a brilliant light, and nothing made her glow more than her love for her family, and her boundless pride in Ada and Bora. Her love for family, for life in all forms, and for life itself glows as a beacon in the gloom.

-KRIS TREGO

The summer of 1993 in Bodrum was truly magical. The dormitories were not yet built, so all of us staying at INA's new Bodrum Research Center (BRC) for the summer roomed and ate together crowded in the basement of the main building. Living in such close quarters, we grew close through our late-night conversations on the back porch after the dishes were done. Among the dozen or so of us, Berta stood out for being so very sincere, so kind, and so much fun. She made a lasting impression. As more summers came and went, she eventually married Tufan and set up a life and a home next to the BRC. It was always a great joy to see her around INA or in her garden, to have a chance to sit and talk, to catch up. In the decades I knew her, she remained constant in herself, steady in her love and appreciation for all that life had given her, especially for the family she had left back in Spain and the new one she had created in Turkey with Tufan and her kids, Ada and Bora, as well as for all the many friends from around the world who adored her.

-PETER VAN ALFEN

Like many other people, I came to regard Berta as someone very special. The warmth of her hospitality, the breadth of her thoughtfulness, her devotion to husband and children, and the graceful ways she shared her life and families, both in Bodrum and in Spain, are so memorable. She was also a wonderful archaeologist, as I came to know in part when sharing a work table with her at the Bodrum Research Center. Her contributions to the study of the glass from Serçe Limanı and her study of the artifacts from the Ottoman frigate *Ertuğrul* are nothing short of brilliant.

As B.J. became more and more confined to our home in Bodrum during her last years, Berta came more often to visit "her Bodrum mother." When I became seriously ill with the flu last year, Berta played an important role in having me meet Sarah Tan, who has become my companion nurse and keeps me well and focused on completing my amphora research. Now and again during my recovery from the flu, Berta would unexpectedly bring a Spanish dish to the VIP Suite for my evening meal. My gratitude to and love for Berta will always remain alive and well in my heart.

-FRED VAN DOORNINCK

I met Berta in 1993 when she first came to Bodrum to work on the Serçe Limanı glass. Due to the lack of common language, in the beginning we communicated like Tarzan and Jane. Over the following years I saw her become fluent in English and Turkish, a clear sign of her intellect. After years as friends and colleagues, I moved into the Bass House, next door to the Turanlıs and we became neighbors. Berta and the entire Turanlı family are the best neighbors you can imagine! She literally saved my life several times (when I fell down and cracked my head, she was the one who took me to the hospital with my husband in the middle of the night and waited through all the procedures until morning) and metaphorically (by helping me on many occasions!). Debbie, Nicolle, Berta, and I were the INA ladies of Sualtı Sokak, having "ladies' nights" in past summers at one of our houses. Drinking, eating, gossiping, and laughing was big fun and these "ladies' nights" are not going to be the same without Berta! In the summer of 2022, the three of us will salute our dear friend, perfect mother, wonderful wife, and scholar. Her presence is missed, and my eyes still look for her by the fence between our gardens.

-TÛBA EKMEKÇI

This page, from left: Berta at the Tektaş Burnu excavation, 1999; hard at work in the conservation laboratory at INA's Bodrum Research Center, 2020.

FAITH HENTSCHEL (1943-2021)

TRIBUTE

Faith Canby Dillon Hentschel was born on November 22, 1943, in Wilmington, Delaware. She received her Bachelor of Arts in art history from Mount Holyoke College in 1965 and received her Doctorate in classical archaeology from Yale University in 1982. In 1974, while a graduate student, Faith joined the Yassıada Byzantine shipwreck excavation and would go on to participate in a dozen INA shipwreck excavations and surveys over the next 40 years. As an underwater archaeologist Faith worked in Maine, Italy, and Spain but dedicated the bulk of her career to INA projects in Turkey, where she trained countless students in the techniques of underwater excavation. Faith was an Affiliated Scholar and Associate Director of INA, and her extraordinary resume included INA excavations at Yassıada, Serçe Limanı, Uluburun, Bozburun, Tektaş Burnu, Pabuç Burnu, and Kızılburun. Faith also directed shipwreck surveys for INA in 2003 and 2004. Beginning in 1983, Faith taught at Central Connecticut State University, retiring in 2009 as a Professor of Art History. In 2017, Faith was diagnosed with a neurological disease called Primary Progressive Apraxia of Speech; she passed away peacefully at home on September 9, 2021. Faith leaves behind two children, Samantha and Michael, four grandchildren, and an INA family filled with admiration for her dazzling accomplishments, graceful leadership, and warm friendship. For a more extensive summary of Faith's career, see INA Quarterly *43.1/2 (Spring/Summer 2016) 18-23.*

I first met Faith at Serçe Limanı, and I'll never forget my first impression of her as she arrived on Hidayet's boat, waving and calling out to all her friends. I truly believe that INA and the work we do was a large part of her life, and she contributed enormously to it. She was my favorite dive partner; people would laugh at us because we were able to talk to each other under water. As a colleague she was tireless. Precision and dedication are what come to mind. She had a work ethic that she passed on to many students and people. Faith was always busy exploring and questioning in both her work and personal life. We traveled a lot together, and she pulled me onto trails I would never have thought to try on my own.

Along with INA, Faith also loved Turkey, even buying a home on a hillside outside of Bodrum. She spent much of her sabbaticals in Turkey working on projects and much of her free time there after retirement. She loved the work and had many lifelong friends from our group.

When I think of Faith, I mostly remember laughter and long talks – she knew how to listen and draw people out. I feel that she had a positive impact on most everyone she met. She always seemed to have time for everyone who was in need of it; she was one of the most generous and big-hearted people I have ever met. Faith was always positive and exuberant about everything she did – always willing to jump in and lend a hand. I sadly say goodbye to her as a colleague, but I can never say goodbye to her as a friend.

-SHEILA MATTHEWS

The last weekend we spent together, Faith took me for a swim. We walked the long way through a wooded path though she was already unsteady on her feet. We came to the shore and swam in the waters that she knew and then beyond where she panicked, suddenly weak. We held on to piles under a pier and rested in the dappled light until she calmed. We then swam back and played in the water, now her element again. We walked home by another route, past shops and houses; she stopped sometimes, introducing me to people by means of gesticulations, for she could no longer speak. I could not always understand, and she sometimes stamped her feet in frustration. Her people were more accustomed; it became clear this was a well-worn path and the encounters expected. Faith still held court in the neighborhood. That evening we sat in quiet on her porch and watched herons congregate in the trees as dusk settled. The last text I received from her was a string of sunset and bird and heart emojis. The Faith I knew and love – intrepid, always 110%, surprised by and could be impatient with bounds, water woman, gregarious and beloved, alive to beauty.

-NICOLLE HIRSCHFELD

Faith was always ready with a smile and laughter, so when I think of her, I can only smile and laugh. She was such an exuberant personality, and it was absolutely contagious. She was so open and disarming that she drew you in, and before you knew it, you might be sharing your most personal thoughts. You just couldn't help it! I first met Faith at the Uluburun excavations, a time of excitement and discovery, lots of hard work, fun, and good friendships. Faith was so generous with her expertise, her time, and her heart. No half measures. She loved art. She loved people. She loved adventure, and she loved Turkey. I have memories of exploring those gorgeous valleys and villages high above Kaş on our days off, the hills and coves of the Bodrum peninsula in winter, and the expanses of eastern Turkey on a long road trip with her. I raise a glass of rakı to you, Faith – with a big smile.

-CLAIRE PEACHEY

This page: Faith on board *Virazon* at Kekova in 2008; with friends George Bass, Robin Piercy, Dick Steffy, and Ann Bass. **Opposite Page:** With Claire Peachey at Bozburun in 1998.

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